NEXTGEN PROTEINS

Bioconversion of Underutilized Resources into Next Generation Proteins for Food and Feed

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Consumer views about the Next Generation proteins for food in Europe

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Table of content

1 Abstract

Consumers' food habits are changing towards healthier and more sustainable food solutions. This, combined with an increased demand of proteins for food and feed, has resulted in a high interest towards protein sources that are alternative to current mainstream sources of protein. The NextGenProteins project is responding to the call by considering three alternative proteins and their production for sustainable food production: spirulina microalgae using CO_2 emissions and waste heat for its growth, insects (crickets), whose production are based on the use of plant-based wasted food biomass, and torula yeast (single cell protein) cultivated on forest biomass.

This study aims to gain a European view on consumer attitudes towards the three NextGen proteins, their production processes, and the use of resulting protein ingredients in food products. The results of the study are based on online focus group discussions with selected consumers from Finland, Germany, Iceland and Italy, and an online survey implemented in Finland, Germany, Iceland, Italy, Poland, Sweden, and UK with 6600 respondents in total.

According to the results, consumers' attitudes towards the NextGen proteins, their production and application in human food, in general, were mostly positive or neutral. Large share of respondents (varying by country and concept) believed in that NextGen concepts provide benefits for the sustainability, livestock and human health. Whereas respondents were not strongly concerned about potential risks. It is noteworthy that the share of respondents having neutral attitude towards the NextGen concepts was high. Given the novelty of these concepts, it is understandable that most people have not readily formed attitudes towards the issue. Accordingly, a large share of consumers did not have strong negative prejudices or preconceptions towards these production methods and ingredients, except for the insect-based concept. Although consumers were receptive for the sustainability related message and value these benefits, they seem to have relatively low belief in personal benefits related to the use of NextGen proteins. The study suggests that whether consumers will choose to use NextGen protein products will much depend on the sensory quality of the final product and on how they are convinced about the other personal benefits related to the food product. Furthermore, the results emphasise the central role of communication and marketing in creation and retainment of consumer trust and escaping potential negative associations that may be elicited by the production technologies and ingredients.

These findings, reported in the study, will act as a guide in developing food products for markets. From the NextGen concepts, insect protein seems to have more barriers to overcome before gaining wider acceptance in food products among European consumers.

The finding that the large majority of consumers are either positive or at least do not have strong negative prejudices provides a neutral basis and creates possibilities for product development and marketing of food products including alternative proteins.

2 Introduction

Consumption of proteins for food and feed is increasing globally due to growing population. It has been forecasted that the world population will exceed nine billion people by 2040 (UN,2019). The increase of protein production to meet the future demand, however, will not be straightforward. Today's protein production, both animal and plant based, causes extensive global greenhouse gas emissions, excessive land and water use, as well as biodiversity loss. Therefore, it is a necessity to find sustainable alternative protein sources to meet the growing demand for the food and feed industry (Forum for the Future, 2019). Another driver for alternative proteins is the change of consumers´ food habits towards healthier and more sustainable food solutions. Boston Consulting Group and Blue Horizon have estimated that the market for alternative proteins will grow from the current 13 million metric tons a year to 97 million metric tons by 2035, representing 11% of the overall protein market (Witte et al. 2021).

The drivers described above have formed the basis of the NextGenProteins project, which considers three concepts for alternative protein production, all utilizing industrial side-streams for bioconversion processes of protein production: microalgae, insects, and microbe (single cell) protein. The microalgae protein raw ingredient is made of spirulina microalgae using CO2 emissions and waste heat from a geothermal power plant for its growth (VAXA, 2021). Production of insects studied in the project is based on the use of plant-based wasted food biomass (by-products from agriculture or by-products and wastes from food industry, e.g. unsold or expired vegetables products, vegetable peel, apple cores) for the growth of insects. Two species of insects with slightly different industrial processes are considered: crickets targeted to food applications (Entocube, 2021) and larvae of black soldier flies to feed applications (Mutatec, 2021). The microbe (single cell) protein in the project is made from torula yeast. The torula yeast is cultivated on substrate made of forest biomass (underused by-products from forest industry, e.g. saw dust, wood chips, residues such as branches) (Arbiom, 2021).

In addition to the technological advances in alternative protein domain, it is suggested that consumer involvement in the development of a sustainable food system through environmentally friendly food choices and diets is crucial (Aiking & Boer, 2020; EAT-Lancet Commission, 2019). There are early signs of emerging sustainable food consumption trends such as rise of flexitarians, and European consumers seem to be generally open-minded in changing their environmentally harmful eating habits (BEUC, 2020). Still, only about 13 % of the European population have deliberately reduced their meat consumption (Statista, 2019). Changing consumer attitudes towards favouring sustainable food consumption and especially food products incorporating alternative proteins with the aim to replace animal-based protein consumption is difficult. There are certain major obstacles to overcome. First, consumers are not well aware of the sustainability of their food choices. Depending on the study, it is estimated that in Europe and the US between 18 and 38 % of consumers know the environmental burden of their animal derived food consumption (Hartmann & Siegrist, 2017). Second, consumers are in general unfamiliar with novel food ingredients, leading to rejection of new products, including even food products with the more traditional plant-based protein ingredients (Banovic et al., 2018). Third, consumers have a tendency to reject food products with highly novel food ingredients especially if the ingredients are labelled and communicated in a manner that is perceived unnatural (Tuorila & Hartmann, 2020),

making acceptance of the most recent food ingredient innovations even more difficult than the more traditional ones.

Although promising trends in sustainable food consumption are visible, they are not enough to make a significant impact on food system sustainability. Therefore, there is a growing need for in-depth understanding of consumer behaviour on alternative protein domain to speed up the change. **This study aims to gain understanding on the attitudes of European consumers towards the three NextGen proteins targeted to food products, their production processes, and the use of resulting protein ingredient in food.** As the focus of the report is on food applications, black soldier fly protein is not considered in the study. A correspondent study has been carried out on the attitudes of European business stakeholders within the value chains of food and feed towards the use of NextGen proteins in food and feed (Paasi et al. 2021). Together these two studies will map new market opportunities for food and feed products containing alternative proteins within different European countries.

The study was carried out in two stages. First, qualitative focus group discussions with selected consumers from Finland, Germany, Iceland, and Italy were held in aim to chart and understand what kind of considerations consumers have around this subject. After that, a large online survey was implemented in Finland, Germany, Iceland, Italy, Poland, Sweden, and UK with 6600 respondents in total. The design of the survey was based on the focus group study findings and relevant literature on consumer acceptance of novel food ingredients. This report summarizes both stages.

The report is arranged as follows: At first in chapter 3, the focus group study is presented, including its aims, methods and key findings for all the three proteins, without going into country specific details. Chapter 4 will then focus on the online survey presenting its aims, methods, summary of results over all countries and some country comparisons. Survey questions are shown in Appendix A. While Chapter 4 aims to give an overview to the findings by presenting results from the total data set and making country-wise comparisons, results from each country can be found in Appendices B1-B7. In these country reports, results are described in detail in order to be useful for product development, business planning, etc. Finally, conclusions of the whole study are given in chapter 5.

3 Focus-group interviews

3.1 Aims

Focus group studies were designed to chart and provide understanding about the kind of thoughts, feelings, values, habits and social conventions etc. which consumer have regarding the NextGen protein concepts. The aim was thus to provide understanding about key factors influencing consumer acceptance.

The aims of the focus-group discussions were to

- acquire understanding about consumer perceptions concerning NextGen methods and ingredients – insects, microalgae, and single-cell proteins
- get initial idea about consumer views towards applying NextGen ingredients different food categories: bakery, meat product alternatives, ready meal components and texture modified soft food
- recognise and provide understanding about the range and type of factors influencing consumers' views
- provide input to the development of the food applications – convenience foods, bakery products, meat alternatives, and soft foods
- provide input to the planning of the subsequent international survey.

This is an overview of the main results of the NextGen focus-group discussions summarised over the four participating countries. The main contribution of this report is to describe the types and range of issues, thoughts, viewpoints brought up by the discussants. As this report summarises results from all countries, all country specific details are not included in this report. At the content category level, we have reported issues that were brought up in several of the countries and discussion groups. More details of the country-specific focus-group results can be obtained from the authors.

3.2 Materials and methods

3.2.1 Data collection and participants

Co-ordinated by VTT, similar methodology was applied for data collection in each of the participating country. Data for the study was collected with means of focus groups discussions with consumers. Discussions were carried out online in **Finland, Iceland, Germany,** and **Italy** during April-May 2020. The data collection analysis and was carried out by TTZ in Germany, by MATIS in Iceland and by VTT in Finland. In Italy the data was collected, analysed and reported by an external service provider Free Thinking.

In each country, 6 group discussions were arranged each with 4 - 5 participants. Half of the groups consisted of respondents who were either vegetarians or ominvores, which had

conscious intentions to reduce meat consumption in their diets. The other half consisted of any kind or omnivores (meat eaters):

Groups (**A)** 1 + 2 + 3 – **meat avoiders** or reducers (various ages)
Groups (**B)** 4 + 5 + 6 – **meat consumers** (various ages)

The following recruitment criteria were applied in all countries:

- 6 groups of 4 –5 participants.
    - Groups A (1 – 3) – meat avoiders or meat reducers (age groups represented: 18 – 35 y., 36 – 55 y., 56 – 75 y.; both genders represented)
    - Groups B (4 - 6) – meat eaters (age groups represented: 18 – 35 y., 36 – 55 y., 56 – 75 y., both genders represented)

- Urban consumers (living in a city of at least 100 000 inhabitants)
- Other inclusion criteria were:
    - not expert / working in related areas (biotechnology, food technology, consumer science, marketing, food product development….) (cf. the questionnaire)
    - not participated in focus group discussion during the last 6 months
    - takes care or participates in food related decisions (grocery shopping, meal planning)

Table 1. Number of participants in each country

	Iceland	Germany	Italy	Finland	Total
Vegetarians or meat reducers	16	15	15	15	**57**
Meat consumers	12	15	15	13	**55**
TOTAL	**28**	**30**	**30**	**28**	**112**

3.2.2 Discussion frame and procedure (all countries)

The focus groups were conducted according to a predetermined protocol to facilitate semi-structured data collection. The main structure and discussion themes are listed in the Table 2. below. The discussions started with short introduction of the participants aiming to provide a bit background information about the participants' life situation, everyday food habits and values. Secondly, respondents' understanding of protein and protein sources as well as familiarity with novel protein ingredients and meat replacer products was shortly dealt with before proceeding into the main subjects of the discussion.

Table 2. The structure and themes of focus group discussions

Welcome and practical information (5') **Part 1: Short introduction of participants (5')** ▪ And a glance to their food habits and values **Part 2: Familiarity with proteins, protein rich products incl. novel meat alternatives (5')** **Part 3a: Views about the general idea of the NextGen proteins (10')** **Part 3b: Views about the three types of NextGen proteins (20')** ▪ Production of protein rich microalgae flour from CO^2 emissions ▪ Production of protein rich single cell flour from forest biomass ▪ Production of protein rich insect flour from food waste **Part 4: Views and use interest relating the food (and feed) applications by application category** (60') ▪ Bakery products ▪ Ready meal components without meat or animal products ▪ Alternatives for processed meat products (e.g. sausages) ▪ Pureed meal components for persons with difficulties in eating solid foods ▪ Application of NextGen ingredients in animal feed **Closure, rewarding, information about the project**

The main discussion started by introducing the general idea of NextGen proteins to participants (**Part 3a**). The moderator explained it shortly based on slide illustrating the three methods: production of microalgae, SCP and insect protein (Figure 1). The aim of this section was to chart consumers' first impressions and attitudes before any they were influenced by any further information.

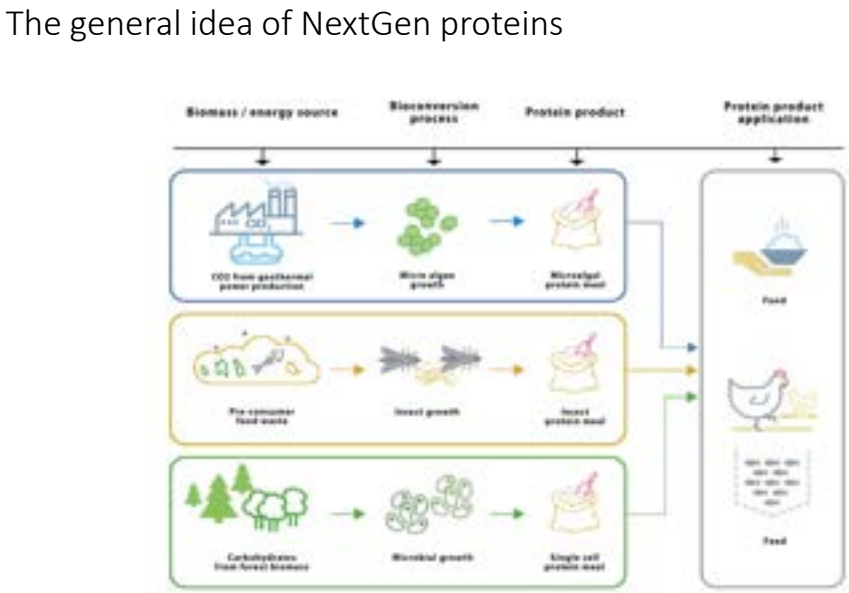

Figure 1. The slide applied to introduce the general idea of NextGen protein production to the participants

After that, in **Part 3b**, each of the three methods were separately discussed based short information texts shortly describing the overall idea of technological processes behind that

ingredient production, as well as the benefits of that method and ingredient from nutritional and sustainability point of view. Each country naturally used material translated into their own languages. The English versions of these information texts can be found at the beginning of each chapter reporting participants' views regarding the food application categories. Note that the information texts applied in the survey were different.

The second half of the focus group discussion (**Part 4**) was devoted to exploring consumers' perceptions and interest towards different types of **food applications** of the three NextGen methods / ingredients. Four application categories were discussed in turn, after which also feed application was shortly dealt with. The order of discussing about each application types were varied between the groups according to the Table 3.

Table 3. The order of the discussing about the different application categories

	The order of discussion (the questionnaire version to be used)
Group A1 and Group B4	ORDER 1 1. bakery 2. ready meal components 3. meat alternatives 4. modified texture (soft food)
GroupA2 and Group B5	ORDER 2 1. meat alternatives 2. modified texture 3. bakery 4. ready meal components
GroupA3 and Group B6	ORDER 1 1. bakery 2. ready meal components 3. meat alternatives 4. modified texture

Discussion on each application category was initiated by showing the participants a stimulus slide with pictures of potential food product types (see example in Figure 2.). Project's relevant industry partners were involved in creation of these stimulus materials for by commenting and providing product pictures. The English language versions of the stimulus slides on potential NextGen protein application examples are presented in the beginning of the result chapters regarding each application category.

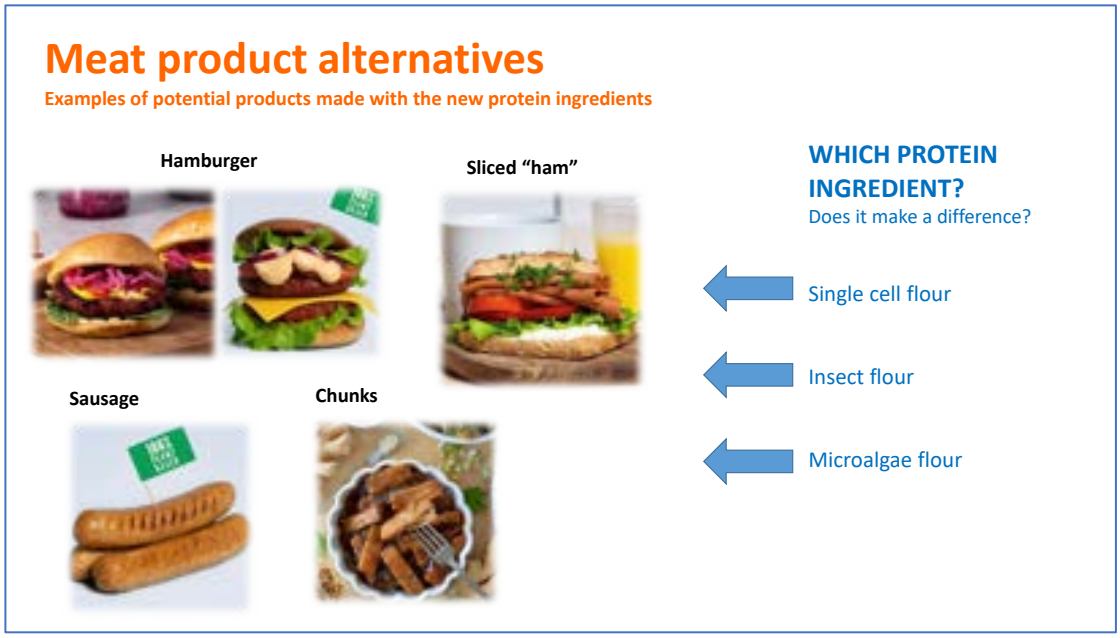

Figure 2. An example of stimulus slide for discussion about a food application category

The final food application category, **Texture modified soft food,** was quite different from the other discussed food categories, as it is not targeted to private consumers directly. It has been and is being developed with the purpose to provide better quality meals for people, who are not able to eat solid food because of old age or illness which causes difficulties in mastication and / or swallowing. These foods aim to provide more sensory pleasure in terms of taste, texture and appearance. These foods are expected to improve the nutrition of e.g. elderly by increasing appetite and by allowing easy ways to enrich the foods with e.g. vitamins or minerals if needed. This background was explained to the participants in a way that is presented below (Table 4), however, without mentioning the expected benefits. The participants were asked to imagine themselves being in a situation where they, for some reason, would not be able to eat normal solid food, rather the only option would be to eat soft, puréed food.

Table 4. Introduction of soft food application category to focus-group participants

The next food type category is a bit different from others: namely foods with soft texture. **Now, I would like you to imagine yourself in a situation / condition e.g. at old age when you have no other option than eat soft food because of mastication and / swallowing difficulties.** Often people in old age living in elderly care institutions have this kind of situation, but there are also younger people with certain diseases or disabilities who cannot eat solid food. These people do not have other option than to eat pureed food, which usually looks like the food described in the picture on the top left (Meal 1). In addition to just mashing the food (e.g. carrots) into a puree and serving it as puree, it is also possible to mould it back to the original form (e.g. that of carrots) (Meal 2), or even use 3D printing to print any form you like. After the food is mashed into puree, it can be formed to look more like normal food either by using moulds or in some cases a 3D food printer can be used. In this process, the nutrition composition of the food can be improved by adding nutritious ingredients, such as the NextGen proteins on the right of the picture. <u>You can imagine, for example a soft food that looks like a chicken leg, but the protein in it is obtained from one of these new ingredients.</u>

3.3 Summary of focus-group results, all countries

This is an overview of the main results of the NextGen focus-group discussions summarised over the four participating countries, Iceland, Italy, Germany, and Finland. As this report summarises results from all countries, all country specific results may not be included in this report. More detailed country-wise results including examples of respondents' quotations may be requested from the authors.

The organisation of the report is the following: The report starts with a description of participants thoughts relating to the overall idea of the NextGen methods, mostly reflecting the first part of the discussion frame. Secondly, discussions specific for each of three NextGen concepts (Microalgal protein, Insect protein and Single Cell protein) are summarised each in turn. The third part of the report deals with participants' reactions to examples of food product applications of these protein ingredients in each of the four food application categories (bakery, ready meal components, alternatives for processed meat products and soft foods) discussed.

The result summary is organised so that participants' positive and negative viewpoints are described separately. In the positive category, we have summarised positive comments describing what kind of benefits the participants have brought up, discussed, valued or presented as justifications for their positive attitude or purchase interest. Correspondingly, the negative category includes negative perceptions, regardless of how strong the opinions were, whether these were doubts, negative associations or justifications for rejection. Many viewpoints were conditional, presented as preconditions of acceptance (e.g. "I could use this if it tastes good").

3.3.1 Views about the overall idea of the three NextGen concepts

The general idea of production of NextGen proteins to be used as food ingredient, as explained to the participants with illustration (Figure 1) was approached with interested, open and positive attitude by most. Although, also rejective, and sceptical attitudes and doubts were presented. E.g. some Italian respondents with traditional food values and habits, commented these ideas as "too strange" for them. In addition, attitudes towards insect protein stood clearly out as more negative than those towards microalgae or SCP. Often the idea of NextGen proteins was often was received with enthusiasm and described as "brilliant idea", "exiting", "genius", but also as "futuristic", but also as "weird" and as difficult to understand.

The idea that food can be made out of waste material or by-products - efficient use of resources - was very widely valued. While some, more practically oriented people, seemed

to value austerity and resource efficiency as such, most participant reflected the ways how NextGen protein production could contribute to solving global food related problems with current large scale food production, animal well-being, environment and sustainability.

Despite their often positive attitude towards the basic idea, the respondents we much less often interested in personally using these products. While the sustainability benefits were valued, those were often "forgotten" when discussing about the food applications and personal use interests. Participants were often willing to *test* the products, but they stressed that their willingness to *use* will depend heavily on what would be the sensory and other characteristics of the final product. Thus, the specific sustainability benefits provided by NextGen methods and ingredients were not sufficient reason for purchase interest. Further, often mentioned reasons for their doubts were lack of information and unfamiliarity of the system. One of the often mentioned reasons for the more doubtful attitudes were novelty and unfamiliarity of the production system. Based on the short explanations provided to them (as well as the bit longer ones later on), many still felt that it is very difficult to evaluate the production system and the resulting food with their potential benefits and disadvantages for sustainability, their health, naturalness or taste of the product.

3.3.1.1 Positive viewpoints about the overall idea of NextGen

Often participants' first reactions were positive and enthusiastic. The idea of being able to produce food while at the same time waste can be reduced and sustainability benefits gained was welcomed as a brilliant idea, although some considered it as a bit "futuristic". Most of the positive sides the discussants brought up related to benefits of these methods for sustainability. Depending on each participant's, level of knowledge and concern about global food and sustainability problems, the content of their statements varied. While others saw NextGen proteins to provide potential solutions to global famine or to specific problems of large-scale meat production, others paid more attention to the efficient use of resources. Clearly, however sustainability benefits were valued by all to some extent.

Generally, the participants did not seem to expect major personal benefits from NextGen proteins. However, the discussions revealed several small opportunities for value creation for consumers. These did quite much vary depending on the type of consumer and expected use contexts. Wider selection to the markets of meat alternatives and vegetarian foods were welcomed. Good nutritional quality of the ingredients was recognised as positive thing.

Sustainability benefits

- **useful / necessary / inevitable development** in order to solve the problems of sustainability; food security, global famine, animal welfare and climate change. At least, they expected that this will be the future – regardless of whether they like it or not.

        - *"it is very important to find alternatives to meat" (A, Germany)*
        - *"the world needs this" (A, Finland)*
    - **Efficient use of resources**; utilisation of waste material was very widely valued positive side of these methods in all countries.
    - **Enables reduction of meat production with its' adverse effects**
    - **Animal welfare** –a typically mentioned benefit, but especially valued by the those for whom animal welfare is a sensitive matter. In the case of insects, this was a controversial matter as insects are animals.

Economic benefits

- While the economic benefits of the methods were much less salient in the discussion than the more obvious sustainability benefits, this point of view is likely to appeal some consumers.
    - **Potentially domestic production** - In case of SCP in Finland and Algae in Iceland, the respondents saw a possibility for domestic production. Respondents were delighted about the idea of maybe being able to use domestic resources (forest in Finland and sea in Iceland).
    - **Economic rationality** – In addition to altruistic sustainability values, economic rationality of utilising waste appealed to some respondents. *"especially the utilisation of material that would otherwise go waste, is rational, ecological and economical" (FI, B6, M45)*
    - A few consumers considered also **economic viability** (or profitability) of the production when forming their attitudes *"Is this profitable?" (GE)*

Personal benefits

- **Wider selection of meat alternative products was welcomed** esp. by people who are seeking for new ways to replace meat products and / or are dissatisfied with the current selection
- **Novelty, innovative products** –people who are interested in testing and tasting new products, were therefore also interested in these new innovations.
- Health benefits from reduced meat consumption – was only rarely mentioned.
- **Protein enrichment** divided opinions, some (e.g. IS people who valued **low-carb** diets) were interested about products (e.g. bread) with higher protein content and less carbohydrates, while many regarded protein enrichment as unnecessary for them. Protein addition was also generally welcomed in light **vegetarian foods** are not **filling** enough.
- **High nutrient quality.** The respondents (in all countries and groups) positively commented on the good nutrient value of the ingredients, but that seemed not to be a driver for interest.
- **Familiarity of the ingredient** – previous experiences with the ingredient type, such as Spirulina or insects contributed to more positive views. This was clear advantage for the algae -based ingredients, since many participants in all countries knew Spirulina as a very nutritious supplement.
- **Perceived naturalness** or better understandability of the production system seemed to contribute to more positive attitude. E.g. raising insects for food was sometimes

easier to understand than SCP production. On the other hand, perception of forest material as pure and natural enhanced attitude towards SCP, as well as positive associations with food fermentation, cheese making and baking.

3.3.1.2 Negative viewpoints about the overall idea of NextGen

Usually the negative comments were not strongly negative or clearly opposing to the idea of NextGen protein ingredients, except in some cases towards insects. Rather these were expressions of doubts about potential problems that may arise, concerns of potential problems if things will not be properly taken care of. Consumers' prime concern related to the taste and sensory quality of the resulting food products. Almost every respondent pointed out that they would not use the product unless it tastes good.

As the NextGen methods are very different from the conventional food production methods in that non-food material – that is waste material – is utilised as the primary source of the food production, it is not surprising that may participants had also doubts and negative associations about it. NextGen proteins concepts were commented as "artificial", "odd", and "quite far from" the normal food production". Some of the negative associations were elicited by the specific terminology or expressions we had used to describe the NextGen production process to the participants.

Categories of negative viewpoints are listed below:

- **Taste and sensory quality** not known and therefore
    - **Good sensory quality was unanimously stated as precondition** for use interest
- **Too, odd and unfamiliar. Difficulty to "understand" or picture the production method** contributed to negative views. *"these are far away from my personal life" (DE) "I cannot imagine how this works" (DE, B)*
- **Unnatural, too technological, artificial, too processed -** One of the typical doubts or justifications for doubtful attitude was perception of the technology or the resulting ingredients or foods as somewhat unnatural, technological or processed. These kind of images were related to or elicited by
    - industrial, large scale indoor "factory" production, high-tech nature of the production. The image of more factories or about raising massive amounts of insects in inside facilities was negative for some people (e.g. FI, IS)
- **Sustainability doubts & need for proof**
    - what if there is not enough of the waste material (forest biomass, CO_2 emissions) and CO_2 emissions would be purposefully produced or trees cut down (e.g. DE, FI)
    - what will be the total sustainability balance if all things are considered

    - proof and information about the sustainability effect was required by respondents
- **No need for novel protein sources**
    - Established vegetarians in all countries often pointed out that they are already able to follow healthy and environmentally sustainable diet using natural food products (pulses, grains etc) and have no need for new protein sources.
- **I don't have need for protein enrichment.** Many (e.g. in FI and DE) felt that protein enrichment is unnecessary e.g. because people generally get too much protein. While others thought that they would benefit from protein enriched products either because they felt they do not get enough protein or because they preferred low-carb diet. The attitude towards protein enrichment varied not only depending on the consumer but also depending on the product type.
- **Safety doubts and need for careful inspection and supervision.**
    - Safety doubts were elicited by e.g. negative association with the **use of food waste**, potential transfer of impurities from the forest material (DE)as well as potential **contamination** / impurities from the use of power plant emissions. In addition, insects were very often, partially unconsciously, connected with impurity.
    - Mostly, however, the participants were **not very worried** about the potential negative consequences of the methods (at least in Finland), but pointed out need for careful testing, control and supervision.
    - Furthermore, risk for **allergies** was brought up.

- **Negative associations with certain terminology:** In lack of deeper familiarity and information, associations elicited by single words used in the method description, had strong influence on the discussion. Negative associations were attached to e.g. **insects** (something impure, disgusting), **food waste** (impure), **taste enhancer** (artificial, unhealthy), **emissions** (impurities), **fungi, bacteria** (disease, impure).

- **Distrust - Concerns about being misled by food industry or food companies**. E.g. misleading marketing claiming sustainability benefits that will not be realised, selling "insect food", which only contain 1 % insects, companies using new ingredients only to be able to get more profits (FI). The results suggest country differences in trust towards food industry and food chain overall. E.g. while the Finnish participants did pay attention to these problems, they seemed to trust that these are taken care of. While e.g. In German focus groups, "a huge scepticism towards the food industry became obvious" among the meat eaters group.

3.3.1.3 Preconditions for acceptance: tasty product and transparent communication

Throughout the discussions in each country, the participants pointed out, that their interest to buy the product application will depend on certain preconditions, first and foremost on

sensory pleasantness, but also on other product characteristics such as **usability** for certain contexts and **price**.

In addition, consumers pointed out that they need more **information** before they are able to judge their final acceptance and before they can be convinced about the safety and sustainability of the system and products. Participants also often emphasized how important **transparency** throughout the system is for them: Transparency from the origin of the material to the production methods up to the ingredients being honestly listed on the product label.

Information needs mentioned:

- many feel the need to better understand how the production works. While some people miss certain technical details or details about sustainability effects, others just need to get some kind of feeling of familiarity, plausibility and understanding of the system.
- more proof and justifications about the sustainability benefits
- people need to feel confident about that the methods and ingredients are profoundly tested and inspected before and during their application
- information about the economic viability of the production

Regarding the product and ingredient

- fair, transparent, not misleading, information and marketing
- all ingredients (and nutritional facts) clearly listed on the food label (the new ingredient should not be disguised)
- information about potential allergens
- information about how to use the product / new protein in terms of cooking and nutrition (is there a limit for intake)

3.3.2 Views about NextGen microalgae protein

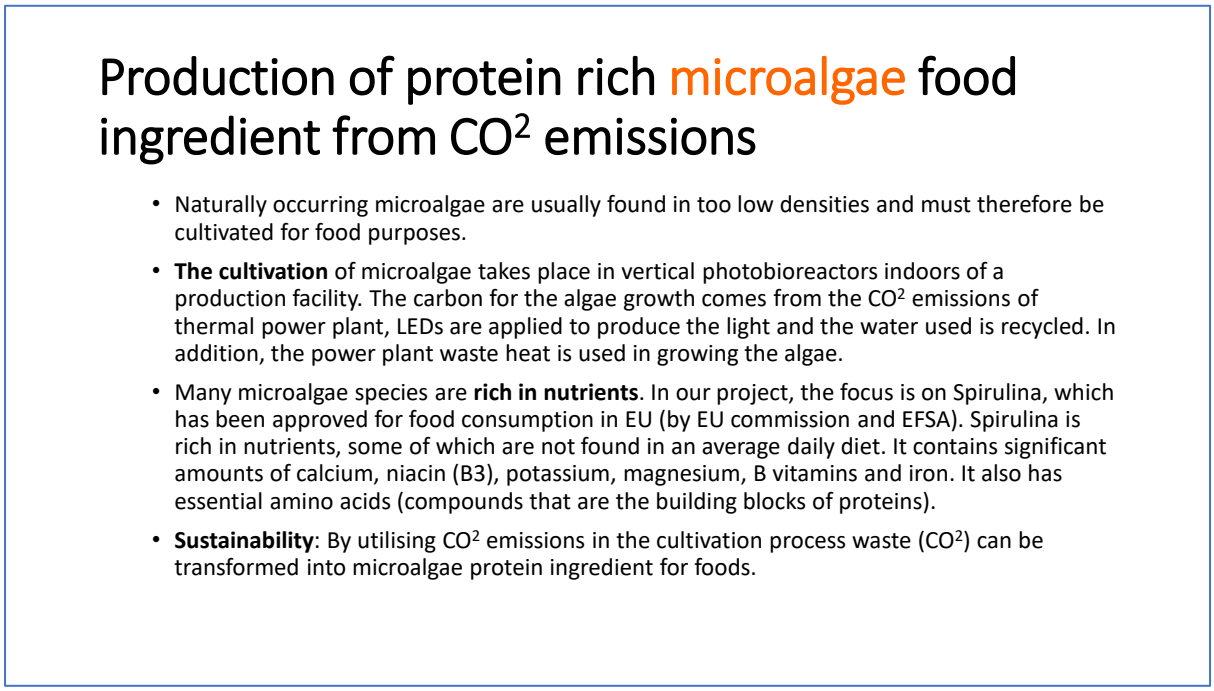

Figure 3. The description of NextGen microalgae protein concept presented to the focus-group participants

Like the overall idea of these NextGen protein production methods, the production of microalgae protein was often considered as an excellent idea as it enables utilisation of waste in food production.

The positive views towards this particular method and ingredient were influenced by many respondents' familiarity with seaweed and Spirulina. The image of Spirulina as safe, edible and natural and nutrient dense were associated with SCP.

The expressed doubts related mainly to the expected strong taste and colour of the ingredient and occasionally to the use of emissions from a power plant in the production because of potential impurities. The impression from the production methods as artificial, not natural was a typical reason for negative views or rejection of the idea (e.g. in Italy).

Positive viewpoints about the NextGen microalgae concept

- **Excellent idea overall** "genius", "fantastic", "brilliant"
- **Sustainability, energy efficiency and animal welfare**
  - ***Utilisation of CO_2 very positive*** *(all countries)*
  - *"too good to be true.. can continue producing emissions and get food out of it"* (FI)
  - "No **animals** need to suffer for this technology" (GE, A) (FI)
  - **Water recycling** received positive attention (e.g. FI, IT)
  - **LED lights** got positive attention as energy efficient technology (FI, B), but also negative attention (e.g. in Italy) because of their artificial nature

- **Natural ingredient and production method**
    - algae, Spirulina (all countries)
    - *"reminds of organic production e.g. because of the use of excess heat"* (DE, A)
- **Potential for domestic production** was valued in Iceland, but not mentioned in other countries.
- **Familiarity with Spirulina > safe, nutritious, understandable**
    - most or at least some knew Spirulina in all countries
    - Spirulina was perceived as safe and nutritious (all countries)
    - Microalgae was also associated with sushi, spinach, salad, Japanese food
    - overall algae is easy to understand and accept as a food ingredient compared to e.g. Single cells *"This can be understood with common sense" (FI, A)*
- **Healthy, high nutrient content** (cf. Spirulina) – includes substances which are difficult to get from a normal diet. Superfood image. (IS, FI)
- Food applications suggested or preferred:
    - combined with fish containing products (FI), sport nutrition (DE)
    - in tofu-like form (DE)
    - good in meat broth (IS)

Negative viewpoints about the NextGen microalgae concept

- **Doubts about realisation of sustainability and high energy need of the indoor production** (DE, FI, IT, IS)
    - *"what if the demand explodes, will more CO_2 be produced for the use of this production method?"*
    - What will be the sustainability balance at the end considering that the indoor production uses energy and may also create emissions?
    - Some participants e.g. in Italy doubted that the industrial production method would consumer high amounts of energy, light, water
- **Doubts about profitability** and viability (DE, FI, IT) "sounds like expensive process" (IT)
- **Artificial, unnatural, complex, industrial, high technology production method** – all counties
    - e.g. complex industrial process, not natural, indoor cultivation with artificial light; large factories, use of LED lighting
- **Too odd, difficult to understand the complexity of the technology**
- **Unnecessary** from nutrition point of view (no need for added protein intake)
- **Strong or special taste and colour -** the taste and colour may be incompatible with some foods (FI, DE, IS)
- **Safety doubts – negative association with power plant emissions**
    - **Contamination** - Doubts about whether harmful chemicals (or heavy metals) from power plant emissions transfer into the food. These should *"be thoroughly researched before you can trust to use it"; "I would never choose anything made of CO2, I don't know why. I just could't stand behind a car and breath in, I find it disgusting"* (IS)

- *"if there are other (unwanted) substances left in the end product, the consequences of which we don't know yet"* (FI)

- **Unhealhty?** Potential allergies (DE, A) Uncertainty if our digestive system can deal with e.g. high amount of micronutrients (IS)
- **High price?** Overpricing. Should not be expensive. (IS, FI)

3.3.3 Views about NextGen Single cell protein

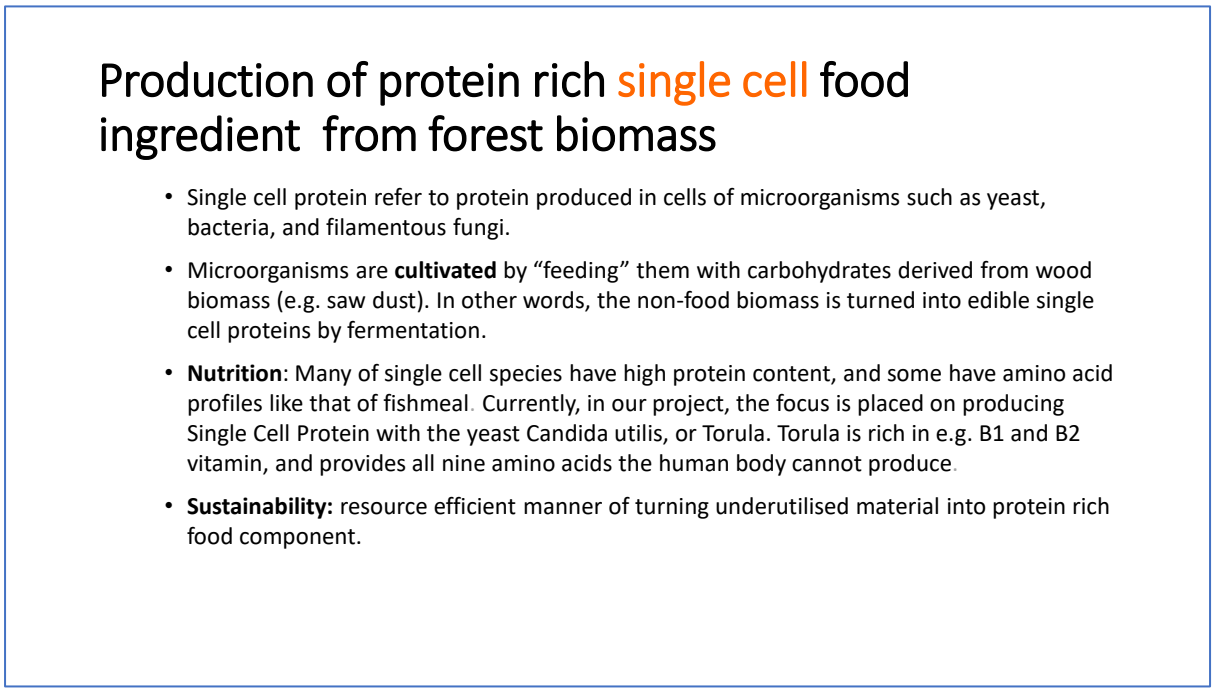

Figure 4. The description of NextGen single cell protein concept presented to the focus-group participants

Many participants found also this method as fascinating and positive idea, and again, the use of waste resources was appreciated. Many Finnish respondents were delighted about the utilisation of forest material, as "forest" is perceived as something natural and pure. These views did not appear in the other countries. On the contrary, forest origin was not always seen as a positive thing. In Germany some people contemplated if the harmful substances in the soil transfer to foods.

The description of the NextGen method, provided to the participants, included a lot of terminology, such as "fungi" and "bacteria", and "fermentation", which created very conflicting images in consumers' minds. Associations with traditional methods of food fermentation (or with Quorn) contributed to positive impression of familiarity and edible material in all countries. While, for others e.g. these terms reminded of disease and impurity.

Many participants found this method as too odd, technological and difficult to grasp and evaluate.

Positive viewpoints about the NextGen SCP concept

Sustainability and utilisation of waste material (all countries)

- "everything seems sustainable, re-used, re-cycled"
- use of waste

Words eliciting positive associations (e.g. natural, familiar, edible, safe)

  - Forest – perceived as something pure, natural (e.g. IT, FI and also as domestic in Finland)
  - Yeast, bacteria, fungi and fermentation recognised as already traditionally applied in food production (associated with cheeses, baking, fermented vegetables, and / or cultivation of mushrooms) in all countries
  - association with **Quorn** facilitated acceptance, but only a few consumers came to think of Quorn in this context, as it was not explicitly mentioned in the method description (IS, FI..)

- **Flavour –** associations with / expected mushrooms flavour created positive taste expectations (IS)
- **Good nutritional profile** (FI, DE, IS, IT?). Respondents were convinced by and valued the good nutritional value of the ingredient
- **Potential for domestic production** was valued and anticipated in Finland
- Not worse than any other processed food (IS)

Negative viewpoints about he NextGen SCP concept

- **Words eliciting negative associations** e.g. about safety and healthiness**:** *yeast, bacteria* (disease), *fungi* (something dirty, gone bad), *saw dust* (not edible), *flavour enhancer* (industrial, chemical, unnatural, unhealthy); *Candida* (Candidiadis). These negative associations were more common among the groups B (meat eaters)
- **Safety doubts**
  - While forest was perceived by the Finnish participants as something that is natural and clean, in Germany some people contemplated if the **harmful substances in the soil** transfer to foods (DE, B). These kinds of notions did not come up in all countries.
  - were elicited by the words *bacteria, fungi, candida, fermenting, flavour enhancer*
- **Doubts about realisation of sustainability**
  - Most of the discussion groups mentioned some concern about **possibility that tress will be cut down** in order to provide material for single cell production. Some of these doubts may have been misunderstanding arising from the expression of "use of forest biomass" to refer to whole trees also, while others were afraid that if the need for the material will grow so that there is not enough waste material, there is a risk of logging.
- **Unfamiliar, artificial, difficult to understand, need for more information**

- SCP production of food was perceived as very far from normal food, as very odd, strange and difficult to understand, and therefore difficult to evaluate also

- **Technological, artificial**
  - "more technological compared to algae" (FI)

3.3.4 Views about NextGen Insect protein

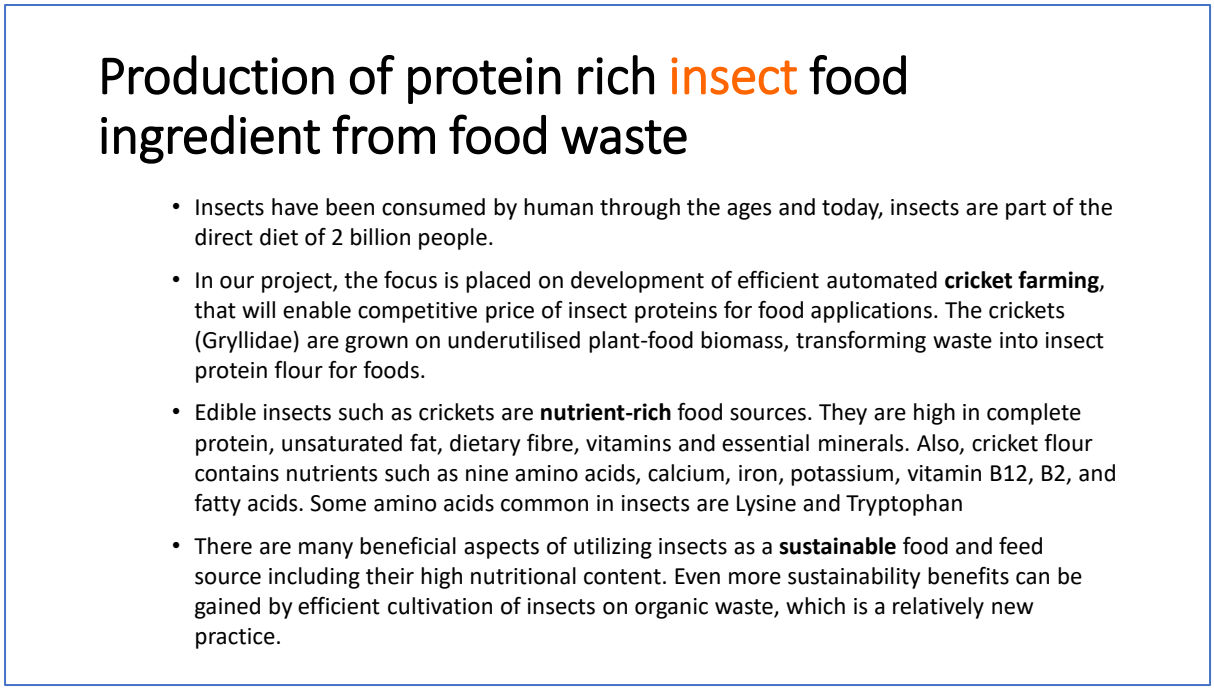

Figure 5. The description of NextGen insect concept presented to the focus-group participants

In all countries, insect protein production was clearly the least often favoured out of the three NextGen ideas. However, the range of attitudes was quite wide. In one end, insects were readily rejected as something repulsive (e.g. some Italian older people with valuing traditional regional food), but on the other end were people, who thought this was the best NextGen concept. These people (one example: enthusiastics who had tasted insects, men in FI) supported the idea of utilisation of insects as it is a natural and promising source of sustainable protein (as "future food"). Positive views were expressed also by some people who generally were not much concerned about what is in their food as long as it tastes good (e.g. some meat eater men). It seems there also exists a group of people, for whom, insects are not a problem. In the middle, many participants recognised and valued the sustainability benefits, but were doubtful whether they could get used to the idea of eating insects. Conflicting attitudes within the same person were typical. While the rational benefits (sustainability, nutritional value) of insect protein were acknowledged, people still could not help having unspecified feelings of disgust and unpalatability, which would be difficult to overcome even if they wished so. Some thought maybe they could eat insect food if the insects cannot be tasted, or most importantly their texture could not be sensed from the food.

Furthermore, it was a very clear result from all countries that insects should not be used in foods targeted to vegetarians or labelled as vegan or vegetarian foods. As insects are animals, also ethical and animal welfare issues were of concern for those consumers for whom these aspects are important. According to these respondents, insect farming is not solving the problems of large-scale animal production as it also is one form of large-scale animal production. On the other hand, raising insects was sometimes also perceived as more natural and easier to understand compared to SCP production, for example.

The description of NextGen insect protein production raised negative associations about hygiene and contamination.

Positive viewpoints about NextGen insect protein concept

- **Sustainable way to produce food;** utilisation of waste, the whole insect is used (all countries) and the potential of reducing meat consumption (IS)
- Economically competitive (IS, FI)
- **Positive associations** with crabs and shrimps (DE, IS)
- **Taste -** Some people, e.g. in Finland and Iceland, mentioned previous experience about eating insects because of which they did not have suspicious towards the taste of them (and naturally had initially mor positive attitude)
- **Natural ingredient and understandable process** (FI, DE, IS) *" more natural than the other methods"*
- **Good nutrition profile** was paid attention to and valued. Some Italian respondents were positively surprised about how good protein source insects are.
- Ok for feed use (DE)
- **Ok, if the taste or texture of insects is not noticeable in the food** – this view was not held by the majority (and not in Italy), but some (e.g. in FI and IS) e.g. brought up that insects as such are good food ingredient, and if they are undetectable from the food, the use of them is ok
    - *"When insects are milled and cannot be identified as insects, I would not have problem with it" (DE)*

Negative viewpoints about NextGen insect concept

- **Neophobia** – The views towards this NextGen protein concept was strongly influenced by the more general neophobia towards insects. Insects are categorised as non-food in western cultures. Many respondents also (esp. in Italy) also explicitly stated that insects do not belong to their traditional cuisines. Insects are perceived as disgusting, repulsive and unhygienic (associated with diseases)**.**
- **Words which elicited negative associations:**
    - "food waste" (mild insecurity about potential contamination)
    - words "efficient", "automated", "production" were considered as inappropriate when talking about living and feeling animals (by people acquainted with animal issues) (DE)

- **Safety risks - doubts about hygiene and contamination** (e.g. DE, IS)
    - *"What about hygiene? After production, everything must be sterilised, so all the nutrients are gone" (DE) "No side streams from meat production should be used" (IS)*
- **Mouthfeel** – thought of sensing the texture of insect (e.g. chitin carapace) in the mouth seemed more repulsive to people than the expected taste otherwise. If the insect is in flour form, some have easier to accept.
- **As animal, not suitable for vegetarians** (vegetarians in all countries)
- **Insect production is not ethical -** as insects are animals, and raising them in large scale does not solve the problems of intensive animal production (people concerned about animal welfare)
- **Unpredictable negative consequences** e.g. if insects break out of the factory and destroy grain fields (DE, IS)
- **Lack of sufficient understanding. Need for more information** in order to be able to evaluate and form the opinions was wished in the case of insects protein production like in case of the other two proteins. People wish more information e.g. in order to be able to confident about the safety, sustainability and lack of adverse effects.

3.3.5 Summary comparison of the three NextGen concepts

All focus-group material considered it can be concluded that the most typical preference order between the three ingredient types was:

1. Algae
2. SCP
3. Insects

This preference order is based on the discussions as well as on focus-group participants' ingredient preference they indicated on closed question online.

As expected, insect-based protein ingredient and production method was the most difficult to accept, overall. Despite of that many participants were aware of and valued the sustainability potential of insects, most had difficulties getting over the association of insects as something unpalatable and impure and not conventionally regarded as food. Still, also participants with positive attitude towards insects did exist.

While insects were clearly the least preferred, the preference order between microalgae and single cell -based protein was less clear and varied e.g. between countries and food types. Both of these were perceived to have advantages and disadvantages. However, since people felt more familiar with algae (and Spirulina) was overall the easiest ingredient to accept, seemingly because it felt more familiar, natural and understandable and Spirulina was known as healthy.

Regarding the results presented below, it is important to bear in mind that given the initial unfamiliarity of the subject, the participants based their reactions on the information we provided in this study. Thus, changes in the wording and contents of the information will most likely to change at least some of the associations the respondents had.

Table 5. Comparison of focus-group participants' perceptions of the three target methods/ingredients, summarised over all countries.

	Microalgae	SCP	Insects
Positive	• **Familiar** • **Generally positive views** • **Sustainable** • **Natural, understandable** • **Nutritious**, healthy • Potentially domestic (IS) • Spirulina (familiar) • **Compatible with fish, sea** and Japanese cuisine • Associated with spinach or salad (DE)	• Sustainable, Innovative • **Natural base material** (wood, biomass, forest) • Potentially domestic (FI) • Associations with baking yeast & (healthy) fermentation (FI) and musroom culturing (DE) • Assumed neutral taste > compatible with many foods (FI)	• Sustainable, future source of protein • **Understandable, natural** • Familiar as protein source • Plausible and feasible technology • Taste - Some had positive taste experiences (FI, IS) • Utilisation of complete animal (DE,FI) • Meat -like ingredient suitable meat substitute (DE,FI)
Negative	• **Sensory characteristics** (colour and strong taste) (FI, DE) • Negative image of factory production, **aftificial, industrial** • **Safety?** Are harmful substances from emissions transferred into food? (IS,IT), allegies? (DE)	• **Unfamiliar ingredient** • **Method difficult to understand** • **Terminology:** "single cell protein", flavour enhancer, MGS, bacteria, fungi, candida • wood as food souce is odd (IT, FI) • Doubts about e.g. increasing lumbering (DE, FI, IT)	• **Neophobia, aversion (mild - to high)-** Not part of our food culture • **Associations with something impure and disgusting** • **Insects are animals > not for vegetarians, ethical issues** • **Sensory** doubts, esp. texture • Terminology: **food-waste** (DE, FI) • >Unsure about diseases and food security (DE, FI)

3.3.6 Views regarding the application categories of Nextgen protein

The fourth part of the focus group discussions (Table 2) aimed to explore participants views towards applying the three NextGen ingredients in four food application categories (bakery, convenience foods, alternatives for processed meat-based convenience foods, and Texture modified soft food). Each application category was discussed in turn. As stimulus material, they were shown slides, each including a picture of e.g. four food examples (see Figure 6, Figure 7, Figure 8, Figure 9). Finally, the idea of applying NextGen protein in animal feed was very briefly discussed.

Most participant approached the idea of the presented food applications openly, stating interest to test how they taste. The nature of the data does not allow direct conclusions about which of the four food categories would be most potential target for applications. Rather, each of them had their own types of potentials and challenges. Use of the new NextGen proteins in the food products was often perceived as kind of tampering and changing of the original product. People felt that the naturalness of the products suffer and use of NextGen proteins increases the level of processing in these foods. Therefore, sometimes people felt easier to accept NextGen ingredients applied in products initially perceived as processed, such that ready food components or meat product alternatives.

However, those people who had negative views about these processed foods overall, were not interested in their NextGen applications either.

3.3.6.1 Bakery products

This chapter summarises focus-group participants views on applying NextGen ingredients in bakery products.

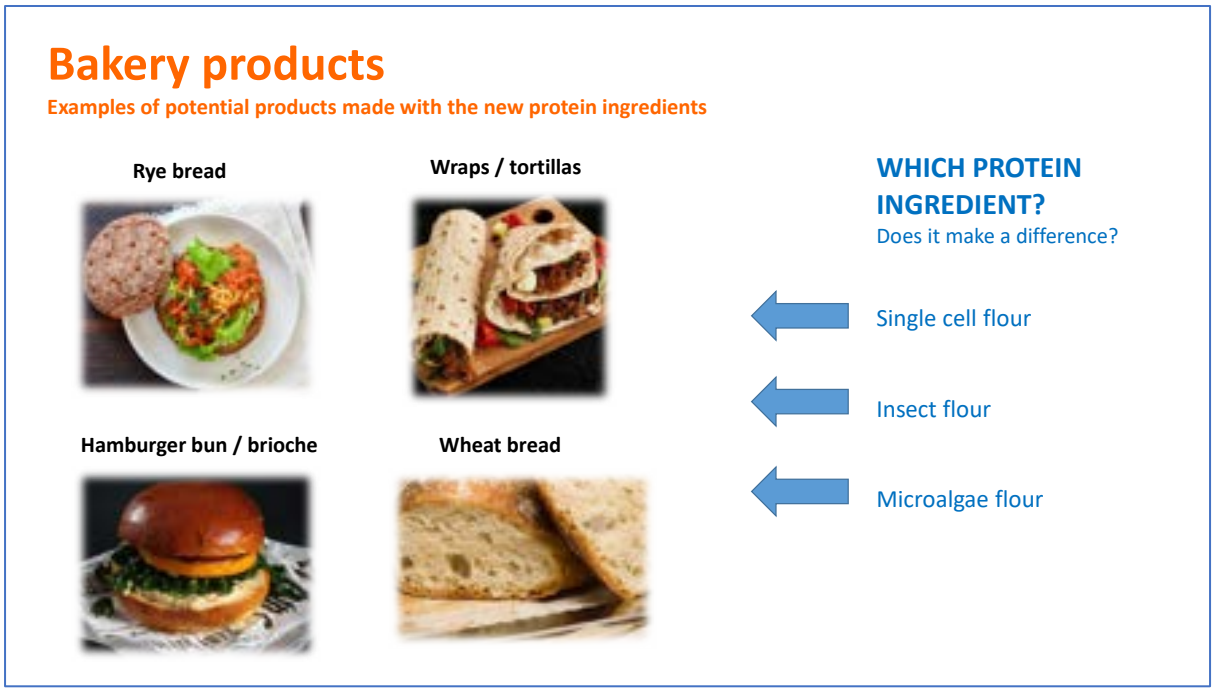

Figure 6. Stimulus material shown to the focus-group participants as introduction to discussion about application of NextGen protein in bakery products. (The participants saw the material in their own language)

The views towards the application of NextGen ingredients in bakery products were quite varying and conflicting. On one hand, a great deal of participants valued the general idea of NextGen protein production and were **more or less open to the bakery applications** also. However, always with the conditions that the taste is good, the taste does not change, the taste of ingredients are not noticeable etc.

Part of the respondents **reacted negatively** however, because it conflicted with their images of **what the bread is like traditionally**. Traditional breads were described as “holy”, as something which **should not be changed or tampered with.** The idea of adding NextGen protein in bakery products was perceived as incompatible with their notion of bread as natural, simple and minimally processed product. Also, the idea of using high protein ingredient in bakery was in conflict with the convention and notion of bread as the carbohydrate dish.

The consumers with most negative views towards bakery application seemed to be people, who especially valued traditional and simple breads. These types of consumers were e.g.

among the groups A (vegetarians or meat reducers) in Finland and middle aged or older respondents in Italy, and also among the German participants.

In Iceland, the participants had a different angle in their discussions as they seemed not to worry much about the traditional features of bread. Instead, especially the group A (vegetarians or meat reducers) were quite excited about the idea of NextGen bakery applications. Two main reasons for this were the overall idea of sustainable NextGen protein production methods and **interest in high-protein low carbohydrate bread**. Overall, it seems that participants in Iceland were most positive and participants in Finland most negative towards the idea of using NextGen ingredients in bakery products. It is possible, however, that this is due to random differences in participant profiles and does not necessarily reflect cultural differences.

Also, in the other countries the idea of increased protein content of initially low protein food was welcomed **by people interested in avoiding carbohydrates, increasing protein intake or replacing animal protein**. As a versatile everyday product, bread would be an easy and pleasant way to do that. It should be noted however, that the consumers have conflicting opinions about whether it is positive or negative to increase protein content in foods. Some consider it unnecessary and even harmful, if people may get too much protein. Therefore, they pointed out that the protein content should be clearly labelled.

Consumers **main worries** related to how NextGen protein would influence the **sensory quality** of bread. Doubts about poor sensory quality were sometimes based on previous negative experiences with protein enriched bread, sometimes on the expected sensory properties of the NextGen ingredients (e.g. green colour from algae) or on the effects of these on the volume and texture (bread would not rise). In Finland and Germany, some respondents referred to their previous experiences with protein enriched bread, which had led them to doubt the sensory qualities of NextGen bakery.

Consumers opinions about **which types of bakery would or would not be suitable carrier for NextGen ingredients were also quite conflicting.** One recurring opinion was that the nature of the traditional breads – whatever it is for each person - should not be changed and traditional bread culture needs to be preserved. Finnish respondents mentioned rye bread as such a traditional product, that it should not be changed, while for the Italians it was white wheat bread. Interestingly, however, participants ratings of their likelihood to buy or eat wheat bread, hamburger buns, wraps and rye bread provides a different picture. The Italian respondents preferred white bread, and the Finns rye bread, and did not reject the other options either. One possible interpretation for this is: while some consumers don't like the idea that their favourite traditional breads would be changed, it may still be more likely that most consumers would buy NextGen bakery application in form of a product that they habitually consume anyway.

Icelandic participant mentioned rye bread is a suitable carrier product because of the compatible health image (both NextGen ingredient and rye bread are healthy), while the quality of traditional white bread might suffer from extra protein ingredients. For some, hamburger bun is not a good carrier, because it does not make sense to eat protein (the bun) inside protein (hamburger beef). While, many others liked the idea.

Positive viewpoints about NextGen bakery applications

Perceived benefits

- **Sustainability and the overall idea of NextGen**
- **Healthier products, e.g. because of protein –** e.g. in IS some respondents perceived NextGen bread applications as kind of health products with their increased protein
- **Improves the selection of protein sources** – More variety and options for how to get protein from food was welcomed.
- **Bread could be an easy and convenient way to get more proteins and to avoid unwanted carbs** (FI, DE, IS).
- **Versatile everyday product**, and thus a good product to have as a carrier for NextGen protein

Potential target groups:

- people interested in learning new ways to comprise their diets, e.g. new vegetarians or meat reducers
- people who feel that they for some reason do not get enough protein from their diet
- people, who aim to eat low-carb diets

Some product ideas listed by the participants

- sweet bakery, confectionary, biscuits (DE, IS)
- low carb products (IS)
- product that can be used in home baking (IS, FI)
- snack bars
- healthy bread with seeds etc.

Negative viewpoints or challenges of NextGen bakery applications

Reasons for negative views

- **Traditional breads and bread culture should not be tampered –** less suitable in white bread
- Less natural – bread should remain as natural and simple product
- People are used to use bread as carbohydrate dish
- **Unnecessary to add protein in bakery**. No need to get additional protein, not suitable for this product type.
- **Doubts about poor sensory quality**, e.g. based on negative experiences with protein enriched breads, and expected green colour and strong flavour from algae

Least potential target groups:

- People who think they have no need to increase their protein intake

- People particular about the traditional and "unprocessed" simple nature of their breads. People who value traditional bread and have strong expectations about how bread should look, taste and feel, expect bread to be natural and made with simple ingredients (e.g. older Italians with traditional eating styles

3.3.6.2 Convenience foods

This chapter summarises focus-group participants views on applying NextGen ingredients in convenience foods.

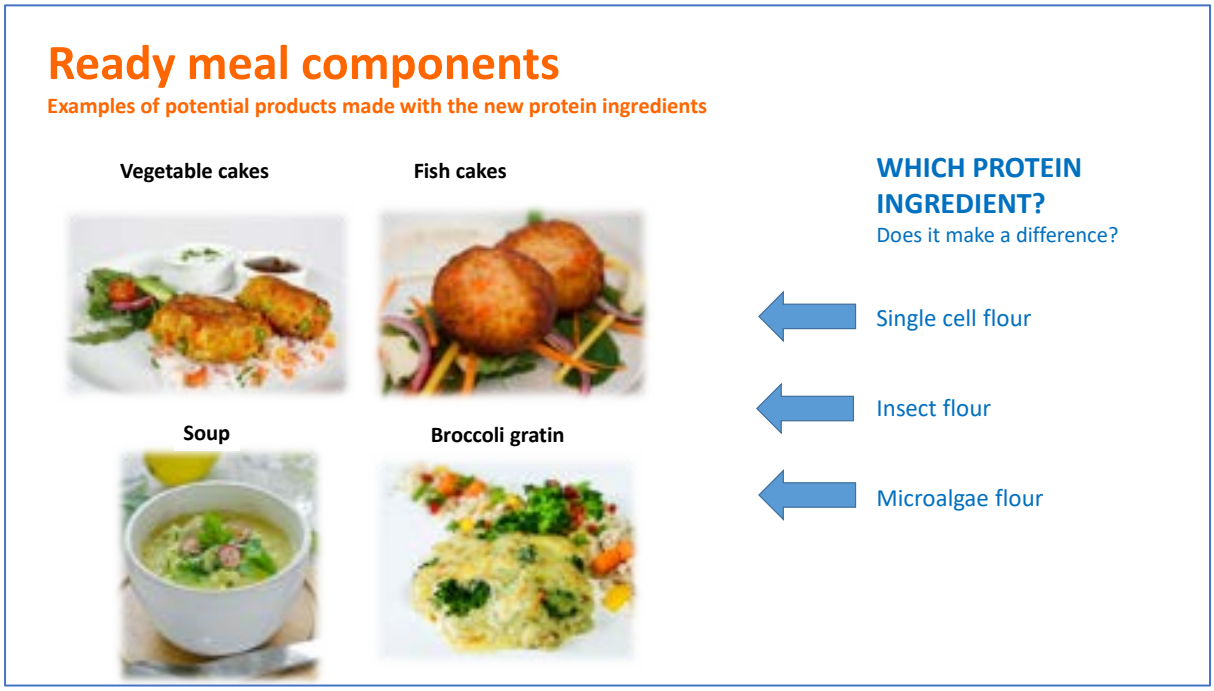

Figure 7. Stimulus material shown to the focus-group participants as introduction to discussion about application of NextGen protein in convenience food products. (The participants saw the material in their own language)

Much of the discussion concerning this application category was influenced by informants' general attitudes towards the food category of processed and convenience foods. That is, if a consumer was negative towards the entire category of processed foods, or mainly relied on home cooked meals, he or she was also negative towards the NextGen versions of these products. Whereas other respondents often pointed out that it is easier for them to accept the Nextgen ingredients in foods compared to e.g. bakery. That was because these foods are already processed and made of several ingredients. Thus, the taste of the novel ingredient would be less detectible from such a multi-ingredient foods.

Many liked the idea of adding NextGen protein in vegetarian convenience foods – with the obvious precondition of good taste, however. Many vegetarian foods (e.g. vegetable patties

or soups) may often be too "light", and the thought of having more filling and protein rich NextGen versions were welcomed.

In terms of the ingredients, algae and single cells were again most preferred and insects divided opinions. That is, also insects were accepted by part of the respondents.

Positive views about applying NextGen ingredients in convenience foods

- Generally open and tentatively positive attitude

Perceived benefits

- Protein enrichment of vegetarian foods, which typically have low protein and energy content (e.g. vegetable soups) > more filling vegetable foods
- Replacement of animal protein
- Potential domestic origin of the ingredient (e.g. algae in Iceland)
- If helps in making more natural convenience foods, e.g. if NextGen ingredients can replace additives (e.g. thickening agents)

Potential consumer types and use contexts

- users of convenience foods
- potentially interesting for very different types of consumers

Liked product types or ingredients

- vegetarian foods initially low in protein
- algae good combination with fish
- products with no additives or chemicals (esp. IT)
- any NextGen ingredient, even insects (by some) easiest to accept in this category

Preconditions for acceptance

- good taste, tastes of the ingredient and carrier product are matching
- no increase in price
- transparency; consumers are not misled e.g. by marketing the product as insect product, while it only contains 3 % of the ingredient or by increasing prices or by suggesting sustainability benefits, which cannot be proved, or by not revealing all ingredients on the label

Some product ideas mentioned

- fish cakes without fish
- powder for blends and drinks
- soup mix (dry product)
- dressings
- pasta meals
- pizza, burgers
- lasagne
- liver casserole (FI)

Negative views about applying NextGen ingredients in convenience foods

Reasons for lack of interest

- High level of processing - Image of the food category as unhealthy junk food
- No habit of using convenience foods
- Negative associations or experiences with protein enrichment
- No perceived need for more protein overall or in initially protein rich products

Least liked product types

- broccoli gratin

Less potential consumer groups

- People avoiding artificial, processed, enriched or convenience foods
- Home cookers

3.3.6.3 Alternatives for processed meat products

This chapter summarises focus-group participants views on applying NextGen ingredients in alternatives for processed meat products.

Figure 8. Stimulus material shown to the focus-group participants as introduction to discussion about application of NextGen protein in alternatives for processed meat products (The participants saw the material in their own language)

Many of the participants' reactions to this food application category had more to do with their attitude either towards meat product alternatives or towards processed meat products in general than with the novel NextGen ingredients. The main reasons for negative views were unwillingness to eat unhealthy processed foods ("junk food") or lack of interest to meat imitation products.

It was also very clear from the results that the potential consumers of processed NextGen meat alternatives are not a unified group, rather it consists of different subgroups with differing habits, needs and values, and thus interest in different types of applications or positioning. The following overall conclusions apply to all or most of the studied countries. Firstly, there were the **long-term vegetarians**, who have learned to compose their vegetarian and sustainable diets largely without meat replacer products. Many of them did not feel need for meat replacer convenience foods because they think they get their protein form other foods (such as from grains and legumes), which they feel also as more sustainable diet. As they are not using meat, they have also learned to live without meat taste. Although, some less "established" vegetarians have craving for occasional treat of eating unhealthy, meat tasting junk food. This group was interested in NextGen applications in form of vegetarian options for **occasional unhealthy treats like hamburgers**.

The Italian vegetarians stood out with their different expectations for meat replacers. They categorise meat replacer products as health food. These foods tend to be positioned as health food and have different form and appearance than meat products. In grocery stores they are placed close to natural food, health food, gluten free food etc. This health image was perceived as contradictory to the artificial NextGen ingredients. The NextGen meat replacers products were strongly associated with meat products resulting in negative attitude. Apparently, imitation of the sensory characteristics of meat was not relevant for them. Products that would more likely to interest this group, on everyday basis, would not be positioned as meat replacers or meat imitation products (e.g. as sausages or hamburgers) since they do not seek for these food categories when shopping.

Another consumer type with low interest in these products was found among **meat eaters**, for whom the taste and texture of real meat was more important than the other benefits of the product. They thought why not choose real meat, so you don't need to compromise with the sensory quality. In German sample, the meat eaters were clearly less interested about these products than vegetarians. Thus, it seems unlikely that these types of consumers would be very interested in NextGen products if these products are perceived by them as kind of fake meat products or meat imitation products with expectedly inferior sensory quality. However, this does not exclude the possibility that some other product types, which do not elicit comparison with meat products, would be of interest for them.

The majority of the respondents seemed to locate in between these two extremes and were positive towards the idea and interested at least in testing the new NextGen meat alternatives. They could be either **vegetarians, flexitarians, or meat eaters**. Especially meat eaters emphasised their further interest depend on the flavour and texture of the final product. The data implies that consumers who are beginners or **less fixed in their ways of finding alternatives for meat**, as well as consumers who already currently use meat replacer products, may be the most receptive towards these products.

The results suggest that there is need for (at least) two opposite types of food concepts / positioning. On one hand, many wished the meat replacers products to be as **natural, healthy and minimally processed** as possible. On the other hand, **junk food delicacies** like hamburgers or sausages were wished. E.g. in Italy and Germany, vegetarians complained that meat alternatives are too much positioned as health food. NextGen applications would be needed in all kind of contexts and use purposes where vegetarian protein products and meat replacers are generally used. Especially in **social contexts**: When you (as an omnivore) invite friends and part of them have vegetarian diet, or when you eat dinner with family consisting of both meat eaters and vegetarians. Barbequing with friends is also the kind of occasion where a meat replacer in the form of sausage would be a desired option by meat avoiders or vegetarians. Because of these products, people with different diets are able to eat similar dish.

Regarding respondents' views about the NextGen **ingredients** especially, the discourse followed same lines as in the previous sections: algae and single cells were preferred. An exception was that some **meat eaters** in all countries **felt insects as especially suitable to be used in this food category** one reason being that as animals insects are closest to meat. Like in the earlier phases of discussion, insects were rejected as ingredient in foods targeted to vegetarians.

Positive viewpoints about the application of NextGen protein in alternatives for processed meat products

General

- Mostly open and interested attitude, interested to test

Perceived benefits

- More options for avoidance of meat or soy / good that meat or soy consumption can be cut down
- Fits well in this already processed food category. NextGen application in multi-ingredient food is easier to accept compared e.g. to simple products like bread

Potential consumer types and use contexts

- New vegetarians, flexitarians and people learning new habits for meat reduction
- All consumers occasionally in certain contexts
- Social eating contexts were people with different diets gather (family dinner, hosting quests, barbeque with friends)

Types of products of interest

- **Healthy,** minimally processed meat alternatives
- Vegetarian **delicacy junk food** (barbeque sausages, hamburgers etc.)
- Product imitating meat products, such as meatballs or patties (suitable for e.g. occasions where people with variety diet share meal)
- Products which are not trying to imitate meat products

- Products **for home cooking**
- **Meat alternatives with good sensory characteristics.** E.g. “a good crispy crust / skin on a sausage would be a competitive advantage”

Some product ideas listed by the participants

- **minced meat or tofu (bites, blocks) types of products**, which can be used in home cooking
- protein spreads, pastes to be used on bread -type of product
- meat balls, nuggets, pulled meat types of product
- schnitzel
- marinated starters
- baby food
- completely new types of products

Negative viewpoints about the application of NextGen protein in alternatives for processed meat products

Reasons for doubt and rejection

- Challenging to meet the expectations for **sensory characteristics**, especially if the consumer has meat product as a point of reference in their minds
- **Previous negative sensory experiences with meat replacers** (texture important)
- **Unhealthy processed image** of junk food
- **No interest in “fake meat”**– rather eat plant protein (vegetarians) or meat products (meat eaters)

Unwanted product types or characteristics

- No insects in vegetarian foods
- Cold cuts least interesting product type
- The entire category in Italy

Challenging consumer types

- Non-users of processed products
- **Established vegetarians** (with established habits of getting protein / with plant protein products like tofu as a reference product)
- **Meat eaters** (more likely to lack strong motivation to avoid meat and thus) not willing to compromise about the real meat taste

Preconditions for acceptance

- good taste, texture
- not high price and information about sustainability benefits, ingredients etc.

3.3.6.4 Texture modified formed soft foods

This chapter summarises focus-group participants views on applying NextGen ingredients in texture modified and formed soft foods targeted for people with mastication or swallowing difficulties.

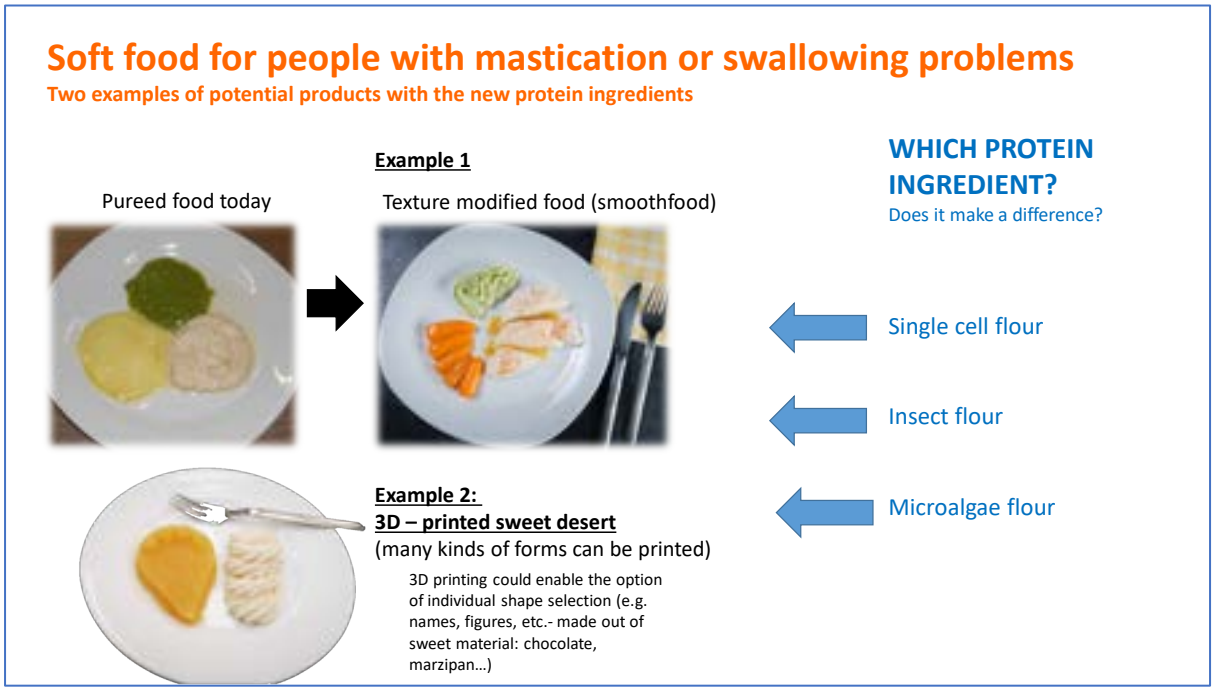

Figure 9. Stimulus material shown to the focus-group participants as introduction to discussion about application of NextGen protein in Texture modified soft foods for people with mastication or swallowing difficulties (The participants saw the material in their own language)

Respondents' views towards the application category of soft, pureed, texture modified and re-shaped soft foods were very positive, overall. Mostly, people were positive because they valued the idea of improving the sensory quality of foods targeted to people who cannot eat solid food, rather than because of the new ingredients. Compared to the other application categories, it seemed easier for the participants to accept any of the suggested NextGen ingredients, even insects – given that certain conditions, such as transparency, safety etc. are met. People tended to think that in the cases were soft food is necessary, e.g. in elderly care, the source of the protein ingredient is of secondary importance. More value was placed to the potential of this food in increasing sensory quality, food intake and thus energy and protein intake of these vulnerable people.

Positive views about NextGen Texture modified soft food applications

Perceived benefits

- **Improved eating experience for the target group**
- **Enjoyable appearance of food is important for the eating experience**
- **Improves food intake and nutrition of the target group**
- Provides creative opportunities; e.g. 3D printing enables unconventional combinations of flavours, colours and forms

- Could be applied also in foods for babies and children
- Might be less expensive because of lower production costs; enables better food with the limited budgets of the nursing homes etc.
- **NG ingredient use generally accepted**
- **Less important what is the particular NextGen ingredient**
- **Creative opportunities, esp. by 3D printing**

Additional ideas

- products for babies and children, use of 3D printing for creative experimentation for children

Negative views about NextGen Texture modified soft food applications

Perceived disadvantages

- **Artificial,** industrial image, does it contain much additives?
- **3D too futuristic**, odd
- **Unable to recognise the ingredients**

Less potential target groups

- Traditional participants in IT: food should not tampered with; "food as food"

3.3.6.5 Animal feed

Application of NextGen proteins in animal feed was only briefly touched upon in the discussions. The results are summarised below.

Application of NextGen proteins in animal feed was only very briefly discussed. For Italian respondents feed application seemed easy to accept as "definitively innovative" idea. The participants in IS and FI were generally positive towards the idea of using NextGen in animal feed, although several concerns and preconditions were brought up. In Germany, the opinions were divided. Some of them pointed out that it would be more sustainable to use the raw materials as human food directly.
Most participants, however, expected NextGen animal feed to have various sustainability benefits, and potentially also economic and health benefits (for animals). Concerns often related to the animal welfare, and one precondition for acceptance was that use of NextGen animal feed should also mean improvement from the point of view of animals.

Positive viewpoints of application of NextGen proteins in animal feed

Sustainability

- Diversification of food and feed production is positive > sustainability (FI)
- Replacement of fish flour and oil for fish feed (DE) Baltic herrings could be saved for humans (FI)
- Replacement of GMO soy (FI)
- Helps to reduce soya production (DE)

- Resource efficient: getting feed kind of from free;
- If domestic production (IS)
- Feed would be a better place to start than food (FI, B)

Economic benefits
- this should also be cheap; good if economically reasonable (FI)
- good if domestic production (IS)

Better animal feed
- When the animals naturally eat that type of food, like chicken eat insects and fish algae (IS,B)
- Maybe this could reduce the use of hormones in production (FI)

Benefits for the human nutrition
- this could even make the food more nutritious (IS, B)

Negative views and preconditions for acceptance – animal feed

Not sustainable – it would be more sustainable to use the ingredients for human food (DE)
Concerns about the animal welfare
- unnatural type of food for animals
- concerns about healthiness and safety of the ingredient for animals
- doubts if the health and safety is not investigated and studied well enough in case of animal feeds (e.g. FI)

Concerns about the resulting quality of human food
- negative sensory effects on food? (IS)

Preconditions for acceptance
- safety of and healthiness of the feed will be thoroughly investigated and inspected
- it should be an improvement also from the point of view of animals
- no negative influence on food taste
- transparency of production system to ensure that it really is sustainable
- information / communication of the benefits of the system for animals and humans

3.3.6.6 Summary and implications from focus-groups

- The participants were quite well aware of the need for these kind of new food production methods and placed **high value on the sustainability benefits**

- The idea of NextGen protein production was predominantly **openly and positively received** – many perceive it as a brilliant idea. The final product acceptance depends on other factors.

- **Sensory characteristics and price.** The NextGeneration ingredients and their sustainability benefits are clearly **not sufficient reason** for buying the food applications – what is, depends on the consumers values, habits and product of

reference (e.g. are the products more sustainable and better tasting than other meat replacers? Are these better tasting than meat products?).

- In most cases, consumers interest to use the products themselves was conditional, the most important condition being pleasant taste and other food product characteristics, part of which depend on the consumers.

- Other important preconditions related to sufficient information, transparency and proof of the benefits.

- Reserved attitude because many feel **don't understand** the technology or the ingredients enough in order to be able to evaluate the potential disadvantages and benefits

- High need for carefully designed information and transparency to build consumer trust.

3.3.6.6.1 Target groups

While the focus-group did not allow systematic analysis of the how participant characteristics explain their opinions, the results point out or support some relating hypotheses.

Easier target groups

- Those more aware of global problems, those already reducing meat consumption, those concerned about animal welfare (not insects).
- People open to innovations and interested in food novelties. E.g. some young men in the Italian and Finnish samples.
- People learning new diets to reduce meat consumption (vs. very long term vegetarians with established eating habits)
- People who are not very particular about which ingredients are used, as long as the food tastes good (e.g. some meat eaters)

More challenging consumer groups

- Meat users with no intention to reduce meat consumption – they often prefer the taste of real meat and lack motivation to change habits
- Vegetarians, who already have established habits of compiling their diets without any processed meat alternative products
- No insects for vegetarians!
- People who avoid processed foods are not interested in NextGen processed foods either (products for home cookers needed)
- Consumers for whom traditional foods and eating habits are very important (esp. in Italy?)

Some potential sources for value propositions

- **Sustainability benefits** clearly the best driver for these products, but it is not enough alone and consumers need proof of it
- Domestic production – if it is possible (e.g. in the case of NextGen microalgae protein in Iceland and SCP (based on forest biomass) in Finland.
- **Microalgae –** already familiar and known to be very nutritious
- Sigle cells – unfamiliar, but "blank board" no strong negative initial expectations (mild taste)
- **High nutritional value** of the ingredients
- **Increased protein content** may appeal people valuing **low-carb** diets (e.g. IS, not FI?), applied in otherwise "light" vegetarian foods to make them more **filling.** However, many feel no need for added protein.

3.3.6.6.2 Some potential product types

- Hamburgers, sausages, patties ("meat balls") etc. products
- Convenient everyday products when e.g. different diets in one family or circle of friends – for all
- Delicacy, junk foods as occasional treats for vegetarians
- Products for social occasions where people with different diets meet (e.g. barbeque sausages) – for vegetarians and meat reducers
- Low carb foods? Iceland. (Not Finland?)
- Plain protein products for home cooking (protein in the form of flour, pieces, block comparative to e.g. tofu). Simple, natural products for people who avoid processed foods and like to make food from scratch.
- Use of new ingredients to create new taste experiences for foodies
- Microalgae replacing (part of the) fish in a product
- Replacement part of the meat in meat products – for the more careless meat eaters

3.3.6.6.3 Some challenges

Below some challenges brought up by the focus-group studies are listed. Most of these are such than can be overcome with means of marketing, positioning and information.

- Unfamiliarity of the method and the ingredients as food source (esp. SCP) and neophobia (Insects). Adoption of these new food ingredients requires to some extend that consumers change their traditional notions about what is categorized as food. Insects, fungi, microbes or even algae do not always elicit images of delicious foods. Consequently, in the marketing of these foods it is relevant to consider to what extent and especially with which words the ingredient brought up to the consumers.
- Artificial and technological image
- Terminology and use of waste elicit negative associations and insecurity about the safety and hygiene of the end product
- Consumer expectations always depend on her or his reference product (importance of product positioning)
- Consumers' previous negative sensory experiences with meat replacers and protein breads.

- Comparison with traditional bread - Controversial views towards NextGen bakery applications – what do different types of consumers expect from e.g. bread; positioning as different from traditional bread?
- Negative health image of processed food > some reject the category, potential if the healthy image can be enhances with NextGen
- COMMUNICATION - How to communicate and market the methods, ingredients and foods in a way that increases consumers trust, feelings of understanding, familiarity and control, but avoid eliciting negative images often attached to technological and biological terminology

4 Consumer survey

4.1 Aims of the consumer survey

The consumer survey aimed to validate results from focus-group studies to see how results apply in large scale in selected European countries.

The aim was to obtain information about **the level and prevalence of consumer acceptance** of the three different NextGen protein concepts in selected European countries.

More particularly, the survey aimed to find out how consumers view these new **methods** of producing food protein **ingredients** and the **application of those in food products**.

Secondly, the aim was **to understand factors influencing consumer attitudes**. For this end it was studied, what kind of beliefs and preconceptions consumers have about the benefits and risks of the production method and about the quality of the (imagined) food applications, and how and if **acceptance varies depending on the consumers'** background characteristics, such as demographics, eating habits, and attitudinal background.

The main aims of this study also include a study of **how consumer acceptance differs between the countries and between the three NextGen concepts and between three examples of carrier products.**

4.2 Materials and methods

4.2.1 Data collection, questions and samples

The data were collected with an online survey 24.5.2021 – 8.6.2021 in UK, Italy, Finland, Sweden, Germany, Poland and Iceland. An external service provider specialised in sampling and collection of online survey data (Bilendi Oy) performed the sampling and data collection in all the other countries except for Iceland. The data collection in Iceland was ordered by MATIS form a local service provider Gallup (GI rannsóknir ehf.). The process was coordinated by VTT.

The survey measurements were chosen, and questions were designed by VTT in co-operation with MATIS and TTZ. The English language base version of the survey was translated into the language of each target country and then translated back to English to check for correctness. Translations for all countries, except Iceland, were carried out by professional translations bought as external service via Bilendi Oy. In addition, one external native or very fluent speaker per each of the language checked the translations. In Iceland, the survey was translated from English to Icelandic by two fluent Icelandic and English

speaking researchers, and back translated by two other fluent Icelandic and English speaking researchers at Matis.

4.2.1.1 Samples

The data collection agency was instructed to recruit samples of 1000 adult consumers (ages 18 – 75 y.) per country, except 600 in Iceland because of their small population. In each country, a nationally representative sample based on age, gender, level of education, area of residence (part of the country as well as urban vs. non urban areas) was recruited.

Other applied inclusion criteria were:

- participating at least to some extent in making decisions of household food purchases (e.g. not living in an institution)
- does not work in the area of consumer or marketing research, food product development or research, or biotechnology research

The final sample sizes and some basic demographic characteristics of the samples in each country is described in the Table 6 below.

With the exception of gender, all the other characteristics presented in the table Table 6 differ statistically significantly between the countries (Chi^2 tests comparing the categories as presented in the table, p =.000). In the analysis, however respondents' answers have been weighted in the analysis so that the results represent each country population, except in Iceland.

The sample from Iceland deviates from the other countries markedly in that the respondents are older. In Iceland the respondents in the oldest age groups (55 or older) are overrepresented in the sample and their share is higher than in the other countries. In addition, the share of respondents with tertiary education in Iceland is higher than in most other countries, except for Poland.

The samples of each country are described in more detail in the country-wise reports in appendix B, chapters "Participant characteristics".

Table 6. Basic demographics of the samples in each country. (Information about the type of living are is missing for the Iceland in this table, because the variable categories measuring the type of living area was different in Iceland).

Gender	UK	Finland	Italy	Sweden	Poland	Germany	Iceland	Total
male	47,0%	48,6%	48,9%	48,0%	48,6%	48,8%	49,6%	48,4%
female	52,4%	51,0%	50,8%	51,7%	51,4%	51,2%	50,4%	51,3%
other / prefer not to say	0,6%	0,4%	0,3%	0,3%	0,0%	0,0%	0,0%	0,2%
Total N	1007	1000	1001	1001	1000	1000	631	6640
Total %	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Age group	**UK**	**Finland**	**Italy**	**Sweden**	**Poland**	**Germany**	**Iceland**	**Total**
18 - 24 Years	9,4%	10,0%	7,9%	8,5%	9,0%	8,6%	3,5%	8,4%
25 - 34 Years	15,6%	16,5%	14,6%	19,3%	17,6%	15,9%	10,5%	16,0%
35 - 44 Years	21,2%	18,5%	22,2%	18,6%	21,5%	18,2%	14,0%	19,4%
45 - 54 Years	21,4%	17,1%	20,5%	18,6%	17,2%	22,9%	16,7%	19,3%
55 - 64 Years	17,7%	19,0%	18,2%	17,4%	19,4%	17,4%	20,8%	18,4%
65 - 75 Years	14,7%	18,9%	16,7%	17,7%	15,3%	17,0%	34,6%	18,4%
Total N	1007	1000	1001	1001	1000	1000	630	6639
Total %	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Household type	**UK**	**Finland**	**Italy**	**Sweden**	**Poland**	**Germany**	**Iceland**	**Total**
I live at home with my parents	11,0%	3,6%	17,3%	6,1%	11,5%	5,9%	2,4%	8,6%
I live alone	20,5%	34,9%	13,1%	29,7%	11,0%	26,5%	14,7%	21,9%
I live alone with my child / children	6,4%	4,4%	3,2%	6,5%	4,2%	5,0%	5,5%	5,0%
I live with my spouse	31,4%	36,5%	28,7%	30,4%	26,5%	34,8%	43,4%	32,5%
I live with my spouse and child / children	24,3%	19,2%	31,6%	22,1%	35,3%	24,2%	31,4%	26,6%
I live with other adults (other than spouse or family members)	4,7%	0,8%	2,9%	3,4%	8,1%	2,1%	1,6%	3,5%
Other	1,3%	0,5%	3,0%	1,4%	2,8%	1,1%	0,3%	1,6%
Prefer not to say	0,5%	0,1%	0,3%	0,5%	0,6%	0,4%	0,6%	0,4%
Total	1007	1000	1001	1001	1000	1000	631	6640
Total N	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Education	**UK**	**Finland**	**Italy**	**Sweden**	**Poland**	**Germany**	**Iceland**	**Total**
Basic	9,00 %	9,70 %	0,10 %	6,80 %	1,00 %	4,30 %	8,70 %	5,5%
Secondary	46,9%	54,9%	63,1%	62,0%	49,5%	66,4%	44,7%	56,0%
Tertiary, university	44,1%	35,4%	36,8%	31,2%	49,4%	29,4%	46,6%	38,5%
Total N	985	994	999	999	993	987	609	6566
Total %	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Diet	**UK**	**Finland**	**Italy**	**Sweden**	**Poland**	**Germany**	**Iceland**	**Total**
omnivore	73,2%	80,5%	78,6%	78,8%	79,9%	69,1%	86,4%	77,6%
meat sometimes / no red meat	18,8%	14,7%	11,0%	13,6%	17,0%	24,2%	9,9%	15,9%
(some form of) vegetarian	8,1%	4,9%	10,4%	7,6%	3,1%	6,7%	3,7%	6,5%
Total N	1002	988	1000	994	999	993	624	6600
Total %	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Type of living area	**UK**	**Finland**	**Italy**	**Sweden**	**Poland**	**Germany**	**Iceland**	**Total**
Capital area	18,6%	22,6%	9,4%	20,7%	17,2%	13,6%	62%	23,4%
a large city that is not in the capital area	18,6%	24,1%	21,4%	29,2%	39,2%	26,8%	18%	25,3%

a small city/town or municipality	47,0%	25,0%	57,8%	34,5%	27,2%	36,1%	16%	34,8%
a rural area	15,9%	28,3%	11,4%	15,7%	16,4%	23,5%	5%	16,6%
Total N	1007	1000	1001	1001	1000	1000	631	6009
Total %	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%		

4.2.1.2 The survey and the measurements

The survey questionnaire (See Appendix A) consisted of three sections:

The first section included questions about the demographic background (questions BG1 – BG6), eating habits and attitudinal background (Q1 – Q11) of the respondents.

The second, and main section measured respondents' **acceptance of the three NextGen proteins.** The respondent answered similar questions concerning each of NextGen concepts, NextGen microalgae, NextGen insects and NextGen Torula, one concept at the time. Before answering the acceptance questions, the respondents saw a written description of the concept in question (Figure 10, Figure 11 and Figure 12). He or she also had the possibility to re-read the description while answering. In the description, the raw materials, production method, nutritional value of the ingredient and sustainability benefits of the production method were described.

The order of presenting the three NextGen concepts and the related acceptance questions were randomised.

In the last section, respondents rated their interest to use three food application examples (vegetable-protein patties, sausages and salty snacks) if these were either conventional or made with the NextGen microalgae, insect or Torula protein.

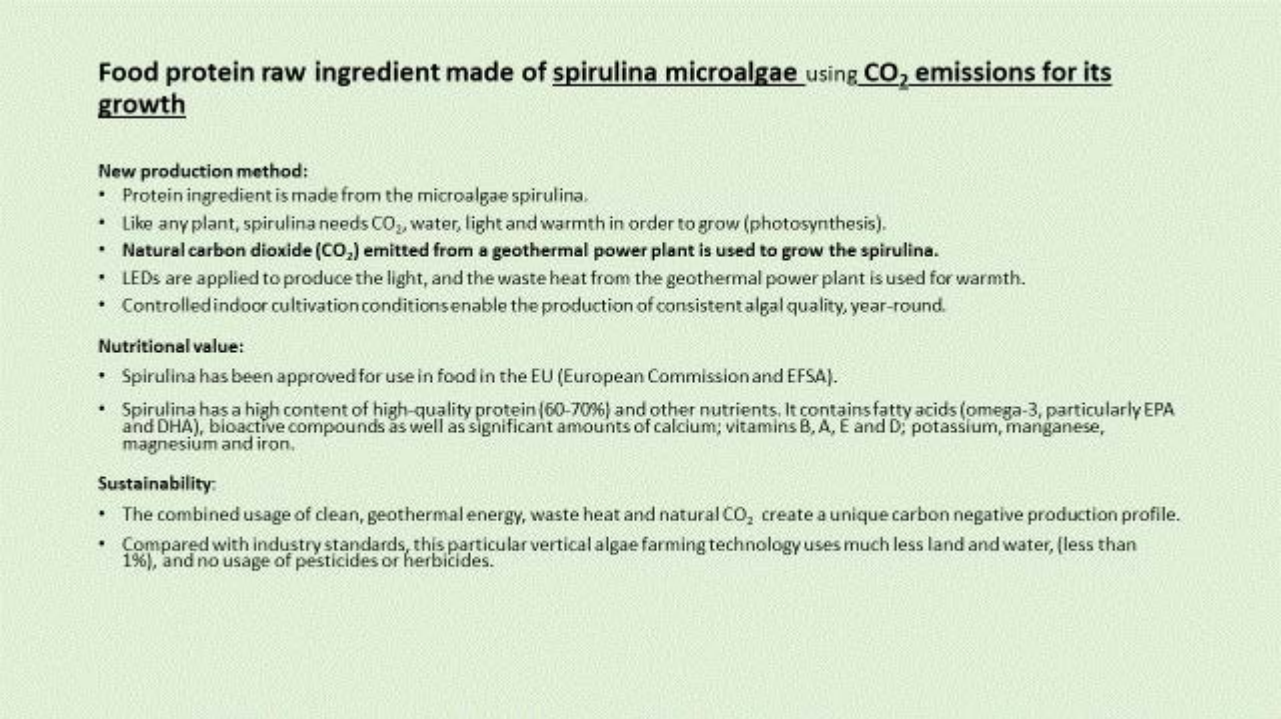

Figure 10. Information presented for the survey respondents about the NextGen microalgae concept.

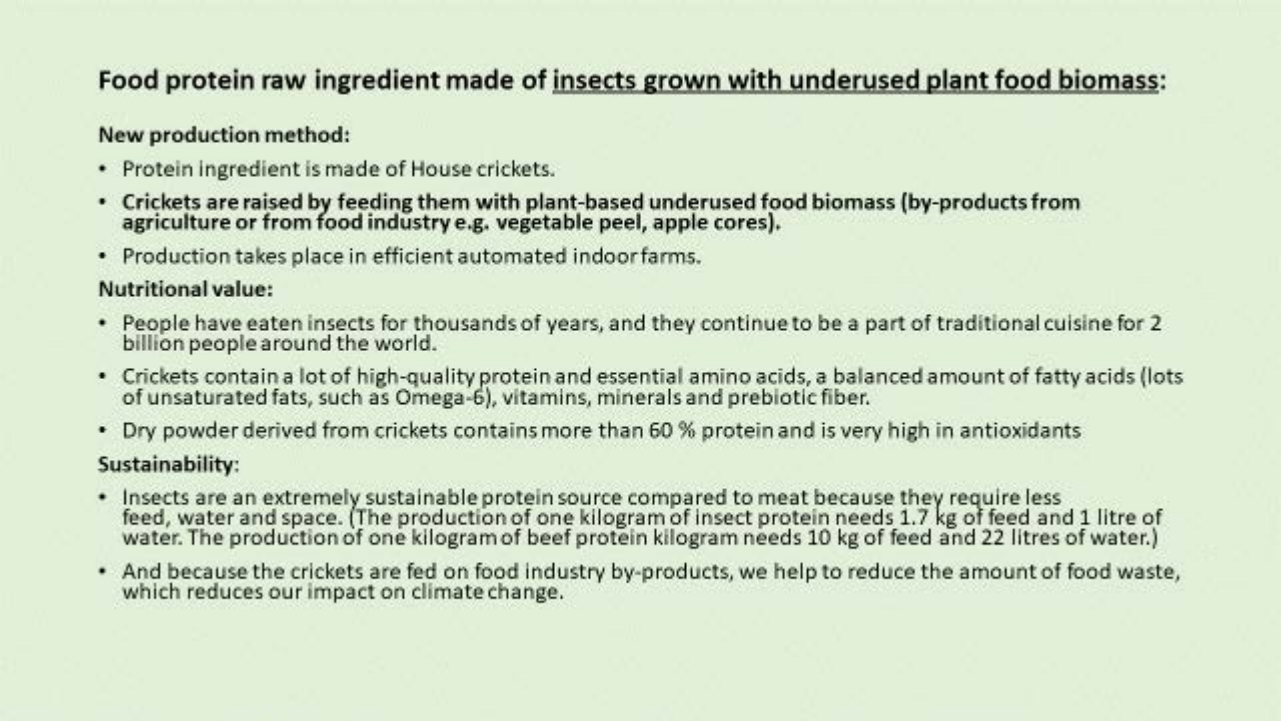

Figure 11. Information presented for the survey respondents about the NextGen insect concept.

Figure 12. Information presented for the survey respondents about the NextGen Torula concept.

Measures of acceptance

Similar sets of five types of acceptance questions were presented after each of the NextGen concept description. In this report we call them **1) attitudes, 2) perceived benefits, 3) perceived risks, 4) foodviews** (respondents' preconceptions about the quality of food if made with that ingredient) **and 5) use interest.** See the Appendix A for the survey questions.

In sum, the measures of acceptance regarding each of the three Nextgen concepts were:

- **ATTITUDE:** General attitude (3 items)
- **BENEFITS:** Likelihood of benefits of the concept (5 items)
- **RISKS**: Level of concern over risks (3 items)
- **FOODVIEWS:** Preconceptions of imaginary food applications made with the ingredient in question (7 items)

Interest to use the example foods with different protein ingredients

- sausages, vegetable-protein patties and snacks

Attitudes were measured by asking *"What do you think about the previously described method of producing a food protein ingredient?".* Respondents answered by rating three sematic differential scales: "*It seems to me as…" 1 =a very bad idea – a very good idea; unwise – wise; I am against this – I am in favour of this"* (from 1 = the most negative view to 5 = the most positive view). As an additional item, we asked whether consumers feel the concept as easy or difficult to understand, but this item was not part of the attitude

measure. Composite measures of attitude towards each of the NextGen protein concept were formed as means of the items, "difficult to understand" excluded.

Benefit perceptions were measured by asking "*According to your beliefs, how likely or unlikely you think it is for this new raw ingredient and method to have the following benefits?"*, followed by list of five potential consequences: 1) "*beneficial to the national economy"*, 2) "*reduces suffering of the livestock"*, 3) "*beneficial to environmental sustainability"*, 4) "*beneficial to human health"* and 5) "*beneficial to me personally"*. Ratings were made on the scale from 1 = very unlikely to 5 = very likely. Compositive variable describing the average level of perceived benefits were formed as means of the benefit items for each of the NextGen protein concept (I don't now answers excluded.).

Thirdly, respondents rated their **concerns about three types of risks** with the scale 1 = *"not at all concerned"* to 5 = *"extremely concerned*". The risk items were: 1) *"Risk concerning human health and food safety"*, 2) *"Risk of unpredicted negative effects on the environment", 3) Risk of being misled by food companies"* 4) *"Other risk".* It was also possible to answer "I don't know" to the benefit and risk questions. Composite variables measuring the average degree of risk perception were formed as means of items 1- 3 for each NextGen concept (I don't now answers excluded.).

The fourth measure aimed to chart **consumers' preconceptions** about **food applications** of these proteins without any other information about these foods except the NextGen ingredient to be applied. The question asked respondents to imagine any food products that would contain the NextGen ingredient in question and rate their preconceptions about the characteristics of these foods. A list of seven semantic differentials were presented: *repulsive – attractive; bad tasting – good tasting, bad for health – good for health, artificial – natural; unhygienic – hygienic; unsafe – safe.* The response scale ranges from 1, which is the most negative description (e.g. bad tasting) to 5, which s the most positive adjective (e.g. good tasting). Composite measures (foodviews) were formed for each of the NextGen concept as means of the items. Thus, the **foodviews** -variables measure how positive or negative views the consumer has about the quality and other characteristics of the food application of that ingredient.

The fifth measure charted consumer **interest to use** three different types of **food applications**: sausages, patties made with vegetables and some of the protein ingredients, and salty snacks. The respondents answered using scales ranging from 1 – "I am not at all interested to use" to 4 "I am extremely interested to use" with the possibility to answer "no opinion / I don't know " also.

For more details about the survey questions, see Appendix A.

Measures of consumers' habits and attitudinal background

Previous research has found certain values, beliefs and consumer characteristics to be related to how consumers evaluate risks, how they approach novel foods, and how they react to food technologies. In addition, previous research on what kind of consumers are more likely to follow vegetarian diets or be more interested in sustainable products and alternative proteins were considered. Based on these literature, we selected a set of measures that can be expected to explain consumer reactions towards NextGen protein concepts which are novel food technologies with expected sustainability benefits resulting in new food products for consumers, which they can use to replace animal protein consumption.

In sum, the measured background characteristics were (Q -numbers refer to the question numbers in Appendix A.):

Demographics, eating habits, familiarity

- Demographics (age, gender, education, type of living area, household type)
- Diet (Q1)
- Meat reduction intentions and reasons for it (Q2 – Q3)
- Familiarity with alternative proteins (Q4)
- Familiarity with future proteins (Q30)
- Use frequency of certain convenience foods (Q5)

Attitudinal background

- Food values (Q6, importance of e.g. taste, health, sustainability etc.)
- Meat attachment (Q7, scale with 9 items)
- Trust in food chain actors (Q8, 7 different actors)
- Attitude towards new food technologies (Q9, scale with 7 items)
- Tendency to avoid novel food tastes (Q10, food taste neophobia)
- Food domain innovativeness (Q11, scale with 4 items)

It is established knowledge that what is habitual and initially familiar is more easily accepted (e.g. Tuorila & Hartman, 2020). Because of the strong influence of habits, consumers who are already using other than animal- based protein could be also more likely to be interested in these novel proteins especially. Therefore, we asked about respondents' current diet (Q1), about their familiarity with more and less conventional protein alternatives for meat as well as about their intentions to reduce meat consumption and about the reasons for it (Q2 and Q3).

Familiarity with alternative proteins (Q4). The respondents were asked to indicate their familiarity with nine different protein sources ranging from the more traditional ones, such as peas and legumes to the fungi-based, soya based and insect-based ones. The provided answer alternatives were 1 = *"I have not heard of these"*, 2 = *"I have heard of these, but I have not tried them"* , 3 = *"I have tried these, but I do not use them"*, 4 = *"I eat these*

occasionally", 4 "I eat these often". The composite variable Familiarity with alternative protein**s** is a mean of all items of question Q4.

At the end of the suvey we also asked about **familiarity of "future proteins**" which referred to novel protein sources which are not yet widely available for consumers: 1) cell-cultured meat, 2) other cell-cultured substance and 3) egg or dairy protein produced using microbes (see Q30 in Appedix A). The mean of these three items was applied as a measure of familiarity with future proteins.

Use of certain convenience foods (Q5). One of the focusses in NextGen project is to develop food applications using the Nextgen proteins. As development of sausages, patties, balls or meal components and snacks have been considered as potential application categories by the food company partners, it is useful to have comparative information about respondents' current use frequency of these types of foods. Based on the items of Q5, composite measures were created to indicate the mean **use frequency of the meat-based convenience foods** (sausages, burgers or meat ball) and use **frequency of vegetarian convenience foods** (oven-prepared meals, meat substitute sausages, meat substitute burgers or patties).

Food choice motives / food values (Q6). Consumers for whom environmental sustainability and nutritional aspects are especially important can be expected to be more favourable towards NextGen proteins, as these were described for the respondents as sustainable and nutritious. This was also suggested by the focus-group results. Respondents' **food-related values** were measured by presenting them a set of 13 food related characteristics (Q6) and asking them to *"…indicate how important it is to you concerning your daily food".* The answering scale ranged from 1 = not important at all to 5 = extremely important. The measure is loosely based on Food choice questionnaire developed by (Steptoe et al 1995, and complemented by Lindeman et al 2000.). Composite variables to measure e.g. importance of sustainability, health, taste etc. were formed a bit differently in each country depending also on the dimensions suggested by factor analyses.

Related to diet, we also measured consumers emotional **attachement to meat** (Q7). The measure reflects consumers' positive attitude towards meat and emotional difficulty to give up meat eating because of seeing it (almost) as the only proper food that is able to provide the taste pleasure and energy you need. We applied a modified and condenced scale from (Garca et al., 2015) including five items, such as *"Nothing compares to the delicious taste of meat"* and *"By eating meat I'm reminded of the death and suffering of animals"* (reversed). The response scale ranged form 1 = completely disagree to 5 = completely agree.

Trust in food chain actors (Q8). Several studies have shown that trust in stakeholders of food domain influence the perception of and acceptance of novel food technologies (for review, see e.g. Frewer et al., 2011) and for example acceptance of cultured meat (Siegrist and Hartmann, 2020). The importance of trust in many different forms came out also in the

the focus-group discussions. (Consumers need proof about the sustainability benefits, they want to know that the safetly of the ingredients are properly investigated before application, they require that food ingredients are honestly indicated in the package etc.) We applied a modified scale from (Siegrist & Hartman, 2020) to measure respondents' trust in various actors (stakeholders) of food chain (Q8 in Appendix A). Trust towards seven different actors were measured with a response scale with 5 answer alternatives, ranging from 1 – I don't trust at all to 5 – have very much trust. Mean of these items is applied as a composite measure of overall trust in food chain actors.

Attitude towards new food technology (Q9). Negative attitude towards use of novel technologies in general is likely to influence consumer views towards the NextGen proteins. In the focus-group studies, consumers justified their negative views by referring to the NextGen methods as "too technological. Respondents' attitudes towards food technology was measured. We utilised modified RISK - dimension from the food technology neophobia scale (Cox & Evans, 2008) and 2 items to measure positive attitude towards food technology (similiar used e.g. by Huotilainen et al. 2006) in forming this scale.

Taste neophobia (Q10) **-** tendency to avoid novel foods because of fear of bad taste and lack of trust in new food - was measured with five items, such as *"I am doubtful of eating something I have ever tasted before"* and *"Foods I have never eaten before seem sort of disgusting"*. Answers were provided with five-point scales ranging from 1 = does not describe me at all to 5 = describes me well. This scale was modified from Nezlek et al 2021 Motivation to eat new foods).

Food innovativeness (Q11). More general interest in food novelties and interest to test new foods is likely to relate consumers reactions towards the NextGen conceptes as well. Food innovativeness scale was applied to measure this aspect of consumer characteristics. The scale was modified from the food domain specific innovativeness scale (Goldsmith & Hofacker 1991; Huotilainen et al. 2006). Consumers were asked to rate four items (e.g. *"I usually try new food products before anyone else in my circle of friends"* with a scale from 1 = completely disagree to 5 = completely agree.

4.2.2 Forming the composite variables

This chapter describes the content and formation of the applied variables in more detail.

Factor analyses and reliability analyses were applied to check for dimensionality of each set of measures in each country (see the country-wise result sections). Composite variables were formed as **means** of items, which – based on these analyses – measured the same dimension.

In this chapter we describe the contents and formation of variables that are used in the analyses of the total dataset and country comparisons. The variables applied in each within country analyses may sligtly differ from these (see the country-wise sections for more).

Before calculation of the composite variables. the "cannot say" -answers given to questions relating *benefits* or *risks* of the three NextGen concepts were omitted from analyses. .i.e. recodes as missing values.

4.2.2.1 Variables measuring consumer background characteristics

Composite variables (indices) were formed to describe the strength of each measured **background attitude** as well as respondents' overall **familiarity** with alternative and future proteins. Note however, that in the country-wise analyses some of the variables may have been formed a bit differently depending on the result of pre-analyses in that country. See the country-wise sections for more detail as well as the reliabilities of the variables.

Table 7. Composite variables describing respondents' background attitudes. The measurement scales for all the listed composite variables are 1 – 5. All countries.

Variable name	Description	The variable has been calculated as mean of question items: (See Appendix A for the question items.)
Familiarity_alt	**Familiarity with alternative proteins** (e.g. legumes, tofu, fungi – based meat substitutes)	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9
Familiarity_fut	**Familiarity with future proteins** (e.g. cell-cultured meat)	Q30r1, Q30r2, Q30r3
Trust	**Trust in food chain actors,** such as farmers, food companies, food industry etc.	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7
FTechnology_attitude	**Attitude towards new food technology**	Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV
Meat_attachment	**Attachment to meat eating**	Q7r1, Q7r2, Q7r4, Q7r5, Q7r6, Q7r3_REV, Q7r8_REV (Q7r7 omitted)
Taste_neophobia	**Suspiciousness towards unfamiliar tastes**, avoidance of tasting new foods	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5
F_innovativeness	**Food innovativeness** (interest in new food products)	Q11r1_REV, Q11r2, Q11r3, Q11r4
Use_vege_convemience	Use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5
Use_meat_convenience	Use of meat based convenience foods	Q5r1, Q5r2

Respondents **food choice motives or their "food values"** were measured by asking them to rate 13 issues on how important these are in their daily foods. For example "It is important to me that the food I eat every day …. is healthy, …ethically produced etc.". Answer alternatives ranged from 1 = not important at all to 5 = extremely important. Composite variables were formed as means of items loading on the same factor on in the pre-analyses. For this reason, in the country-wise analyses, the composition of these variables may differ a bit from each other and from these below.

The table below describes the composite variables that are similar across countries.

Table 8. Composite variables to describe food values. Total sample.

Variable name Food values / food choice motives	Description	The variable has been calculated as mean of question items: See Appendix A for the questions.
MO_Sensory	good taste, appearance and texture	Q6r1, Q6r2, Q6r3
MO_Healthy	healthy and nutritious	Q6r5, Q6r6
MO_Natural	natural, no artificial ingredients	Q6r7, Q6r8
MO_Env_ethics	Environmental sustainability, animal welfare and ethics of food production	Q6r9, Q6r11, Q6r12, Q6r13
MO_Conv_price	Is inexpensive, does not require much time to prepare	Q4, Q10

4.2.2.2 Variables measuring consumers' acceptance of the NextGen protein concepts

Composite variables were formed as means of the scale items.

New variables were formed to reflect positivity or negativity of respondents' ***attitude*** towards each of the three NextGen concepts: Spirulina microalgae, insects and Torula. In addition, composite variables were formed to measure how much respondents believed in ***benefits*** of each of the NextGen concept, and how much they were ***concerned about the risks*** of the three NextGen concept. Fourth, respondents' ratings (views or pre-assumptions) about food characteristics of the imagined NextGen food applications were averaged for each Nextgen concept. These ***food views*** variables measure the to what extent the consumers associate positive vs. negative characteristics to food application of each of the NextGen ingredient.

Finally, consumer interest to use three food types, vegetable-protein patties, salty snacks and sausages, if made with the each of the three NextGen proteins were asked, thus resulting with 9 variables measuring consumer interest towards NextGen food applications. For the sake of comparison, consumer interest to use similar foods as conventional versions were also asked.

Acceptance of each of the three Nextgen concepts were measured with five set of questions, and composite variables for each concept were formed accordingly.

The following composite variables were formed for each of the three NextGen concepts as means of the scale items.

1. **ATTITUDE:** General attitude (items 1, 2 and 4 of Q12, Q17, and Q22)
2. **BENEFITS:** Likelihood of benefits of the concept (5 items of Q)
3. **RISKS**: Level of concern over risks (3 items)
4. **FOODVIEWS:** Preconceptions of imaginary food applications made with the ingredient in question (7 items)

5. **USE INTEREST** of NextGen food application examples (vegetable-protein patties, sausages, and salty snacks)

Table 9. Composite variables measuring acceptance. The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation and items
ATTITUDES	*Scale: 1 = negative end … 5 = positive end*
ATT_Algae	Attitude towards NextGen microalgae protein *(mean of items Q12r1, Q12r2, Q12r4)*
ATT_Insect	Attitude towards NextGen insect protein *(mean of items Q17r1, Q17r2, Q17r4)*
ATT_Torula	Attitude towards NextGen Torula protein *(mean of items Q22r1, Q22r2, Q22r4)*
PERCEIVED BENEFITS	*Scale 1 = very unlikely … 5 = very likely*
BENEFIT_Algae	Likelihood of benefits from NextGen microalgae protein *(mean of items Q13r1 – Q13r5)*
BENEFIT_Insects	Likelihood of benefits from NextGen insect protein *(mean of items Q18r1 – Q18r5)*
BENEFIT_Torula	Likelihood of benefits from NextGen Torula protein *(mean of items Q23r1 – Q23r5)*
PERCEIVED RISKS	*Scale 1 = not at all concerned … 5 = extremely concerned*
RISK_Algae	Concern about risks relating to production of NextGen microalgae proteins *(mean of items Q14r1-Q14r3)*
RISK_Insects	Concern about risks relating to production of NextGen insect proteins *(mean of items Q19r1-Q19r3)*
RISK_Torula	Concern about risks relating to production of NextGen Torula proteins *(mean of items Q24r1-Q24r3)*
FOOD APPLICATION VIEWS	Scale 1 = the negative end of the sematic differential sclales, e.g. "repulsive" … 5 = the positive end of the semantic differential scale, e.g. "attractive
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein *(mean of items Q15r1-Q15r7)*
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein *(mean of items Q20r1-Q20r7)*
FOODVIEWS_Torula	Views towards foods made with NextGen Torula protein *(mean of items Q25r1-Q25r7)*
USE INTEREST	one item -variables with scale from 1 = not at all interested to use to **4** = extremely interested to use (note however that in Iceland the scale was 1 – 5)
IN_Sausage_Algae	Interest to use sausages made with NextGen microalgae protein (Q27r3)
IN_Sausage_Insect	Q27r1
IN_Sausage_Torula	Q27r2
IN_snacks_Algae	Q28r3
IN_snacks_Insect	Q28r1
IN_snacks_Torula	Q28r2
IN_patties_Algae	Q29r3
IN_patties_Insect	Q29r1
IN_patties_Torula	Q29r2
INT_Algae	mean of Q27r3, Q28r3, Q29r3
INT_Insect	mean of Q27r1, Q28r1, Q29r1
INT_Torula	mean of Q27r2, Q28r2, Q29r2

Composite variables to measure subjective norms towards the use of NextGen concepts (Q16, Q21, Q26) were not formed nor applied in the further analyses. This is because of poor reliability. Assumingly, part of the respondents seem not to have noticed the negative formulation of the second item *"Most of the people I know would not be interested in purchasing these foods".*

4.2.3 Data analysis

The main results reported in this deliverable are based on analyses, which were carried out separately with the dataset of each individual country. These are also reported separately for each country. This approach was chosen in order to allow more detailed data screening and to allow to potential differences in each dataset to come out. This also helped the division of analysis and reporting work. The most important reason was however our aim to provide the kind detailed results, which could be useful for food and ingredient companies developing products for markets in a certain country. For this purpose, we chose to analyse consumer segments separately in each country.

In addition to the country-specific analyses, some analyses have been carried out with the joint dataset allowing direct country comparisons.

Cluster analyses

Cluster analyses were performed separately for each of the NextGen concept in each country. The aim was to group consumers on the basis of what kind of views they have about the NextGen concept in question. Description of the typical characteristics of the cluster members aims to help in understanding how consumers with different views towards the each of the NextGen concepts differ from each other in terms of their demographic characteristics and mindsets.

Clustering was carried out on the basis of composite variables measuring acceptance towards the NextGen concept in question. Thus, for example when consumers were clustered on the basis of their views towards NextGen Spirulina microalgae concept, that was done on the basis of composite variables measuring their attitudes towards that concept, their beliefs about the benefits of the concept, their concerns about the risks of the concept as well as their mean evaluations of the quality of the imaginary food application of NextGen microalgae protein (i.e. variables: ATT_Algae, BENEFIT_algae, RISK_algae and FOODVIEWS_algae, cf. 4.2.2.2).

Cluster analyses were performed in three steps.
Phase 1. Three sets of hierarchical cluster analyses were performed using random sub-samples of 33 % of respondents (of the country in question) in order to define the number of clusters that best fit the data.

Phase 2. K-means clusters analyses were run using the numbers of clusters suggested by the dendrograms of the hierarchical clustering. The cluster solution that best brought up the qualitative differences in the data was selected and saved as cluster membership variable. In most of the cases, the result was either three or four clusters. In the three cluster solutions, one of the clusters included respondents with most positive views, the second those with intermediate or indifferent attitudes, and the third included respondents with

negative views towards the NextGen concept in question. In the case of four clusters, the fourth cluster often consisted of respondents who had rather positive views, but were to some extent concerned about the risks of the concept.

Phase 3. Description of the resulting consumers clusters in terms of their demographic characteristics and other background factors related to eating habits, attitudes, preferences familiarity with novel proteins etc.

4.3 Overall results and country comparisons

4.3.1 Respondents' diet and attitudinal background compared between countries

In this chapter, we go through some differences in the background profiles of samples from different countries. More detailed results can be seen in the country reports in appendixes.

The share of respondents' who either are some form of vegetarians or avoid eating red meat, only eat meat occasionally varies between countries from 14 % in Iceland to 31 % in Germany. Among the respondents in Poland, Iceland and Finland the share of vegetarians was lowest (below 5 %).

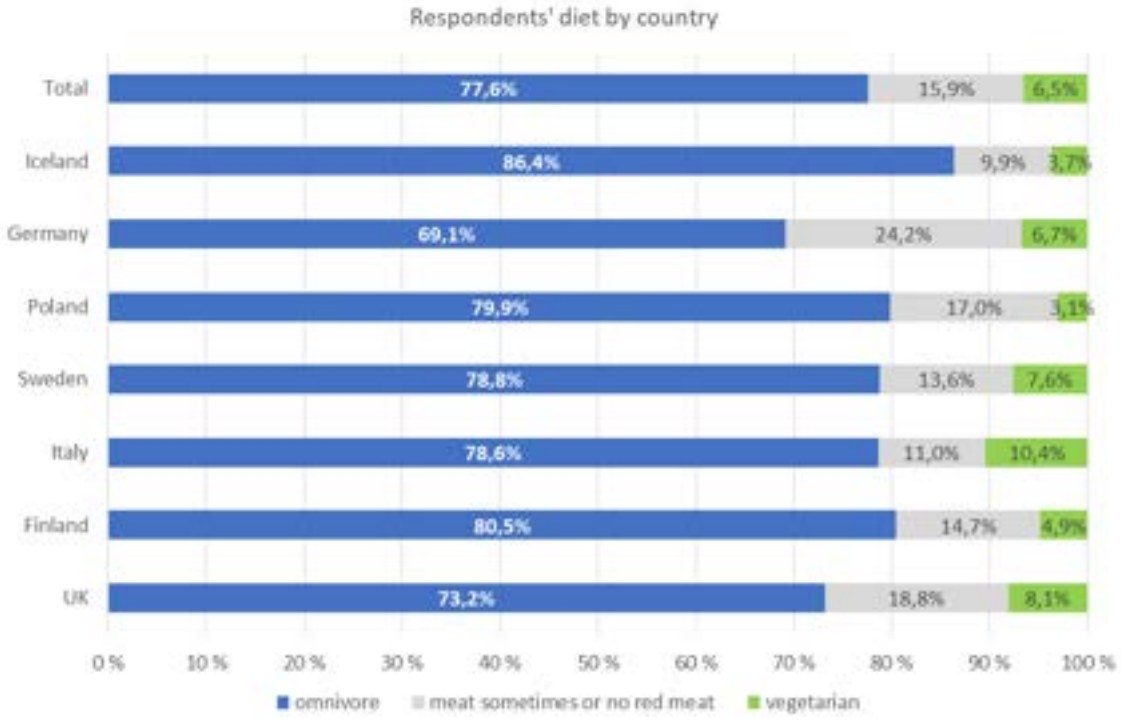

Figure 13. Respondents' diet by country. (The option "meat sometime or no red meat" includes answers to items 2 and 3 to the question 1)

The respondents who were either omnivorous or indicated to eat meat only sometimes were asked if they are intentionally aiming to reduce the meat consumption in their diets (Q1, items 1 and 2). Further, they were asked what are their most important reasons for doing that. The figures below show how respondents in different countries answered this question. (Figure 14.)

The Swedish and Icelandic respondents stand out from other countries in that they more often state sustainability and animal welfare as the most important reason for meat reduction aims. For more detailed results see the country reports in appendixes.

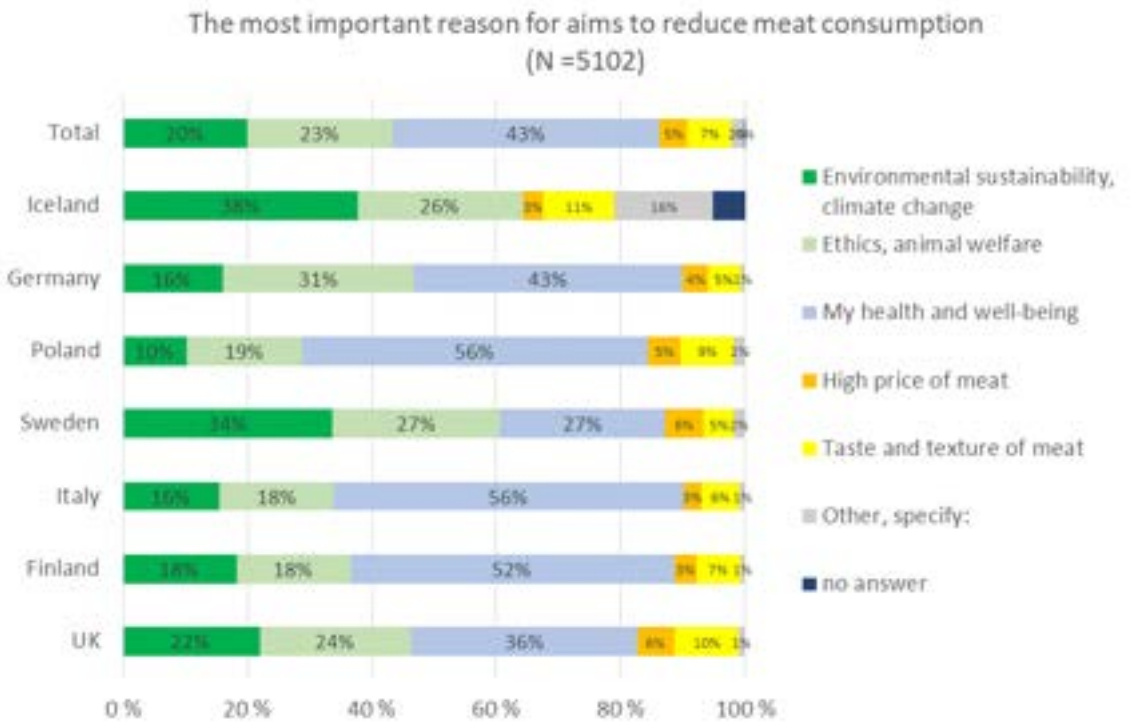

Figure 14. The most important reason for intentionally aiming to reduce meat consumption by country.

The familiarity and use of other protein sources than animal-based ones, varied greatly between the countries, especially in the case of Fava beans and Lupini beans. Italian and Polish respondents seem to be much more familiar with fava beans and also with Lupini beans than most of the other countries. While respondents in Iceland, Sweden and UK were quite unfamiliar with these protein sources. In contrast, the UK and Swedish respondents are more familiar with fungi-based proteins (e.g. Quorn). In Finland and Germany larger share consumers have at least tasted insects than in Italy (Tukey's Post hoc test, p <.000), Figure 15.

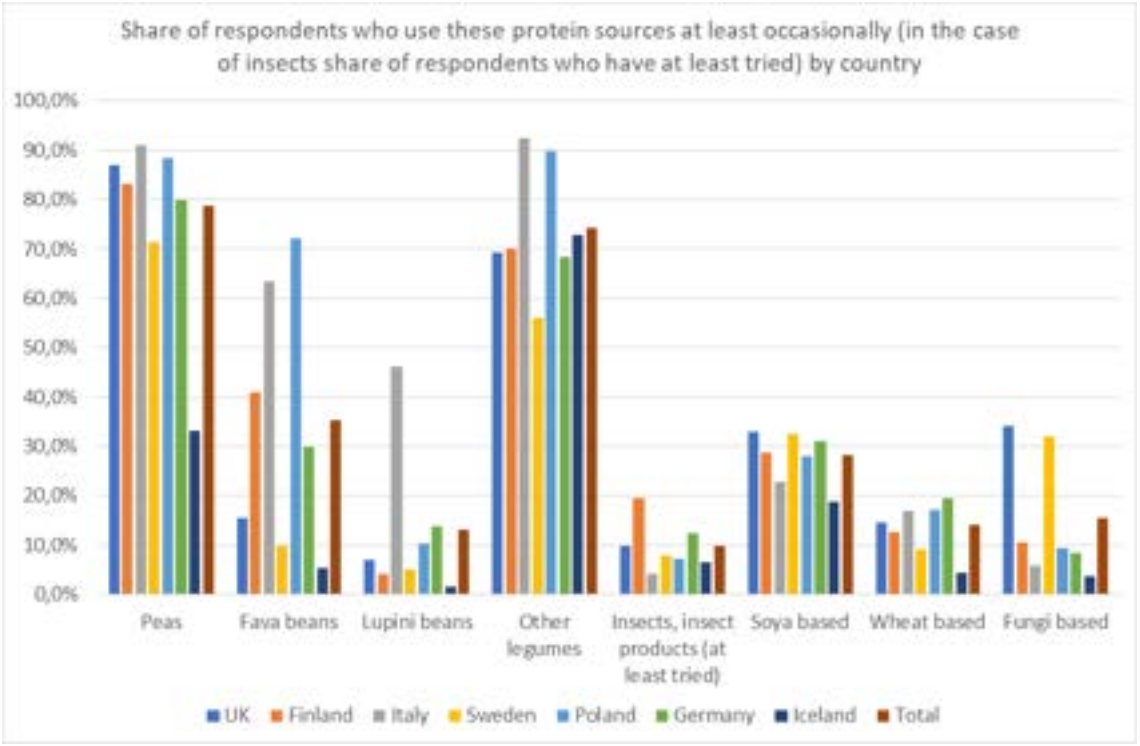

Figure 15. Share of respondents who use various protein sources, alternative to meat, at least occasionally. In the case of insects, the figure includes those who have at least tasted. Country comparison.

The respondents were also asked about their familiarity with three examples of novel proteins, which are not yet in consumer market. The figure below shows that most of the consumers had at least heard of cell cultured meat, but the other two options were mostly unfamiliar to them. (See more detailed results in Appendixes B1-B7).

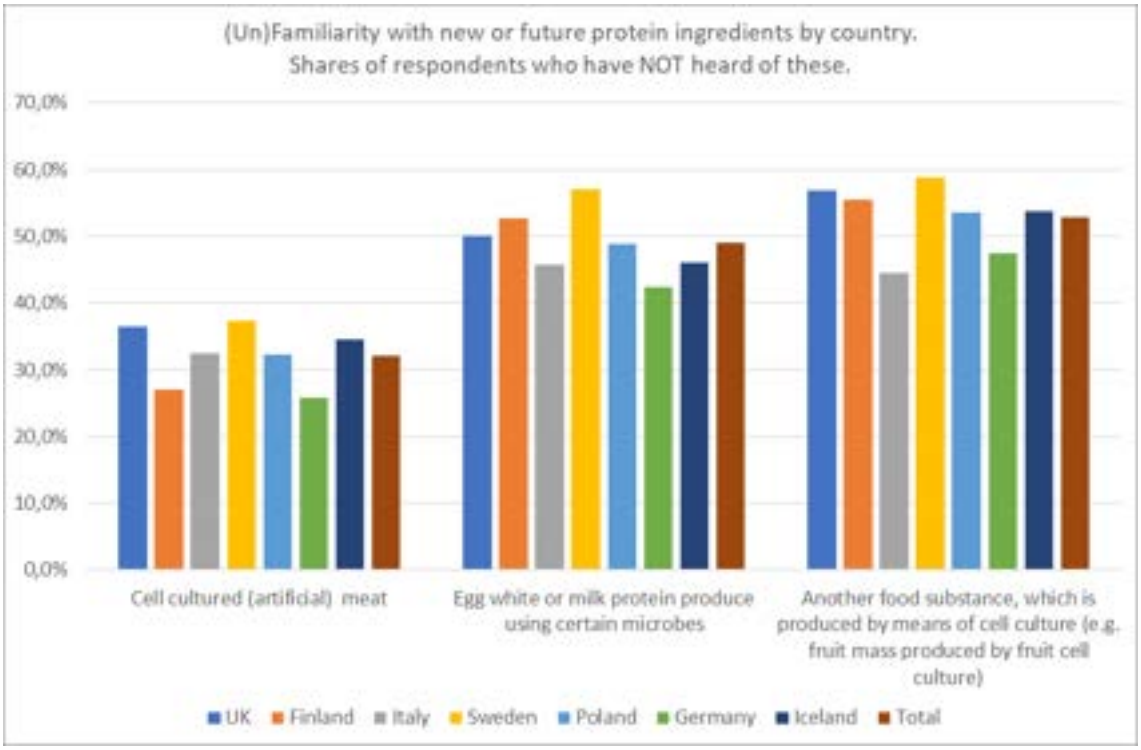

Figure 16. Unfamiliarity with certain new protein sources. Shares of respondents by country, who have never heard of these.

Regarding trust in the actors of food chain, consumers in all countries had highest trust in primary food producers and small food producers. In addition, Food scientists and consumer associations were also well trusted. Countries however differ in their level of trust. Respondents from Iceland report the highest level of trust in all actors. In Germany, the trust in food industry is especially low. Other countries tending to express lower trust were Poland and UK.

Figure 17. Means of trust in various actors of food chain compared between the countries. All the mean trust indices significantly differ between the countries at the level p < .000. (Scale ranges from 1 = no or very little trust to 5 = very much trust).

The Figure 18 below presents the means of the composite variables describing respondents' attitudinal background. (The formation of composite variables is described in chapter 4.2.2.1, e.g. the variable TRUST describes consumers' overall trust in food chain actors, as it is the means of the seven items of the trust question).

Countries significantly differed in all the background attitudes presented in the figure. Most noteworthy is the deviation of Iceland from the other countries. Compared to the other countries the Icelandic respondents have higher trust in the food chain actors overall, they are more attached to meat eating, have clearly more positive attitude towards the use of novel technologies in food production, and lowest reluctance to experience new food tastes (taste neophobia). Based on this data, we cannot say whether this reflects real differences between the countries. However, it is quite possible, and even likely, that **the Icelandic data is biased towards including more of these types of consumers.** This bias can thus be one

reason for the more positive views the Icelandic respondents tend to have towards the NextGen proteins.

Apart from Iceland, the lowest overall level of **trust** can be found in the UK and Polish samples, and the highest in Sweden, Italian and Finnish samples. (Figure 18.)

Sweden, Italy and Finland also score a bit higher in positive **attitude towards food technology** compared e.g. to Germany and Poland. (Figure 18.)

Respondents in UK, Finland and Poland tend to be more **attached to meat** eating than the respondents in Sweden, Italy (and Germany). (Figure 18.)

Interestingly, the Italians rate the highest in the interest in **new food products** coming into market (F_innovativeness), but also have the highest **phobia towards new food tastes** along with UK respondents. (Figure 18.)

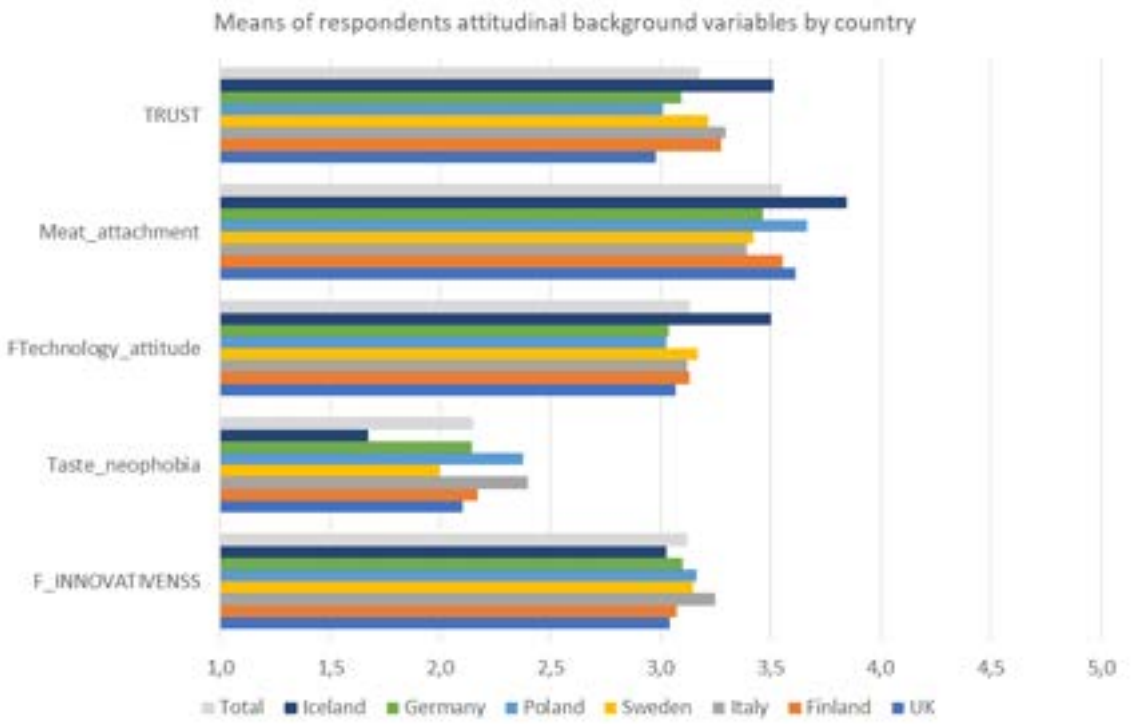

Figure 18. Means of composite variables describing respondents' attitudinal background by country. Within each variable the means significantly differ depending on the country (p < .000).

4.3.2 Acceptance of the NextGen concepts overall – comparison of countries and concepts

Generally **over half of the respondents in all countries stated that they were "in favour of"** the production method of NextGen microalgae, below half that they were in favour of NextGen Torula and only about third of the respondents in total were in favour of the NextGen insect concept. (Figure 19.)

The share of respondents with **neutral attitude was also high**, varying around 30 – 40 percent depending on the country and concept. However, the share of respondents with **opposing attitude** was lower, varying around 10 % - 20 % in case of Torula and microalgae, but around 30 – 50 % in the case of NextGen insect concept. (For more details see the country reports in Appendixes B.)

Generally, consumers were more positive towards the **overall idea** of NextGen protein production (e.g. their attitude ratings) **than towards the food applications** of these proteins. Despite of the respondents' predominantly positive or neutral views towards the ideas of NextGen protein production, they were more suspicious about the quality of the foods in which these new proteins would be applied (foodviews). (cf. Figure 27, Figure 30, Figure 33), NextGen insect concept, was an exception to this, as this concept was rated most negatively on all measures. In similar vein, respondents' interests in using the food application examples (sausages, vegetable-protein patties and salty snacks) were clearly lower compared to their attitudes.

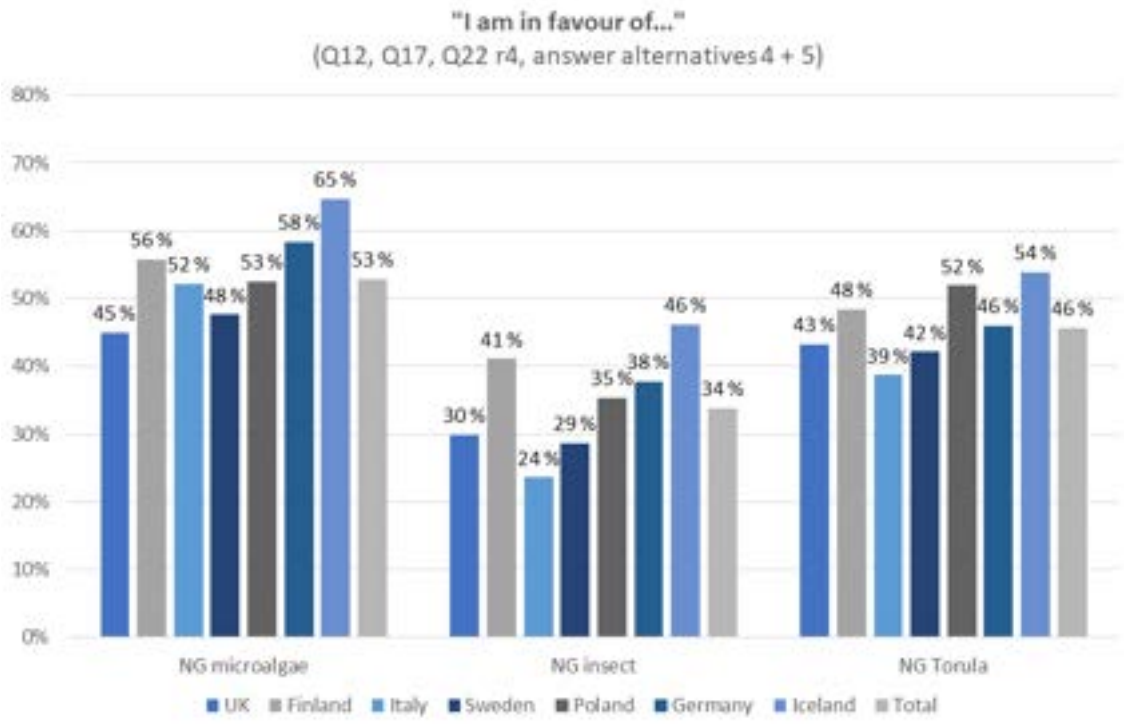

Figure 19. Percentage of respondents indicating that they are "in favour of" three NextGen concept by country.

4.3.2.1 *Differences between the concepts: NextGen microalgae, NextGen insects, NextGen Torula*

Besides attitude, all other measures of consumer acceptance suggested the same: out of the three NextGen protein concepts, the **insect concept was clearly the most difficult one to accept**[1]**.** This was the case in all countries.

NextGen microalgae concept seems to be the easiest to accept, but often there is not much difference between Torula and microalgae acceptance. The level of respondents' attitudes and other acceptance ratings, however, varies depending on the country and concept[2]. In most countries, the acceptance of **Torula and Microalgae was at the same level**, but in Germany, Iceland, Italy, microalgae concept was more positively viewed than the Torula based one. (Figure 20)

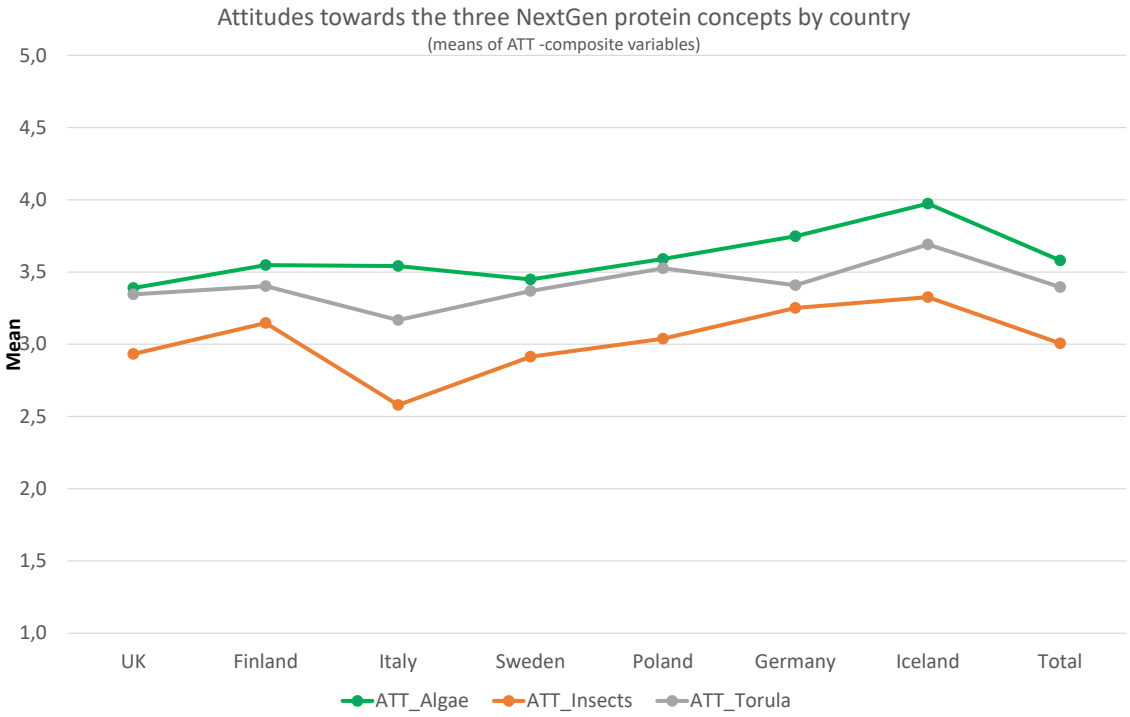

Figure 20. Attitudes towards the three NextGen concept by country. Mean of the composite measure ATTITUDE. Repeated measures analysis of variance comparing means of attitude variables (ATT_algae, ATT_insects, ATT_torula), between the countries: Interaction effect of country and concept: F(12)=20,830, p=.000)

[1] Repeated measures analysis of variance comparing means of either attitude, benefit, risk or foodview variables between the concepts and countries: main effect for country and concept are significant at the level p <.000, and so are the interactions between country and concept.

[2] Repeated measures analysis of variance comparing means of attitude variables (ATT_algae, ATT_insects, ATT_torula) between the countries: Interaction effect of country and concept: F(11,243)=20,830, p=.000)

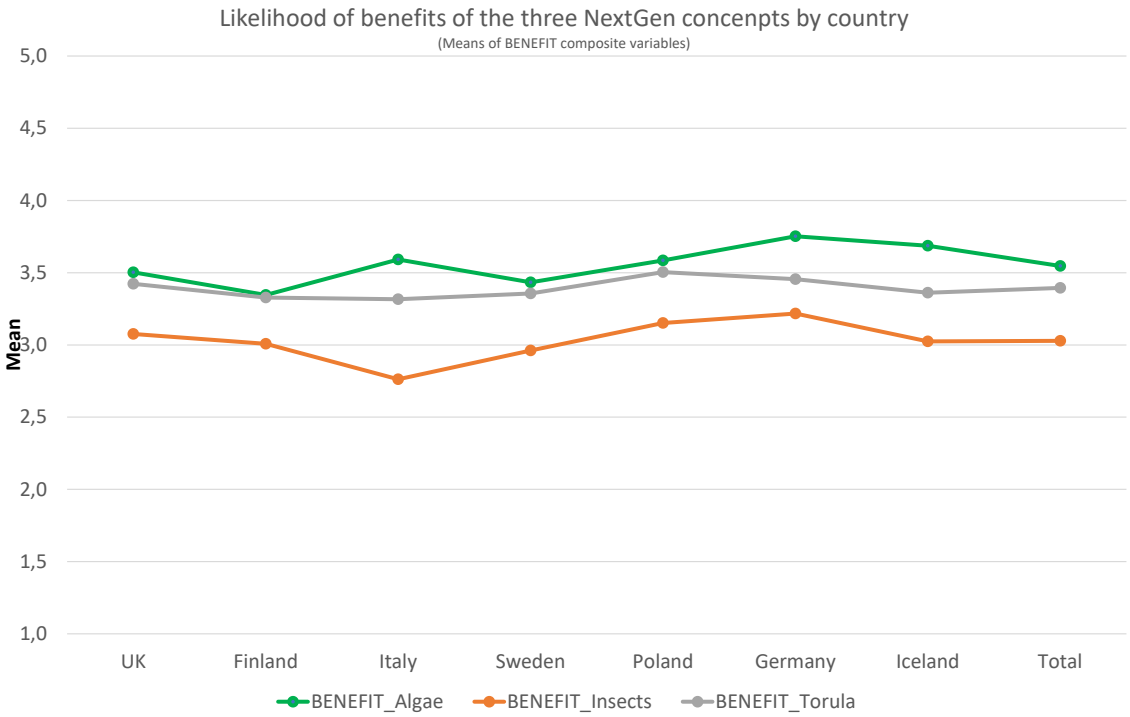

Figure 21. Comparison of mean benefit ratings between the countries and NextGen protein concepts. (1 = very unlikely benefit … 5 = very likely benefit). WS analysis of variance: Interaction effect of country and concept: F(12)=15,438, p=.000)

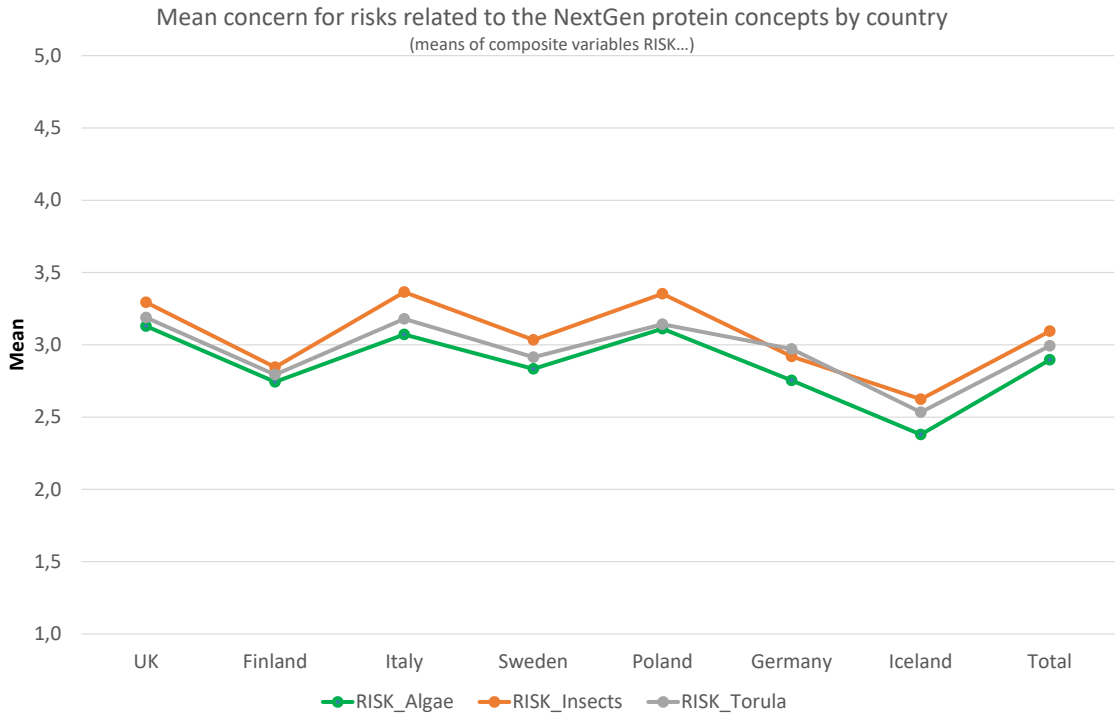

Figure 22. Comparison of mean risk concerns between the countries and NextGen concepts. (1 = not at all concerned about the risk … 5 = extremely concerned about the risk). WS analysis of variance: Interaction effect of country and concept: F(12)=4,645, p=.000)

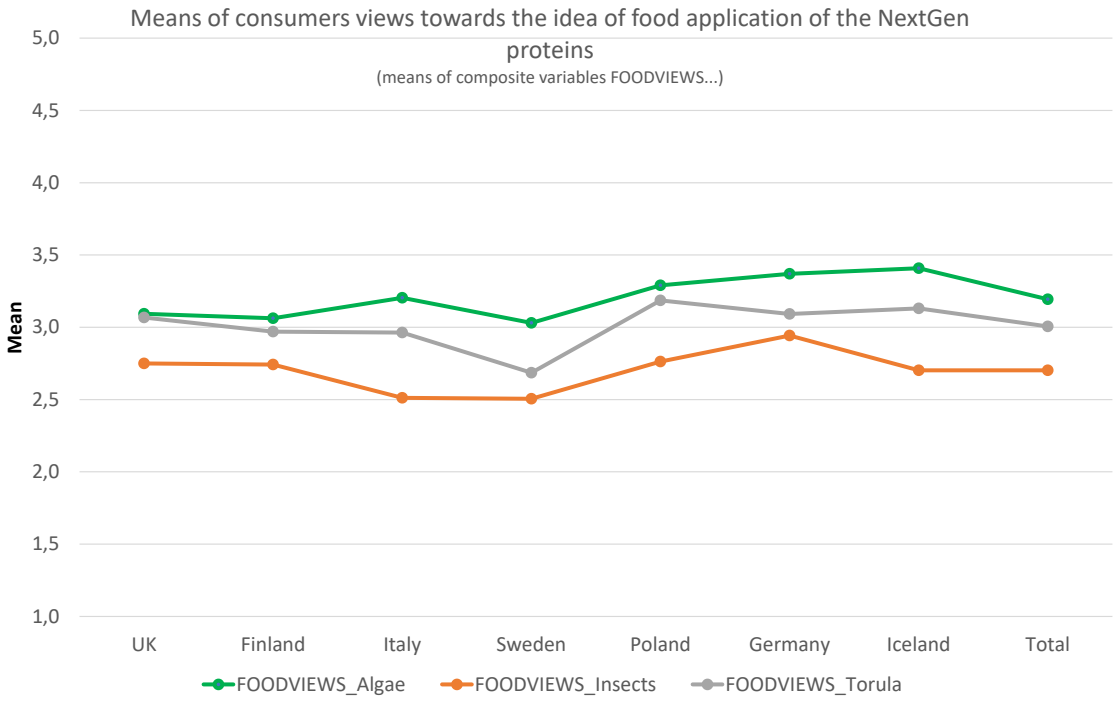

Figure 23. Preconceptions about the quality of food applications. Comparison of mean ratings of imagined characteristics of food applications by NextGen concept and country. (1 = the negative ends of the scales … 5 =positive ends of the scales). WS analysis of variance: Interaction effect of country and concept: F(12)=23,002, p=.000)

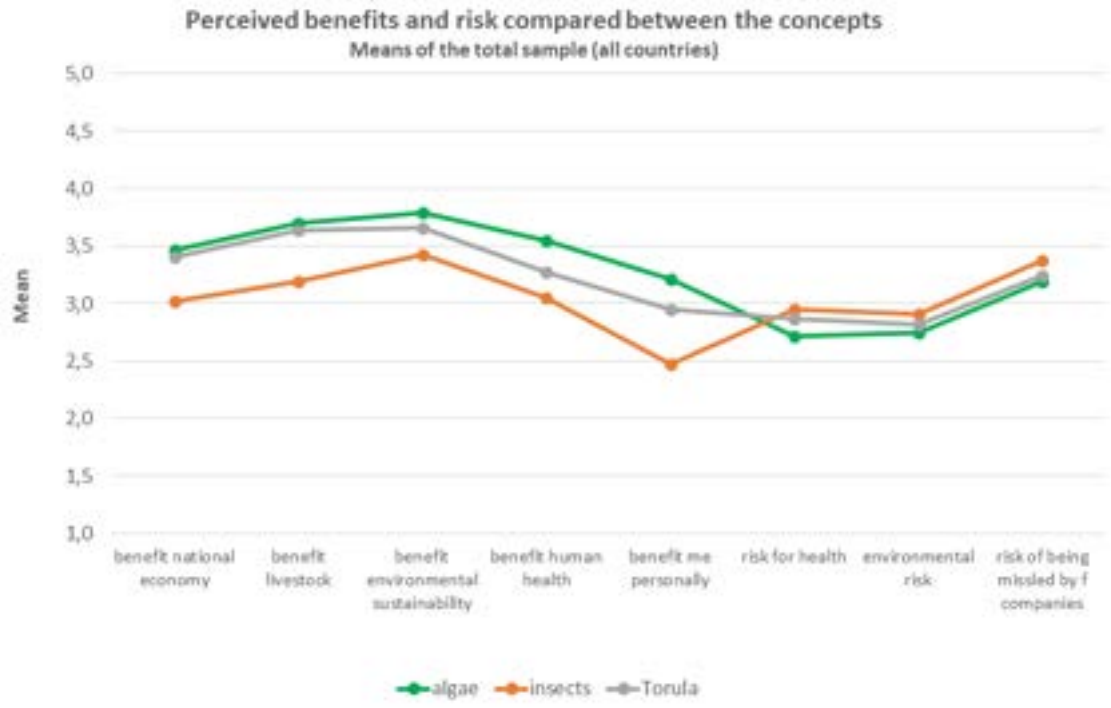

Figure 24. Perceived benefits and risks by NextGen concept. Mean ratings over all countries.

According to respondents' preconceptions, foods made using NextGen **microalgae** and to some extent also **Torula** protein were seen more as **good** than bad **for health** and more as **hygienic** than unhygienic. All the NextGen food applications were perceived more likely as

weird rather than as normal. In contrast, foods made with NextGen **Insect protein** were expected to be clearly more weird, repulsive, bad tasting, and unhygienic and unsafe than the foods made with the other two protein types (all these differences are statistically significant at the level p < .000). However, the concepts are perceived as almost equal in terms of their naturalness. (Figure 25.)

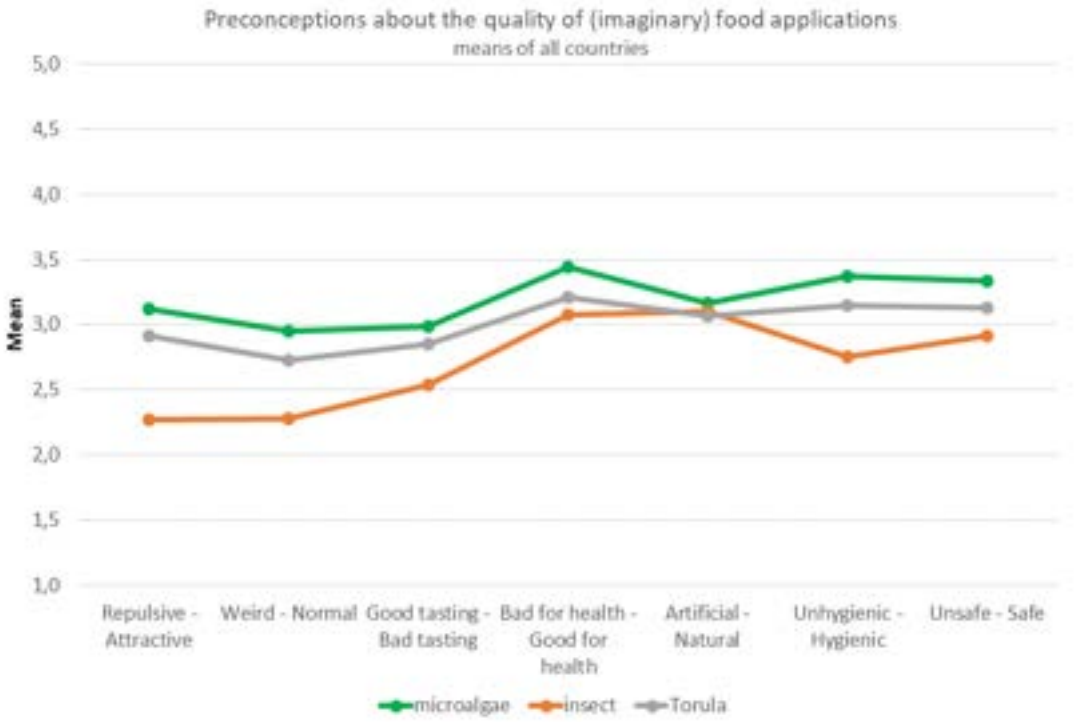

Figure 25. Preconceptions about the quality of (imaginary) food applications. Means of foodview items (Q15, Q20, Q25) over all countries. Tested with repeated measures analyses of variances all the ratings significantly differed between the three NextGen concepts (p<.000).

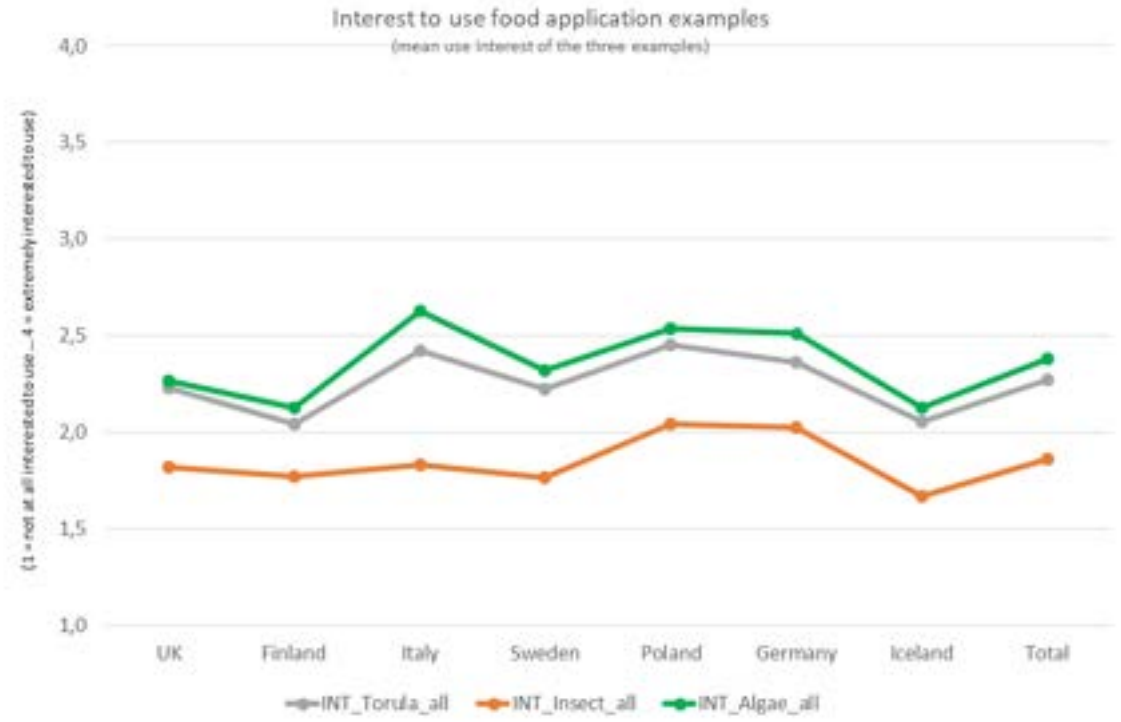

Figure 26. Interest to use the food application examples by concept and country. Means of use interest of three product examples.

4.3.2.2 Differences between the countries

Respondents' views towards the NextGen concepts varied by country and the concept. **Iceland** stood out as most positive towards the NextGen concepts, overall. However, this result should be interpreted with caution, because the result may be influenced by sample biases.

Attitudes towards the **microalgae concept** were most positive in **Iceland and Germany**. They had the most positive ratings of attitude, believed most in the benefits of the concept, were least concerned about the risks and had most positive preconceptions about the quality of imagined food applications (significantly different from e.g. Poland). (Figure 19; Figure 20; Figure 21; Figure 22; Figure 23).

Insect-based concept was most strongly rejected in Italy and most positively regarded (based on mean attitudes) in **Finland, Germany, and Iceland**. (Figure 19; Figure 20).

NextGen Torula concept (based on mean attitude) was regarded most positively in **Finland, Iceland and Poland.** In addition to the insect concept, the Italians were a bit more negative towards the NextGen Torula concept than the respondents in the other countries[3]. Swedish respondents tended to be more suspicious about the quality of the NextGen food applications, especially in the case of Torula (Figure 23; Figure 29; Figure 33; Figure 35.)

Regardless of the concept or country, consumers rated the **benefits for the environmental sustainability and livestock** as the most likely benefits, and personal benefits as the least likely. Benefits for human health also sounded plausible for over half of the respondents. This result was expected as sustainability benefits and nutritional values of the ingredients were described to the respondents before answering the acceptance questions (cf. chapter 4.2.1.2.) Regardless of the concept or country, the **risk of being misled by food companies** appeared to the respondents as most likely (most concern was related to it). (The concept description provided to the respondents did not say anything about the risks.) (*Figure 24*.)

The level of the rated likelihood of each benefit significantly differ between the three concepts (e.g. in the case of benefit for the environment, repeated measures analysis of variance, the main effect for concept is F(2)= 230,329, p =.000, and interaction for concept x country F(12)= 7,031, p =.000): All the **benefits of insect concept were rated as less likely compared to the other two concepts.** *Figure 24***.**

[3] Multivariate analysis of variance ATT_Torula, BENEFIT_Torula, FOODVIEWS_Torula, RISK_Torula: main effect of country: F(24)=31,155, p =.000; Tukey's Post Hoc test: Italy significantly differs for each of the other countries.

4.3.3 More detailed views per concept by country

In this chapter, acceptance measures are compared between the countries separately for the three NextGen concepts in more details. Most of the results have already been mentioned previously. However, more details are shown about, e.g. what kind of preconceptions consumers in different countries have about the food applications and what kind of benefits and risks are most believed in.

4.3.3.1 Views towards NextGen microalgae concept by country

As already mentioned, the level of attitude ratings of the NextGen microalgae concept significantly differ between the countries. The views were most positive in **Iceland and Germany**. They had the most positive ratings of attitude, believed most in the benefits of the concept, were least concerned about the risks and had most positive preconceptions about the quality of imagined food applications (significantly different from e.g. Poland). (Figure 27.)

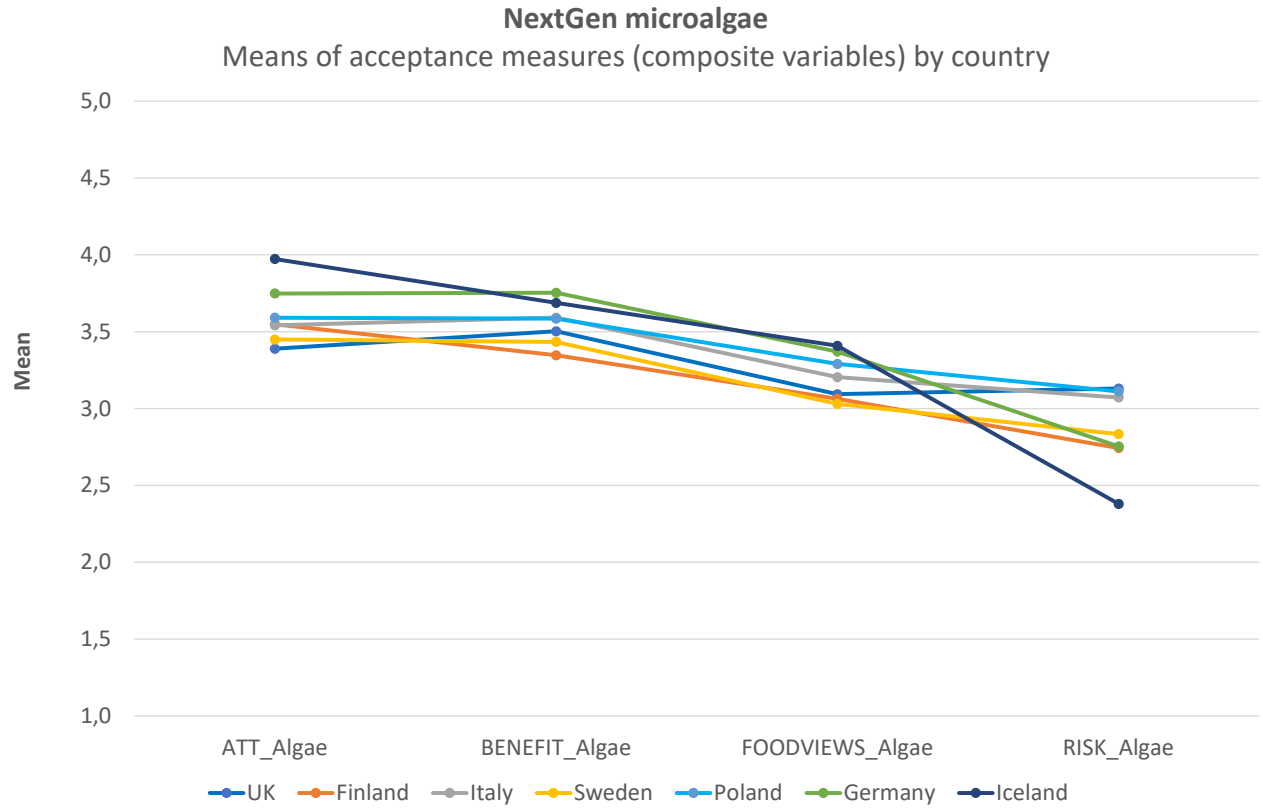

Figure 27. Acceptance of the NextGen microalgae concept by country. Means of the four composite variables measuring acceptance: attitudes, likelihood of benefits, concerns for three risks listed in the survey and mean ratings of food applications. (Scales range from 1 = negative view or low risk concern to 5 = positive view or high risk concen).

Reflecting their more positive attitudes, the respondents in **Iceland** were much less concerned about the risks of NextGen microalgae concept than respondents in the other countries. They also tended to have higher beliefs in the benefits of the concept. As exception, in Iceland, the benefits for animal welfare were rated less likely than in most of the other countries. (Figure 27.)

Iceland stands out also with their higher beliefs in **national economic benefits resulting from NextGen microalgae production**. This may explain why they in Iceland were especially positive towards the microalgae -based concept. This result is in line with the focus-group discussions in Iceland. The participants seemed to think that microalgae cultivation would be especially suitable for their country and they valued the potential for their national economy. (Figure 28.)

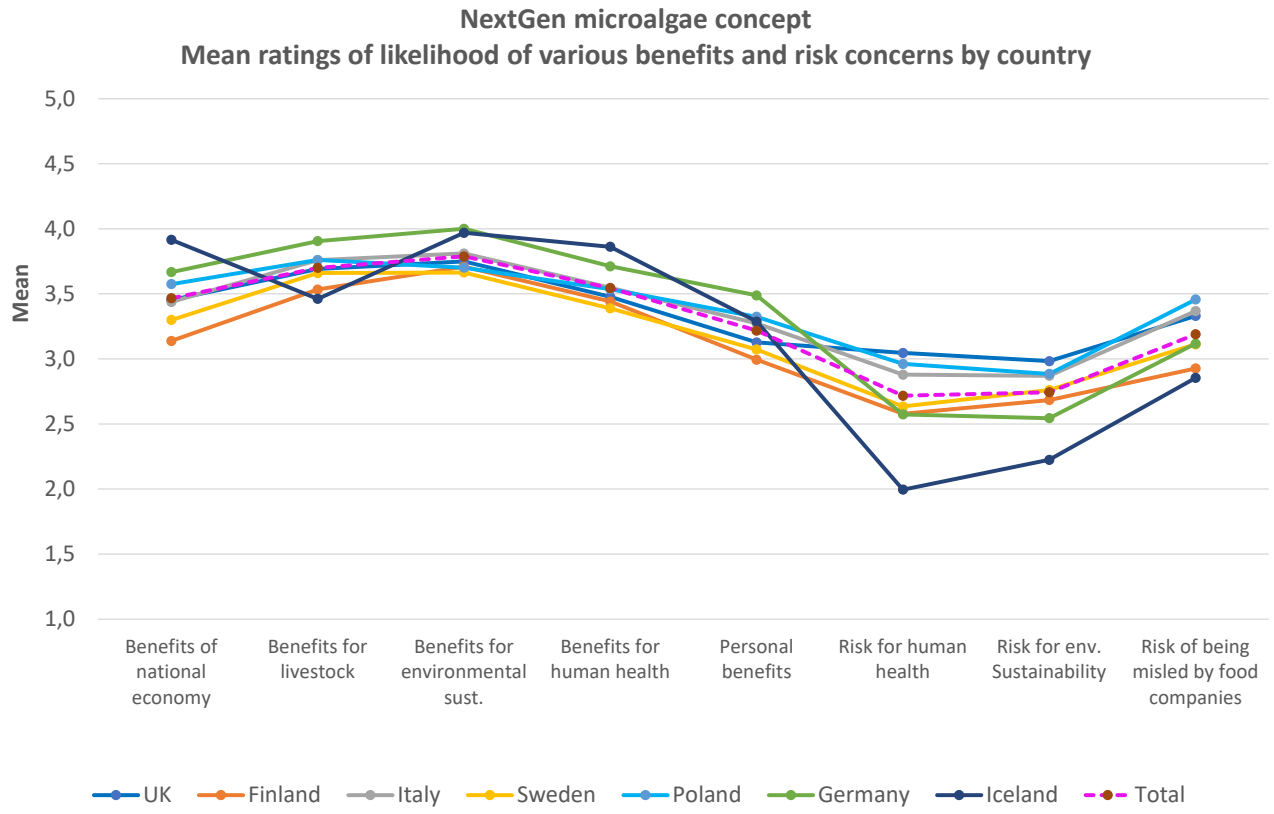

Figure 28. Means of respondents' ratings of benefits and risks related to the NextGen microalgae concept. (Q13 and Q14 in the survey)

As can be seen from the Figure 29. below, consumers' preconceptions about the characteristics of the food applications made with NextGen microalgae protein were very similar regardless of the country, (with some exceptions). Only the level of ratings vary. The Finnish and Swedish respondents tended to be most critical in their ratings and the Icelandic and German respondents had more positive expectations or ratings. (It is possible, that these country-wise differences reflect different response tendencies in addition to differences in views)

Generally, the preconceptions about the NextGen **microalgae food applications** were in average rather positive. These foods were perceived more as being **good for health** than bad for health, more as **hygienic** than unhygienic, and more as **safe** than unsafe, but a bit **weird** and potentially bad tasting.

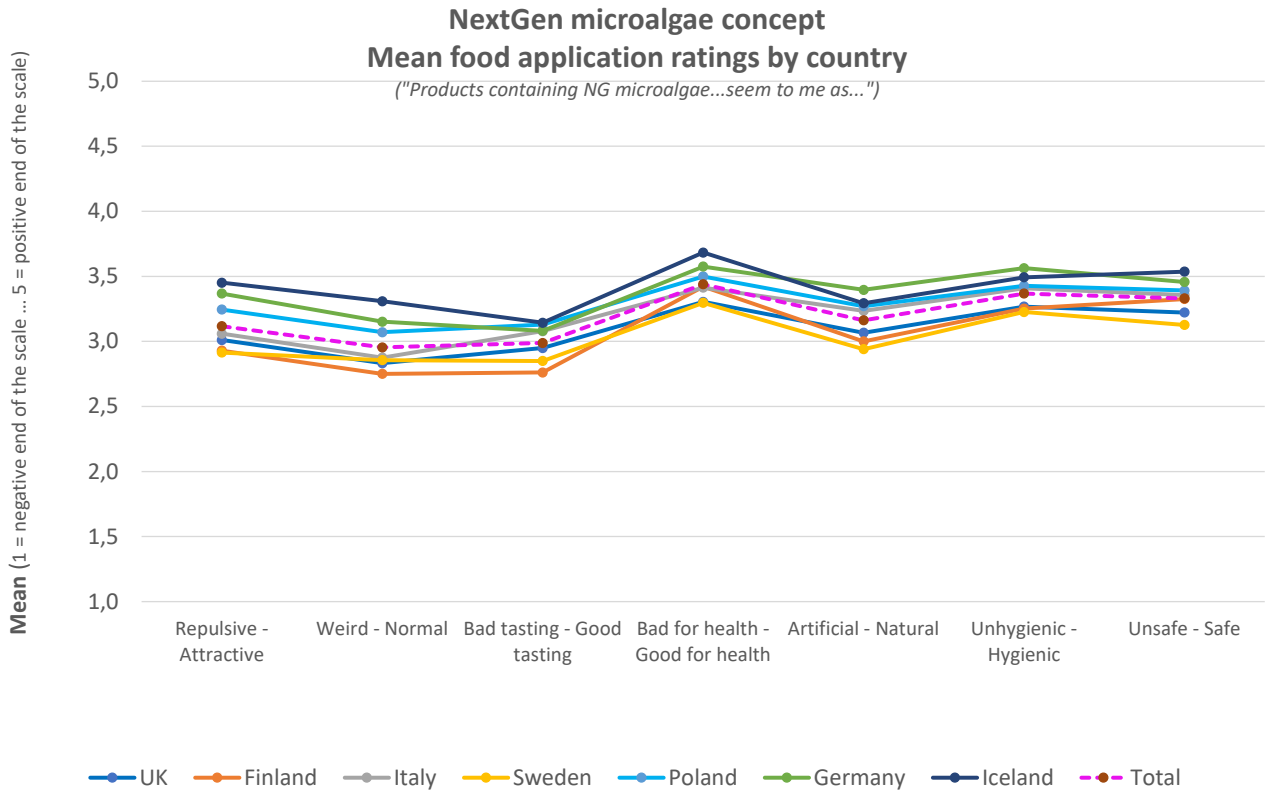

Figure 29. Means of respondents' preconceptions about NextGen microalgae protein food applications. (Q15 in the survey)

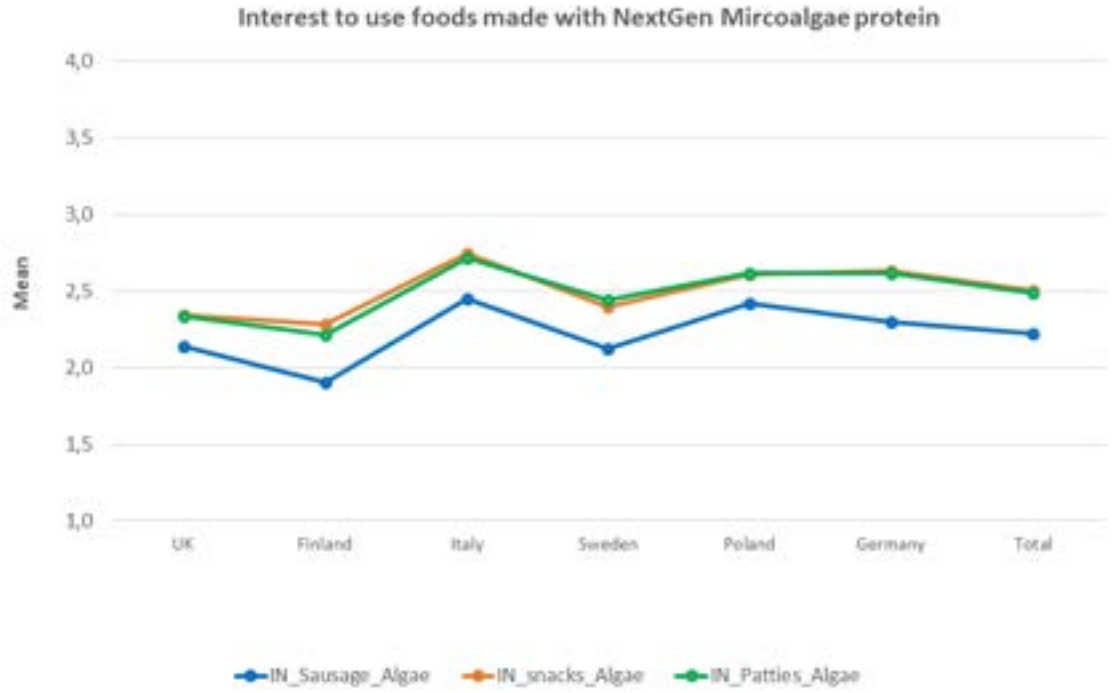

Figure 30. Means of respondents' interest to use the three examples of food applications if made with NextGen Microalgae protein. Iceland is omitted from this comparison as different response scale was used there. Based on WS analysis of variance, the means significantly differ between the countries, and the country x ingredient interaction is significant at the level p=.000. (Q27r1 – Q29r1 in the survey)

In each country, the sausage application was of least interest, but snacks or vegetable-protein -patties equally interesting if made with NextGen microalgae protein. (Based on WS analysis of variance, the means significantly differ between the countries, and the country x ingredient interaction is significant at the level p=.000.). In UK and Finland, consumers rated their interest lower than in the most other countries. Compared to the other countries, Italian respondents rated their interest highest regardless of the food type.

4.3.3.2 Views towards NextGen insect concept by country

The means of each of the acceptance measures concerning the NextGen insect concept (House crickets) significantly differ between the countries (multivariate analysis of variance, p=.000). **Italy deviates from the (most) other countries with the more negative views** on attitudes (Tukey's Post Hoc test, p=.000) and perceived benefits (Tukey's Post Hoc test p <.01). Figure 31.

Along with Italian consumers, the respondents in Sweden had more negative overall preconceptions about the characteristics of food applications made with NextGen insect protein (FOODVIEWS) than the respondents in the other countries (Tukey's Post Hoc test, p=.000). Figure 31.

Respondents in **Iceland were the least concerned about the risks** related to this concept (Tukey's Post Hoc test p <.01), and respondents in Italy, Poland and UK most concerned.

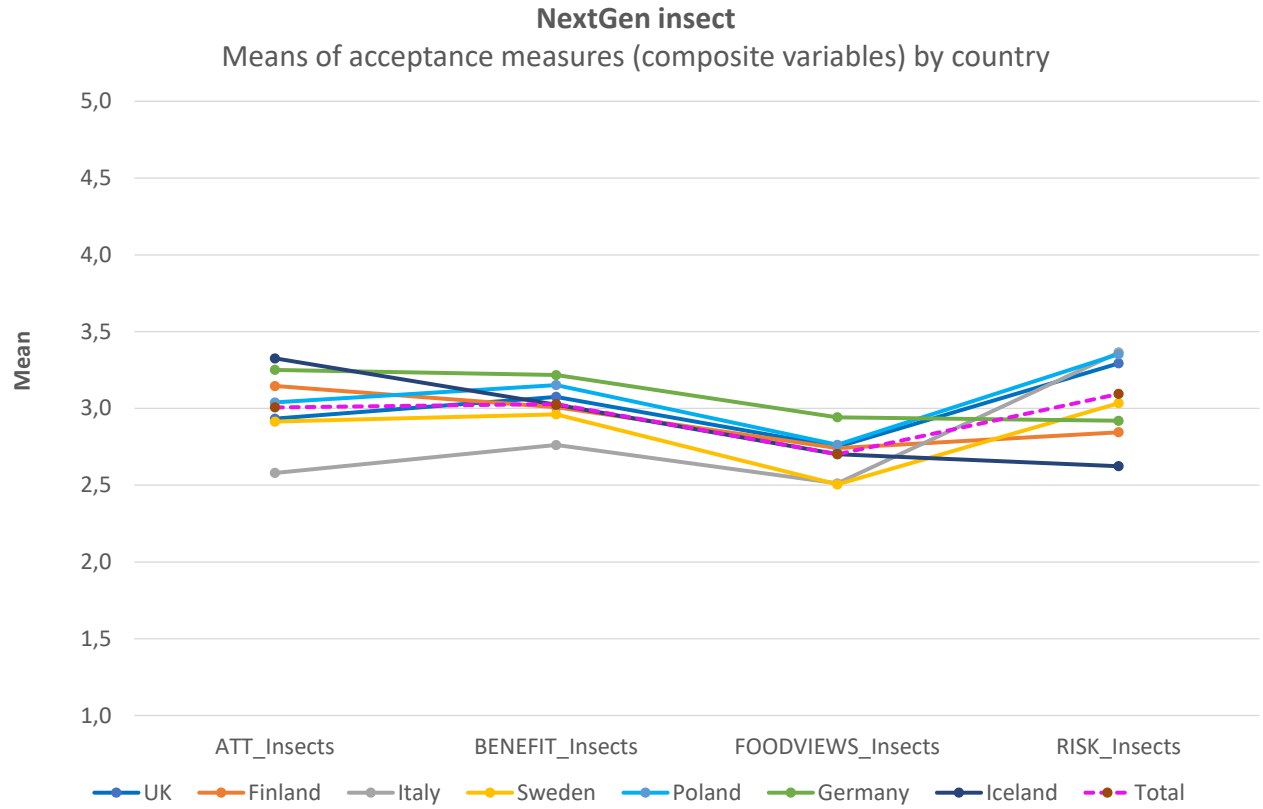

Figure 31. Acceptance of the NextGen insect concept by country. Means of the four composite variables measuring acceptance: attitudes, likelihood of benefits, concerns for three risks listed in the survey and mean ratings of food applications.

Much like in the case of the other NextGen concepts, the respondents rated the **benefits for environment, and animals and to some extend also in health benefits** as the most likely ones. Assumingly, the main reason for this is that these benefits were the ones that the respondents were informed about before answering the questions. Compared to these, **personal benefits** and to some extent also benefits for the **national economy** were less often expected. (Figure 32.)

Evaluation of the risk for human health divided opinions most between the countries: Respondents in **UK, Italy and Poland rated the health risks higher** than respondents in Iceland, Germany and Finland. (Figure 32.)

Reflecting their more positive attitudes, the respondents in **Iceland** were much less concerned about the risks (like in the case of the other concepts) than respondents in the other countries. (Figure 32.)

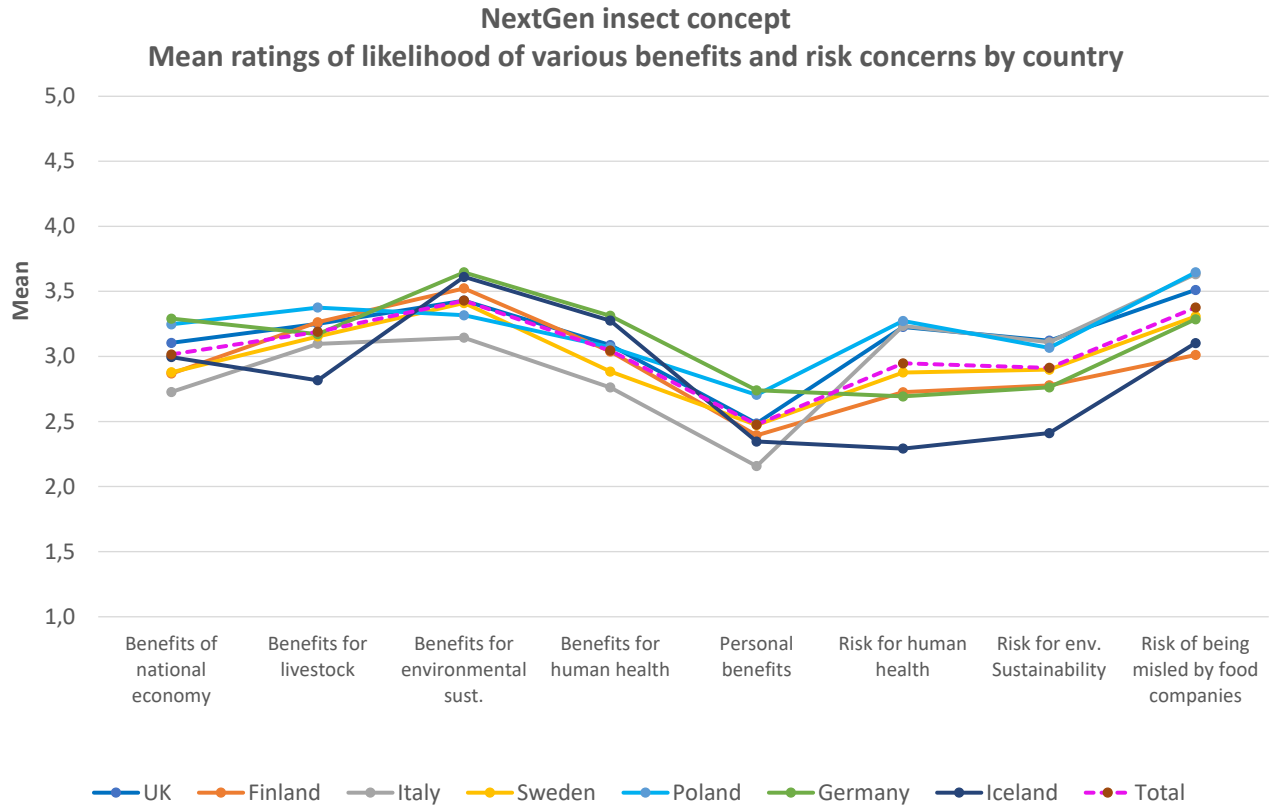

Figure 32. Means of respondents' ratings of benefits and risks related to the NextGen insect concept. (Q18 an Q19 in the survey)

Consumers' preconceptions about the quality and nature of imaginary NextGen **insect food applications** were on average rather negative (compared to the other concepts). Foods made with NextGen insect protein were perceived as **repulsive, weird, and bad tasting** rather than attractive, normal or good tasting in all the countries. However, to some extent these were also perceived as **natural.** Perception of the protein production based on insects as natural was observed also in the focus-group discussions. (Figure 33.)

As can be seen from the figure below, their preconceptions about the characteristics of the food application are rather similar regardless of the country, only the level of ratings vary a bit. The Italian and Swedish respondents tended to be most critical in their ratings deviating from the Icelandic, Polish and German respondents which had often more positive expectations or ratings (e.g. in the case of good taste – bad taste, Tukey's test, p<.000). (It is possible, that the country-wise differences reflect different response tendencies in addition to differences in views). (Figure 33.)

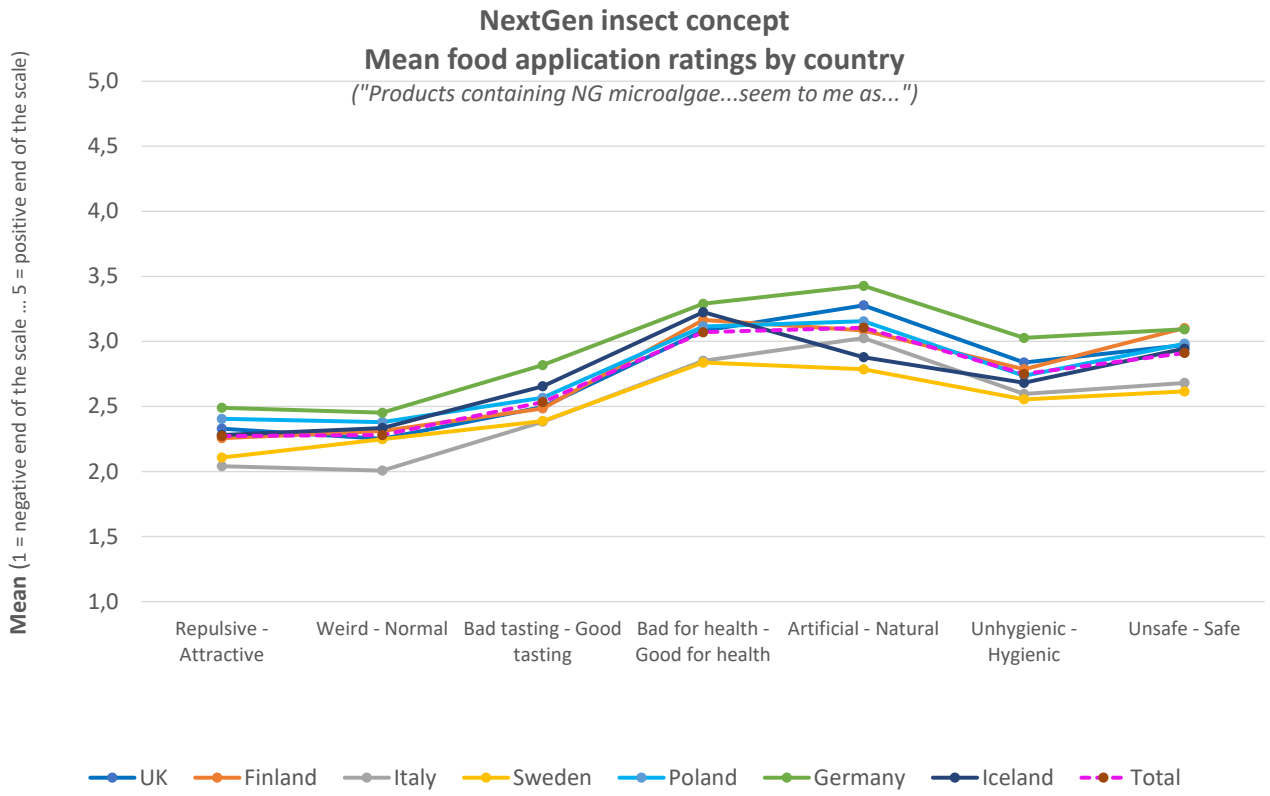

Figure 33. Means of respondents' preconceptions about NextGen insect protein food applications. (Q20 in the survey)

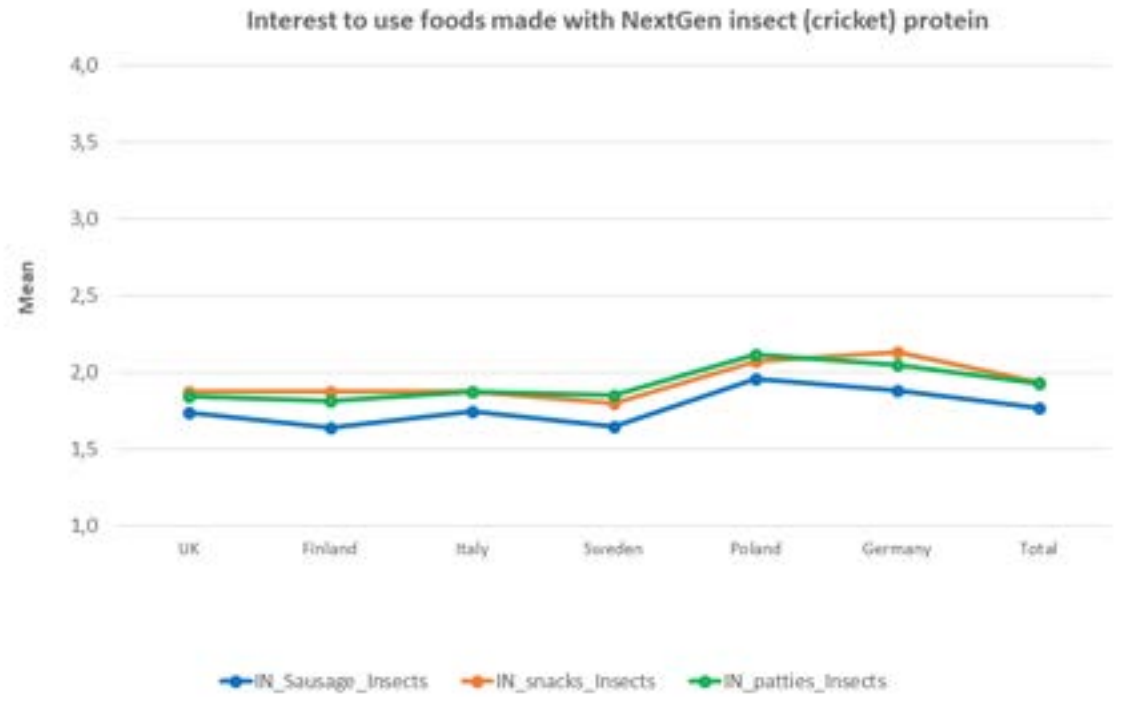

Figure 34. Means of respondents' interest to use the three examples of food applications if made with NextGen insect protein. Iceland is omitted from this comparison as different response scale was used there. Based on WS analysis of variance, the means significantly differ between the countries, and the country and ingredient interaction is significant at the level p=.000.

Reflecting the low acceptance of the NextGen insect protein, also the use interest ratings were low. In average, consumers did not have interest in these applications. Like in the case

of the other NextGen ingredient, the sausage application was of least interest in each country. However, the differences between the applications were much smaller than in the case of the other two NextGen proteins. (Based on WS analysis of variance, the means significantly differ between the countries, and the country x ingredient interaction is significant at the level p=.000.). In Sweden and Finland, consumers rated their interest lower than in the most other countries. Compared to the other countries, Italian respondents rated their interest highest regardless of the food type. This may reflect country differences in response style.

4.3.3.3 Views towards NextGen Torula concept by country

Attitudes towards the NextGen Torula concept were most positive in **Iceland and least positive in Italy**. However, the differences between the countries were small and varied depending on the country and measure.

Consumers had **very similar beliefs about the benefits** of the NextGen Torula regardless of the country (although the mean BENEFIT -ratings did significantly differ between the countries F(6)=3,998, p=.001; as the two extremes Italy and Poland differed significantly, Tukey, p=.003).

Sweden stood out with their most negative preconceptions regarding the **food applications**.

The **country-wise differences were largest in ratings of risk concerns** (like they were in the case of the other two NextGen concepts). Most concerns were felt in Italy and Poland and least in Iceland. E.g. Sweden, with its medium ratings, differs significantly from all other countries except for Finland and Germany)

Like in the case of NextGen microalgae, consumers were more doubtful about the quality of the food applications than what they were about the benefits of the concept, especially in **Sweden** .

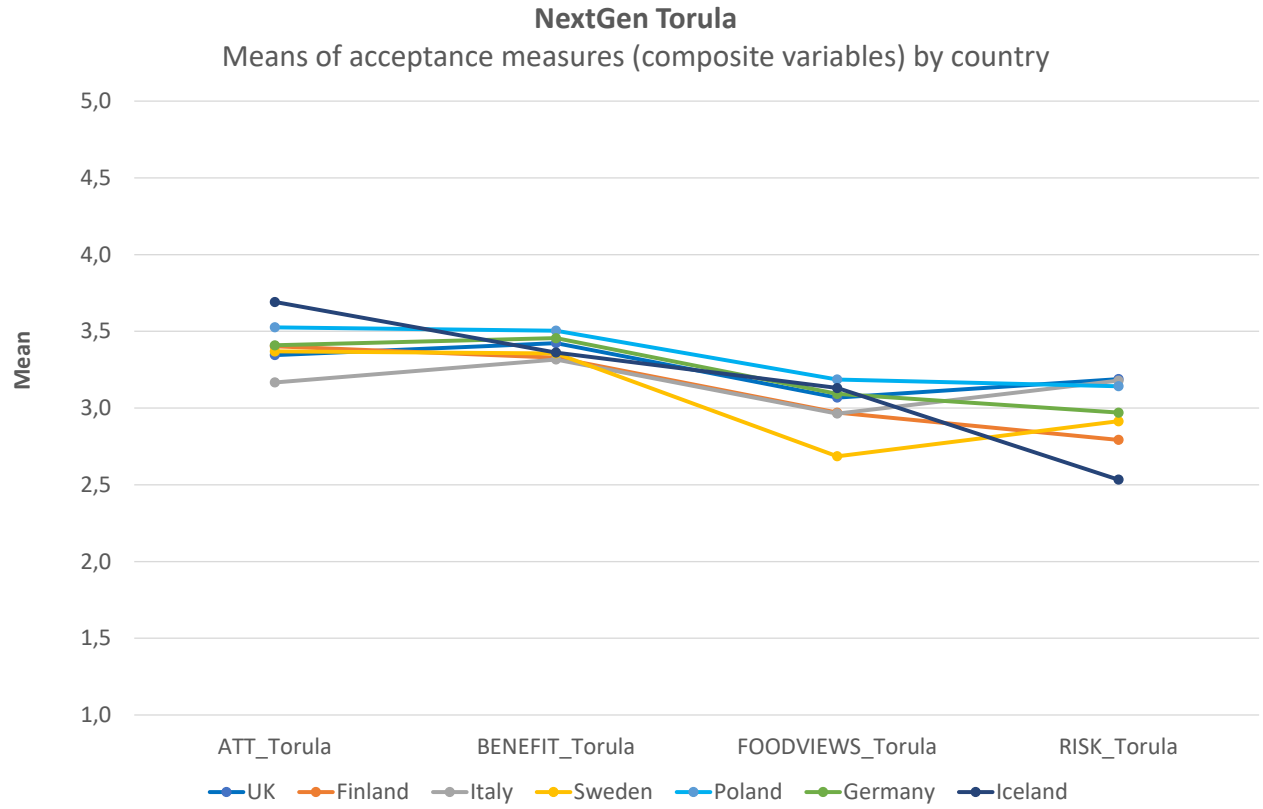

Figure 35. Acceptance of the NextGen Torula concept by country. Means of the four composite variables measuring acceptance: attitudes, likelihood of benefits, concerns for three risks listed in the survey and mean ratings of food applications.

Like in the case of the other concepts, respondents were quite unanimous about which of the benefits of the concept are most likely: benefits for the environment and animals, whereas the benefits for oneself were rated the least likely. Differences in the level of ratings of benefits were small between the countries. E.g. the mean ratings of benefit for the environmental sustainability do not significantly differ between countries (anova, p =.099), but the perceived benefits for the livestock do differ ($F(6)=6.953$, $p<.000$). Based on the Tukey post hoc test respondents in Germany and Poland believe more on these benefits than respondents in Iceland and Finland ($p <.05$).

More country variation can be observed in risk concerns. Like in the case of the other two concepts, least risks, especially for human health, were expected in Iceland.

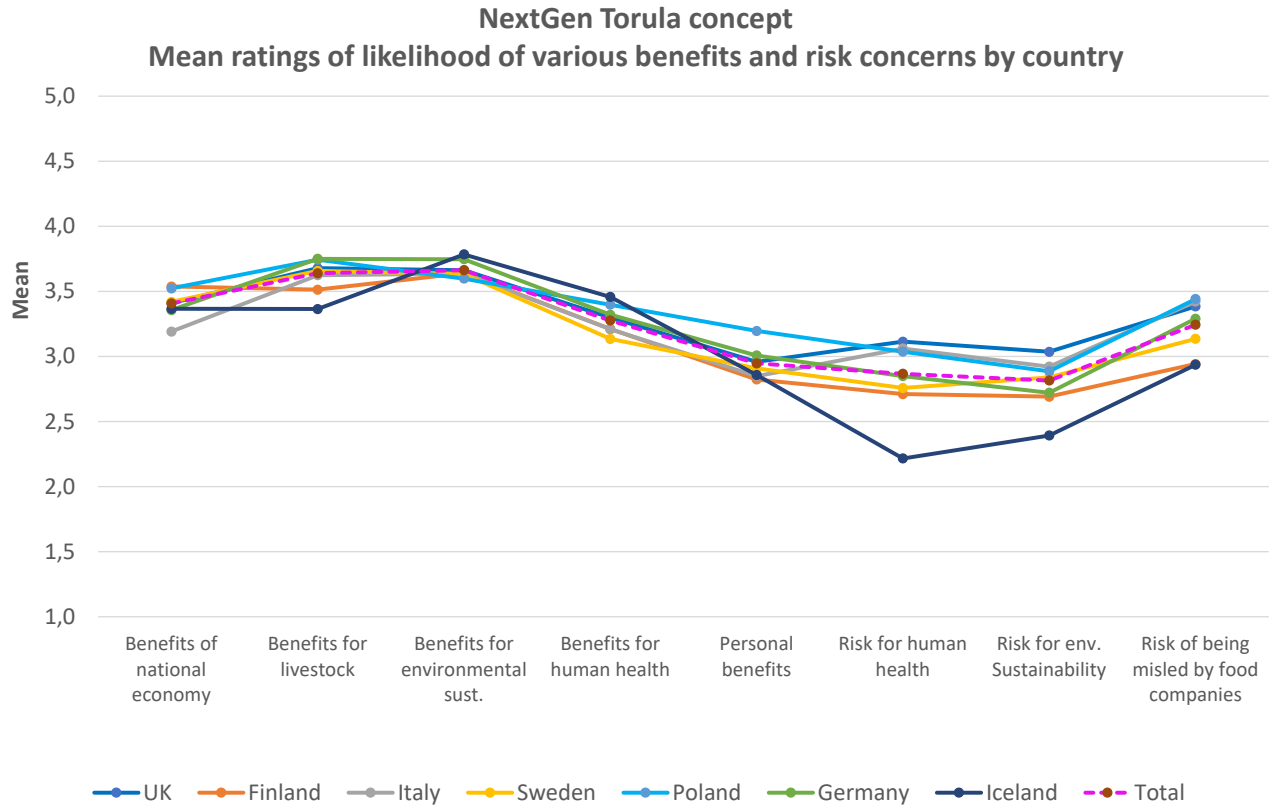

Figure 36. Means of respondents' ratings of benefits and risks related to the NextGen Torula concept. (Q23 and Q24 in the survey)

Generally, respondents' preconceptions about the NextGen **microalgae food applications** were in average rather neutral or positive. These foods were expected to be **good for health, hygienic and safe** but a bit **weird** and maybe bad tasting. Figure 37.

As can be seen from the figure below, their preconceptions about the characteristics of the food application are very similar regardless of the country, only the level of ratings vary. However, the **Swedish respondents stands out with their most critical ratings** and the Icelandic, Polish and German respondents had more positive expectations or ratings. Figure 37.

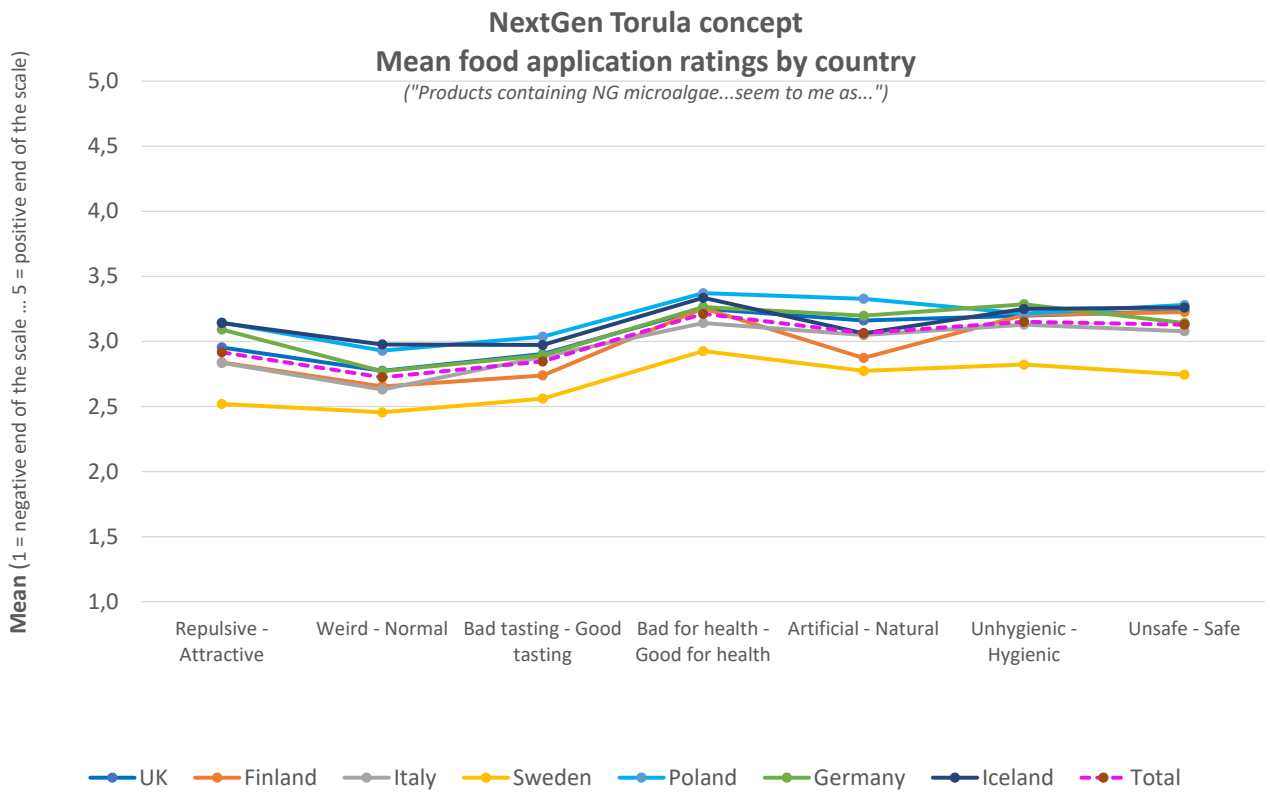

Figure 37. Means of respondents' preconceptions about NextGen Torula protein food applications. (Q25 in the survey)

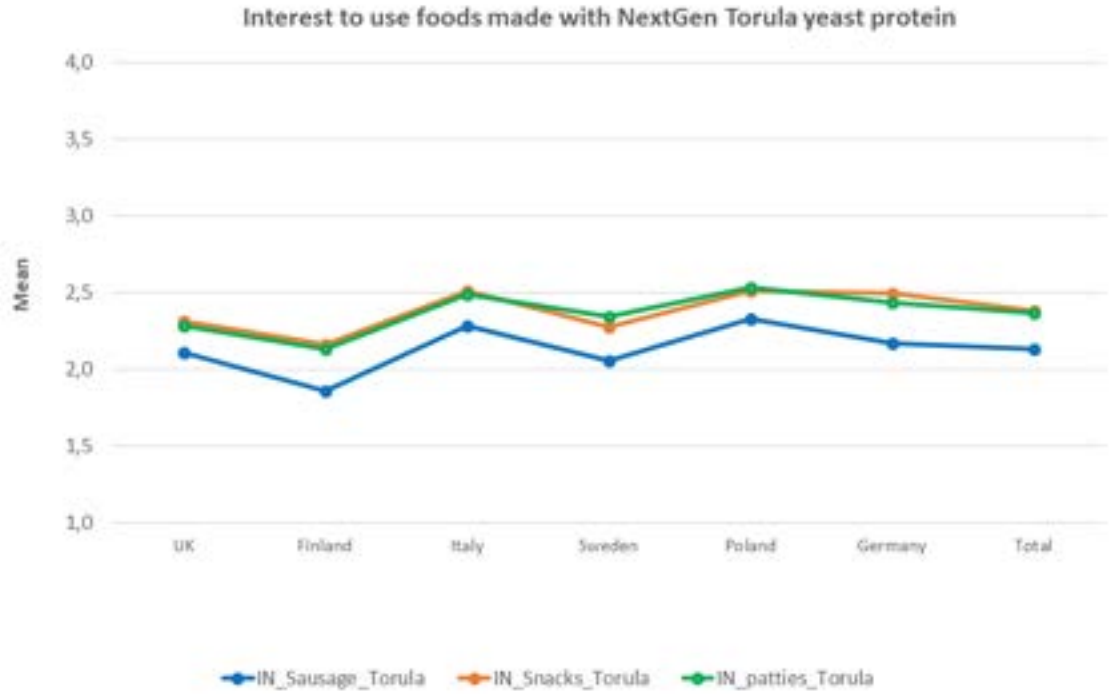

Figure 38. Means of respondents' interest to use the three examples of food applications if made with NextGen Torula protein. Iceland is omitted from this comparison as different response scale was used there. Based on WS analysis of variance, the means significantly differ between the countries, and the country and ingredient interaction is significant at the level p=.000.

Like in the case of the other NextGen ingredient, the sausage application was of least interest in each country, but snacks or vegetable-protein -patties equally interesting. (Based on WS analysis of variance, the means significantly differ between the countries, and the country x ingredient interaction is significant at the level p=.000.). In Sweden and Finland, consumers rated their interest lower than in the most other countries. Compared to the other countries, Italian respondents rated their interest highest regardless of the food type. This may reflect country differences in response style.

4.3.4 Which kind of beliefs about benefits, risks and food quality characteristics explain consumer attitudes towards the concepts?

Regression analyses were performed for the total dataset (all countries) to get an overall idea about which of the measured consumers beliefs and views **explain their attitudes** towards the each NextGen concept. One analysis (linear regression) was run for each of the NexGen concept using the composite variables measuring attitude (ATT_microalgae, ATT_insects, ATT_Torula) as dependent variables.

Table 10. Regressions of composite variables Attitude towards each of the NextGen protein concepts on consumers' benefit and risk perceptions as well as on their preconceptions about the characteristics of foods made with that protein.

		NextGen Insect (R^2=.72)		NextGen Microalgae (R^2=.70)		NextGen Torula (R^2=.68)	
		Std. Beta	Sig.	Std. Beta	Sig.	Std. Beta	Sig.
Likelihood of benefits							
	Benefits for national economy	.05	.000	.06	.000	**.09**	.000
	Benefits for the livestock	-.03	.005	-.02	.054	.00	.979
	Benefits for env. Sustainability	**.19**	.000	**.21**	.000	**.21**	.000
	Benefits for human health	**.12**	.000	**.11**	.000	**.10**	.000
	Benefits for me personally	**.14**	.000	**.08**	.000	**.09**	.000
Concerns for risks							
	Risk for human health and food safety	-.10	.000	-.08	.000	**-.14**	.000
	Risk of unpredicted negative consequences for the environment	.00	.817	-.02	.242	-.01	.459
	Risk of being misled by food companies	.03	.000	.04	.000	.05	.000
Preconceptions about food applications							
	Repulsive - Attractive	.08	.000	.07	.000	.10	.000
	Weird - Normal	.04	.010	.02	.120	.02	.179
	Bad tasting - Good tasting	.07	.000	.00	.878	-.01	.676
	Bad for health - Good for health	**.15**	.000	**.15**	.000	**.12**	.000
	Aftificial - Natual	.02	.156	.02	.153	.02	.191
	Unhygienic - Hygienic	.01	.508	.09	.000	.07	.000
	Unsafe - Safe	**.13**	.000	**.16**	.000	**.11**	.000

Consumers belief in how likely the NextGen concepts are to yield benefits for **environmental sustainability was the most influential factor explaining their attitudes** – regardless of the concept. In addition, respondents' beliefs about the likelihood of benefits **for human health and "for me personally"** significantly explained the variation in attitudes. The importance of health came out also from the risk concern "**risk for human health**" and from the expectations of food quality "bad for health – **good for health**" and "unsafe – **safe**", which also significantly explained the attitudes.

In other words, if consumers who believe, that the NextGen proteins production and food applications are beneficial for the environmental sustainability, healthy and safe and beneficial for themselves (in some way), they are more likely have positive attitude towards those. The result about the lack of influence of **taste expectation** of attitudes does not mean that taste is unimportant, it means that when consumers rated their attitude towards the general idea of the NextGen protein production to be used in foods, they think about the actual products and taste yet in this phase.

Although consumers often believed in that these new production methods have benefits for the livestock, this belief did not much influence their attitudes. This does not mean that expectation of better animal welfare is unimportant for the consumers. This measure just don't have additional importance on top of the sustainability benefits. In addition, these are only one-item measures, and thus a different formulation of the question item might have brought a different result. The formulation of the item was "Reduces suffering of livestock".

Another set of regressions were performed to predict consumers' **interest to use the food applications** (Table 11). The mean interests to use three food applications (vegetable-protein patties, sausages and salty snacks) made with each of the ingredient was applied as dependent variables.

As could be expected those respondents who are more interested in the food applications are more likely to perceive personal benefits from food applications (Table 11). Thus, the perception of personal benefit was influencing respondents use interest more than their beliefs about benefits or risks. Consumers belief about the **taste** of the food was the most influential out of the application related preconceptions. Interest to use especially the **insect**-based food applications was strongly influenced also by perception of insect foods as **repulsive.**

Table 11. Regressions of composite variables INTall (mean intention to use food application patties, sausages and snacks) made with each of the NextGen protein on consumers' benefit and risk perceptions as well as on their preconceptions about the characteristics of foods made with that protein.

		Insect (R^2=.52)		Microalgae (R^2=.46)		Torula (R^2=.48)	
		Std. Beta	Sig.	Std. Beta	Sig.	Std. Beta	Sig.
Likelihood of benefits							
	Benefits for national economy	.04	.030	.03	.189	.02	.257
	Benefits for the livestock	.02	.246	.08	.000	.06	.001
	Benefits for env. Sustainability	-.01	.788	.03	.249	.04	.043
	Benefits for human health	.00	.940	.02	.463	.01	.580
	Benefits for me personally	**.37**	.000	**.28**	.000	**.31**	.000
Concerns for risks							
	Risk for human health and food safety	-.03	.112	-.02	.372	-.07	.000
	Risk of unpredicted negative consequences for the environment	.02	.169	-.02	.358	.02	.158
	Risk of being misled by food companies	-.04	.005	.01	.555	.00	.928
Preconceptions about food applications							
	Repulsive - Attractive	**.23**	.000	.09	.000	.07	.001
	Weird - Normal	.09	.000	.05	.022	.09	.000
	Bad tasting - Good tasting	.06	.004	**.12**	.000	.08	.000
	Bad for health - Good for health	-.03	.184	.01	.633	.00	.824
	Aftificial - Natual	.02	.288	.05	.007	.08	.000
	Unhygienic - Hygienic	.00	.892	.02	.274	.04	.063
	Unsafe - Safe	.02	.465	.03	.234	.00	.840

5 Summary and conclusions

Consumers' views towards the three NextGen protein concepts – protein production based on cultivation of microalgae, insects (crickets) and Torula yeast – were investigated with two methods. First, focus-group interviews were carried out in Germany, Iceland, Finland and Italy. Secondly, comprehensive surveys were conducted in seven countries: UK, Finland, Italy, Sweden, Poland, Germany and Iceland. All the consumer studies deal with charting and understanding consumers' views towards the NextGen production methods and use of the resulting protein ingredient in food products. Consumers' attitudes towards feed applications was not in focus.

Consumers were positive and open to the idea of NextGen protein production

Overall, consumers' attitudes towards the NextGen protein production and its' application in human food were mostly positive or neutral. Only a minority of respondents had negative views varying around 10 % - 20 % in case of Torula and microalgae, but around 30 – 50 % in the case of NextGen insect concept. While, the shares of respondents with positive views in the case of Microalgae 45 % - 65 % and in the case of Torula 39 % - 54 % (percentage of respondents "In favour of" the concept)

Consumer reactions to the NextGen **insect concept** (i.e. to the idea of production of protein food ingredients by cultivating house crickets) were clearly, and significantly more negative than towards the concepts based on microalgae or SCP Torula in all countries.

Because novelty and unfamiliarity of these concepts, a large share of consumers did not know what to think

It is noteworthy that a considerable share (around 30 – 40 % depending on the concept and country) of respondents had neutral attitude towards the NextGen concepts, although there is variation between the countries and concepts. As these proteins and their production methods are new and unfamiliar to the respondents' this can be considered as a positive result. It is likely, that most respondents have not thought of this issue before, and thus they have only started to form their attitudes based on the information they received in the survey. Thus, this result suggests, that large share of consumers do not have strong negative prejudices or preconceptions towards these production methods and ingredients – with exception the one based on insects. This provides more neutral basis and creates possibilities for product development and marketing.

The protein ingredients based on insects is the most challenging concept

As we all know, European people are not used to eating insects, and insects have been culturally defined as non-food traditionally. In the focus-groups, consumers associated insects with something impure with risk of diseased. In the survey, food applications made with NextGen insect protein were perceived as weird and repulsive and imagined as bad tasting. Although, more and more people are starting to recognise the sense of utilising this protein source for human food, the attitudes towards insects are still predominantly if not totally rejective, at least very reserved. This was strongly reflected also in the consumer views towards the NextGen insect-based protein concept. Compared to the other two concept it was clearly the most negatively received in all countries, while the acceptance of microalgae and torula yeast -based concepts were quite equally accepted.

The NextGen concepts are regarded as a good thing in principle, but the personal interest is lower

In the focus-group discussions, participants were often positive towards the NextGen concepts and even excited about how ingenious these ideas of NextGen protein production are, and about how necessary these are for our globe. However, when the discussion proceeded to food applications, the interest declined. The survey results only partially support this conclusion.

The share of respondents who had positive attitude towards the idea of NextGen protein production and the share of respondents who believed in the benefits for sustainability were larger than the share of them believing in that they would themselves benefit from the NextGen concepts. However, almost the same share of respondents that have positive attitude (e.g. 53 % are in favour of NextGen microalgae) are also to some extent interested in using the food application examples (e.g. 52 % of the respondents in the case of NextGen microalgae vegetable-protein patties).

The acceptance is conditional, depending on taste, trust, not being misled by food companies etc.

The results from focus-group discussions help in understanding what the consumers with neutral or indifferent attitudes towards the NextGen concepts think. Throughout the discussions in each country, the participants pointed out, that they are interested in testing the products, but their use interest will depend on certain preconditions, first and foremost on sensory pleasantness and on other product characteristics. In addition, consumers pointed out that they need more information about the production method and its consequences before they are able to judge

their final acceptance and before they can be convinced about the safety and sustainability of the system and products. Focus-group participants had some suspicions about that food companies might take advantage of the good sustainability-image of the new ingredients and mislead consumers in the marketing. Thus, transparency throughout the system was named as important: Transparency from the origin of the material to the production methods up to the ingredients being honestly listed on the product label. Consumers need to be able to trust that twhat is told about the benefits is true and in that all risks are minimised with thorough investigations and authority controls.

The survey supported these observations. For example, respondents who had higher trust in the actors of food chain tended to be more positive towards the NextGen concepts. Generally, consumers were not strongly worried about risks related to the NextGen proteins, but the risk they were most concerned about was that of being mislead by the food companies.

Together with other results, e.g. from the survey and focus-groups, this means that whether consumers will choose to use NextGen protein products will much depend on the sensory quality and on how they are convinced about the other personal benefit. A lot of work remains to be done with product development, marketing and targeting the right products to right consumers.

Consumers' expectation of positive consequences for sustainability, animal and human health are the basis of the positive attitudes towards these concepts – as expected

Out of the five benefits listed to the respondents in the survey, benefits for the environmental sustainability was rated as the most likely. In addition, benefits for the livestock and human health were in average believed in. However, respondents were less likely to believe in that they themselves get benefits from these new concepts. Regression analyses confirmed that consumers' attitude towards each of the three NextGen protein concepts were largely based on what they believed about the consequences for sustainability, animals and their health. Concerns about the risk did not play much role in the formation of their attitudes (when consideres over all countries), except for the small influence of concern about food safety. (see e.g. chapter 4.3.4). These results are reflecting the information we provided for the respondents about the NextGen concepts prior measuring their attitude and other views. In that information, risks were not brought up neither did we advertise any personal benefits except indirectly by describing nutritional value of the ingredients. In any case, it is good news that consumers do not have strong fears about these production methods and ingredients.

While respondents' **attitude** was largely formed on the basis of beliefs about the benefits, their interest **to use** the application examples of NextGen protein ingredients are driven mostly by what they believe the benefits for themselves would be – when we look at the results over all countries (chapter 4.3.4). This confirms the observation from the focus groups: although many consumers greatly value these sustainability of these new production methods, that is not enough to make them interested in actually buying these foods.

What kind of consumers are most positive towards the NextGen concepts?

It can be concluded that the type of consumers, who usually tend to be the forerunners or first ones to adopt new food related innovations overall, are also likely to be most interested in the novel NextGen foods. Consumers who had clearly positive views towards the NextGen protein concepts were minority. They differed from the other, neutral or more negative consumer segments as follows:

Consumers most positive towards NextGen concepts were more likely to have **tertiary level education** and to follow some form of **vegetarian diet** or at least avoid red meat or eat meat only occasionally. They consumed vegetarian convenience foods more often and were initially **more familiar** with various **alternatives for animal-based protein.**

The demographic profile of consumers´ with most positive views towards the NextGen insect concept was a bit different. The diet of the respondent was not connected with his or her views towards the NextGen insect concepts. Vegetarians were not more positive towards insect like in the case of other concepts. On the other hand, gender had more relevance for the acceptance of insect-based concept. Positive views came more often from males than females, while no consistent and significant gender differences were found for the other two concepts.

Regarding their attitudinal background, consumers with the most positive views towards the NextGen concepts were very similar across countries and across concepts. They tended to be more **interested in food novelties** (higher food innovativeness) and to have more **positive attitude towards the use of new technologies** in food production. They tend to be less afraid of experiencing new food tastes (rated **lower on taste neophobia**), and they are **less attached to meat** eating. In many, but not in all counties, the positive cluster had a bit **higher trust in food chain actors** (trust in all actors averaged). In addition, especially **sustainable and ethical production method**, and often also healthiness and naturalness of food are more important for them in their daily food choice than for the consumer clusters with less positive attitude towards NextGen.

The above presented summary on characteristics of positive consumers, was based on segmentation analyses carried out separately in each country and for each NextGen ingredient. Above, we compared the characteristics of the smallest consumer segments, which the most positive views towards the NextGen concept with the rest of the consumer segments with less positive or negative views. For more details see the country reports in appendix B.

Table 12. Characteristics of consumer clusters with the most positive views towards NextGen proteins (comparisons done in respect to consumer clusters having negative or neutral views).

Summary of how and if respondents in the clusters Positive (the most positive views towards each of the NextGen concepts) differ from the other consumer clusters, especially from those with Negative views. The table is based on the results of cluster analyses carried out separately for each NextGen concept and in each country. For more detail, see the country reports in appendix. It should be noted that the number and content of consumer clusters were a bit different depending on the country and concept.

Consumer cluster >	**Spirulina microalgae positive**	**Insects (crickets), positive**	**Torula yeast, positive**
Consumer background variable			
DEMOGRAPHICS			
Gender	no significant difference	no significant difference (except more males in GB, and IT)	no sign. difference
Age group	mostly ns, tendency: the oldest age group least prevalent	younger (< 44y) except in SE, IS	mostly ns, tendency: the oldest age group least prevalent
Education (3 categories)	tertiary	tertiary	tertiary
Type of living area	no sign. difference, except in FI (large cities, capital area)	no sign. difference, except in FI (large cities, capital area)	no sign. difference, but in IS, FI, SE capital area
Household with children vs. no children	no consistent differences	no significant differences	no significant differences, except in SE, PL, FI: more childless households
HABITS			
Diet (3 categories)	more vegetarians and meat reducers	no significant differences	more vegetarians and meat reducers
Familiarity with alternative proteins	more familiar	more familiar	more familiar
Use of salty snacks	no sign. differences, except higher in IS and PL	no clear differences	no clear differences, except higher in PL and IS
Use of meat convenience food	lower (except PL)	no clear difference, except lower in FI	no difference, except lower in GB, FI, IS
Use of vegetarian convenience food	higher	higher	higher
BACKGROUND ATTITUDES			
Food innovativeness	higher	higher	higher
Trust in food chain actors	a bit higher (ns in DE)	higher, except ns in DE, IS	higher, except ns in DE, IS
Taste neophobia	lower	lower	lower
Food technology attitude	more positive	more positive	more positive
Meat attachment	lower	lower (except in IT)	lower
FOOD VALUES			
sustainability and ethical production	more important	more important (except in IT)	more important
healthiness and naturalness	more important (also for the cluster positive but concerned)	slightly more important (except in IT)	more important
sensory properties	no difference	no difference	no difference

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7 Appendix A - The survey questions

QUESTIONS IN THE NEXTGEN CONSUMER SURVEY Spring 2021

CONSUMER BACKGROUND

BG1 What is your gender?

- Male
- Female
- Other
- Prefer not to say

BG2 How old are you?
BG3 Zip code?

Region..country specific

AREA: Which of the following describes your place of residence?

1. live in the capital city / area
2. live I a large city that is not in the capital area
3. live in a small city/town or municipality
4. live in rural area

BG5 EDUCATION: What is the highest level of education you have achieved?

1. Basic education or lower
2. Upper secondary vocational qualification
3. Upper secondary degree
4. Tertiary degree or vocational qualification
5. First stage of tertiary education
6. Tertiary education, university, bachelor degree
7. Tertiary education, university, master's degree or higher (MA/MSc, PhD, MD)
8. Other / I do not know

BG6 HOUSEHOLD TYPE: What is your household like?

1. I live at home with my parents
2. I live alone
3. I live alone with my child / children
4. I live with my spouse
5. I live with my spouse and child / children
6. I live with other adults (other than spouse or family members)
7. Other
8. Prefer not to say

Attitudinal and habit background

Q1- DIET: Which of the following statements describe your diet and eating habits the best?

1. I regularly eat products of animal origin and non-animal origin (omnivorous)
2. I only eat meat sometimes (e.g. beef, pork, poultry, fish, seafood)
3. I avoid red meat (e.g. or pork, beef), but eat other meat products like chicken or fish
4. I do not eat meat (e.g. beef, pork or poultry), but I eat fish (I'm a pesco-vegetarian)
5. I do not eat meat (e.g. beef, pork, poultry or fish), but I eat other products of animal origin (e.g. eggs, cheese, milk) (I'm a lacto-ovo-vegetarian)
6. I do not eat any meat, eggs or dairy products (I'm a vegetarian)
7. I do not eat anything of animal origin (I'm a vegan)

8. Other, specify:

Q2- MEAT REDUCTION: Do you intentionally aim to reduce the amount of meat and / or other products of animal origin in your diet?

1- Yes
0- No

Q3 - Reasons for meat reduction:
What are your main reasons for reducing or avoiding the use of products of animal origin?
Select the three main reasons in the following list and place them in order of importance: 1. most important, 2. second most important and 3. third most important
Q3_1 Most important reason
Q3_2 Second most important reason
Q3_3 Thrid most important reason

1- Environmental sustainability, climate change
2- Ethics, animal welfare
3- My health and well-being
4- High price of meat
5- Taste and texture of meat
6- Other, specify:

Q4 - FAMILIARITY WITH ALTERNATIVE PROTEINS: Below is a list of protein-rich food ingredients and food ingredient types. How well do you know them?

Response scale:

1. ***I have not heard*** *of these*
2. *I have heard of these, but* ***I have not tried them***
3. *I have tried these, but* ***I do not use them***
4. *I eat these* ***occasionally***
5. *I eat these* ***often***

Question items:

1. **Peas** (or products derived from them)
2. **Fava beans** (or products derived from them)
3. **Lupini beans** (or products derived from them)
4. **Other legume vegetables** (peas, beans)
5. **Insects** or products containing insects
6. **Soya-based** meat substitutes such as tofu or tempeh
7. **Wheat-based** meat substitutes such as seitan
8. **Fungi-based** meat substitutes such as Quorn ®
9. **Other meat substitutes** (produced using other protein sources such as oat, egg, etc.**)**

Q5 - USE OF TARGET CONVENIENCE FOODS: How often do you buy the following types of convenience foods?
Response scale:

1. *Rarely or never*
2. *Several times a year*
3. *1-3 times per month*
4. *Weekly*
5. *More than once a week*

Question items:

1. Sausages (e.g. BBQ sausages and frankfurters)
2. Minced meat burgers or meatballs
3. Vegetarian / meat substitute burgers or meatballs
4. Vegetarian oven-prepared meals

5. Vegetarian / meat substitute sausages
6. Salty snacks (e.g. potato crisps, cheese snacks)

Q6- FOOD CHOICE MOTIVES: Next to each statement, indicate how important it is to you concerning your daily food

It is important to me that the food I eat every day ...

Response scale:

1. *not important at all*
2. *slightly important*
3. *rather important*
4. *important*
5. *extremely important*

Question items:

1. provide me with taste pleasure
2. looks good
3. has pleasant texture
4. is inexpensive
5. is healthy
6. does not contain "empty calories" but are nutritious
7. does not contain artificial ingredients
8. is natural
9. is ethically produced
10. does not require a lot of time to prepare
11. is produced in a way that respects animal rights
12. is produced in a way that does not interfere with nature's equilibrium
13. is produced in an environmentally friendly way

Q7- MEAT ATTACHMENT: How do you think and feel about meat?

Response scale:

1. *Completely disagree*
2. *Partially disagree*
3. *neither agree or disagree*
4. *Partially agree*
5. *Completely agree*

1. Nothing compares to the delicious taste of meat
2. I don't (cannot) picture myself without eating meat regularly
3. To eat meat is disrespectful towards life and the environment (REV)
4. We humans are supposed to eat meat as part of our diets
5. I love meat dishes / foods
6. To eat meat is an unquestionable right of every person
7. I (would) feel well eating a meatless diet (REV)
8. By eating meat I'm reminded of the death and suffering of animals (REV)
9. If I couldn't eat meat I would feel weak

Q8 - TRUST IN FOOD CHAIN ACTORS: How much do you trust the following food industry players? Indicate your general level of trust with consideration towards how much you trust the operators' professional skills, honesty and good will (i.e. that they consider the consumers' interests in addition to their own)

Response scale:

1. *Don't trust at all or have very little trust*
2. *Have some trust*
3. *Have a moderate amount of trust*
4. *Have a lot of trust*

5. *Have very much trust*

1. Primary food producers (farmers)
2. Small food producers
3. Food industry
4. Regulatory and supervising authorities
5. Food scientists
6. Retailers
7. Consumer associations

Q9 - FOOD TECHNOLOGY ATTITUDE

New technologies are constantly being developed so that food production and processing methods can be improved. Depending on the technology, the target of the development may be improvement of production efficiency, nutritional content, product safety or taste or products, improvement of sustainability, and / or solving global food security challenges.

What do you think about the development of scientific and technological innovations and their application in food production? *Please indicate the extent to which you agree or disagree with the following statements*

Response scale:

1. *Completely disagree*
2. *Partially disagree*
3. *Neither agree nor disagree*
4. *Partially agree*
5. *Completely agree*

1. I believe in the potential of new food technologies
2. New food technologies are something I am doubtful about (REV)
3. It can be risky to switch to new food technologies too quickly (REV)
4. It is necessary to develop new food technologies in order to provide solutions to global sustainability challenges
5. I trust that new food technologies are studied in depth so they are safe before they are applied
6. Society should not depend heavily on technologies to solve its food problems (REV)
7. I am afraid that new food technologies have long-term negative effects (REV)

Q10 - Tendency to avoid novel foods: How do you relate to foods that are new to you?

Response scale:

1. *Does not describe me at all*
2. *describes me slightly*
3. *Describes me to some extent*
4. *Describes me*
5. *Describes me well*

1. I think that if I eat something I have not tasted before that will taste strange
2. I am doubtful about eating things I have never had before
3. I think that, if I eat something I haven't eaten before, I won't like it
4. I don't really trust new foods
5. Foods I have never eaten before seem sort of disgusting

Q11- FOOD INNOVATIVENESS: Please indicate the extent to which you agree or disagree with the following statements

Response scale:

1. *Completely disagree*
2. *Partially disagree*
3. *Neither agree nor disagree*
4. *Partially agree*

5. Completely agree

1. In general, I am among the last in my circle of friends to know about the new food products appearing in the market (REV)
2. When I hear that a new kind of food product has become available, I become interested enough to buy it
3. I usually try new food products before anyone else in my circle of friends
4. I am really interested in learning about new food products.

ACCEPTANCE QUESTIONS

The following questions were presented for one concept at the time after the concept description was shown to the respondent. The presentation order of the concepts was rotated.

ATTITUDES Q12 - ALGAE / Q17 - INSECTS / Q22- TORULA

What do you think of the previously described method of producing a food protein raw ingredient?

In my opinion, this seems like...

A very bad idea	1	2	3	4	5	A very good idea
Difficult to understand*	1	2	3	4	5	Easy to understand
Foolish / unwise	1	2	3	4	5	Wise
I am against this	1	2	3	4	5	I am in favour of this

*)not included in the composite measure of attitude

BENEFITS Q13 - ALGAE /Q18 - INSECTS / Q23 - TORULA

According to your beliefs, how likely or unlikely do you think it is for this new raw ingredient and method to have the following benefits?

Response scale: Very unlikely = 1 ….Very likely =5, (99- "I don't know")

1. Beneficial to the national economy
2. Reduces the suffering of livestock
3. Beneficial to environmental sustainability
4. Beneficial to human health
5. Beneficial to me personally

RISKS Q14 - ALGAE / Q19 - INSECTS / Q24 - TORULA

To what extent are you concerned about the risks related to this new raw ingredient and its production method?

Response scale: I am not concerned at all = 1 ….I am extremely concerned = 5, (99- "I don't know")

1. Risk concerning human health and food safety
2. Risk of unpredicted negative effects on the environment
3. Risk of being misled by food companies
4. Oher risk, specify

FOOD APPLCATION VIEWS Q15 - ALGAE / Q20 - INSECTS / Q25 - TORULA

Now consider FOOD PRODUCTS (any) that would be made using this new MICROALGAE PROTEIN produced using CO_2 emissions / new INSECT PROTEIN produced using by-products from food production / new TORULA PROTEIN (produced using forestry by-products) as one of the raw ingredients.
In my opinion, FOOD PRODUCTS containing XXXXXX seem to me as…

Repulsive	1	2	3	4	5	Attractive
Weird	1	2	3	4	5	Normal
Bad tasting	1	2	3	4	5	Good tasting
Bad for health	1	2	3	4	5	Good for health
Artificial	1	2	3	4	5	Natural
Unhygienic	1	2	3	4	5	Hygienic
Unsafe	1	2	3	4	5	Safe

DESCRIPTIVE NORM Q16 - ALGAE / Q21 - INSECTS / Q26 - TORULA
How do you expect others to react to FOOD PRODUCTS that have been produced using XXX ?

Response scale:

1. *very unlikely*
2. *rather unlikely*
3. *somewhere in between*
4. *rather likely*
5. *very likely*

1. Such food products would be appreciated in my social circles (among my family, friends, colleagues, etc.)
2. Most of the people I know would not be interested in purchasing these food products (REV)

USE INTEREST

Response scale:

1. ***I am not at all interested** to use*
2. *slightly interested to use*
3. *rather interested to use*
4. ***extremely interested** to use*

99 - no opinion / I do not know

Q27 - How interested would you be to use...

SAUSAGES

1. **Sausages, which have been made with insect protein,** which has been produced in the previously described manner
2. **Sausages, which have been made with torula yeast protein,** which has been produced in the previously described manner
3. **Sausages, which have been made with microalgae protein,** which has been produced in the previously described manner
4. Conventional (meat-based) sausages
5. Conventional vegan sausages

Q28 - How interested would you be to use...

SALTY SNACKS

1. **Salty snacks, which have been made with insect protein,** which has been produced in the previously described manner
2. **Salty snacks, which have been made with torula yeast protein,** which has been produced in the previously described manner
3. **Salty snacks, which have been made with microalgae protein,** which has been produced in the previously described manner
4. Conventional salty snacks

Q29 - How interested would you be to use...

VEGETABLE – PROTEIN PATTIES

1. **Vegetable - protein patties, which have been made with vegetables and insect protein,** produced with the above described new method
2. **Vegetable - protein patties, which have been made with vegetables and torula yeast protein,** produced with the above described new method
3. **Vegetable - protein patties, which have been made with vegetables and microalgae protein,** produced with the above described new method
4. Conventional vegetable- protein patties made with vegetables and plant protein

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In addition to the new technologies and food substances reviewed in this questionnaire, there are some other new ways of producing protein without the need of fields or animals.

Q30 - Familiarity with future proteins:

How familiar are the following new protein ingredients, which are currently not yet commercially available?

Response scale:

1. ***I have never heard of them***
2. *I have heard of them, but* ***I don't know anything about it***
3. ***I have an understanding of what this is***
4. ***This is rather familiar to me*** *(e.g. I have read articles about it)*
5. ***I know quite a lot about the subject***

1. Cell-cultured meat (artificial meat)
2. Another food substance, which is produced by means of cell culture (e.g. fruit mass produced by fruit cell culture)
3. Egg white or milk protein produce using certain microbes
4. Other, specify

8 Appendix B1 - UK survey report

8.1 Summary of results from UK

The UK sample consisted of 1000 respondents, rather well distributed between different demographic groups. About 92 % of the respondents were omnivores and 8 % some form of vegetarians. Out of the omnivores, 42 % aimed to reduce their meat consumption or already did that. One's own health and well-being was the most important reason for meat reduction intentions, environmental sustainability and animal welfare came second.

Like in the other countries, the UK respondents were familiar with conventional legumes such as peas and beans. Fungi (Quorn) and soy- based (tofu) meat substitutes were also well known. Soy-based and fungi products were consumed at least occasionally by 32.5 % and 32.1 %, respectively. Wheat-based protein, Fava beans and Lupini beans were unfamiliar for most and so were insects. Many have heard about insects, but only 8 % had tasted insect products.

Like in the other countries, small food producers and primary food producers were the most **trusted actors of food chain**. Around 50 % had high trust in small food producers and in primary food producers. The lowest level of trust was expressed towards the food industry; only 15.7 % of the respondents had high trust, but still, even 65.5 % had moderate trust in them.

Below half of the UK respondents were **in favour of** the NextGen microalgae (45 %) and of NextGen Torula concepts (43 %). The NextGen insect concept was the least popular, like in the other countries. About 30 % of the respondents were in favour of the NextGen insect concept. All the applied acceptance measures pointed to the same direction: NexGen microalgae and NextGen Torula were more readily accepted than the NextGen insect concept.

Generally, respondents believed in the **benefits** of the NextGen concepts, although less in the benefits of insect concept. Benefits for environment and livestock were found as most likely consequences in the case of all three concepts. About half of the UK respondents rated these as likely. Less was believed in benefits to oneself and in benefits for the national economy. Out of the three types of risks, the respondents were most concerned about **risks** of being misled by food companies. E.g. about 40 % was concerned about being misled by food companies and 28 % about "the unpredicted negative effects on the environment" in the case of NextGen microalgae concept.

In this survey, we also asked respondents to rate their **interest to use three examples of food applications** made with either of the three NextGen proteins. Like in the other

countries, sausages were less interesting carrier product for these ingredients than were vegetable-protein patties or salty snacks regardless of the NextGen protein ingredient.

Segmentation of UK consumers into clusters was carried out on the basis of how they rated each of the three NextGen concepts. Cluster analyses yielded three clusters for all for the NextGen microalga and insect clusters, but four for the Torula concept. Clusters were named **positive**, when they had the most positive ratings on all the acceptance measures concerning the concept in question (positive attitude, higher beliefs in benefits, lowest concern for risks and higher preconceptions about the quality of the food applications of the ingredient in question). The clusters with most negative ratings were named as **negative**. Clusters named as **neutral** (or indifferent) were in-between these two. Clustering based on the acceptance of NextGen Torula concept yielded four clusters. The fourth cluster was **Positive, but concerned**. Respondents in this cluster were moderately positive, but also concerned about the risks of the concept. The highest shares of respondents fell into the Neutral clusters, which comprised the majority of the respondents (40 – 68 % of respondents depending on the concept). Positive clusters comprised 21 – 32 % of respondents, and the negative clusters 16 %, 26 % and 15 % for the microalgae, Torula and insects, respectively. In addition, the Torula cluster Positive but concerned included 25 % of the respondents.

The above-mentioned consumer clusters were compared with each other in term of their background demographics, eating habits and attitudinal tendencies – separately for each of the NextGen concept.

The negative and positive clusters background opinions were pretty much opposite to each other differentiating these clusters from each other, and the neutral clusters were in-between. The positive, but concerned Torula cluster was quite similar with the neutral cluster. Overall, in UK, **the positive clusters differed from the other clusters, or at least from the negative clusters as follows**: Regardless of the concept, they were more likely to have **tertiary education**, but no consistent age differences were found. Respondents gender did not significantly vary depending on the clusters, except for that those with **positive views towards insects were more likely to be males than females.** Consumers in the most positive segments more often follow either some form of **vegetarian diet** or restrict meat consumption. Except, in the case of NextGen insect concept, consumers views were not related to their diets.

Like in the other countries, the consumers in the positive clusters, regardless of the NextGen protein concept, were more (and negative cluster less) **familiar with alternative proteins**, as well as with emerging new proteins. They rated higher in **food innovativeness** (interest towards new emerging food products), **lower in taste neophobia** (thus less afraid of tasting new foods overall), and had more **positive attitude toward the use of novel and latest technologies in food production**. In addition, they had **higher trust in food chain actors**.

Consumers in the positive clusters tended to **value sustainable and ethical** way of food production more than consumers in the other clusters.

8.2 Participant characteristics, UK

8.2.1 Participants' demographics, UK

The UK sample consists of 1000 respondents. About half of them were male and the other half female. All demographic categories were quite well represented in the sample. Like in the case of other countries, respondents' answers have been weighted in the analysis so that the results represent the country population.

Table 13. Demographic background of UK respondents

	Count	Percent
Gender		
1. male	494	49.4%
2. female	500	50.0%
3. other / prefer not to say	3	0.6%
missing answer	7	0.7%
Total	*1000*	*100 %*
Age group		
1. 18 - 24 Years	108	10.8%
2. 25 - 34 Years	173	17.3%
3. 35 - 44 Years	203	20.4%
4. 45 - 54 Years	206	20.6%
5. 55 - 64 Years	169	16.9%
6. 65 - 75 Years	141	14.1%
Total	*1000*	*100 %*
Type of living area		
1. I live in the capital city / area	179	17.9%
2. I live in a large city that is not in the capital area	187	18.7%
3. I live in a small city/town or municipality	474	47.4%
4. I live in a rural area	160	16.0%
Total	*1000*	*100 %*
Region_UK		
1. North East (Uk)	40	4.0%
2. North West (Uk)	109	10.9%
3. Yorkshire And The Humber	83	8.3%
4. East Midlands (Uk)	67	6.7%
5. West Midlands (Uk)	92	9.2%
6. East of England	85	8.5%

7. London	125	12.5%
8. South East (Uk)	143	14.3%
9. South West (Uk)	82	8.2%
10. Wales	49	4.9%
11. Scotland	94	9.4%
12. Northern Ireland (Uk)	30	3.0%
Total	*1000*	*100 %*
Education		
1. Basic education or lower	90	9.0%
2. Upper secondary vocational qualification	213	21.3%
3. Upper secondary degree	117	11.7%
4. Tertiary degree or vocational qualification	125	12.5%
5. First stage of tertiary education	62	6.2%
6. Tertiary education. university. bachelor degree	255	25.5%
7. Tertiary education. university. master's degree or higher (MA/MSc. PhD. MD)	115	11.5%
8. Other / I do not know	23	2.3%
Total	*1000*	*100 %*
Education_3		
1. Basic (option 1)	90	9.2%
2. Secondary…first stage tertiary (options 2 – 4)	455	46.6%
3. Tertiary, university (options 5 – 7)	432	44.2%
Total	*977*	*100%*
Household type		
1. I live at home with my parents	120	12.0%
2. I live alone	202	20.2%
3. I live alone with my child / children	60	6.0%
4. I live with my spouse	310	31.0%
5. I live with my spouse and child / children	242	24.2%
6. I live with other adults (other than spouse or family members)	47	4.7%
Other	13	1.3%
Prefer not to say	5	0.5%
Total	*1000*	*100%*
Household_3 (2.9.)		
no children (options 2 and 4)	*512*	*52.2%*
with children (options 3 and 5)	*302*	*30.7%*
other (options 1 and 6 – 8)	*168*	*17.1%*
	982	*100%*

8.2.2 Participants' dietary habits and attitudinal background, UK

Over 73 % of UK participants were omnivores who eat meat regularly, while 18.4 % restrict their meat consumption either by avoiding red meat or eating meat only occasionally. The remaining 8 % follow some form of vegetarian diets. (Table 14).

Out of the consumers of red meat (diet 1 or 2), 42 % indicate that they intentionally aim to reduce their meat consumption. The most important reasons they had for this meat avoidance relate to their own health and well- being and secondly to environmental sustainability. **Taken together, these results suggest that around 60 % of UK consumers were to some extent interested in obtain more of their protein from other sources than mammal or poultry meat.** At the moment, around 22 - 23 % of UK respondents use vegetarian sausages or oven-prepared ready meals at least monthly (Figure 39).

Table 14. Dietary habits of respondents in UK

	Count	Percent
Diet		
1. I regularly eat products of animal origin and non-animal origin (omnivorous)	731	73.2%
2. I only eat meat sometimes (e.g. beef. pork. poultry. fish. seafood)	133	13.3%
3. I avoid red meat consumption (e.g. beef or pork). but eat other meat products like chicken or fish	51	5.1%
4. I do not eat meat (e.g. beef. pork or poultry). but I eat fish (I'm a pesco-vegetarian)	26	2.6%
5. I do not eat meat (e.g. beef. pork. poultry or fish). but I eat other products of animal origin (e.g. eggs. cheese. milk	33	3.3%
6. I do not eat any meat. eggs or dairy products (I'm a vegetarian)	4	0.4%
7. I do not eat anything of animal origin (I'm a vegan)	17	1.7%
8. Other. specify:	5	0.5%
Total	*1000*	*100 %*
Diet_3		
1. Omivore (option 1)	731	73.5%
2. Meat sometimes / no red meat (options 2-3)	184	18.5%
3. Vegetarian (options 5-7)	79	8.0%
Total	*995*	*100%*
Do you intentionally aim to reduce meat consumption? (question was targeted to respondents who described their diet with options 1 - 2 above)		
1. Yes	366	42.3%
2. No	499	57.7%
Total	865	*100%*
Main reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability. climate change	117	22,4
2. Ethics. animal welfare	122	23,5
3. My health and well-being	188	36,2
4. High price of meat	32	6,2
5. Taste and texture of meat	55	10,5
6. Other. specify:	6	1,2
Total	520	*100%*
Second most important reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability. climate change	134	25,7

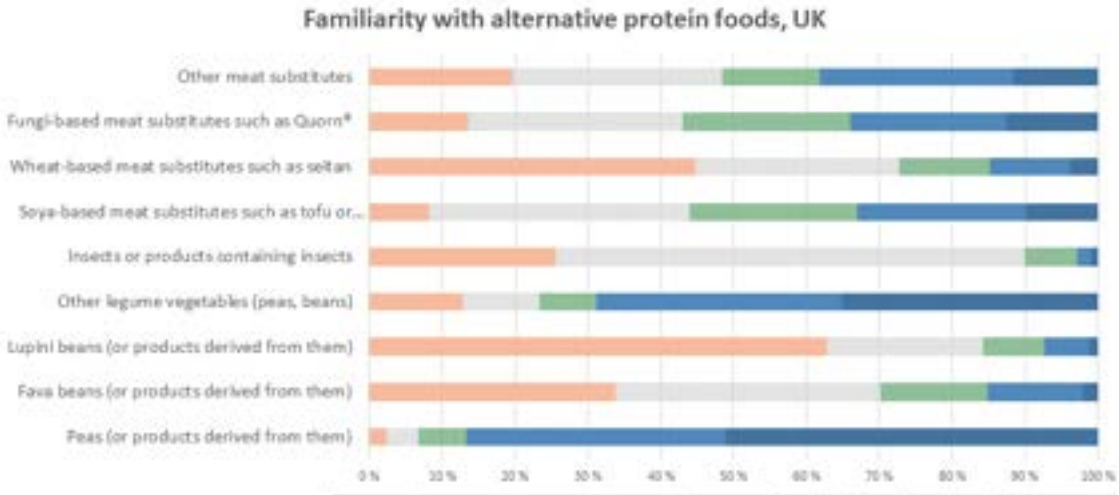
2. Ethics. animal welfare	148	28,5
3. My health and well-being	114	22,0
4. High price of meat	63	12,2
5. Taste and texture of meat	54	10,3
6. Other. specify:	7	1,3
Total	*520*	*100%*

	Sausages (e.g. BBQ sausages and frankfurters)	Minced meat burgers or meatballs	Vegetarian / meat substitute burgers or meatballs	Vegetarian oven-prepared meals	Vegetarian / meat substitute sausages	Salty snacks (e.g. potato crisps, cheese snacks)
Rarely or never	18,4%	22,5%	56,8%	60,7%	58,9%	6,7%
Several times a year	23,3%	28,3%	18,2%	17,6%	18,4%	14,4%
1-3 times per month	35,1%	30,3%	15,3%	13,8%	12,7%	31,4%
Weekly	20,4%	16,4%	7,4%	6,3%	8,6%	35,6%
More than once a week	2,7%	2,5%	2,2%	1,6%	1,5%	11,9%

Figure 39. Use of certain convenience foods by the UK respondents.

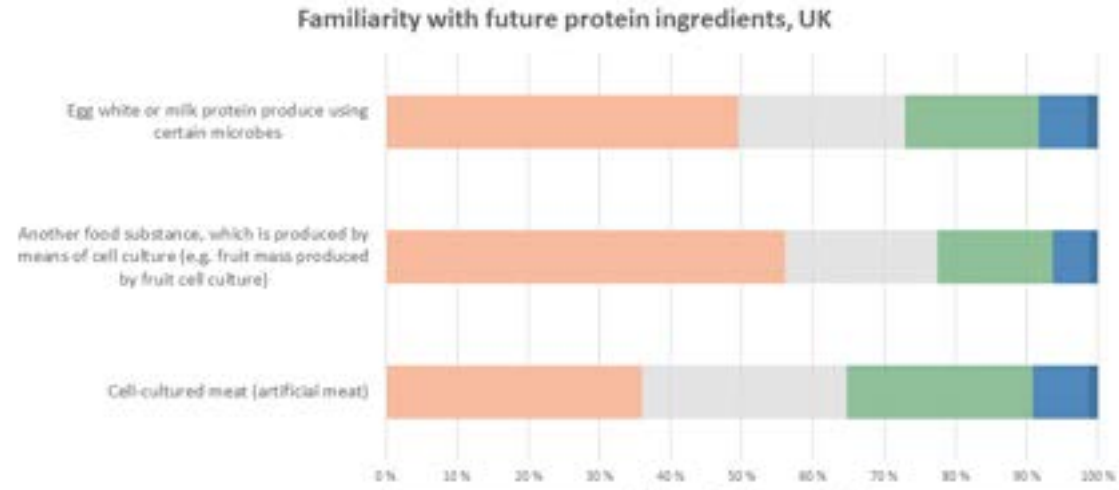
Based on the previous literature, we expect that consumers' previous familiarity with alternative protein sources (currently available ones as well as emerging future ones) will reflect consumers' readiness for adopting the new NextGen proteins. Expectedly, the UK consumers were most familiar with legumes, and second most familiar with soy and fungi-based meat substitutes. Soy products were used by 33 % and fungi-based by 34 % of the respondents. Whereas Fava beans and especially Lupini beans were mostly unfamiliar to them. Still around 30 % UK respondents had at least tried Fava beans. (Figure 40.). Insects were clearly the most unfamiliar protein source in terms of personal experience, while 75 % had heard about insect protein products. (Figure 40.)

In the further analyses a familiarity indices will be calculated as mean of these question items, and that will be applied in describing consumers with different views towards the NextGen proteins.



	Peas (or products derived from them)	Fava beans (or products derived from them)	Lupini beans (or products derived from them)	Other legume vegetables (peas, beans)	Insects or products containing insects	Soya-based meat substitutes such as tofu or tempeh	Wheat-based meat substitutes such as seitan	Fungi-based meat substitutes such as Quorn®	Other meat substitutes
I have not heard of these	2,4%	35,8%	62,8%	12,7%	25,5%	8,2%	44,8%	13,5%	19,6%
I have heard of these, but I have not tried them	4,3%	36,5%	21,4%	10,6%	64,5%	35,8%	28,0%	29,5%	28,8%
I have tried these, but I do not use them	6,6%	14,6%	8,6%	7,9%	7,3%	23,0%	12,4%	22,9%	13,4%
I eat these occasionally	35,6%	13,1%	6,1%	35,7%	1,9%	23,1%	11,1%	21,5%	26,6%
I eat these often	51,2%	2,1%	1,2%	35,0%	0,9%	9,9%	3,8%	12,5%	11,6%

Figure 40. UK respondents' previous familiarity with alternative protein sources and meat substitutes made of these

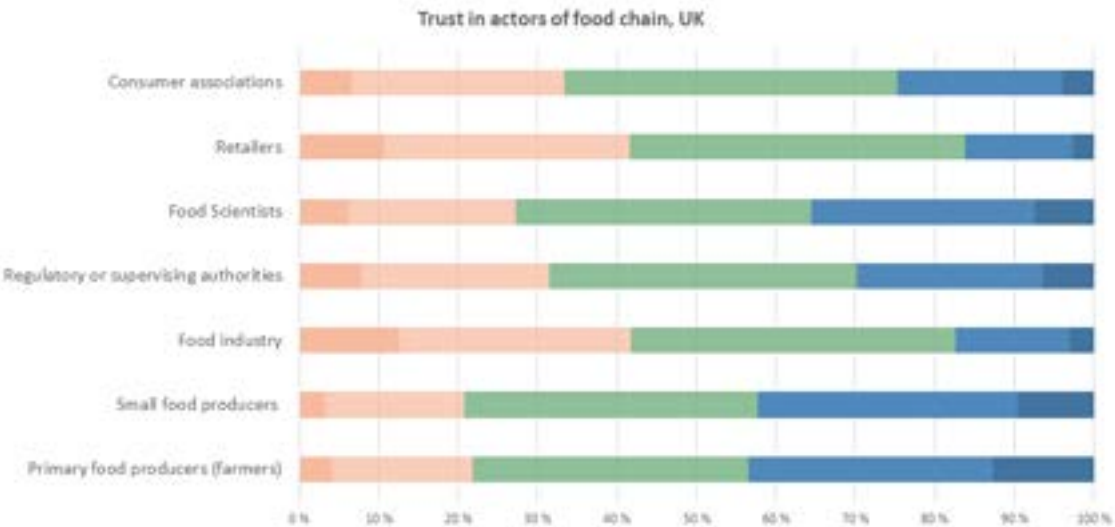


	Cell-cultured meat (artificial meat)	Another food substance, which is produced by means of cell culture (e.g. fruit mass produced by fruit cell culture)	Egg white or milk protein produce using certain microbes
I have never heard of them	56,0%	56,1%	49,5%
I have heard of them but I don't know anything about it	28,8%	21,4%	23,4%
I have an understanding of what this is	26,1%	16,2%	18,8%
This is rather familiar to me (e.g. I have read articles about it)	7,9%	5,2%	6,8%
I know quite a lot about the subject	1,2%	1,1%	1,5%

Figure 41. Familiarity with future (emerging) protein sources, UK

The consumers in UK had trust in primary food producers (farmers) and small food producers, but trust in larger food industry and food retailers is clearly lower (Figure 42). This result is quite typical in most countries and expected based on previous knowledge.

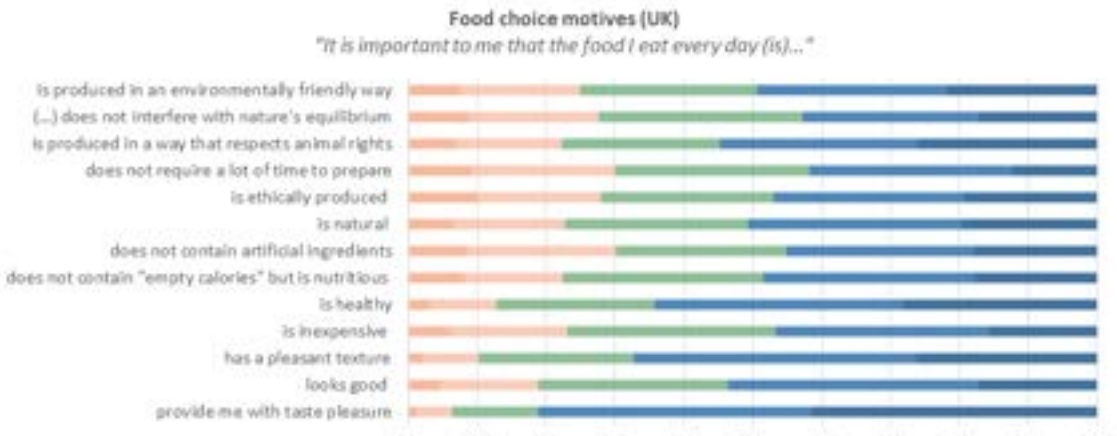
In the further analyses, a trust index / composite variable will be calculated as mean of these question items, and that will be applied in understanding reasons behind consumer acceptance of NextGen proteins.



	Primary food producers (farmers)	Small food producers	Food industry	Regulatory or supervising authorities	Food Scientists	Retailers	Consumer associations
Don't trust at all or have very little trust	4,1	3,2	12,5	7,8	6,1	10,7	6,5
Have some trust	17,7	17,7	29,3	23,7	21,2	30,9	26,9
Have a moderate amount of trust	34,7	36,9	40,9	38,6	37,2	42,2	41,9
Have a lot of trust	30,8	32,6	14,3	23,5	28,2	13,7	20,8
Have very much trust	12,7	9,6	3,0	6,4	7,3	2,6	3,9

Figure 42. Trust in various actors of food chain in the UK sample.

Figure 43. describes UK respondents' answers to question Q6 about how important various criteria are for them in their daily foods. The overall result is typical: taste and other sensory quality characteristics are of prior importance, followed by healthiness. After these, respecting **animal rights** in the production method is rated the most important. About **half of the respondents rated environmentally friendly production as important for them.**



	provide me with taste pleasure	looks good	has a pleasant texture	is inexpensive	is healthy	does not contain "empty calories" but is nutritious	does not contain artificial ingredients	is natural	is ethically produced	does not require a lot of time to prepare	is produced in a way that respects animal rights	(...) does not interfere with nature's equilibrium	is produced in an environmentally friendly way
Not important at all	1,1	4,4	1,9	6,0	2,9	8,0	8,5	6,4	9,9	9,1	6,7	8,8	7,3
Slightly important	5,2	14,4	8,3	17,1	9,8	14,4	21,9	16,3	18,1	20,9	15,5	18,8	17,7
Rather important	12,6	27,6	22,4	30,3	23,0	29,1	24,7	26,7	25,0	28,3	22,9	29,6	25,6
Important	39,7	36,6	41,2	31,2	36,1	30,6	27,2	31,0	27,8	29,4	28,8	25,7	27,6
Extremely important	41,4	17,0	26,1	15,4	28,2	17,9	17,9	19,6	19,1	12,3	26,1	17,0	21,8

Figure 43. Perceived importance of food values (food choice motives) in the UK sample.

8.3 Forming the composite variables, UK

Composite variables were formed as **means** of items, which measured the same dimension based on these analyses in addition to the theory. For more details about the questions see the questionnaire in Appendix A.

8.3.1 New variables describing respondents' background attitudes, UK

Factor analyses (principal axis factoring, varimax rotation) were performed to check the dimensionality of items for each scale. In the case of the items measuring Food technology attitudes (Q9) and Meat attachment (Q7) the analysis yielded two factors with eigenvalues over 1. Based on the emerged dimensions, two variables were constructed for both of these. However, as the two dimensions represented opposite views: negative vs. positive, and using these distinct variables did not increase understanding compared to the analysis using one composite variable, we decided to apply one composite variable per theoretical concept instead of the two. That is, the measures of Meat_attachment and F_innovativeness are applied.

Each composite variable has been formed as mean of the relevant question items (Table 15 and the survey questions in Appendix A). In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" are not included in the analyses, which apply these variables.

Table 15. Composite variables describing respondents' background attitudes. The measurement scale for all the listed composite variables is 1 – 5. UK.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.79
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	,84
Trust	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	.89
FTechnology_attitude	Attitude towards new food technology	Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV	.77
Meat_attachment	Attachment to meat eating	Q7r1, Q7r2, Q7r4, Q7r5, Q7r6, Q7r3_REV, Q7r8_REV Note Q7r7 omitted	.88
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.92
F_innovativeness	Food innovativeness (interest in new food products)	(all items) Q11r1_REV, Q11r2, Q11r3, Q11r4	.80
Use_vege_convemience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.87
Use_meat_convenience	Mean frequency of use of meat based convenience foods	Q5r1, Q5r2	.82

Table 16. New variables to describe UK respondents' food values.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
M_Sensory	Good sensory characteristics	Q6r1, Q6r2, Q6r3	.79
M_Healthy_natural	Healthiness and naturalness	Q6r5 – Q6r8	.89
M_Environment_ethics	Produced in ethical and environmentally friendly way	Q6r9, Q6r11 - 13	.92
M_conv_price	Is inexpensive and does not require much time to prepare	Q6r4, Q6r10	.57

8.3.2 New variables measuring acceptance of the three NextGen concepts, UK

New variables were formed to reflect positivity or negativity of respondents' ***attitude*** towards each of the three NextGen concepts. In addition, composite variables were formed to measure respondents' beliefs in ***benefits*** of each of the NextGen concept as well as to indicate the strength of respondents' concern about potential ***risks*** of the NextGen concepts. All the resulting variables had high internal reliabilities. Finally, also respondents' ratings (views or pre-assumptions) about the characteristics of food products made using each of the NextGen ingredient were averaged for each Nextgen concept to form a composite measure of how positively or negatively NextGen microalgae, NextGen insect and NextGen Torula protein based food application are viewed (See Table 17). The latter will be subsequently called ***food application views***.

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. **That is, respondents who answered "I don't know" are not included in the subsequent analyses, which apply these variables.**

Table 17. Composite variables measuring acceptance, their contents and reliabilities (UK). The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	Cronbach Alpha
ATTITUDES		
ATT_Algae	Attitude towards NextGen microalgae protein *(mean of items Q12r1, Q12r2, Q12r4)*	.94
ATT_Insect	Attitude towards NextGen insect protein *(mean of items Q17r1, Q17r2, Q17r4)*	.94
ATT_Torula	Attitude towards NextGen Torula protein *(mean of items Q22r1, Q22r2, Q22r4)*	.93
PERCEIVED BENEFITS	*mean of all 5 items*	
BENEFIT_Algae	Likelihood of benefits from NextGen microalgae protein *(mean of items Q13r1 – Q13r5)*	.90
BENEFIT_Insects	Likelihood of benefits from NextGen insect protein *(mean of items Q18r1 – Q18r5)*	.88
BENEFIT_Torula	Likelihood of benefits from NextGen Torula protein *(mean of items Q23r1 – Q23r5)*	.89
PERCEIVED RISKS	*mean of 3 items, "other risk" not included*	
RISK_Algae	Concern about risks relating to production of NextGen microalgae proteins *(mean of items Q14r1-Q14r3)*	.92
RISK_Insects	Concern about risks relating to production of NextGen insect proteins *(mean of items Q19r1-Q19r3)*	.90
RISK_Torula	Concern about risks relating to production of NextGen Torula proteins *(mean of items Q24r1-Q24r3)*	.90
FOOD APPLICATION VIEWS	*mean of all the 7 items*	
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein *(mean of items Q15r1-Q15r7)*	.94
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein *(mean of items Q20r1-Q20r7)*	.93
FOODVIEWS_Torula	Views towards foods made with NextGen Torula protein *(mean of items Q25r1-Q25r7)*	.93

8.4 Comparison of the three NextGen protein concepts, UK

8.4.1 Which of the NextGen protein ingredients is most positively viewed in UK?

Out of the three NextGen concepts, the one with insect-based protein was clearly the most difficult to accept, while the acceptance of the microalgae and Torula based protein concepts were roughly at the same level. All the acceptance measures suggest the same result: attitudes towards NextGen insect concept were more negative, respondents had in average lower belief in the benefits of it and higher risk concerns. They expect the quality of food products be lower if the food is made with NextGen insect protein vs. the NextGen microalgae or Torula protein. Finally, the mean interest to use the examples of food applications (sausages, vegetable-protein patties and salty snacks) is lower in the case of NextGen insect protein. (See Figure 41 and Table 18).

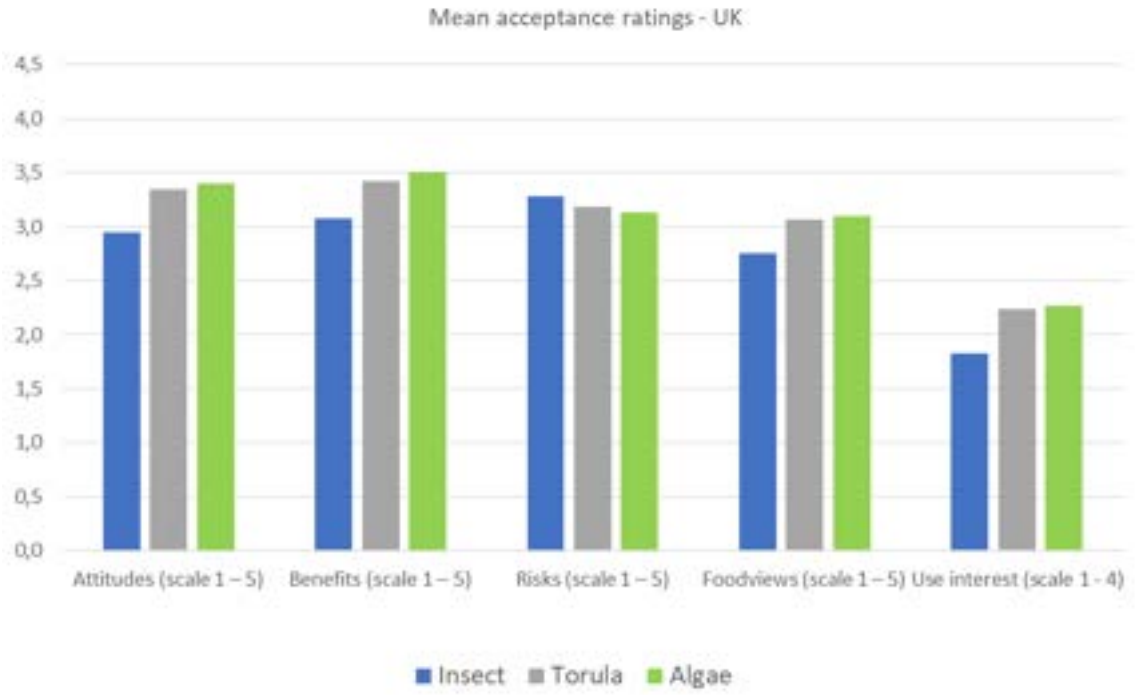


Figure 44. Means of composite variables measuring acceptance towards each of the three NextGen protein concept in UK sample.

Table 18. Comparison of means of acceptance ratings (composite variables) between the three Nextgen protein concepts. Significance of difference tested with repeated measures analysis of variance. UK.

Composite variables:	Insect	Torula	Algae	df	F	Sig.
Attitudes (scale 1 – 5)	2,95	3,35	3,40	2	125.284	.000
Benefits (scale 1 – 5)	3,08	3,42	3,50	2	113.476	.000
Risks (scale 1 – 5)	3,28	3,19	3,13	2	11.743	.000
Foodviews (scale 1 – 5)	2,76	3,07	3,10	2	213.425	.000
Mean use interest of all the food application examples (scale 1 - 4)	1,83	2,23	2,27	2	213.778	.000

The respondents in UK expected the insect based NextGen protein food applications[4] to be of inferior quality compared to those based on NextGen microalgae or Torula protein. Tendency to assume NextGen insect contain foods as to be **repulsive, weird, bad tasting** as well as **unhygienic** rather than the opposite, stand out. Insect based NextGen food application was however perceived slightly more **natural** compared to the other ingredients. (Figure 45 and Table 19).

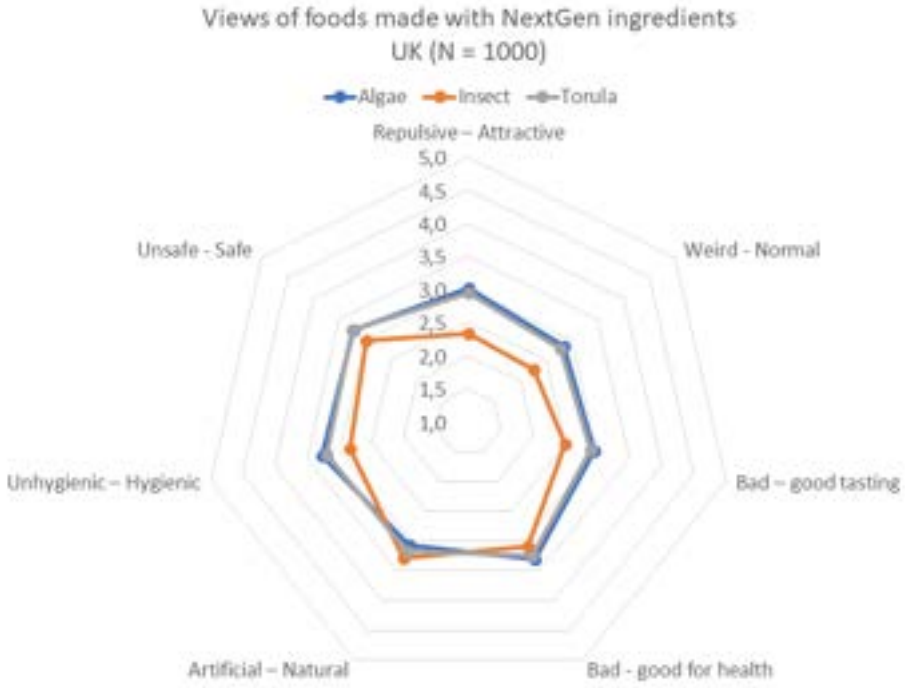


Figure 45. Means of respondents' preconceptions about the characteristics of imaginary foods made using the NextGen ingredients. UK.

Table 19. Means of respondents' preconceptions about the characteristics of imaginary foods made using the NextGen ingredients. UK. Significance of differences in means between the NextGen ingredients tested with repeated measures analysis of variances.

Food application views	Algae	Insect	Torula	df	F	Sig.
Repulsive – Attractive	3,02	2,34	2,95	2	249.851	.000
Weird - Normal	2,84	2,26	2,78	2	164.778	.000
Bad – good tasting	2,95	2,50	2,91	2	128.510	.000
Bad - good for health	3,31	3,09	3,25	2	28.741	.000
Artificial – Natural	3,07	3,29	3,16	2	15.916	.000
Unhygienic – Hygienic	3,27	2,84	3,20	2	103.097	.000
Unsafe - Safe	3,23	2,98	3,24	2	43.883	.000

[4] The questions Q15, Q20 and Q25 asked the respondents to consider (imagine) any food products that would be made using this ingredient as one of the raw ingredients.

8.4.2 What is the most interesting food application of NextGen proteins in UK?

Regardless of the NextGen ingredient type, the respondents were less interested in buying NextGen food applications in the form of sausages than in the form of snacks or vegetable-protein patties *(repeated measures of analysis of variance, main effect of food type: F(2)=40.193, p=.000)*. In the case of all food types, the ones with insect -based protein were always rated as less interesting to use *(repeated measures of analysis of variance, main effect of food type: F(2)=206.132, p=.000).*

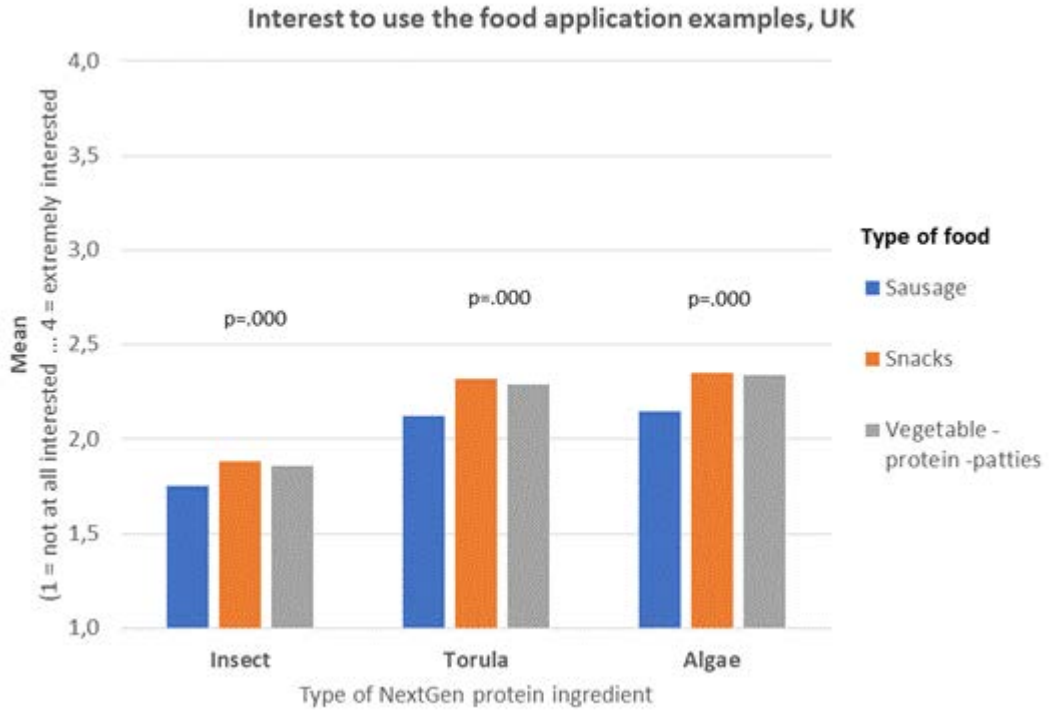


Figure 46. Means of interest to use the examples NextGen food applications by product type and NextGen ingredient type in UK. Significance of differences in means between the food types.

8.5 Acceptance of NextGen Microalgae protein concept, UK

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen microalgae concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen microalgae method and foods.

8.5.1 The level of acceptance of NextGen microalgae protein, UK

Nearly half (45 %) of the UK respondents were in favour of the idea of production of NextGen microalgae protein food ingredient. About 38 % had neutral attitude, and the minority (17.1 %) was against the idea.

Besides of the attitudes, we also asked about how understandable the concept was to the participants. Nearly 30 % felt the NextGen microalgae concept as difficult to understand.

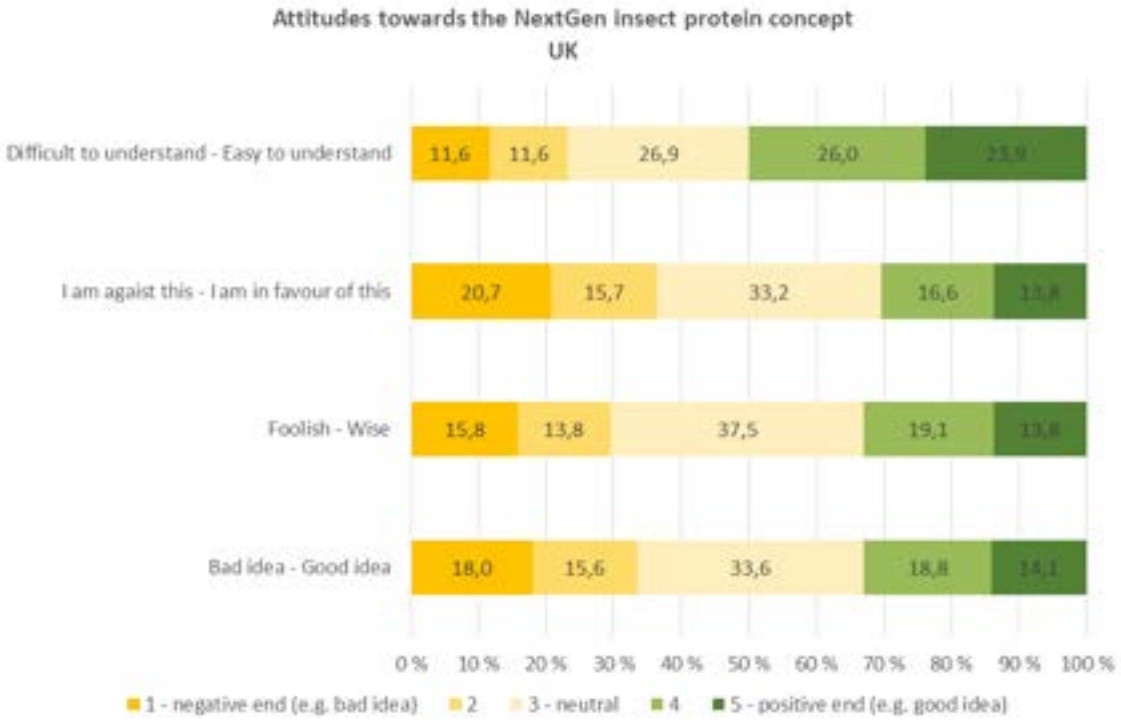


Figure 47. Attitudes towards the NextGen microalgae concept. Percentages of the UK respondents.

Over half of the respondents in UK rated the benefits of NextGen microalgae concept for environment (54.5%) and animals (53.1%) as likely, while personal benefits were expected to be less likely (32% of UK respondents). (Figure 48.)

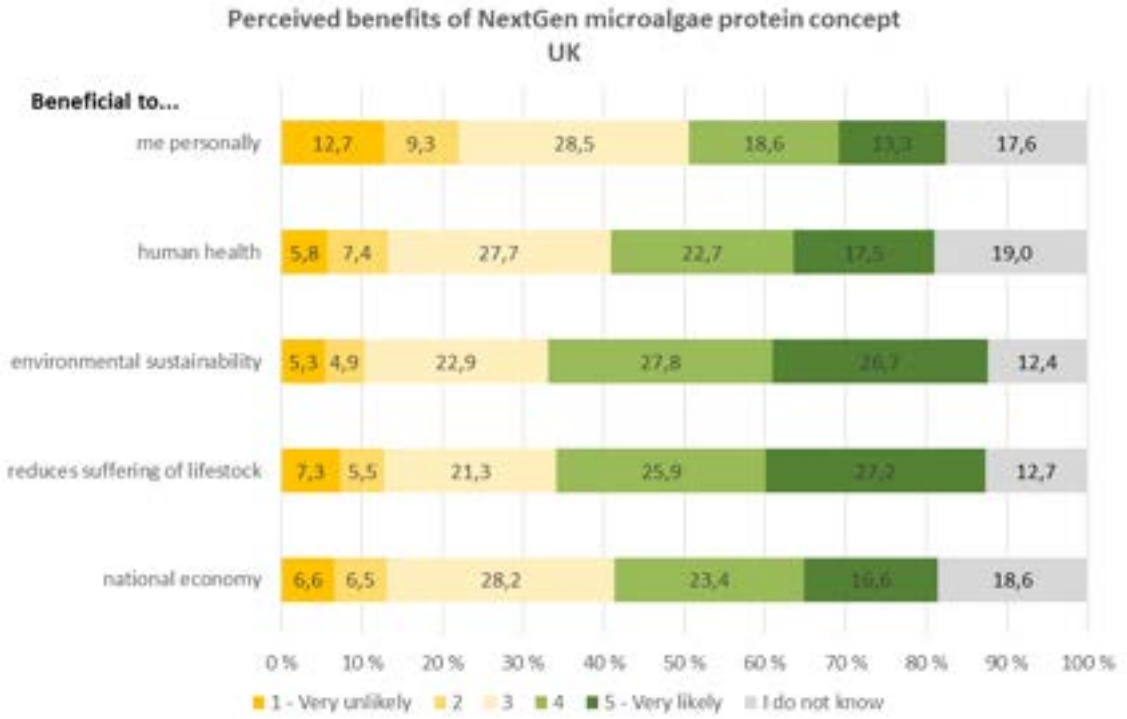


Figure 48. Perceived benefits of the NextGen microalgae protein concept. Percentages of the UK respondents.

Like in the other countries, the risks consumers were most worried about related to the honesty and integrity of the food companies: Around 40 % was concerned about being misled by the food companies in the case of NextGen microalgae protein. Potential risks for the environment or human health caused the least concern.

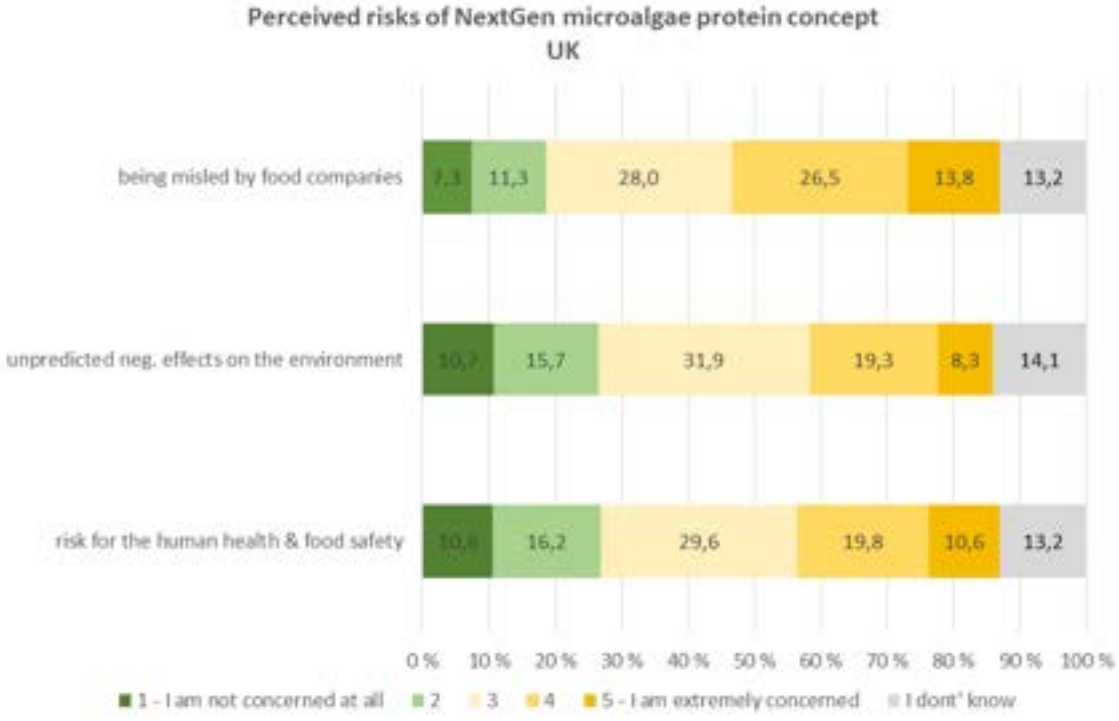


Figure 49. Perceived risks of the NextGen microalgae protein concept. Percentages of UK respondents.

The next question aimed to chart whether the consumers have preconceptions about the characteristics of the NextGen microalgae food applications. The answers indicate that UK respondents' image of these foods is more on the positive side than negative side. The most negative perception of these foods is them being rather **weird** than normal by 38 %, and rather **artificial** than natural by 31 % of respondent. On the other hand, consumers did **not seem to have worries e.g. about the safety** of these foods.

The most noteworthy result here is that most (around 40 – 50 %) respondent **did not have clear preconceptions about the characteristics of these foods** (Figure 50**)**.

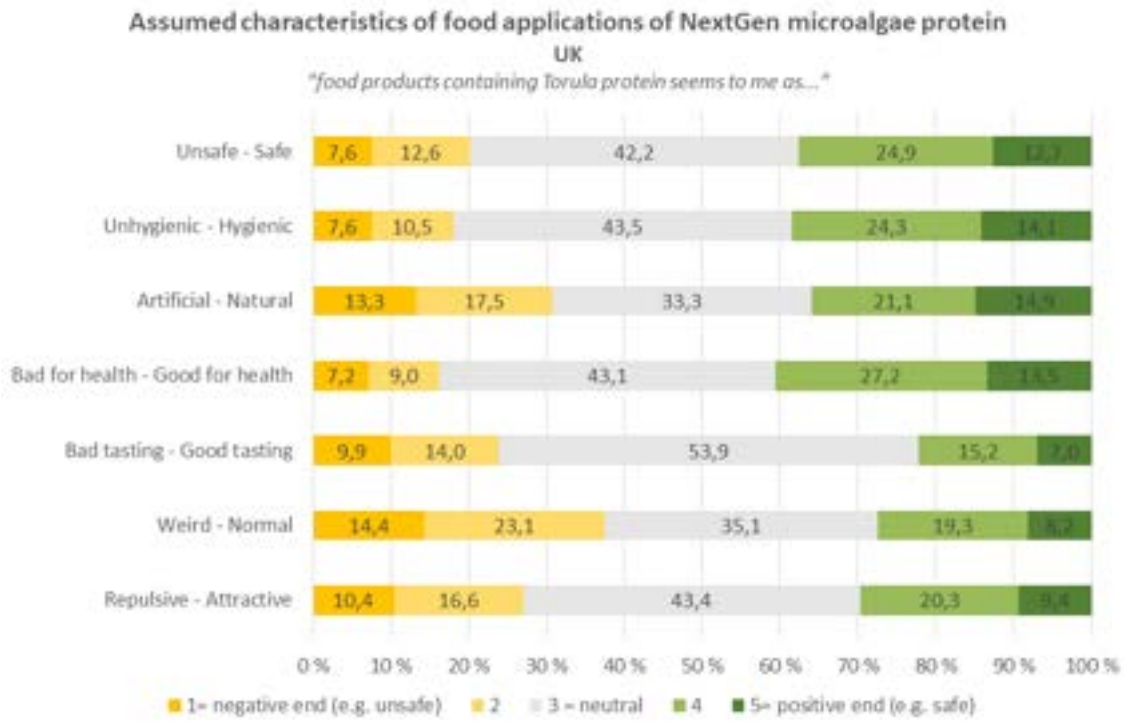


Figure 50. Characteristics associated by respondents with the imaginary food applications made with NextGen microalgae protein. Percentages of UK respondents.

Respondents subjective norms – i.e. their perceptions about what other people who were important to them, think about the NextGen concepts / foods - were asked in order to have a rough measure of subjective perception of normative influence towards using these foods. **About 20 % of the UK respondents think that the NextGen microalgae foods would be appreciated in their social circles.** (Figure 51.)

These items are not applied in the further analyses, however because of apparent invalidity. Based on the correlations of these items (-.05) it seems that part of the respondents may not have noticed the negative formulation of the second item *"Most of the people I know would not be interested in purchasing these foods".*

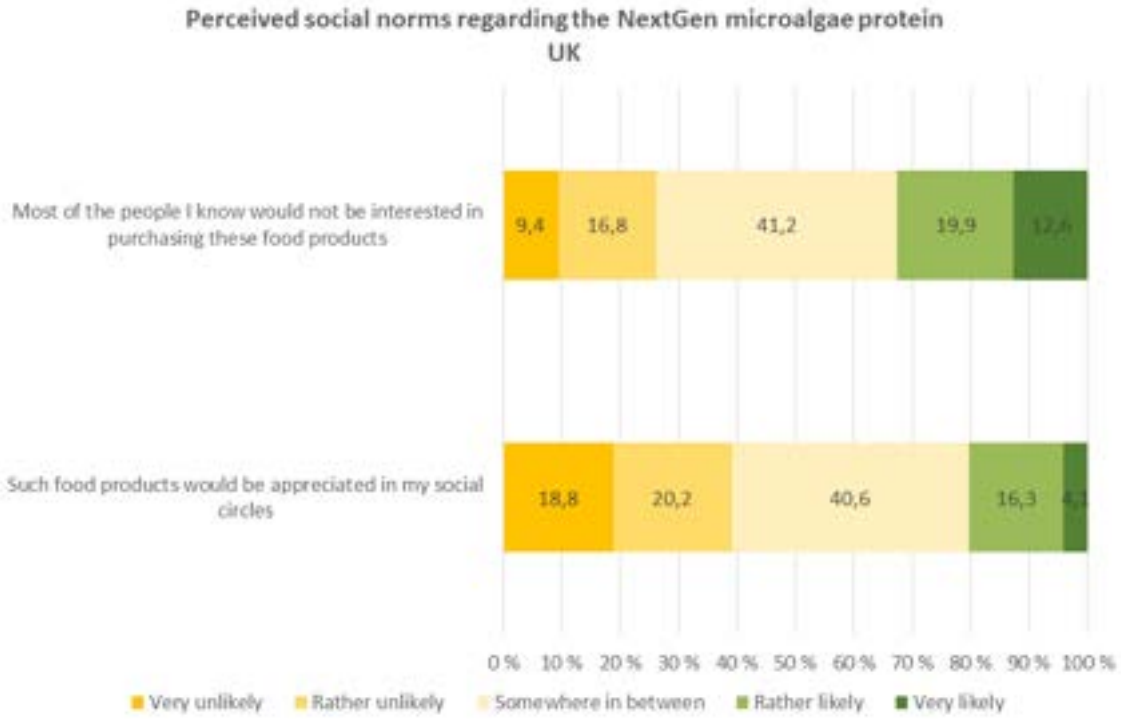


Figure 51. Perceived social norms regarding NextGen microalgae protein food products. Percentages of UK respondents.

The share of UK respondents indicating interest to use food applications made with NextGen microalgae protein varied between 35.3 % and 43.1 %.

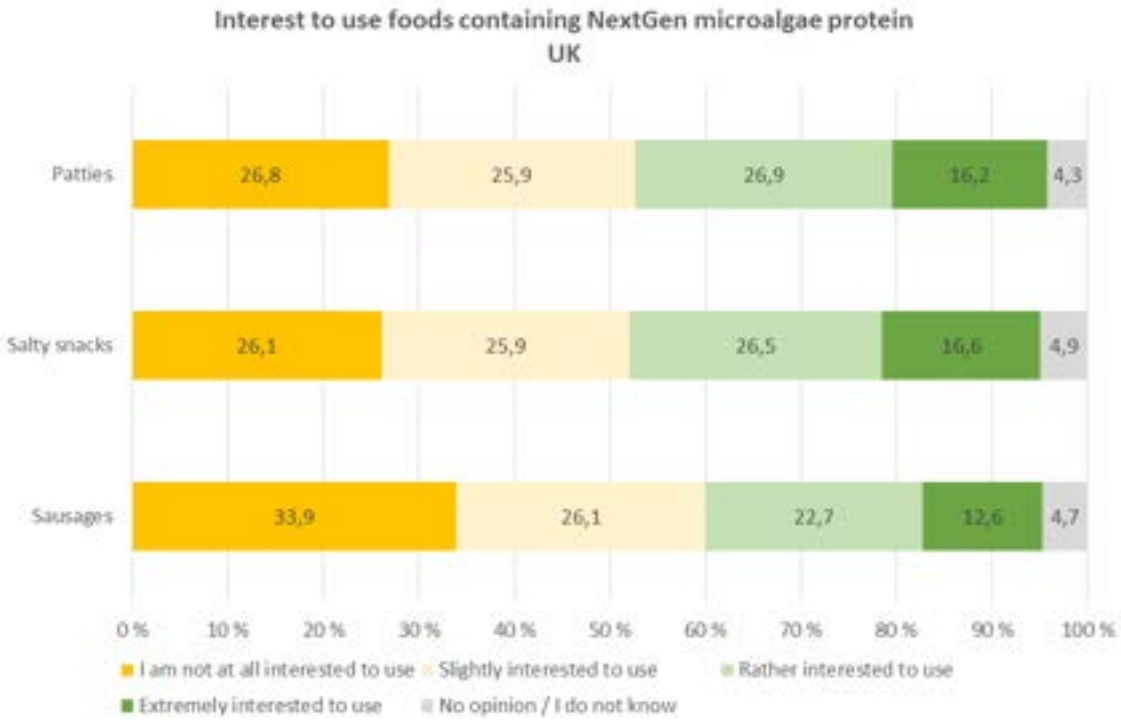


Figure 52. Interest to use the food application examples of NextGen microalgae protein. Shares of UK respondents with each answer alternative.

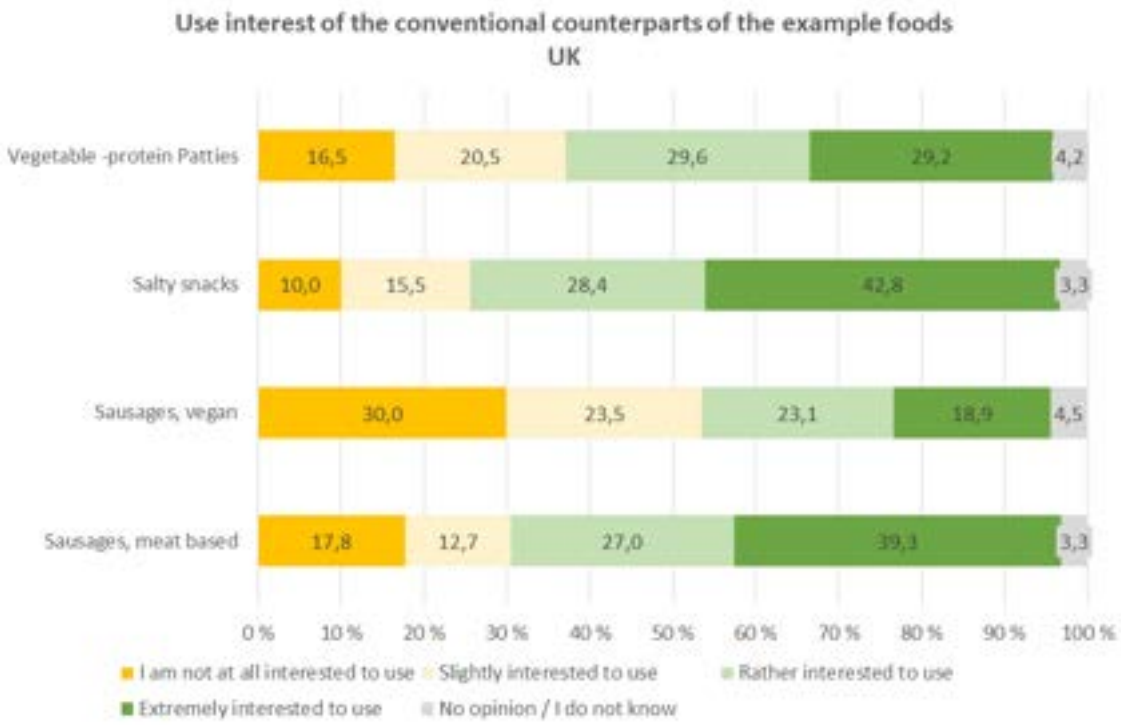


Figure 53. Use interest of the conventional counterparts of the food application examples. Percentages of UK respondents.

8.5.2 Consumer clusters based on views towards NextGen microalgae protein concept, UK

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGen microalgae concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 2 – 3 clusters. Subsequent K-means clustering, run with 2, 3 and 4 clusters, confirmed that 3 cluster solution best brings out the differences in the sample.

The resulting clusters were named based on their means of the clustering variables (Table 20.). The first cluster, consisting of 16.3 % of respondents was named as **Negative** as in this cluster the all the acceptance ratings were the most negative of these clusters: They had least positive attitude towards the NextGen microalgae concept, believe the least in the benefits of the concept and were most concerned about the risks of the NextGen microalgae concept, and finally has most negative expectations about the characteristics of the food applications of this protein. The third cluster, called **Positive**, accounting for 31.7 % of the respondents, is the direct opposite to the negative cluster with its' most positive views. Following the same lines, the second cluster is called **Neutral,** as they were intermediate in their acceptance ratings. Most (68.3 %) of the UK respondents fell into this category.

Table 20. Consumer clusters based on respondents' views towards NextGen microalgae protein concept. The result of K-means cluster analysis with 3 clusters. Means of acceptance variables in each cluster. UK

Cluster >	1 - Negative	2 - Neutral	3 - Positive	Total	F	Sig.
Number of cases	143	457	279	879		
Percent of cases	16.3%	68.3%	31.7%	100%		
Variables applied as basis of the clustering						
ATT_Algae	1.80	3.26	4.64		1310,619	.000
BENEFIT_Algae	1.96	3.43	4.47		856,208	.000
RISK_Algae	3.80	3.36	2.39		147,643	.000
FOODVIEWS_Algae	1.77	3.01	4.05		799,463	.000

8.5.2.1 Demographic profile and eating habits of NextGen microalgae protein consumer clusters, UK

The demographic characteristics of the consumer clusters with negative, neutral or positive views towards the NextGen microalgae concept have been characterised in Table 21.

Compared to the other clusters, the members of **cluster Positive** were

- more likely to have higher (tertiary) level education
- less likely to be 18 – 24 y or 55 - 64 years old
- more likely vegetarians

In contrast, the members of the **Negative** cluster were likely to

- belong to the age groups 45 – 64 y.
- have omnivorous diets

While in the **Neutral cluster**

- younger age groups (25 – 44 y.) were most common

No significant differences were observed between the clusters in gender, or whether one had children in the family, nor type of living area.

Table 21. Demographic profile of consumer clusters based on views towards NextGen microalgae protein concept, UK. Percentages of respondents. Statistical significance of differences within each background variable has been tested with Pearson Chi² – tests.

	Negative	Neutral	Positive	Total %	Pearson Chi²	Sign.	Total N
Gender_2					3.456	ns	873
male	46.8%	53.2%	46.9%	50.2%			
female	53.2%	46.8%	53.1%	49.8%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Age group					46.167	.000	880
Age group							
18 - 24 Years	9.8%	9.4%	**14.6%**	11.1%			
25 - 34 Years	12.6%	**19.7%**	14.3%	16.8%			
35 - 44 Years	10.5%	**22.8%**	21.8%	20.5%			
45 - 54 Years	**14.7%**	21.2%	21.1%	20.1%			
55 - 64 Years	**30.1%**	15.5%	13.6%	17.3%			

65 - 75 Years	22.40 %	11.40 %	14.60 %	14.20 %			
Education_3					19.443	.001	826
Basic	12.9%	9.6%	6.9%	9.3%			
Secondary...first stage tertiary	55.7%	47.5%	39.9%	46.4%			
Tertiary. university	31.4%	42.8%	**53.3%**	44.3%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Type of living area					3.893	ns	880
Capital area	15.3%	19.7%	18.3%	18.5%			
a large city that is not in the capital area	15.3%	19.9%	19.0%	18.9%			
a small city/town or muncipality	51.4%	45.3%	47.0%	46.8%			
a rural area	18.1%	15.1%	15.8%	15.8%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Household_3Bchild					3.980	ns	870
no children (1 or 2 adults)	58.2%	49.6%	52.0%	51.7%			
1-2 adults with children	28.4%	33.0%	29.6%	31.1%			
all other alternatives	13.5%	17.5%	18.4%	17.1%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Diet					12.116	.017	879
ominivore	**75.0%**	74.2%	67.6%	72.2%			
meat sometimes or no red meat	20.1%	18.8%	19.1%	19.1%			
vegetarian	4.9%	7.0%	**13.3%**	8.6%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*			

Differences in some food habits and familiarity with alternative proteins are described in Figure 51. Compared with the Negative and Neutral clusters, the consumer cluster with **positive views towards NextGen microalgae concept** in UK, can be characterised as: more often

- vegetarian
- more likely to use vegetarian convenience foods
- less likely to use meat convenience foods
- more familiar with alternative and future protein foods and sources

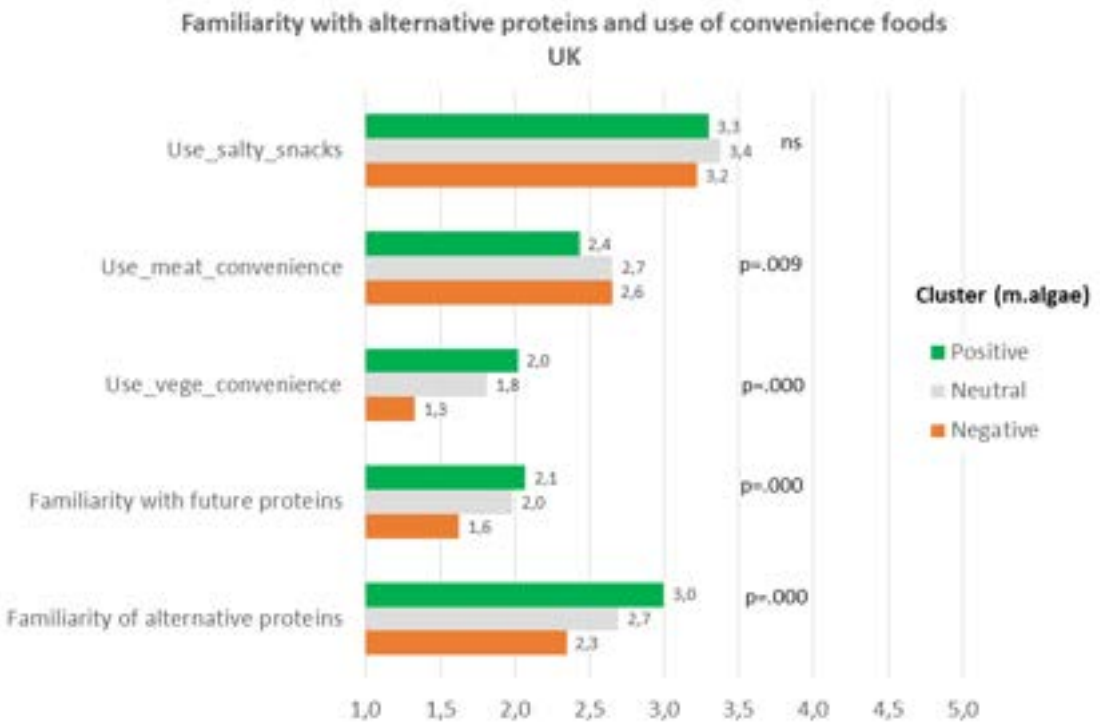


Figure 54. Use of certain convenience food types and familiarity with alternative proteins by NextGen microalgae consumer clusters in the UK sample. Means. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

8.5.2.2 Attitudinal background of NextGen microalgae protein consumer clusters, UK

Compared with the Negative and Neutral clusters (Figure 55 and Figure 56), the UK consumer cluster with positive views towards NextGen microalgae concept can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having higher trust in different actors of food chain
- having lower taste neophobia (reluctance to taste unfamiliar tastes)
- having more positive attitudes towards food technology in general
- being less attached to meat

In terms of what they value in their daily foods, the cluster Positive vs. Negative more typically valued (Figure 56):

- Sustainability and ethical issues of food choice
- Healthiness of food

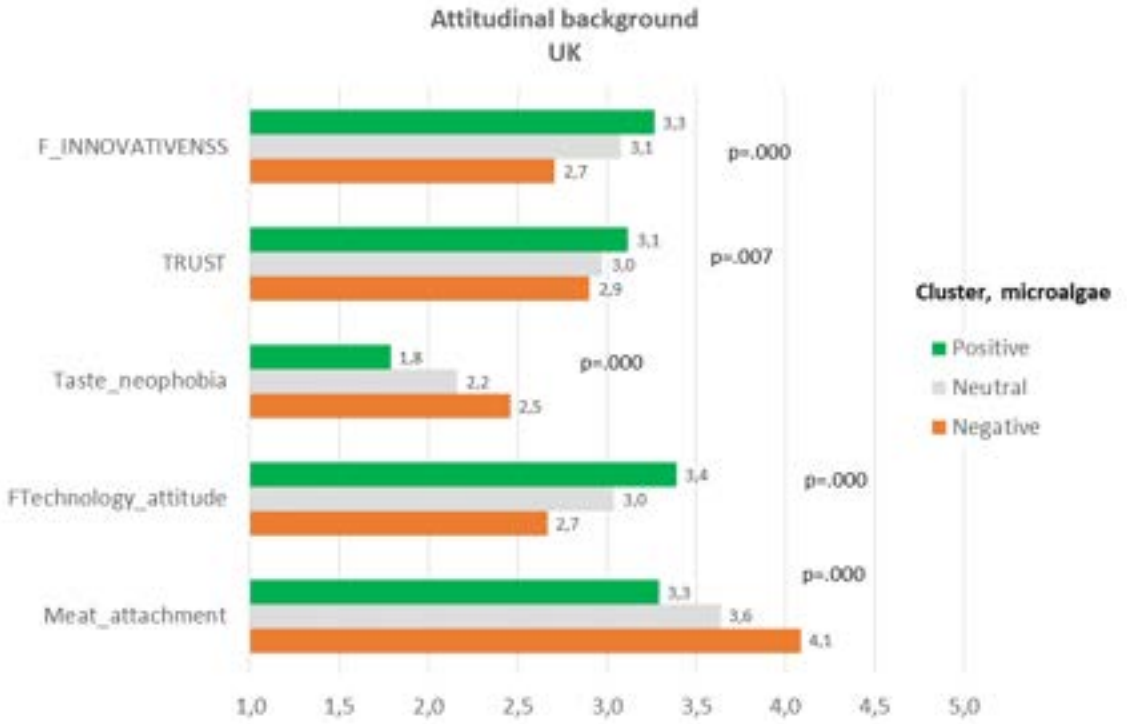


Figure 55. Background attitudes of the respondents in the clusters based on their views towards NextGen microalgae concept. UK (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

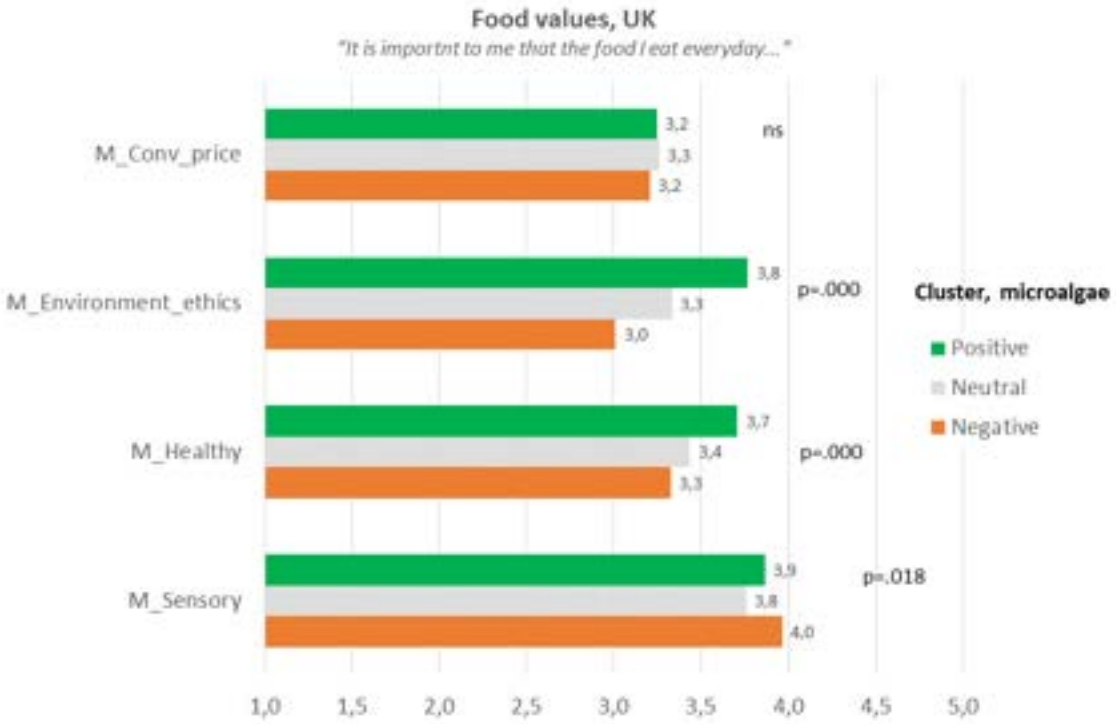


Figure 56. Means of food choice motives (values) of consumer clusters based on their views on NextGen microalgae concept. UK. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

8.5.2.3 *Interest to use food applications by NextGen microalgae protein consumer clusters, UK*

The cluster with positive views towards NextGen microalge also had very much higher interest in the food application examples of NextGen microalgae protein, as can be seen in the figure below.

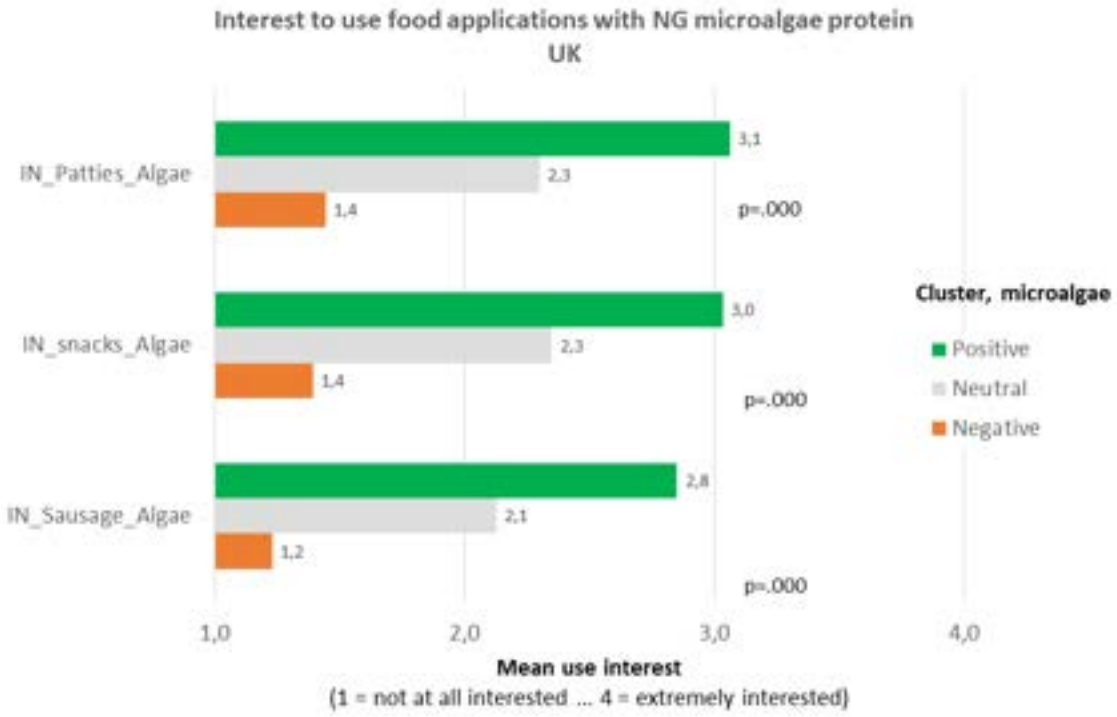


Figure 57. Respondents' mean interest to use vegetable – protein patties, salty snack and sausages made with NextGen microalgae. Means, and significance of differences between clusters. UK.

8.6 Acceptance of NextGen Insect protein concept, UK

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Insect** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Insect concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Insect method and foods.

8.6.1 The level of acceptance of the NextGen insect protein

Only 30.4 % of the UK respondents were in favour of the idea of production of NextGen insect protein food ingredient. About 33 % had neutral attitude, and 36.4 % was against the idea. Figure 58.

Besides of the attitudes, we also asked about how understandable the concept was to the participants. About 23 % of the respondents felt the NextGen insect concept as difficult to understand.

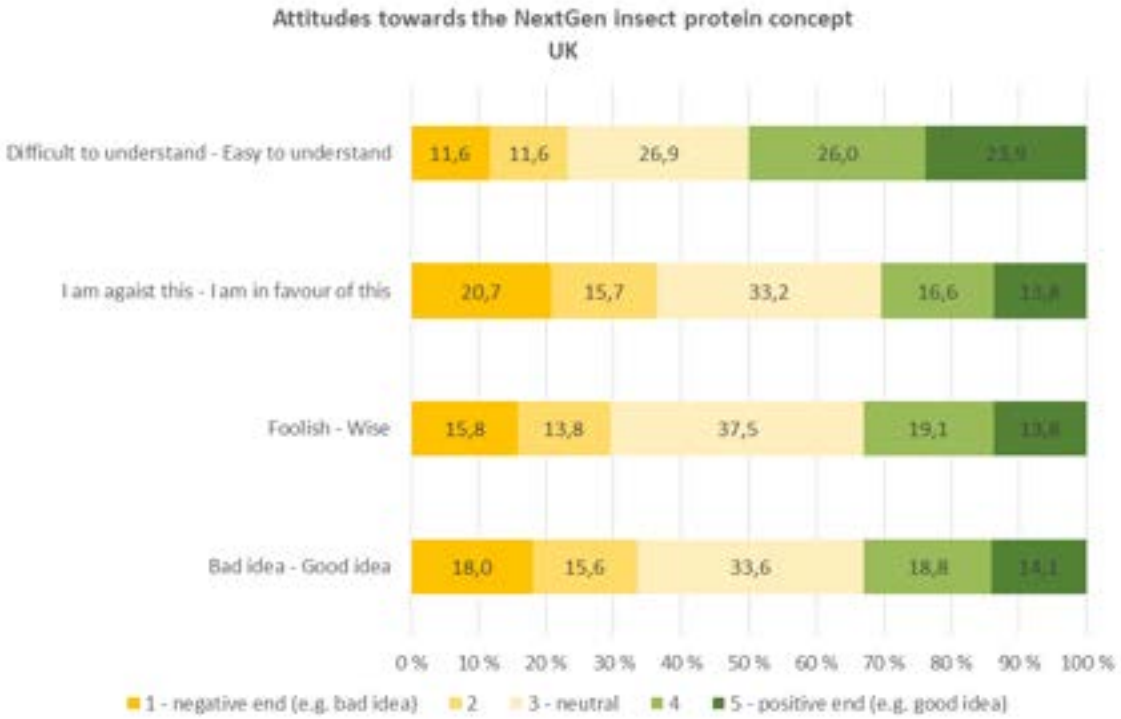


Figure 58. Attitudes towards the NextGen insect protein concept. Percentages of UK the respondents.

Regarding the expected benefits of the NextGen insect concept, benefits related to **environmental sustainability and animal welfare were again regarded as most plausible ones, and the personal benefits as the least likely.** Almost half of the respondents in UK rated the benefits of NextGen insect concept for environment (45.9 %) and animals (39.1 %) as likely, while personal benefits were expected only by 20.9 % of UK respondents. (Figure 59.)

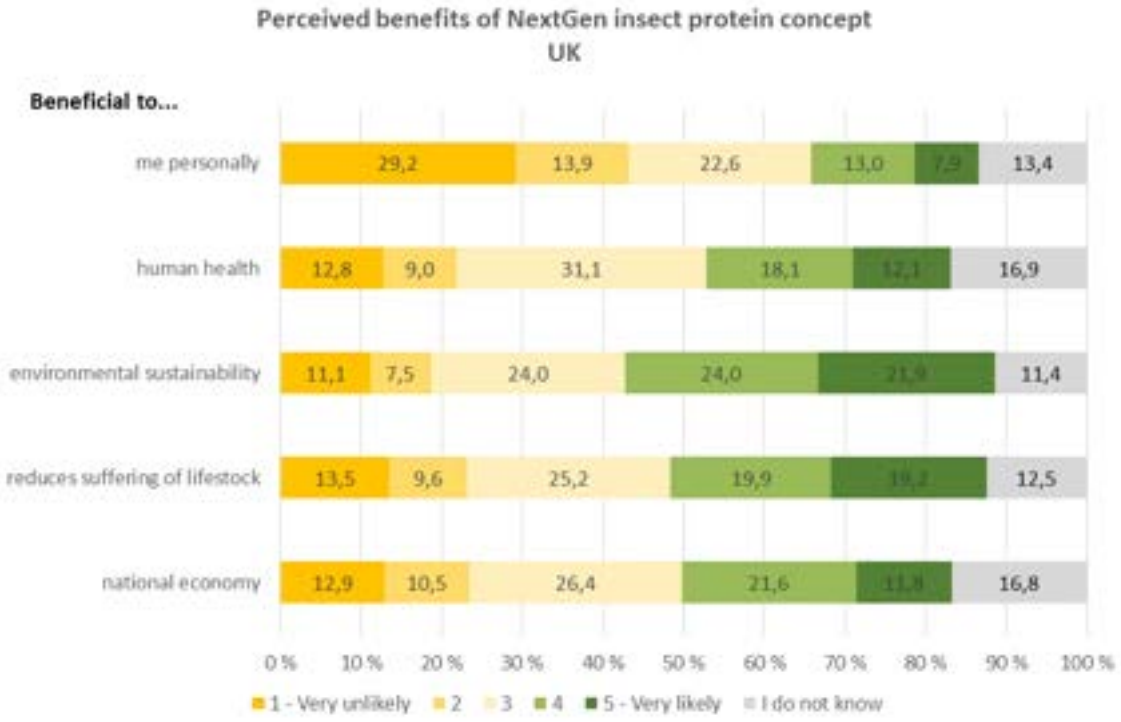


Figure 59. Perceived benefits of the NextGen insect protein concept. Percentages of UK the respondents.

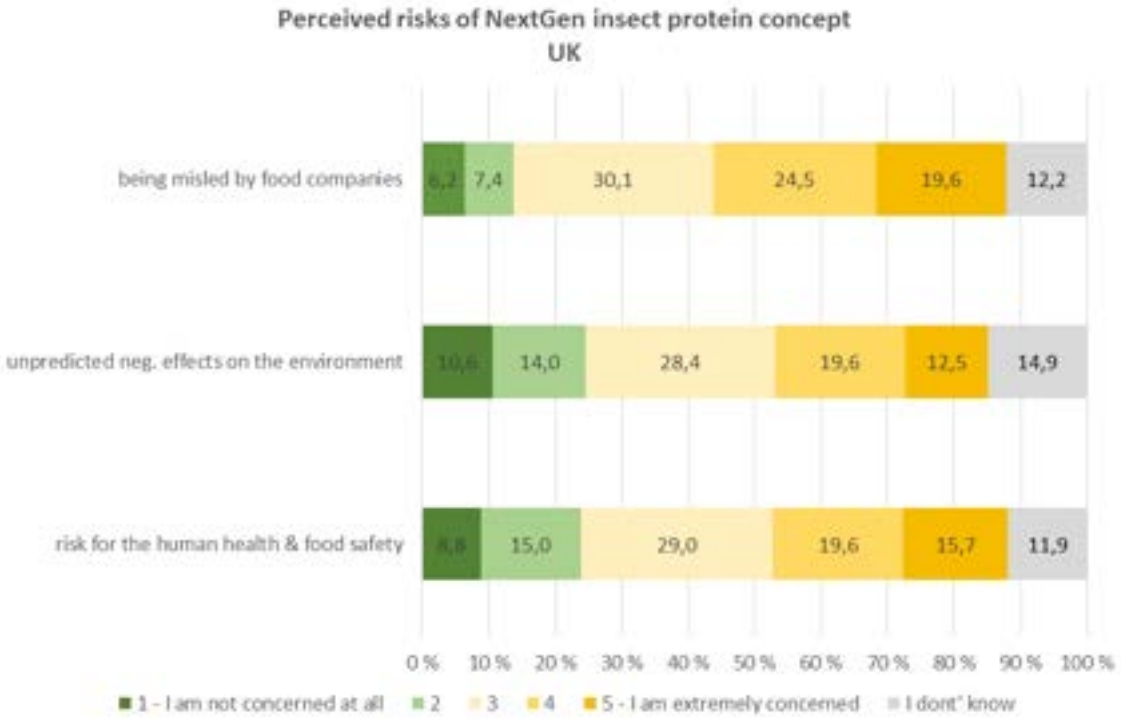


Figure 60. Perceived risks of the NextGen insect protein concept. Percentages of UK the respondents.

Like in the case of other countries and ingredients, the risks consumers were most worried about related to the honesty and integrity of the food companies: Around 44 % was concerned about being misled by the food companies in the case of NextGen insect protein.

A great share of consumers provided neutral ratings, suggesting that they felt unable to estimate their concerns. Only around 23 – 24 % were not concerned about the risks. Figure 60.

Regarding consumers preconceptions about the characteristics of the NextGen insect food applications the answers indicate that UK respondents' image of these foods is more on the negative side than on the positive side – unlike in the case of microalgae, for example. Quite a large share of respondents perceived the NextGen insect food applications as **weird** (60.9 %), **repulsive** (55 %) and **bad tasting** (44.1 %). Interestingly **not many** (22.4 %) **regarded insect applications as artificial -** to the same extent than the other two NextGen ingredients.

The lower share of respondents with neutral ratings compared to microalgae suggests, that consumers had more extreme views about insects than about the other NextGen ingredients. Still the share of respondents with no clear preconceptions about the food characteristics was large. Figure 61.

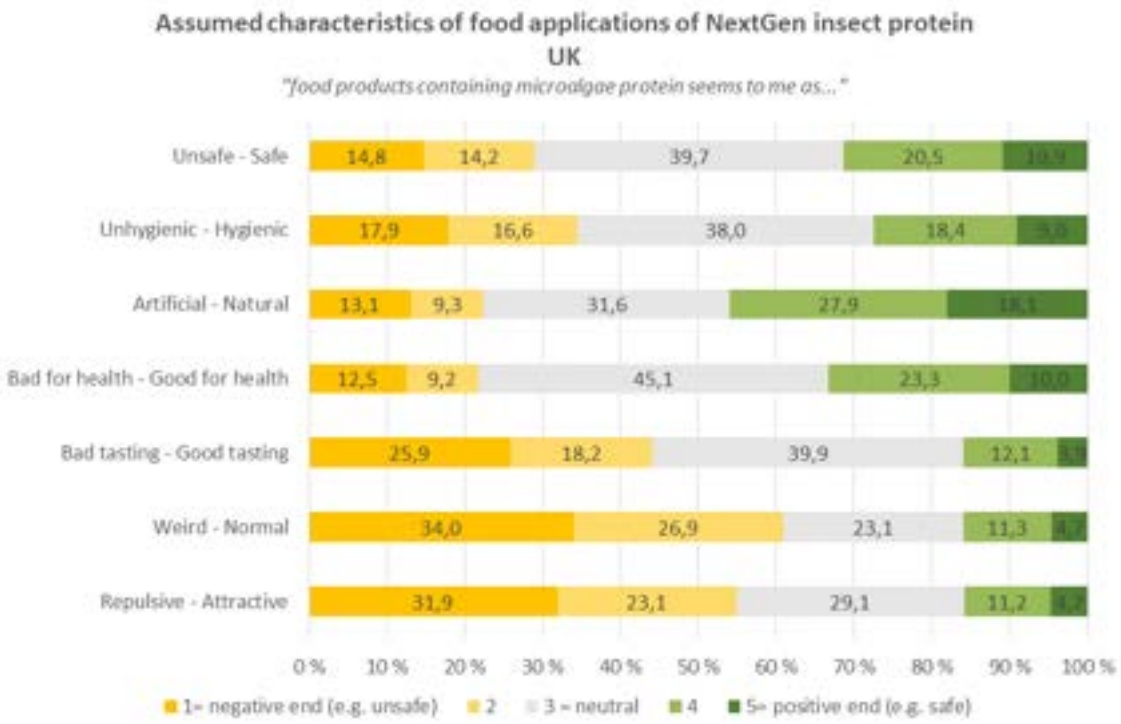


Figure 61. Characteristics associated with food applications made with NextGen insect protein. Percentages of UK respondents.

Respondents subjective norms – i.e. their perceptions about what other people who were important to them, think about the NextGen concepts / foods - were asked in order to have a rough measure of subjective perception of normative influence towards using these foods. Only a minority (11 %) of the UK respondents think that the NextGen insect foods would be appreciated in their social circles. (Figure 62.)

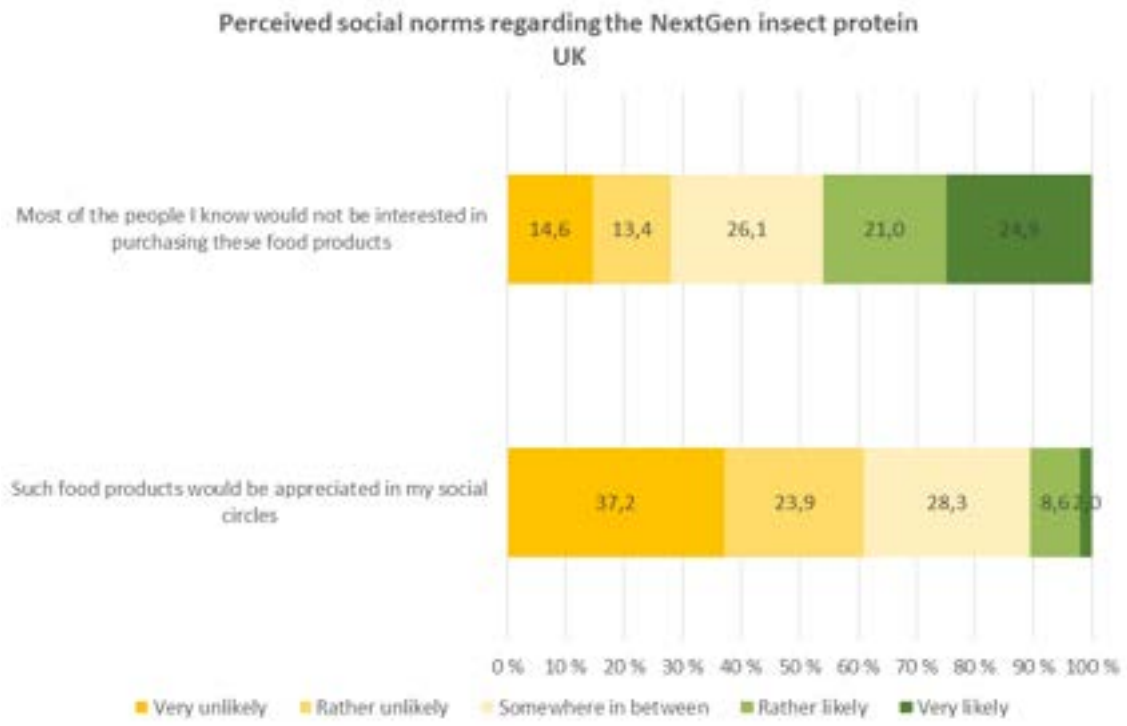


Figure 62. Perceived social norms regarding NextGen insect protein food products. UK.

UK consumers interest to use the three examples of NextGen insect protein applications was low. Over half of the respondents clearly reject these foods, while e.g. 28.8 % would be interested in salty snack applications.

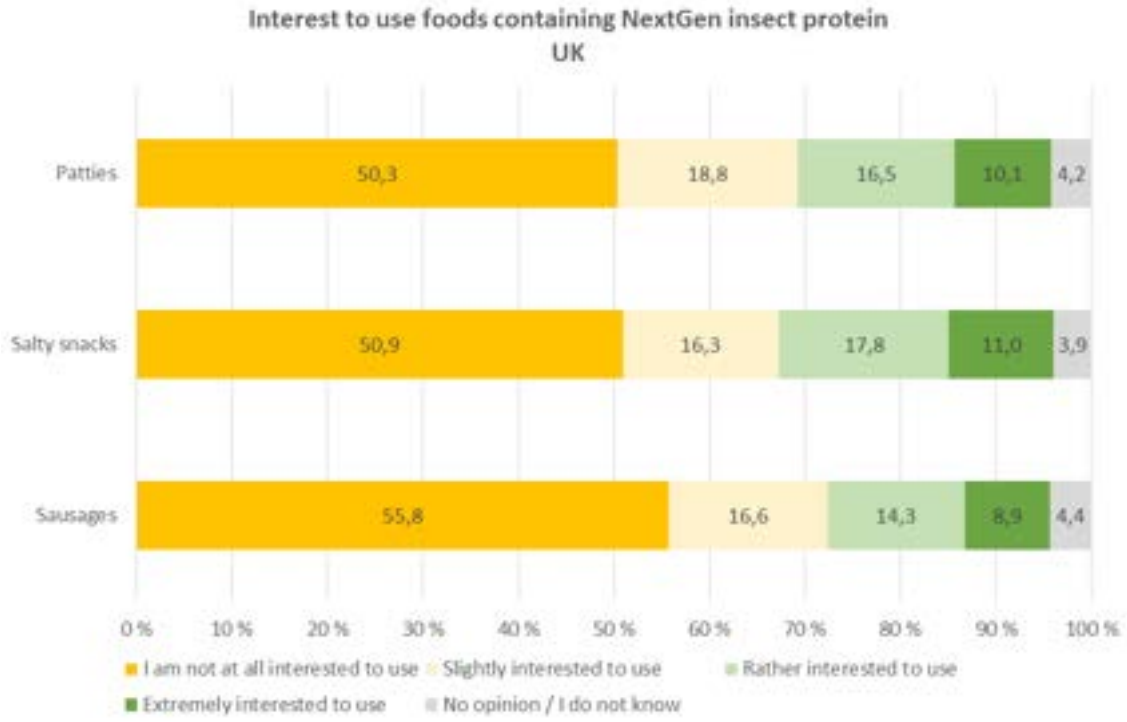


Figure 63. Interest to use the food application examples of NextGen Torula protein. Shares of UK respondents with each answer alternative.

8.6.2 Consumer clusters based on views towards NextGen insect protein concept, UK

The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested three cluster solution. One of the clusters consists of respondents with negative views, another with neutral views and the third with positive views. As can be seen from the table below, respondents in the negative cluster were less likely to have positive attitudes towards the NextGen insect concept, less likely to believe that it would have the benefits listed in the survey, but more likely to worry about the risks of it. Consistently with these negative views, they also expected the NextGen insect food products to be of inferior quality compared to the more positive or neutral cluster. Only 25.5 % of the UK respondents belong to the negative cluster. Majority of the respondents had neutral views.

Table 22. Consumer clusters based on respondents' views towards NextGen insect protein concept. The result of K-means cluster analysis with 3 clusters. UK

Cluster >	1 - Negative	2 - Neutral	3 - Positive	Total	F	Sig.
Number of cases	228	432	234	893		
Percent of cases	25.5 %	48.3 %	26.1 %			
Variables applied as basis of the clustering						
ATT_Insects	1.48	3.00	4.47	3.00	1617.043	.000
BENEFIT_Insects	1.72	3.17	4.27	3,01	1016.239	.000
RISK_Insects	3.98	3.25	2.64	3,28	117.551	.000
FOODVIEWS_Insects	1.58	2.83	3.87	2,78	1037.043	.000

8.6.2.1 Demographic profile and eating habits of NextGen Insect protein consumer clusters, UK

The share of male respondents was higher than the share of female respondents in the cluster with positive views towards NextGen insect concept. Otherwise the consumer clusters did not significantly differ from each other in terms of their demographic background. A tendency for older age-groups being more often in the cluster Negative, can however be observed.

Compared with the Negative and Neutral clusters, the Italian consumer cluster with **positive views towards NextGen microalgae concept** in UK, can be characterised as:

- more likely male gender
- more likely to use vegetarian convenience foods
- more familiar with alternative and future protein foods and sources

but not more likely to be vegetarians (as in the case of NextGen microalgae and Torula)

Table 23. Demographic profile and eating habits of the NextGen microalgae consumer clusters, UK

	Negative	Neutral	Positive	Total %	Pearson Chi^2	Sign.	Total N
Gender_2					21.450	.000	887
male	37.1%	52.9%	**57.3%**	50.1%			
female	**62.9%**	47.1%	42.7%	49.9%			
total	100.0%	100.0%	100.0%	100.0%			
Age group					16.922	ns	893
18 - 24	9.3%	11.1%	**12.4%**	11.0%			
25 - 34 Years	16.7%	17.6%	15.0%	16.7%			
35 - 44 Years	18.5%	**21.3%**	20.9%	20.5%			
45 - 54 Years	**15.4%**	21.3%	**23.9%**	20.5%			
55 - 64 Years	**21.1%**	16.7%	12.8%	16.8%			
65 - 75 Years	**18.9%**	12.0%	15.0%	14.6%			
Total	100.0%	100.0%	100.0%	100.0%			
Education_3					8.331	ns	876
Basic	8.9%	9.5%	8.3%	9.0%			
Secondary...first stage tertiary	51.6%	47.3%	39.5%	46.3%			
Tertiary. university	39.6%	43.3%	52.2%	44.6%			
Total	100.0%	100.0%	100.0%	100.0%			
Type of living area					6.402	ns	895
Capital area	14.5%	18.2%	20.9%	18.0%			
a large city that is not in the capital area	19.7%	18.5%	18.4%	18.8%			
a small city/town or muncipality	46.5%	49.4%	44.9%	47.5%			
a rural area	19.3%	13.9%	15.8%	15.8%			
Total	100.0%	100.0%	100.0%	100.0%			
Household_3Bchild					4.496	ns	879
no children (1 or 2 adults)	56.6%	50.5%	51.7%	52.3%			
1-2 adults with children	30.3%	30.4%	32.2%	30.8%			
all other alternatives	13.1%	19.2%	16.1%	16.8%			
Total	100.0%	100.0%	100.0%	100.0%			
Diet					3.441	ns	889
ominivore	68.0%	73.7%	74.9%	72.6%			
meat sometimes or no red meat	22.8%	18.1%	17.7%	19.2%			
vegetarian	9.2%	8.1%	7.4%	8.2%			
Total	100.0%	100.0%	100.0%	100.0%			

Differences in some food habits and familiarity with alternative proteins are described in Figure 64. Compared with the Negative and Neutral clusters, the consumer cluster with **positive views towards NextGen insect concept** in UK, can be characterised as:

- more likely to use vegetarian convenience foods
- more familiar with alternative and future protein foods and sources

However, **vegetarians were not** more prevalent in the cluster with positive views towards NextGen insect protein in UK. The focus-group discussions – although not carried out in UK – suggest that vegetarians are not willing to eat any kind of insects because also insects are animals – regardless of how much they value the positive sustainability benefits of NextGen.

The use frequency of (conventional) salty snacks or meat-based convenience foods do not differ between the clusters.

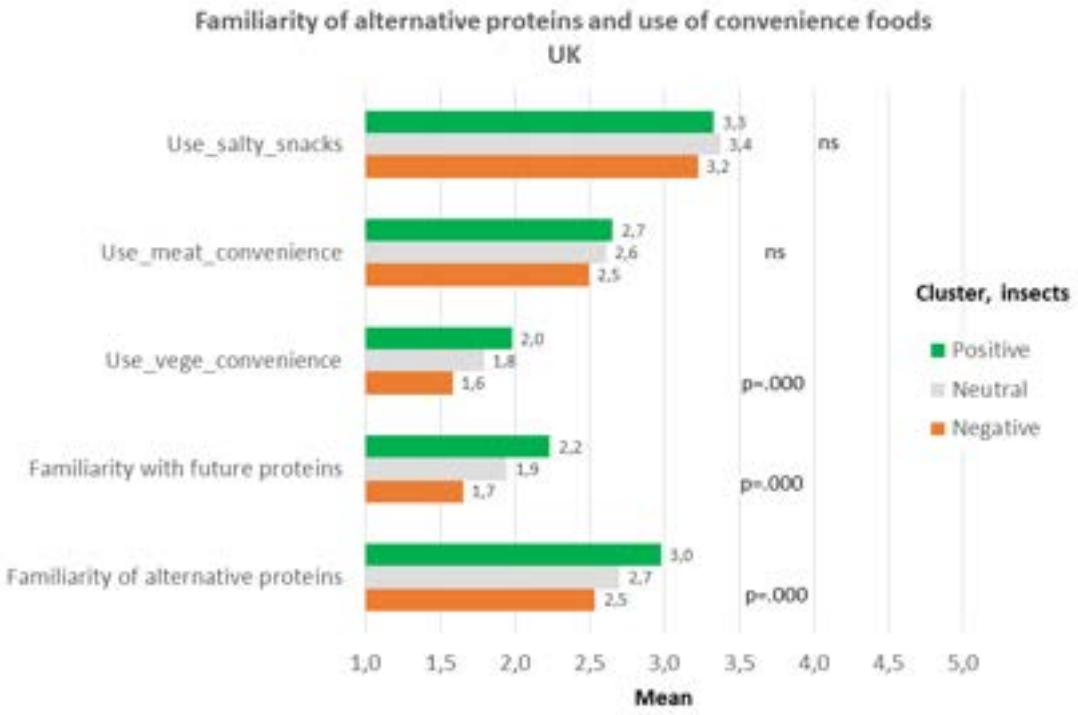


Figure 64. Mean use frequencies of certain convenience foods and familiarity with alternative proteins by consumer clusters based on their views on NextGen insect protein concept. UK. (The level of statistical significance of differences in means between the clusters has been marked with p -values, ns = not significant)

8.6.2.2 Attitudinal background of NextGen insect clusters, UK

Compared with the Negative and Neutral clusters, the UK consumer cluster with positive views towards NextGen **insect** concept can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having higher trust in different actors of food chain
- having lower taste neophobia (reluctance to taste unfamiliar tastes)
- having more positive attitudes towards food technology in general
- being less attached to meat

In terms of what they value in their daily foods, the cluster Positive vs. Negative more typically valued:

- Sustainability and ethical issues of food choice
- Healthiness of food

while sensory pleasure was more important to the Negative than to the Positive cluster.

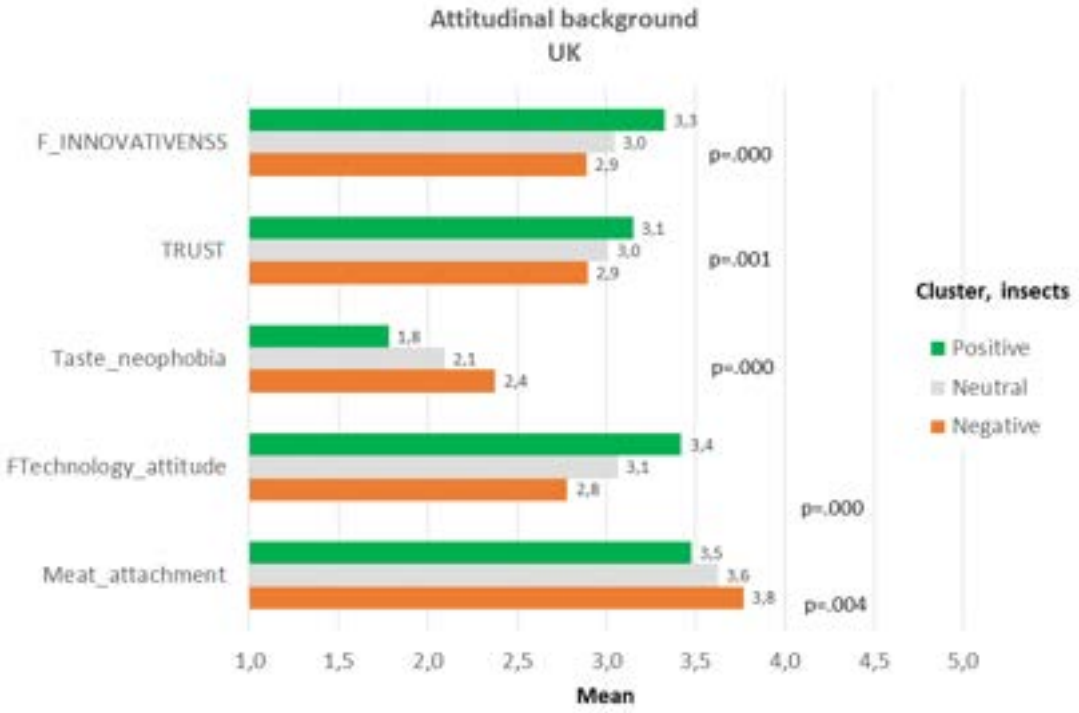


Figure 65. Background attitudes of the respondents in the clusters based on their views towards NextGen insect concept. UK (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

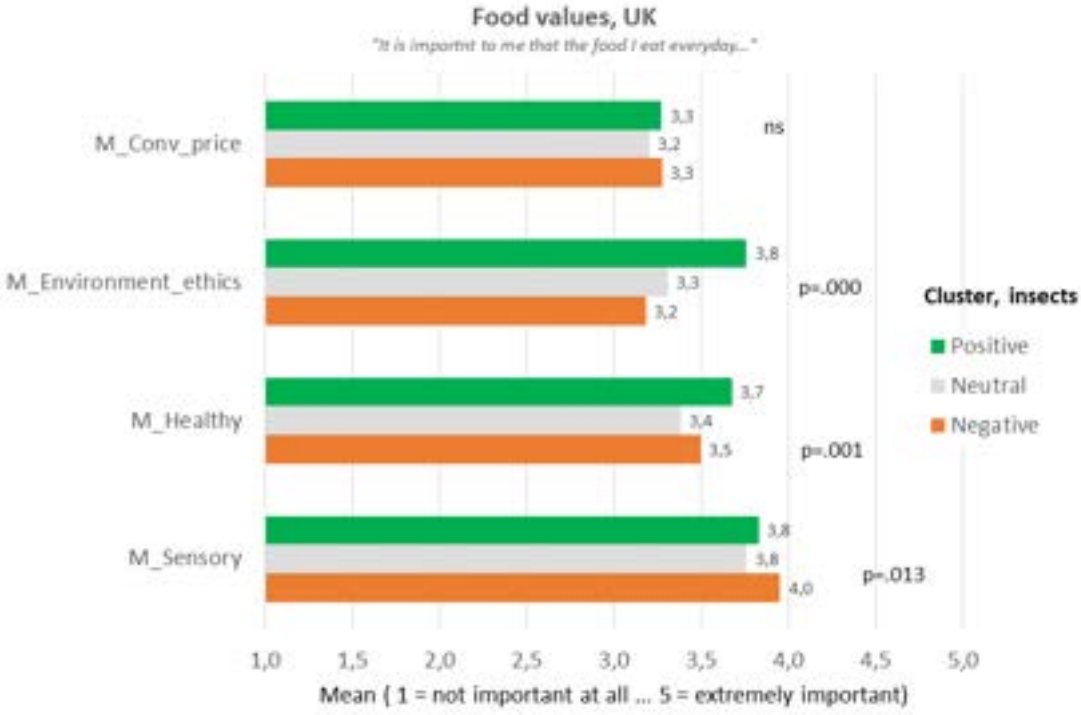


Figure 66. Means of food choice motives (values) of consumer clusters based on their views on NextGen insect concept. UK. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

8.6.2.3 Interest to use the food applications by NextGen insect consumer clusters

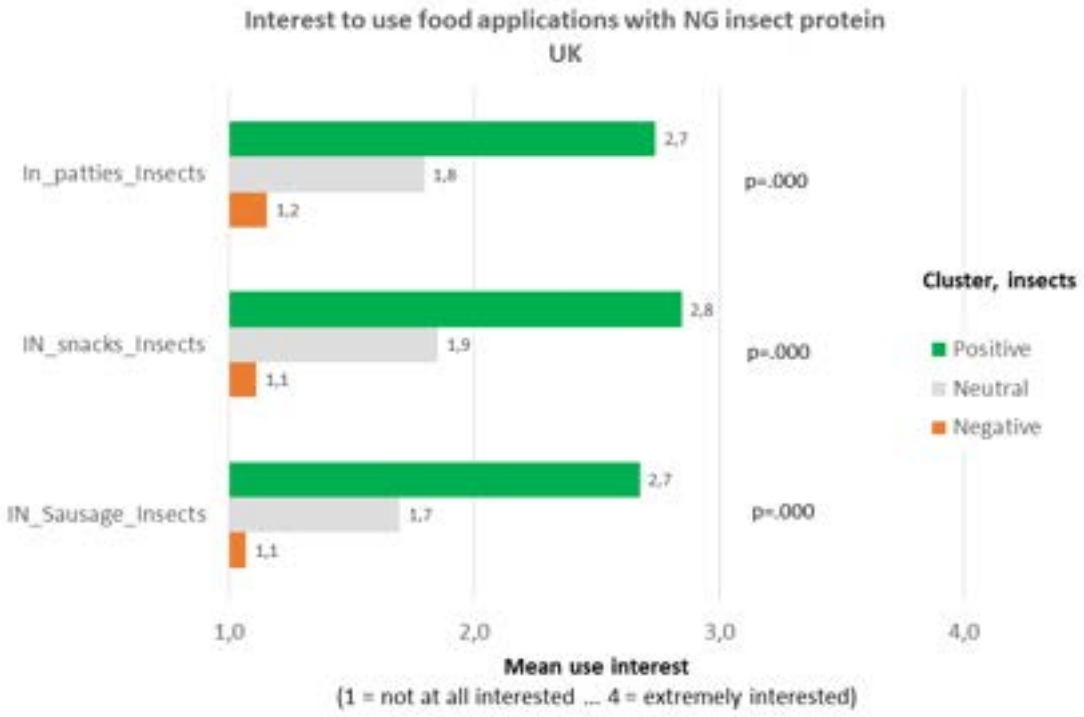


Figure 67. Interest to use food applications by consumer clusters based on their views towards NextGen insect protein concept. UK. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

8.7 Acceptance of Nextgen Torula protein concept, UK

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Torula** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Torula concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Torula method and foods.

8.7.1 The level of acceptance of NextGen Torula protein, UK

Less than half of the UK respondents (43.2 %) were in favour of the NextGen Torula concept, almost as many (38.7 %) of them did not have clear opinion either for or against. Only about one fifth had a negative attitude, a bit varying depending on the attitude statement. Figure 68.

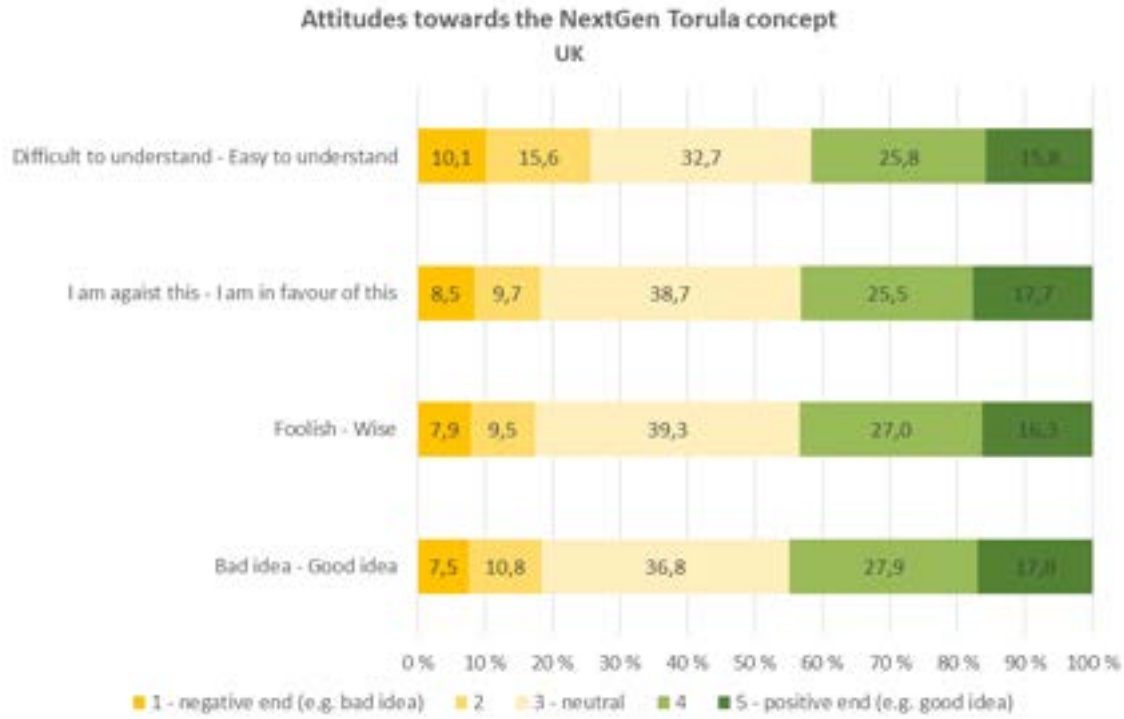


Figure 68. Attitudes towards the NextGen Torula concept. Percentages of UK respondents

Benefits related to environmental sustainability and animal welfare were again - like in the case of most countries and NextGen concepts - regarded as the most likely benefits from NextGen Torula concept, and the personal benefits as the least likely. Over half of the respondents in UK rated the benefits of for environment (53 %) and for the livestock (54 %) as likely, while personal benefits were expected to be less likely (28 % of UK respondents). Considerable share of respondents did not know what think about the benefits. E.g. if the answer options 3 (neither likely nor unlikely) and "cannot say" are summated, 49 % of the respondents did not take a stand (Figure 69.).

Like in the most cases of other countries and ingredients, the risks consumers were most worried about related to the honesty and integrity of the food companies: Around 31.6 % was concerned about being misled by the food companies in the case of NextGen Torula protein. The share of consumers with no opinion or neutral in terms of risk concerns was almost half in the case of environmental risks. (Figure 70.).

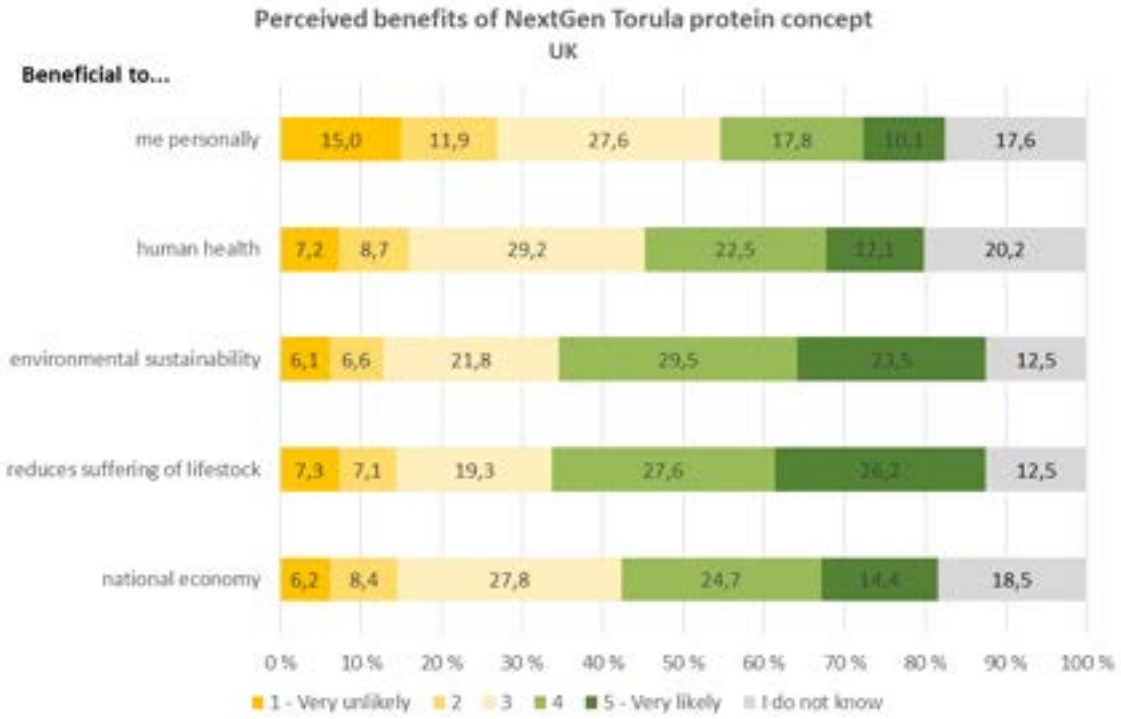


Figure 69. Perceived benefits of NextGen Torula protein concept. Percentages of UK respondents.

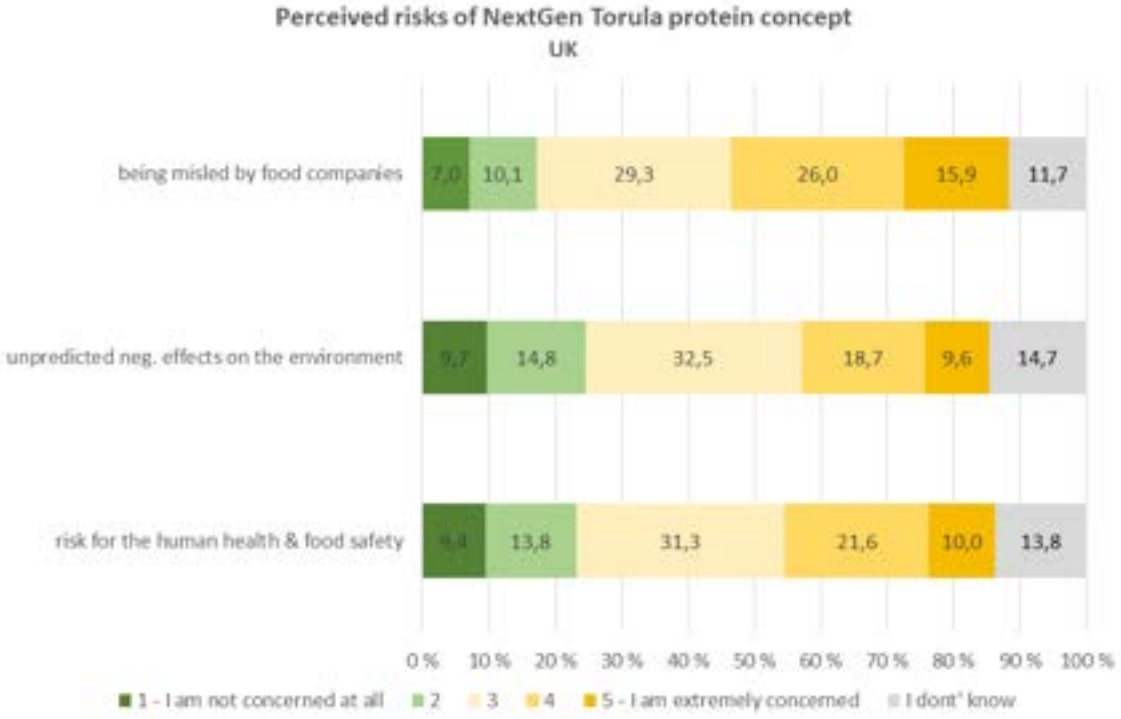


Figure 70. Perceived risks of NextGen Torula protein concept. Percentages of UK respondents.

Around half of the UK respondents did not have any preconceptions about the characteristics of NextGen Torula food applications (without knowing the type of food and without any previous experience about those). Overall respondents' preconceptions were more on the positive than on the negative side. Out of the listed characteristics the most typical negative views of NextGen Torula foods were perceiving them as something weird and repulsive (and artificial). In contrast, these foods were more often expected to be good

for health, safe, hygienic, natural than as bad for health, unsafe, unhygienic or artificial. Figure 71.

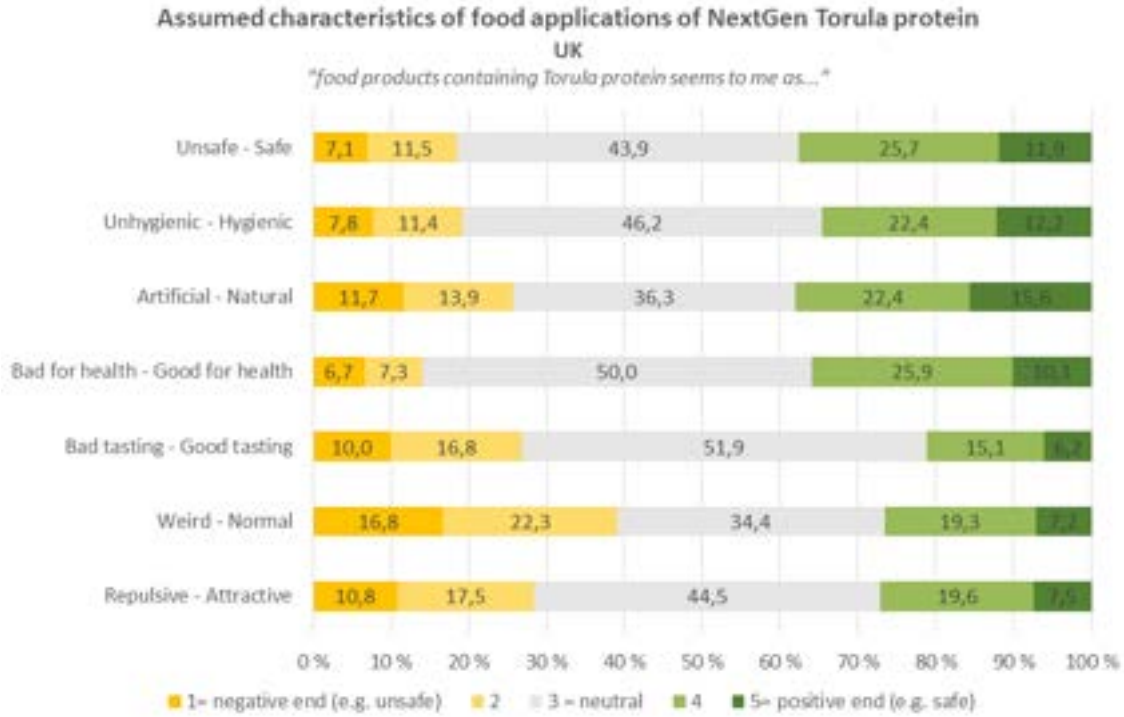


Figure 71. Characteristics associated with food applications of NextGen Torula protein. Percentages of UK respondents.

About 27 % of the UK respondents thought that the NextGen microalgae foods would be appreciated in their social circles. (Figure 72.) These items are not applied in the further analyses, however because of apparent invalidity. Based on the correlations of these items (-.08) it seems that part of the respondents may not have noticed the negative formulation of the second item *"Most of the people I know would <u>not</u> be interested in purchasing these foods".*

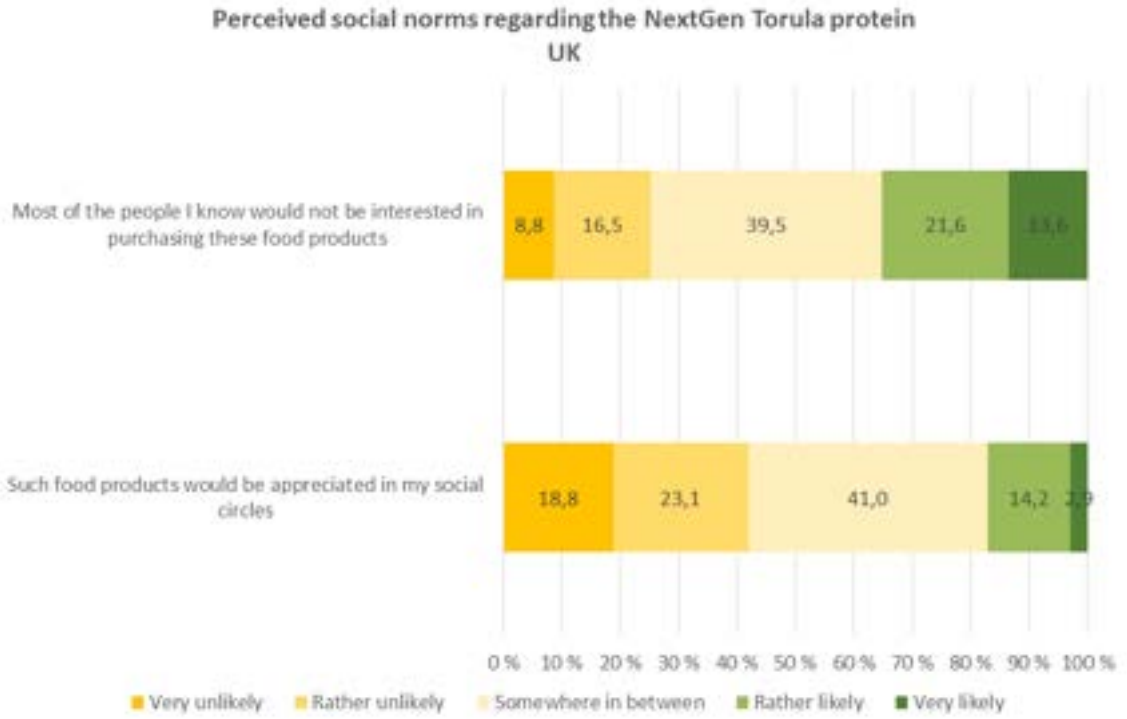


Figure 72. Perceived social norms related to NextGen Torula protein foods. Percentage of UK respondents.

The final measure of consumers' acceptance towards the Torula concept, was about their interest to use three different types of food applications. Based on this measure, around 40 % of the UK respondents would be – at least in the principle – somewhat interested in using vegetable – protein – patties (40 %) or salty snacks (42 %) containing NextGen Torula protein. Interest to use the sausage application, was somewhat lower (33 %). Figure 73.

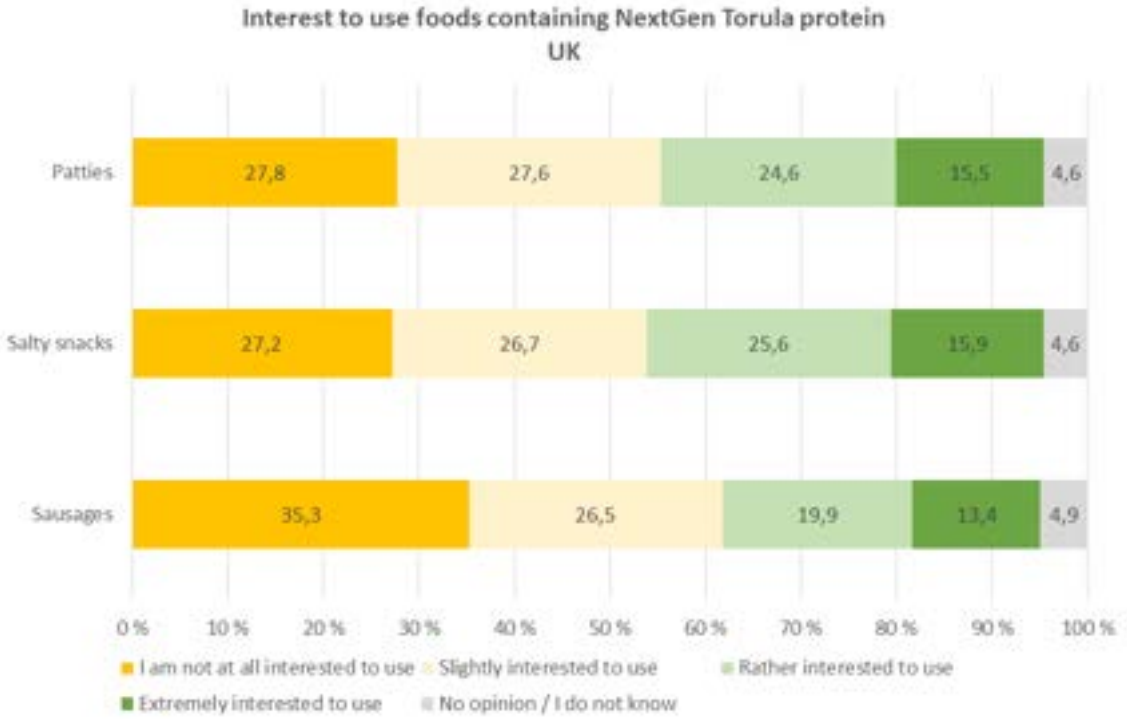


Figure 73. Interest to use the food application examples of NextGen Torula protein. Shares of UK respondents with each answer alternative.

8.7.2 Consumer clusters based on views towards NextGen Torula protein concept, UK

The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested four or two cluster solutions. Subsequent K-means clustering, run with 2, 3 and 4 clusters, confirmed that 4 cluster solution best brings out the differences in the sample.

The clusters were named as 1 - Positive, 2 – Indifferent, 3 – Negative, 4 - Positive, but concerned (cf. means in . In comparison to the other clusters, the Torula cluster Positive has more positive attitudes, is more likely to believe in the positive consequences of Nextgen Torula protein concept, less likely to be concerned about the risks related to it and more likely to expect NextGen Torula food applications to have positive quality characteristics. Correspondingly, the Torula cluster 3 - Negative, is an opposite to this. The cluster 4 – Positive but concerned is otherwise like the Positive cluster, but regardless of their positive views, they were also to some extent concerned about the risks related to the NexGen Torula concept. The final cluster 2 – indifferent is characterised by its' neutral ratings regardless of the question. (See the table below)

Table 24. Consumer clusters based on respondents' views towards NextGen Torula protein concept. The result of K-means cluster analysis with 4 clusters. Means of acceptance variables in each cluster UK.

	1 - Positive	2- Indifferent	3- Negative	4- Positive but concerned	Total	F	Sig.
Number of cases	182	349	129	223	883		
Percent of cases	20.6	39.5	14.6	25.3	100 %		
Variables applied as basis of the clustering							
ATT_Torula	4.55	3.07	1.72	3.95	3.40	702.002	.000
Benefits_Torula	4.30	3.14	1.73	4.10	3.42	645.731	.000
RISK_Torula	1.98	3.17	3.84	3.79	3.18	227.585	.000
FOODVIEWS_Torula	4.00	2.87	1.66	3.56	3.10	528.076	.000

8.7.2.1 Demographic profile and eating habits of NextGen Torula consumer clusters, UK

The demographic characteristics of the consumer clusters with negative, neutral or positive views towards the NextGen Torula concept have been described in Table 24.

Compared to the Torula clusters Negative, the respondents in the **cluster Positive** are more likely to

- be in the youngest and middle aged age groups, but less likely to be over 55 years.
- have university level education
- be vegetarians or ominovres limiting their meat consumption
- be familiar with alternative proteins than the negative clusters
- to be users of vegetarian convenience foods

The consumers in cluster **Positive, but concerned** were more likely to

- be 25 – 34 years old and omnivores, who intent to limit their meat consumption
- more familiar with alternative proteins than the negative cluster.
- Interestingly, compared to the cluster Positive their familiarity with alternative proteins is rather higher than lower -although the difference is not significant (Figure 74).

Clusters Negative and **Indifferent** include

- more omnivores (meat eaters) compared to the more positive clusters.

Based on these analyses, both genders were equally likely to have positive views towards the NextGen Torula concept in UK. Neither did the type of living area or presence of children in the family significantly relate to the cluster membership.

Table 25. Demographic profile of the consumer clusters based on views towards NextGen Torula concept, UK

	Positive	Indifferent	Negative	Positive, but concerned	Total %	Pearson Chi²	Sign.	Total N
Gender_2						1.028	ns	876
male	49,7%	51,6%	46,5%	49,3%	49,9%			
female	50,3%	48,4%	53,5%	50,7%	50,1%			
total	100,0%	100,0%	100,0%	100,0%	100,0%			
Age group						31.433	.008	883
18 - 24	**14,4%**	10,3%	10,1%	10,3%	11,1%			
25 - 34 Years	11,6%	17,7%	17,1%	**19,7%**	16,9%			
35 - 44 Years	20,4%	22,0%	10,1%	22,9%	20,2%			
45 - 54 Years	**26,5%**	21,4%	16,3%	18,4%	21,0%			
55 - 64 Years	14,4%	15,1%	**23,3%**	15,7%	16,3%			
65 - 75 Years	12,7%	13,4%	**23,3%**	13,0%	14,6%			
Total	100,0%	100,0%	100,0%	100,0%	100,0%			
Education_3						22.050	.001	863
Basic	7,3%	8,6%	**15,1%**	6,3%	8,7%			
Secondary...first stage tertiary	**39,1%**	46,0%	**55,6%**	47,5%	46,3%			
Tertiary, university	**53,6%**	45,4%	**29,4%**	46,2%	45,0%			
Total	100,0%	100,0%	100,0%	100,0%	100,0%			
Type of living area						13.750	ns	883
Capital area	17,0%	16,6%	15,5%	23,8%	18,3%			
a large city that is not in the capital area	20,3%	18,9%	13,2%	20,2%	18,7%			
a small city/town or muncipality	46,2%	46,7%	54,3%	45,3%	47,3%			
a rural area	16,5%	17,8%	17,1%	10,8%	15,6%			
Total	100,0%	100,0%	100,0%	100,0%	100,0%			
Household_3Bchild						8.894	ns	872
no children (1 or 2 adults)	57.0%	47.1%	59.5%	49.3%	51.5%			
1-2 adults with children	27.4%	33.8%	26.2%	30.8%	30.6%			

all other alternatives	15.6%	19.1%	14.3%	19.9%	17.9%			
Total	100,0%	100,0%	100,0%	100,0%	100,0%			
Diet						14.427	.025	881
ominivore	70,9%	**74,7%**	**74,6%**	67,4%	72,1%			
meat sometimes or no red meat	**15,9%**	17,2%	21,5%	**24,4%**	19,4%			
vegetarian	**13,2%**	8,0%	**3,8%**	8,1%	8,5%			

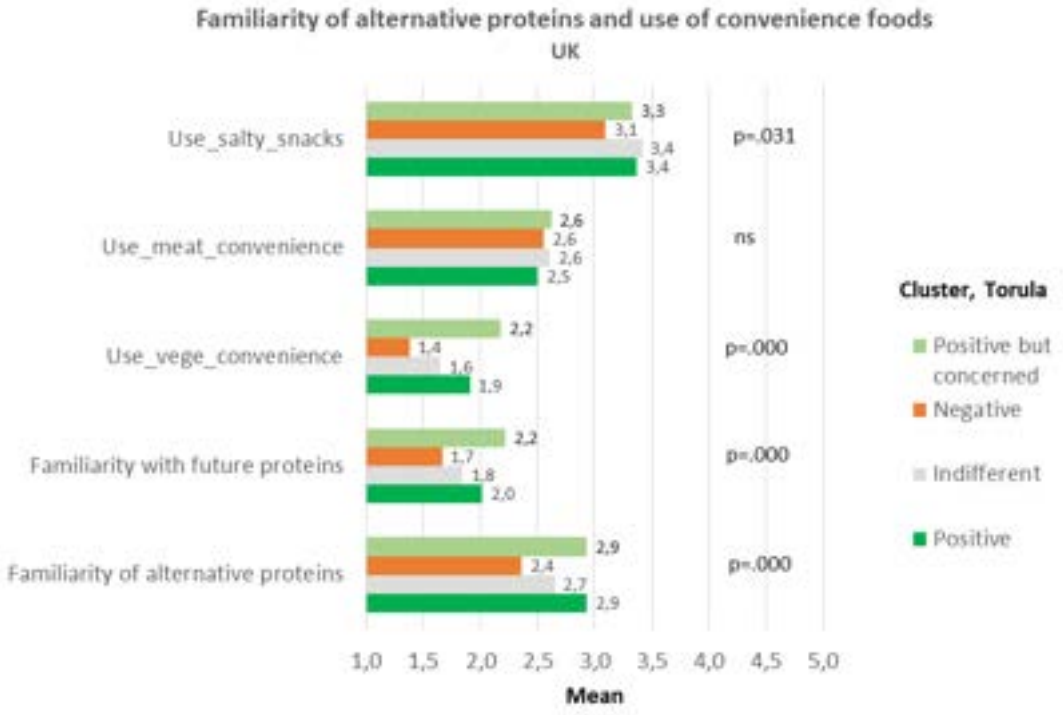


Figure 74. Use (mean use frequency) of certain convenience foods and familiarity with novel and alternative proteins compared between the consumer clusters based on their views towards NextGen Torula concept. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

8.7.2.2 Attitudinal background of NextGen Torula consumer clusters, UK

Compared with the Negative and Neutral clusters, the UK consumer **cluster with positive views** towards NextGen Torula concept can be characterised as (Figure 75):

- being more interested in food product novelties (Food innovativeness)
- having higher trust in different actors of food chain
- having clearly lower neophobia towards new food tastes
- having more positive attitudes towards food technology in general
- being less attached to meat

In terms of what they value in their daily foods (Figure 76), the cluster Positive and the cluster Positive, but concerned vs. cluster Negative more typically valued:

- Sustainability and ethical issues of food choice
- Healthiness of food

The cluster **Positive, but concerned** (i.e. consumers who had both positive views, but also concerns related to the NextGen Torula concept) is very much like the cluster Positive, except they seem to be

- more neophobic towards new tastes
- rate all food characteristics as important
- Health and sustainability were even more important for them

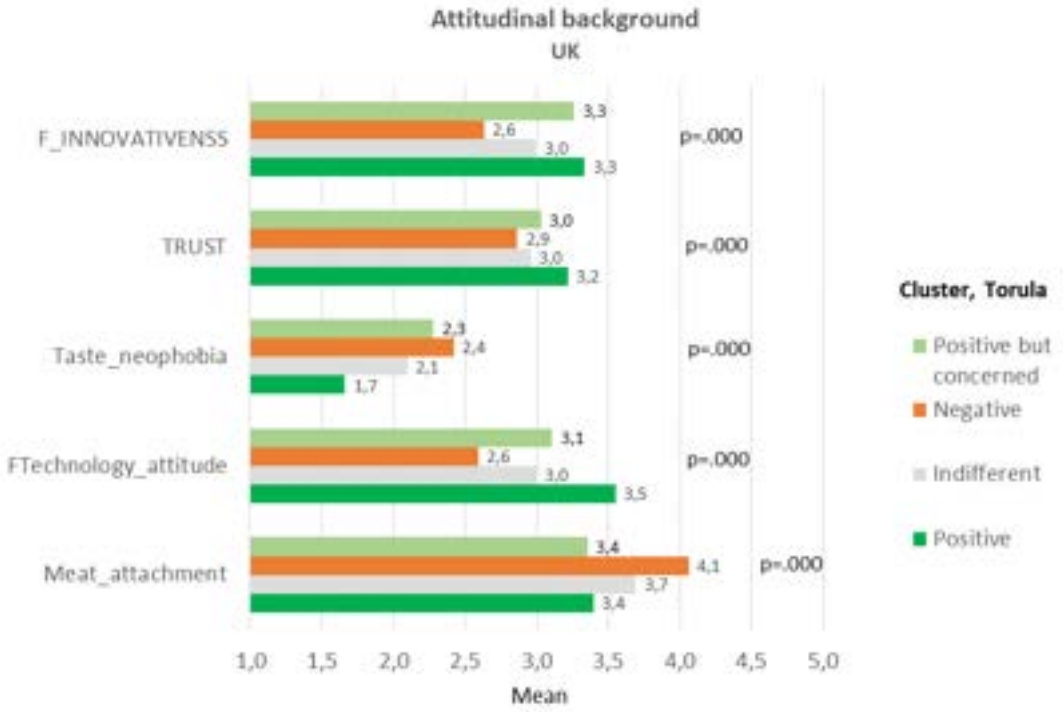


Figure 75. Background attitudes of the respondents in the clusters based on their views towards NextGen Torula concept. UK (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

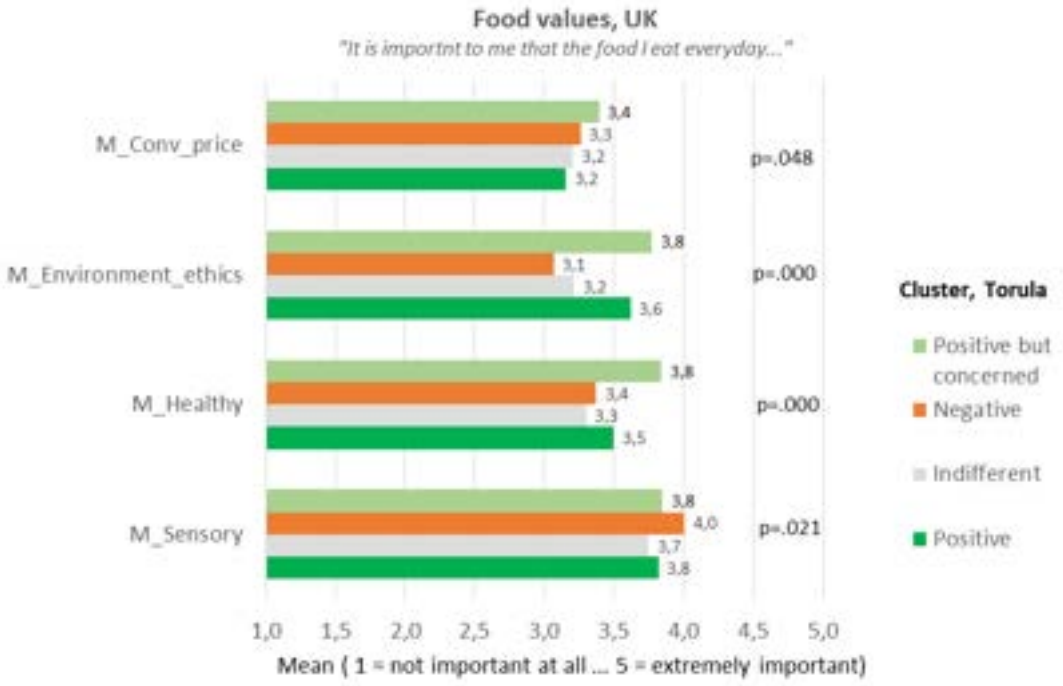


Figure 76. Means of food choice motives (values) of consumer clusters based on their views on NextGen Torula concept. UK. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

8.7.2.3 Interest to use the food applications by NextGen Torula clusters, UK

The interest to use the food application examples is expectedly the highest in the cluster Positive, a little bit lower in the cluster positive but concerned, and lowest in the cluster negative. The result is the same regardless of the product type, whether it is vegetable-protein -patties, salty snacks or sausages. Figure 77.

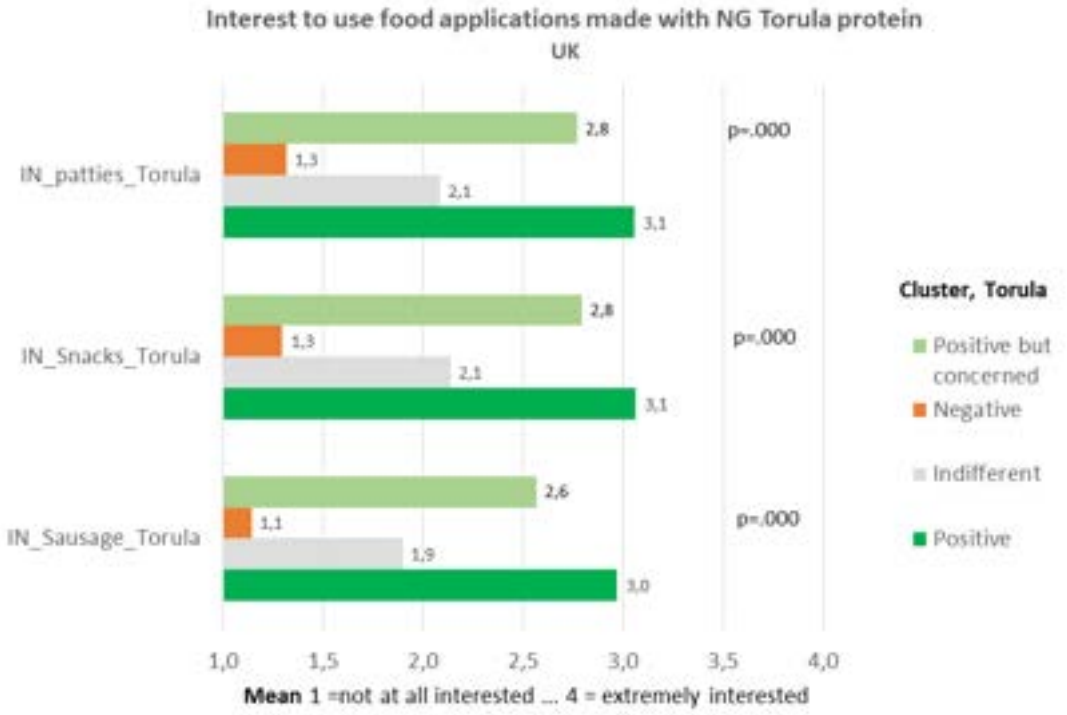


Figure 77. Interest to use food applications by consumer clusters based on their views towards NextGen Torula protein concept. UK. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

9 Appendix B2 – ITALY survey report

9.1 Summary of results from Italy

The Italian sample consisted of 1000 respondents, well distributed between different demographic groups. About 90 % of the respondents were omnivores and 10 % some form of vegetarians. Out of the omnivores, 48.6 % aimed to reduce their meat consumption or already did that. One's own **health and well-being** was by far the most important reason for meat reduction intentions, environmental sustainability came second.

Like in the other countries, the Italian respondents were well familiar with conventional legumes such as peas and beans. Deviating from most other countries, nearly all (97 %) **knew Fava beans**, at least by name, and even 63.3 % used them. Soy and wheat-based protein were also well recognised but used only by 23 % (soy) and 16.9 % (wheat) at least occasionally. For the Italians, Fungi-based meat substitute products (such as Quorn) was the most unfamiliar of these: used only by 9.8 %. **Insect protein based meat substitutes were also unfamiliar** (51.7% had not heard of those), but a bit larger share of respondents had tasted those, although not used.

In Italy, like in the other countries too, small food producers and primary food producers were the most trusted actors of food chain. Around 60 % had high trust in small food producers and 53.7 % in primary food producers. The lowest level of trust was expressed towards the food industry; only by 24.6 % of the respondents had high trust, but still, even 72.7 % had moderate trust in them.

Half of the Italian respondents were in favour of the NextGen microalgae (52 %) and less (39 %) in favour of NextGen Torula concepts. The NextGen insect concept was not at all popular. It was supported only by 24 % of the respondents. A large share had neutral or indifferent attitude and only minority was opposing these ideas of protein production – with the exception of insects, which was clearly opposed by half of the Italian respondents. All the applied acceptance measures pointed to the same direction: NexGen microalgae was the easiest, NextGen Torula second and insects most difficult concept to accept by Italians.

Generally, respondents believed in the benefits of microalgae and Torula concepts, especially regarding the benefits for environment and livestock. Less was believed in benefits to oneself and in benefits for the national economy. Out of the three types of risks, the respondents were most concerned about risks of being misled by food companies. The general level of risk concern was rather high. E.g. 41 % was concerned about being misled by food companies and 25 % about "the unpredicted negative effects on the environment" in the case of NextGen microalgae concept.

In this survey, we also asked respondents to rate their **interest to use three examples of food application**s made with either of the three NextGen proteins. Like in the other countries, sausages were less interesting carrier product for these ingredients than were vegetable-protein patties of salty snacks regardless of the NextGen ingredient.

Segmentation of Italian consumers into clusters was carried out on the basis of how they rated each of the three NextGen concepts. Cluster analyses yielded three clusters for all the three concepts. The consumers clusters were cluster Positive, cluster Neutral and cluster Negative regarding each of the NextGen concept. Cluster positive had the most positive ratings on all the acceptance measures concerning the concept in question (positive attitude, higher beliefs in benefits, lowest concern for risks and higher preconceptions about the quality of the food applications of the ingredient in question), and the cluster Negative the most negative ratings. Highest share of respondents fell into the cluster Neutral, which comprised the majority of the respondents (42 – 53 % of respondents depending on the concept). Positive clusters comprised about third of respondents, and then negative clusters 15 %, 19 % and 33 % for the microalgae, Torula and insects, respectively.

The above-mentioned consumer clusters were compared with each other in term of their background demographics, eating habits and attitudinal tendencies – separately for each of the NextGen concept.

The negative and positive clusters background opinions were pretty much opposite to each other differentiating these clusters from each other, and the neutral clusters were in-between. Overall, in Italy, **the positive clusters differed from the other clusters, or at least from the negative clusters as follows**: in the microalgae clusters they have higher education, and in the case of NextGen insects they are more likely to be younger and rather males than females. Consumers in the most positive segments more often follow either some form of vegetarian diet or restrict meat consumption. Except, in the case of NextGen insect concept, consumers views were not related to their diets.

Like in the other countries, the consumers in the positive clusters, regardless of the NextGen concept, were more (and negative cluster less) familiar with alternative proteins, as well as with emerging new proteins. They rated higher in food innovativeness (interest towards new emerging food products), lower in taste neophobia (thus less afraid of tasting new foods overall), and had more positive attitude toward the use of novel and latest technologies in food production. In addition, they had higher trust in food chain actors. Consumers in the positive clusters tended to value sustainable and ethical way of food production more than the ones in the negative cluster.

9.2 Participant characteristics, IT

9.2.1 Participants' demographics, Italy

The Italian sample consists of 1000 respondents. Respondents' demographic characteristics are described in the table below. It suggests that the respondents were well distributed into different demographic groups. In the analyses the answers are weighted to roughly represent the Italian population in terms of gender, age group, household type and residential area. Table 26.

Table 26. Demographic background of the Italian respondents

	Count	Percent
	1000	
Gender		
1. male	489	48.9%
2. female	508	50.8%
3. other / prefer not to say	3	0.30 %
Total	1000	100 %
Agegroup		
1. 18 - 24 Years	83	8.3%
2. 25 - 34 Years	145	14.5%
3. 35 - 44 Years	220	22.0%
4. 45 - 54 Years	204	20.4%
5. 55 - 64 Years	181	18.1%
6. 65 - 75 Years	166	16.6%
Total	1000	100 %
Type of living area		
1. I live in the capital city / area	93	9.3%
2. I live in a large city that is not in the capital area	214	21.4%
3. I live in a small city/town or municipality	579	57.9%
4. I live in a rural area	114	11.4%
Total	1000	100 %
Country region		
1. Nord-Ovest	271	27.1%
2. Sud	224	22.4%
3. Isole	112	11.2%
4. Nord-Est	191	19.1%
5. Centro	202	20.2%
Total	1000	100 %
Education		
1. Basic education or lower	1	0.1%
2. High school	85	8.5%
3. Upper secondary vocational or other equvivalent[1]	545	54.5%
4. First stage of tertiary education (univ. of applied sciences)	100	10.0%
5. Tertiary education, university, batchelor degree	201	20.1%
6. Tertiary education, university, master's degree or higher (MA/MSc, PhD, MD)	67	6.7%
Other / I do not know	2	0.2%
Total	1000	100 %
EducationIT2		
Basic or secondary	420	48.7%
Tertiary	442	51.3%
Total	862	100 %
Household type		
1. I live at home with my parents	176	17.6%
2. I live alone	130	13.0%

3. I live alone with my child / children	32	3.2%
4. I live with my spouse	286	28.6%
5. I live with my spouse and child / children	314	31.4%
6. I live with other adults (other than spouse or family members)	29	2.9%
7. Other	30	3.0%
8. Prefer not to say	3	0.3%
Total	1000	100 %
Household_3		
1-2 adults no children	633	63,3
1-2 adults with children	302	30,2
something else (e.g. living with parents)	65	6,5
Total	1000	100,0

9.2.2 Participants' dietary habits and attitude tendencies, Italy

Around 79 % of the Italian respondents were omnivorous, thus assumingly regular meat eaters. An additional 11 % only sometimes eat meat or avoids especially red meat. Over 10 % indicate they are following some form of vegetarian diet.

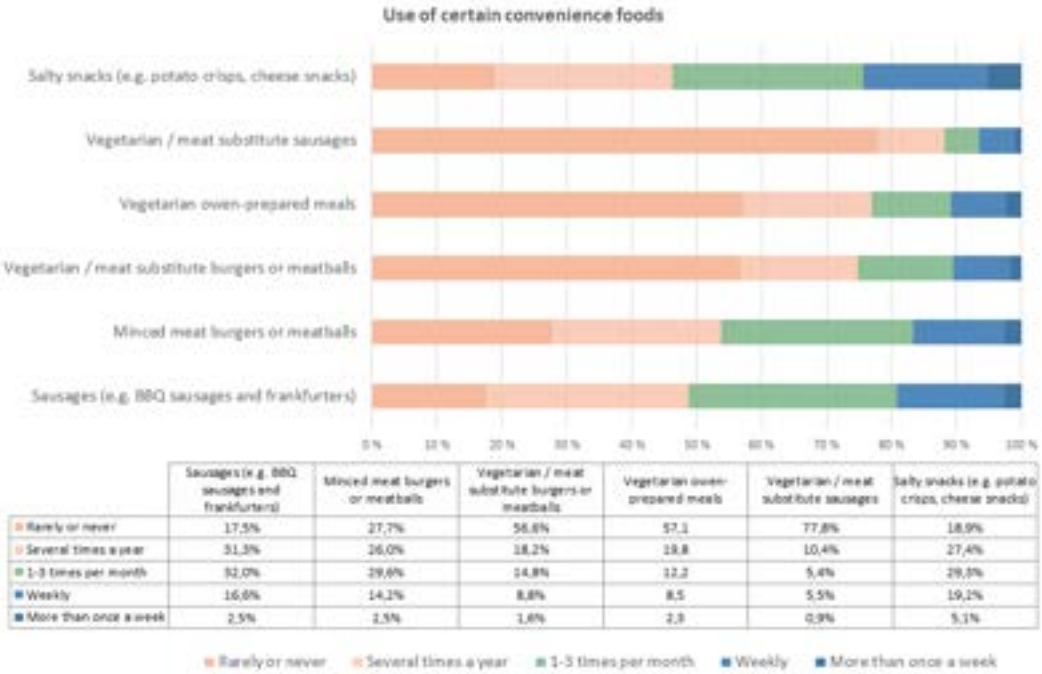
Out of the consumers of red meat (diet 1 or 2), 49.6 % indicate that they intentionally aim to reduce their meat consumption. For the majority of them (56.2 %) their own health and well- being is the main reason for this. The second most important reason (by 35.7 %) being and environmental sustainability. Taken vegetarians and those who aim to reduce meat consumption together, around 60 % of Italian consumers were to some extent interested in obtaining more of their protein from other sources than mammal or poultry meat. Table 27.

Table 27. Dietary habits of the Italian respondents

Diet	**Count**	**Percent**
1. I regularly eat products of animal origin and non-animal origin (omnivorous)	786	78.6%
2. I only eat meat sometimes (e.g. beef, pork, poultry, fish, seafood)	95	9.5%
3. I avoid red meat consumption (e.g. beef or pork), but eat other meat products like chicken or fish	15	1.5%
4. I do not eat meat (e.g. beef, pork or poultry), but I eat fish (I'm a pesco-vegetarian)	73	7.3%
5. I do not eat meat (e.g. beef, pork, poultry or fish), but I eat other products of animal origin (e.g. eggs, cheese, milk	24	2.4%
6. I do not eat any meat, eggs or dairy products (I'm a vegetarian)	3	0.3%
7. I do not eat anything of animal origin (I'm a vegan)	4	0.4%
8. Other, specify:	1	0.1%
Total		
Diet_3		
1. Omnivore	786	78.6%
2. Meat sometimes, or no red meat	110	11.0%
3. Vegetarian (any kind)	104	10.4%
Total		
Do you intentionally aim to reduce meat consumption (question was targeted only to respondents who did not already reduce or avoid meat: options 1 – 2 above)		
• Yes	436	49.6%
• No	444	50.4%
Total	880	100
Reason for reducing meat consumption, most important reason		
1. Environmental sustainability, climate change	88	15,6%
2. Ethics, animal welfare	104	18,3%

3. My health and well-being	318	56,2%
4. High price of meat	16	2,8%
5. Taste and texture of meat	35	6,2%
6. Other, specify:	5	0,9%
Total	566	100,0%
Reason for reducing meat consumption, second most important reason		
1. Environmental sustainability, climate change	202	35,7%
2. Ethics, animal welfare	136	24,0%
3. My health and well-being	101	17,8%
4. High price of meat	55	9,7%
5. Taste and texture of meat	69	12,1%
6. Other, specify:	4	0,7%
Total	566	100%

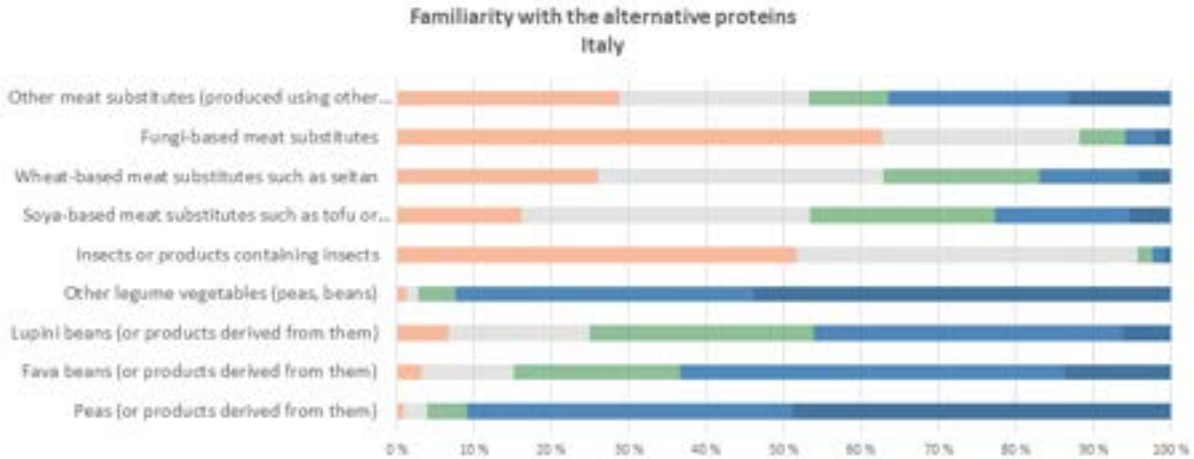
Reflecting the share of vegetarians (10. 4 %), about the same percentage of respondents report they eat vegetarian convenience foods at least weekly. An additional 14.8 % eats vegetarian or meat substitute burgers or meat balls on monthly basis. (Figure 78.)



	Sausages (e.g. BBQ sausages and frankfurters)	Minced meat burgers or meatballs	Vegetarian / meat substitute burgers or meatballs	Vegetarian oven-prepared meals	Vegetarian / meat substitute sausages	Salty snacks (e.g. potato crisps, cheese snacks)
Rarely or never	17,5%	27,7%	56,6%	57,1	77,8%	18,9%
Several times a year	31,3%	26,0%	18,2%	19,8	10,4%	27,4%
1-3 times per month	32,0%	29,6%	14,8%	12,2	5,4%	29,3%
Weekly	16,6%	14,1%	8,8%	8,5	5,5%	19,2%
More than once a week	2,5%	2,5%	1,6%	2,3	0,9%	5,1%

Figure 78. Use of convenience foods (that correspond to food application examples used in this study) in Italian sample.

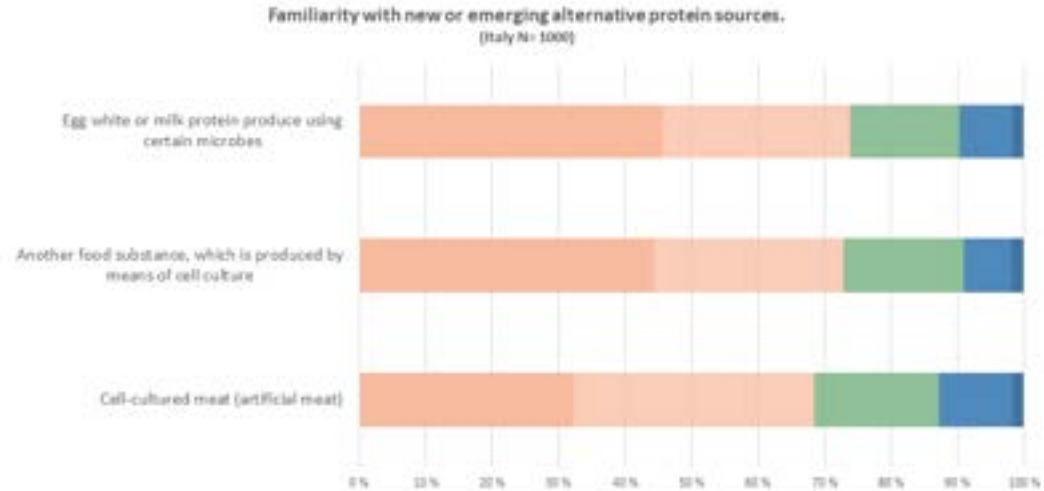
The respondents were asked to rate their familiarity with various proteins sources other than animal based or products made of these. Like in the other countries, the Italian respondents were well familiar with conventional legumes such as peas and beans. Many also know Fava beans, although not often use them. Soy and wheat-based protein were also well recognised, but used only by 23 % (soy) and 16.9 % (wheat) at least occasionally. Fungi-based meat substitute products (such as Quorn) was the most unfamiliar of these: 62.8 % had not even heard of those. Insect protein-based meat substitutes were also unfamiliar (51.7% had not heard of those), but a bit larger share of respondents had tasted those, although not used. Figure 79.



	Peas (or products derived from them)	Fava beans (or products derived from them)	Lupini beans (or products derived from them)	Other legume vegetables (peas, beans)	Insects or products containing insects	Soya-based meat substitutes such as tofu or tempeh	Wheat-based meat substitutes such as seitan	Fungi-based meat substitutes	Other meat substitutes (produced using other protein sources such as oat, egg, etc.)
I have not heard of these	1,0	3,1	6,7	1,2	51,7	16,1	26,0	62,8	28,8
I have heard of these, but I have not tried them	3,0	12,1	18,2	1,6	44,0	37,3	36,8	25,4	24,5
I have tried these, but I do not use them	5,0	21,5	29,1	4,8	1,9	23,8	20,2	5,9	10,3
I eat these occasionally	42,2	49,5	39,9	38,5	1,6	17,5	12,8	3,9	23,3
I eat these often	48,7	13,8	6,2	53,9	0,7	5,3	4,1	2,0	13,1

Figure 79. Previous familiarity with alternative protein sources in the Italian sample.

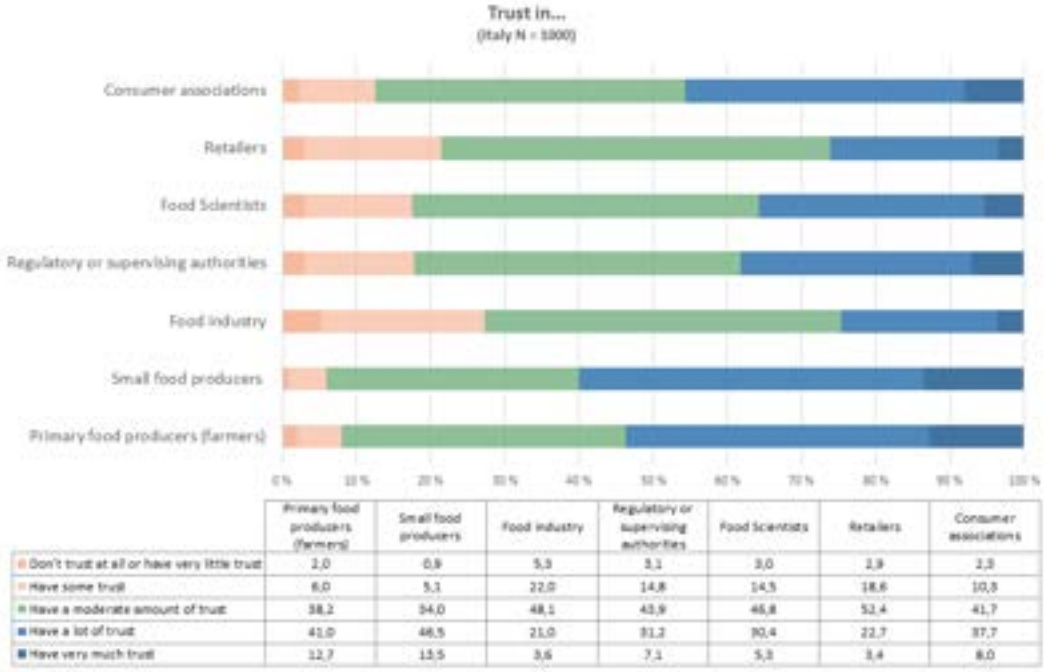
As expected, the majority of respondents were not very familiar with the examples of emerging new protein sources, such as using microbes to produce egg or milk protein or artificial meat. Still, around 32 % felt they understand what e.g. cell-cultured meat, egg or dairy protein is.



	Cell-cultured meat (artificial meat)	Another food substance, which is produced by means of cell culture	Egg white or milk protein produce using certain microbes
I have never heard of them	32,3	44,4	45,6
I have heard of them but I don't know anything about it	36,1	28,5	28,3
I have an understanding of what this is	18,8	18,0	16,4
This is rather familiar to me (e.g. I have read articles about it)	11,1	7,1	8,0
I know quite a lot about the subject	1,7	1,9	1,7

Figure 80. Familiarity with future or emerging protein sources in the Italian sample.

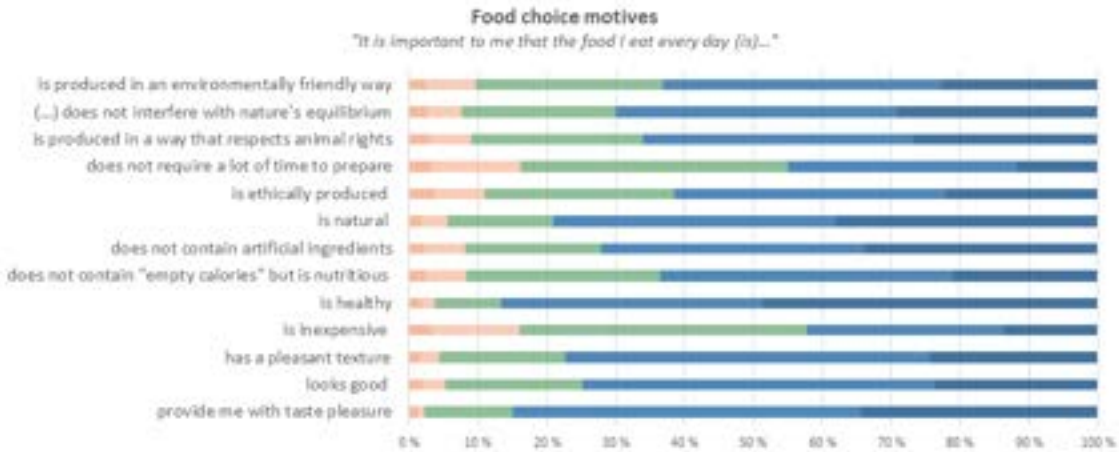
The best trusted actors of food chain were the primary food produces (farmers) and small food producers, and the least trusted is food industry. Figure 81.



	Primary food producers (farmers)	Small food producers	Food industry	Regulatory or supervising authorities	Food Scientists	Retailers	Consumer associations
Don't trust at all or have very little trust	2,0	0,9	5,3	3,1	3,0	2,9	2,3
Have some trust	6,0	5,1	22,0	14,8	14,5	18,6	10,3
Have a moderate amount of trust	38,2	34,0	48,1	43,9	46,8	52,4	41,7
Have a lot of trust	41,0	46,5	21,0	31,2	30,4	22,7	37,7
Have very much trust	12,7	13,5	3,6	7,1	5,3	3,4	8,0

Figure 81. Trust in various actors of food chain in the Italian sample. Percent of respondents.

Figure 82. describes Italian respondents' answers to question Q6 about how important various criteria are for them in their daily foods. The overall result is typical: taste and other sensory quality characteristics were highly important for the most people along with healthiness and the natural, not artificial quality of the food. Respecting animal rights in the production method and environmentally friendly production were rated important by 66 % and 63.2 % of the respondents, respectively.



	provide me with taste pleasure	looks good	has a pleasant texture	is inexpensive	is healthy	does not contain "empty calories" but is nutritious	does not contain artificial ingredients	is natural	is ethically produced	does not require a lot of time to prepare	is produced in a way that respects animal rights	(...) does not interfere with nature's equilibrium	is produced in an environmentally friendly way
Not important at all	1,2	1,9	1,6	5,2	1,7	2,4	2,2	1,8	3,8	5,2	3,1	2,5	2,4
Slightly important	1,0	3,4	2,8	12,9	2,1	5,9	6,0	3,8	7,2	13,0	5,9	5,2	7,2
Rather important	12,8	19,9	18,2	41,6	9,6	28,1	19,7	15,4	27,5	38,8	25,0	22,4	27,2
Important	50,6	51,3	53,0	28,8	37,9	42,6	38,3	41,0	39,4	33,1	39,0	40,9	40,5
Extremely important	34,4	23,5	24,4	13,5	48,7	21,0	33,7	30,0	22,0	11,8	27,0	29,1	22,7

Figure 82. Perceived importance of food values (choice motives) in the Italian sample.

9.3 Forming the composite variables, IT

Composite variables were formed as **means** of items, which measured the same dimension based on these analyses in addition to the theory. For more details about the questions see the questionnaire in Appendix A.

9.3.1 New variables describing respondents' background attitudes, Italy

Factor analyses (principal axis factoring, varimax rotation) were performed to check the dimensionality of items for each scale. In the case of the items measuring Food technology attitudes (Q9) and Meat attachment (Q7) the analysis yielded two factors with eigenvalues over 1. Based on the emerged dimensions, two variables were constructed for both of these in addition to the one dimension. However, as the two dimensions represented opposite views: negative vs. positive and using these distinct variables did not increase understanding compared to the analysis using one composite variable, we decided to apply one composite variable per theoretical concept instead of the two. That is, the measures of Meat_attachment and F_innovativeness are applied.

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" are not included in the analyses, which apply these variables.

Table 28. Composite variables describing Italian respondents' background attitudes. The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.74
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	,88
Trust	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	.86
FTechnology_attitude	**Attitude towards new food technology**	**Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV**	**.74**
Meat_attachment	Attachement to meat eating	Q7r1, Q7r2, Q7r4, Q7r5, Q7r6, Q7r3_REV, Q7r8_REV Note Q7r7 omitted	.88
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.90
F_innovativeness_it		Q11r2, Q11r3, Q11r4 (item Q11r1_REV omitted!)	.81
Use_vege_convemience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.84
Use_meat_convenience	Mean frequency of use of meat based convenience foods	Q5r1, Q5r2	.77

Factor analysis (PAF + varimax rotation) performed for the food choice value items (Q6r1 – Q6r13) yielded two factors with eigenvalues over 1. Items reflecting sustainable and ethical production method as well as natural, non-artificial quality of the food, loaded on the first factor. While the second factor mostly reflected sensory pleasantness of the food. Item "healthy" and "inexpensive loaded on both factors and "does not require long time to prepare had weak loadings on both of the factors.

The factor analysis of the items indicated that for the Italian respondents, naturalness, not containing empty calories or artificial ingredients, ethical and environmentally friendly production were closely linked; i.e. these were highly correlated with each other.

Table 29. New variables to describe Italian respondents' food values.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
M_Sensory	Good sensory characteristics of food	Q6r1, Q6r2, Q6r3	.83
M_Natural_and_sust	Sustainable and ethical production and natural food	Q6r6, Q6r7,Q6r8, Q6r9,Q6r11, Q6r12, Q6r13	.92
M_Inexpensive	Inexpensive price	Q6r4	-
M_Healthy	Healthiness of food	Q6r5	-
M_Convenience	Does not require long time to prepare	Q6r10	-

9.3.2 New variables measuring acceptance of the three NextGen concepts, IT

New variables were formed to reflect positivity - negativity of respondents' *attitude* towards each of the three NextGen concepts. In addition, composite variables were formed to measure the extent to which respondents believe in *benefits* of each of the NextGen concept as well as to indicate the strength of respondents' concern about potential *risks* of the NextGen concepts. Finally, also respondents' ratings (views or pre-assumptions) about the characteristics of food products made using each of the NextGen ingredient were averaged for each Nextgen concept to form a composite measure of how positively or negatively NextGen microalgae, NextGen insect and NextGen Torula based food application are viewed. All the resulting variables had high internal reliabilities. (See Table 30).

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" are not included in the analyses, which apply these variables.

Table 30. Composite variables measuring acceptance, their contents and reliabilities (Italy). The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	Cronbach Alpha
ATTITUDES		
ATT_Algae	Attitude towards NextGen microalgae protein *(mean of items Q12r1, Q12r2, Q12r4)*	.93
ATT_Insect	Attitude towards NextGen insect protein *(mean of items Q17r1, Q17r2, Q17r4)*	.94
ATT_Torula	Attitude towards NextGen Torula protein *(mean of items Q22r1, Q22r2, Q22r4)*	.93
PERCEIVED BENEFITS	*mean of all 5 items*	
BENEFIT_Algae	Likelihood of benefits from NextGen microalgae protein *(mean of items Q13r1 – Q13r5)*	.94
BENEFIT_Insects	Likelihood of benefits from NextGen insect protein *(mean of items Q18r1 – Q18r5)*	.92
BENEFIT_Torula	Likelihood of benefits from NextGen Torula protein *(mean of items Q23r1 – Q23r5)*	.94
PERCEIVED RISKS	*mean of 3 items, "other risk" not included*	
RISK_Algae	Concern about risks relating to production of NextGen microalgae proteins *(mean of items Q14r1-Q14r3)*	.85
RISK_Insects	Concern about risks relating to production of NextGen insect proteins *(mean of items Q19r1-Q19r3)*	.85
RISK_Torula	Concern about risks relating to production of NextGen Torula proteins *(mean of items Q24r1-Q24r3)*	.85
FOOD APPLICATION VIEWS	*mean of all the 7 items*	
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein *(mean of items Q15r1-Q15r7)*	.93
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein *(mean of items Q20r1-Q20r7)*	.93
FOODVIEWS_Torula	Views towards foods made with NextGen Torula protein *(mean of items Q25r1-Q25r7)*	.93

9.4 Comparison of the three NextGen protein production concepts and applications, Italy

9.4.1 Which of the NextGen ingredients is most positively viewed in Italy?

All the acceptance measures suggest that the NextGen concept of Microalgae protein was easiest to accept followed by Torula concept and the NextGen insect protein was the most difficult to accept.

In average, the Italian respondents' attitudes towards the NextGen microalgae concept were the most positive and towards the Insect concept the least positive. Compared to the other two concepts, the NextGen microalgae concept is (in average) estimated as most likely to have benefits, consumers were least concerned about the risks related to this concept and they had most positive preconceptions of the quality of (imagined) foods products made with NextGen microalgae protein. Finally, the mean interest to use the examples of food applications (sausages, vegetable-protein patties and salty snacks) was lower in the case of NextGen insect protein. (Figure 83 and Table 31).

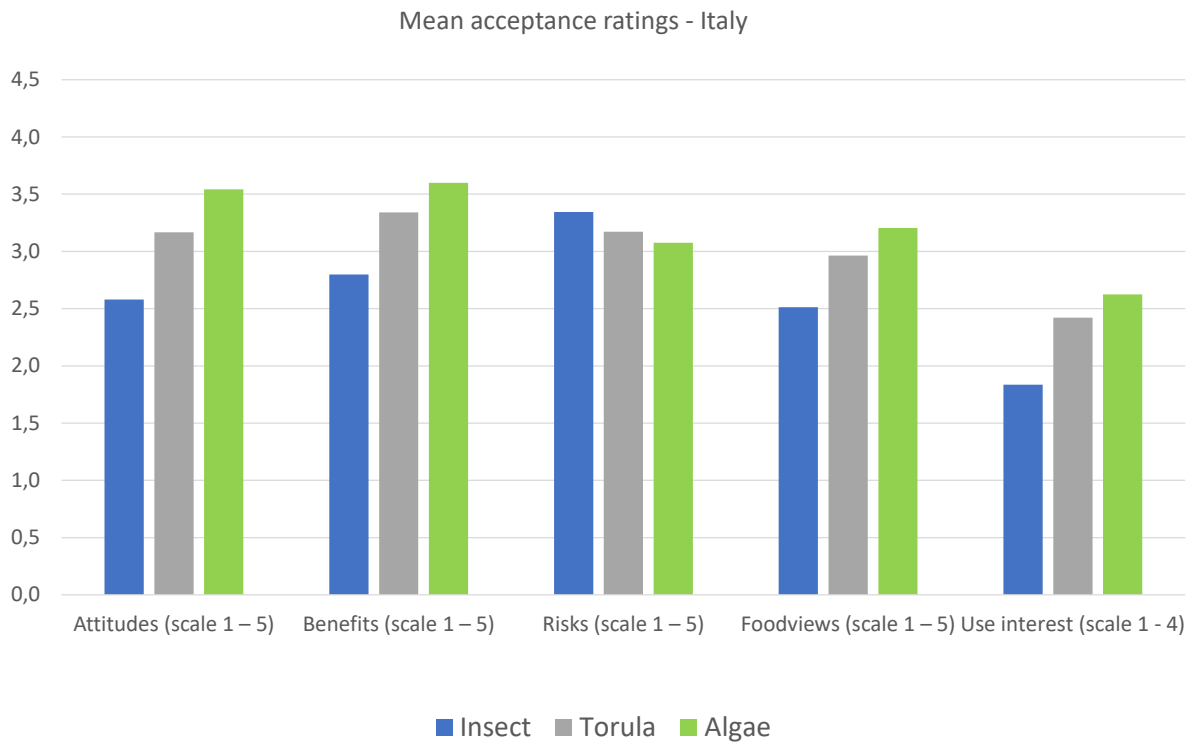


Figure 83. Comparison of mean attitudes. perceived benefits and risks. and food views as well as mean interest to use the three food application examples (sausages. vegetable-protein -patties and salty snacks.

Table 31. Comparison of means of acceptance ratings (composite variables) between the three Nextgen protein concepts. Significance of difference tested with repeated measures analysis of variance. Italy.

Composite variables:	Insect	Torula	Algae	df	F	Sig.
Attitudes (scale 1 – 5)	2.58	3.17	3.54	2	335.009	.000
Benefits (scale 1 – 5)	2.80	3.34	3.60	2	247.711	.000
Risks (scale 1 – 5)	3.34	3.17	3.08	2	28.493	.000
Foodviews (scale 1 – 5)	2.51	2.96	3.20	2	316.231	.000
Use interest (mean over all three food examples)	1.84	2.42	2.62	2	462.620	.000

The Italian respondents' negative views related to insect-based food ingredients also stands out from their preconceptions towards imaginary food applications. The means of the individual items of the "food views" questions reveal that the food applications made with NextGen insect protein were perceived as **repulsive, weird, bad tasting, unhygienic** and **bad for health** rather than the opposite (i.e. attractive, normal, good tasting etc.) (Figure 84)

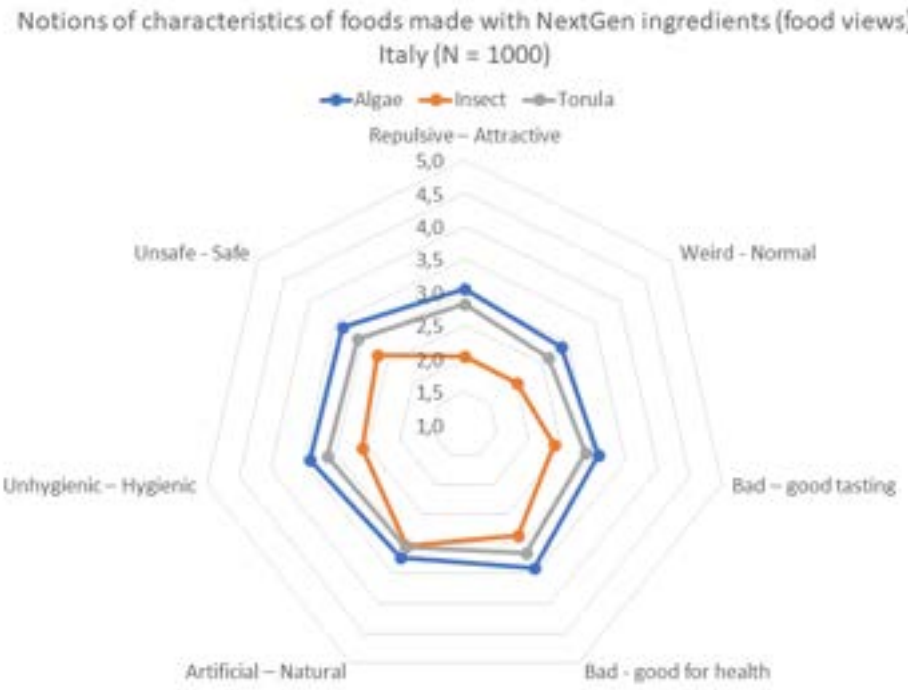


Figure 84. Respondents' preconceptions (means) about the characteristics of imaginary foods made using the NextGen ingredients. Italy.

9.4.2 What is the most interesting food application of NextGen in Italy?

Out of the NextGen food applications, **sausages were the least interesting** product type in the case of all ingredient types *(repeated measures analysis of variance comparing the means of the three NextGen ingredients and three food examples. main effect for WS factor "ingredient" F(2)=74.983. p < .000).* Out of the NextGen ingredients, microalgae was most

interesting and insects clearly the least interesting (*main effect for "ingredient" F(2)=439.458. p < .000)*. Thus, the least interesting food application was **sausages with NextGen insect** ingredient while patties and snacks either with NextGen microalgae or with Torula were of more interest *(interaction of food type and ingredient type was significant F(4)=14.224. p < .000).*

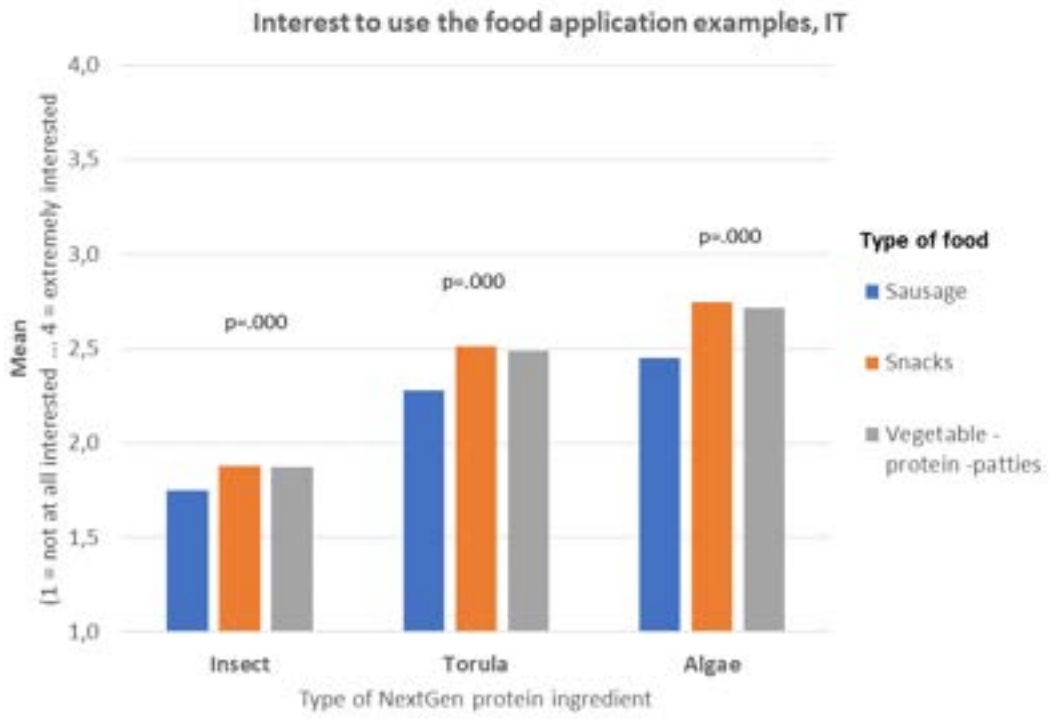


Figure 85. Means of interest to use the examples NextGen food applications by product type and NextGen ingredient type in Italy. Significance of differences in means between the food types.

9.5 Acceptance of NextGen Microalgae protein, Italy

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen microalgae concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen microalgae method and foods.

9.5.1 The level of acceptance of NextGen microalgae protein in Italy

This chapter presents the percentage distributions of answers to each individual survey question measuring acceptance towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

Almost half of the Italian respondents were generally in favour of the idea production of NextGen microalgae protein to be applied in foods (47.8 %)

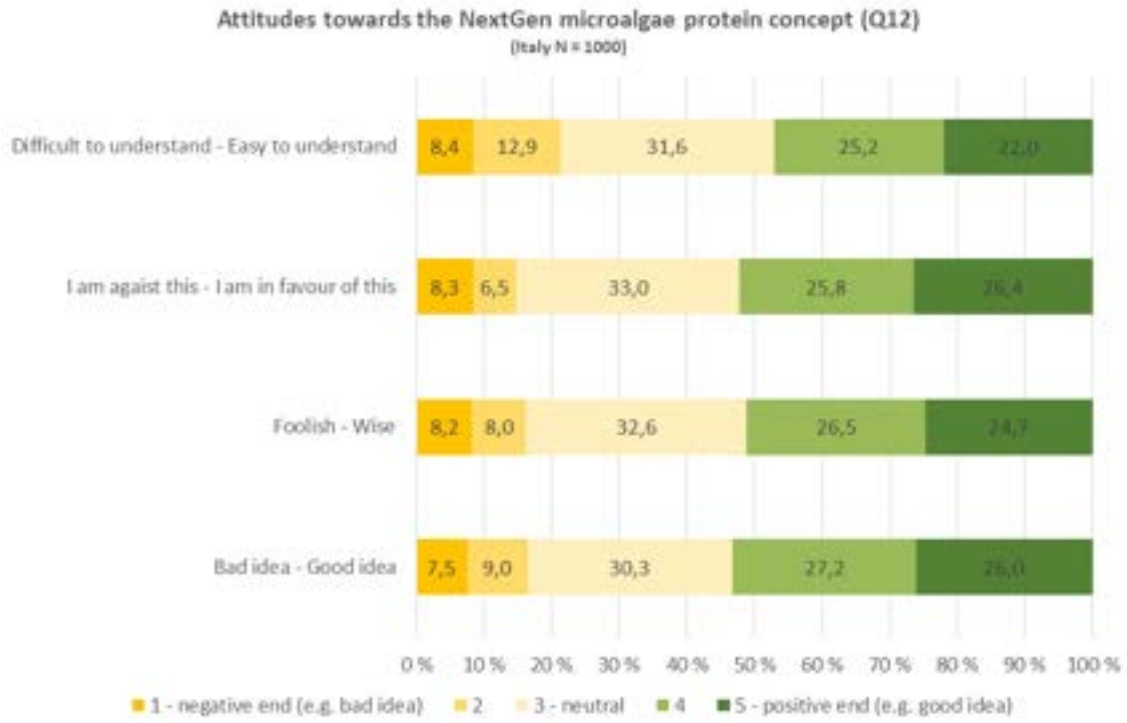


Figure 86. Attitudes towards NextGen microalgae protein concept. Answers to individual question items. Percentage of Italian respondents.

The beliefs in benefits for the environment and sustainability (53.7 %) as well as on animal welfare (56.5 %) were most common, while only 38.2 % believed in personal benefits. It is noteworthy, that disbelief the listed benefits was not common (see Figure 87). Considerable share of respondents did not know what think about the benefits. E.g. if the answer options 3 (neither likely nor unlikely) and "cannot say" were summated, 49 % of the respondents did not take a stand regarding benefits for health, for example.

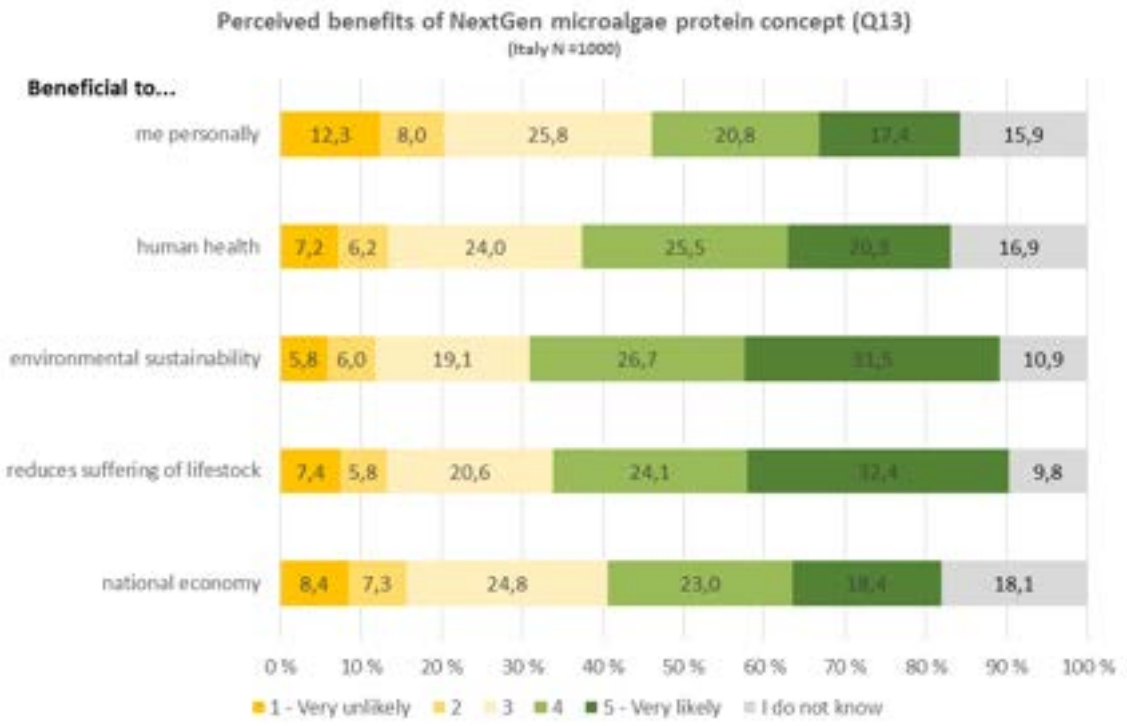


Figure 87. Perceived benefits of the NextGen microalgae protein concept. Answers to individual question items. Percentage of Italian respondents.

Like in the case of other countries and ingredients, the risks consumers were most worried about related to the honesty and integrity of the food companies: Around 41 % was concerned about being misled by the food companies in the case of NextGen insect protein. Overall, one third of the respondents were not concerned about the risks.

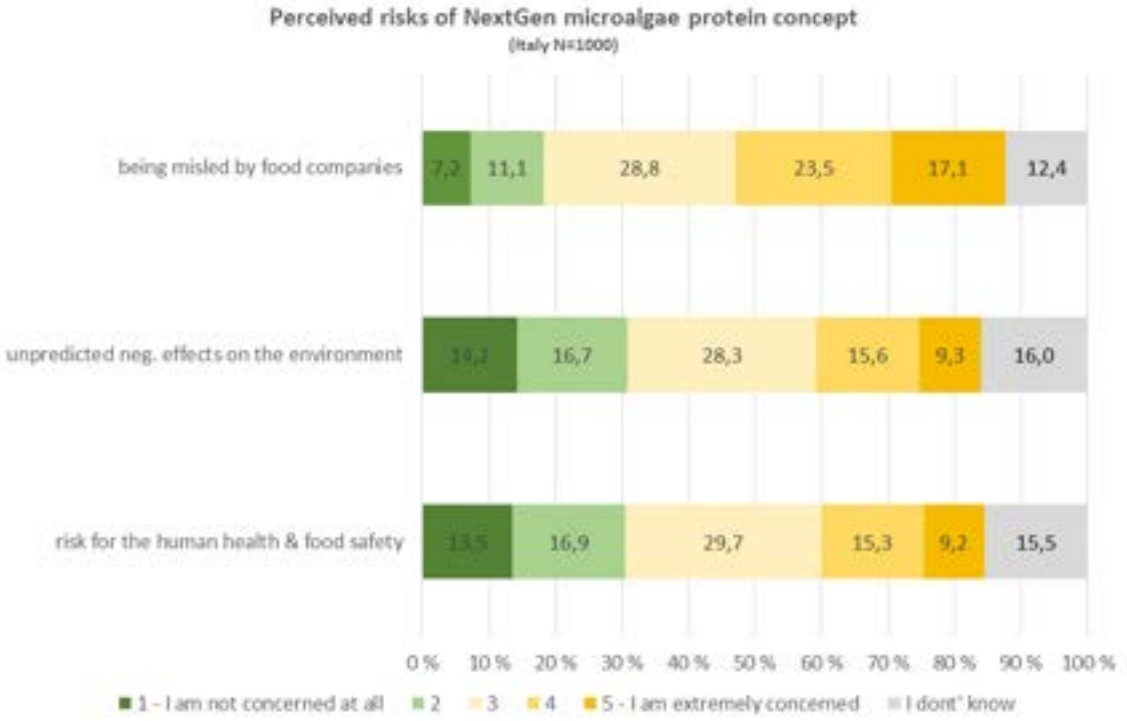


Figure 88. Perceived risks of the NextGen microalgae protein concept. Answers to individual question items. Percentage of Italian respondents.

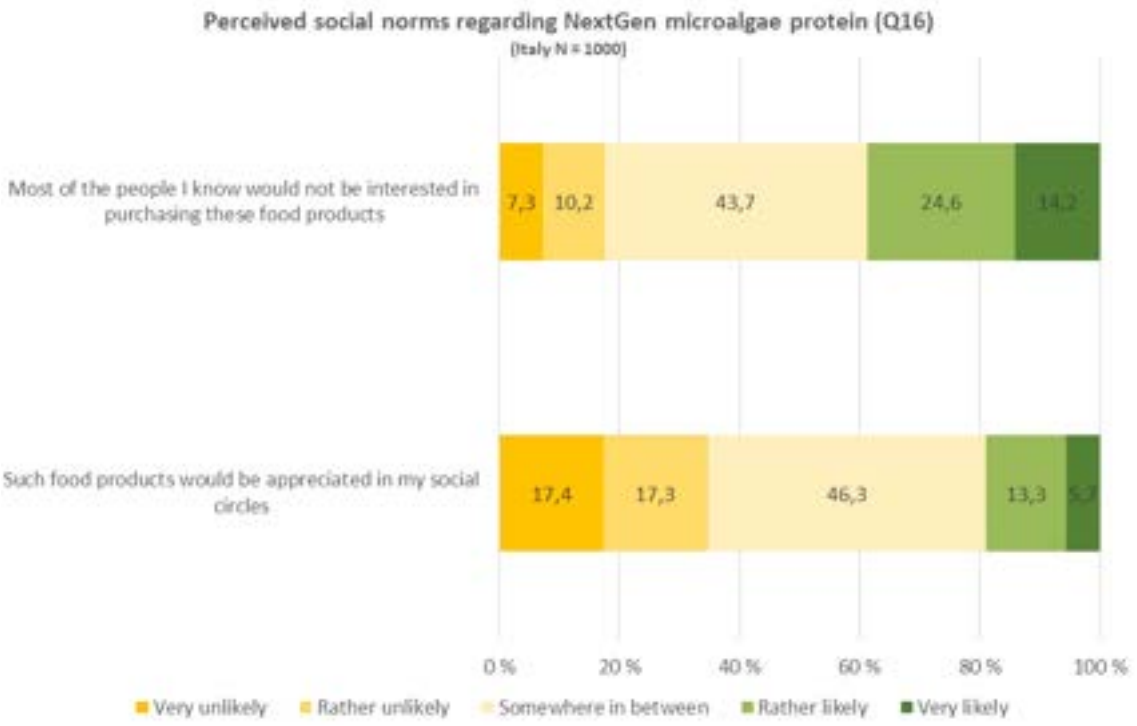


Figure 89. Perceived social norms regarding NextGen microalgae protein food products. Italy.

The next question aimed to chart whether the consumers have preconceptions about the characteristics of the NextGen microalgae food applications. The answers indicate that Italian respondents' image of these foods is more on the positive side and negative preconceptions were not common, although 35.8 % did consider these foods as weird rather than normal. On the other hand, consumers did not seem to have worries e.g. about the safety of these foods. The fact that most respondents did not have either positive or negative views about the characteristics of these imaginary food applications of NextGen microalgae protein is positive result.

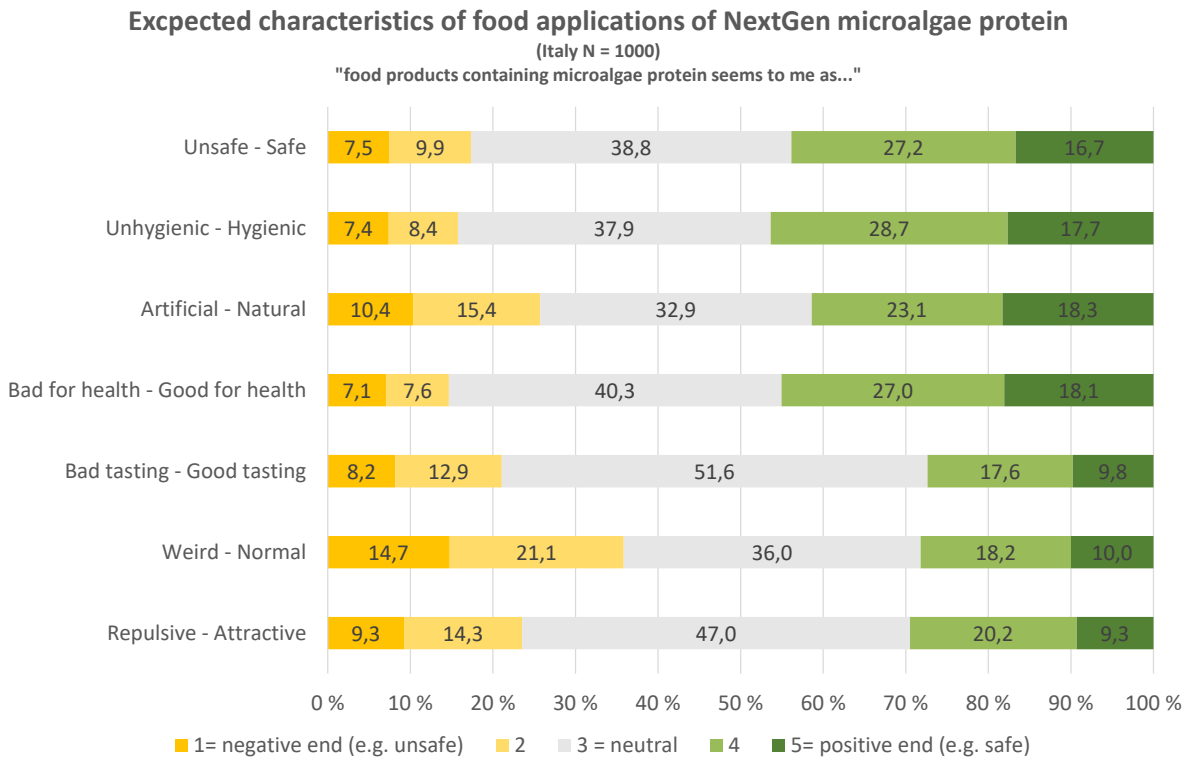


Figure 90. Characteristics associated with (imaginary) foods containing NextGen microalgae protein. Percentages of respondents. Semantic differential scales have been used, where the number 1 always stand for the negative end of the scale on the left (e.g. unsafe) and number 5 the positive end of the scale on the right (e.g. safe). Shares of respondents for each answer alternative.

In Italy, the consumers were a bit more often interested in using salty snacks made with NextGen microalgae than about the other two food application examples. As much as 64 % were to some extent interested in using salty snacks made with NetGen microalgae protein. Figure 91.

For the sake of comparison, the shares of respondents interested in using the conventional counterparts of these example foods are presented in Figure 92.

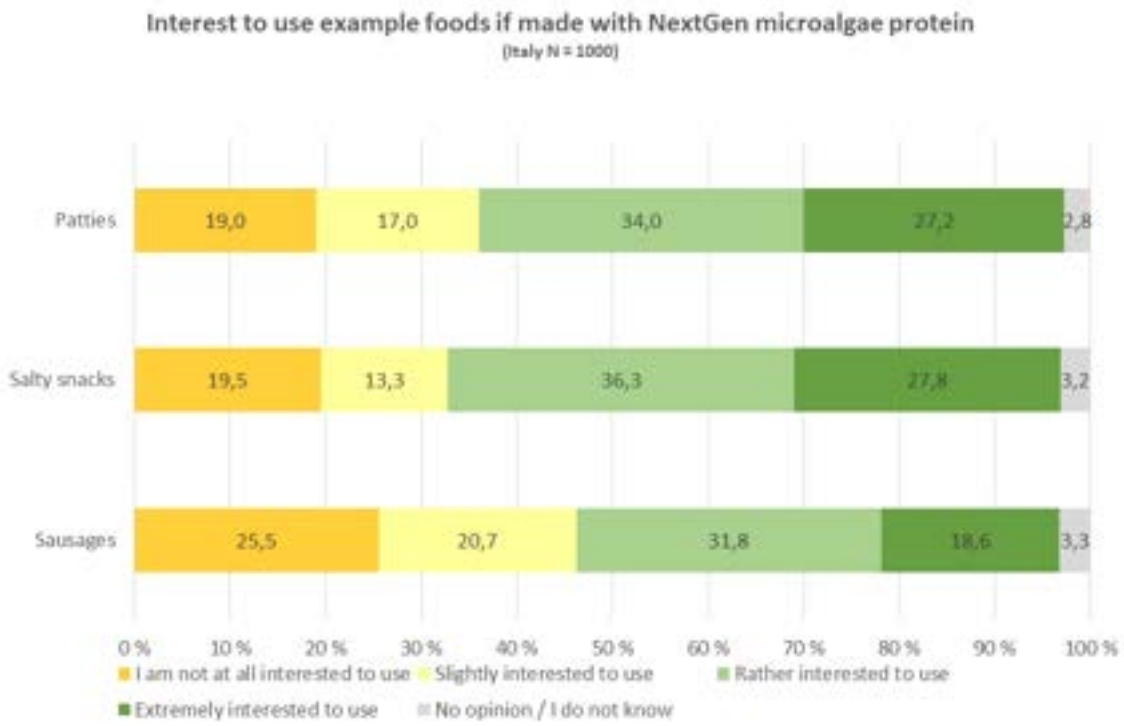


Figure 91. Interest to use the food application examples made with NextGen microalgae protein. Italy.

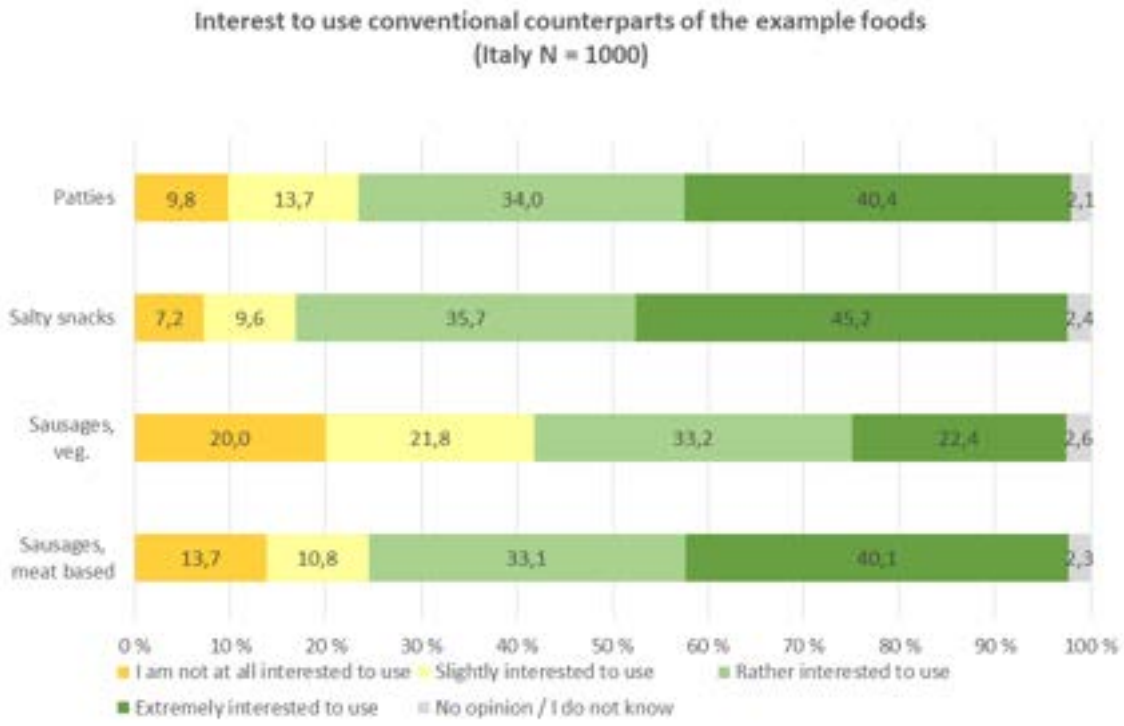


Figure 92. Interest to use the conventional counterparts of the example foods, Italy.

9.5.2 Consumer clusters based on ratings of NextGen microalgae concept, Italy

The cluster analysis procedure clearly suggested three different cluster to be formed on the basis of the acceptance measures regarding the NextGen microalgae (see the table below).

Reflecting the means of acceptance measure in each cluster, the clusters were named as Positive, Neutral and Negative. Over half of the respondents belong to the cluster Neutral, while the Negative cluster is the smallest.

Table 32. Consumer clusters based on respondents' views towards NextGen microalgae protein concept. The result of K-means cluster analysis with 3 clusters.

	1 - Positive	2 - Negative	3 - Neutral	Total	F	Sig.
Number of cases	302	132	465	899		
Percent of cases	33.6	14.7	51.7	100 %		
ATT_Algae	4.71	1.81	3.39		1177.888	.000
BENEFIT_Algae	4.60	1.77	3.48		1084.378	.000
RISK_Algae	2.40	3.70	3.30		118.506	.000
FOODVIEWS_Algae	4.13	1.82	3.08		797.717	.000

The cluster 1. had the most positive ratings on all acceptance measures: it had most positive attitudes, highest belief in benefits, lowest concern for risk, and most positive expectations about the characteristics of food applications of NextGen microalgae protein. The cluster 2. was total opposite to cluster 1. with the most negative views on all measures, while the cluster 3., including the highest number of respondents had neutral ratings. Consequently, the clusters were named as Positive, Negative and Neutral (towards the idea of NextGen microalgae)

9.5.2.1 Demographic profile and eating habits of NextGen microalgae protein consumer clusters, Italy

Compared with the Negative and Neutral clusters, the Italian consumer cluster with **positive views towards NextGen microalgae concept** can be characterised as:

- having lower education level
- higher familiarity with alternative and future proteins
- higher use of vegetarian convenience foods
- lower use of meat-based convenience foods

For the consumer cluster with negative views towards NextGen microalgae concept opposite characteristics were more typical.

Table 33. Demographic profile and eating habits of the NextGen microalgae consumer clusters, Italy

		Positive	Negative	Neutral	Total	Pearson Chi²	Sig.	Total N
Gender						,323	ns	439
	male	47,8%	48,5%	49,9%	49,0%			
	female	52,2%	51,5%	50,1%	51,0%			
		100 %	100 %	100 %	100 %			
Age group						28,009	.000	899
	18 - 34 y.	22,2%	9,1%	28,0%	23,2%			
	35 - 44 y.	19,9%	25,0%	21,5%	21,5%			
	45 - 54 y.	**22,2**%	20,5%	19,4%	20,5%			
	55 - 64 y.	18,5%	18,9%	17,4%	18,0%			
	65 - 75 y.	17,2%	26,5%	13,8%	16,8%			
		100 %	100 %	100 %	100 %			
Education						6,678	.035	897
	Primary or secondary	57,0%	68,9%	63,9%	62,3%			
	Tertiary	43,0%	31,1%	36,1%	37,7%			
		100 %	100 %	100 %	100 %			
Household type						2,944	ns	898
	no children	42,5%	45,5%	38,7%	41,0%			
	1 - 2 pers with children	33,9%	34,1%	35,3%	34,6%			
	something else (Note. Incl. Living with parents)	23,6%	20,5%	26,0%	24,4%			
		100 %	100 %	100 %	100 %			
Type of living area						11,271	ns	900
	I live in the capital city / area	8,6%	9,1%	10,3%	9,6%			
	I live in a large city that is not in the capital area	23,8%	22,0%	20,8%	22,0%			
	I live in a small city/town or municipality	56,3%	50,8%	60,1%	57,4%			
	I live in a rural area	11,3%	18,2%	8,8%	11,0%			
		100 %	100 %	100 %	100 %			
Region						9,419	ns	899
	Nord-Ovest	29,1%	25,0%	25,4%	26,6%			
	Sud	19,9%	28,0%	23,0%	22,7%			
	Isole	11,9%	15,2%	10,1%	11,5%			
	Nord-Est	19,9%	15,9%	19,1%	18,9%			
	Centro	19,2%	15,9%	22,4%	20,4%			
Diet		100,0%	100,0%	100,0%	100,0%	24,517	.000	899
	ominivore	70,9%	86,4%	79,4%	77,5%			
	meat sometimes or no red meat	11,3%	7,6%	12,5%	11,3%			
	vegetarian	17,9%	6,1%	8,2%	11,1%			
		100 %	100 %	100 %	100 %			

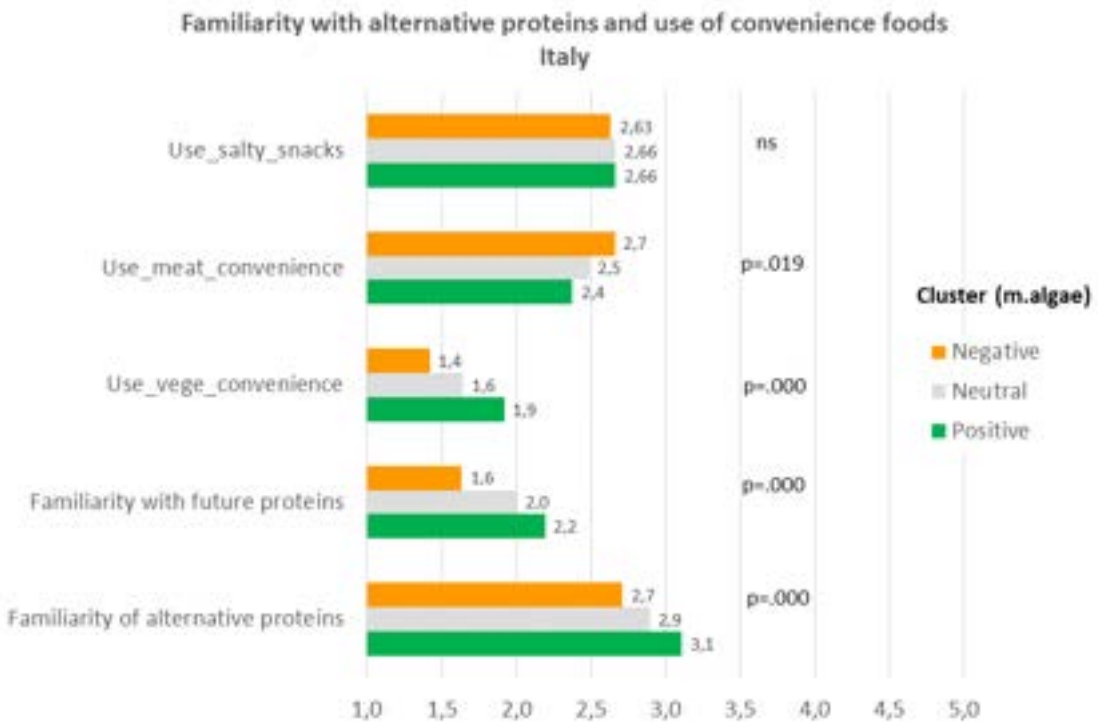


Figure 93. Use of certain convenience food types and familiarity with alternative proteins by NextGen microalgae consumer clusters in the Italian sample. Means. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

9.5.2.2 Attitudinal background of NextGen microalgae consumer clusters, Italy

Compared with the Negative and Neutral clusters, the Italian consumer cluster with **positive** views towards NextGen microalgae concept can be characterised as Figure 94:

- being more interested in food product novelties (Food innovativeness)
- having higher trust in different actors of food chain
- having lower taste neophobia
- having less concern about the risks of food technology in general and having more positive attitudes towards food technology in general
- being less attached to meat

In terms of what they value in their daily foods, the cluster Positive vs. Negative more typically valued:

- convenience
- healthiness
- naturalness and sustainability
- sensory pleasure

The results suggest that consumers with positive views towards the Next Gen microalgae appear to be more interested and involved in food overall.

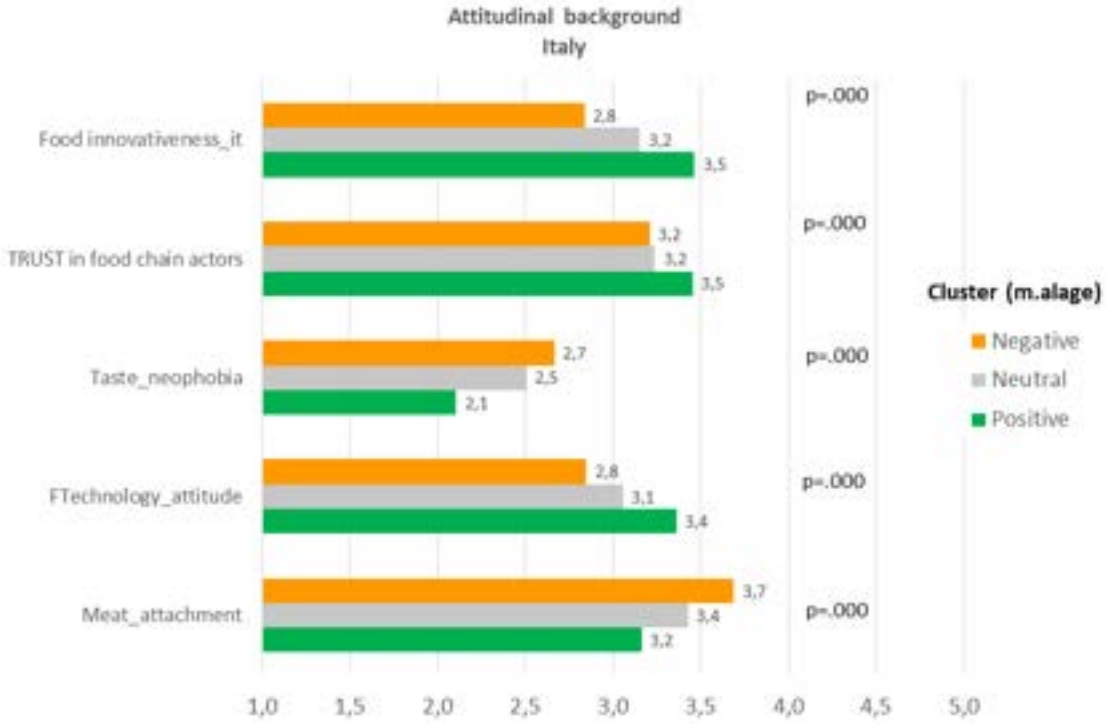


Figure 94. Background attitudes of the respondents in the clusters based on their views towards NextGen microalgae concept. Italy. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

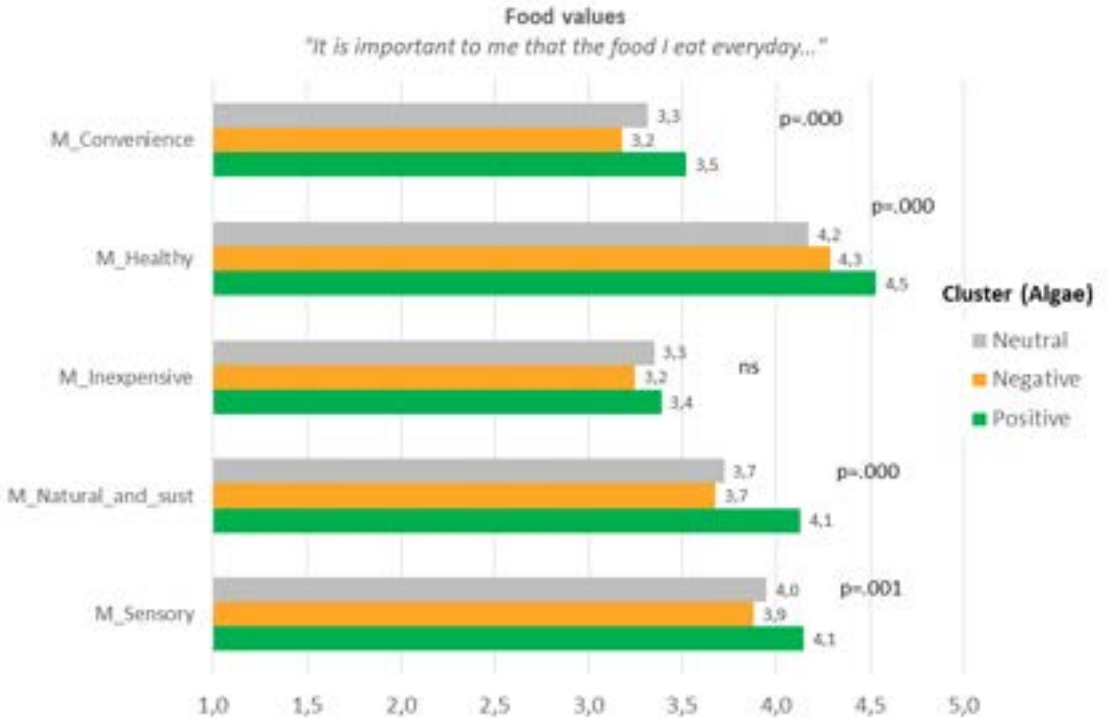


Figure 95. Means of food choice motives (values) of consumer clusters based on their views on NextGen microalgae concept. Italy. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

9.5.2.3 *Interest to use food applications of NextGen microalgae protein in the consumer clusters*

The differences between the consumer clusters Positive, Neutral and Negative towards the NextGen microalgae concept were most pronounced in their interest to use the food application examples made with NextGen microalgae protein. The cluster positive is clearly more interested than the other two clusters. The type of product does not make a difference.

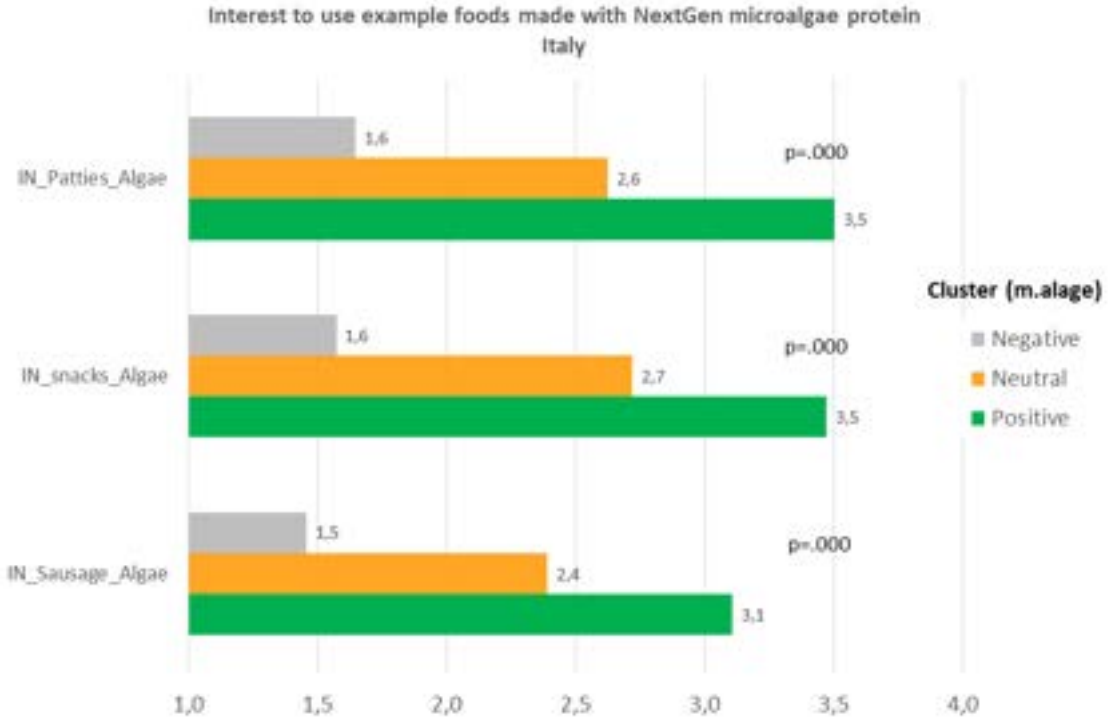


Figure 96. Mean interest to use the example foods when these contain NextGen microalgae protein. Comparison of consumer clusters based on views towards NextGen microalgae concept. Italy.

9.6 Acceptance of Nextgen Insect protein concept, Italy

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Insect** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Insect concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Insect method and foods.

9.6.1 The level of acceptance of the NextGen insect protein, IT

Only 23.6 % of respondent in Italy were in favour of the idea of production of NextGen insect proteins to be used in foods, and a considerable shar of them (50.8 %) were against this idea.

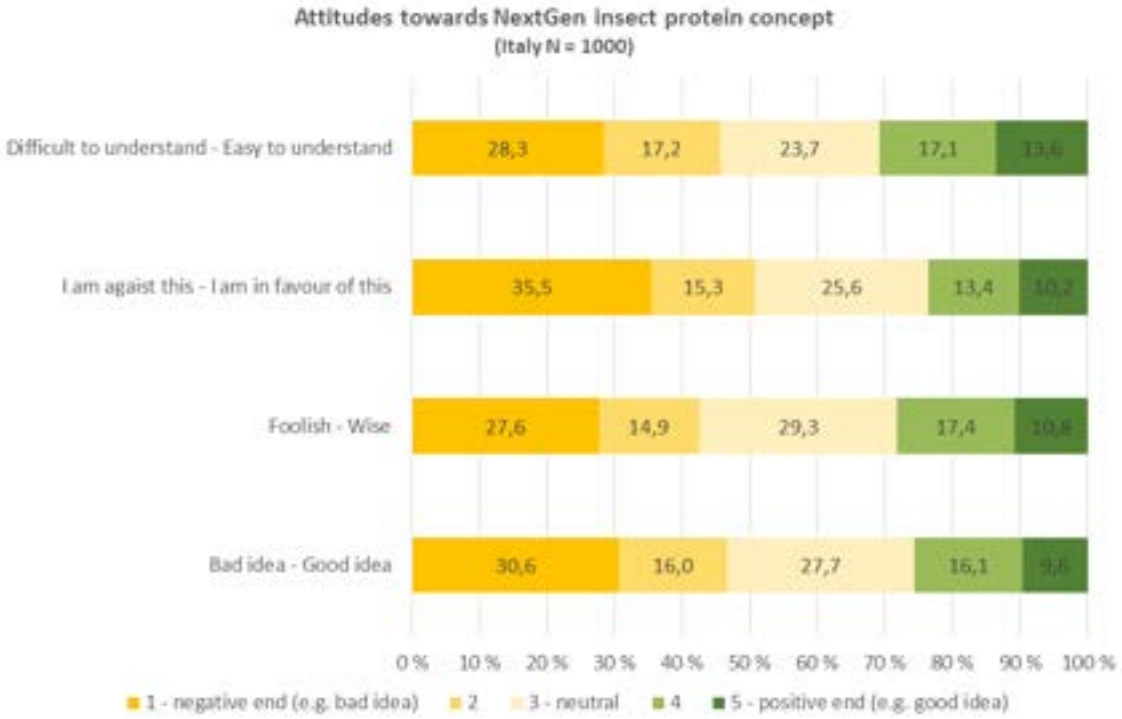


Figure 97. Attitudes towards NextGen insect protein concept (Italy). Answers to individual question items. Percentage of respondents.

The perceived benefits and risks related to the NextGen insect concept were similar compared to the other ingredients in that environmental and sustainability as well as animal welfare benefits were easiest to believe in, and personal benefits least so.

A noteworthy share of respondents had distrust in honesty of food companies that would sell these foods (Figure 99).

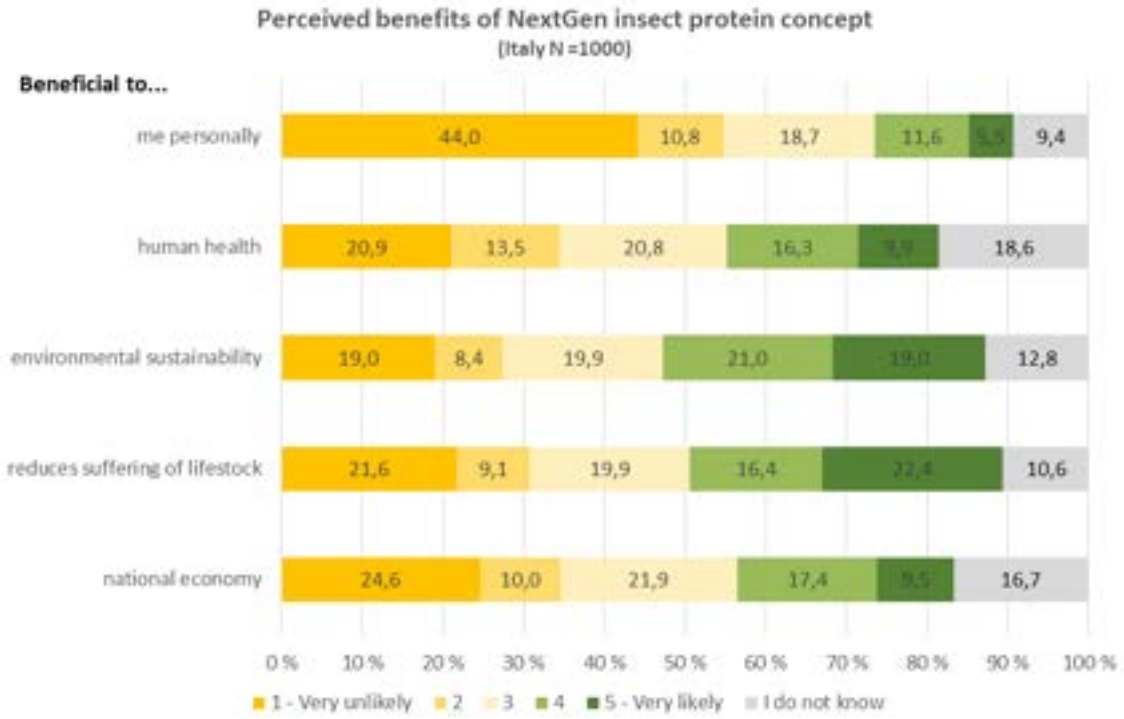


Figure 98. Perceived benefits of the NextGen insect protein concept. Italy.

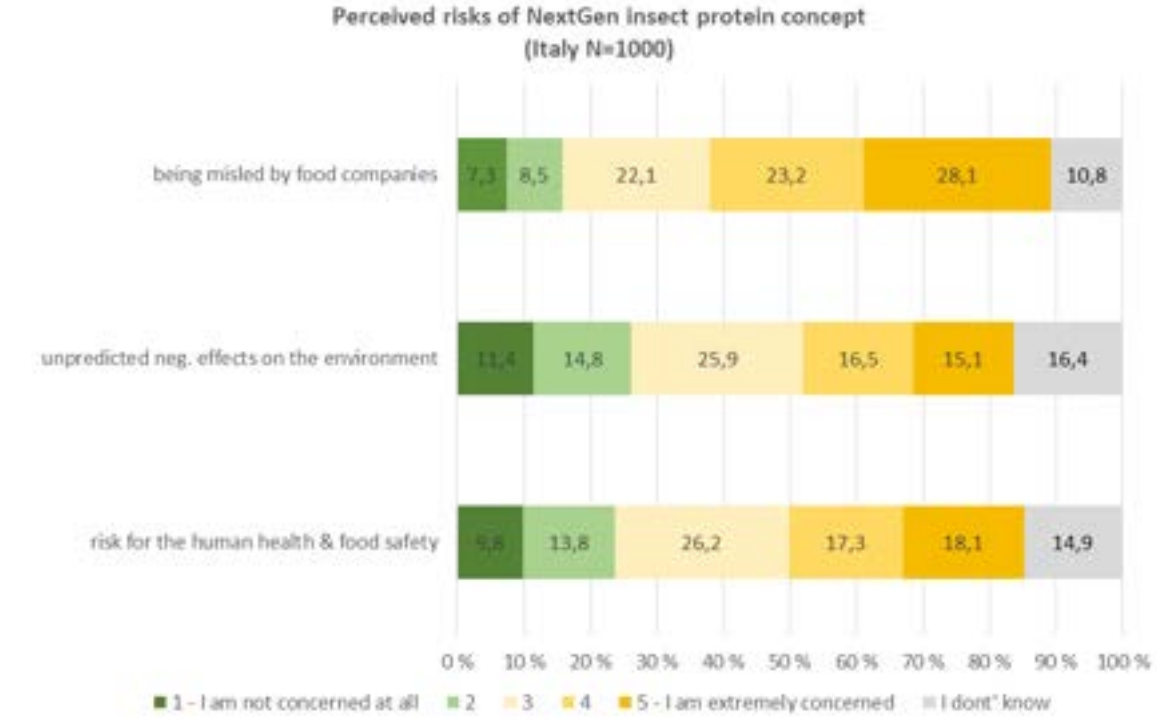


Figure 99. Perceived risks of the NextGen insect protein concept. Italy.

The majority of the Italian respondents consider or expect NextGen insect food applications to be **repulsive** (65.3 %), bad tasting (47.5 %) and **weird** (57.5 %). However, a large share of the respondents do not indicate any preconceptions about taste, as they rate the neutral option. Figure 100.

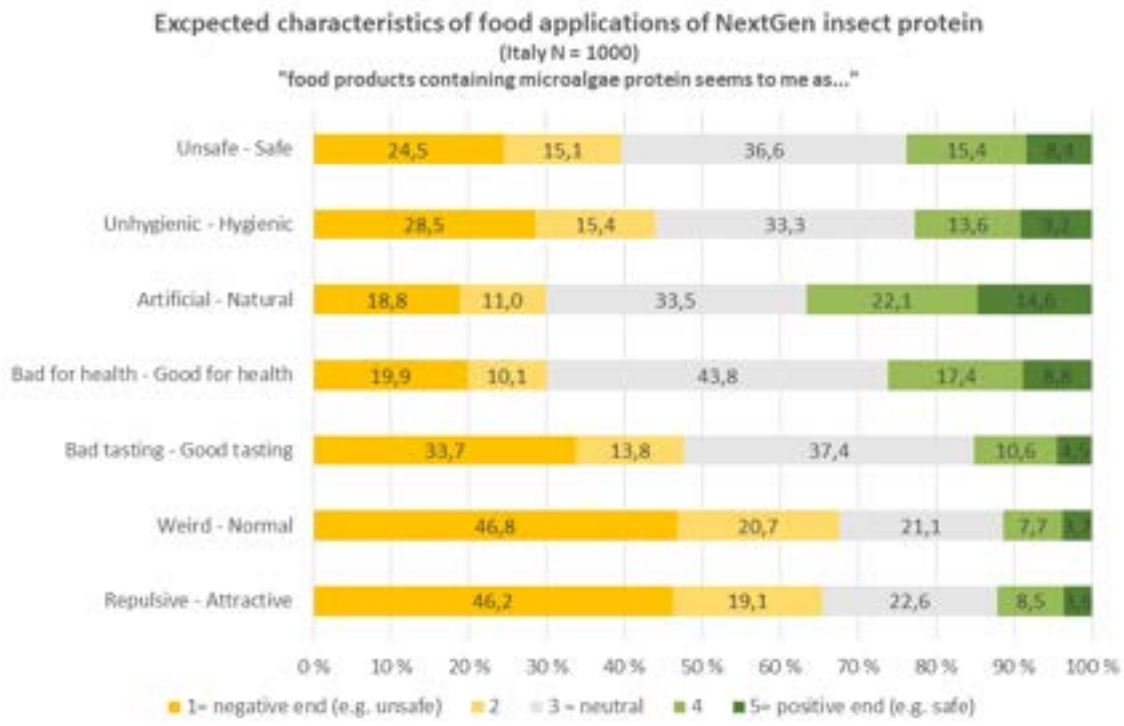


Figure 100. Characteristics associated with (imaginary) foods containing NextGen insect protein. Percentages of respondents. Semantic differential scales have been used. where the number 1 always stand for the negative end of the scale on the left (e.g. unsafe) and number 5 the positive end of the scale on the right (e.g. safe). Shares of respondents for each answer alternative. Italy

About 70 % of the Italian respondent assume that these foods would not be valued in their social circles. Figure 101.

Italian consumers interest to use NextGen insect protein applications was low. **Over half of the respondents clearly reject these foods**, while around 29 % would be interested in salty snack or vegetable-protein -pattie -applications. Figure 102.

The correspondent percentages of Italian respondents' interest to use conventional versions of these foods are presented in Figure 92.

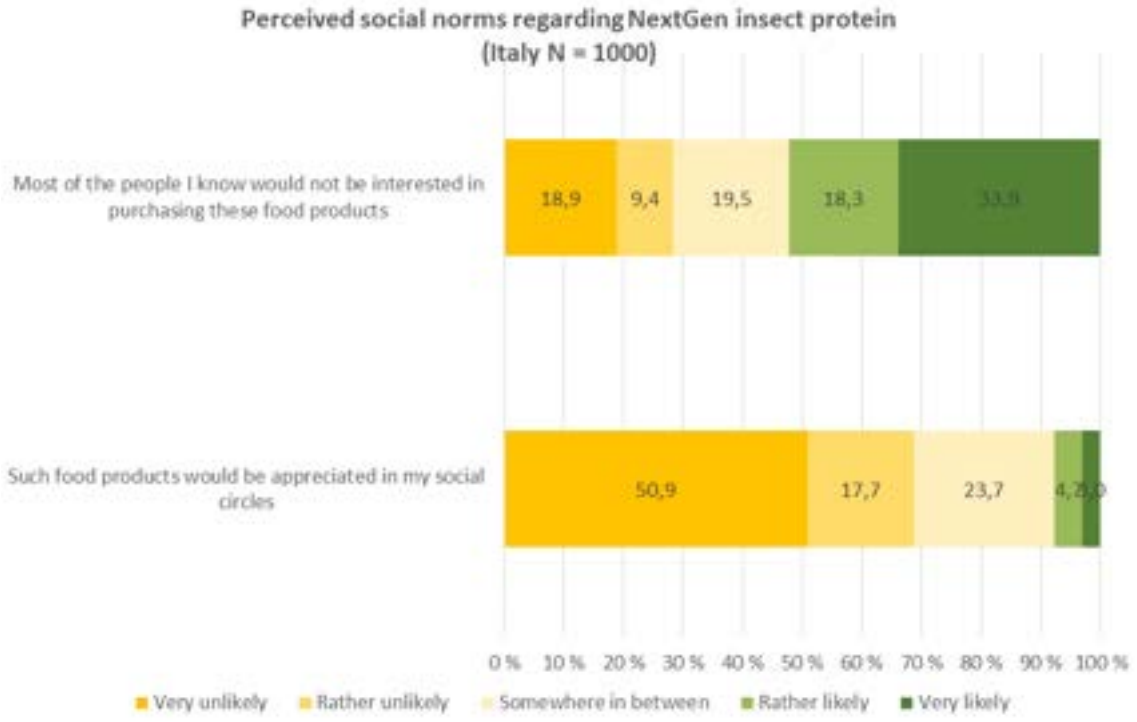


Figure 101. Perceived social norms regarding NextGen insect protein food products. Italy.

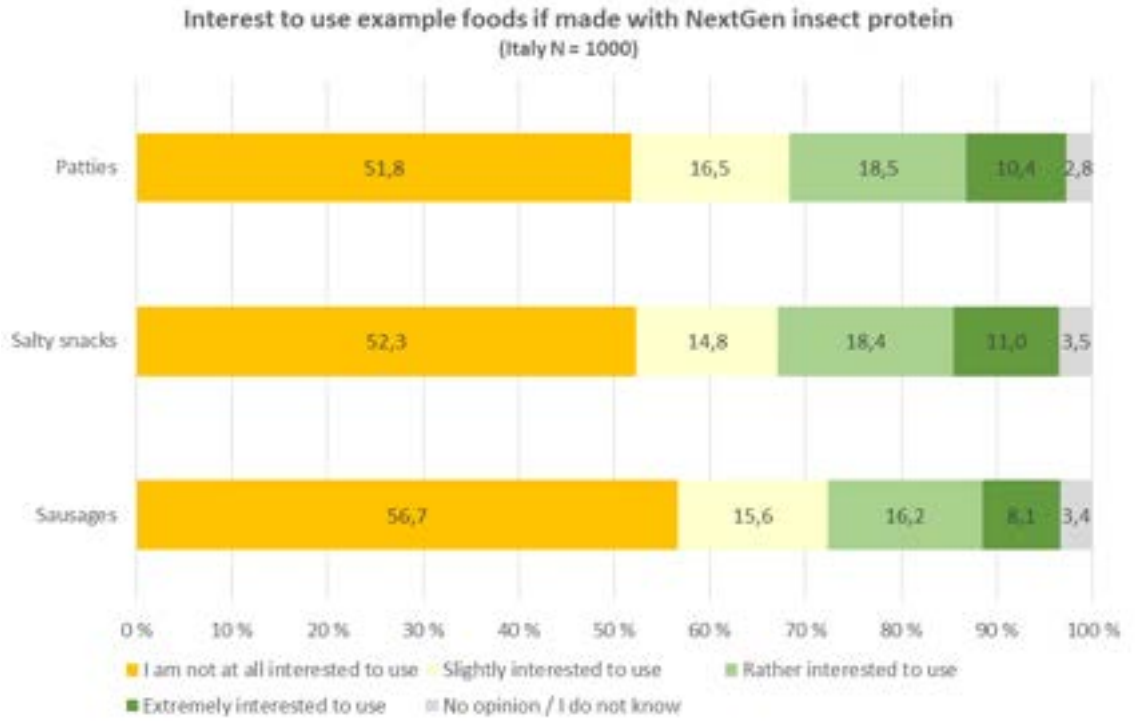


Figure 102. Interest to use the food application examples made with NextGen insect protein. Italy.

9.6.2 Consumer clusters based on ratings of NextGen insect protein concept, Italy

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGen insect concept

(ATT_insects, BENEFIT_insects, RISK_insects and FOODVIEWS_insects. The set of hierarchical cluster analyses suggested 2 – 3 clusters. K-means cluster analyses were run with 2, 3 and 4 clusters. As the 3-cluster solution provided more information than the 2-cluster solution and more meaningful interpretation than 4 cluster solution, that was selected. The clusters were named as Negative, Neutral and Positive reflecting their views as presented in the table below. The largest share of respondents (41.8 %) belong to the cluster Neutral, while the Negative and positive were close to similar size.

Table 34. Consumer clusters based on respondents' views towards NextGen insect protein concept. The result of K-means cluster analysis with 3 clusters.

	1 - Negative	2 - Neutral	3 - Positive	Total	F	Sig.
Number of cases	299	381	231	911		
Percent of cases	32,8	41,8	25,4	100 %		
ATT_Insects	1,28	2,68	4,24	2,61	573.470	.000
BENEFIT_Insects	1,46	3,03	4,13	2,80	484.121	.000
RISK_Insects	4,05	3,13	2,86	3,36	110.208	.000
FOODVIEWS_Insects	1,50	2,62	3,71	2,53	320.408	.000

9.6.2.1 Demographic profile and eating habits of NextGen insect consumer clusters, Italy

Compared with the Negative and Neutral clusters (Table 34), the Italian consumer cluster with **positive views towards NextGen insect concept** were more likely, and cluster Negative less likely to be:

- male
- younger
- highly educated

and have

- higher familiarity with alternative and future proteins (Figure 103.)

Whereas the clusters did not differ e.g. in their use habits of meat-based convenience foods, or area of living, for example. See Table 34. for more detail.

Table 35. Demographic profiles of three consumer clusters based on their views towards NextGen insect concept. Italy

		Consumer cluster / NextGen insects			Total	Pearson Chi²	Sig.	Total N
Gender		Negative	Neutral	Positive		21.614	.000	909
	male	39,3%	52,1%	59,0%	49,6%			
	female	60,7%	47,9%	41,0%	50,4%			
		100%	100%	100%	100%			
Age group						22.935	.003	913
	18 - 34 y.	17,0%	24,9%	28,9%	23,3%			
	35 - 44 y.	19,3%	20,7%	23,3%	20,9%			
	45 - 54 y.	19,0%	22,6%	17,7%	20,2%			
	55 - 64 y.	22,7%	17,6%	14,7%	18,5%			
	65 - 75 y.	22,0%	14,2%	15,5%	17,1%			
		100%	100%	100%	100%			
Education						15.405	.000	911
	Primary or secondary	71,0%	59,7%	55,4%	62,3%			
	Tertiary	29,0%	40,3%	44,6%	37,7%			
		100%	100%	100%	100%			
Household						2.740	ns	911
	no children	44,1%	40,5%	38,8%	41,3%			
	1 - 2 pers with children	33,8%	36,6%	34,5%	35,1%			
	something else (Incl. Living with parents)	22,1%	22,9%	26,7%	23,6%			
		100%	100%	100%	100%			
Type of living area						3.775	ns	912
	I live in the capital city / area	9,3%	10,2%	10,0%	9,9%			
	I live in a large city that is not in the capital area	19,7%	21,5%	23,8%	21,5%			
	I live in a small city/town or municipality	57,7%	58,8%	55,4%	57,6%			
	I live in a rural area	13,3%	9,4%	10,8%	11,1%			
		100%	100%	100%	100%			
Region		Negative	Neutral	Positive		11.742	ns	911
	Nord-Ovest	28,1%	23,2%	29,3%	26,3%			
	Sud	25,1%	22,6%	19,4%	22,6%			
	Isole	12,0%	10,5%	9,9%	10,9%			
	Nord-Est	14,4%	21,8%	22,4%	19,5%			
	Centro	20,4%	21,8%	19,0%	20,6%			
		100%	100%	100%	100%			
Diet						3.701	ns	912
	ominivore	80,7%	79,0%	74,0%	78,3%			
	meat sometimes or no red meat	9,7%	11,0%	13,0%	11,1%			
	vegetarian	9,7%	10,0%	13,0%	10,6%			
		100%	100%	100%	100%			

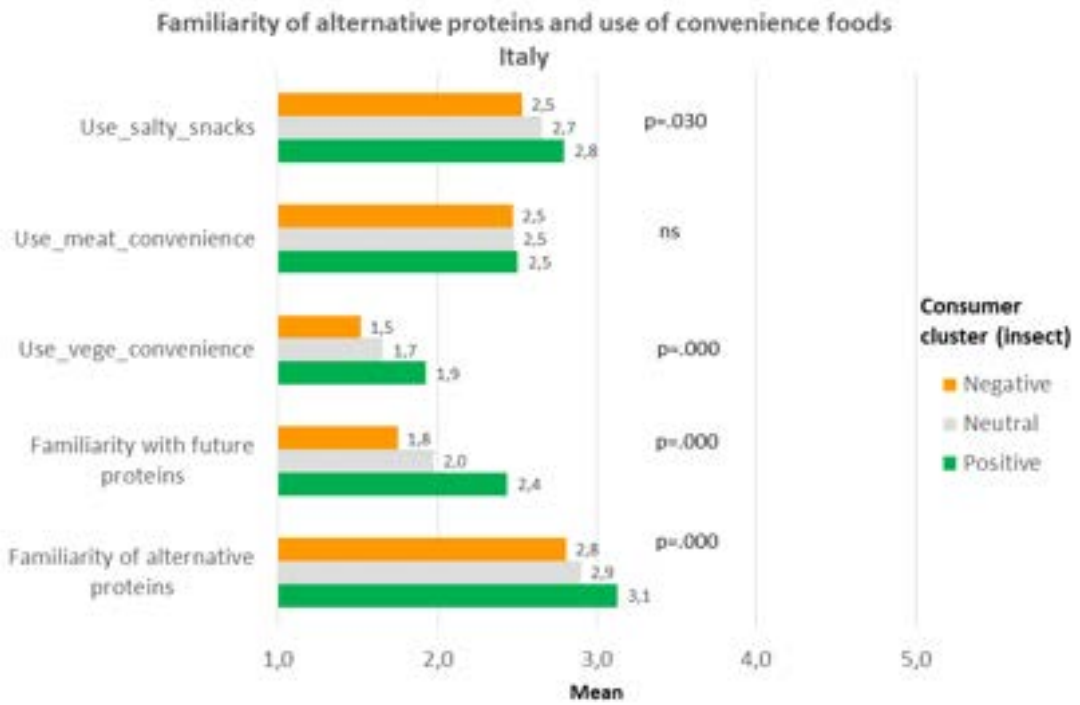


Figure 103. Mean use frequencies of certain convenience foods and familiarity with alternative proteins by consumer clusters based on views towards NextGen insect protein concept. Italy. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

9.6.2.2 Attitudinal background of NextGen insect consumer clusters, Italy

Compared with the Negative and Neutral clusters, the Italian consumer cluster with **positive** views towards NextGen **insect** concept is more likely (and the cluster Negative less likely) to

- be more interested in food product novelties (Food innovativeness)
- have higher trust in different actors of food chain
- have lower taste neophobia
- have less concern about the risks of food technology in general and having more positive attitudes towards food technology in general

As can be seen from the Figure 104., the cluster Negative is about the opposite of cluster Positive, and the neutral is in the middle in terms of their background attitudes.

Unlike in the case of NextGen microalgae, the respondents' attachment to meat eating does not significantly differ between the NextGen insect consumer clusters.

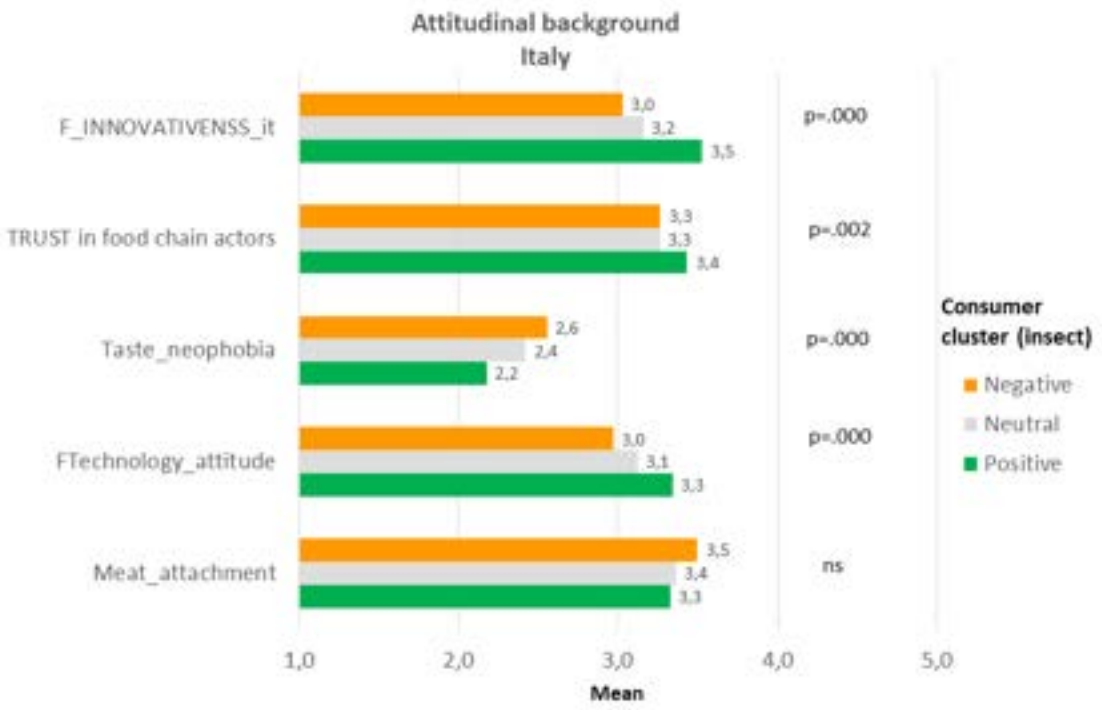


Figure 104. Means of background attitudes of consumers in the three clusters based on views towards NectGen insect protein concept. Italy. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

Neither do consumer clusters Positive and Negative differ in their food values like they do in the case of microalgae: That is, while e.g. consumers with positive views towards NextGen microalgae value naturalness and sustainability of their foods than other clusters, this is not the case for the NextGen insects clusters. The cluster Positive (towards NextGen insects) do value naturalness and sustainability of foods more than the cluster with Neutral views, however. Figure 105.

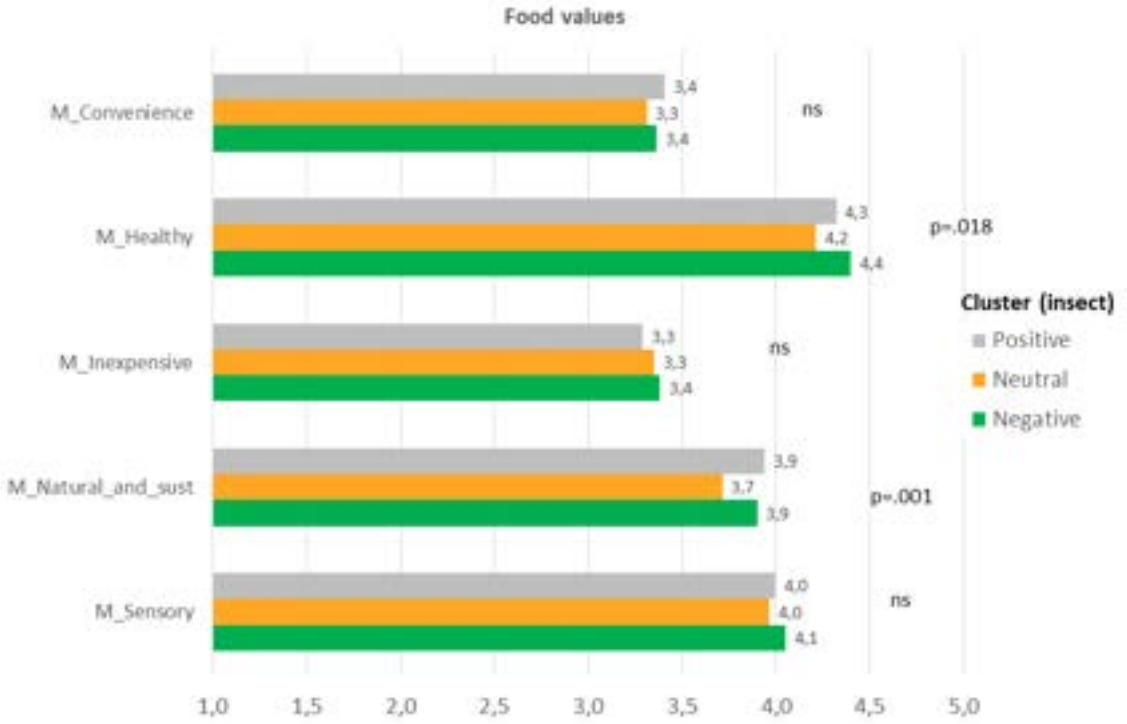


Figure 105. Means of food values (food choice motives) in the three consumer clusters based on views towards nextGen insect protein concept in Italy. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

9.6.2.3 Interest to use food applications of NextGen insect protein in the consumer clusters

The more positive views towards the NextGen insect concept is clearly reflected in consumers' interest in using the food applications. Regardless of the product type, the Positive (insect) cluster is much more interested in using the NextGen insect protein food applications than the other two clusters.

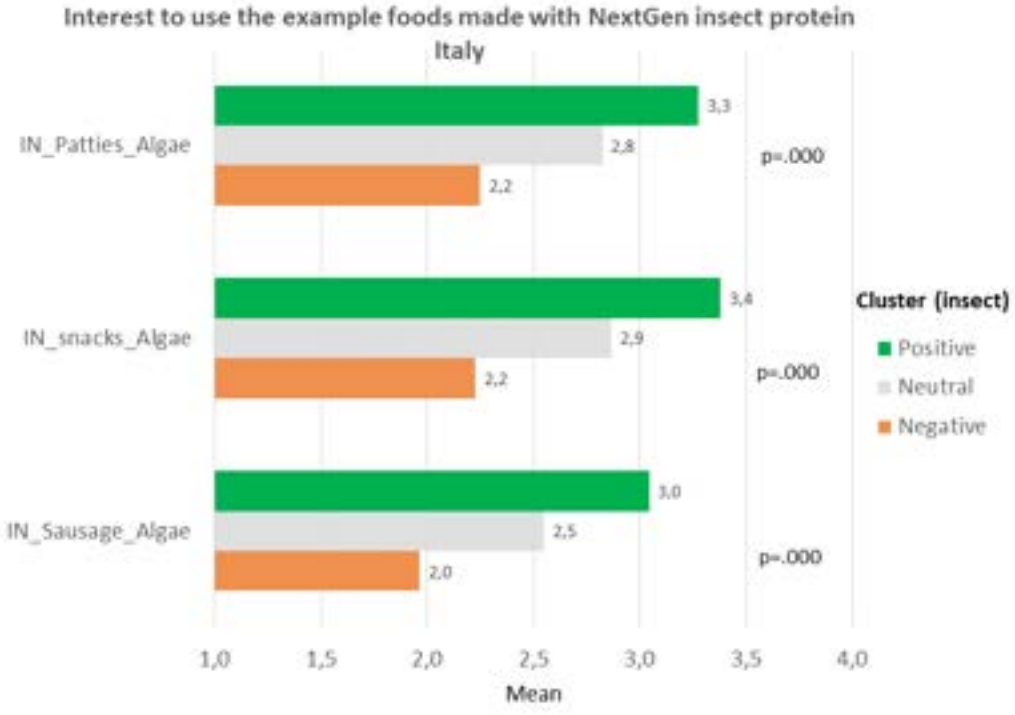


Figure 106. Mean interest to use the example foods when these contain NextGen insect protein. Comparison of consumer clusters based on views towards NextGen insect concept. Italy.

9.7 Acceptance of Nextgen Torula protein concept, Italy

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Torula** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Torula concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Torula method and foods.

9.7.1 The level of acceptance of NextGen Torula protein, IT

Out of the Italian sample, **38.7 % was in favour of the idea of NextGen Torula protein** production to be used as food ingredient. Like in the case of the other countries and ingredients, again, the share of respondents with neutral answer was high, and that of those with negative answer smaller than the share of positive answers: 23.2 % opposed the idea. Figure 107.

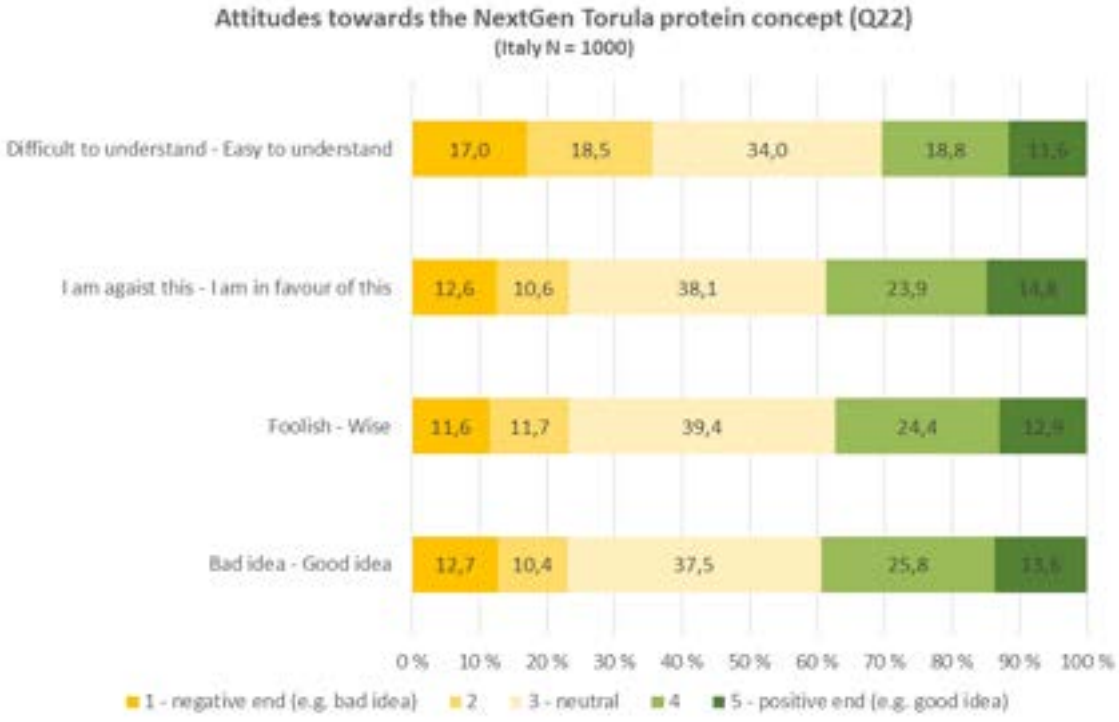


Figure 107. Attitudes towards NextGen Torula protein concept (Italy). Answers to individual question items. Percentage of respondents.

The sums of the neutral and "cannot say" answers (e.g. 36.4 % in the case of sustainability benefits, and 50.5 % in the case of worry about unpredictable risks for human health)

suggest that most respondents felt they are not able to evaluate whether the benefits or risks listed are likely. Again, the results show, that people do consider the benefits related to sustainability and animal welfare as most plausible ones – maybe because they were convinced about the way these were explained in the information provided to them. Figure 108.

The risks consumers were most worried about related to the honesty and integrity of the food companies: Around 42 % was concerned about being misled by the food companies in the case of NextGen Torula protein. A great share of consumers provided neutral ratings, suggesting that they felt unable to estimate their concerns. Only around 16 – 27 % were not concerned about the risks. Figure 109.

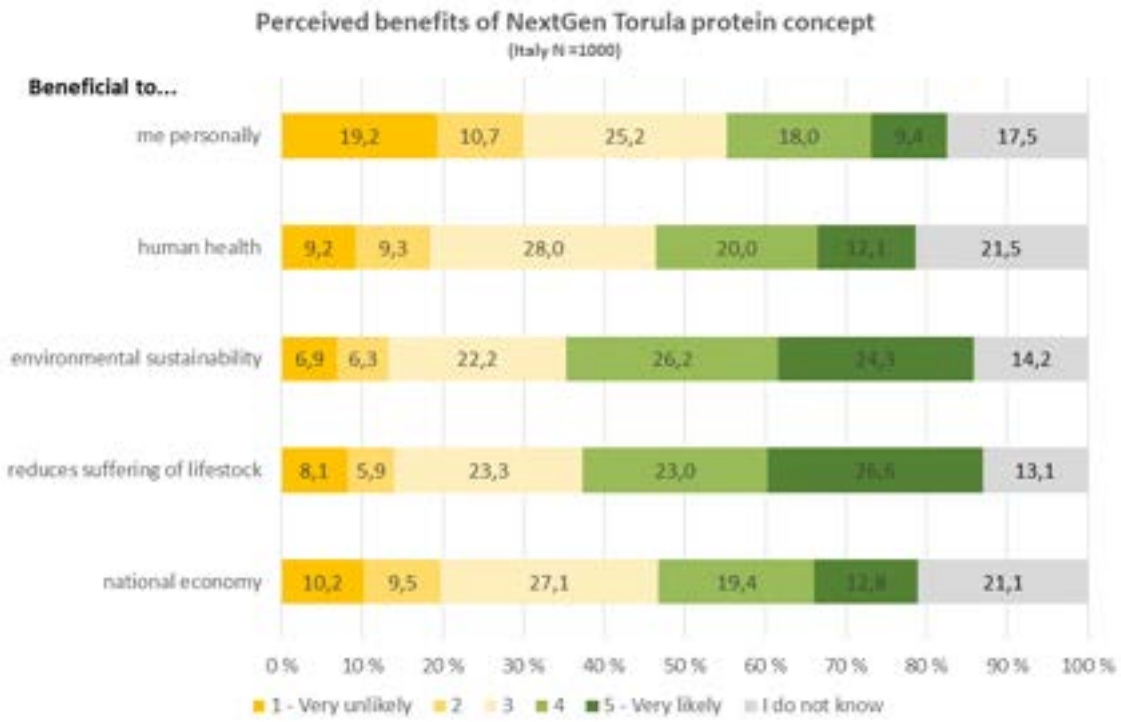


Figure 108. Perceived benefits of the NextGen Torula protein concept. Italy.

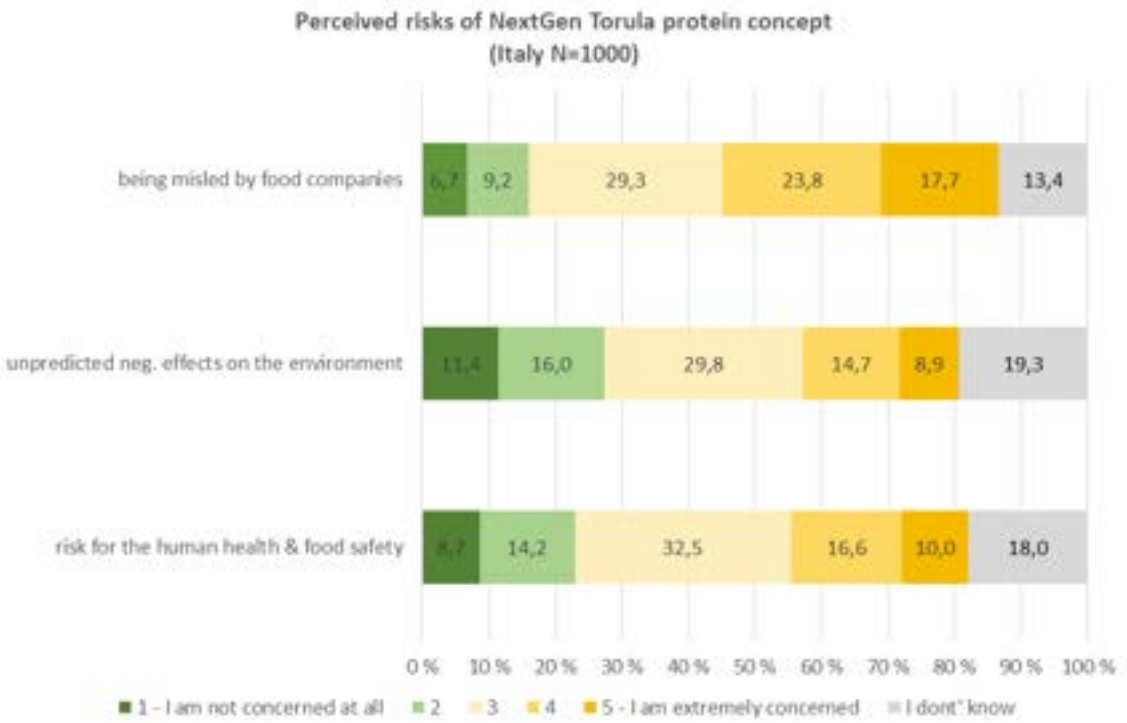


Figure 109. Perceived risks of the NextGen Torula protein concept. Answers to individual question items. Percentage of Italian respondents.

The next question aimed to chart whether the consumers have preconceptions about the characteristics of the NextGen Torula food applications. The answers indicate that Italian respondents' image of these foods were quite evenly distributed between negative and positive views. The most common negative views were perception of these foods as **weird** rather than normal (by 44.8 % of Italian respondents), and as **artificial** rather than natural (by 29.7 % of Italian respondents). On the other hand, larger share of respondents had **positive than negative expectations about qualities related to health effects, hygiene and safety.** Figure 110**.**

Around 40 – 50 % respondent did not have clear preconceptions about the characteristics of these foods, which was expected given these foods do not yet exist in the markets and consumers have no experience about them.

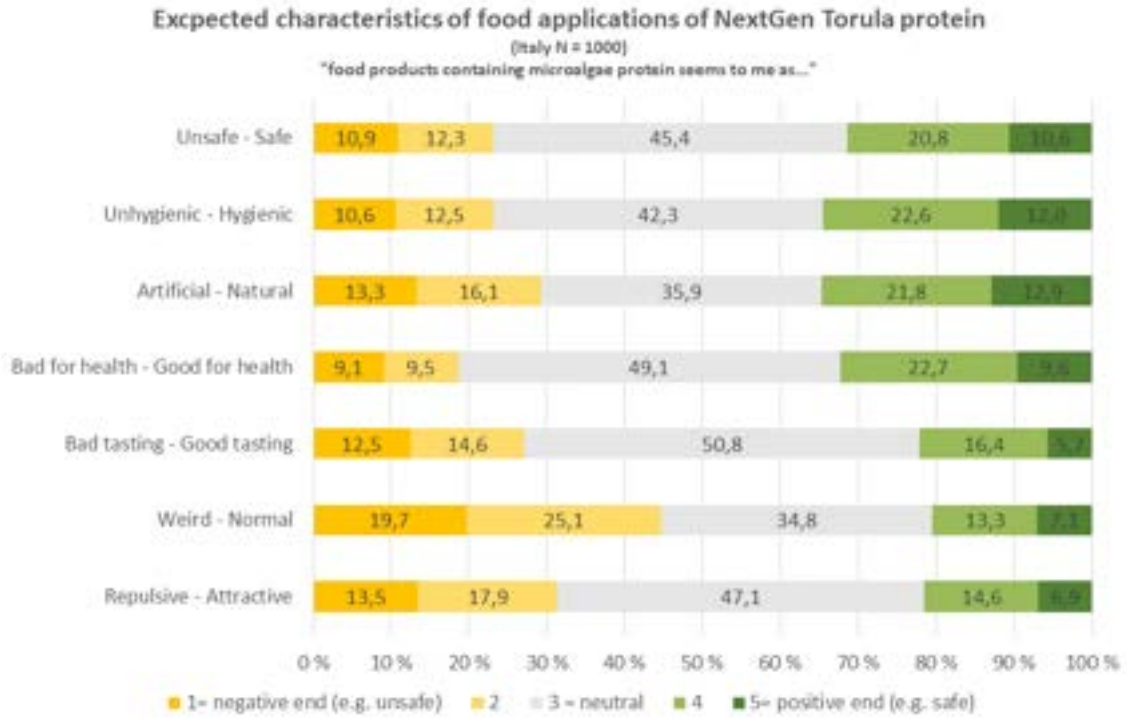


Figure 110. Characteristics associated with (imaginary) foods containing NextGen Torula protein. Percentages of respondents. Semantic differential scales have been used. where the number 1 always stand for the negative end of the scale on the left (e.g. unsafe) and number 5 the positive end of the scale on the right (e.g. safe). Shares of respondents for each answer alternative. Italy

The perceived social norm -questions suggest, that the Italian consumers do not feel any social pressure to use NextGen Torula protein food applications.

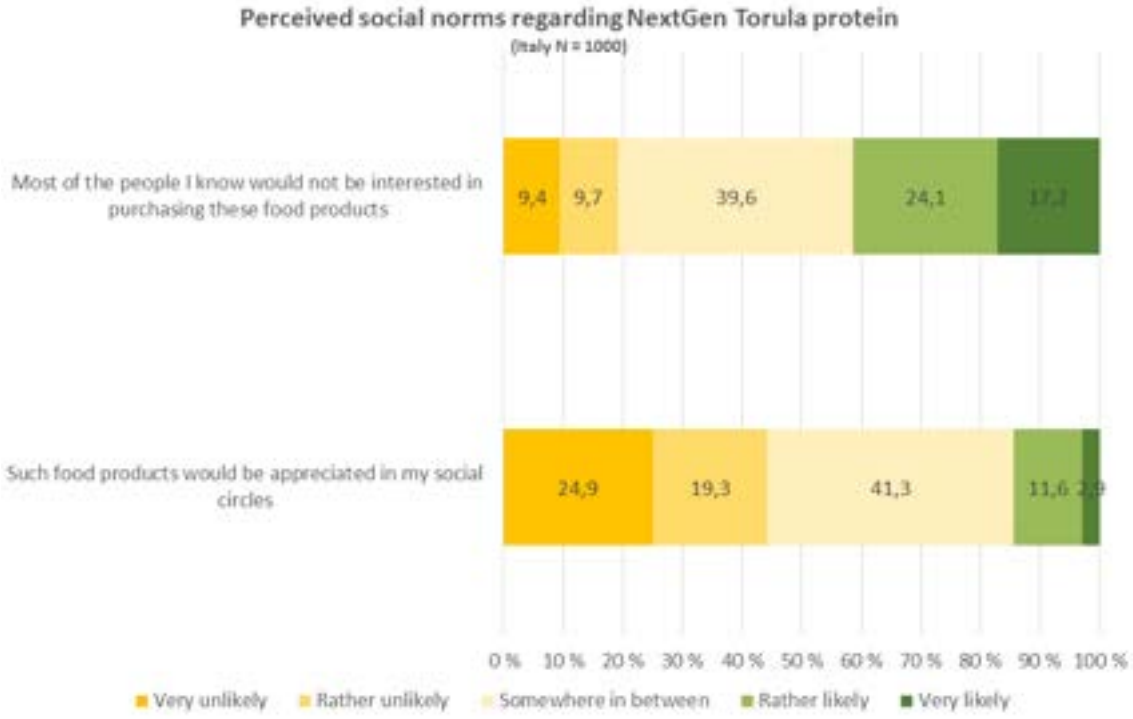


Figure 111. Perceived social norms regarding NextGen Torula protein food products. Italy.

Around 52 % - 42 % of the Italian respondents were to some extent interested in using the food application examples of NextGen Torula (Figure 112). The interest to use salty snacks and vegetable-protein patties was higher than interest to use the sausage application. *(Repeated measures analysis of variance comparing the means of the three NextGen ingredients and three food examples: main effect for BS factor "ingredient" F(2)=74.983. p < .000).*

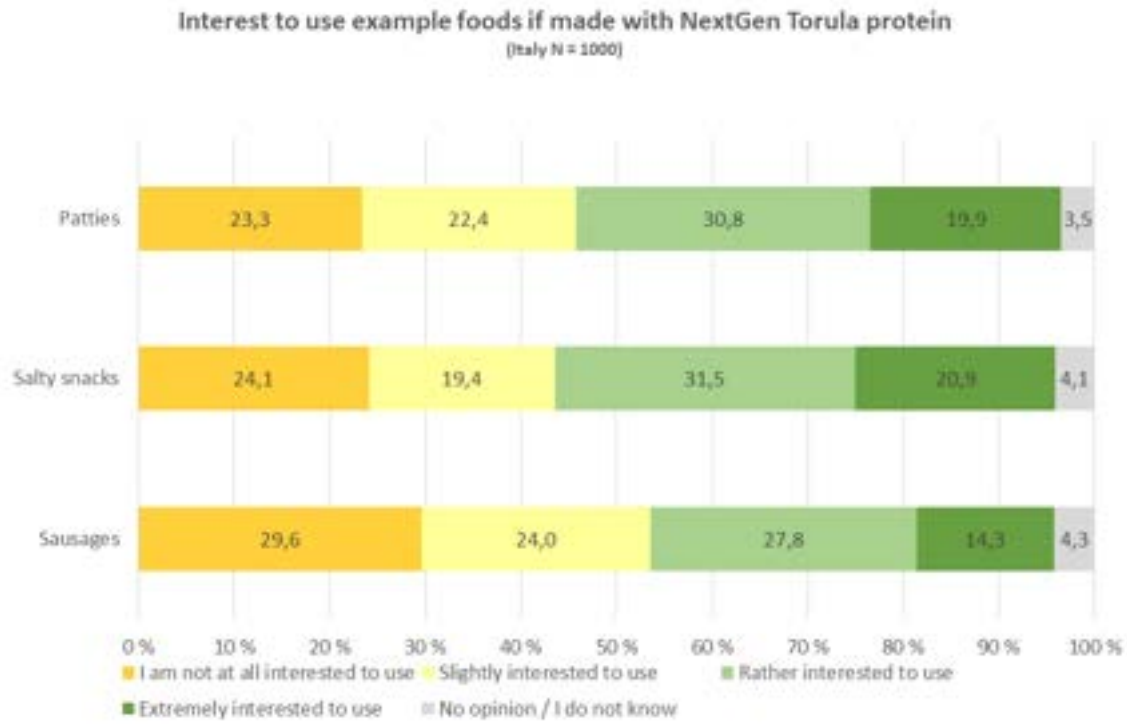


Figure 112. Interest to use the food application examples made with NextGen Torula protein. Italy.

9.7.2 Consumer clusters based on ratings of NextGen Torula concept, Italy

Hierarchical cluster analyses suggested three clusters for NextGen Torula acceptance in Italy. The result was confirmed by running K-Means clustering with 3 and 4 clusters. Again, the main basis for forming this clusters was how positive or negative views they had. Thus, the cluster were named as Neutral, Negative and Positive. The cluster Neutral was clearly the largest one, comprising 53 % of the respondents, and the cluster Negative was the smallest with 19 % of the respondents.

Table 36. Consumer clusters based on respondents' views towards NextGen Torula protein concept. The result of K-means cluster analysis with 3 clusters. Italy.

	1- Neutral	2 - Negative	3 - Positive	Total	F	Sig.
Number of cases	469	167	217	880		
Percent of cases	53.30	18.98	24.66	100 %		
Variables applied as basis of the clustering						
ATT_Torula	3.20	1.61	4.49	3.22	1132.080	.000
BENEFIT_Torula	3.37	1.76	4.47	3.34	859.463	.000
RISK_Torula	3.30	3.81	2.37	3.17	127.765	.000
FOODVIEWS_Torula	2.99	1.68	4.03	2.30	862.466	.000

9.7.2.1 Demographic profile and eating habits of NextGen Torula consumer clusters, Italy

Compared with the NextGen Torula clusters Positive and Neutral, the Italian consumer cluster with **negative views towards NextGen Torula concept** can be characterised (Table 37.) as more like to be

- omnivorous (than vegetarian)
- older in average age (F(2)=6.766, p =.001).

Otherwise, the clusters do not clearly differ in terms of their demographic characteristics.

Like in the case of the other ingredients, those with positive views towards NextGen Torula protein were more likely to (Figure 113.)

- be more familiar with alternative and future proteins
- use vegetarian convenience foods more often

Table 37. Demographic characteristics of the three consumer clusters based on views towards NextGen Torula protein concept. Italy.

		Neutral	Negative	Positive	Total	Pearson Chi²	Sig.	Total N
Gender						1.797	ns	878
	male	50,6%	44,6%	49,5%	49,2%			
	female	49,4%	55,4%	50,5%	50,8%			
		100,0%	100,0%	100,0%	100,0%			
Age group		Neutral	Negative	Positive	Total	16.697	.033	882
	18 - 34 y.	28,0%	14,9%	21,6%	23,9%			
	35 - 44 y.	21,0%	22,0%	21,1%	21,2%			
	45 - 54 y.	19,8%	22,0%	21,1%	20,5%			
	55 - 64 y.	16,5%	17,3%	18,8%	17,2%			
	65 - 75 y.	14,7%	23,8%	17,4%	17,1%			
Education		Neutral	Negative	Positive		4.284	ns	879
	Primary or secondary	60,7%	69,0%	59,9%	62,1%			
	Tertiary	39,3%	31,0%	40,1%	37,9%			
Household type		Neutral	Negative	Positive	Total	3.518	ns	881
	no children	40,1%	44,6%	41,5%	41,3%			
	1 - 2 pers with children	33,7%	36,3%	34,1%	34,3%			
	something else (incl.. Living with parents)	26,2%	19,0%	24,4%	24,4%			
Type of living area		Neutral	Negative	Positive	Total	1.210	ns	882
	I live in the capital city / area	9,9%	9,5%	9,7%	9,8%			
	I live in a large city that is not in the capital area	21,3%	20,8%	24,4%	22,0%			
	I live in a small city/town or municipality	57,3%	57,7%	55,8%	57,0%			
	I live in a rural area	11,5%	11,9%	10,1%	11,2%			
Region		Neutral	Negative	Positive	Total	3.209	ns	882
	Nord-Ovest	26,6%	23,2%	27,5%	26,2%			
	Sud	24,2%	21,4%	21,6%	23,0%			
	Isole	10,7%	12,5%	11,0%	11,1%			
	Nord-Est	18,5%	22,6%	18,3%	19,3%			
	Centro	20,0%	20,2%	21,6%	20,4%			
Diet		Neutral	Negative	Positive	Total	17.059	.002	881
	ominivore	79,0%	85,1%	70,0%	78,0%			
	meat sometimes or no red meat	11,3%	9,5%	12,9%	11,4%			
	vegetarian	9,7%	5,4%	17,1%	10,7%			
		100,0%	100,0%	100,0%	100,0%			

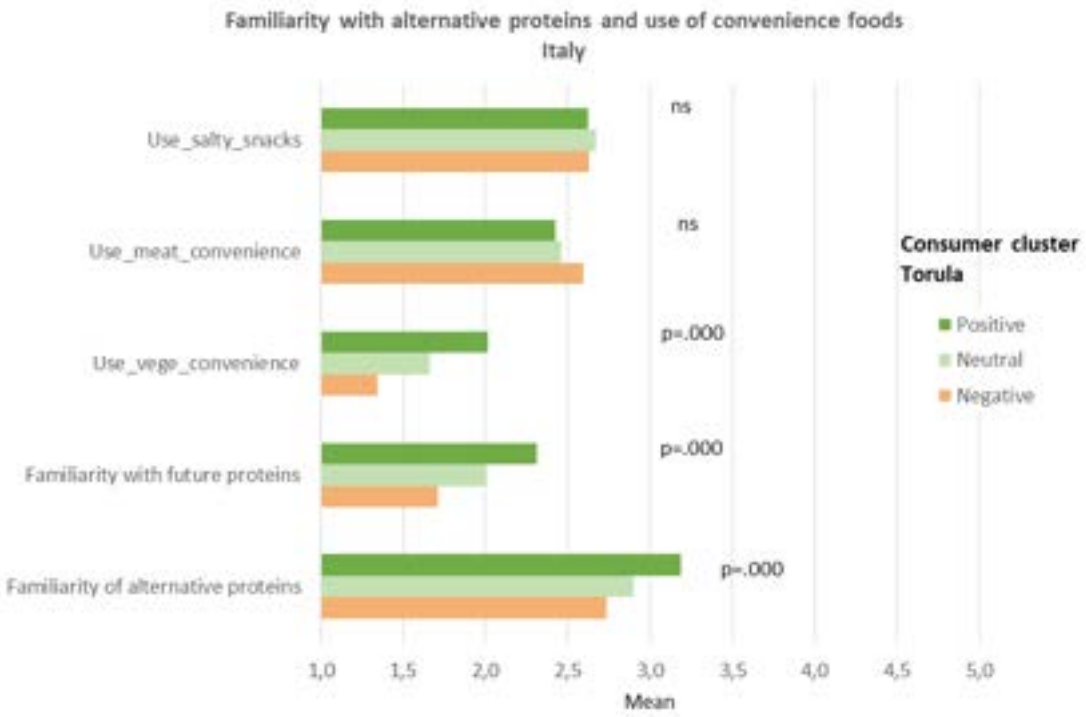


Figure 113. Familiarity with novel and alternative proteins as well as use of convenience foods by consumer clusters based on views towards NextGen Torula protein concept. Italy.

9.7.2.2 Attitudinal background of NextGen Torula consumer clusters, Italy

The attitudinal background of NextGen Torula consumer clusters is very similar to that of NextGen microalgae clusters in Italy. Compared with the Negative and Neutral clusters, the Italian consumer cluster with positive views towards NextGen **Torula** concept (Figure 114.) can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having higher trust in different actors of food chain
- having lower taste neophobia
- having less concern about the risks of food technology in general and having more positive attitudes towards food technology in general
- being less attached to meat

While in the cluster Negative, the opposite of these opinions were more likely.

In terms of what they value in their daily foods, the cluster Positive vs. Negative more typically valued:

- convenience
- healthiness
- naturalness and sustainability

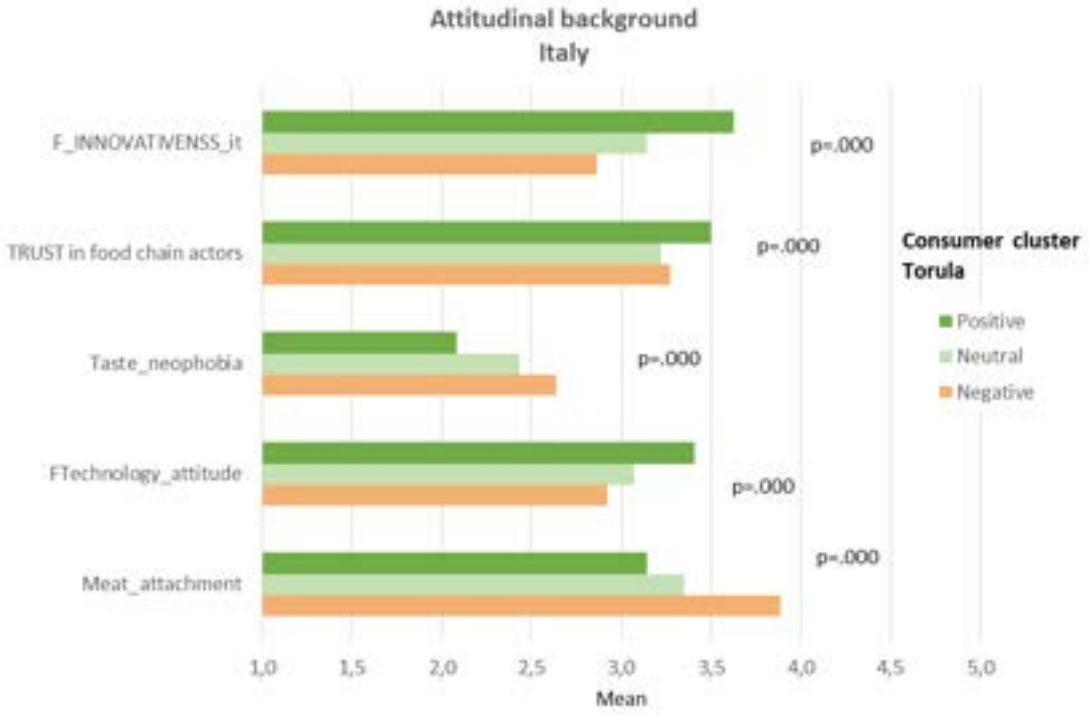


Figure 114. Attitudinal background of consumer clusters based on views towards NextGen Torula concept in Italy. (The means of all measures significantly differ between the consumer clusters with positive, neutral or negative views towards NextGen Torula at the level of p=.000.)

In terms of their food values - i.e. what is important for them in their daily food - consumers belonging to cluster Positive rated the importance of naturalness and environmentally friendliness (M_Natural_and_sust) higher than those belonging to the cluster Neutral or Negative. Figure 115.

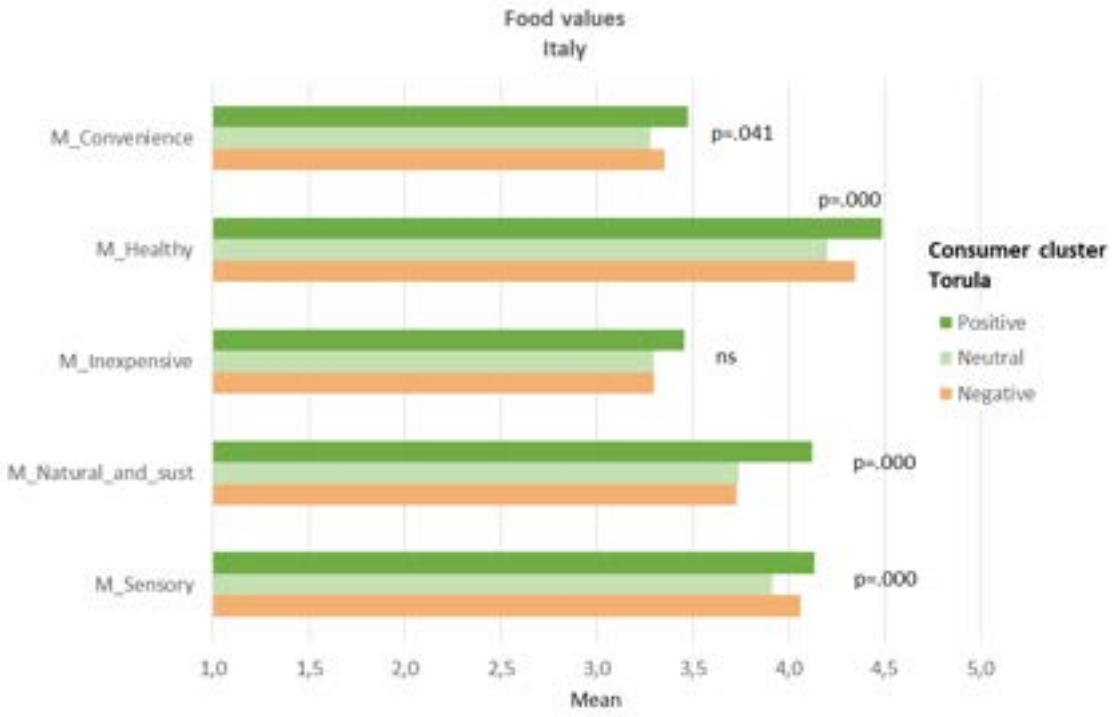


Figure 115. Food values (food choice motives) by consumer clusters based on views towards NextGen Torula protein concept. (The 'p =' refers to the level of significance of differences in means between the three clusters is marked, ns = no significant difference)

9.7.2.3 Interest to use food applications of NextGen Torula protein in the consumer clusters

Respondents' interest to use the food application examples made with NextGen Torula protein clearly follow their overall view towards the concept and idea of application: The most positive cluster has clearly higher interest to use all of the three imaginary application of NextGen Torula protein regardless of the food type (Figure 116).

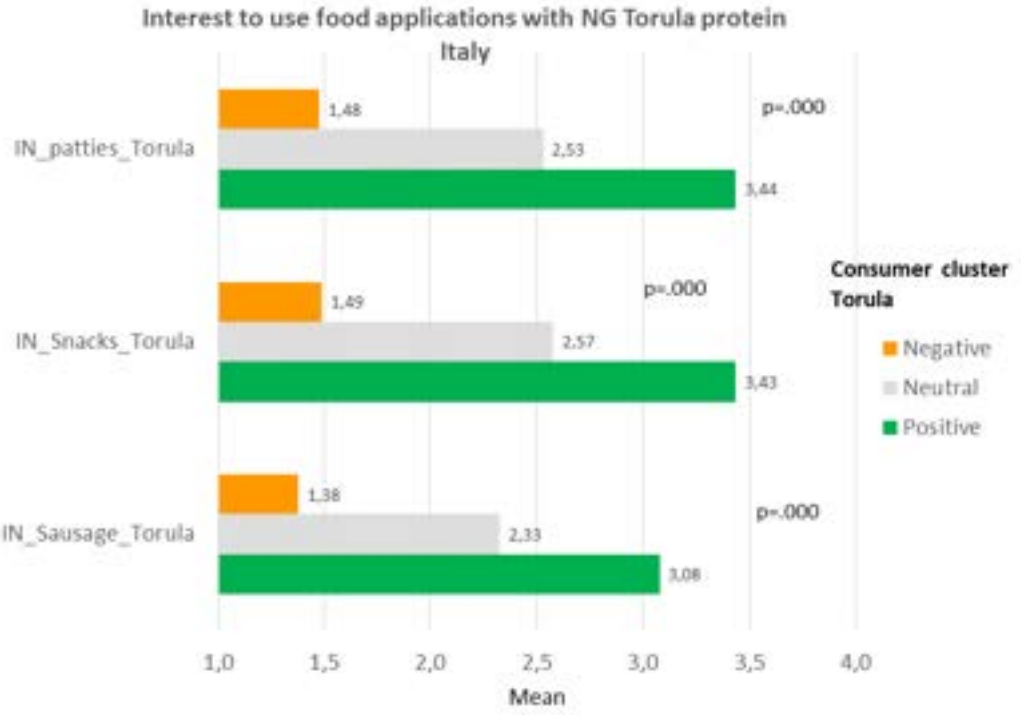


Figure 116. Mean interest to use the example foods when these contain NextGen Torula protein. Comparison of consumer clusters based on views towards NextGen Torula concept. Italy.

10 Appendix B3 – FINLAND survey report

10.1 Summary of results from Finland

The Finnish sample consisted of 1001 respondents, well distributed between different demographic groups. About 95 % of the respondents were omnivores and 5 % some form of vegetarians. Out of the omnivores, 37 % aim to reduce their meat consumption or already eat meat only occasionally. Health and sustainability were their main reasons for reduction of meat consumption, and environmental sustainability came second.

The Finns are quite familiar with conventional meat alternatives, such as legumes, about 60 % use these. Soya based alternatives (tofu) were at least occasionally used by 28.4 % and fungi based (Quorn) by 10.5 %. About 19 % had at least tested foods with insects.

Finnish respondents' trust in small food producers and primary food producers was high (around 60 % had high trust and over 70 % at least moderate trust), while 45 % had high trust in regulatory or supervising authorities and only 22 % had high trust in food industry.

About half of the Finnish respondents were in favour of the NextGen microalgae (55.7 %) and NextGen Torula concepts (48.4 %). The NextGen insect concept was less popular, supported only by 41 % of the respondents. A large share had neutral or indifferent attitude and only minority was opposing these ideas of protein production. All the applied acceptance measures pointed to the same direction: NexGen microalgae and NextGen Torula were the easiest to accept, and the NextGen insects most difficult one for the Finnish respondents. Generally, respondents believed in the benefits of these concepts, especially regarding the benefits for environment, livestock and human health. Less was believed in benefits to oneself. NextGen Torula stood out in that Finnish respondents (unlike the respondents in the other countries) associated benefits to the national economy to it more than to the other NextGen concepts. Based on the focus-group discussions in Finland (see Chapter 3) the reason for this is the use of forest-based waste material in this concept.

In this survey, we also asked respondents to rate their interest to use three examples of food applications made with either of the three NextGen proteins. For some reason, sausages were less interesting carrier product for these ingredients than were vegetable-protein patties of salty snacks. Maybe consumers who are most interested in the NextGen applications use less sausages – this needs to be analysed further.

Segmentation of Finnish consumers into clusters was carried out on the basis of how they rated the each of the three NextGen concepts. Cluster analyses yielded three clusters for the insect and four clusters for the Torula and microalgae. The **insect** consumer clusters were cluster Positive, cluster Neutral and cluster Negative. Cluster positive (31 % of the respondents) had the most positive ratings on all the acceptance measures concerning

NextGen insects (positive attitude, higher beliefs in benefits, lowest concern for risks and higher preconceptions about the quality of NextGen insect food applications), and the cluster Negative (with 18.4%) the most negative ratings. Highest share of respondents was classified into the cluster Neutral, which comprised the majority of the respondents (47.4 %). The consumer clusters for NextGen **Torula and NextGen microalgae** followed similar logic with the exception that the analysis yielded also a fourth cluster. This fourth cluster comprised of respondents who had moderately positive views, but also were a bit concerned about the risks (unlike the positive cluster). The positive clusters for microalgae and Torula comprised of 26.2 % and 24.3 %, and the cluster positive but concerned 23.9 % and 23.5 % of the respondents for microalgae and Torula, respectively. Only 14 % of the respondents were classified into the negative clusters (microalgae or Torula) – that is the great majority of consumers have to some extent positive or neutral views.

The above-mentioned consumer clusters were compared with each other in term of their background demographics, eating habits and attitudinal tendencies – separately for each of the NextGen concept.

The main results form these analyses were similar regardless of the NextGen concepts. **Finnish respondents with the most positive views towards the NextGen protein concepts** significantly differed from the other clusters or at least from the negative cluster in that they were more likely to be younger than 45 y., have tertiary level education, live in the capital area, have no children, follow either some form of vegetarian diet or restrict meat consumption. In average, they were initially more familiar with various sources of alternative proteins, as well as with emerging new proteins. Further, compared to the other, more negative clusters, they had higher food innovativeness (interest towards new emerging food products), lower taste neophobia (thus less afraid of tasting new foods overall), and more positive attitude toward the use of novel and latest technologies in food production. In addition, the consumers in clusters with the most positive views, tended to be less attached to meat and have higher trust in food chain actors. Finally, the positive and negative clusters also differed in terms of what they most value in their daily foods. For the positive clusters especially sustainable and ethical production, but also to some extent healthiness and naturalness were more important.

10.2 Participant characteristics, FI

10.2.1 Participants' demographics, Finland

The Finnish sample consists of 1001 respondents. Respondents' demographic characteristics are described in the table below (Table 38). It suggests that the respondents rather were well distributed into different demographic groups. However, the raw data as such does not quite represent the Finnish population, e.g. the share of families with children is underrepresented. In the analyses the answers were weighted to roughly represent the

country population in terms of gender, age group, household type and residential area, like in the other countries.

Table 38. Characteristics of the participants from Finland (N =1001)

	Count	Percent
Gender		
1. male	489	48.9%
2. female	508	50.8%
3. other / prefer not to say	4	0.4 %
Total	1001	100%
Agegroup		
1. 18 - 24 Years	99	9.8%
2. 25 - 34 Years	162	16.1%
3. 35 - 44 Years	181	18.1%
4. 45 - 54 Years	169	16.8%
5. 55 - 64 Years	192	19.1%
6. 65 - 75 Years	199	19.9%
Total	1001	100%
Country region		
1. Eastern Finland	103	10.3%
2. Southern Finland	440	44.0%
3. Western Finland	343	34.3%
4. Northern Finland	115	11.5%
Total	1001	100%
Type of living area		
1. I live in the capital city / area	227	22.7%
2. I live in a large city that is not in the capital area	240	24.0%
3. I live in a small city/town or municipality	250	25.0%
4. I live in a rural area	284	28.3%
Total	1001	100%
Education		
1. Basic education or lower	97	9.7%
2. Upper secondary vocational qualification	282	28.2%
3. Upper secondary degree (high school)	107	10.7%
4. Tertiary degree or vocational qualification (college)	157	15.6%
5. First stage of tertiary education (univ. of applied sciences)	166	16.6%
6. Tertiary education. university. bachelor degree	66	6.6%
7. Tertiary education. university. master's degree or higher (MA/MSc. PhD. MD)	120	12.0%
8. Other / I do not know	6	0.6%
Total	1001	100%
Household type		
1. I live at home with my parents	35	3.5%
2. I live alone	349	34.9%
3. I live alone with my child / children	43	4.3%
4. I live with my spouse	369	36.9%
5. I live with my spouse and child / children	190	19.0%
6. I live with other adults (other than spouse or family members)	8	0.8%
7. Other	5	0.5%
8. Prefer not to say	1	0.1%
Total	1001	100%
Household_3		
no children (options 2 and 4)	714	71.8%
with children (options 3 and 5)	236	23.7%
other	44	4.4%
Total	994	100%

10.2.2 Participants' dietary habits and attitudinal background, Finland

The large majority (79.5 %) of the Finnish participants were omnivores who eat meat regularly, while 14.6 % restrict their meat consumption either by avoiding red meat or eating meat only occasionally. **Only 4.8 % of this sample follow some form of vegetarian diet.** Table 39.

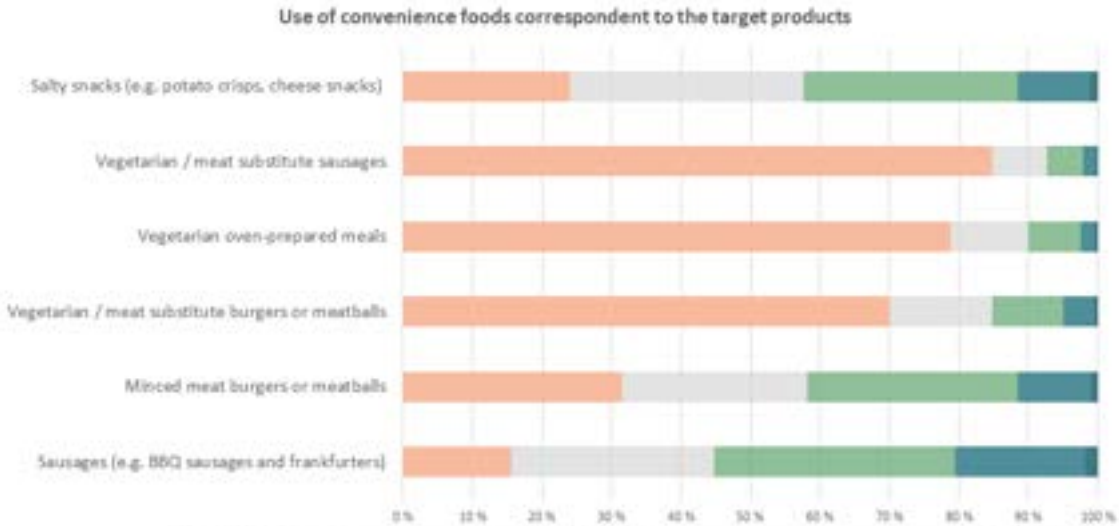
Out of the omnivorous (diet 1 or 2), **31.5 % indicate that they intentionally aim to reduce their meat consumption.** The most important reasons they had for this meat avoidance relate to their own health and well- being and secondly to environmental sustainability. Vegetarians and meat reducers and those indicating intention to reduce meat consumption taken together, these results suggest that only around 50.8 % of Finnish respondents were to some extent interested in obtaining more of their protein from other sources than mammal or poultry **meat.** This is less compared to e.g. the 60 % in UK and Italy. The result may be partially explained by the low share of the Finnish respondents living in the capital area. The share of vegetarians in this sample was higher in the capital area compared to the total sample (8.5 % vs. 4.9 % in the total sample).

Table 39. Dietary habits of respondents in Finland.

Dietary habits		
1. I regularly eat products of animal origin and non-animal origin (omnivorous)	795	79.5%
2. I only eat meat sometimes (e.g. beef. pork. poultry. fish. seafood)	56	5.6%
3. I avoid red meat consumption (e.g. beef or pork). but eat other meat products like chicken or fish	90	9.0%
4. I do not eat meat (e.g. beef. pork or poultry). but I eat fish (I'm a pesco-vegetarian)	15	1.5%
5. I do not eat meat (e.g. beef. pork. poultry or fish). but I eat other products of animal origin (e.g. eggs. cheese. milk	18	1.8%
6. I do not eat any meat. eggs or dairy products (I'm a vegetarian)	3	0.3%
7. I do not eat anything of animal origin (I'm a vegan)	12	1.2%
8. Other	12	1.2 %
Total	1001	100%
Diet_3		
1. Omnivore		80.5 %
2. Meat sometimes or no red meat		14.7%
3. Vegetarian (all kinds)		4.9%
Total	989	100%
Do you intentionally aim to reduce meat consumption (question was only targeted to those who eat meat: options 1 – 2 above)		
1. Yes	267	31.3%
2. No	585	68.7%
Total	851	100%
Reasons for reducing meat consumption (1. most important).		
1. Environmental sustainability. climate change	73	7.3%
2. Ethics. animal welfare	74	7.3%
3. My health and well-being	212	21.2%
4. High price of meat	14	1.4%
5. Taste and texture of meat	29	2.9%
6. Other. specify:	3	0.3%
Reasons for reducing meat consumption (2. most important).		
1. Environmental sustainability. climate change	160	16.0%
2. Ethics. animal welfare	91	9.0%
3. My health and well-being	62	6.2%

4.	High price of meat	46	4.6%
5.	Taste and texture of meat	44	4.4%
6.	Other. specify:	2	0.2%

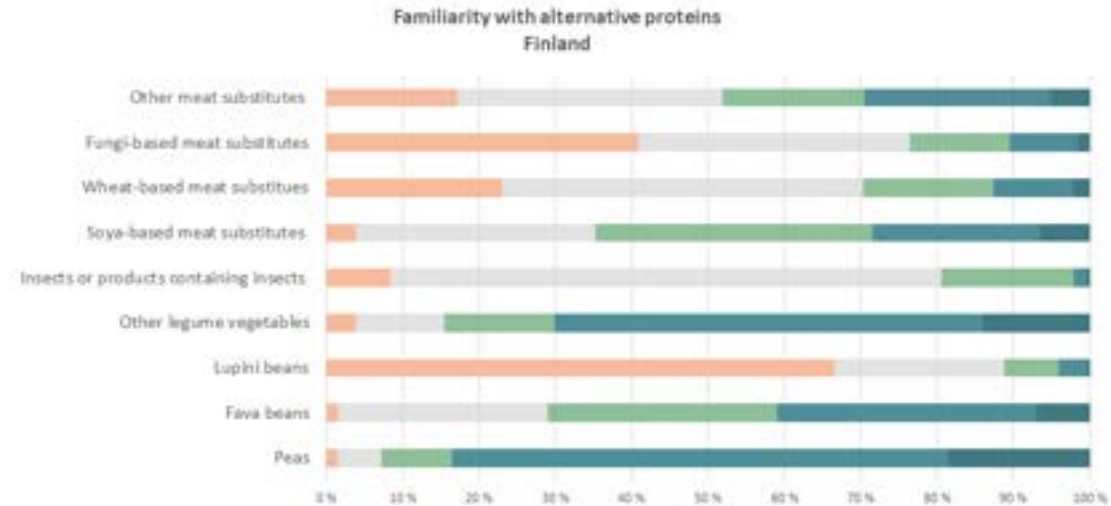
The share of respondents who use vegetarian convenience foods at least weekly is roughly similar to the share of vegetarians. Figure 117.



	Sausages (e.g. BBQ sausages and frankfurters)	Minced meat burgers or meatballs	Vegetarian / meat substitute burgers or meatballs	Vegetarian oven-prepared meals	Vegetarian / meat substitute sausages	Salty snacks (e.g. potato crisps, cheese snacks)
Rarely or never	15,6%	31,5%	70,0%	78,9%	84,7%	24,0%
Several times a year	29,2%	26,7%	14,8%	11,1%	8,0%	33,6%
1-3 times per month	34,7%	30,3%	10,3%	7,5%	5,1%	30,8%
Weekly	18,7%	10,4%	4,5%	2,0%	1,8%	10,4%
More than once a week	1,7%	1,0%	0,4%	0,5%	0,3%	1,1%

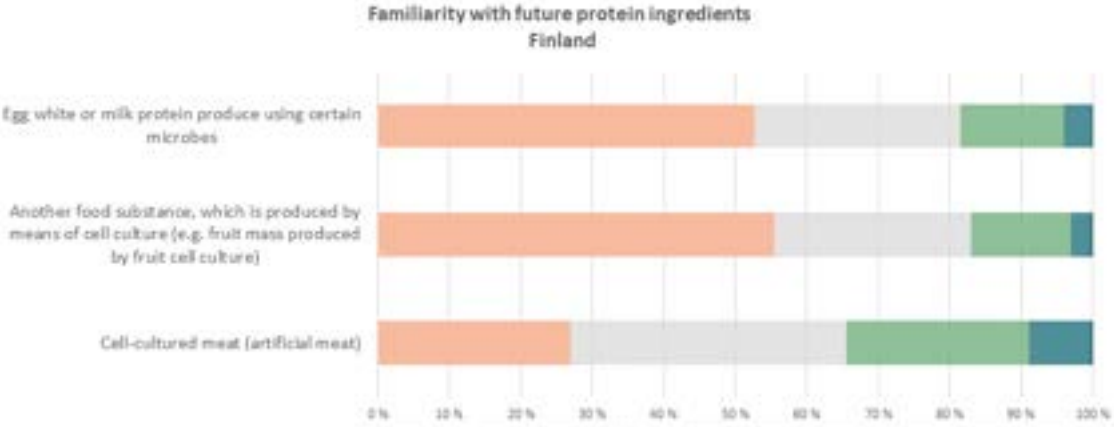
Figure 117. Use of certain convenience foods. Finland.

The respondents were asked to rate their familiarity with various proteins sources other than animal based. Like in the other countries, the Finnish respondents are well familiar with conventional legumes such as peas and beans. Fava beans were also familiar to many Finns. As much as 71 % claim they have at least tasted Fava beans. Soy and wheat -based protein were also well recognised but used only by 28.4 % (soy) and 12.6% (wheat) of respondents at least occasionally. Fungi based products (such as Quorn) were clearly the most unfamiliar type of these foods. Even 40.8 % had not even heard about those before. While most of the Finnish respondents had heard about insect-based protein products, but only minority (19%) had tasted it. (Figure 118.)



	Peas	Fava beans	Lupini beans	Other legume vegetables	Insects or products containing insects	Soya-based meat substitutes	Wheat-based meat substitutes	Fungi-based meat substitutes	Other meat substitutes
I have not heard of these	1,4%	1,6%	66,4%	3,8%	8,5%	3,8%	23,1%	40,8%	17,1%
I have heard of these, but I have not tried them	5,9%	27,4%	22,4%	11,7%	72,1%	31,5%	47,3%	35,6%	34,8%
I have tried these, but I do not use them	9,3%	30,1%	7,1%	14,5%	17,4%	36,3%	17,1%	13,1%	18,6%
I eat these occasionally	64,9%	33,9%	3,9%	56,1%	1,6%	21,9%	10,4%	8,8%	24,3%
I eat these often	18,5%	7,0%	0,2%	14,0%	0,4%	6,5%	2,2%	1,7%	5,2%

Figure 118. Finnish respondents' previous familiarity with alternative protein sources



	Cell-cultured meat (artificial meat)	Another food substance, which is produced by means of cell culture (e.g. fruit mass produced by fruit cell culture)	Egg white or milk protein produce using certain microbes
I have never heard of them	27,0%	55,4%	52,6%
I have heard of them but I don't know anything about it	38,5%	27,6%	28,9%
I have an understanding of what this is	25,6%	14,0%	14,5%
This is rather familiar to me (e.g. I have read articles about it)	8,5%	2,6%	3,8%
I know quite a lot about the subject	0,4%	0,4%	0,2%

Figure 119. Finnish respondents' familiarity with future or emerging protein sources

Figure 120 describes Finnish respondents' answers to question Q6 about how important various criteria are for them in their daily foods. The overall result is typical: taste and other sensory quality characteristics were rated as important by most respondents, followed by healthiness and naturalness.

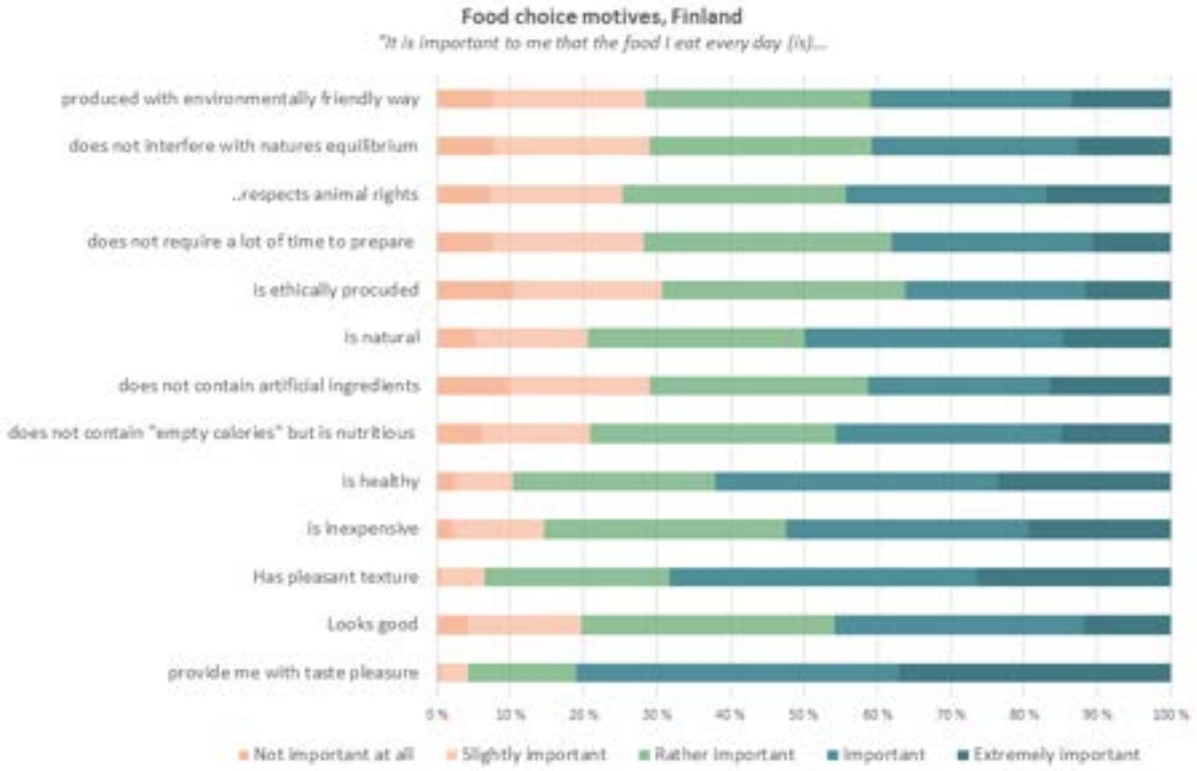
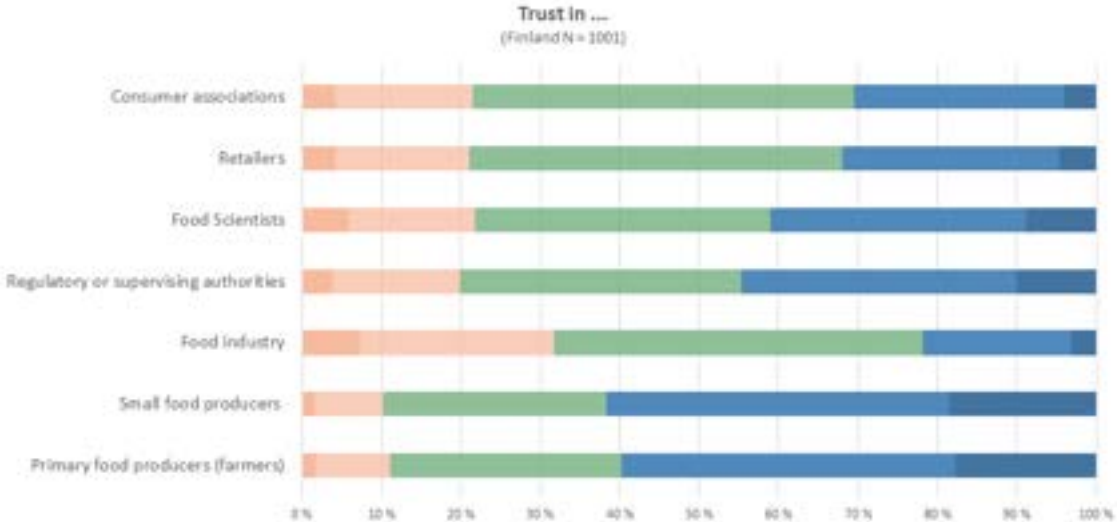


Figure 120. perceived importance of food choice motives. Percentages of Finnish respondents' answers for each answer alternative. Finland.

Nearly 90 % of the Finnish respondents had at least moderate trust in small food producers and farmers. Trust in the larger food industry is lowest, still 68 % had at least moderate trust in them. Figure 121.



	Primary food producers (farmers)	Small food producers	Food industry	Regulatory or supervising authorities	Food Scientists	Retailers	Consumer associations
Don't trust at all or have very little trust	1,8	1,6	7,3	3,8	5,9	4,2	4,2
Have some trust	9,4	8,6	24,5	18,1	15,9	16,8	17,3
Have a moderate amount of trust	29,0	28,2	46,4	35,4	37,2	47,0	48,0
Have a lot of trust	42,1	43,1	18,7	34,6	32,2	27,2	26,4
Have very much trust	17,7	18,5	3,1	10,0	8,8	4,8	4,0

Figure 121. Trust in food choice actors by respondents in Finland.

10.3 Forming the composite variables for further analyses, FI

Composite variables were formed as means of items, which measured the same dimension based on these analyses in addition to the theory. For more details about the questions see the questionnaire in Appendix A.

10.3.1 New variables describing respondents background attitudes

Factor analyses (principal axis factoring, varimax rotation) were performed to check the dimensionality of items for each scale. Meat attachment (Q7) loaded on one factor, like they were expected to do based on the theoretical source of the measure. In the case of the items measuring Food technology attitudes (Q9) the analysis yielded two factors with eigenvalues over 1. As the two dimensions of Food technology attitude represented opposite views: negative vs. positive and using these distinct variables did not increase understanding compared to the analysis using one composite variable, we decided to apply one composite variable. That is, the measures of Meat_attachment and F_innovativeness were applied.

Table 40. Variables to describe respondents' background attitudes. Composite variables computed as means of items measuring given dimension.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.81
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	.85
Trust in food actors	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	
FTechnology_attitude	Attitude towards new food technology	Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9R7_REV, Q9r1, Q9r4, Q9r5	.82
Meat_attachment	Attachment to meat eating	Q7r1, Q7r2, Q7r4, Q7r5, Q7r3_REV, Q7r8_REV (note Q7r6 and Q7r7 are omitted because of illogical correlations)	.90
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.92
F_innovativeness	Food innovativeness (interest in new food products)	Q11r1_REV, Q11r2, Q11r3, Q11r4	.79
Use_vege_convenience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.82
Use_meat_convenience	Mean frequency of use of meat based convenience foods	Q5r1, Q5r2	.74

Table 41. New variables to describe Finnish respondents' food values.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
M_Sensory	Good sensory characteristics	Q6r1, Q6r2, Q6r3	
M_Healthy_natural	Healthiness and naturalness	Q6r5 – Q6r8	
M_Environment_ethics	Produced in ethical and environmentally friendly way	Q6r9, Q6r11 - 13	
M_conv_price	Is inexpensive and does not require much time to prepare	Q6r4, Q6r10	

10.3.2 New variables measuring acceptance of the three NextGen concepts, FI

New variables were formed to reflect positivity or negativity of respondents' ***attitude*** towards each of the three NextGen concepts. In addition, composite variables were formed to measure respondents' beliefs in ***benefits*** of each of the NextGen concept as well as to indicate the strength of respondents' concern about potential ***risks*** of the NextGen concepts. All the resulting variables had high internal reliabilities. Finally, also respondents' ratings (views or pre-assumptions) about the characteristics of food products made using each of the NextGen ingredient were averaged for each Nextgen concept to form a composite measure of how positively or negatively NextGen microalgae, NextGen insect and NextGen Torula based food application are viewed. The latter are subsequently called ***food application views***. (Table 42).

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" were not included in the analyses, which apply these variables.

Table 42. Composite variables measuring acceptance, their contents and reliabilities (Finland). The measurement scale for all the listed composite variables is 1 – 5. Finland.

Composite variables	Explanation	Cronbach Alpha
ATTITUDES		
ATT_Algae	Attitude towards NextGen microalgae protein *(mean of items Q12r1, Q12r2, Q12r4)*	.93
ATT_Insect	Attitude towards NextGen insect protein *(mean of items Q17r1, Q17r2, Q17r4)*	.94
ATT_Torula	Attitude towards NextGen Torula protein *(mean of items Q22r1, Q22r2, Q22r4)*	.91
PERCEIVED BENEFITS	*mean of all 5 items*	
BENEFIT_Algae	Likelihood of benefits from NextGen microalgae protein *(mean of items Q13r1 – Q13r5)*	.92
BENEFIT_Insects	Likelihood of benefits from NextGen insect protein *(mean of items Q18r1 – Q18r5)*	.90
BENEFIT_Torula	Likelihood of benefits from NextGen Torula protein *(mean of items Q23r1 – Q23r5)*	.91
PERCEIVED RISKS	*mean of 3 items, "other risk" not included*	
RISK_Algae	Concern about risks relating to production of NextGen microalgae proteins *(mean of items Q14r1-Q14r3)*	.86
RISK_Insects	Concern about risks relating to production of NextGen insect proteins *(mean of items Q19r1-Q19r3)*	.87
RISK_Torula	Concern about risks relating to production of NextGen Torula proteins *(mean of items Q24r1-Q24r3)*	.88
FOOD APPLICATION VIEWS	*mean of all the 7 items*	
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein *(mean of items Q15r1-Q15r7)*	.93
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein *(mean of items Q20r1-Q20r7)*	.92
FOODVIEWS_Torula	Views towards foods made with NextGen Torula protein *(mean of items Q25r1-Q25r7)*	.93

10.4 Comparison of the three NextGen protein production concepts and applications in Finland

10.4.1 Which of theNextGen ingredients is most positively viewed in Finland?

All the (composite variables of) acceptance measures suggest – like in the other countries – that the NextGen concept of Microalgae protein was easiest to accept followed by Torula concept, and the NextGen insect protein was the most difficult to accept.

Compared to the other two NextGen concepts, Finnish respondents believed least in the benefits of the insect concept and were more concerned about the risks related to it. Although, the level of risk concern was not that different between the concepts – given the large sample size - it was statistically significant. In the same line, Finnish consumers had in average more positive preconceptions about the food applications of NextGen microalgae protein (Foodviews), and least positive about the applications of NextGen insect protein. All the differences in means between the NextGen concepts were statistically significant (Table 43).

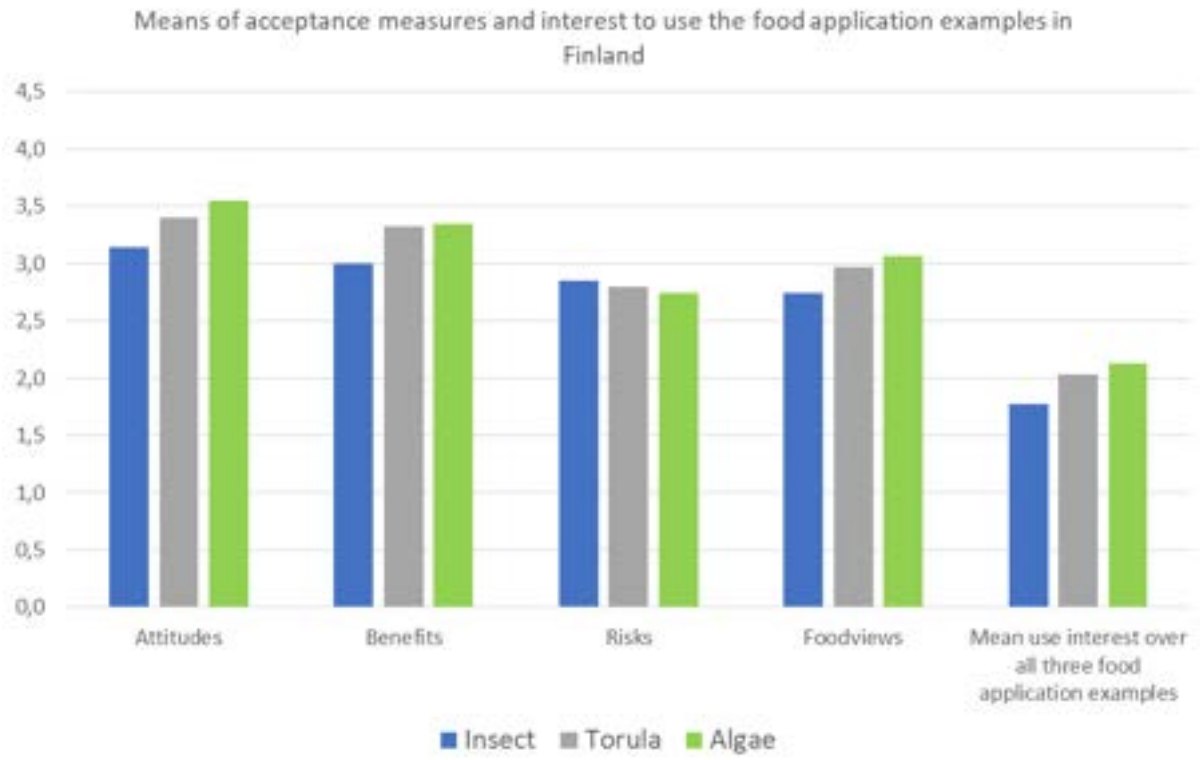


Figure 122. Comparison of mean attitudes. perceived benefits and risks. expected food characteristics if foods would be made with the NextGen ingredients (food views) as well as mean interest to use the three food application examples in Finland. The scale for the variables ranges from 1 = most negative to 5 =most positive. except for the use interest. which ranges from 1 to 4.

Table 43. Comparison of means of acceptance ratings (composite variables) between the three Nextgen protein concepts. Significance of difference tested with repeated measures analysis of variance. Finland.

	Insect	Torula	Algae	df	F	Sig.
Attitudes (scale 1 – 5)	3.14	3.40	3.55	2	79.954	0.000
Benefits (scale 1 – 5)	3.01	3.33	3.34	2	108.551	0.000
Risks (scale 1 – 5)	2.85	2.80	2.74	2	7.706	0.000
Food views (scale 1 – 5)	2.74	2.97	3.06	2	92.877	0.000
Mean use interest over all three food application examples (scale 1 – 4)	1.77	2.04	2.12	2	133.012	0.000

The Figure 123 shows respondents' mean answers to questions about preconceptions they might have about the food application of the NextGen concepts (Q15, Q20, Q25) . The **insect-based food application** stands out from the others. Respondents' imagined insect based food applications as more **repulsive** more **weird, worse tasting, and more unhygienic**, but slightly **more natural** in comparison to the other two NextGen ingredients (Figure 123). All the means of food views significantly differed between the three NextGen concepts (Table 44). Still respondents had quite similar notions about the quality and safety of the foods whether Torula or microalgae -based ingredient would be used.

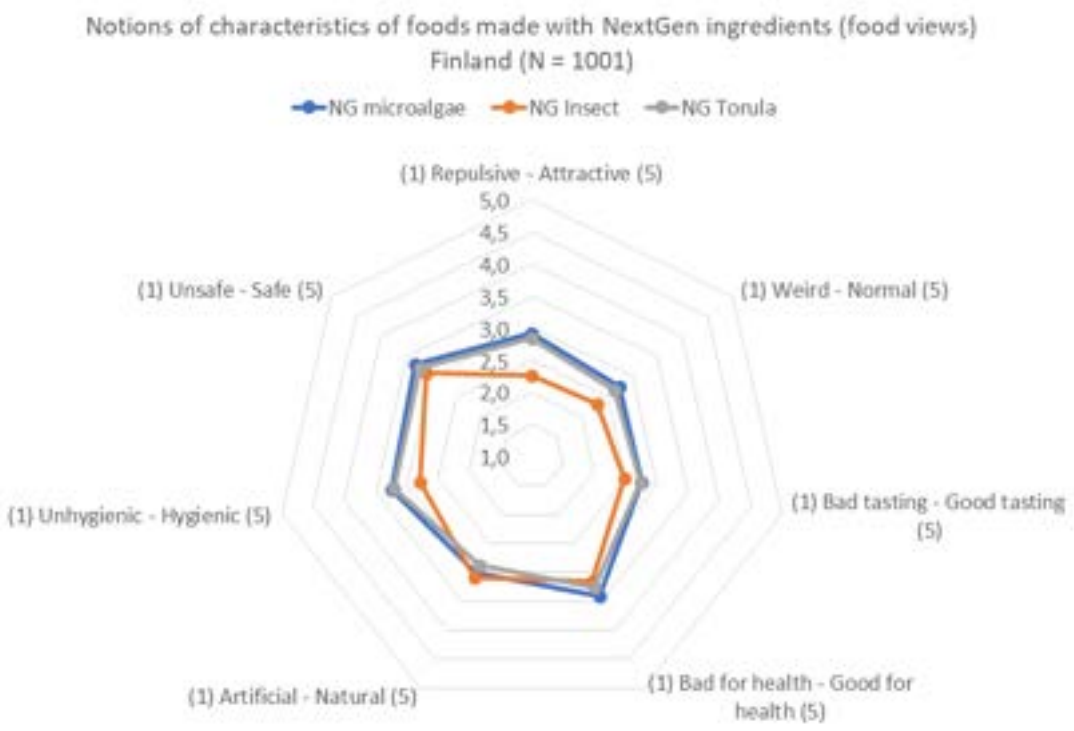


Figure 123. Means of respondents' Food views, i.e. their preconceptions about the characteristics of (imaginary) foods made using the NextGen ingredients. (The questions Q15, Q20 and Q25 in the survey: "In my opinion food products containing ____ protein seem to me as…".). Finland.

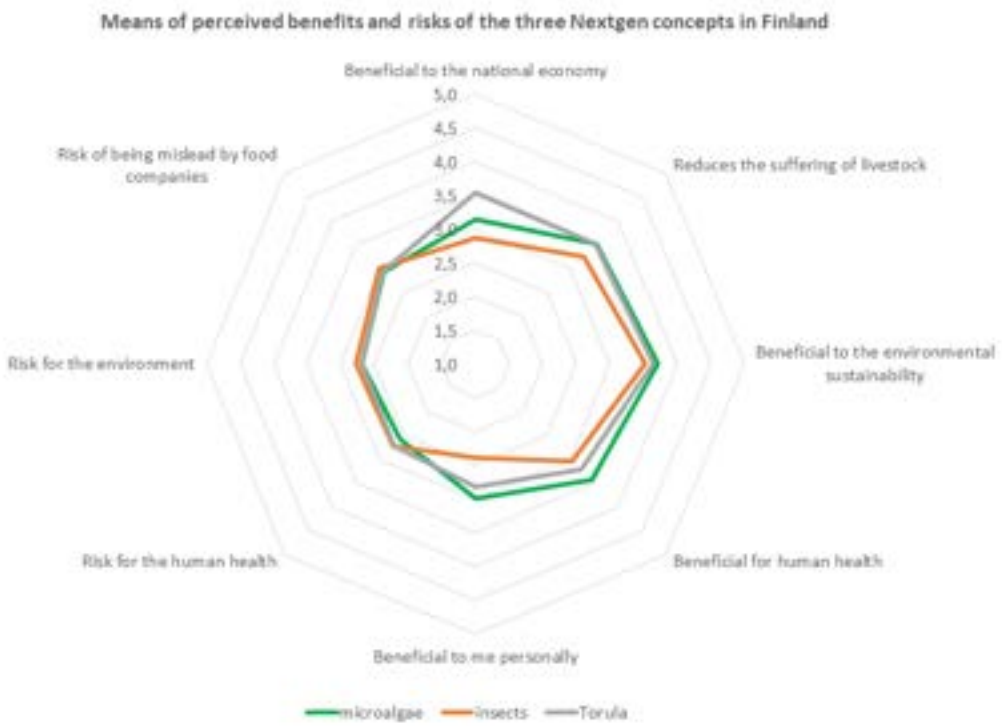


Figure 124. Means of respondents' evaluations of benefits and risks related to each of the three NextGen concepts. Finland.

Table 44. Means of food views and statistical significance of differenced in means between the three NextGen ingredient (repeated measures analyses of variance)

	Algae	Insect	Torula	df	F	Sig.
Repulsive – Attractive	2.929	2.257	2.839	2	197.506	.000
Weird - Normal	2.751	2.311	2.655	2	81.206	.000
Bad – good tasting	2.761	2.485	2.739	2	45.689	.000
Bad - good for health	3.421	3.165	3.255	2	39.201	.000
Artificial – Natural	3.000	3.084	2.873	2	16.774	.000
Unhygienic – Hygienic	3.252	2.786	3.203	2	116.131	.000
Unsafe - Safe	3.326	3.103	3.226	2	23.102	.000

10.4.2 What is the most interesting food application of NextGen in Finland?

Food application of NextGen protein in was **easiest to accept in the form of snacks** and most difficult to accept in the form of sausages regardless of the ingredient *(repeated measures analysis of variance comparing the means of the three NextGen ingredients and three food examples. main effect for WS factor "product" F(2)=105.336. p < .000).* Out of the NextGen ingredients. microalgae was most interesting and insects clearly the least interesting (*main effect for "ingredient" F(2)=134.348. p < .000)*. Thus. the least interesting food application would be sausages with NextGen insect ingredient while patties and snacks either withNextGen microalgae or with Torula were of more interest *(interaction of food type and ingredient type was significant F(4)=14.945. p < .000).*

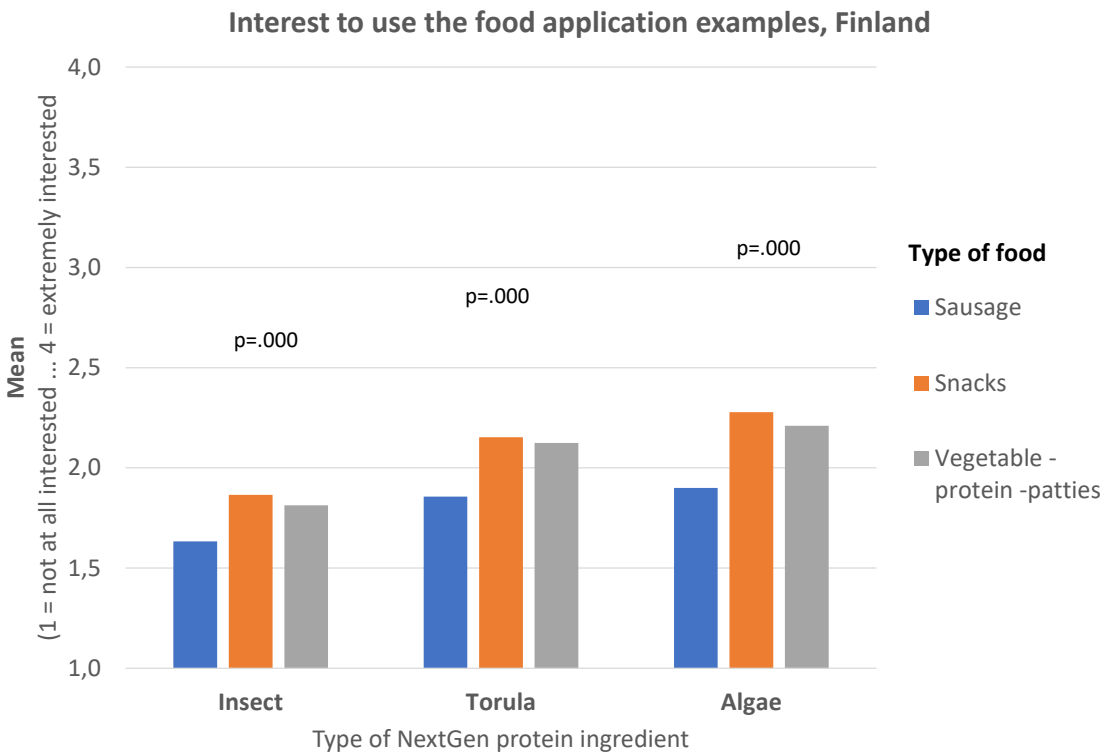


Figure 125. Means of Finnish consumers' interest to use the examples of NextGen food applications by food product type and NextGen ingredient type. Significance of differences within each ingredient and between the food types is marked.

10.5 Acceptance of NextGen Microalgae protein, Finland

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen microalgae concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen microalgae method and foods.

10.5.1 The level of acceptance of NextGen microalgae protein concept, Finland

This chapter presents the percentage distributions of answers to each individual survey question measuring acceptance towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

Over half of the Finnish respondents were generally in favour of the idea production of NextGen microalgae protein to be applied in foods (55.7 %). The share of respondents with neutral opinions was large, close to 30 %, as expected because of the novelty of the idea.

Only 17 % were against the idea. Almost 30 % of the Finnish respondents felt that the concept was in some way “difficult to understand”. Figure 126.

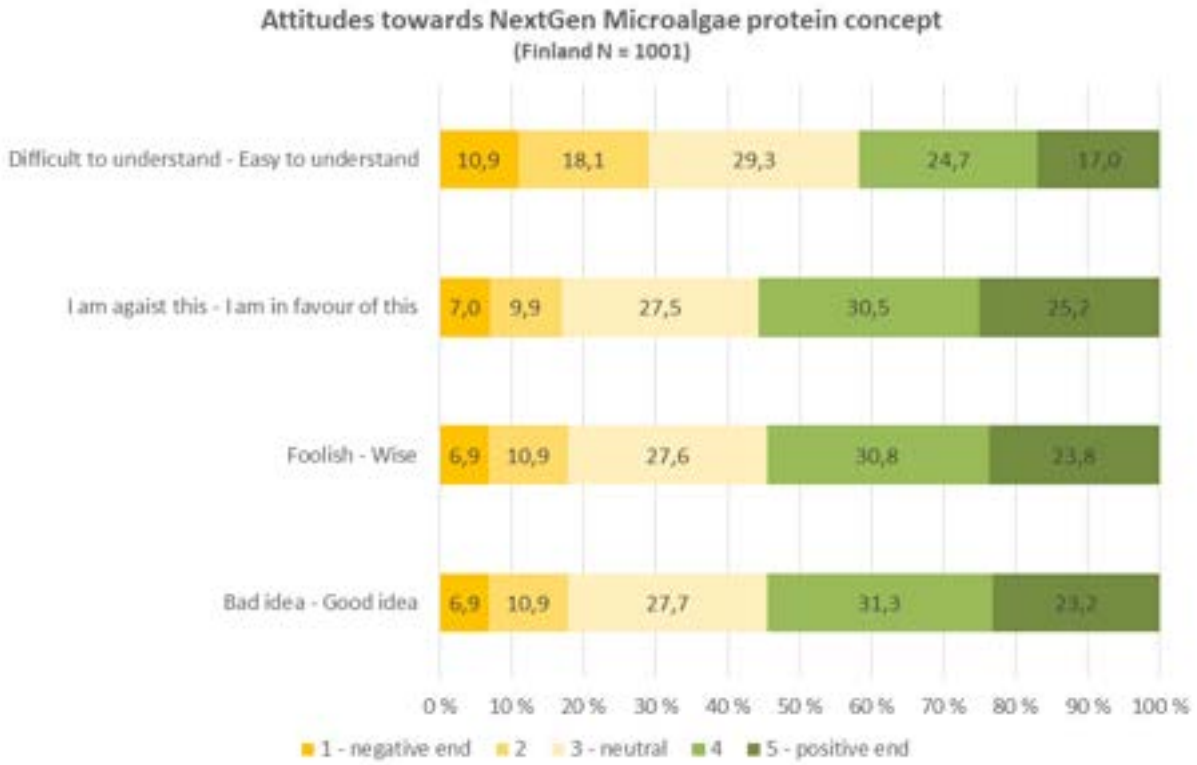


Figure 126. Attitudes towards NextGen microalgae protein concept (Finland). Answers to individual question items. Percentage of respondents. Finland.

Around half (53.7 %) of the respondents believed in that production of NextGen microalgae protein and its’ application in food would result in benefits for the environmental sustainability. It was also believed to bring better life for the production animals. However, only a minority believed in benefits for human health (31%), or even less so in personal benefits (20,.2 %)(Figure 127.). It is good to remember, that they were provided information about the potential benefits before answering the questions, see Figure 10 - Figure 12.

Answers to the questions about risk concerns suggest that may felt they don’t know what to think about the potential risks: Around 40 % of respondents answered either “cannot say” or ticked the middle alternative. The most prevalent (27.1 %) worry was about the risk of being misled by the food companies, which was however clearly lower than e.g. the 40 % in Uk and Italy. Figure 128.

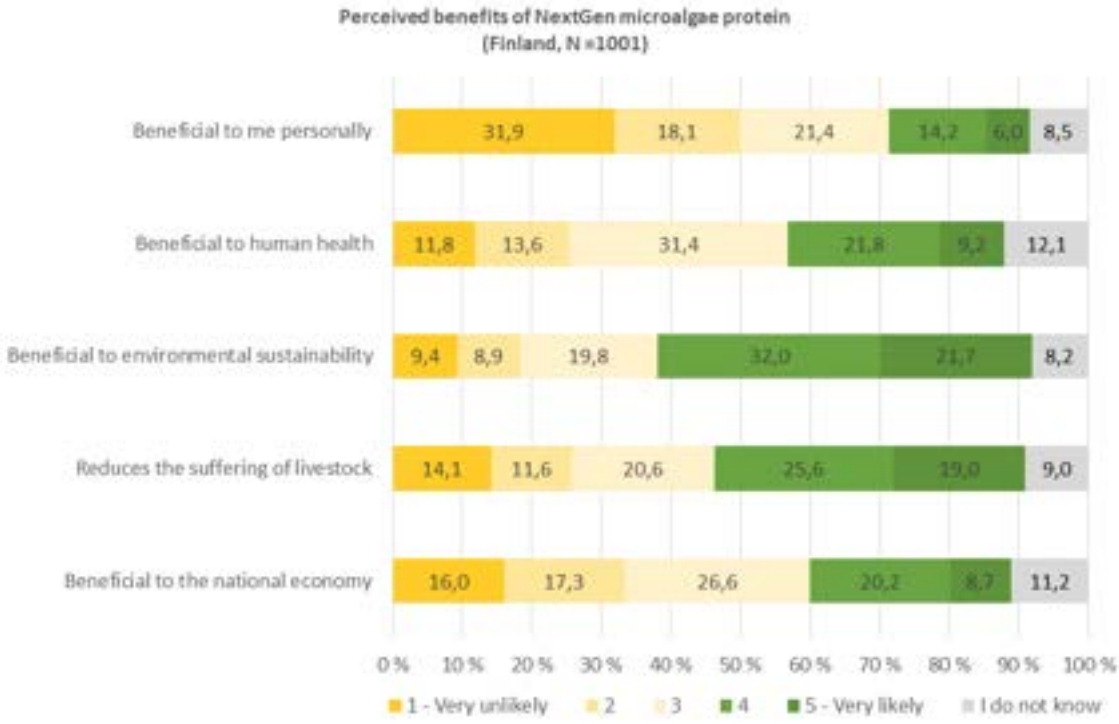


Figure 127. Perceived benefits of the NextGen microalgae protein concept. Finland.

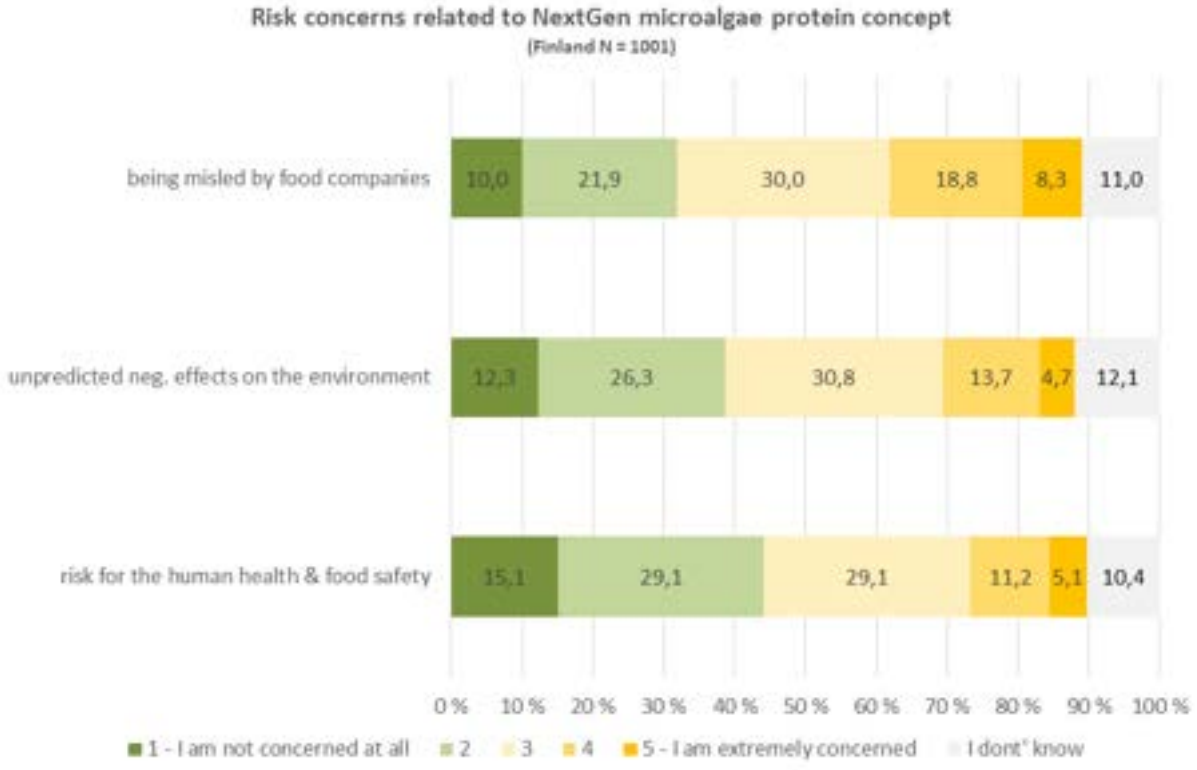


Figure 128. Perceived risks of the NextGen microalgae protein concept. Finland.

As the food applications made with NextGen microalgae are not in the market yet, it is natural that the respondents feel they cannot evaluate the characteristics of these foods: Very large share of respondents selected the middlemost alternative, thus indicating that

they do not have any clear expectation about the characteristics of these foods (Figure 129). However, it is noteworthy that clear negative preconceptions were not held by many.

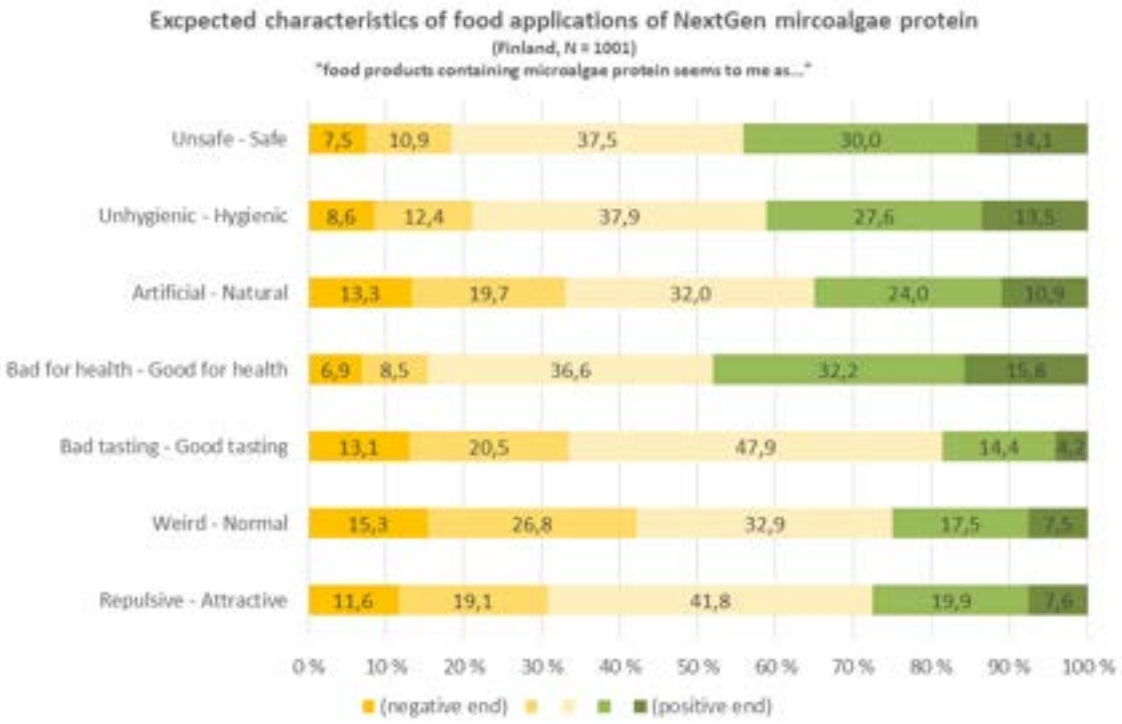


Figure 129. Characteristics associated with (imaginary) foods containing NextGen microalgae protein n Finland. Percentages of respondents. (Semantic differential scales have been used. where the number 1 always stand for the negative end of the scale on the left (e.g. unsafe) and number 5 the positive end of the scale on the right (e.g. safe). Shares of respondents for each answer alternative.) Finland.

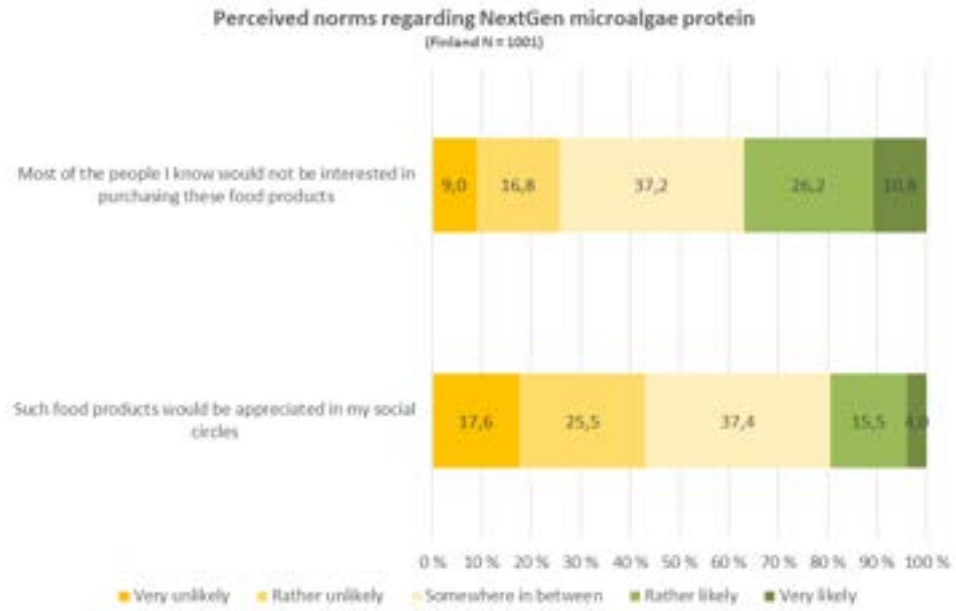


Figure 130. Perceived social norms regarding NextGen microalgae protein food products. Finland.

Interestingly, respondents expected their social environment appreciate these foods less than what they themselves did (e.g. based on their attitude and use interest ratings.) . These

measures of subjective norm were not applied in further analyses, because of apparently being misunderstood by part of the respondents.

Out of the three food applications presented as examples of NextGen microalgae applications, the snacks (39%) and patties made with vegetables and microalgae protein (36.7%) were found interesting by greater share of the Finnish respondents than the sausage application (24.7 %).Figure 131.

For the sake of comparison, use interests of the conventional food products of correspondent type, can be seen in Figure 132.

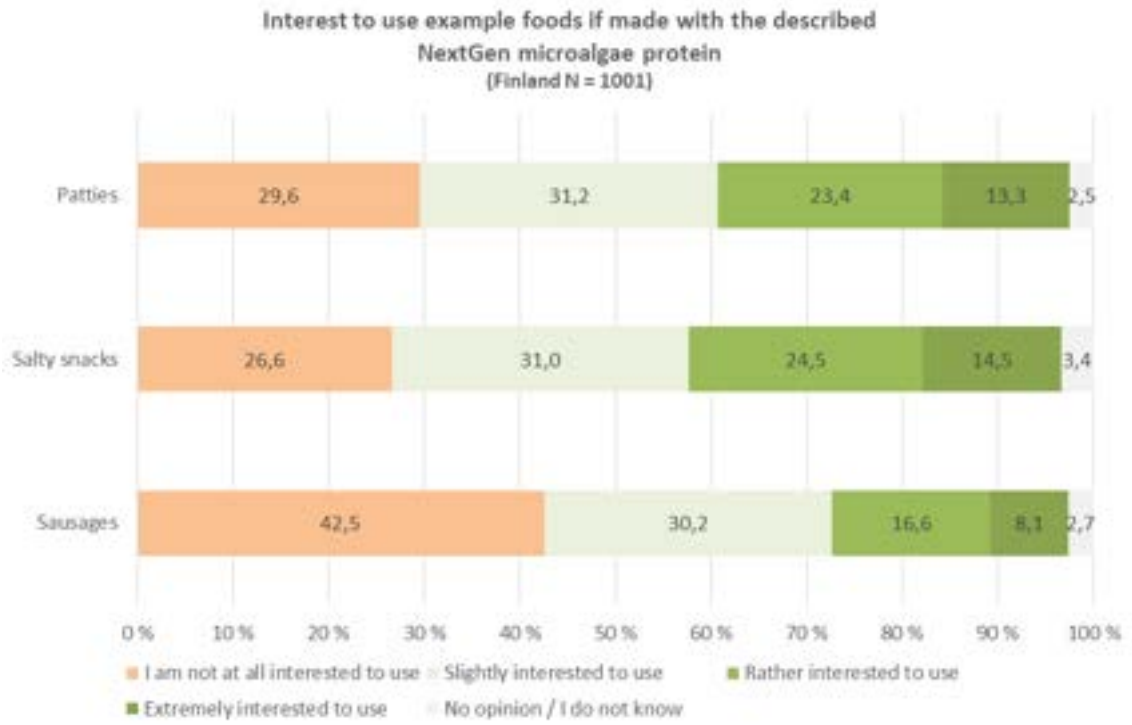


Figure 131. Interest to use the food application examples of NextGen microalgae protein. Finland.

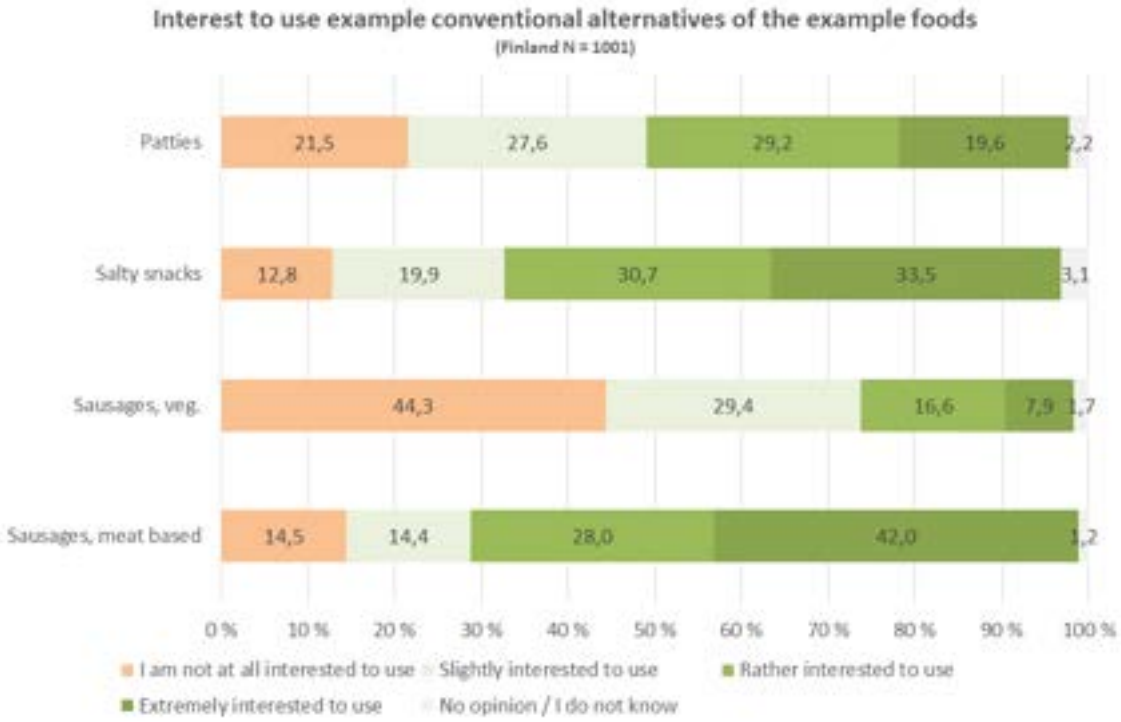


Figure 132. Interest to use conventional counterparts of the example foods. Finland

The interest to use vegetable – protein patties made with NextGen microalgae protein was at the same level than interest to use conventional vegetarian patties. As these two had correlation of r =.55 it suggests that it is often the same people who now use vegetarian sausages, who were interested in NextGen microalgae version of these (correlation with use interest of conventional sausages is .37)

10.5.2 Consumer clusters based on the ratings of the NextGen microalgae concept, Finland

Based on variables ATT_Algae. Benefit_Algae, Risks_Algae and Foodviews_Algae (cf. Chapter 9.3.) the Finnish respondents were clustered into segments reflecting their views towards the Next Gen microalgae concept.

The cluster analyses were performed as described in the method section (4.2.3.1). The dendrograms form hierarchical cluster analyses did not provide a unified suggestion about the number of clusters. K-means cluster analyses were run with 2. 3. 4 and 5 cluster, and as 4 cluster solution was interpretatively logical and most informative, that was chosen. E.g. further number of clusters would not have provided any additional information, and three cluster solution would not have revealed the cluster 2. which had positive views, but was moderately concerned about risks, while the cluster 3 (positive) had positive attitudes. and was least concerned about the risks.

Table 45. Distribution of respondents into the consumer clusters of NextGen microalgae concept and means of acceptance measures (which were used as basis of clustering) these clusters.

Cluster >	Negative	Positive but concerned	Positive	Neutral	Total	F	Sig.
Number of cases in each cluster	128	221	242	334	925		
Percent of cases in each cluster	13.8 %	23.9 %	26.2 %	36.1 %	100 %		
Variables applied as the basis of clustering							
ATT_Algae	1.92	4.19	4.63	3.12	3.60	823.050	.000
FOODVIEWS_Algae	1.68	3.39	3.98	2.81	3.10	551.602	.000
BENEFIT_Algae	1.65	3.92	4.26	3.06	3.38	680.672	.000
RISK_Algae	3.63	3.25	1.71	2.82	2.74	279.638	.000

The clusters were named based on their means on the clustering variables. **The first cluster** will be called **Negative** as respondents in this cluster had the most negative attitude towards NextGen microalgae protein concept consist of 14 % of the respondents. They had lowest beliefs in the benefits of it, lowest expectations about the quality of food application and they were most concerned about risks related to this concept. The second cluster includes 26 % of the respondents and was called **Positive, but concerned.** They had relatively positive attitudes and higher beliefs in benefits, but they were also moderately concerned about potential risks of the method and about the quality of the food applications. **The third cluster** is called **Positive** (26 % of the respondents), as it had the most positive responses on all the scales – they believed most in benefits and were least concerned about risks. **The fourth** and the largest cluster is called **Neutral**, because all the ratings of this group were at average level compared to the other clusters. About 36 % of the respondents were classified into this cluster.

10.5.2.1 Demographic profile and eating habits of NextGen microalgae consumer clusters, Finland

The demographic profiles of the four clusters are described in Table 45. The following list summarises the characteristics of the clusters that differentiate each cluster from the other clusters. More detailed results are presented in the figures and tables that follow (Table 46, Table 47, Figure 133.) Note that the comparison between cluster characteristics is based on comparing the shares (% of consumers) in each cluster.

Cluster Positive (towards the NextGen microalgae concept)

- younger (under 44 y.)
- no children in the family
- highly educated (tertiary education)
- flexitarians or vegetarians

- most likely user of vegetarian convenience foods
- along with the Positive but concerned – cluster. most familiar with alternative proteins

Cluster Positive but concerned (about the NextGen microalgae concept)

- Has almost similar profile with the Positive cluster.
- younger (especially in the age group 25 – 34 y.).
- highly educated (tertiary education)
- flexitarians or vegetarians
- families with children
- second most likely user of vegetarian convenience foods
- together with Positive -cluster most familiar with alternative proteins

Cluster Neutral

- More 35 – 54 y. people than in the other clusters
- omnivores
- basic or secondary education
- children in the family
- in between the other clusters regarding e.g. familiarity with alternative proteins

Cluster Negative (towards the NextGen microalgae concept)

- Over 65 y. and middle aged people (45 – 64 y) were more prevent in this cluster than in the other clusters, and 18 – 24 y. least typical compared to the other age groups.
- omnivores
- low or intermediate level education
- least likely user of vegetarian convenience foods
- least familiar with alternative proteins

Table 46. Demographic profile of consumer clusters based on their views towards NextGen microalgae concept. Finland.

CLUSTER (FI. algae)	Negative	Positive but concerned	Positive	Neutral	Total %	Pearson Chi^2	Sign.	Total N
Gender_2						4.000	ns	922
male	53.9%	45.0%	46.3%	51.2%	48.8%			
female	46.1%	55.0%	53.8%	48.8%	51.2%			
Total	*100 %*	*100 %*	*100 %*	*100 %*	*100 %*			
Agegroup						24.404	.059	925
18 – 24 Years	5.4%	10.4%	**12.9%**	10.2%	10.3%			
25 – 34 Years	12.4%	19.9%	**17.0%**	16.5%	16.9%			
35 – 44 Years	10.9%	17.6%	**18.7%**	20.4%	17.9%			
45 – 54 Years	**19.4%**	14.9%	15.4%	17.4%	16.5%			
55 – 64 Years	**21.7%**	19.9%	17.0%	19.2%	19.1%			
65 – 75 Years	**30.2%**	17.2%	19.1%	16.5%	19.2%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Education_3						33.804	.000	919
Basic education	11.8%	5.9%	7.4%	11.2%	9.0%			
Secondary education	63.8%	52.5%	44.6%	59.5%	54.5%			
Tertiary education	24.4%	41.6%	47.9%	29.3%	36.5%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			

CLUSTER (FI. algae)	Negative	Positive but concerned	Positive	Neutral	Total %	Pearson Chi²	Sign.	Total N
Type of living area						17.093	.047	925
capital area	14.8%	24.4%	28.1%	19.5%	22.3%			
a large city that is not in the capital area	25.8%	25.8%	26.0%	21.9%	24.4%			
a small city/town or municipality	28.1%	25.3%	21.1%	25.7%	24.8%			
a rural area	*31.3%*	*24.4%*	*24.8%*	*32.9%*	*28.5%*			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Country region						23.344	.005	927
Eastern Finland	11.6%	10.4%	9.1%	12.0%	10.8%			
Southern Finland	32.6%	45.7%	53.1%	37.7%	42.9%			
Western Finland	41.9%	35.3%	27.2%	35.9%	34.3%			
Northern Finland	14.0%	8.6%	10.7%	14.4%	12.0%			
Household (child_family)						11.661	.009	921
no children	81.9%	76.4%	82.2%	71.2%	76.8%			
1-2 adults with children	18.1%	23.6%	17.8%	28.8%	23.2%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Household						26.834	ns	928
I live at home with my parents	3.1%	2.3%	3.7%	5.1%	3.8%			
I live alone	32.0%	36.0%	38.7%	30.7%	34.3%			
I live alone with my child / children	3.1%	5.0%	2.5%	6.0%	4.4%			
I live with my spouse	45.3%	36.0%	38.3%	34.6%	37.4%			
I live with my spouse and child / children	14.8%	18.9%	15.2%	22.7%	18.8%			
I live with other adults (other than spouse or family members)	0.8%	1.8%	0.8%	0.3%	0.9%			
Other	0.8%	0.0%	0.8%	0.6%	0.5%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Diet_3						35.125	.000	915
omnivore	91.2%	74.7%	71.5%	83.4%	79.2%			
meat sometimes or no red meat	5.6%	19.8%	18.6%	14.5%	15.6%			
vegetarian (peso-. ovo-. lactovegetarian or vegan)	3.2%	5.5%	9.9%	2.1%	5.1%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			

Table 47. Familiarity with alternative proteins and use of three types of convenience foods by consumer clusters of NextGen microalgae concept. Finland. Mean scores of composite indices to measure the overall familiarity and use.

	Negative	Positive but concerned	Positive	Neutral	Total	F	sign.
Familiarity with alternative proteins	2.37	2.82	2.96	2.56	2.70	43.946	0.000
Familiarity with future proteins	1.62	2.02	2.00	1.76	1.87	13.062	0.000
Use_vege_convenience	1.12	1.50	1.57	1.26	1.38	20.351	0.000
Use_meat_convenience	2.61	2.33	2.20	2.54	2.41	9.447	0.000
Use_salty_snacks	2.03	2.33	2.34	2.40	2.32	4.677	0.003

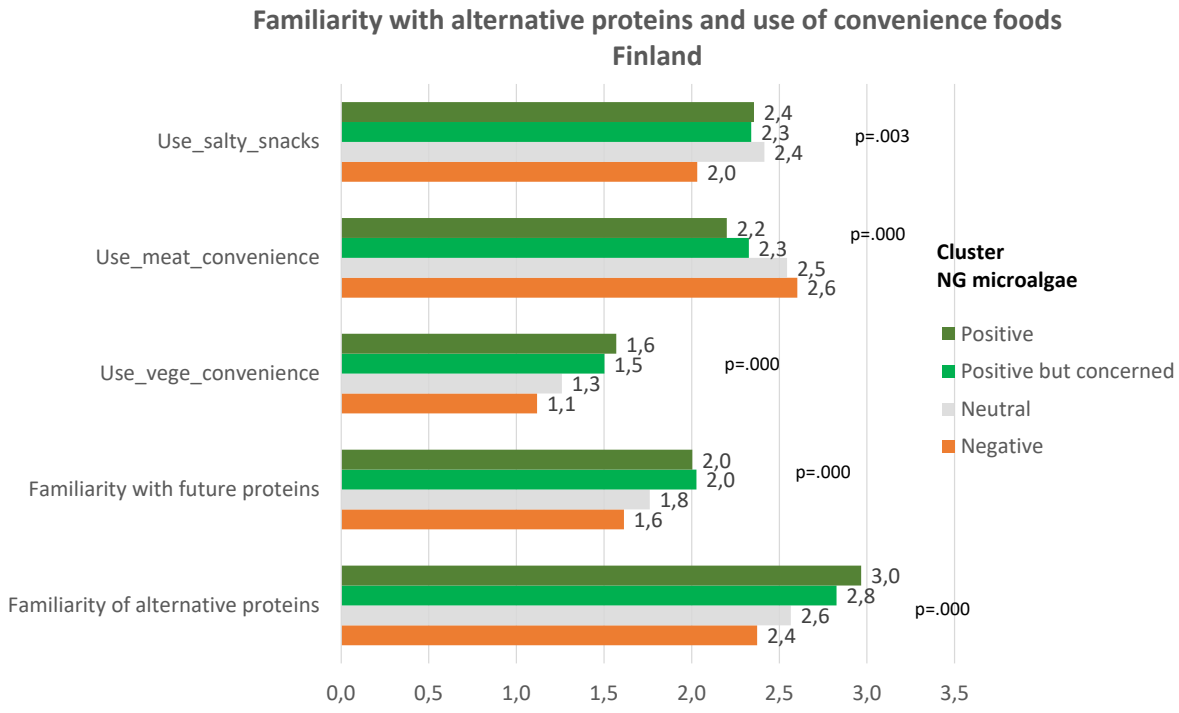


Figure 133. Use of certain convenience food types and familiarity with alternative proteins by NextGen microalgae consumer clusters in Finland. means (The level of significance of differences in means between the clusters is marked. p =.000 denotes highly significant difference).

10.5.2.2 Attitudinal background of consumer clusters for NextGen microalgae

The opinions differentiating the negative and positive clusters from each other were opposite to each other. The Positive, but concerned -cluster seem as a milder version of the cluster Positive as regards to their background attitudes. The cluster Neutral has not only neutral attitudes towards the NextGen microalgae, but also their background attitudes were neutral. (See below: Table 48, Table 49, Figure 134, Figure 135.)

Compared to the other clusters, respondents in the cluster Positive had in average lowest attachment to meat (i.e. the taste of and eating of meat is less important for them), they were most positive towards the use of novel food technologies in general, and they had in average highest trust in various actors of the food chain. Further, compared to the other Finnish clusters of Nextgen microalgae, they were more likely interested in new food products in general. Overall, they seem to be more involved in their food choices as they rated sustainable and ethical production, naturalness and healthiness of their daily foods as more important than other clusters overall.

The characteristics that differentiate the clusters from each other are summarised below:

Cluster Positive
- lowest meat attachment
- most positive attitude towards food technology (Ftechnology_attitude)
- lowest neophobia towards new food tastes (Taste_neophobia)
- highest trust in actors of food chain
- highest interest in new foods (food innovativeness)

- they value sustainability and ethical aspects, naturalness and healthiness in their daily food more (Figure 135.)

Cluster Positive, but concerned
- lower meat attachment
- average attitude towards food technology (Ftechnology_attitude)
- average neophobia towards new food tastes (Taste_neophobia)
- second highest interest in new foods (food innovativeness)

- they value healthiness and naturalness more than the other clusters, but also sustainability (Figure 135.)

Cluster Neutral
- medium high meat attachment
- average attitude towards food technology (Ftechnology_attitude)
- average neophobia towards new food tastes (Taste_neophobia)

- value naturalness of food least among the clusters (Figure 135.)

Cluster Negative
- higher attachment to meat (meat is important part of diet for them)
- highest neophobia towards new food tastes (Taste_neophobia)
- lowest interest in new foods (food innovativeness)
- most negative attitude towards food technology (Ftechnology_attitude)
- lowest trust in the different actors of food chain
- environmental sustainability of their foods less important than for the other clusters
- a little lower importance of health aspects of food
- convenience (quick preparation of food) slightly less important than for the other clusters

‘

Table 48. Comparison of the four consumers clusters (NG microalgae) in terms of their attitudinal tendencies. Means in each cluster.Finland.

	Negative	Positive but concerned	Positive	Neutral	Total	F	sign.
Meat_attachment	4.17	3.33	3.19	3.81	3.58	38.456	0.000
Ftechnology_attitude	2.54	3.03	3.63	3.07	3.14	106.925	0.000
Taste_neophobia	2.55	2.19	1.78	2.28	2.16	24.546	0.000
TRUST	2.99	3.28	3.45	3.26	3.28	13.993	0.000
F_INNOVATIVENSS	2.73	3.16	3.45	2.92	3.09	28.046	0.000

Table 49. Comparison of the four consumers clusters (NG microalgae) in terms of their food values (i.e. what factors are important to them regarding their daily foods)

	Negative	Positive but concerned	Positive	Neutral	Total	F	sign.
M_Sensory	3.83	3.77	3.85	3.73	3.78	1.527	ns
M_Healthy	3.24	3.73	3.59	3.22	3.44	18.109	0.000
M_Environment_ethics	2.68	3.51	3.58	2.92	3.20	41.497	0.000
M_Inexpensive	3.56	3.55	3.53	3.53	3.54	0.056	ns
M_Natural	3.30	3.69	3.51	3.21	3.42	10.427	0.000
M_Convenience	2.94	3.18	3.17	3.17	3.14	1.695	ns

Regarding food choice motives (or food characteristics that are important in their daily foods). all the four segments consider price. sensory quality as important (no significant differences between the clusters). Whereas the clusters differ in how they value naturalness. health aspects and sustainability aspects in their foods. The segment with most positive attitude towards NextGen microalgae protein concept puts more value to environmental sustainability (incl. also animal rights) than the other clusters. Correspondingly, the most negative segment cares the least about sustainability of their food. The cluster Positive, but concerned values the healthiness and naturalness of food more compared to the other segments.

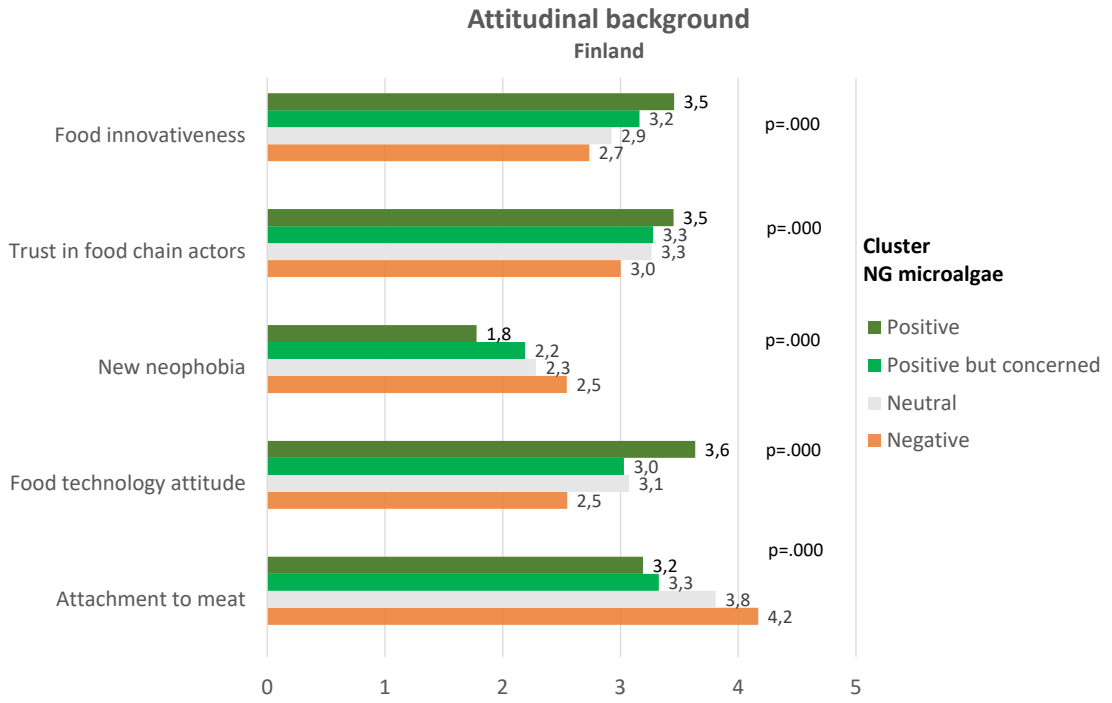


Figure 134. Comparing the consumer clusters of NextGen microalgae on their attitudinal background. Means of compositive variables measuring the background attitudes. Finland.

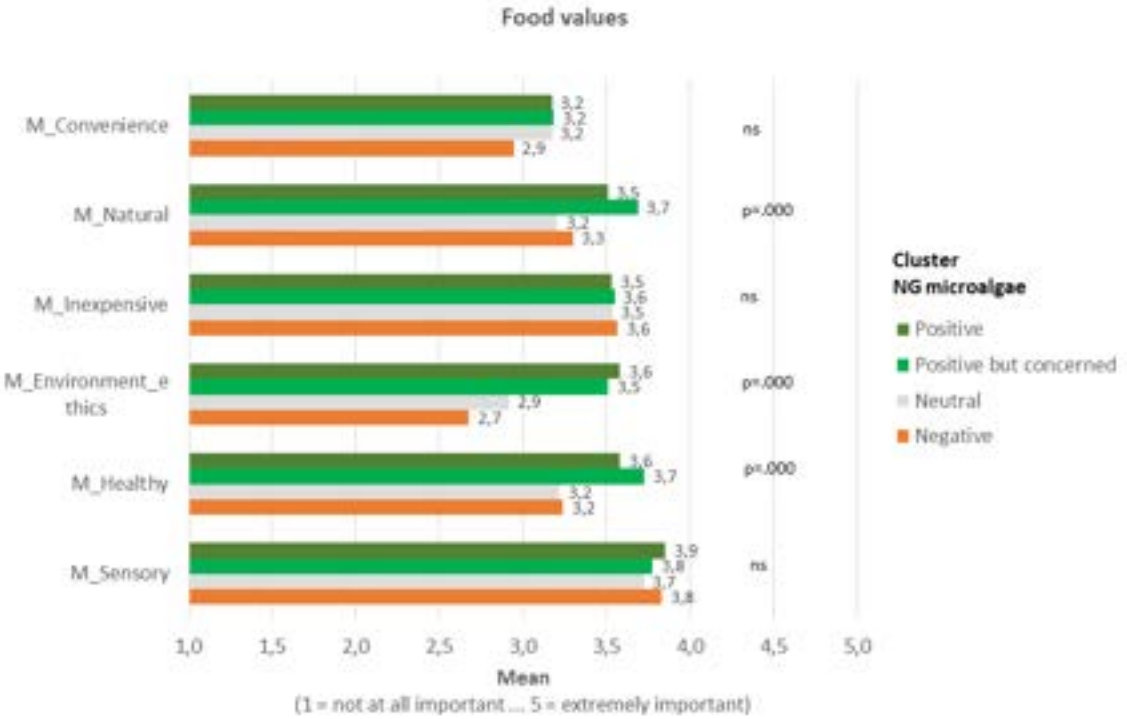


Figure 135. Comparing consumer clusters of NextGen microalgae on their food choice motives (composite variables of how important different aspects are in their daily food. scale 1 = not important at all … 5 = extremely important). Finland.

10.5.2.3 Interest to use food applications of NextGen microalgae protein in the consumer clusters

As could be expected, the cluster Negative was least interested in all the NextGen food applications while the cluster Positive was most interested (all means between the clusters significant at the level p =.000). Figure 136.

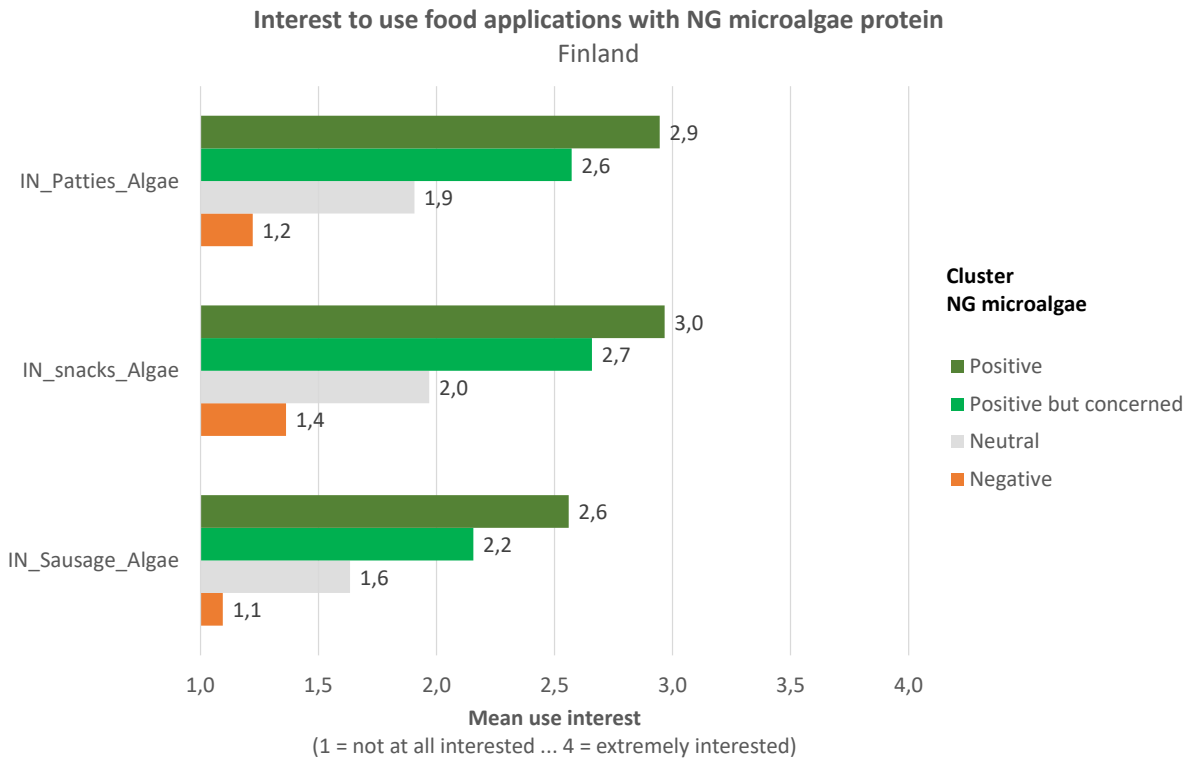


Figure 136. Interest to use food applications made with NextGen microalgae protein and their conventional counterparts. Comparison of means between the consumer clusters for NextGen microalgae concept. Finland.

10.6 Acceptance of Nextgen Insect protein concept, Finland

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Insect** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Insect concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Insect method and foods.

10.6.1 The level of acceptance of the NextGen insect protein

Below half (41.1 %) of the Finnish respondents were generally in favour of the idea production of NextGen insect protein to be applied in foods**.** Around 30 % were against the

idea. Thus, the attitudes towards NextGen insect protein were more negative than towards NextGen microalgae or NextGen Torula protein.

Figure 137. Attitudes towards NextGen insect protein concept (Finland). Answers to individual question items. Percentage of respondents. Finland.

Like in the case of microalgae protein, the Finnis respondents were most likely to believe that the production and use of NextGen insect protein in foods could benefit the environmental sustainability (53.7 % of the respondents) and animal well-being (44.6 %). Less was believed in benefits for human health and only 22 % believed it would be beneficial for them personally.

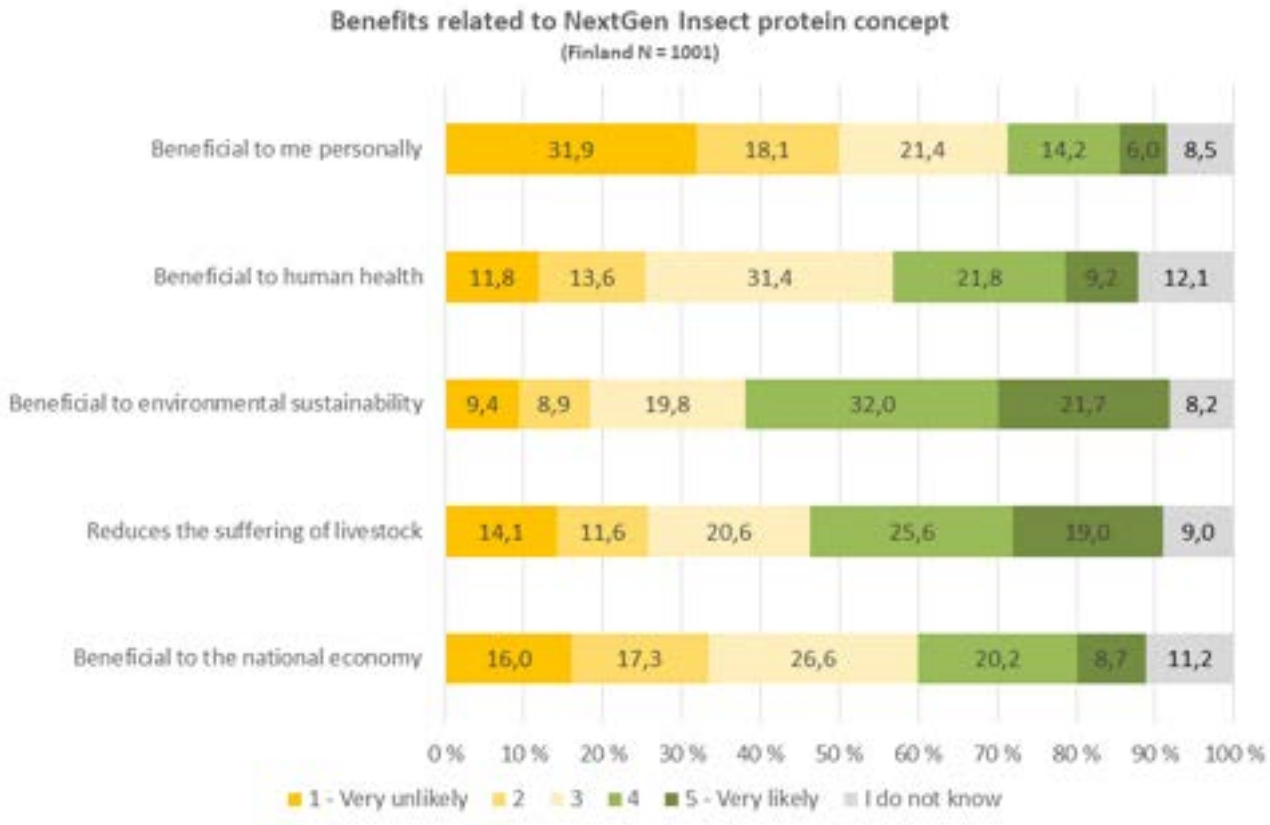


Figure 138. Perceived benefits of the NextGen insect protein concept. Finland.

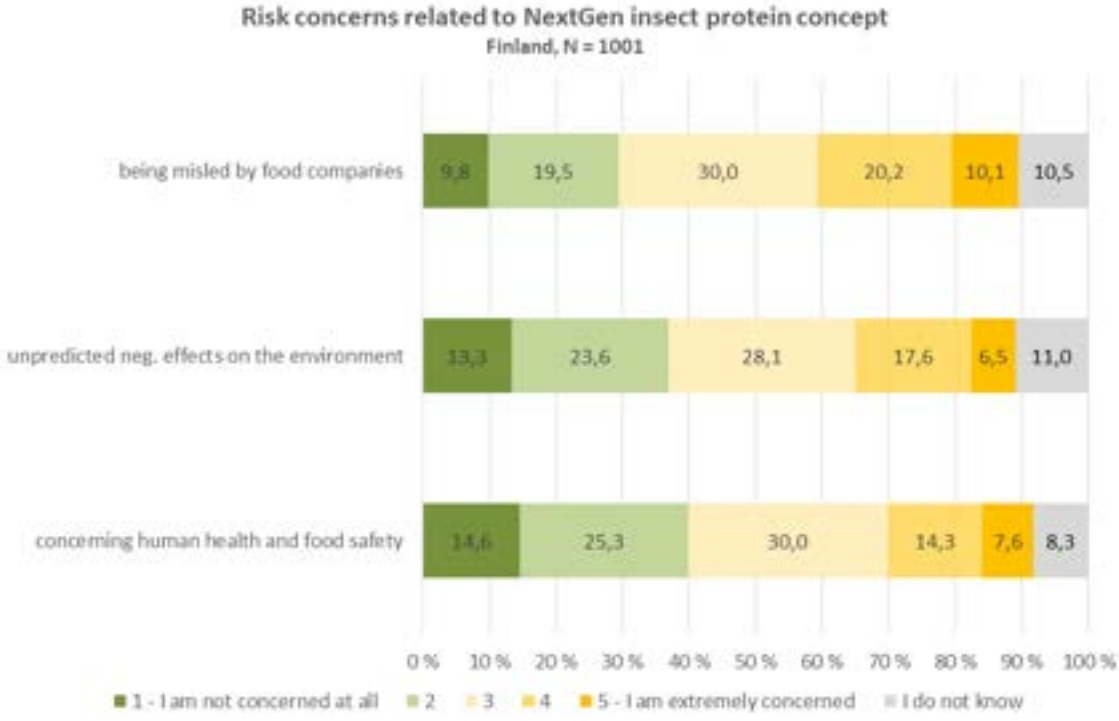


Figure 139. Perceived risks of the NextGen insect protein concept. Shares of respondents, Finland.

The most prevalent worry relating to NextGen insect protein was that of being misled by the food companies, like in the case of NextGen microalgae. About 30 % of the Finnish respondents were concerned about this risk. Overall, the share of respondents **not** worried about some of the risks was around 30 – 40 %. (Figure 139.)

A third of respondents or more did not have any negative or positive expectations about the quality of the NextGen insect protein food applications, as they clicked the neutral alternative.

Those who had an opinion, often rated NextGen insect protein foods as weird (59.8 %), repulsive (59.5 %) and bad tasting (46 %). On the other hand, larger share of respondents saw them as natural (39.8 %) rather than artificial (30%). Figure 140.

These results are in line with those obtained in focus group interviews. Respondents had somehow easier to understand the process of insect farming compared to the other NextGen protein production methods. Farming (even small) animals for food is more familiar and concrete concept for people, than cultivation of micro-organisms or making food from emissions. In the Finnish focus-group interviews, the use of food waste as source material (feed for the insects) elicited some contemplation about safety by few. This survey confirms our interpretation that while these thoughts may have a negative halo effect on the image of these foods, real distrust in safety of insect foods is not prevalent, although existing.

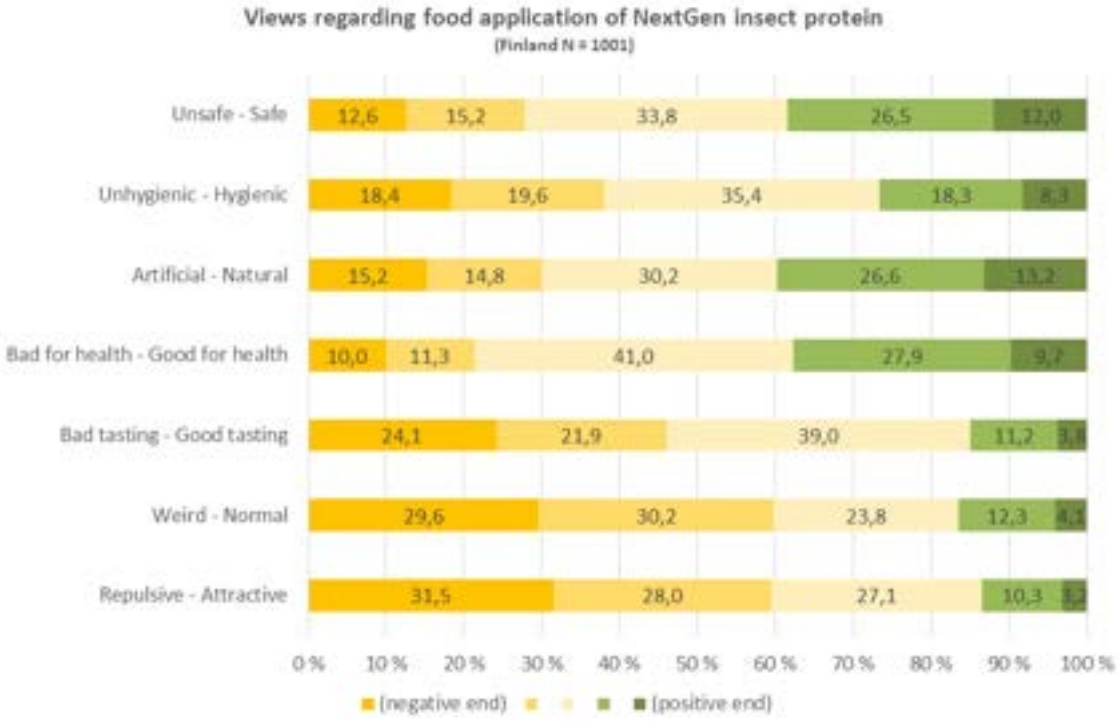


Figure 140. Characteristics associated with (imaginary) foods containing NextGen insect protein in Finland. Percentages of respondents. Semantic differential scales have been used. where the number 1 always stand for the negative end of the scale on the left (e.g. unsafe) and number 5 the positive end of the scale on the right (e.g. safe). Shares of respondents for each answer alternative.

The respondents did not expect that NextGen protein products would be appreciated in their social circles, which suggest low social pressure for use of these products.

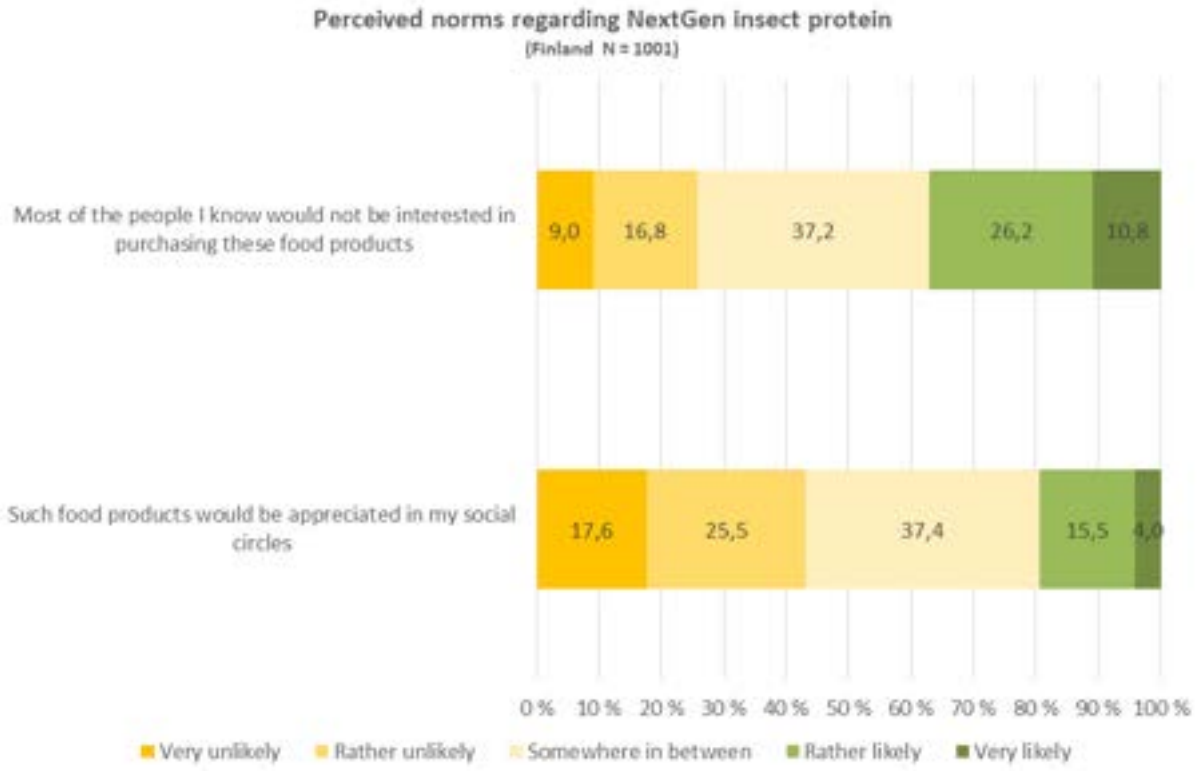


Figure 141. Perceived social norms regarding NextGen insect protein food products. Finland.

In Finland, out of the three food application examples of NextGen insect protein, the salty snack were found as most interesting (23.5 % of respondents rated it extremely or rather interesting to use), vegetable-protein -patties were found as second most interesting (24.8 %), and the sausage applications least interesting (16.8 %). Overall, around half of the Finnish participants were not at all interested in using the food applications made with NextGen insect protein. Figure 142**.**

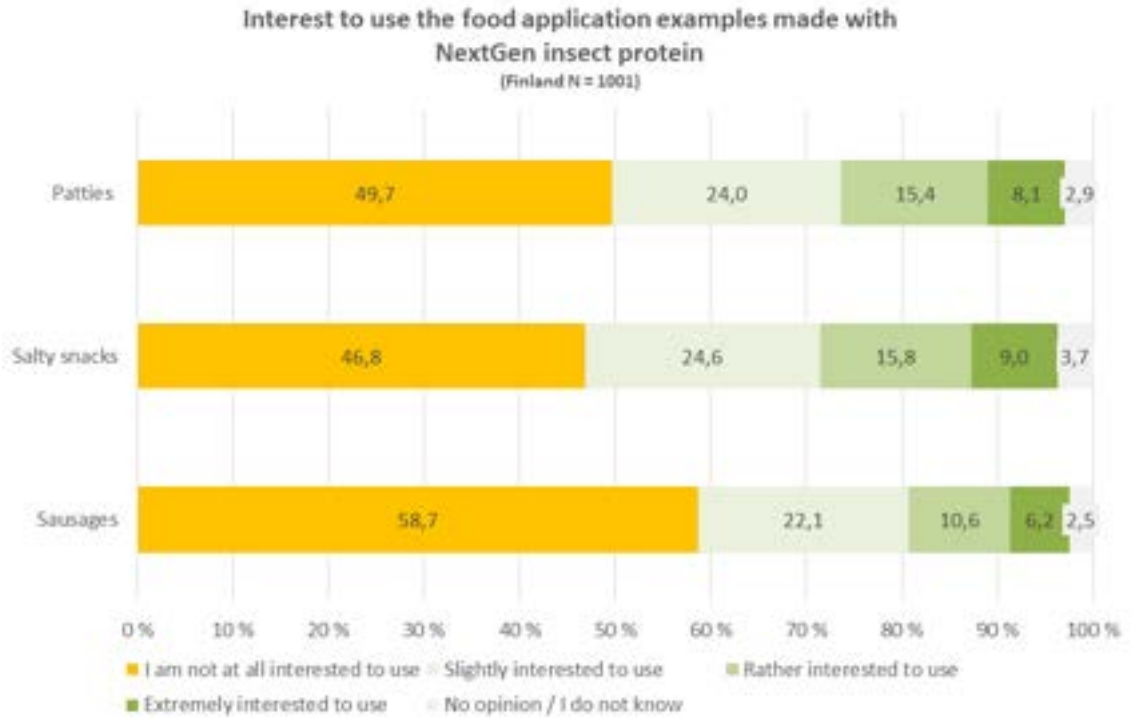


Figure 142. Interest to use the food application examples of NextGen insect protein.

10.6.2 Consumer clusters for NextGen insect concept, FI

Consumer clusters to reflect Finnish respondents' differences in how they view the NextGen insect protein concept were created with similar procedure as described in the method section 4.2.3.1.

The three Hierarchical cluster analyses, all suggested either three clusters or very different numbers of clusters. The three and four cluster alternatives were run with K-means clustering. Three cluster solution was chosen because larger number of clusters did not reveal any qualitative differences between the clusters. Only the intensity of the attitude varied.

The clusters with most negative ratings of attitudes, benefits and food characteristics and with highest concern about the risks was named as Cluster **Negative** (insects). Around 18 % the respondents belong to that cluster. The largest cluster comprising almost half of the respondents were classified into the Cluster **Neutral**, as they provided quite average ratings for all the measures. The last cluster was called **Positive**. having the highest ratings on attitudes, benefits and characteristics of NextGen insect protein food applications and lowest concern about the risks of NextGen insect protein concept.

Table 50. Distribution of respondents in to the consumer clusters of NextGen insect concept and means of acceptance measures (which were used as basis of clustering) in these clusters. Finland.

	Negative	Neutral	Positive	Total	F	Sig.
Number of cases in each cluster	184	443	307	934		
Percentage of cases in each cluster	18.4 %	47.4 %	30.7 %	100		
Variables applied as basis of the clustering						
ATT_Insects	1.52	3.03	4.44	3.19	1343.612	.000
FOODVIEWS_Insects	1.55	2.68	3.64	2.77	792.969	.000
Benefit_Insects	1.64	2.95	4.06	3.05	871.850	.000
Risk_Insects	3.76	2.94	2.17	2.85	199.978	.000

10.6.2.1 Demographic profile and eating habits of consumer NextGen insect consumer clusters

In terms of demographic characteristics, the most likely consumer type to have negative views towards NextGen insect protein concept is over 55 years, has low education, lives in small city or in the rural area and is an omnivore. In addition to omnivores, the there was a relatively large share of vegetarians in the Negative cluster also. On the basis of the focus-group study, this result was expected. Vegetarians often refuse to eat any kind of animals, thus also insects.

However, it is good to bear in mind that the above description is based on comparing the most positive cluster with the Cluster Negative. In addition, the Positive cluster is – compared to the other clusters – initially more familiar with various alternative and emerging protein sources. The Positive cluster also is initially more accustomed to use vegetarian convenience foods.

The demographic and food habit characteristics of the consumer clusters based on their views towards the Nextgen insect concept are summarised below. Note that these characteristics are compared to the other clusters. For more detailed results, see Table 51, Table 52 and Figure 143.

Cluster Positive

- more consumers from the youngest groups, under 34 y.
- more often consumers living in the capital area or in some other large city
- larger share of consumers with high education level
- highest share of consumers limiting their meat consumption (e.g. avoiding red meat. or only sometimes eating meat)

- lowest use of meat-based convenience foods and highest use of vegetable -based convenience foods (Figure 140)

- most familiar with alternative protein sources and with emerging new proteins (Figure 143)

Cluster Neutral

- more consumers from the middle-aged group. 35 – 44 y.
- regarding all the tested variables, the neutral cluster was in-between the positive and negative cluster

Cluster Negative

- more often from older age groups, such as over 55 years
- larger share of consumers with lower education levels
- larger share of consumers living in small cities or in rural areas than in the positive cluster
- largest share of ominvores and vegatarians compared to the other segment

- least familiar with alternative protein sources and with emerging new proteins (Figure 143)

Table 51. Demographic profile and diet of NextGen insect protein consumer clusters, FI

	Negative	Neutral	Positive	*Total*	Chi²	Sig.	Total N
Gender_2					3.414	ns	932
male	46.7%	53.3%	47.5%	*50.1%*			
female	53.3%	46.7%	52.5%	*49.9%*			
Total (N =932)	100.0%	100.0%	100.0%	*100.0%*			
AGEGROUP					29.659	.001	932
18 - 24 Years	3.3%	10.4%	13.4%	*10.0%*			
25 - 34 Years	14.1%	16.1%	18.6%	*16.5%*			
35 - 44 Years	13.6%	21.0%	16.0%	*17.9%*			
45 - 54 Years	17.4%	17.4%	14.1%	*16.3%*			
55 - 64 Years	24.5%	18.1%	18.6%	*19.5%*			
65 - 75 Years	27.2%	17.0%	19.3%	*19.7%*			
Total (N = 932)	100.0%	100.0%	100.0%	*100.0%*			
Education_3					14.774	.005	927
Basic education	**12.1%**	9.6%	5.9%	*8.8%*			
Secondary. plus	**58.8%**	56.5%	50.7%	*55.0%*			
Tertiary education	29.1%	33.9%	**43.5%**	*36.1%*			
Total (N=927)	100.0%	100.0%	100.0%	*100.0%*			
Household (child family)					1.482	ns	928
no children	72%	71.4%	72.8%	72.0%			
1-2 with children	24.7%	23.4%	23.3%	*23.6%*			
something else	3.3%	5.2%	3.9%	*4.4%*			
Household_3					6.193	ns	936
I live at home with my parents	2.7%	4.5%	2.9%	*3.6%*			
I live alone	33.5%	32.4%	37.1%	*34.2%*			
I live alone with my child / children	4.3%	4.1%	4.6%	*4.3%*			

I live with my spouse	38.4%	39.0%	35.5%	*37.7%*			
I live with my spouse and child / children	20.0%	18.9%	18.2%	*18.9%*			
I live with other adults (other than spouse or family members)	0.5%	0.7%	1.0%	*0.7%*			
Other	0.5%	0.2%	0.7%	*0.4%*			
Prefer not to say		0.2%		*0.1%*			
Total (N=936)	100.0%	100.0%	100.0%	*100.0%*			
Type of living area					17.243	.008	933
I live in the capital city / area	16.9%	21.7%	26.7%	*22.4%*			
I live in a large city that is not in the capital area	19.7%	24.2%	28.7%	*24.8%*			
I live in a small city/town or municipality	30.6%	25.3%	19.9%	*24.5%*			
I live in a rural area	32.8%	28.9%	24.8%	*28.3%*			
Total (N= 933)	100.0%	100.0%	100.0%	*100.0%*			
Country region					11.027	ns	934
Eastern Finland	9.7%	10.9%	10.4%	10.5%			
Southern Finland	37.8%	43.2%	47.9%	43.7%			
Western Finland	40.5%	36.0%	28.0%	34.3%			
Northern Finland	11.9%	10.0%	13.7%	11.6%			
Diet_3					14.998	.005	925
omnivore	85.2%	81.7%	74.1%	*79.9%*			
meat sometimes or no red meat	8.8%	13.7%	21.0%	*15.1%*			
vegetarian	6.0%	4.6%	4.9%	*5.0%*			
Total (N=925)	100.0%	100.0%	100.0%	*100.0%*			

Table 52. Previous familiarity with alternative proteins and use habits of convenience foods. Comparison of means between the three consumer clusters of NextGen insect concept. Finland.

	Negative	**Neutral**	**Positive**	***Total***	**F**	**Sig.**
Familiarity of alternative proteins	2.50	2.64	2.91	*2.70*	34.493	.000
Familiarity with future proteins	1.61	1.82	2.10	*1.87*	27.168	.000
Use_vege_convenience	1.19	1.36	1.50	*1.37*	13.014	.000
Use_meat_convenience	2.47	2.49	2.31	*2.42*	3.889	.021
Use_salty_snacks	2.12	2.39	2.32	*2.32*	4.972	.007

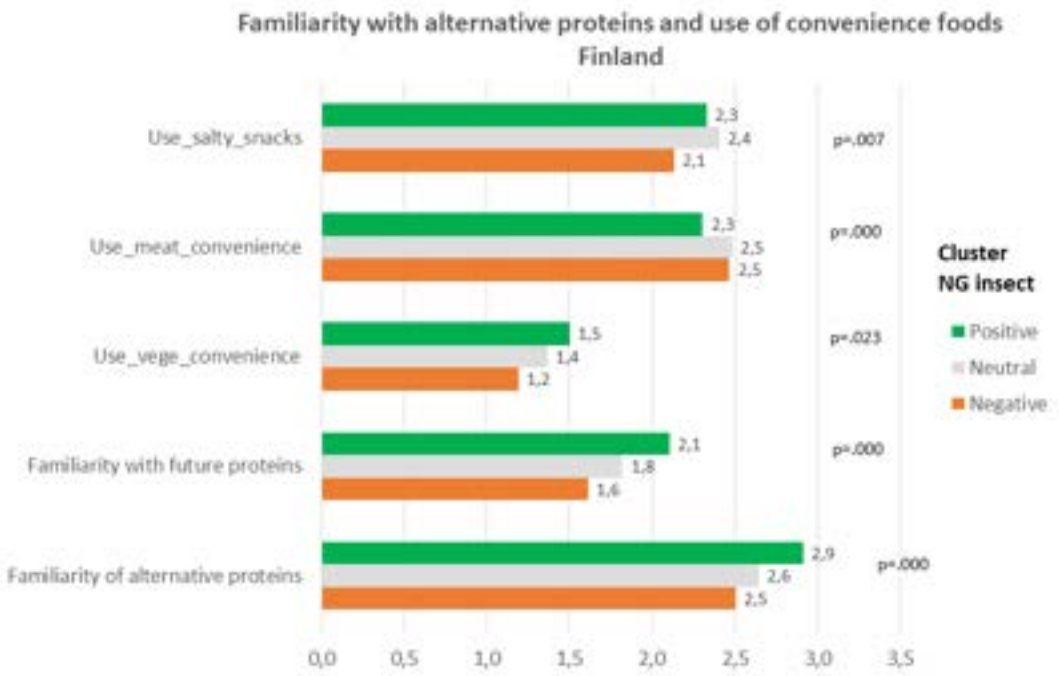


Figure 143. Mean use frequencies of certain convenience foods and familiarity with alternative proteins in consumer clusters based on their views on NextGen insect concept in Finland.

10.6.2.2 Attitudinal background of NextGen insect consumer clusters

The attitudinal characteristics of the Finnish consumer clusters (based on their views towards the NextGen insect concept) are described below. Overall, the consumers with positive views towards the NextGen insect concept were very similar to the ones positive towards the other NextGen concept. (For more details see Table 53, Table 55, Figure 144, *Figure 145).*

Compared to the other clusters…

Cluster Positive (towards NextGen insect concept)

- lowest meat attachment
- most positive attitude towards food technology in general (FTechnology_attitude)
- lowest neophobia towards new food tastes (Taste_neophobia)
- highest trust in actors of food chain
- highest interest in new foods (food innovativeness)

- environmental sustainability, healthiness and naturalness were more important food values than for e.g. to the cluster Negative

Cluster Neutral (towards NextGen insect concept)

- between the negative and positive cluster regarding each background attitude mentioned above and below

Cluster Negative (towards NextGen insect concept)

- highest attachment to meat (meat is important part of diet for them)
- highest neophobia towards new food tastes (Taste_neophobia)
- lowest interest in new foods (food innovativeness)
- most negative attitude towards food technology (FTechnology_attitude)
- lowest trust in the different actors of food chain

- environmental sustainability and animal ethics as criteria for their daily foods were less important than for the other clusters
- lower importance of naturalness and health aspects of food

The importance of good taste and other sensory characteristics as well as price of food did not differentiate between the clusters. I.e. these issues were equally important for all when they consider they daily food choices.

Table 53. Comparison of the three consumers clusters (NG insect) in terms of their attitudinal tendencies. Means in each cluster. Finland.

Cluster >	Negative	Neutral	Positive	Total	F	Sig.
Meat_attachment	3.95	3.59	3.39	3.59	17.406	.000
FTechnology_attitude	2.80	3.05	3.47	3.14	73.683	.000
Taste_neophobia	2.45	2.25	1.87	2.17	27.353	.000
TRUST	3.06	3.24	3.48	3.28	25.631	.000
F_INNOVATIVENSS	2.86	3.00	3.32	3.08	20.141	.000

Table 54. Comparison of the four consumers clusters (NG insect) in terms of their food values. Means in each cluster. Finland.

Cluster > Food values	Negative	Neutral	Positive	Total	F	Sig.
M_Sensory	3.85	3.77	3.76	3.78	0.811	ns
M_Healthy	3.28	3.40	3.55	3.43	5.467	.004
M_Environment_ethics	2.87	3.12	3.45	3.18	20.134	.000
M_Inexpensive	3.61	3.48	3.57	3.54	1.311	ns
M_Natural	3.26	3.36	3.53	3.40	4.073	.017
M_Convenience	3.11	3.15	3.09	3.12	0.296	ns

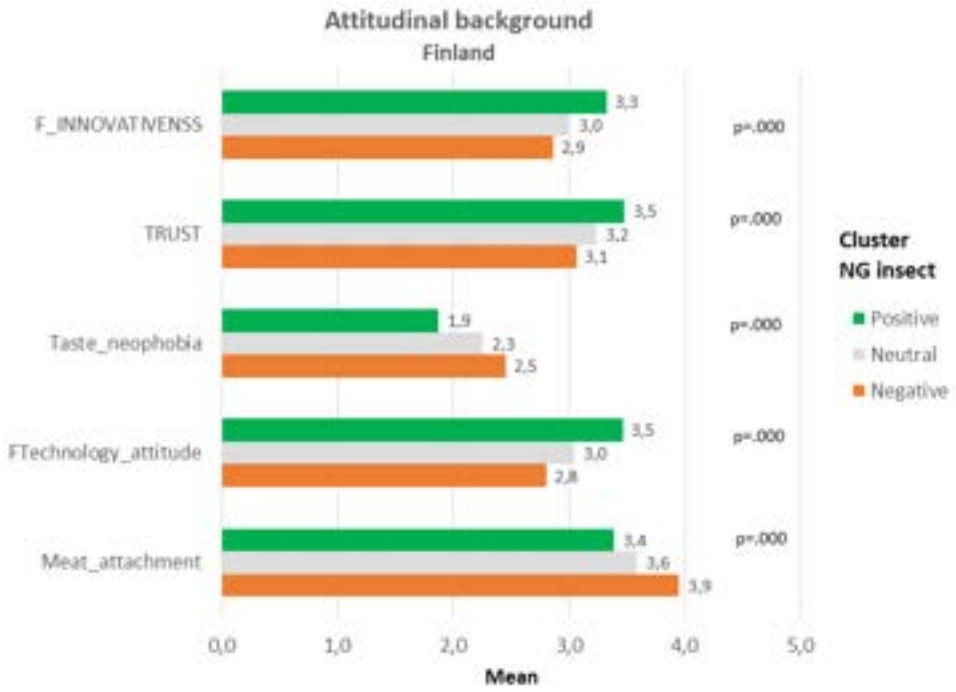


Figure 144. Means of background attitudes compared between the three clusters (based on their views on NectGen insect concept) in Finland. All means differ statistically significantly between the clusters.

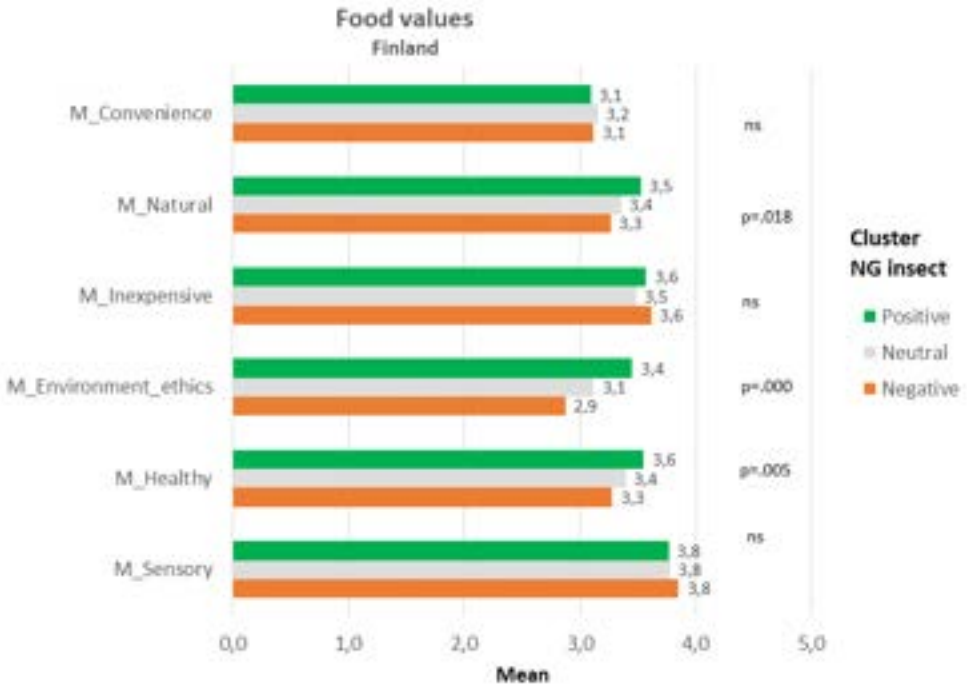


Figure 145. Means of food values compared between the consumer clusters (formed in the basis of their views towards NextGen insect concept) in Finland. (ns = not statistically significant difference in means between the clusters).

10.6.2.3 Interest to use food applications of NextGen insect protein in the consumer clusters

Finally, the NextGen consumer clusters, which have been formed on the basis of their views towards the NextGen insect concept are compared in terms of their intentions to use the food application examples. The Figure 143 clearly shows that their use interest of food applications, regardless of the product type, is in line with their attitudes and views towards the total concept. Figure 146.

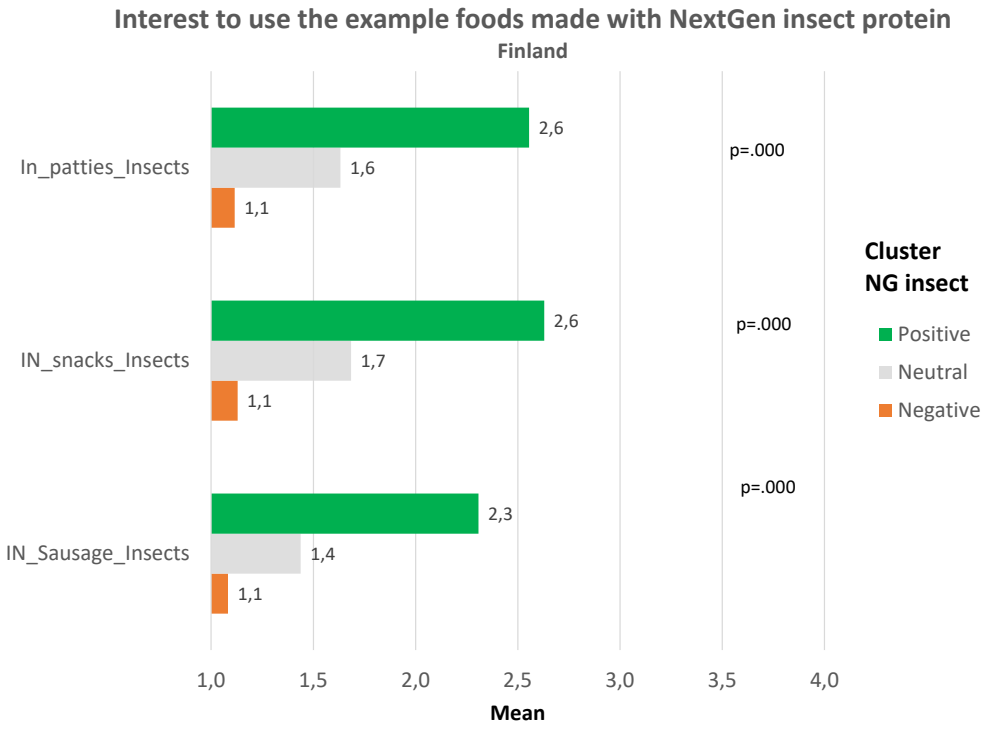


Figure 146. Mean interest to use the examples of NextGen insect food applications compared between the NextGen insect clusters in Finland.

10.7 Acceptance of Nextgen Torula protein concept, FI

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Torula** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Torula concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Torula method and foods.

10.7.1 The level of acceptance of NextGen Torula protein

Close to half (48.4%) of the Finnish respondents were generally in favour of the idea production of NextGen Torula protein to be applied in foods. The share of respondents with neutral opinions was high, close to 30 %, as expected because of the novelty of the idea. Only 18.7 % were against the idea. Figure 147.

Figure 147. Attitudes towards NextGen Torula protein concept (Finland). Answers to individual question items. Percentage of respondents. Finland.

Over half (57.3 %) of the respondents believed in that production of NextGen Torula protein and its' application in food would result in benefits for the environmental sustainability. It was also believed to bring better life for the production animals. Deviating from the other two NextGen ingredients, respondents in Finland quite often believed that this production method would also **benefit the national economy** (52.8 % vs. only 28.9 % in the case of NextGen microalgae). The focus group discussions reveal the reason for this result: It was very typical (only) for the Finnish respondents to suggest that as forest material is utilised as raw material in this production process, it would be potentially good opportunity to make business with the clean and abundant forests. Potential for domestic production was thus perceived as a clear benefit.

A clearly lower share of respondents believed in benefits for human health (35.1%), or even less so in personal benefits (28.6 %). Figure 148.

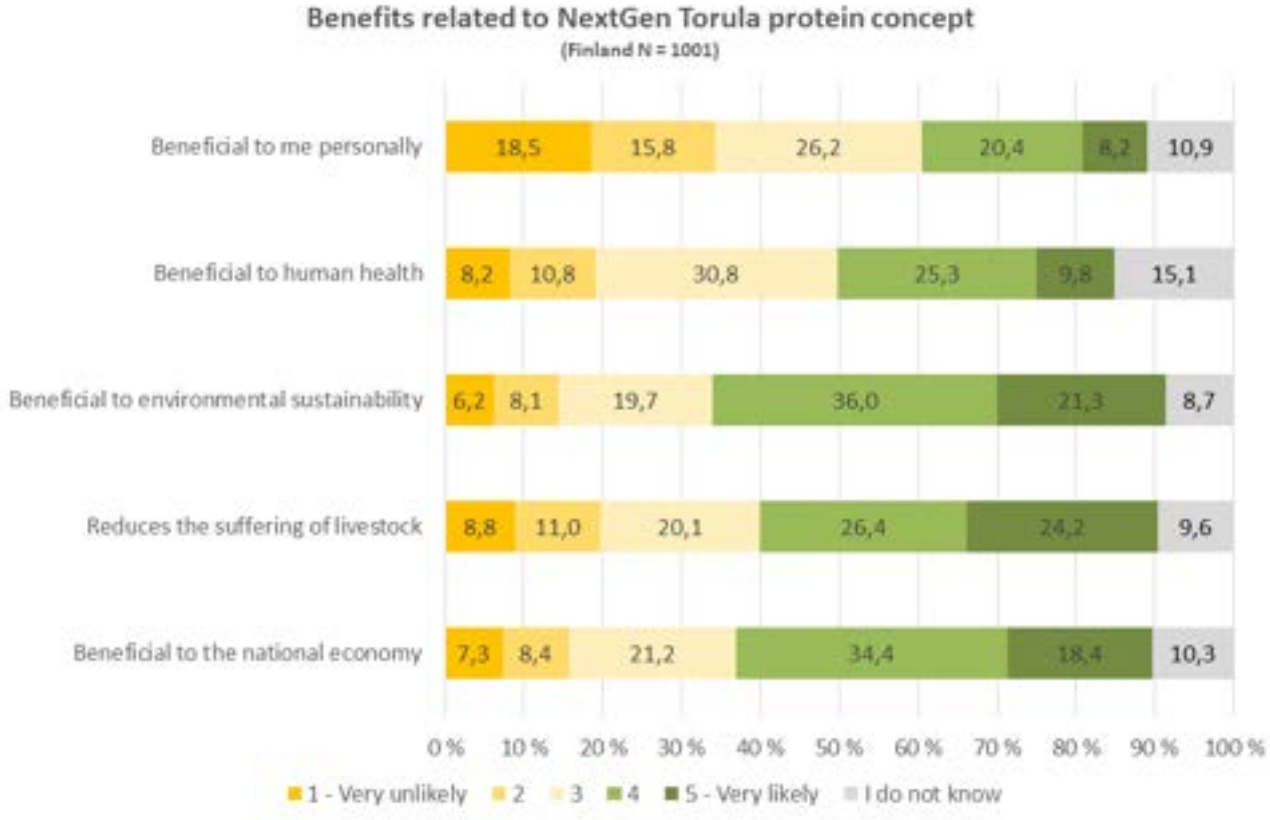


Figure 148. Perceived benefits of the NextGen Torula protein concept. Finland.

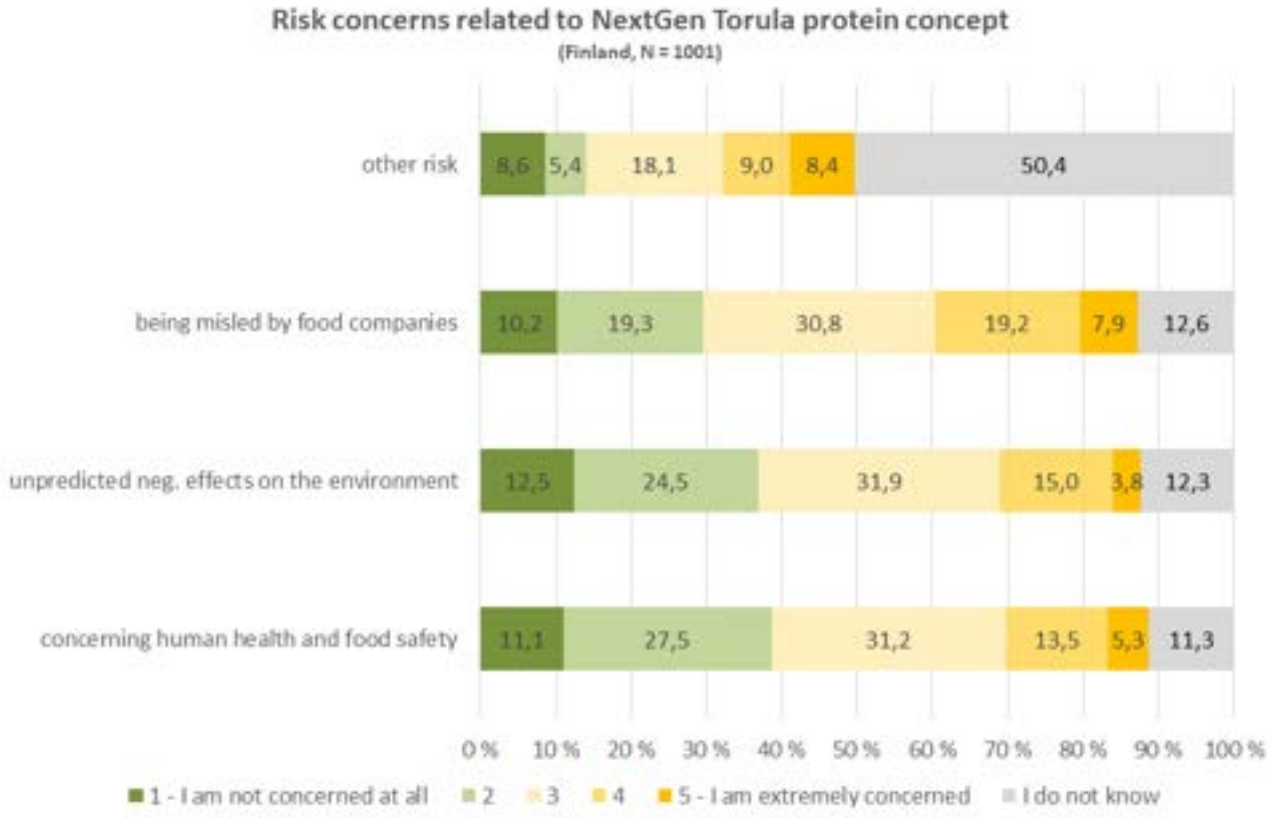


Figure 149. Perceived risks of the NextGen Torula protein concept. Finland.

Answers to the questions about benefits and risk concerns suggest that many felt they don't know what to think about the potential benefits or risks: In many cases, around 40 % of respondents answered either "cannot say" or ticked the middle alternative.

The respondents were most worried about the risk of being misled by the food companies, like they were in the case of the other two NextGen concepts. Most importantly, however, feelings of not being concerned about the risks were more common than worry about the risks. Figure 149.

Most respondents seem to feel they were not able evaluate the characteristics of these foods as around 40 % them have selected the middlemost alternative from the semantic differential scales (e.g. good tasting … bad tasting). Given the lack of experience about these yet not existing products, the result was expected. The results indicate however, that many **Finnish consumers did not have strong negative preconceptions about the quality of these foods**. The negative and positive expectations were rather balanced. As an exception, as much as 46.3 % of the Finnish respondents did consider NextGen Torula protein foods as something **weird** rather than normal and **artificial** rather than natural. Figure 150.

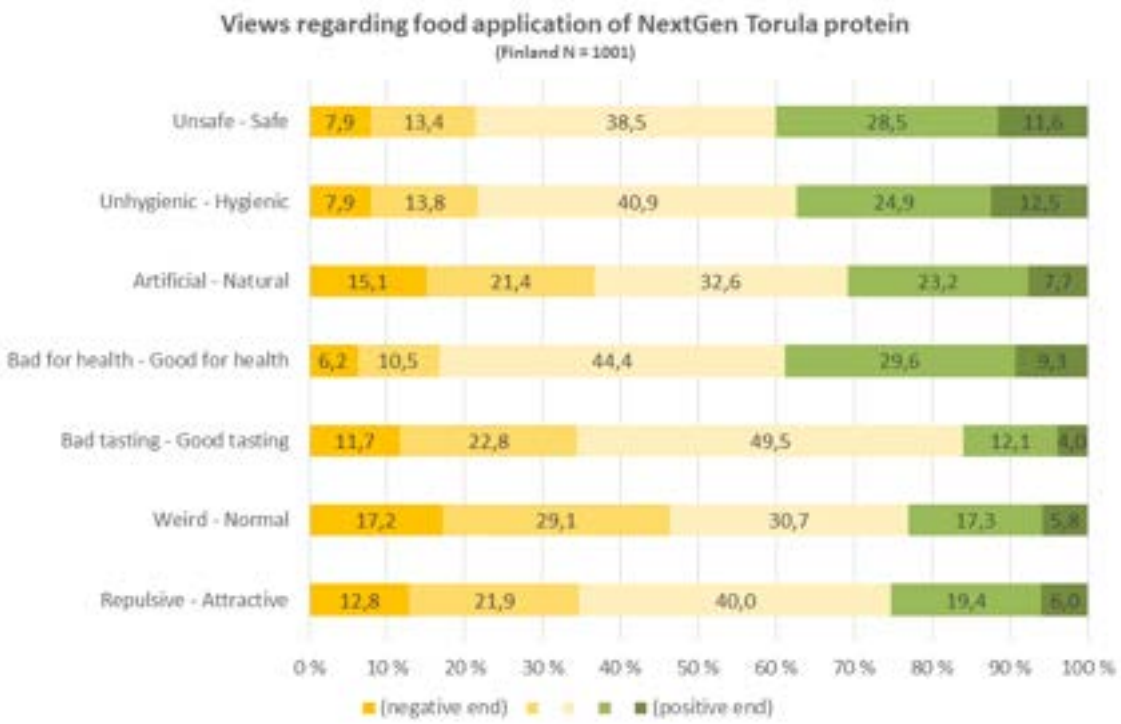


Figure 150. Characteristics associated with (imaginary) foods containing NextGen Torula protein. Percentages of respondents. Semantic differential scales have been used. where the number 1 always stand for the negative end of the scale on the left (e.g. unsafe) and number 5 the positive end of the scale on the right (e.g. safe). Shares of respondents for each answer alternative.

Overall, the share of Finnish respondents interested in using the NextGen Torula food application examples was rather low, only around 23 – 33 %. People were more interested in using NextGen Torula protein in the form of snacks and vegetable-protein patties than in the form of sausages. About 33 % of the respondents were very or rather interested in using snacks or patties, while the correspondent percentage for sausages was 23 %. Figure 151.

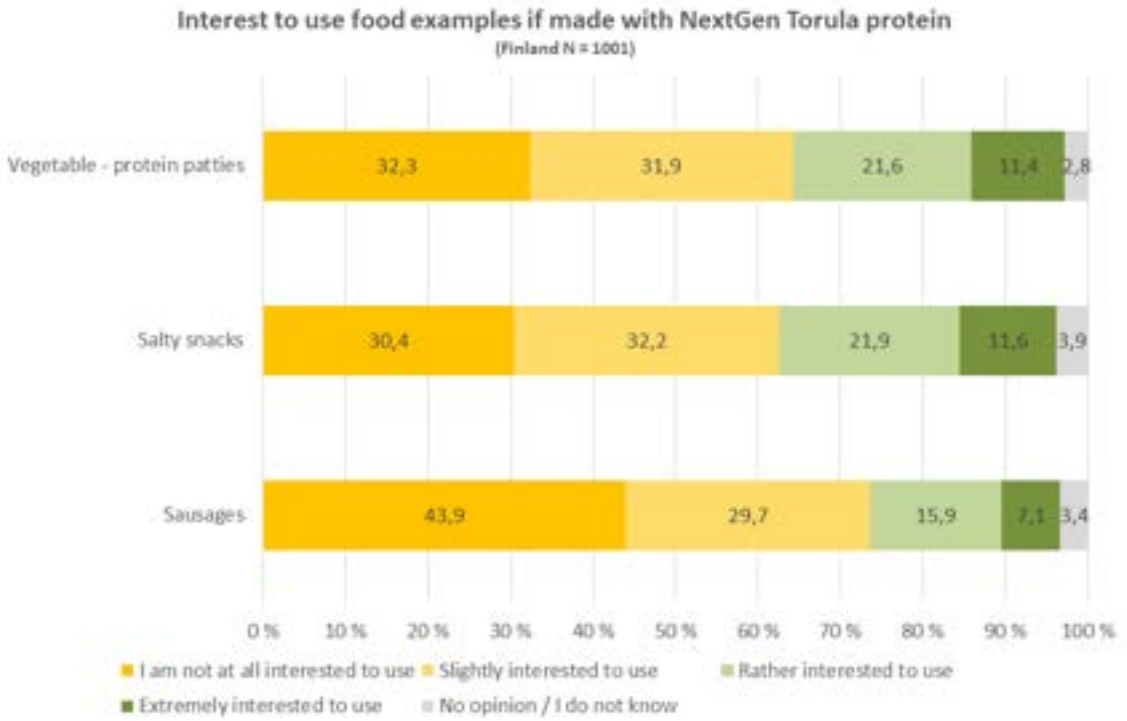


Figure 151. Interest to use the food application examples of NextGen Torula protein. Finland.

10.7.2 Consumer clusters based on their views towards NextGen Torula concept

The variables applied for clustering the Finnish respondents based on their views towards NextGen Torula protein concept were: ATT_Torula. Benefit_Torula. Risks_Torula and Foodviews_Torula (see chapter 9.3.2.)

The cluster analyses were performed as described in the method section (4.2.3.1). The three dendrograms form hierarchical cluster analyses did not provide clear, unified suggestion about the number of clusters. K-means cluster analyses were run with 2. 3. 4 and 5 clusters. and as 4 cluster solution was interpretatively logical and most informative that was chosen.

The clusters were named based on their means on the clustering variables. The first cluster includes 23.5 % of the respondents and was called **Positive, but concerned.** They had relatively positive attitudes and higher beliefs in benefits, but they were also moderately concerned about potential risks of the method and about the quality of the food applications. **The second** and the largest cluster is called **Neutral**, because all the ratings of

this group were at average level compared to the other clusters. About 38 % of the respondents were classified into this cluster. **The third cluster** is called **Positive** (24.3 % of the respondents), as it had the most positive responses on all the scales – they believed most in benefits and were least concerned about risks. Finally, **the fourth cluster** was called **Negative** as respondents in this cluster had the most negative attitude towards NextGen microalgae protein concept consist of 14 % of the respondents. They had lowest beliefs in the benefits of it, lowest expectations about the quality of food application and they were most concerned about risks related to this concept. (Table 55.)

Table 55. Distribution of respondents in to the consumer clusters of NextGen Torula and means of acceptance measures (which were used as basis of clustering) in these clusters. Finland.

	Positive, but concerned	Neutral	Positive	Negative	Total	F	Sig.
Number of cases in each cluster	214	348	222	128	913		
Percent of cases in each cluster	23.5 %	38.2 %	24.3 %	14.0 %	100 %		
Variables applied as basis of clustering							
ATT_Torula	4.12	3.01	4.50	1.82	3.47	843.828	.000
Benefits_Torula	4.01	3.05	4.18	1.73	3.37	568.809	.000
Risks_Torula	3.23	2.91	1.67	3.70	2.79	308.434	.000
FOODVIEWS_Torula	3.38	2.75	3.82	1.67	3.01	478.682	.000

10.7.2.1 Demographic profile and eating habits ofNextGen Torula protein consumer clusters

The following list summarises the characteristics of the clusters which were more typical for that than for the other clusters. For more details see Table 56 and Figure 152.

Cluster Positive (towards NextGen Torula concept)

- young (under 24 y.)
- no children in the family
- highly educated (tertiary education)
- more vegetarians and meat reducers

- most frequent user of vegetarian convenience foods
- most familiar with alternative and novel proteins

Cluster Positive, but concerned (towards NextGen Torula concept)

- education tertiary or higher
- children in the family
- live in a small city
- more (flexitarians) meat reducers

- frequent user of vegetarian convenience foods
- familiar with alternative and novel proteins

Cluster Neutral (towards NextGen Torula concept)

- 25 – 44 years old
- higher or tertiary education
- live in a small city or in a rural area

Cluster Negative (towards NextGen Torula concept)

- Middle aged people (45 – 64 y)
- basic or secondary education
- live with spouse, no children
- omnivores

- most frequent users of meat-based convenience foods
- least frequent user of vegetarian convenience foods
- least familiar with alternative or novel proteins

Table 56. Demographics of the consumer clusters based on their views towards the NextGen Torula concept in Finland.

	Positive. but concerned	Neutral	Positive	Negative	Total	Chi2	Sig.
Gender_2						4.312	ns
male	49.1%	53.2%	44.3%	48.4%	49.4%		
female	50.9%	46.8%	55.7%	51.6%	50.6%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		
Agegroup						30.982	.009
18 - 24 Years	9.3%	9.8%	14.0%	6.2%	10.2%		
25 - 34 Years	18.7%	19.5%	13.1%	13.2%	16.9%		
35 - 44 Years	15.4%	21.0%	19.4%	8.5%	17.5%		
45 - 54 Years	17.3%	16.4%	14.9%	19.4%	16.6%		
55 - 64 Years	18.7%	16.1%	21.2%	24.8%	19.2%		
65 - 75 Years	20.6%	17.2%	17.6%	27.9%	19.6%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		
Education_4						37.337	.000
Basic education	7.5%	9.6%	7.2%	12.6%	8.9%		
Secondary	34.1%	44.2%	30.6%	44.9%	38.6%		
Tertiary	38.3%	30.8%	32.0%	33.1%	33.2%		
Higher	20.1%	15.4%	30.2%	9.4%	19.3%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		
Education_3	**Positive. but concerned**	**Neutral**	**Positive**	**Negative**	**Total**	25.866	.000
Basic education	7.5%	9.6%	7.2%	12.6%	8.9%		
Secondary plus education	53.3%	58.4%	45.0%	63.8%	54.7%		
Tertiary education	39.3%	32.0%	47.7%	23.6%	36.4%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		

Household						30.957	.074
I live at home with my parents	2.3%	4.0%	4.5%	3.1%	3.6%		
I live alone	32.6%	29.2%	43.7%	31.3%	33.8%		
I live alone with my child / children	4.7%	4.3%	3.6%	4.7%	4.3%		
I live with my spouse	36.7%	38.1%	35.6%	42.2%	37.7%		
I live with my spouse and child / children	21.9%	23.2%	11.3%	17.2%	19.1%		
I live with other adults (other than spouse or family members)	0.5%	0.6%	1.4%	0.8%	0.8%		
Other	1.4%	0.3%		0.8%	0.5%		
Prefer not to say		0.3%			0.1%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		
Household Child_family	**Positive. but concerned**	**Neutral**	**Positive**	**Negative**	**Total**	14.080	.003
no children	73.1%	72.3%	85.1%	78.1%	76.5%		
1-2 adults with children	26.9%	27.7%	14.9%	21.9%	23.5%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		
Type of living area						22.525	.007
I live in the capital city / area	22.0%	19.3%	30.2%	17.2%	22.3%		
I live in a large city that is not in the capital area	27.1%	23.9%	27.0%	20.3%	24.9%		
I live in a small city/town or municipality	27.1%	26.1%	19.4%	25.0%	24.6%		
I live in a rural area	23.8%	30.7%	23.4%	37.5%	28.3%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		
Country region						10.661	ns
Eastern Finland	9.3%	10.9%	11.2%	9.3%	10.4%		
Southern Finland	42.8%	40.2%	50.7%	38.8%	43.2%		
Western Finland	35.3%	36.5%	27.4%	41.1%	34.6%		
Northern Finland	12.6%	12.4%	10.8%	10.9%	11.8%		
Diet_3						24.882	.000
omnivore	75.2%	83.4%	71.6%	88.1%	79.3%		
meat sometimes or no red meat	20.5%	13.4%	19.4%	7.9%	15.7%		
vegetarian	4.3%	3.2%	9.0%	4.0%	5.0%		
Total	100.0%	100.0%	100.0%	100.0%	100.0%		

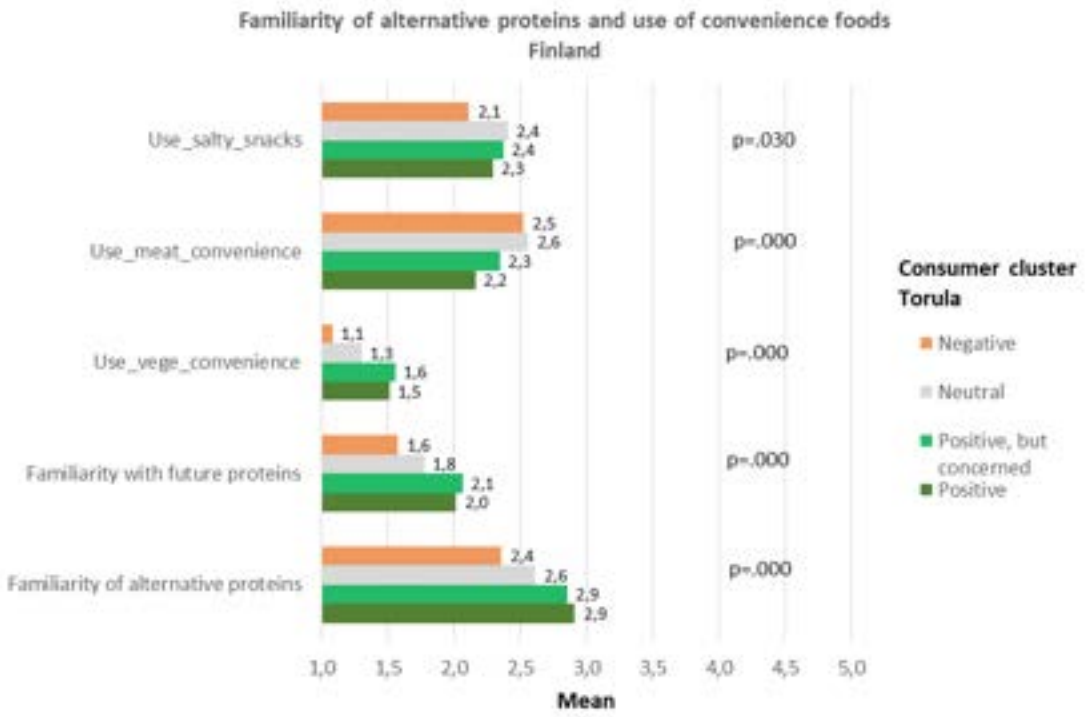


Figure 152. Use (mean use frequency) of certain convenience foods and familiarity with novel and alternative proteins compared between the consumer clusters based on their views towards NextGen Torula concept. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

10.7.2.2 Attitudinal background of NextGen Torula consumer clusters

Below is a summary of the attitudinal background of the NextGen Torula consumer. Characteristics that were more typical for the cluster in comparison to the other clusters are mentioned. For more details see Figure 153, Figure 154, Table 57 and Table 58.

Cluster Positive

- lowest meat attachment along with cluster positive but concerned
- most positive attitude towards food technology (Ftechnology_attitude)
- lowest neophobia towards new food tastes (Taste_neophobia)
- highest trust in actors of food chain
- highest interest in new foods (food innovativeness)

- as food choice criteria, they value sustainability and ethical aspects more than cluster neutral or negative (Figure 154.)

Cluster Positive, but concerned

- lowest meat attachment along with cluster positive
- average attitude towards food technology (Ftechnology_attitude)
- average reluctance to test new food tastes (Taste_neophobia)
- second highest interest in new foods (food innovativeness)

- characteristics they value in their daily food more than the other clusters are sustainability, ethics, healthiness and naturalness (Figure 154.)

Cluster Neutral

- average compared to the other clusters in most regards

- lowest value for naturalness of food (Figure 154.)

Cluster Negative

- higher attachment to meat (meat is important part of diet for them)
- highest neophobia towards new food tastes (Taste_neophobia)
- lowest interest in new food prducts (food innovativeness)
- most negative attitude towards food technology (Ftechnology_attitude)
- lowest trust in the different actors of food chain
- environmental sustainability of their foods less important than for the other clusters

Table 57.Comparison of attitudinal background between the four consumer clusters of NextGen Torula. Means and significance of differences of means between the clusters. (ns = not significant difference)

	Positive. but concerned	Neutral	Positive	Negative	Total	F	Sig.
Meat_attachment	3.29	3.76	3.27	4.13	3.58	29.278	.000
FTechnology_attitude	3.13	3.01	3.64	2.61	3.13	91.181	.000
Taste_neophobia	2.13	2.27	1.76	2.63	2.16	29.114	.000
TRUST	3.33	3.21	3.48	3.02	3.27	15.591	.000
F_INNOVATIVENSS	3.23	3.01	3.33	2.65	3.09	20.372	.000

Table 58. Comparison of food values (food choice motives) between the four consumer clusters of NextGen Torula. Means and significance of differences in means between the clusters. (ns = not significant difference)

	Positive. but concerned	Neutral	Positive	Negative	Total	F	Sig.
M_Sensory	3.82	3.73	3.81	3.85	3.79	1.124	ns
M_Healthy	3.69	3.29	3.49	3.38	3.44	8.797	.000
M_Environment_ethics	3.51	3.02	3.43	2.82	3.21	20.762	.000
M_Inexpensive	3.60	3.54	3.46	3.61	3.54	0.889	ns
M_Natural	3.71	3.24	3.40	3.40	3.41	9.056	.000
M_Convenience	3.11	3.17	3.13	3.10	3.13	0.200	ns

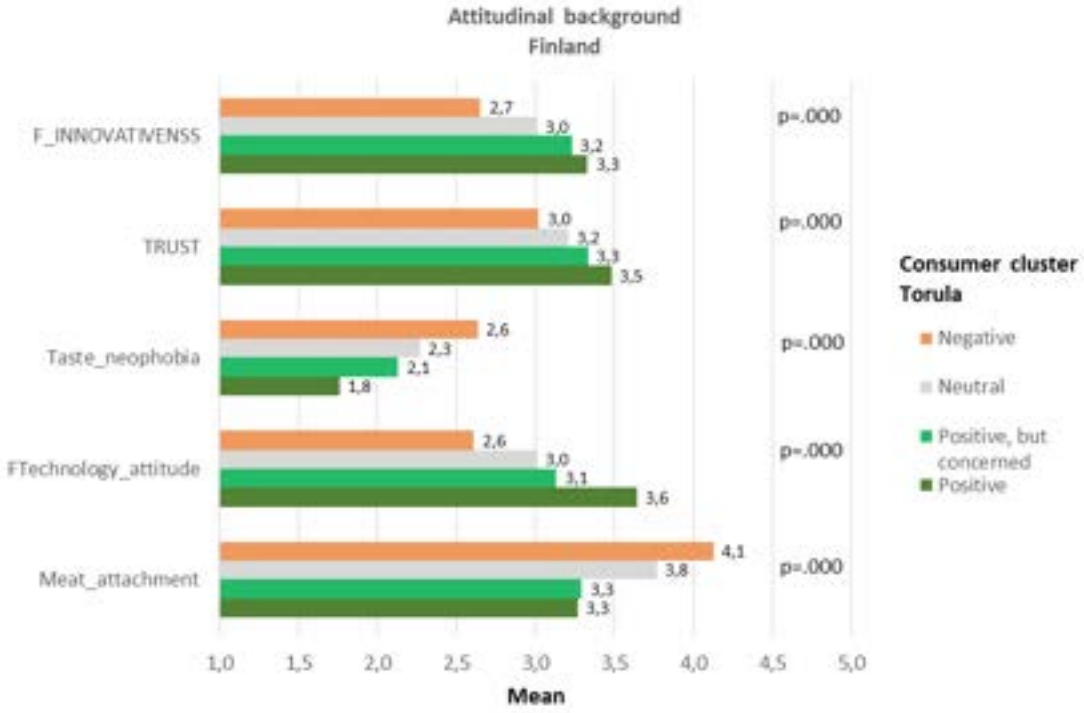


Figure 153. Attitudinal background compared between the consumer clusters (based on views towards the NextGen Torula concept). Means and statistical significance of differences in means between the clusters. Finland.

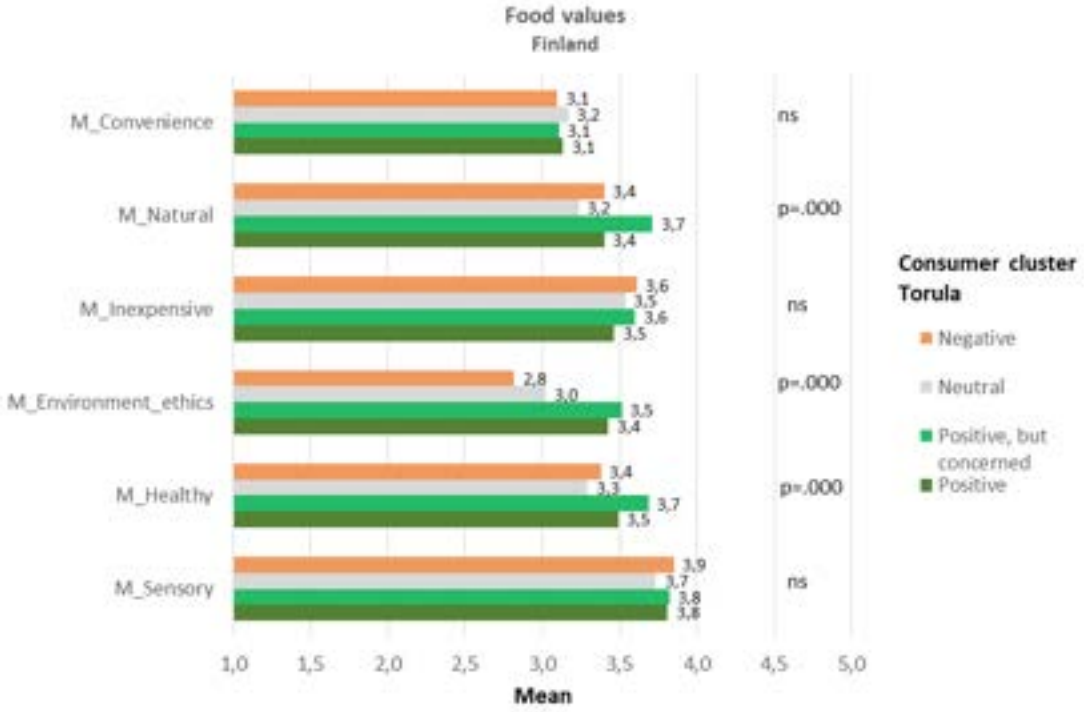


Figure 154. Importance of food values compared between the NextGen Torula consumer clusters in Finland. Means of compositive variables and statistical significance of means between the clusters (ns = not significant).

10.7.2.3 Interest to use food applications of NextGen Torula protein

The mean interest to use NextGen Torula food applications was highest in the cluster Positive and second highest in the Cluster Positive but concerned, and lowest in the cluster Negative – as it should be based on their views.

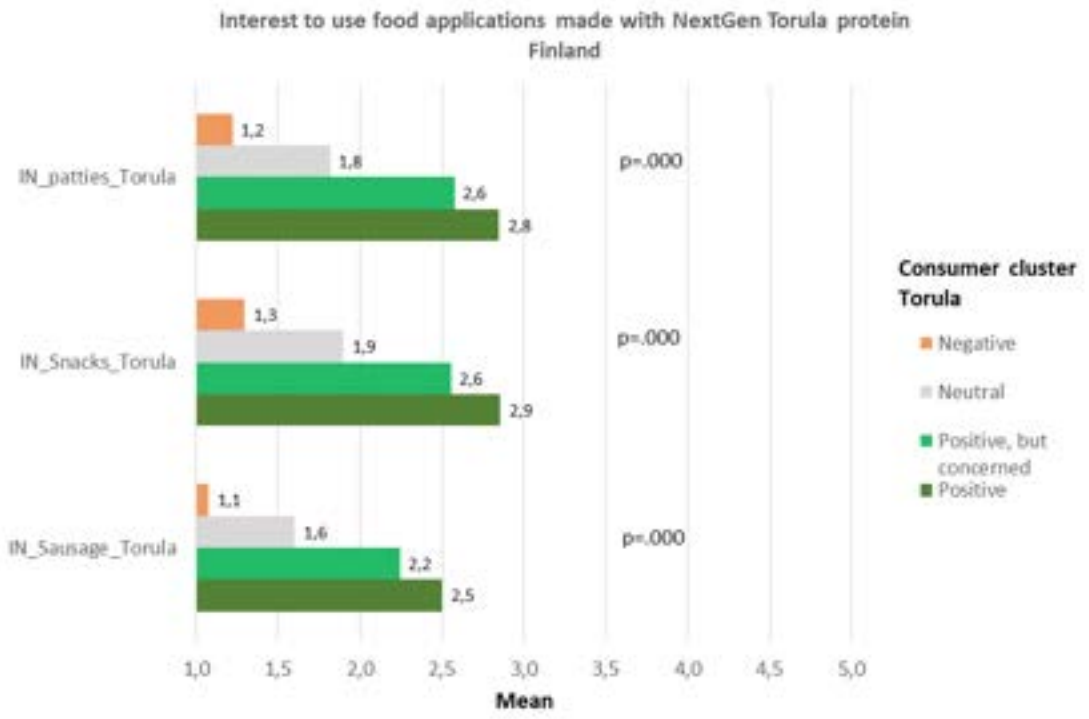


Figure 155. Interest to use food applications made with NextGen Torula protein and their conventional counterparts. Comparison of means between the consumer clusters for NextGen Torula concept.

11 Appendix B4 – SWEDEN survey report

11.1 Summary of the results from Sweden

The Swedish sample consisted of 1001 respondents, well distributed between different demographic groups. About 92 % of the respondents were omnivores and 8 % some form of vegetarians. Out of the omnivores, 40 % aimed to reduce their meat consumption or already do that. Environmental sustainability was the most common reason for reduction of meat consumption. Second was health.

Like in the other countries, the Swedish respondents are well familiar with conventional legumes such as peas and beans. In addition, soya and fungi-based proteins were familiar to many Swedish respondents as proximately 32 % claim they eat those at least occasionally. Even though majority of Swedish respondents had heard about insects or products containing them, only minority (8%) had tasted insects. In addition to insects, also lupine and fava beans as well as wheat-based meat substitutes were the most unfamiliar alternative protein foods. Even 65.2 % had not even heard about these.

Out of different actors of food chain, the Swedish respondents trusted most in small food producers and primary food producers (around 50 % had high trust and over 91 % at least moderate trust). Also, food scientists were highly trusted. Regulatory or supervising authorities was highly trusted by 36 % and food industry only by 15.7 % of the respondents.

Below half of the Swedish respondents were in favour of the NextGen microalgae (47.6 %) and NextGen Torula concepts (42.1 %). The NextGen insect concept was less popular, supported only by 28.6 % of the respondents. A large share had neutral or indifferent attitude and only minority was opposing these ideas of protein production. All the applied acceptance measures pointed to the same direction: NexGen microalgae and NextGen Torula were the easiest to accept, and the NextGen insect protein the most difficult one. Generally, respondents believed in the benefits of these concepts, especially regarding the benefits for environment and livestock. Less was believed in benefits to oneself and in benefits for the national economy. Out of the three types of risks, Swedish respondents were most concerned about risks of being misled by food companies. The general level of risk concern was rather low. E.g. only 19.6 % was concerned about “the unpredicted negative effects on the environment” in the case of NextGen microalgae concept, 25 % in the case of NextGen insect concept and 20.9 % in the case of NextGen Torula concept.

In this survey, we also asked respondents to rate their **interest to use three examples of food application**s made with either of the three NextGen proteins. Like in the other countries, sausages were less interesting carrier product for these ingredients than were vegetable-protein patties of salty snacks regardless of the NextGen ingredient.

Segmentation of Swedish consumers into clusters was carried out on the basis of how they rated each of the three NextGen concepts. Cluster analyses yielded **four clusters** for all the three concepts. For each of the NextGen concept, similar clusters Negative, Neutral and Positive were found. In the Negative clusters the consumers had the lowest attitudes, lowest beliefs in benefits and lowest preconceptions about the quality of food applications, but highest risk concerns. The Positive clusters were the opposite to the negative clusters with the most positive views, and the cluster Neutral was in-between. The fourth clusters differed a bit depending on the Nextgen concept. Cluster Positive, but concerned had positive ratings about NextGen microalgae, but was also to some extent concerned about the risks. In the case of insects, the fourth cluster was Negative, but not so concerned, as consumers in that cluster were less concerned about the risks compared to the Negative cluster. In the case of Torula, the fourth cluster was Positive, but suspicious. Suspiciousness refers to their more negative preconceptions about the quality of NextGen Torula food applications.

The lowest share of respondents was fell into the clusters Negative (12 % for microalgae and Torula, 16 % for insects), the neutral clusters were the highest (with 39 % - 45 % of the respondents depending on the concept). The clusters positive, and the other intermediate clusters comprised of 17 – 26 % of the respondents.

The above-mentioned consumer clusters were compared with each other in term of their background demographics, eating habits and attitudinal tendencies – separately for each of the NextGen concept.

The negative and positive clusters background opinions were pretty much opposite to each other differentiating these clusters from each other. The other clusters, which varied a bit depending on the concept were somewhere in-between these. Generally, **the positive clusters differed from the other clusters, or at least from the negative clusters as follows**: They were more likely to be younger than 45 y., have tertiary level education and live in the capital area, while in the less extreme groups the share of child families was highest. Consumers in the most positive segments more often follow either some form of vegetarian diet or restrict meat consumption. **However, in the case of NextGen insect concept, consumers views were not related to their diets.**

The clusters positive were, regardless of the NextGen concept, initially more familiar with various sources of alternative proteins, as well as with emerging new proteins. Further, compared to the other, more negative clusters, they had higher food innovativeness (interest towards new emerging food products), lower taste neophobia (thus less afraid of tasting new foods overall), and more positive attitude toward the use of novel and latest technologies in food production. In addition, the consumers in clusters with the most positive views, tended to be less attached to meat and have higher trust in food chain actors. However, actually, the most negative clusters stood out from other clusters in that

they are clearly most attached to meat eating. Finally, the positive and negative clusters also differed in terms of what they most value in their daily foods. For the positive clusters especially sustainable and ethical production, but in the case of Torula and microalgae also healthiness and naturalness were more important than for the other clusters.

In the case of insects, consumers background did not explain their cluster membership in the similar way than in the case of the other two NextGen concepts. This suggest, that being a vegetarian or a consumer who value healthiness and naturalness of food are not any more likely to accept NextGen insect concept than the other consumers. That is, insect-based concept is more likely to be rejected also by "avergage" people.

11.2 Participant characteristics, SE

11.2.1 Participants' demographics, SE

The Swedish (SE) sample consists of 1001 respondents. Respondents' demographics are described in Table 59 below. About half of them were male and the other half female. All demographic categories were quite well represented in the sample.

Table 59. Demographic background of Swedish respondents

	Count	Percent
Gender		
1. male	480	48.0%
2. female	518	51.7%
3. other / prefer not to say	3	0.3%
missing answer	0	0.0%
Total	*1001*	*100 %*
Age group		
1. 18 - 24 Years	85	8.5%
2. 25 - 34 Years	193	19.3.%
3. 35 - 44 Years	186	18.6.%
4. 45 - 54 Years	186	18.6%
5. 55 - 64 Years	174	17.4%
6. 65 - 75 Years	177	17.7%
Total	*1001*	*100 %*
Type of living area		
5. I live in the capital city / area	207	20.7%
6. I live in a large city that is not in the capital area	292	29.2%
7. I live in a small city/town or municipality	345	34.5%
8. I live in a rural area	157	15.7%
Total	*1001*	*100 %*
Region_SE		
13. Eastern central Sweden (östra mellansverige)	397	39.7%

14. Småland with the islands (Småland med öarna)	78	7.8%
15. Southern Sweden (sydsverige)	145	14.5%
16. Western Sweden (västsverige)	206	20.6%
17. Northern Sweden (norra sverige)	175	17.5%
Total	*1001*	*100 %*
Education		
9. Basic education or lower	68	6.8%
10. Upper secondary vocational qualification	120	12.0%
11. Upper secondary degree	309	30.9%
12. Tertiary degree or vocational qualification	134	13.4%
13. First stage of tertiary education	56	5.6%
14. Tertiary education. university, bachelor degree	219	21.9%
15. Tertiary education. university. master's degree or higher (MA/MSc. PhD. MD)	93	9.3%
16. Other / I do not know	2	0.2%
Total	*1001*	*100 %*
Education_3		
4. Basic (option 1)	68	6,8%
5. Secondary…first stage tertiary (options 2 – 5)	619	62%
6. Tertiary, university (options 6 – 7)	312	31,2%
Total	*999*	*100%*
Household type		
7. I live at home with my parents	61	6.1%
8. I live alone	297	29.7%
9. I live alone with my child / children	65	6.5%
10. I live with my spouse	304	30.4%
11. I live with my spouse and child / children	221	22.1%
12. I live with other adults (other than spouse or family members)	34	3.4%
Other	14	1.4%
Prefer not to say	5	0.5%
Total	*1001*	*100%*
Household_3 (2.9.)		
no children (options 2 and 4)	*601*	*61.2%*
with children (options 3 and 5)	*286*	*29.1%*
other (options 1 and 6 – 8)	*95*	*9.7%*
	982	*100%*

11.2.2 Participants' dietary habits and attitudinal background, SE

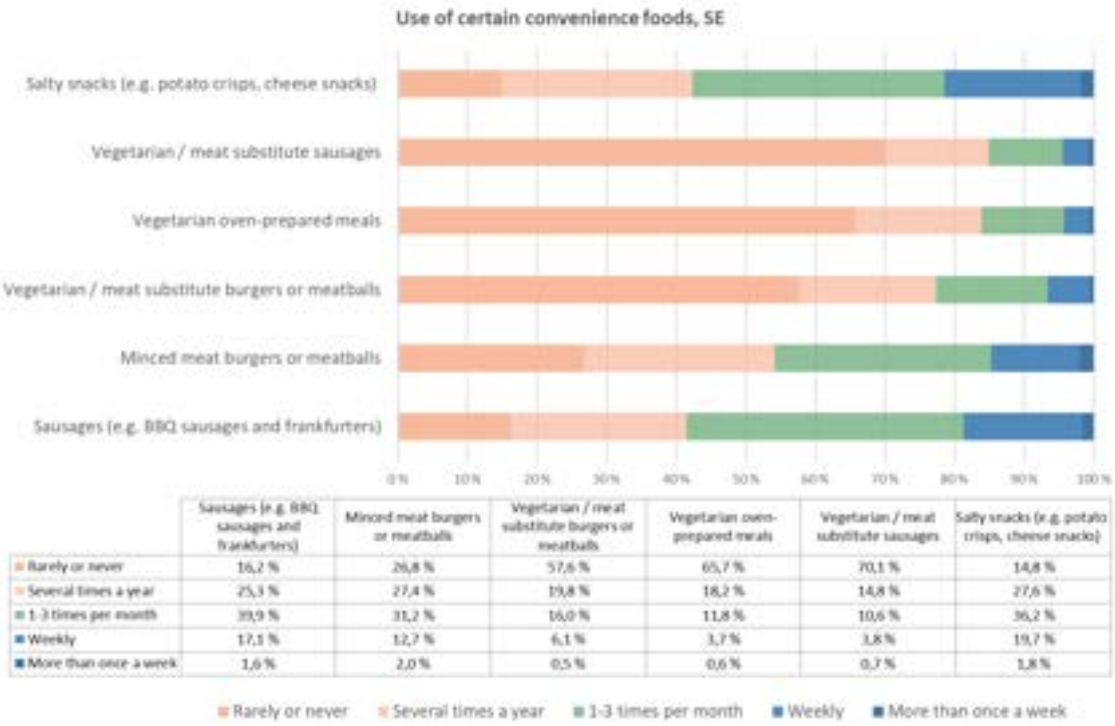
Most of the Swedish respondents were omnivorous and just 7.6% of respondents avoid eating meat and follow some form of vegetarian diet (see Table 60 below). From the consumers who eat red meat (diet 1 or 2), 40% indicate that they intentionally aim to reduce their meat consumption. Most of them responded that environmental sustainability was the main reason for this (33.6%). In addition, ethical reasons as well as personal health and wellbeing issues were seen as important reasons to reduce meat consumption.

Table 60. Dietary habits of respondents in Sweden

	Count	Percent
Diet		
1. I regularly eat products of animal origin and non-animal origin (omnivorous)	783	78.2%
2. I only eat meat sometimes (e.g. beef. pork. poultry. fish. seafood)	90	9.0%
3. I avoid red meat consumption (e.g. beef or pork). but eat other meat products like chicken or fish	45	4.5%
4. I do not eat meat (e.g. beef. pork or poultry). but I eat fish (I'm a pesco-vegetarian)	23	2.3%
5. I do not eat meat (e.g. beef. pork. poultry or fish). but I eat other products of animal origin (e.g. eggs, cheese, milk)	32	3.2%
6. I do not eat any meat. eggs or dairy products (I'm a vegetarian)	6	0.6%
7. I do not eat anything of animal origin (I'm a vegan)	15	1.5%
8. Other. specify:	7	0.7%
Total	*1001*	*100 %*
Diet_3		
1. Omnivore (option 1)	783	78.8%
2. Meat sometimes / no red meat (options 2-3)	135	13.6%
3. Vegetarian (options 5-7)	76	7.6%
Total	*994*	*100%*
Do you intentionally aim to reduce meat consumption? (question was targeted to respondents who described their diet with options 1 - 2 above)		
• Yes	348	39.9%
• No	525	60.1%
Total	873	*100%*
Main reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability, climate change	157	33.6%
2. Ethics. animal welfare	126	27.0%
3. My health and well-being	124	26.6%
4. High price of meat	29	6.2%
5. Taste and texture of meat	22	4.7%
6. Other. specify:	9	1.9%
Total	467	*100%*
Second most important reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability. climate change	149	31.9%
2. Ethics. animal welfare	104	22.3%
3. My health and well-being	118	25.3%
4. High price of meat	60	12.8%
5. Taste and texture of meat	31	6.6%
6. Other. specify:	5	1.1%
Total	467	*100%*

All together, the share of vegetarian convenience food used at least weekly basis by Swedish respondents is about 7%. The meat substitute burgers or meatballs were mainly

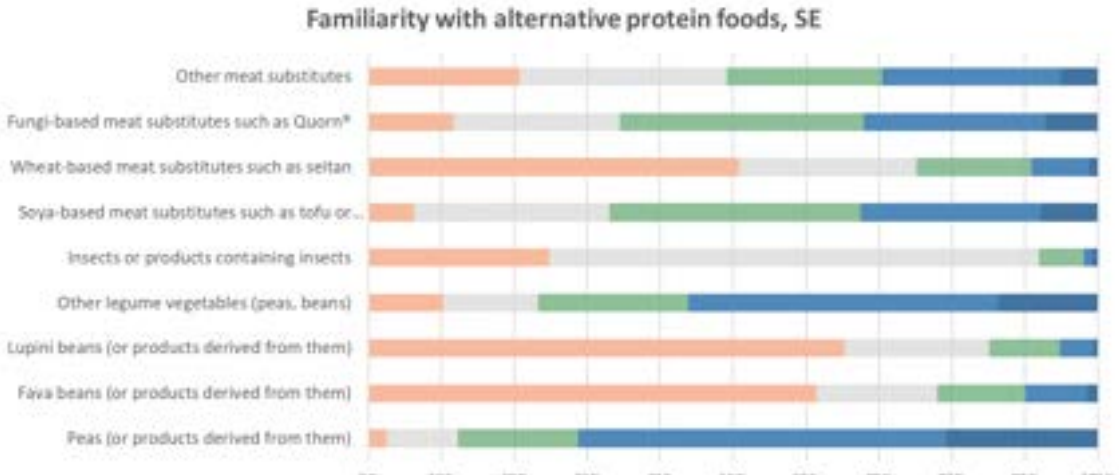
used vegetarian convenience foods, 22.6% of respondents eat these at least monthly (see Figure 156 below).



	Sausages (e.g. BBQ sausages and frankfurters)	Minced meat burgers or meatballs	Vegetarian / meat substitute burgers or meatballs	Vegetarian oven-prepared meals	Vegetarian / meat substitute sausages	Salty snacks (e.g. potato crisps, cheese snacks)
Rarely or never	16,2 %	26,8 %	57,6 %	65,7 %	70,1 %	14,8 %
Several times a year	25,3 %	27,4 %	19,8 %	18,2 %	14,8 %	27,6 %
1-3 times per month	39,9 %	31,2 %	16,0 %	11,8 %	10,6 %	36,2 %
Weekly	17,1 %	12,7 %	6,1 %	3,7 %	3,8 %	19,7 %
More than once a week	1,6 %	2,0 %	0,5 %	0,6 %	0,7 %	1,8 %

Figure 156. Use of certain convenience foods by the Swedish respondents.

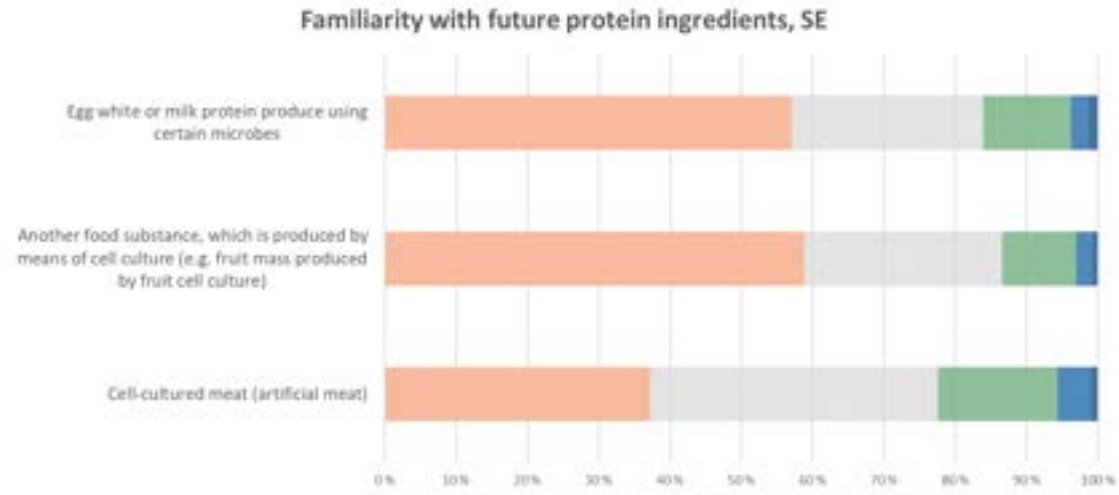
The respondents were asked to rate their familiarity with various proteins sources other than animal based (Figure 157). Like in the other countries, the Swedish respondents are well familiar with conventional legumes such as peas and beans. About 56 % eat “other legume vegetables” at least occasionally. In addition, soya and fungi-based proteins were familiar to many Swedish respondents and approximately 32 % claim they eat them at least occasionally. Even though majority of Swedish respondents have heard about insects or products containing them, only minority (8%) had tasted them. In addition to insects, also lupine and fava beans as well as wheat-based meat substitutes were the most unfamiliar alternative protein foods. Even 65.2 % had not even heard about those.



	Peas (or products derived from them)	Fava beans (or products derived from them)	Lupini beans (or products derived from them)	Other legume vegetables (peas, beans)	Insects or products containing insects	Soya-based meat substitutes such as tofu or tempeh	Wheat-based meat substitutes such as seitan	Fungi-based meat substitutes such as Quorn®	Other meat substitutes
I have not heard of these	2,5 %	61,5 %	65,2 %	10,2 %	24,8 %	6,2 %	50,8 %	11,6 %	20,7 %
I have heard of these, but I have not tried them	9,7 %	16,5 %	19,9 %	13,1 %	67,2 %	26,9 %	24,3 %	22,9 %	28,5 %
I have tried these, but I do not use them	16,5 %	12,1 %	9,7 %	20,6 %	6,1 %	34,5 %	15,8 %	33,5 %	21,3 %
I eat these occasionally	50,5 %	8,5 %	4,6 %	42,5 %	1,2 %	24,8 %	7,9 %	25,0 %	24,5 %
I eat these often	20,8 %	1,4 %	0,6 %	13,7 %	0,7 %	7,7 %	1,2 %	7,1 %	5,3 %

Figure 157. Swedish respondents' previous familiarity with alternative protein sources and meat substitutes made of these

Swedish respondents were not familiar with future protein ingredients, which can be seen in Figure 158 below. Cell-cultured meat was the one that most of them have heard of, however only some respondent had understanding of it or they have read an article about the subject (21.5 %).

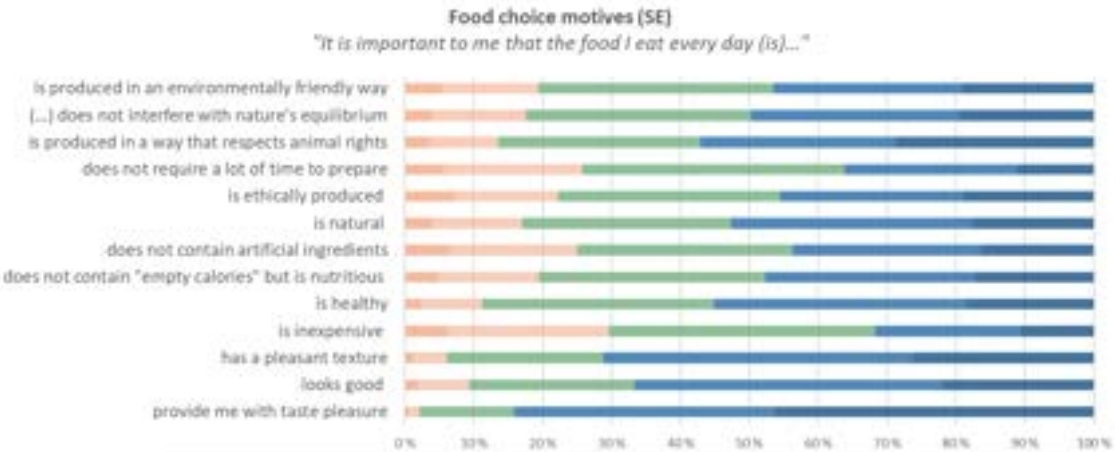


	Cell-cultured meat (artificial meat)	Another food substance, which is produced by means of cell culture (e.g. fruit mass produced by fruit cell culture)	Egg white or milk protein produce using certain microbes
I have never heard of them	37,3 %	58,8 %	57,0 %
I have heard of them but I don't know anything about it	40,4 %	27,8 %	26,9 %
I have an understanding of what this is	16,8 %	10,4 %	12,3 %
This is rather familiar to me (e.g. I have read articles about it)	4,7 %	2,3 %	2,6 %
I know quite a lot about the subject	0,9 %	0,7 %	1,2 %

Figure 158. Familiarity with future (emerging) protein sources, SE

Figure 159 describes Swedish respondents' answers to question about important aspects for them in their daily foods. The overall result is typical since most respondents rated sensory

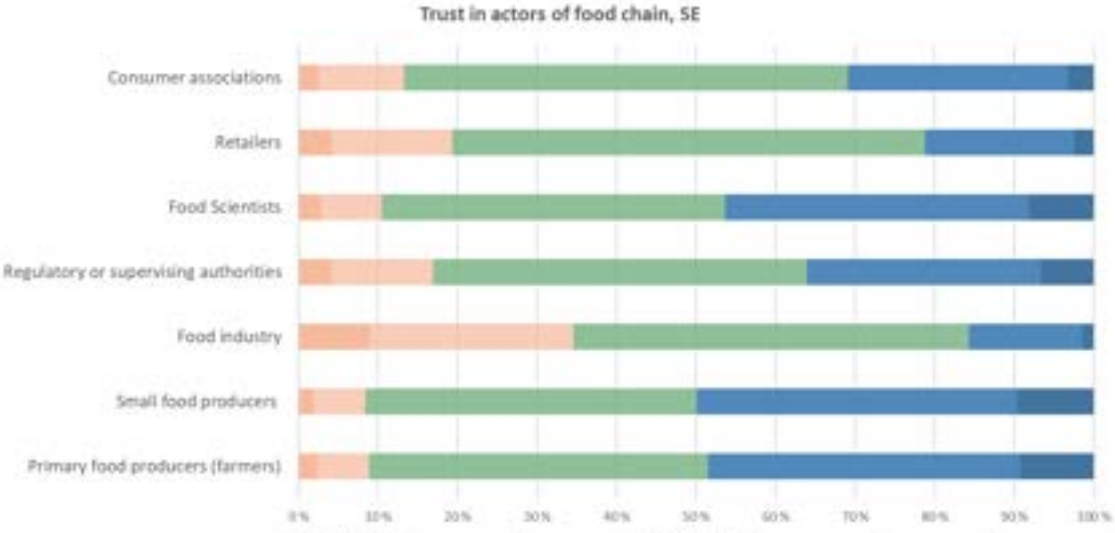
quality characteristics like taste as extremely important. The ethical issues like animal welfare, healthiness and environmental issues were also considered to be important.



	provide me with taste pleasure	looks good	has a pleasant texture	is inexpensive	is healthy	does not contain "empty calories" but is nutritious	does not contain artificial ingredients	is natural	is ethically produced	does not require a lot of time to prepare	is produced in a way that respects animal rights	(...) does not interfere with nature's equilibrium	is produced in an environmentally friendly way
Not important at all	0,5 %	1,8 %	1,1 %	6,1 %	2,4 %	4,7 %	6,6 %	4,0 %	7,2 %	5,7 %	3,5 %	3,7 %	5,3 %
Slightly important	1,6 %	7,6 %	5,0 %	23,6 %	8,8 %	14,7 %	18,4 %	13,0 %	15,0 %	20,1 %	10,1 %	13,9 %	14,1 %
Rather important	13,8 %	24,0 %	22,7 %	38,7 %	33,7 %	33,0 %	31,4 %	30,4 %	32,3 %	38,1 %	29,4 %	32,7 %	34,1 %
Important	37,9 %	44,8 %	44,9 %	21,0 %	36,7 %	30,4 %	27,4 %	35,1 %	26,6 %	25,1 %	28,4 %	30,2 %	27,5 %
Extremely important	46,3 %	21,9 %	26,4 %	10,7 %	18,5 %	17,3 %	16,3 %	17,6 %	19,0 %	11,1 %	28,7 %	19,6 %	19,1 %

Figure 159. Perceived importance of food values (food choice motives) in the Swedish sample.

The Swedish respondents trust towards small food producers and farmers is in good level since over 90 % of them has at least moderate trust in them. Trust in the larger food industry is lowest, still 65.5 % had at least moderate trust in them (Figure 160)



	Primary food producers (farmers)	Small food producers	Food industry	Regulatory or supervising authorities	Food Scientists	Retailers	Consumer associations
Don't trust at all or have very little trust	2,3 %	1,9 %	9,0 %	4,1 %	2,8 %	4,1 %	2,5 %
Have some trust	6,6 %	6,5 %	25,6 %	12,8 %	7,7 %	15,3 %	10,8 %
Have a moderate amount of trust	42,6 %	41,7 %	49,8 %	47,1 %	43,2 %	59,4 %	55,7 %
Have a lot of trust	39,3 %	40,4 %	14,3 %	29,5 %	38,3 %	18,8 %	27,7 %
Have very much trust	9,3 %	9,6 %	1,4 %	6,6 %	8,1 %	2,4 %	3,3 %

Figure 160. Trust in various actors of food chain in the Swedish sample.

11.3 Forming the composite variables for further analysis, Sweden

Composite variables were formed as **means** of items, which measured the same dimension based on these analyses in addition to the theory (see Table 61).

11.3.1 New variables describing respondents' background attitudes, Sweden

Factor analyses (principal axis factoring, varimax rotation) were performed to check the dimensionality of items for each scale. In the case of the items measuring Food technology attitudes (Q9) and Meat attachment (Q7) the analysis yielded two factors with eigenvalues over 1. Based on the emerged dimensions, two variables were constructed of these. However, as the two dimensions represented opposite views: negative vs. positive, and using these distinct variables did not increase understanding compared to the analysis using one composite variable, we decided to apply one composite variable per theoretical concept instead of the two (the ones not applied have been struck through in the list below). That is, the measures of Meat_attachment and F_innovativeness are applied.

Table 61. Composite variables describing Swedish respondents' background attitudes. The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.80
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	.83
Trust	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	.84
FTechnology_attitude	Attitude towards new food technology	Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV	.74
Meat_attachment	Attachment to meat eating	Q7r1, Q7r2, Q7r4, Q7r5, Q7r6, Q7r9, Q7r3_REV, Q7r7REV, Q7r8_REV	.90
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.89
F_innovativeness	Food innovativeness (interest in new food products)	(all items) Q11r1_REV, Q11r2, Q11r3, Q11r4	.76
Use_vege_convemience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.86
Use_meat_convenience	Mean frequency of use of meat based convenience foods	Q5r1, Q5r2	.78

Table 62. New variables to describe Swedish respondents' food values.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
M_Sensory	Good sensory characteristics of food	Q6r1, Q6r2, Q6r3	.80
M_Healthy_and_Natural	Healthiness and natural food	Q6r5, Q6r6, Q6r7, Q6r8	.84
M_Environment_ethics	Sustainable and ethical production	Q6r9,Q6r11, Q6r12, Q6r13	.90
M_Convenience	Does not require long time to prepare	Q6r10	
M_ Inexpensive	Is inexpensive in price	Q6r4	

11.3.2 New variables measuring acceptance of the three NextGen concepts, SE

New variables were formed to reflect positivity or negativity of respondents' ***attitude*** towards each of the three NextGen concepts. In addition, composite variables were formed to measure respondents' beliefs in ***benefits*** of each of the NextGen concept as well as to indicate the strength of respondents' concern about potential ***risks*** of the NextGen concepts. All the resulting variables had high internal reliabilities. Finally, also respondents' ratings (views or pre-assumptions) about the characteristics of food products made using each of the NextGen ingredient were averaged for each Nextgen concept to form a composite measure of how positively or negatively NextGen microalgae, NextGen insect and NextGen Torula based food application are viewed. The latter are subsequently called ***food application views***.

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" are not included in the analyses, which apply these variables.

Table 63. Composite variables measuring acceptance, their contents and reliabilities (SE). The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	Cronbach Alpha
ATTITUDES		
ATT_Algae	Attitude towards NextGen microalgae protein *(mean of items Q12r1, Q12r2, Q12r4)*	.94
ATT_Insect	Attitude towards NextGen insect protein *(mean of items Q17r1, Q17r2, Q17r4)*	.94
ATT_Torula	Attitude towards NextGen Torula protein *(mean of items Q22r1, Q22r2, Q22r4)*	.92
PERCEIVED BENEFITS	*mean of all 5 items*	
BENEFIT_Algae	Likelihood of benefits from NextGen microalgae protein *(mean of items Q13r1 – Q13r5)*	.88
BENEFIT_Insects	Likelihood of benefits from NextGen insect protein *(mean of items Q18r1 – Q18r5)*	.89
BENEFIT_Torula	Likelihood of benefits from NextGen Torula protein *(mean of items Q23r1 – Q23r5)*	.87
PERCEIVED RISKS	*mean of 3 items, "other risk" not included*	
RISK_Algae	Concern about risks relating to production of NextGen microalgae proteins	.90

	(mean of items Q14r1-Q14r3)	
RISK_Insects	Concern about risks relating to production of NextGen insect proteins *(mean of items Q19r1-Q19r3)*	.89
RISK_Torula	Concern about risks relating to production of NextGen Torula proteins *(mean of items Q24r1-Q24r3)*	.89
FOOD APPLICATION VIEWS	*mean of all the 7 items*	
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein *(mean of items Q15r1-Q15r7)*	.94
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein *(mean of items Q20r1-Q20r7)*	.94
FOODVIEWS_Torula	Views towards foods made with NextGen Torula protein *(mean of items Q25r1-Q25r7)*	.95

11.4 Comparison of the three NextGen protein production concepts and applications in Sweden

11.4.1 Which of the NextGen ingredients is most positively viewed in Sweden?

All the (composite variables of) acceptance measures suggest – like in the other countries – that the NextGen concept of Microalgae protein was easiest to accept followed by Torula concept, and the NextGen concept with insect based protein was clearly the most difficult to accept.

All the acceptance measures suggest the same result: attitudes towards NextGen insects are more negative, respondents have in average lower belief in the benefits of it and higher risk concerns when compared with the other NextGen concepts. Respondents expect the quality of food products be lower if the food is made with NextGen insect protein vs. the NextGen microalgae or Torula protein. Finally, the interest to use the examples of food applications (sausages, vegetable-protein patties and salty snacks) is lower in the case of NextGen insect protein. (See Figure 161 and Table 64).

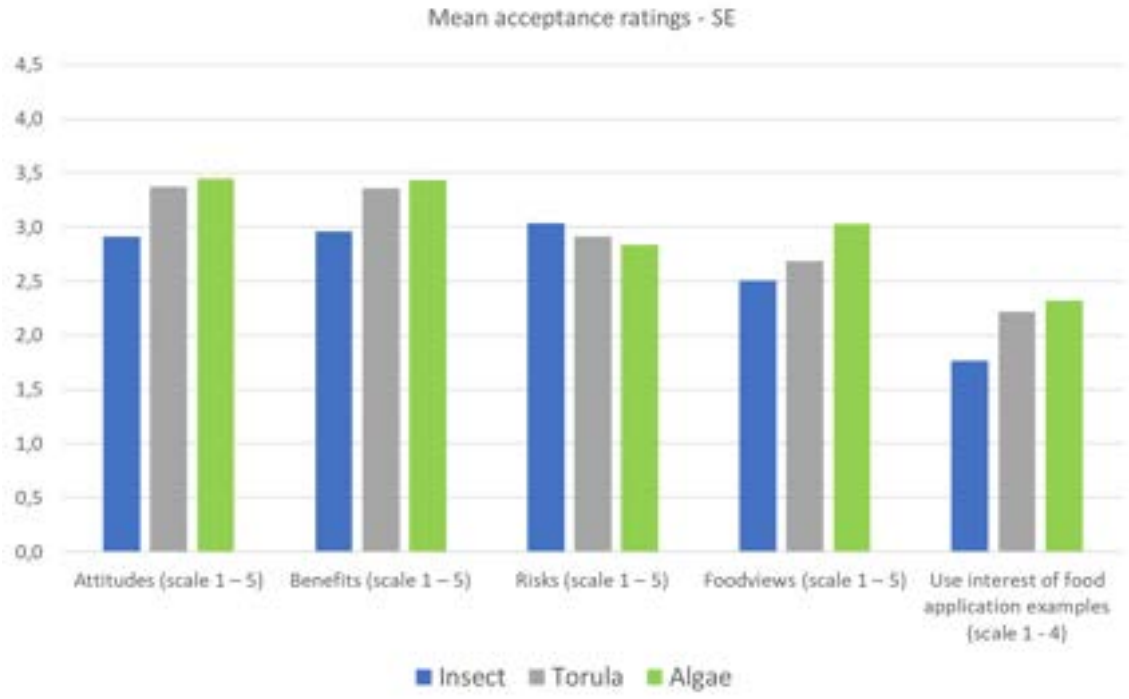


Figure 161. Means of composite variables measuring acceptance towards each of the three NextGen protein concept in Swedish sample.

Table 64. Comparison of means of acceptance ratings (composite variables) between the three Nextgen protein concepts. Significance of difference tested with repeated measures analysis of variance. Sweden.

Composite variables:	Insect	Torula	Algae	df	F	Sig.
Attitudes (scale 1 – 5)	2,91	3,37	3,45	2	145.322	.000
Benefits (scale 1 – 5)	2,96	3,36	3,43	2	133.99	.000
Risks (scale 1 – 5)	3,03	2,91	2,83	2	19.956	.000
Foodviews (scale 1 – 5)	2,51	2,69	3,03	2	198.646	.000
Use interest of the food application examples (scale 1 - 4)	1,77	2,22	2,32	2	297.902	.000

The Figure below shows respondents' answers to questions about preconceptions they might have about the food application of the NextGen concepts (Q15, Q20, Q25). The respondents in Sweden expected **the microalgae based NextGen protein food applications to be of bit better quality** compared to those based on Torula or insect. The views about insect-based food applications were more negative. Respondents imagined insect-based food applications as more **repulsive** more **weird, worse tasting, and more unhygienic** in comparison to the other two NextGen ingredients. However, in safety, healthy and natural issues respondents' preconceptions were quite similar in insect and Torula based food applications. Figure 162.

All the means of food views significantly differed between the three NextGen concepts (Table 65).

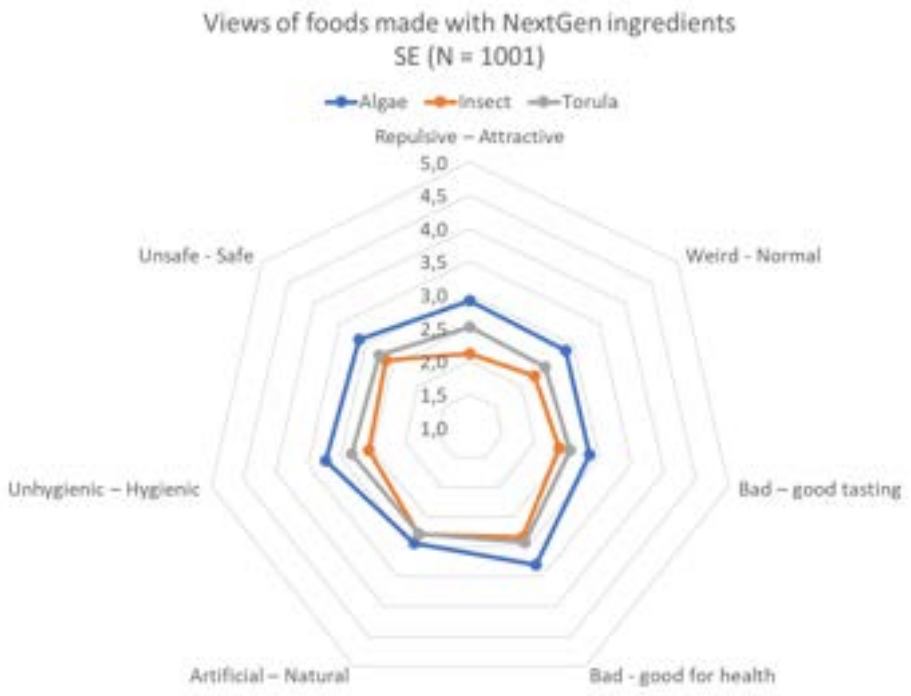


Figure 162. Means of respondents' Food views, i.e. their preconceptions about the characteristics of (imaginary) foods made using the NextGen ingredients. (The questions Q15, Q20 and Q25 in the survey: "In my opinion food products containing ____ protein seem to me as…"). Sweden.

Table 65. Means of respondents' preconceptions about the characteristics of imaginary foods made using the NextGen ingredients. Sweden. Significance of differences in means between the NextGen ingredients tested with repeated measures analysis of variances.

Food application views	Algae	Insect	Torula	df	F	Sig.
Repulsive – Attractive	2,91	2,11	2,52	2	245,981	.000
Weird - Normal	2,86	2,25	2,45	2	147,377	.000
Bad – good tasting	2,85	2,39	2,56	2	106,811	.000
Bad - good for health	3,30	2,84	2,93	2	98,805	.000
Artificial – Natural	2,94	2,79	2,77	2	11,661	.000
Unhygienic – Hygienic	3,23	2,55	2,82	2	178,627	.000
Unsafe - Safe	3,13	2,62	2,74	2	122,530	.000

11.4.2 What is the most interesting food application of NextGen in Sweden?

Both the type of the ingredient and the type of the food influenced respondents' interest to use the example food applications *(interaction effect of food type x ingredient F(4)=10.359, p=.000)*. Sausage applications gained least interest *(repeated measures of analysis of variance, main effect of food type: F(2)=283,863, p=.000)*, and use interest of the applications made with NextGen insect protein was lower than that of the other NextGen ingredient types *(main effect of ingredient: F(2)=83.290, p=.000).* Figure 163.

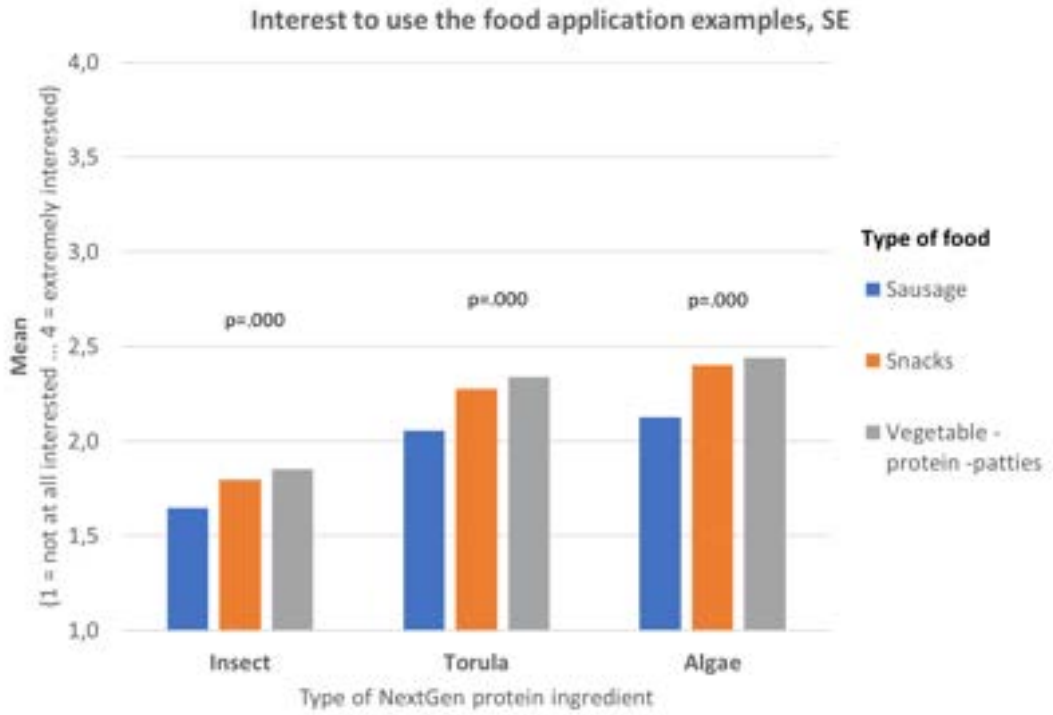


Figure 163. Means of interest to use the examples NextGen food applications by product type and NextGen ingredient type in Sweden. Significance of differences in means between the food types (repeated measures analysis of variance).

11.5 Acceptance of NextGen Microalgae protein, Sweden

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views towards the NextGen microalgae concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen microalgae method and foods.

11.5.1 The level of acceptance of NextGen microalgae protein, Sweden

Nearly half (47.6 %) of the Swedish respondents were in favour of the idea of production of NextGen **microalgae** protein to be applied in foods. About 35.3 % had neutral attitude, and the minority (17.2 %) was against the idea. In addition, the respondents thought it is good idea (49 %) and wise (48.1 %) to produce NextGen microalgae protein food ingredient. About third of respondents (28 %) felt the NextGen microalgae concept as difficult to understand. Figure 164.

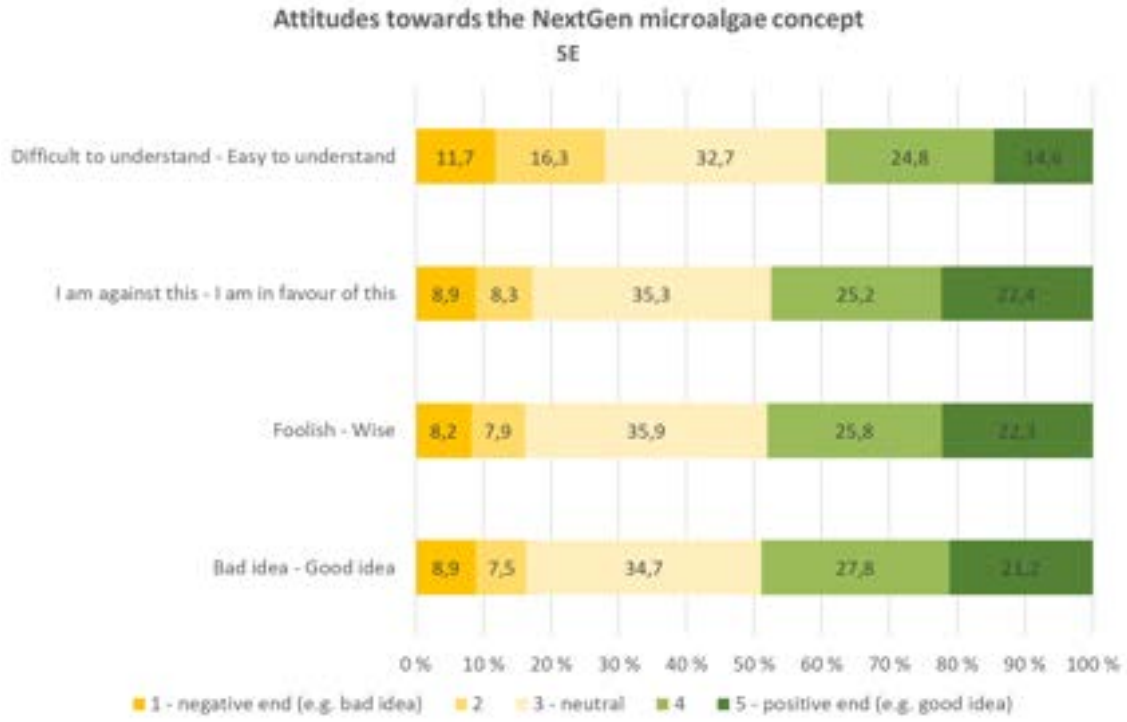


Figure 164. Attitudes towards the NextGen microalgae concept. Percentages of the Swedish respondents.

Over half of the respondents in Sweden believed that production of NextGen microalgae protein and its' application in food would result in the benefits for environment (53.4%) and to bring better life for the production animals (51.8%). The benefits for human health were less expected (41.3%) and even less for personal benefits (31.2%). Figure 165.

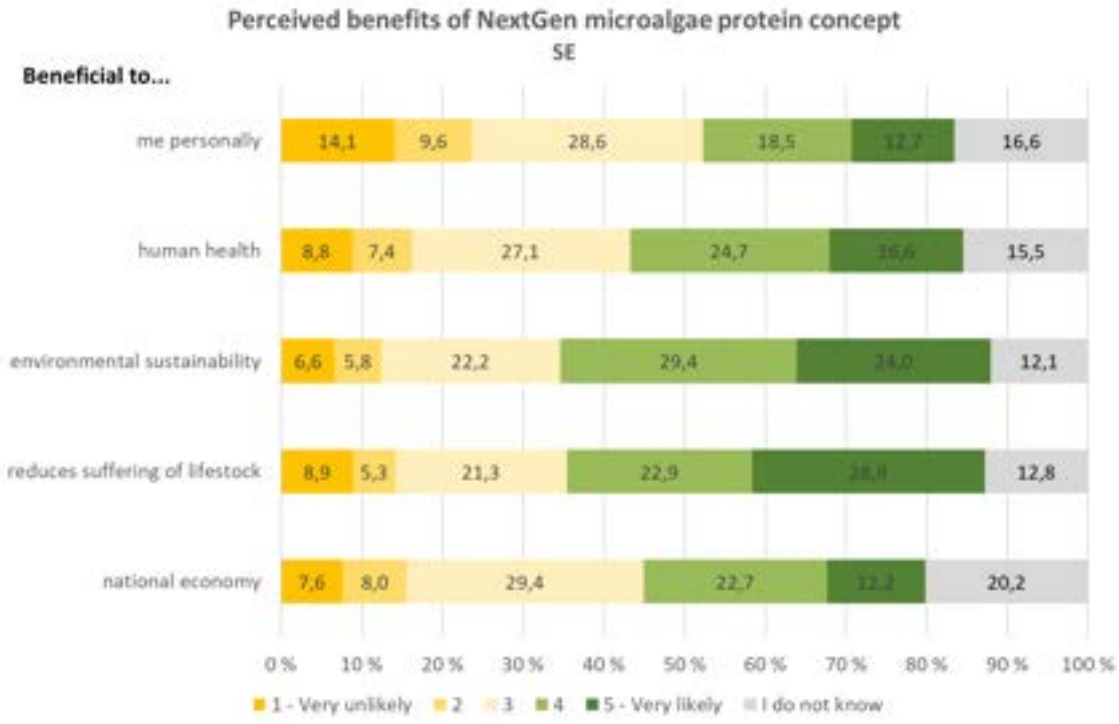


Figure 165. Perceived benefits of the NextGen microalgae protein concept. Percentages of the Swedish respondents.

The risks the Swedish respondents were most worried about were related to the honesty and integrity of the food companies. Around 30 % was concerned about being misled by the food companies in relation to production and food application of NextGen microalgae protein. Potential risks for the environment or human health caused somewhat least concern. Figure 166.

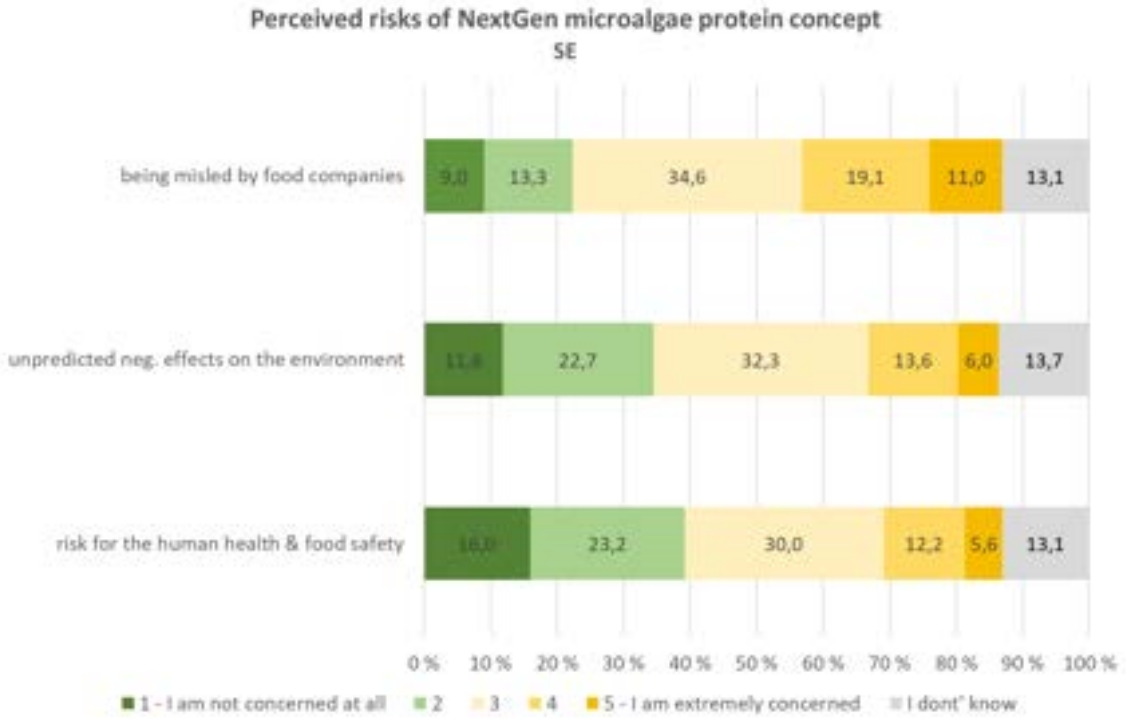


Figure 166. Perceived risks of the NextGen microalgae protein concept. Percentages of Swedish respondents.

Very large share of respondents selected the middlemost alternative indicating that they do not have any clear expectation about the characteristics of the food applications made with NextGen microalgae. It is natural, since these applications are not available in the market yet and respondents feel they are not able to evaluate these foods. In addition, it is noteworthy that many respondents did not hold negative preconceptions towards food applications of NextGen microalgae protein. Figure 167.

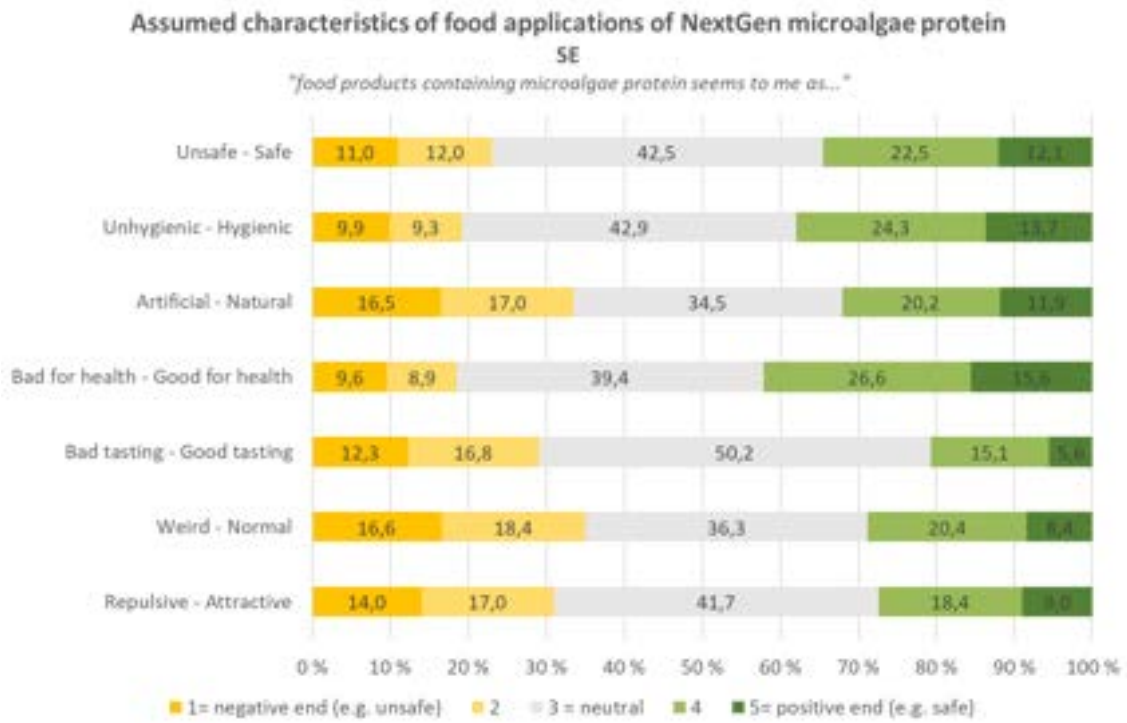


Figure 167. Characteristics associated by respondents with the imaginary food applications made with NextGen microalgae protein. Percentages of Swedish respondents.

Swedish respondents expected their social environment would not appreciate much these foods even though their own attitudes towards NextGen microalgae protein were more in positive than negative end. Figure 168.

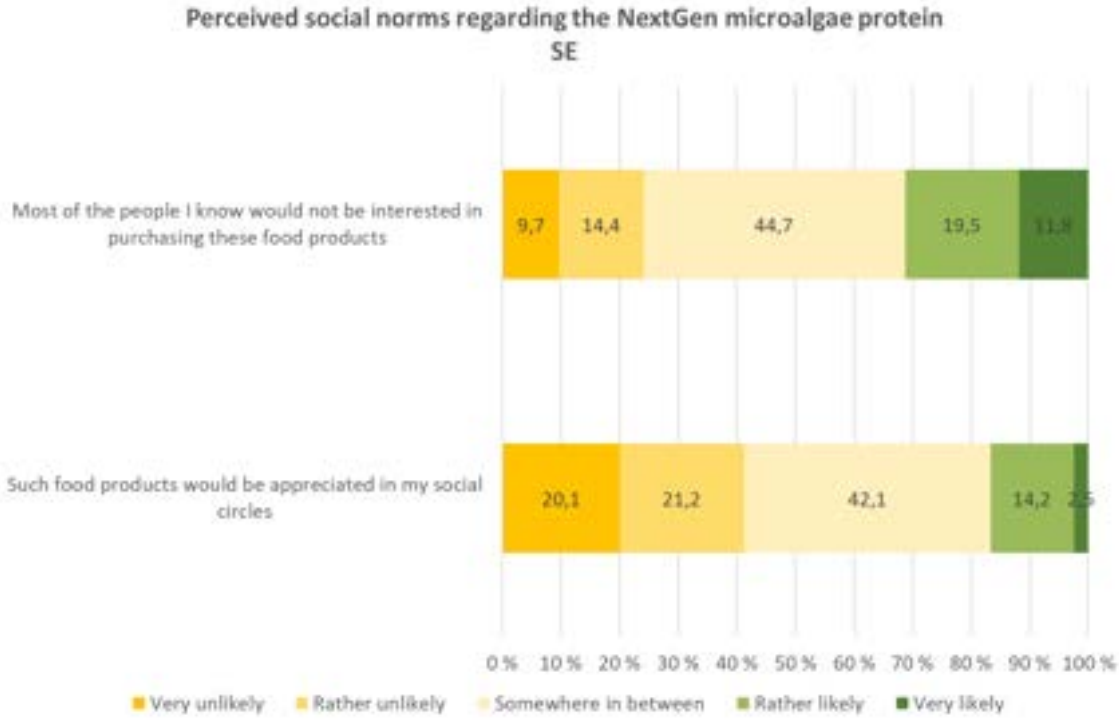


Figure 168. Perceived social norms regarding NextGen microalgae protein food products. Percentages of Swedish respondents.

Out of the three food applications presented as examples of NextGen microalgae applications, Swedish respondents found using the patties and salty snacks containing

NextGen microalgae protein as interesting (48.4 % and 47.1 % of respondents, respectively). The sausage application gained a bit less interest while 35.8% responded to be rather or extremely interested to use sausages containing microalgae protein. Figure 169.

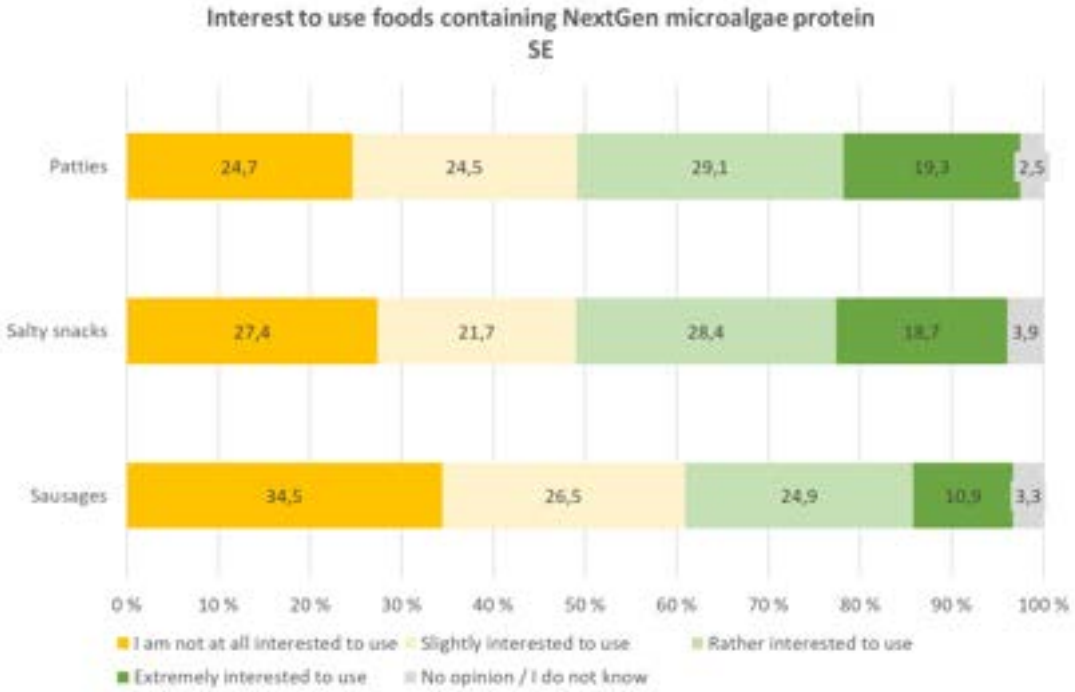


Figure 169. Interest to use the food application examples of NextGen microalgae protein. Shares of Swedish respondents with each answer alternative.

For the sake of comparison, use interests of the conventional food products of correspondent type can be seen in Figure 170.

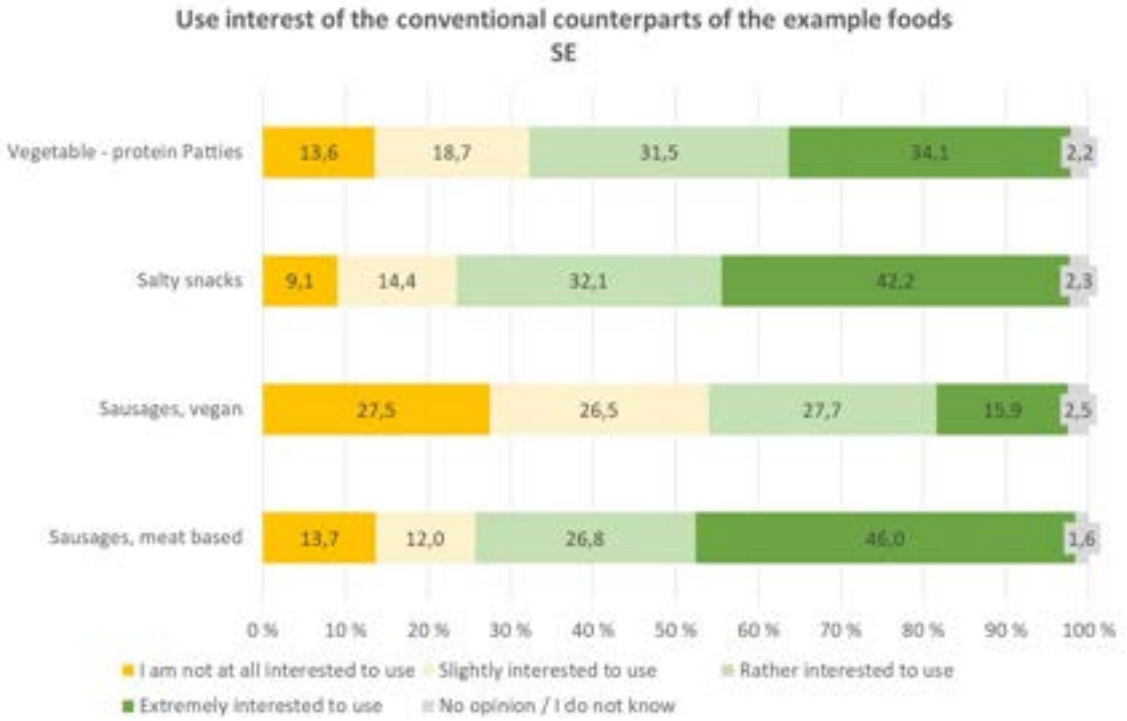


Figure 170. Use interest of the conventional counterparts of the food application examples. Percentages of Swedish respondents.

11.5.2 Consumer clusters based on ratings of NextGen microalgae concept, Sweden

Based on variables ATT_Algae, Benefit_Algae, Risks_Algae and Foodviews_Algae the Swedish respondents were clustered into segments reflecting their views towards the Next Gen microalgae concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 3 – 4 clusters. Subsequent K-means clustering, run with 3 and 4 clusters, confirmed that 4 cluster solution best brings out the differences in the sample. One of the clusters consists of respondents with negative views, another with neutral views and the third with positive views. The fourth cluster consist of the respondents with positive view but concerns about risks of NextGen microalgae.

Table 66. Consumer clusters based on respondents' views towards NextGen microalgae protein concept. The result of K-means cluster analysis with 4 clusters. SE

	1 - Negative	2 - Neutral	3 - Positive concerned	4 - Positive	Total	F	Sig.
Number of cases	104	346	208	228	886		
Percent of cases	12%	39%	23%	26%	100%		
ATT_Algae	1,72	2,98	4,05	4,65	3.51	818.695	.000
BENEFIT_Algae	1,52	3,15	3,94	4,32	3.44	580.574	.000
RISK_Algae	3,76	2,89	3,41	1,77	2.83	270.702	.000
FOODVIEWS_Algae	1,50	2,71	3,44	4,05	3.08	549.402	.000

The clusters were named based on their means on the clustering variables. **The first cluster** will be called **Negative** as respondents in this cluster had the most negative attitude towards NextGen microalgae protein concept. This cluster consist of 12 % of the respondents. They had lowest beliefs in the benefits, lowest expectations about the quality and they were most concerned about risks related to this concept. The second and largest cluster includes 39 % of the respondents and was called **Neutral**, because all the ratings of this group were at average level compared to the other clusters. The third cluster is called **Positive but concerned** and 23 % of the respondents were classified into this cluster. They had relatively positive attitudes and higher beliefs in benefits, but they were also moderately concerned about potential risks of the concept and about the quality of the food applications. The fourth cluster **Positive** (26 % of the respondents) had the most positive responses on all the scales – they believed most in benefits and were least concerned about risks. Table 66.

11.5.2.1 Demographic profile and eating habits of NextGen microalgae consumer clusters, Sweden

The demographic profiles of the four clusters are described in Table 67. The following list summarises the characteristics that differentiate each cluster from the other clusters. More

detailed results are presented in the figures and tables that follow (Table 67 and Figure 171). Note that the comparison between cluster characteristics is based on comparing the shares (% of consumers) in each cluster.

Compared to the other clusters, the members of **cluster Positive** were

- more likely to have higher (tertiary) level education
- more likely to be under 54 years old
- more likely vegetarians or eating meat sometimes
- most familiar with alternative proteins

Positive but concerned cluster has almost similar profile than the Positive cluster

- younger (especially in the age group 25 – 34 y.).
- more likely vegetarians or eating meat sometimes
- most likely user of vegetarian convenience foods
- most familiar with alternative and future proteins

In contrast, the members of the **Negative** cluster were likely to

- more likely to have secondary level education
- belong to the age groups 45 – 75 y.
- having no children
- have omnivorous diets
- least familiar with alternative or future proteins
- least likely user of vegetarian convenience foods

While in the **Neutral cluster**

- most likely living in the small city or municipalities
- younger age groups (25 – 44 y.) were most common
- in between the other clusters regarding e.g. familiarity with alternative and future proteins

No significant differences were observed between the clusters in gender, age group, nor type of living area.

Table 67. Demographic profile of consumer clusters based on views towards NextGen microalgae protein concept, SE

	Negative	Neutral	Positive concerned	Positive	Total %	Pearson Chi²	Sign.	Total N
Gender_2						5.961	ns	883
male	**57.7%**	47.4%	52,4%	44.9%	49.2%			
female	42.3%	52.6%	47,6%	**55.1%**	50.8%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Age group						17.522	ns.	886
18 - 24 Years	4.8%	9.5%	8.7%	10.1%	8.9%			
25 - 34 Years	12.5%	21.1%	20.7%	21.5%	20.1%			
35 - 44 Years	12.5%	19.9%	20.2%	18.0%	18.6%			
45 - 54 Years	24.0%	16.8%	15.4%	18.4%	17.7%			
55 - 64 Years	21.2%	15.6%	18.3%	14.5%	16.6%			
65 - 75 Years	25.0%	*17.1%*	*16.8%*	*17.5%*	*18.1%*			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Education_3						18.427	0.005	884
Basic	6.8%	5.8%	4.3%	6.6%	5.8%			
Secondary...first stage tertiary	**75.7%**	64.3%	59.1%	**54.8%**	62.0%			
Tertiary, university	**17.5%**	29.9%	36.5%	**38.6%**	32.2%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Type of living area						14.841	ns.	886
Capital area	14.4%	22.3%	21.2%	**24.1%**	21.6%			
a large city that is not in the capital area	**34.6%**	24.9%	27.4%	**32.9%**	28.7%			
a small city/town or muncipality	30.8%	**38.4%**	33.2%	29.8%	34.1%			
a rural area	20.2%	14.5%	18.3%	13.2%	15.7%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Household_3						13.346	0.038	870
no children	**73.0%**	58.0%	59.4%	61.8%	61.0%			
1-2 with children	25.0%	32.0%	30.4%	25.8%	29.2%			
something else	**2.0%**	10.1%	10.1%	12.4%	9.8%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Diet						20.883	0.002	881
ominivore	**88.3%**	**82.3%**	74.0%	70.4%	78.0%			
meat sometimes or no red meat	8.7%	10.5%	**17.3%**	**18.1%**	13.8%			
vegetarian	2.9%	7.3%	8.7%	**11.5%**	8.2%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			

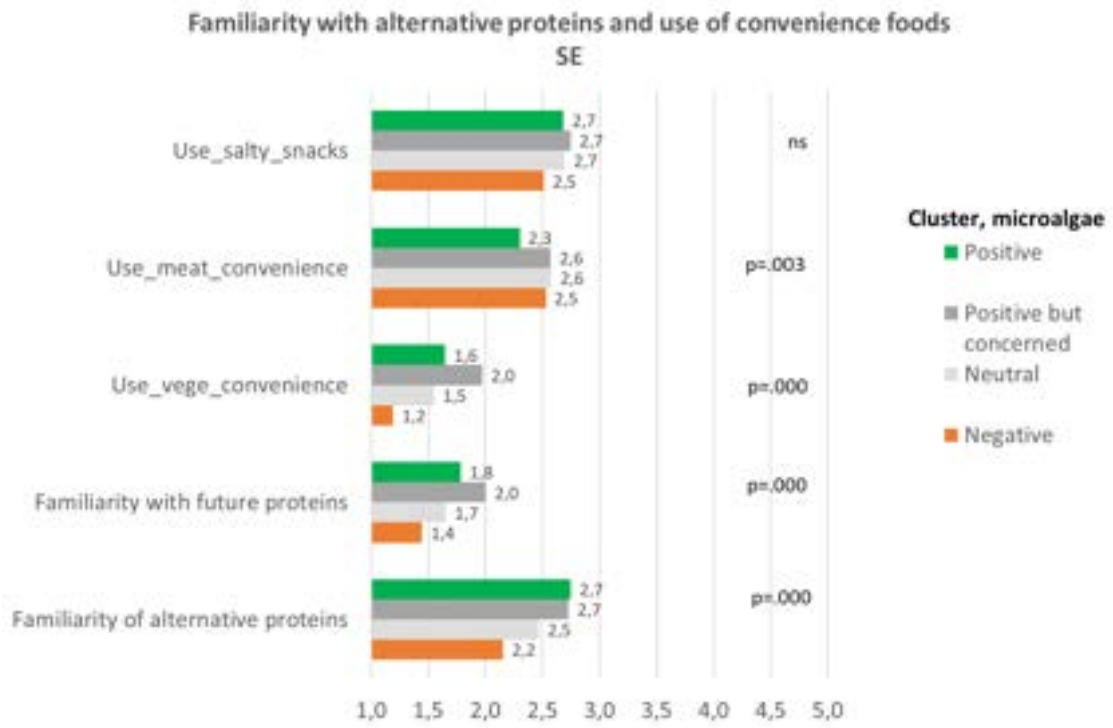


Figure 171. Use of certain convenience food types and familiarity with alternative proteins by NextGen microalgae consumer clusters in the Swedish sample. Means. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

11.5.2.2 Attitudinal background of NextGen microalgae consumer clusters, Sweden

The negative and positive clusters opinions were pretty much opposite to each other differentiating these clusters from each other. The cluster Neutral has neutral attitudes towards the NextGen microalgae concept and their background attitudes were mainly neutral as well. Compared with the Negative and Neutral clusters the clusters Positive and Positive but concerned had in average lowest attachment to meat (i.e. eating of meat is less important for them) and they were more likely interested in new food products in general. In addition, the Positive cluster was most positive towards the use of novel food technologies. Figure 172.

Positive clusters views towards NextGen microalgae concept can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having lower taste neophobia (reluctance to taste unfamiliar tastes)
- having more positive attitudes towards food technology in general
- being less attached to meat

The Positive and Positive but concerned clusters seem to be more involved making sustainable food choices as they rated environmental and ethical issues of their daily foods as more important than other clusters overall. Regarding food choice motives (or food

characteristics that are important in their daily foods) all the four segments consider price, sensory quality as important (no significant differences between the clusters). Figure 173.

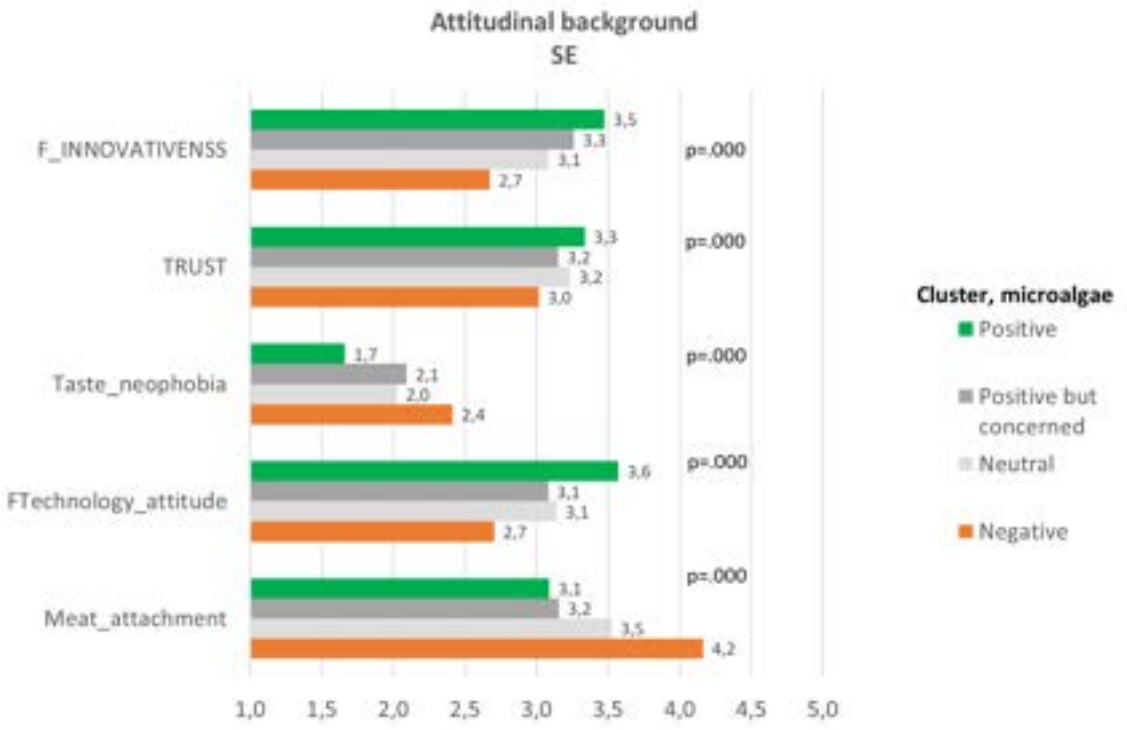


Figure 172. Background attitudes of the respondents in the clusters based on their views towards NextGen microalgae concept. SE.

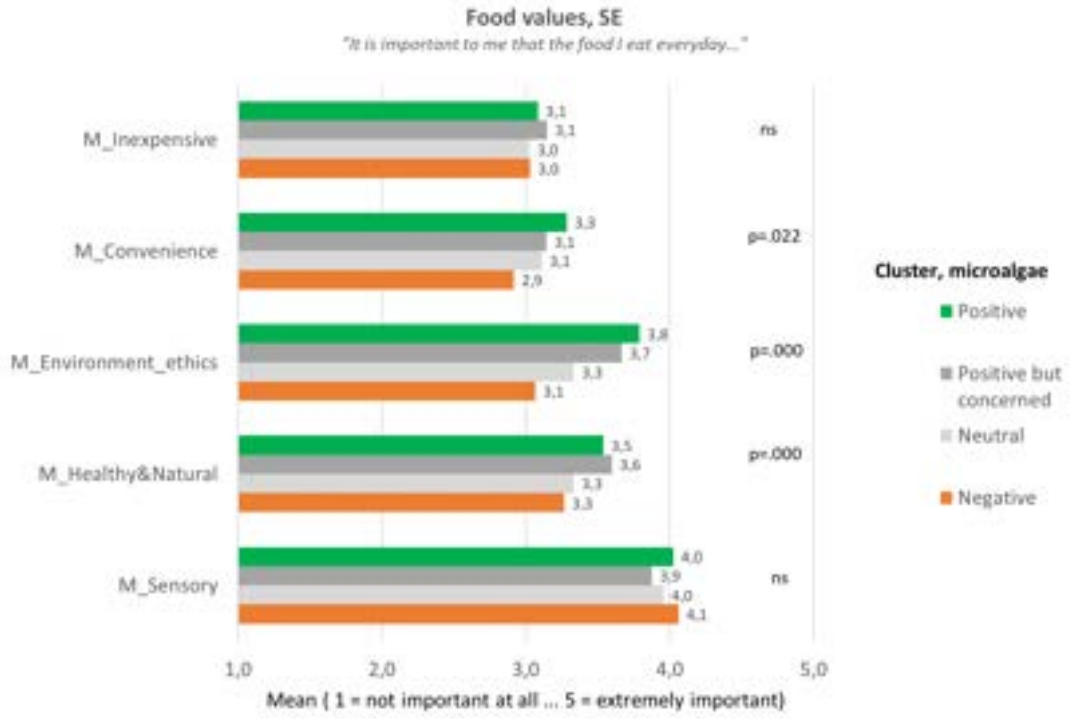


Figure 173. Means of food choice motives (values) of consumer clusters based on their views on NextGen microalgae concept. SE. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

11.5.2.3 Interest to use food applications by NextGen microalgae consumer clusters, Sweden

As could be expected, the clusters Positive and Positive but concerned were more interested in all the NextGen food applications than Negative and Neutral clusters (all means between the clusters significant at the level p =.000). Figure 174.

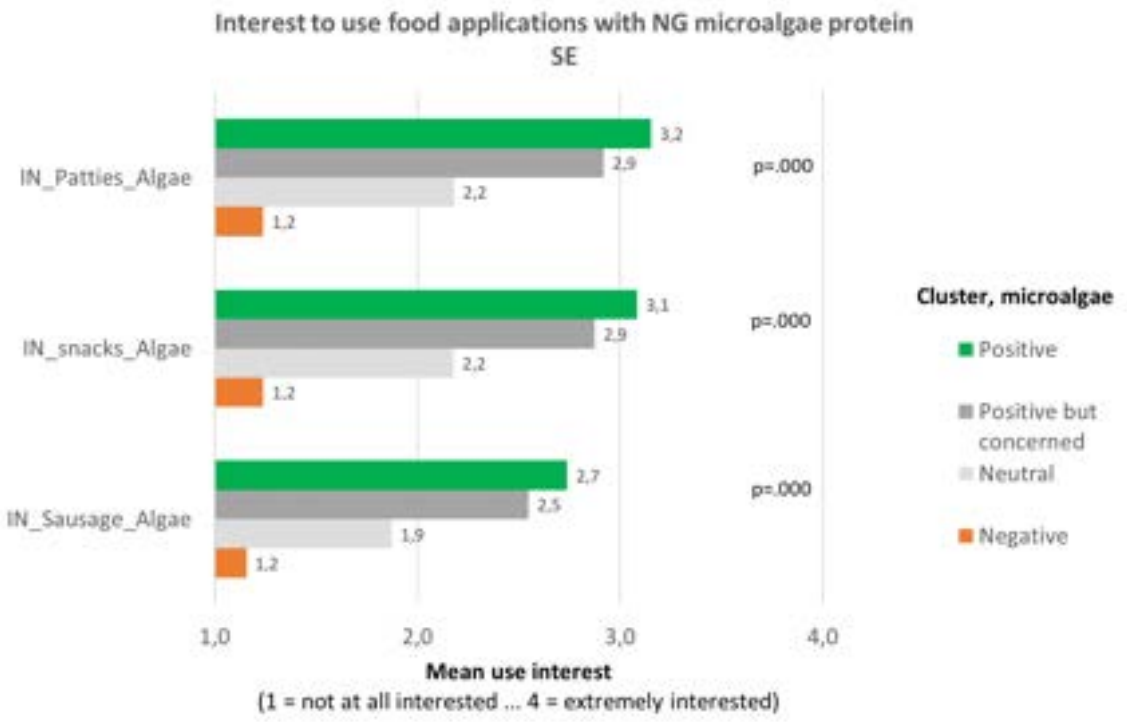


Figure 174. Means of interest to use food applications by NextGen of consumer clusters based on their views on NextGen microalgae concept. SE.

11.6 Acceptance of NextGen Insect protein concept, Sweden

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Insect** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views towards the NextGen Insect concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Insect method and foods.

11.6.1 The level of acceptance of the NextGen insect protein

Below third (28.6 %) of the Swedish respondents were in favour of the idea production of NextGen insect protein to be applied in foods**.** The attitudes towards NexGen insect protein were more negative than towards NextGen microalgae or NextGen Torula protein.

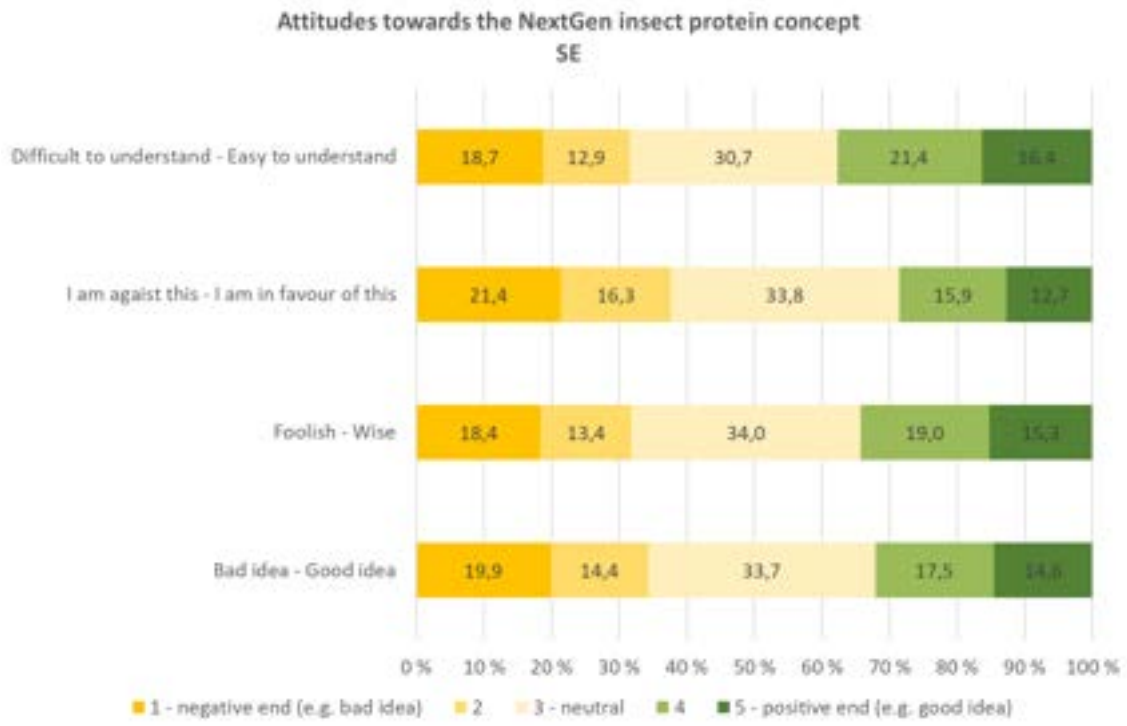


Figure 175. Attitudes towards the NextGen insect protein concept. Percentages of the Swedish respondents.

Like in the case of the NextGen microalgae protein, the Swedish respondents were most likely to believe that the production and use of NextGen insect protein in foods could benefit the environmental sustainability (46 %) and the animal well-being (38.2 %). Less of them believed in benefits for human health (26.7 %) and only 18.7 % believed it would be beneficial to them personally. Figure 176.

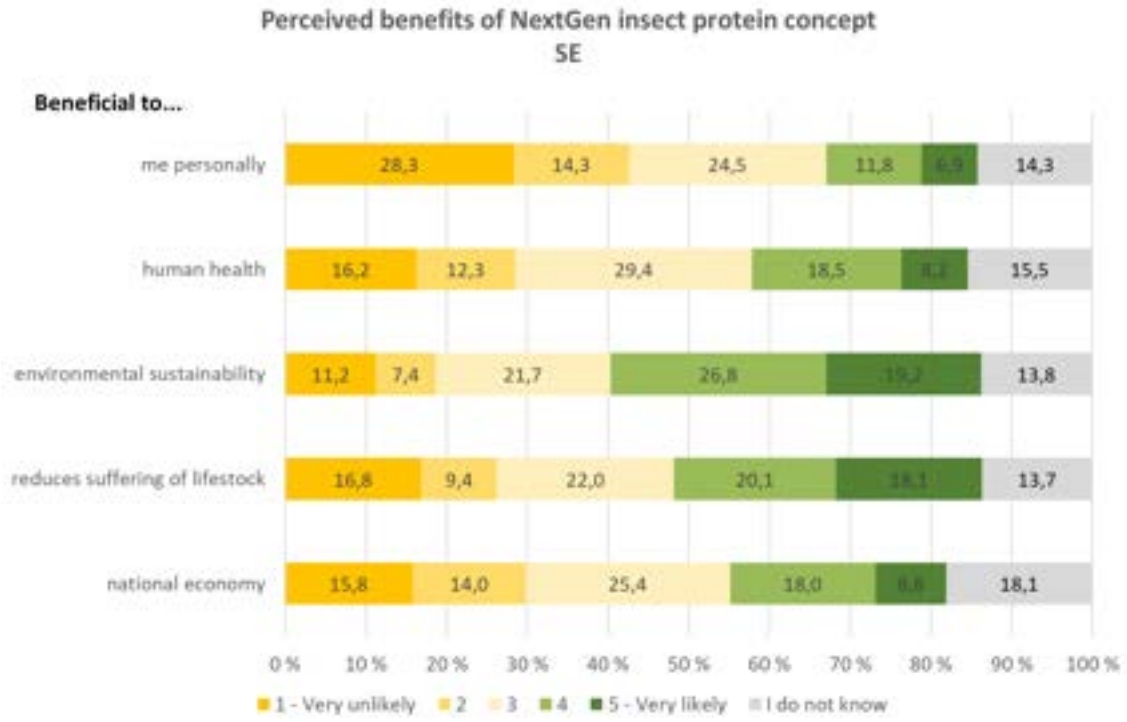


Figure 176. Perceived benefits of the NextGen insect protein concept. Percentages of the Swedish respondents.

The risks the Swedish respondents were most worried about were related to concerns about being misled by the food companies in relation to production method and food application of NextGen insect protein. Around 36 % were concerned about the issue. Potential risks for the environment or human health caused somewhat least concern.

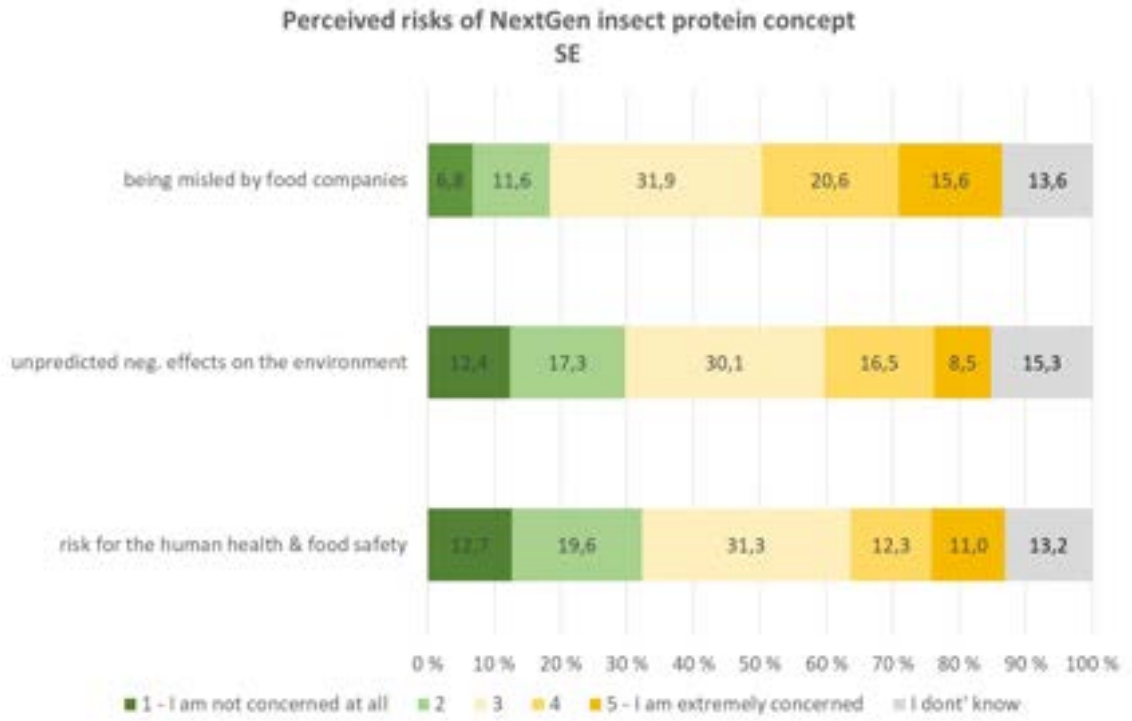


Figure 177. Perceived risks of the NextGen insect protein concept. Percentages of the Swedish respondents.

The attitudes towards NextGen insect protein foods were quite negative. Respondents assumed that food applications of NextGen insect protein would be repulsive (62.6 %), weird (57.8 %), bad tasting (46.4 %), unhygienic (43.3 %) and unsafe (41.8 %). The less negative expectations were seen related to health and naturalness (32.5 % in both). As seen from Figure 178 it is notable that in many cases quite a large share of respondents were neutral when evaluating the characteristics of food applications of NextGen insect protein.

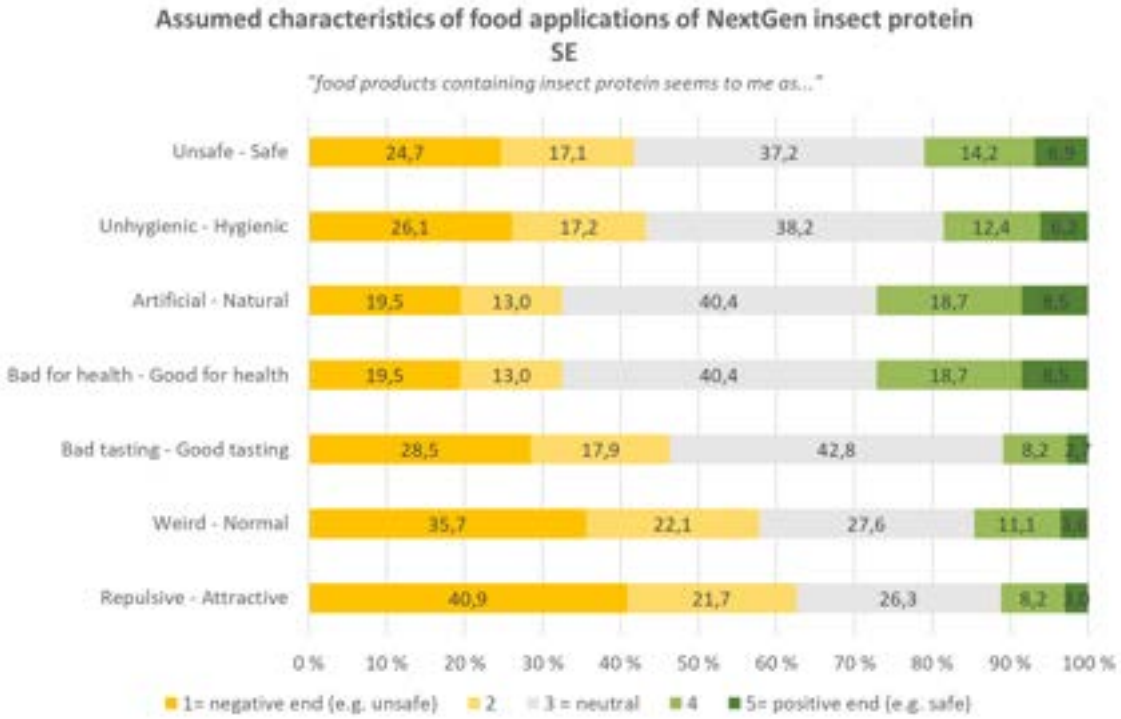


Figure 178. Characteristics associated with food applications made with NextGen insect protein. Percentages of the Swedish respondents.

The respondents did not expect that NextGen insect protein products would be appreciated or be purchased in their social circles. Figure 179.

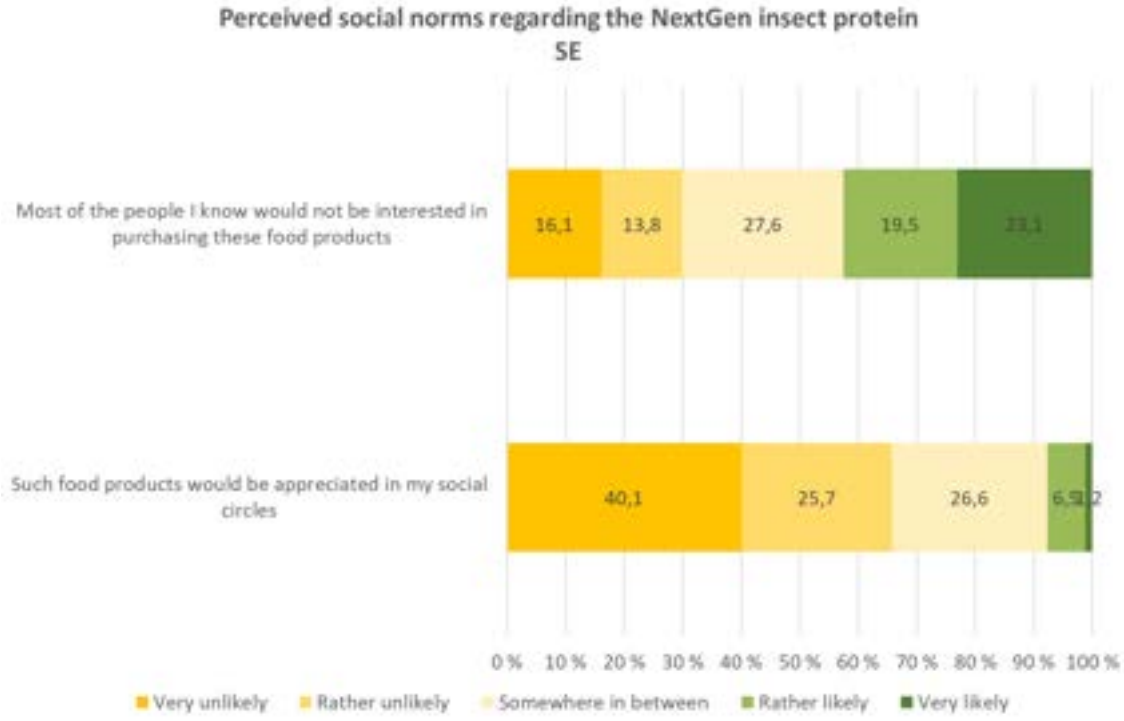


Figure 179. Perceived social norms regarding NextGen insect protein food products. SE.

Out of the three food application examples of NextGen insect protein, the patties were found as most interesting (25.5 % of respondents rated it extremely or rather interesting to

use), but quite evenly with the salty snacks which were found as second most interesting (24.3 %), and the sausage applications least interesting (19 %). However, in all cases almost half or even more respondents were not at all interested in using the food applications made with NextGen insect protein. Figure 180.

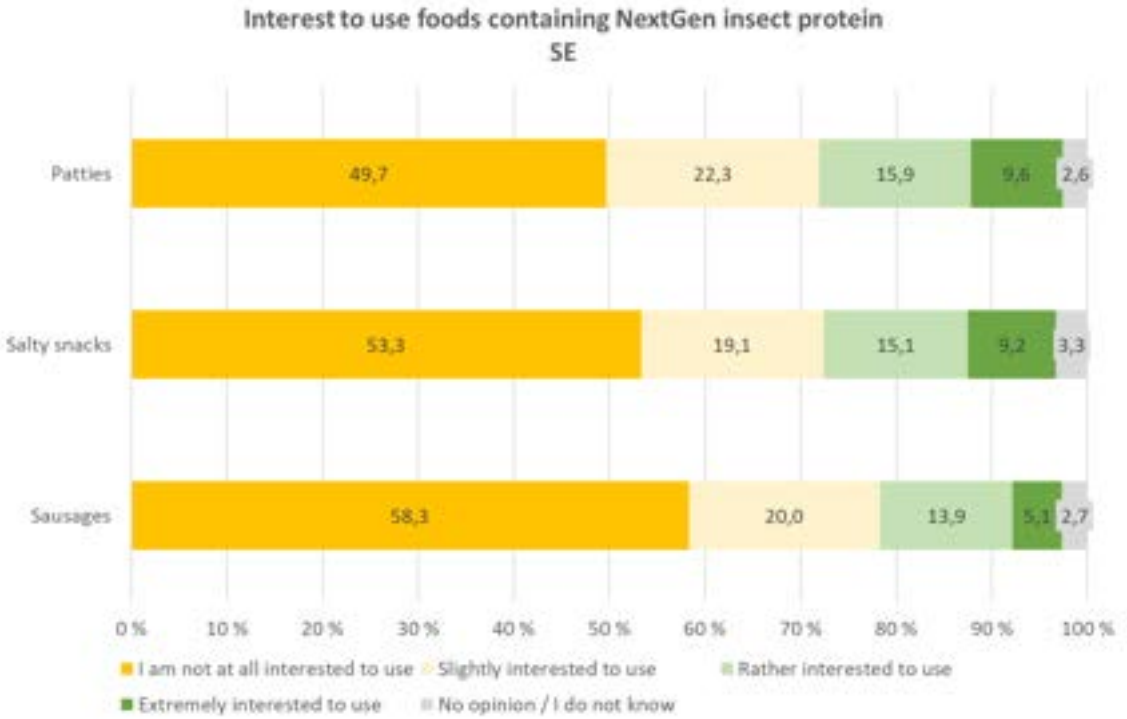


Figure 180. Interest to use the food application examples of NextGen insect protein. Shares of Swedish respondents with each answer alternative.

11.6.2 Consumer clusters based on views towards NextGen insect protein concept, Sweden

Consumer clusters to reflect Swedish respondents' differences in how they view the NextGen insect protein concept were created with similar procedure as described in the method section.

The three hierarchical cluster analysis all suggested three or four cluster solution. Subsequent K-means clustering, run with three and four clusters, confirmed that four cluster solution best brings out the differences in the sample. Like in the previous cases, one of the clusters consists of respondents with negative views, another with neutral views and the third with positive views. In addition, the fourth cluster consist of the respondents with negative views, but they are not so concerned about risks and they see more benefits of NextGen insects.

The cluster with most negative ratings of attitudes, benefits and food characteristics and with highest concern about the risks was named as **Negative**. Around 16 % of the respondents belong to Negative cluster. The cluster with less negative ratings of attitudes benefits and food characteristics but not so concerned about the risks was named as

Negative not so concerned, containing 17 % of respondents. The largest cluster comprising 41 % of the respondents were classified as **Neutral**, as they provided average ratings for all the measures. The last cluster including 26 % of respondents was called **Positive** having the highest ratings on attitudes, benefits and characteristics of NextGen insect protein and lowest concern about the risks of NextGen insect protein concept. Table 68.

Table 68. Consumer clusters based on respondents' views towards NextGen insect protein concept. The result of K-means cluster analysis with 4 clusters. SE

	Negative	Negative not so concerned	Neutral	Positive	Total	F	Sig.
Number of cases	142	147	361	233	883		
Percent of cases	16%	17%	41%	26%	100%		
ATT_Insects	1.34	1.98	3.11	4.41	2.98	954.746	.000
BENEFIT_Insects	1.37	2.28	3.18	4.11	2.98	606.293	.000
RISK_Insects	4.30	2.43	3.29	2.23	3.03	265.731	.000
FOODVIEWS_Insects	1.23	1.88	2.69	3.56	2.55	486.361	.000

11.6.2.1 Demographic profile and eating habits of NextGen Insect consumer clusters, SE

The demographic profiles of the four clusters are described in Table 69. The consumer clusters did not significantly differ from each other in terms of their demographic background. More detailed results are presented in the figures and tables that follow (Table 69 and Figure 181).

Compared to the other clusters, the members of **cluster Positive** were

- more likely to have higher (tertiary) level education
- more likely to be 25 – 34 years old
- more likely eating meat sometimes
- most familiar with alternative proteins

In contrast, the members of the **Negative** cluster were likely to

- belong to the age groups 45 – 75 y.
- least familiar with alternative or future proteins
- least likely user of vegetarian convenience foods

Negative not so concerned cluster has almost similar profile than the Negative cluster

- belong age groups 25 – 34 or 55 – 64 years
- least familiar with alternative or future proteins
- least likely user of vegetarian convenience foods

While in the **Neutral cluster**

- in between the other clusters regarding e.g. familiarity with alternative and future proteins

Table 69. Demographic profile of consumer clusters based on views towards NextGen insect protein concept, SE

	Negative	Negative not so concerned	Neutral	Positive	Total %	Pearson Chi²	Sign.	Total N
Gender_2						1.923	ns	880
male	47.9%	46.3%	51.9%	47.6%	49.2%			
female	52.9%	53.7%	48.1%	52.4%	50.8%			
total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Age group						17.555	ns	883
18 - 24 Years	**3.5%**	9.5%	9.7%	9.0%	8.5%			
25 - 34 Years	16.9%	21.1%	17.7%	**25.3%**	20.2%			
35 - 44 Years	19.0%	18.4%	19.9%	19.3%	19.4%			
45 - 54 Years	23.2%	17.7%	18.3%	13.7%	17.8%			
55 - 64 Years	16.9%	19.0%	17.5%	14.6%	16.9%			
65 - 75 Years	20.4%	14.3%	16.9%	18.0%	17.3%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Education_3						14.782	0.022	883
Basic	8.5%	**8.8%**	4.2%	6.0%	6.1%			
Secondary...first stage tertiary	**66.2%**	64.6%	62.6%	54.9%	61.5%			
Tertiary, university	25.4%	26.5%	33.2%	**39.1%**	32.4%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Type of living area						12.242	ns	883
Capital area	**14.1%**	21.1%	23.5%	**24.0%**	21.7%			
a large city that is not in the capital area	32.4%	26.5%	26.3%	30.5%	28.4%			
a small city/town or muncipality	32.4%	38.1%	33.8%	33.0%	34.1%			
a rural area	**21.1%**	14.3%	16.3%	**12.4%**	15.7%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Household						4.688	ns	869
no children	65.5%	58.3%	60.5%	60.3%	60.9%			
1-2 with children	29.5%	32.6%	29.4%	28.9%	29.8%			
something else	5.0%	9.0%	10.2%	10.8%	9.3%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Diet						11.653	ns	876
ominivore	79.3%	80.8%	79.4%	73.9%	78.2%			
meat sometimes or no red meat	**10.0%**	**10.3%**	13.9%	**19.6%**	14.2%			
vegetarian	10.7%	8.9%	6.7%	6.5%	7.6%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			

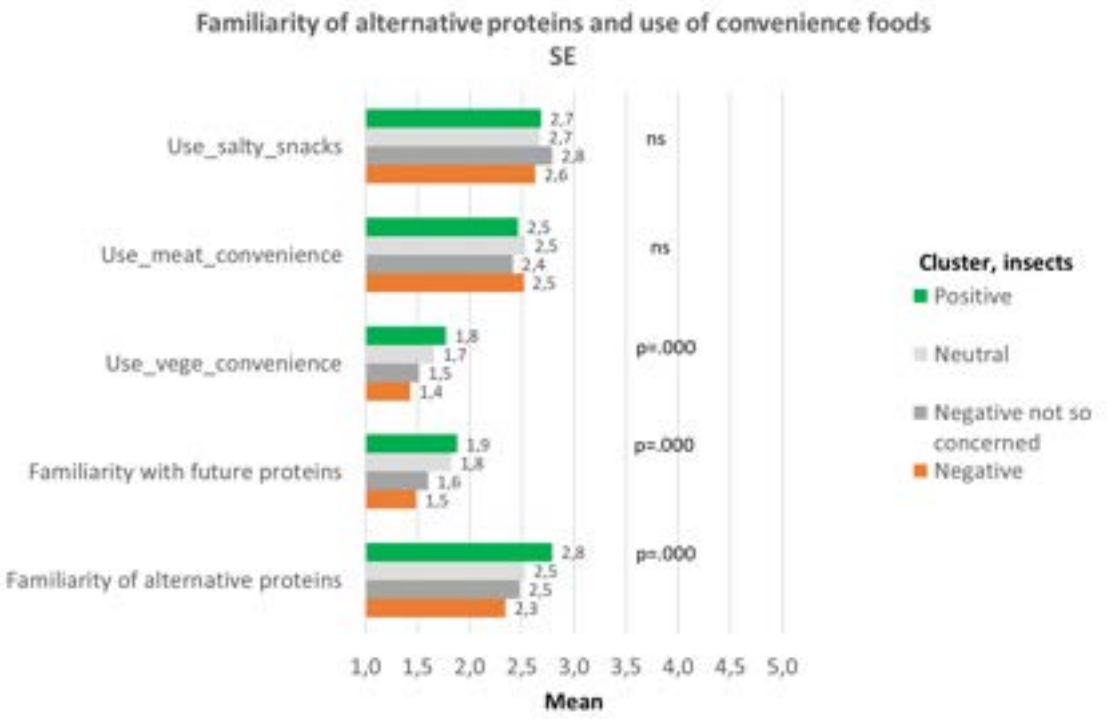


Figure 181. Mean use frequencies of certain convenience foods and familiarity with alternative proteins by consumer clusters based on their views on NextGen insect protein concept. SE. (The level of statistical significance of differences in means between the clusters has been marked with p -values, ns = not significant)

11.6.2.2 Attitudinal background of NextGen insect clusters, SE

The cluster Neutral has both neutral attitudes towards the NextGen insect protein and neutral attitudinal bakground. The cluster Negative not so concerned seems to have quite similar attitudinal background with Neutral cluster, while the Positive and negative clusters opinions were pretty much opposite to each other. Compared to other clusters the Negative cluster had in average highest attachment to meat, i.e. eating meat is more important for them. In addition, they were less interested in new food products as well as less positive towards the use of novel food technologies. Figure 182.

Positive clusters views towards NextGen insect concept can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having lower taste neophobia (reluctance to taste unfamiliar tastes)
- having more positive attitudes towards food technology in general
- being less attached to meat

Regarding food characteristics that are important in daily food, all clusters consider sensory quality and price as important (no significant differences between the clusters). The Positive cluster rated environmental and ethical issues as slightly more important than other clusters. Figure 183.

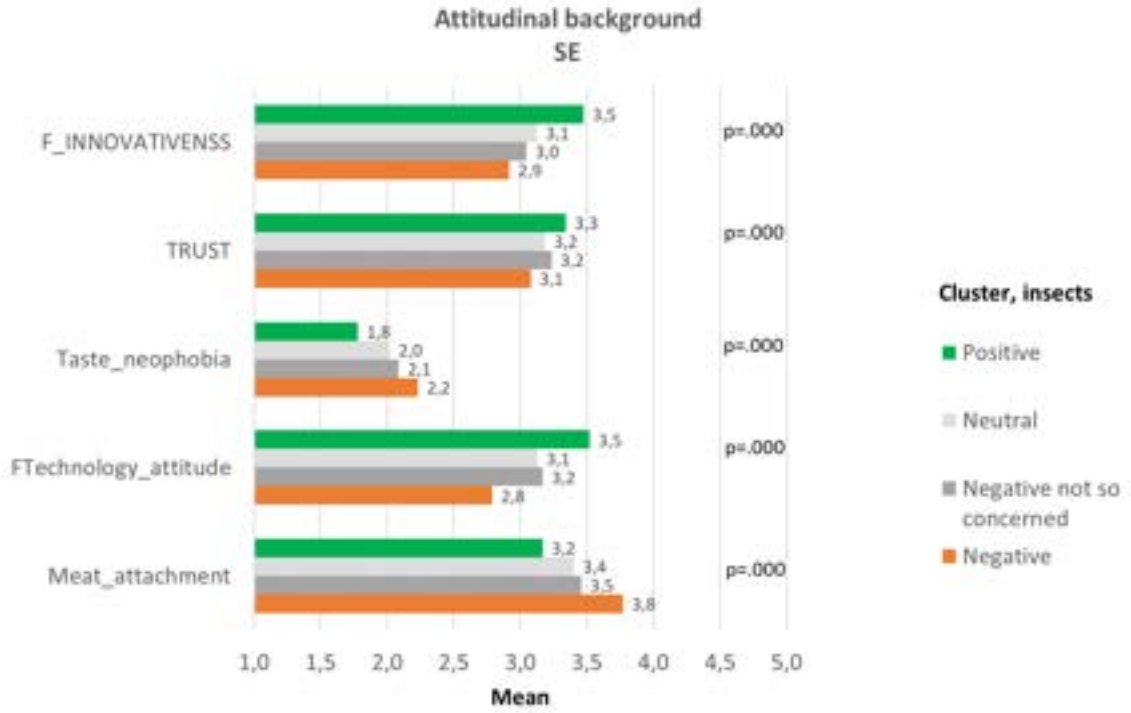


Figure 182. Background attitudes of the respondents in the clusters based on their views towards NextGen insect concept. SE (The level of significance of differences in means between the clusters is marked).

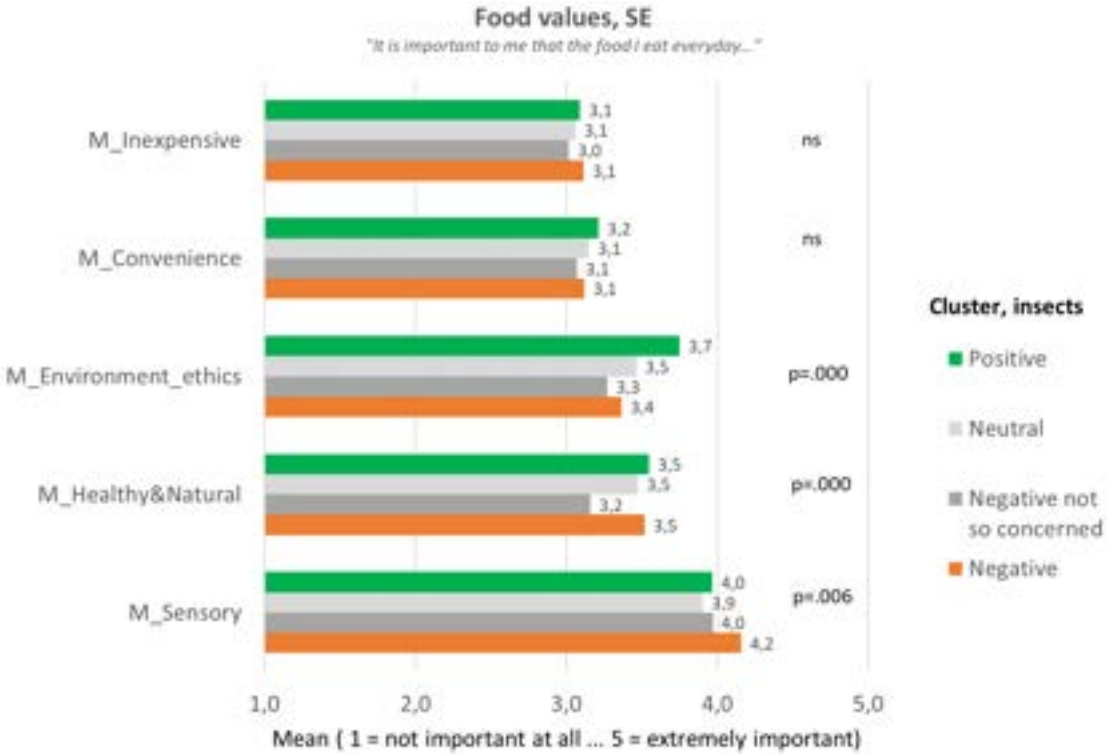


Figure 183. Means of food choice motives (values) of consumer clusters based on their views on NextGen insect concept. SE. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

11.6.2.3 Interest to use the food applications of NextGen insect protein consumer clusters, SE

The Figure 184 clearly shows that the use interest of food applications with NextGen insect protein is in line with clusters' attitudes and views towards the total concept. The negative

cluster was not at all interested while positive cluster was at least some extent interested to use food applications with insect protein.

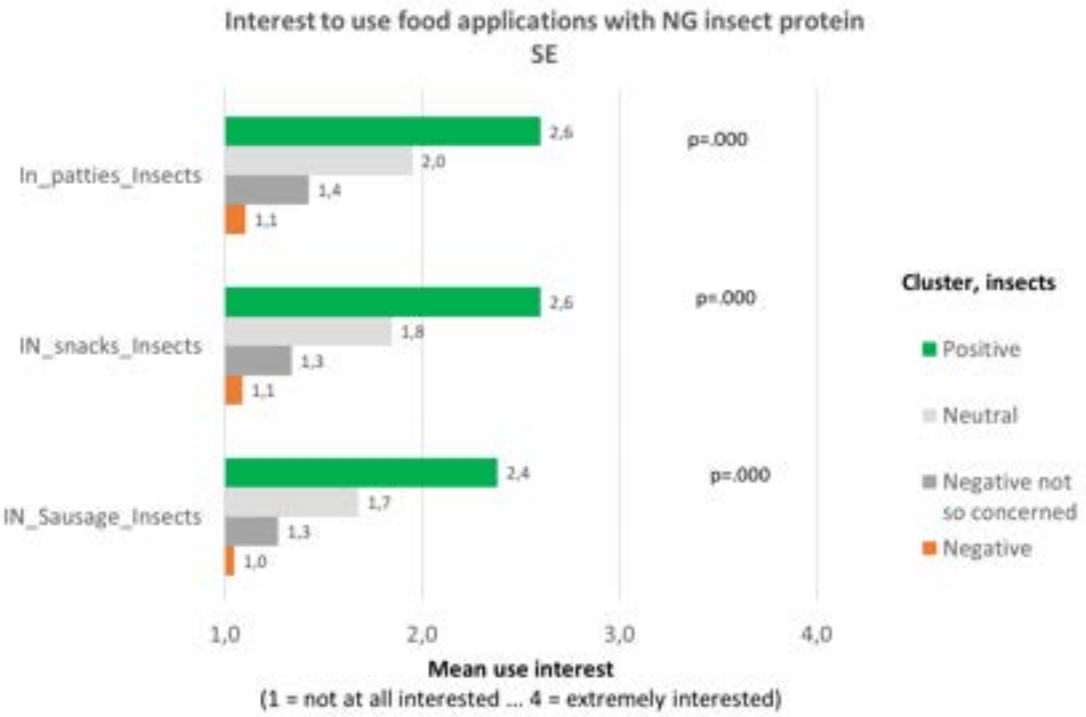


Figure 184. Interest to use food applications by consumer clusters based on their views towards NextGen insect protein concept. SE. (The levels of significance of differences in means between the clusters are marked).

11.7 Acceptance of NextGen Torula protein concept, Sweden

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen Torula** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen Torula concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen Torula method and foods.

11.7.1 The level of acceptance of NextGen Torula protein

Likewise, in other NextGen concepts also attitudes towards the NextGen Torula protein was mainly neutral. This was expected because of the novelty of the idea. About 42 % of the Swedish respondent were in favour of the idea about producing NextGen Torula protein to be applied in foods. Almost half of them responded this to be wise and good idea. Figure 185.

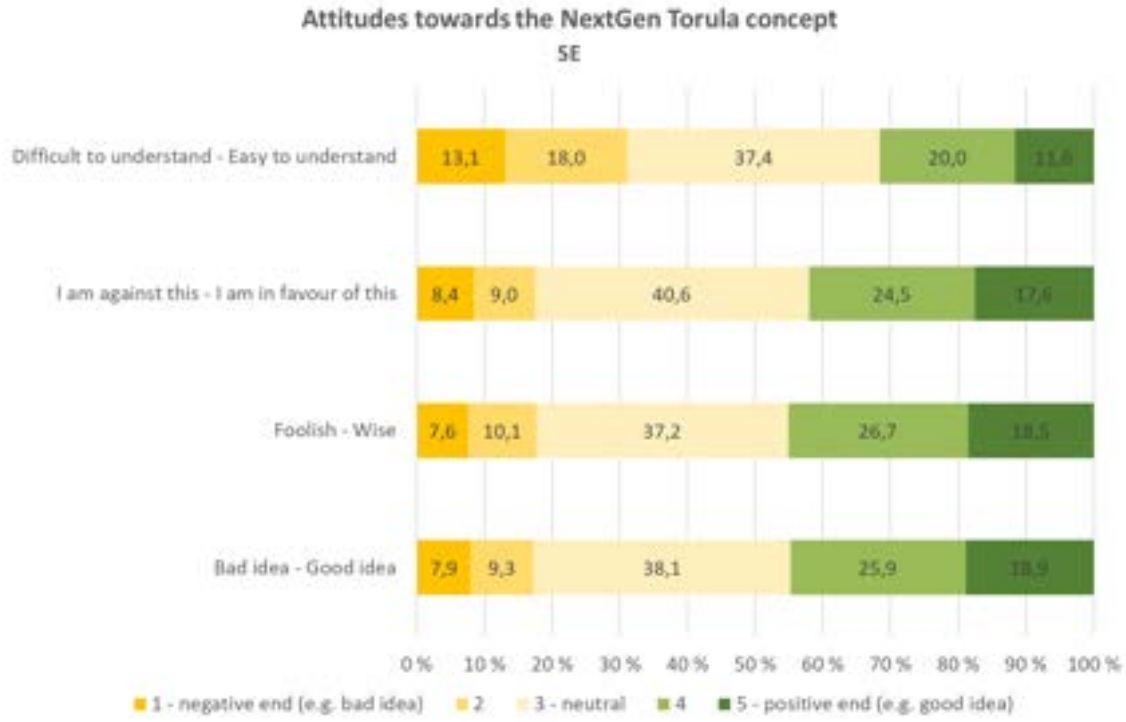


Figure 185. Attitudes towards the NextGen Torula concept. Percentages of Swedish respondents

It was believed by over the half of respondents that production of NextGen Torula protein and its' application in food would result in benefits for the environmental sustainability and bring better life for the production animals. In addition, about 41 % of respondents believed that this production method can also benefit the national economy which was different than responses gathered from microalgae and insect (34.9 % in case of NextGen microalgae and 26.8 % in case of NextGen insect).

Less of respondents believed in benefits for human health (29.5 %) and even less believed it would be beneficial to them personally (25.3 %). Figure 186.

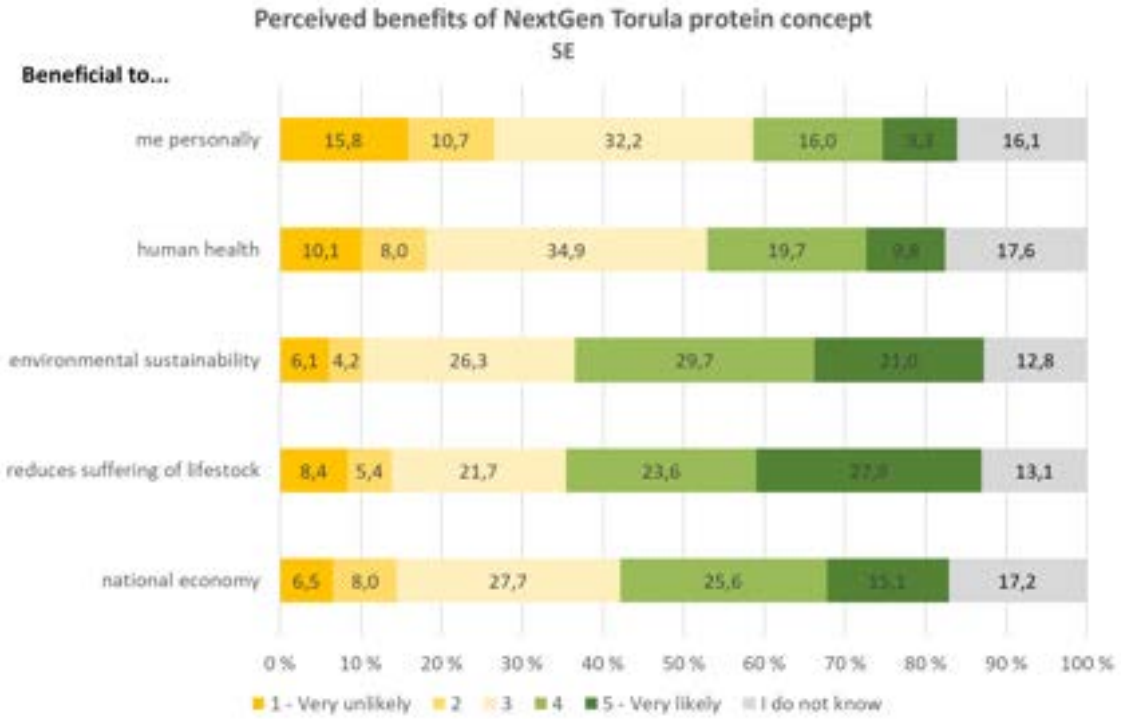


Figure 186. Perceived benefits of NextGen Torula protein concept. Percentages of Swedish respondents.

Answers to the questions about risk concerns suggest that many felt they do not know what to think about the potential benefits or risks: In many cases, over 46 % of respondents answered either “cannot say” or ticked the middle option. The respondents were most worried about the risk of being misled by the food companies, like they were in the case of the other two NextGen concepts. It is notable that in case of the unpredicted negative effects on environment and risks for human health & food safety, responds not being concerned were more common than worries towards these risks. Figure 187.

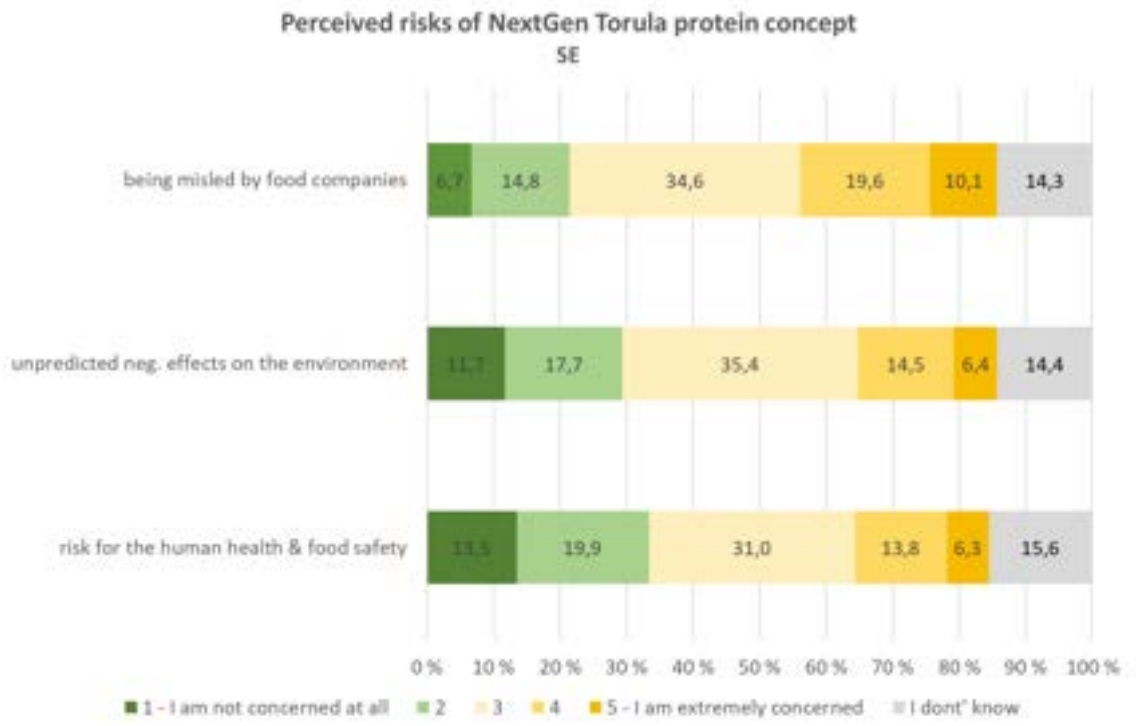


Figure 187. Perceived risks of NextGen Torula protein concept. Percentages of Swedish respondents.

Majority of respondents were neutral towards the assumed characteristics of food applications of NextGen Torula protein. The respondents did consider NextGen Torula protein foods as **weird** rather than normal and **repulsive** rather than attractive. Figure 188.

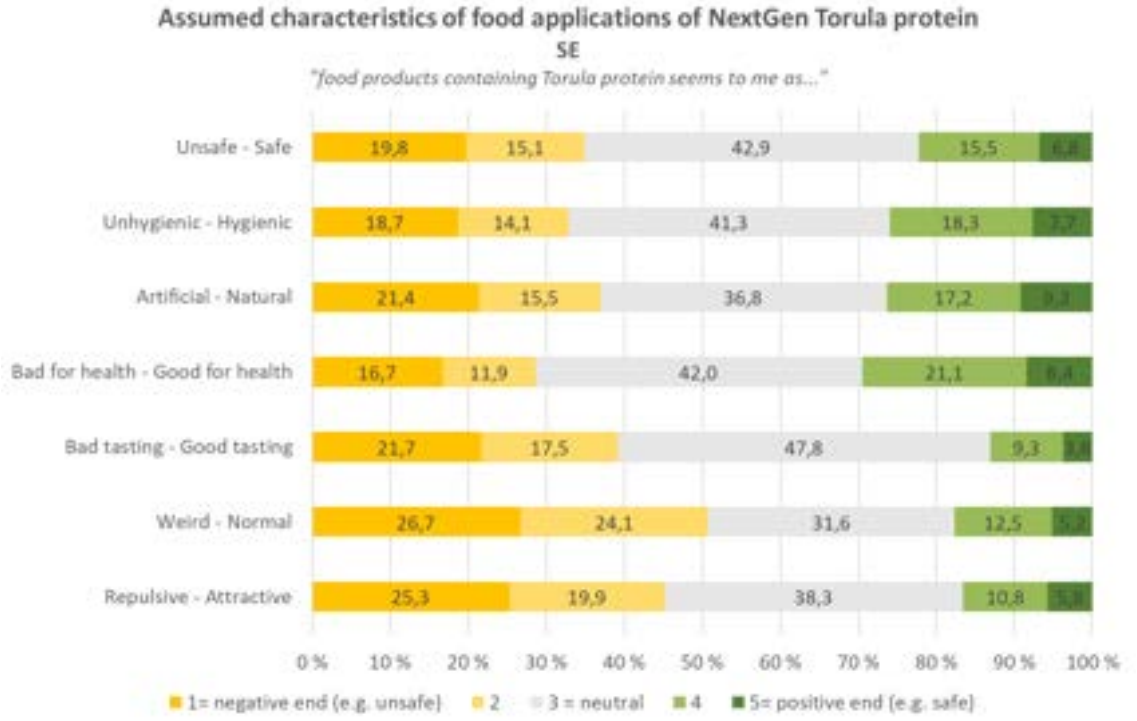


Figure 188. Characteristics associated with food applications of NextGen Torula protein. Percentages of Swedish respondents.

Similar to other NextGen concepts, also in the case of Torula the respondents did not expect that NextGen Torula protein products would be appreciated or be purchased in their social circles. Figure 189.

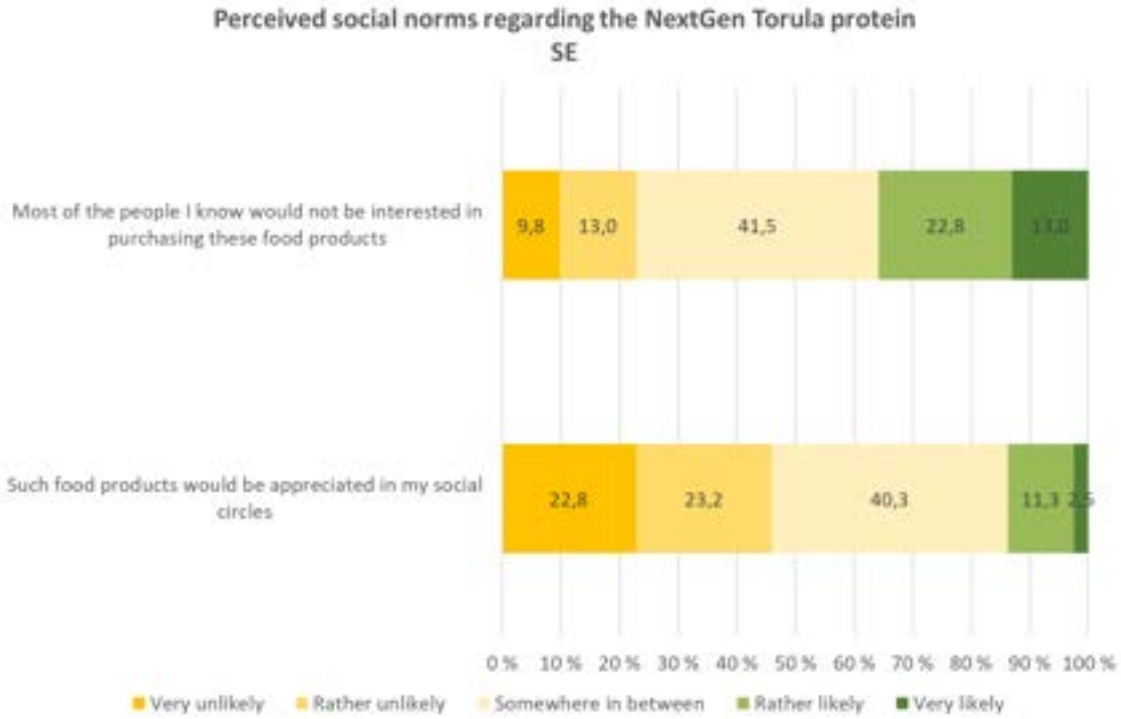


Figure 189. Perceived social norms related to NextGen Torula protein foods. Percentage of Swedish respondents.

Out of the three food application examples of NextGen Torula protein, the patties were found as most interesting since 44.5 % of respondents rated it extremely or rather interesting to use. Salty snacks were found as second most interesting (41.2 %), and the sausage applications least interesting (31.6 %). Figure 190.

In all three NextGen protein concepts (microalgae, insect and Torula) the patties were found as most interesting food application containing these ingredients. In addition, the salty snacks was the second in all cases and sausages gain less interest in all cases.

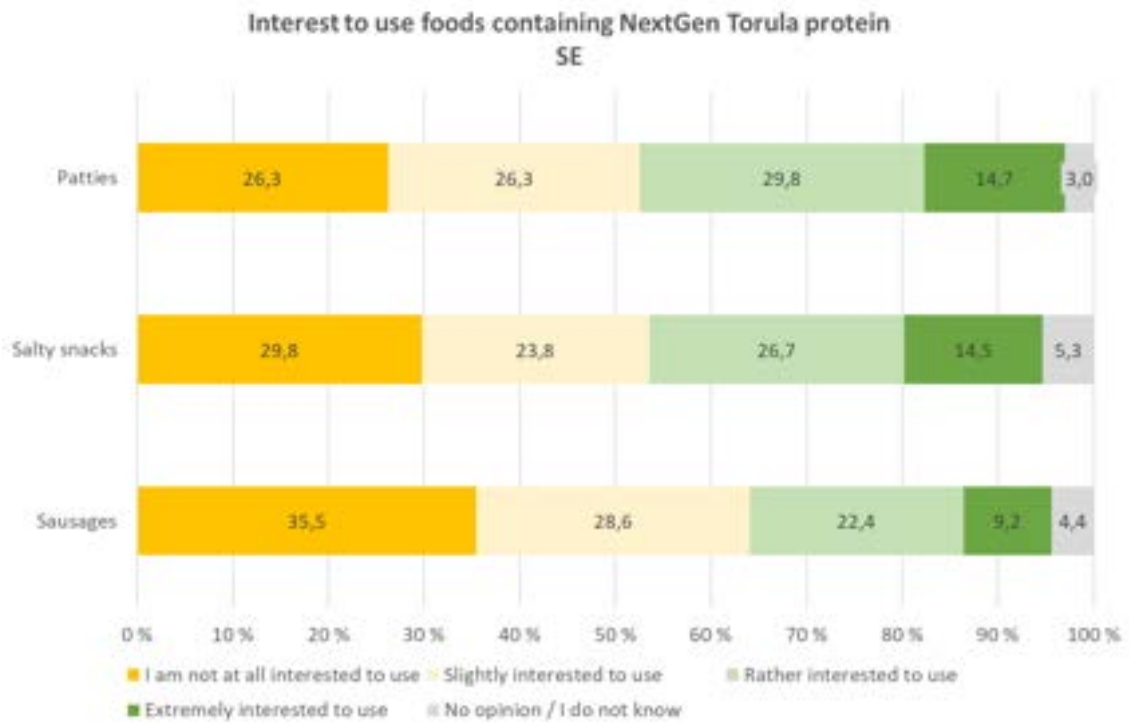


Figure 190. Interest to use the food application examples of NextGen Torula protein. Shares of Swedish respondents with each answer alternative.

11.7.2 Consumer clusters based on views towards NextGen Torula protein concept, SE

The set of three hierarchical cluster analyses all suggested four or three cluster solutions. Subsequent K-means clustering, run with 3 and 4 clusters, confirmed that 4 cluster solution best brings out the differences in the sample.

The clusters were named as **Negative, Neutral, Positive but suspicious and Positive**. The cluster **Positive** (18 % of respondents) has more positive attitudes and is more likely to believe in the positive consequences of NextGen Torula protein concept, less likely to be concerned about the risks related to it and more likely to expect NextGen Torula food applications to have positive quality characteristics. Correspondingly, the Torula cluster **Negative,** is an opposite to this having more negative expectations of the concept. This is the smallest cluster including 12 % of respondents. The cluster **Positive but suspicious** (25 % of respondents belonging to this) is otherwise pretty much like the Positive cluster, but regardless of their positive views, they are a bit more suspicious about the benefits and food views of the NextGen Torula concept. The final cluster **Neutral** is characterised by its' neutral ratings regardless of the question. Majority (45 %) of the respondents belong to this cluster. Table 70.

Table 70. Consumer clusters based on respondents' views towards NextGen Torula protein concept. The result of K-means cluster analysis with 4 clusters. SE

	Negative	Neutral	Positive but suspicious	Positive	Total	F	Sig.
Number of cases	108	395	220	159	882		
Percent of cases	12%	45%	25%	18%	100%		
ATT_Torula	1.65	3.08	4.06	4.60	3.42	732.657	.000
Benefits_Torula	1.60	3.15	3.84	4.48	3.37	681.684	.000
RISK_Torula	3.71	3.23	2.33	2.33	2.90	123.468	.000
FOODVIEWS_Torula	1.33	2.61	2.67	4.07	2.73	380.547	.000

11.7.2.1 Demographic profile and eating habits of NextGen Torula protein consumer clusters, Sweden

The demographic profiles of the four clusters are described in Table 70. The following list summarises the characteristics that differentiate each cluster from the other clusters. Results that are more detailed are presented in the figures and tables that follow (Table 71 and Figure 74).

Compared to the other clusters, the members of **cluster Positive** were

- more likely to have higher (tertiary) level education
- younger especially in age group 25-34 years
- more likely vegetarians or eating meat sometimes
- most familiar with alternative proteins

Positive but suspicious cluster has almost similar profile than the Positive cluster

- lives in small city or municipality
- belongs to age group 35 – 54 years
- most likely user of vegetarian convenience foods
- most familiar with alternative and future proteins

In contrast, the members of the **Negative** cluster were likely to

- more likely to have secondary level education
- male belonging to the age group 45 – 75 years
- having no children
- have omnivorous diets
- least familiar with alternative or future proteins
- least likely user of vegetarian convenience foods

While in the **Neutral cluster**

- most likely living in the small city or municipalities
- younger age groups (25 – 44 y.) were most common
- in between the other clusters regarding e.g. familiarity with alternative and future proteins
-

Table 71. Demographic profile of the consumer clusters based on views towards NextGen Torula concept, SE

	Negative	Neutral	Positive, but suspicious	Positive	Total %	Pearson Chi²	Sign.	Total N
Gender_2						5.940	ns	879
male	**60.2%**	48.2%	46.6%	49.4%	49.5%			
female	39.8%	51.8%	53.4%	50.6%	50.5%			
total	100,0%	100,0%	100,0%	100,0%	100,0%			
Age group						34.238	0.003	882
18 - 24	6.5%	8.1%	9.1%	10.7%	8.6%			
25 - 34 Years	**9.3%**	20.8%	16.4%	**28.3%**	19.6%			
35 - 44 Years	**11.1%**	**20.3%**	**21.4%**	16.4%	18.7%			
45 - 54 Years	**25.0%**	17.5%	20.0%	**15.1%**	18.6%			
55 - 64 Years	**23.1%**	17.2%	15.5%	**10.7%**	16.3%			
65 - 75 Years	**25.0%**	**16.2%**	17.7%	18.9%	18.1%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Education_3						13.831	0.032	881
Basic	4.7%	6.8%	4.5%	5.7%	5.8%			
Secondary...first stage tertiary	**71.0%**	63.8%	61.4%	**52.2%**	62.0%			
Tertiary, university	**24.3%**	29.4%	34.1%	**42.1%**	32.2%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Type of living area						17.465	0.042	882
Capital area	19.4%	21.3%	**18.6%**	**28.3%**	21.7%			
a large city that is not in the capital area	30.6%	25.6%	28.2%	32.1%	28.0%			
a small city/town or municipality	28.7%	36.7%	**40.5%**	**26.4%**	34.8%			
a rural area	**21.3%**	16.5%	**12.7%**	13.2%	15.5%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Household						16.224	0.013	868
no children	**78.1%**	57.5%	60.9%	58.0%	60.9%			
1-2 with children	**18.1%**	32.5%	29.8%	30.6%	29.7%			
something else	**3.8%**	10.0%	9.3%	11.5%	9.3%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			
Diet						18.488	0.005	875
ominivore	**88.6%**	80.2%	75.2%	69.2%	77.9%			
meat sometimes or no red meat	**9.5%**	11.5%	16.5%	**20.1%**	14.1%			
vegetarian	**1.9%**	8.4%	8.3%	10.7%	8.0%			
Total	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*			

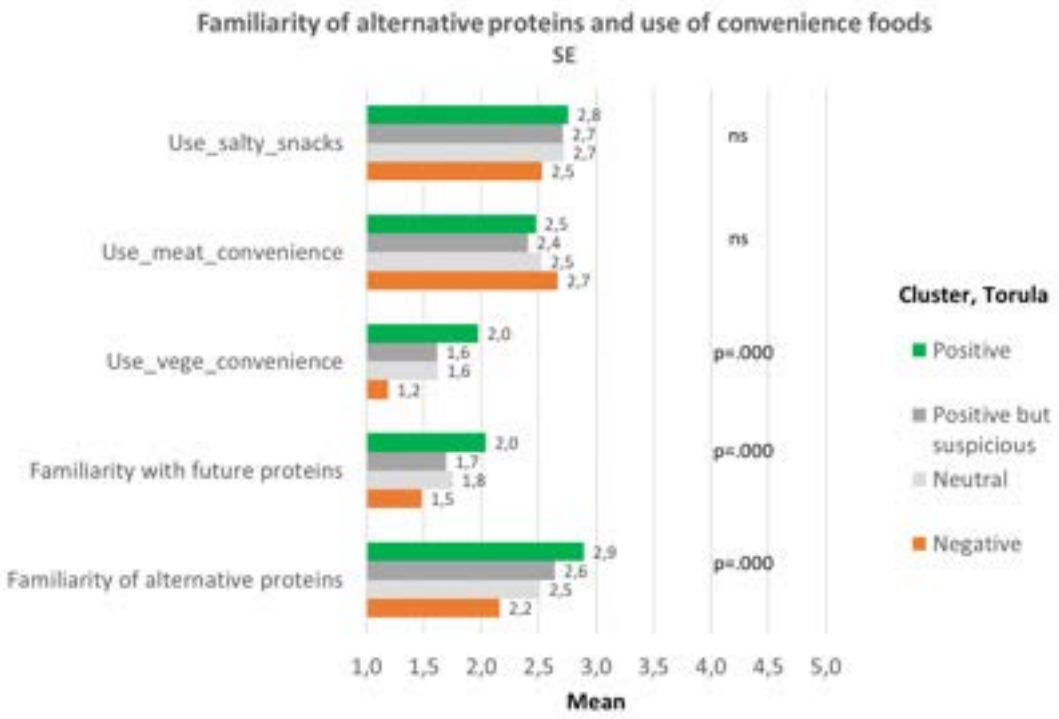


Figure 191. Background attitudes of the respondents in the clusters based on their views towards NextGen Torula concept. SE (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

11.7.2.2 Attitudinal background of NextGen Torula protein consumer clusters, SE

Likewise, in the microalgae and insect concepts the cluster Neutral has both neutral attitudes towards the NextGen Torula protein and neutral attitudinal bakground. The cluster Positive but suspicious cluster seems to settle mostly between the Neutral and Positive clusters. The Positive and negative clusters attitudinal opinions were pretty much opposite to each other.

Compared to other clusters the Negative cluster had in average highest attachment to meat, i.e. eating meat is more important for them. In addition, they were less interested in new food products as well as less positive towards the use of novel food technologies and also their trust towards food industry player is in lower level. Figure 192.

Positive clusters views towards NextGen insect concept can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having lower taste neophobia (reluctance to taste unfamiliar tastes)
- having more positive attitudes towards food technology in general
- being less attached to meat

Regarding food characteristics that are important in daily food, all clusters consider sensory quality and price as important (no significant differences between the clusters). The Positive cluster rated environmental and ethical issues being more important than other clusters. In

addition the health and natural issues, also convenience was valued more by Positive cluster. Figure 193.

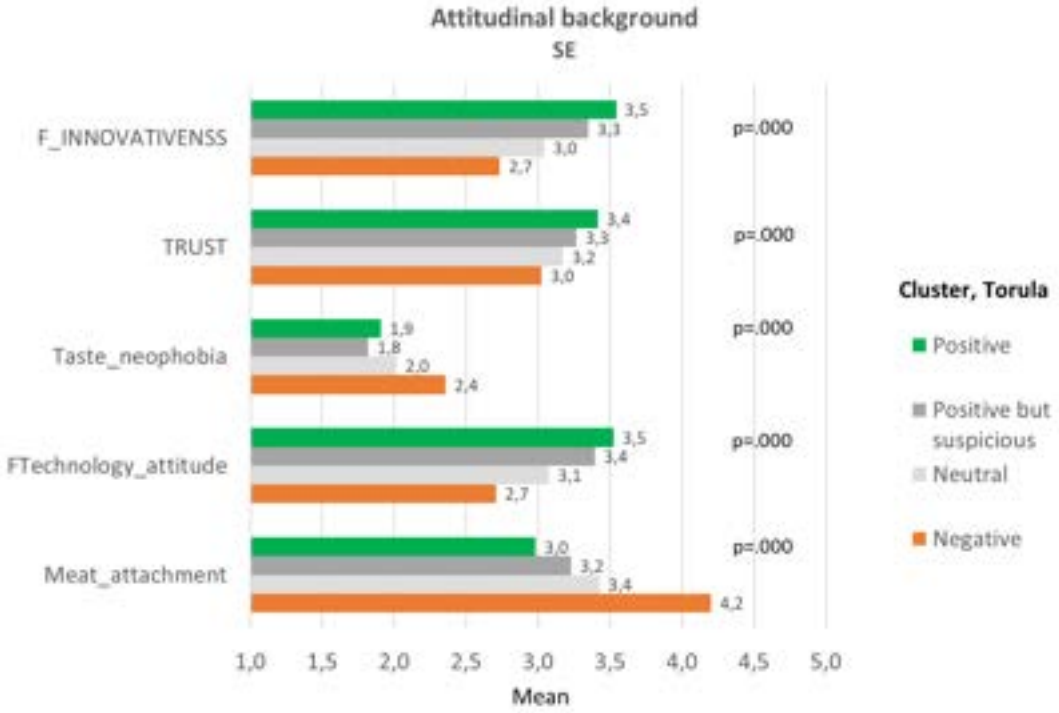


Figure 192. Background attitudes of the respondents in the clusters based on their views towards NextGen Torula concept. SE (The level of significance of differences in means between the clusters is marked).

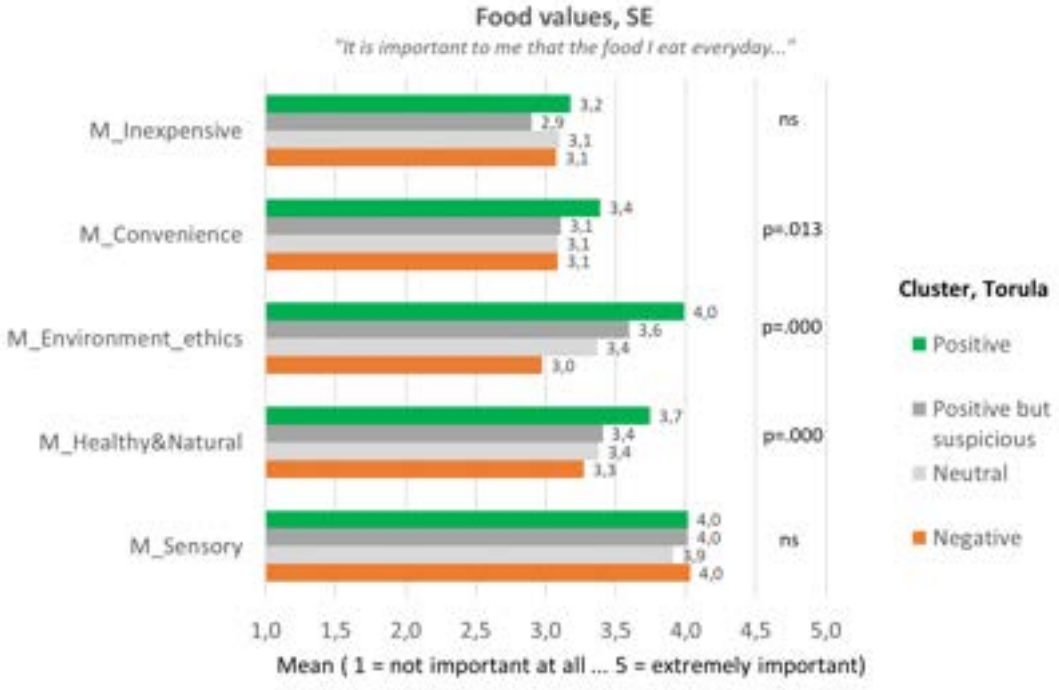


Figure 193. Means of food choice motives (values) of consumer clusters based on their views on NextGen Torula concept. SE. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

11.7.2.3 Interest to use the food applications by NextGen Torula consumer clusters, Sweden

Again likewise in the other NextGen concepts also in Torula the use interest of food applications with NextGen Torula protein is in line with clusters' attitudes and views towards the total concept (Figure 194). The negative cluster was not at all interested while Positive cluster was at least some extent interested to use food applications with Torula protein. The Positive but suspicious are a bit more interested in different applications than Neutral cluster.

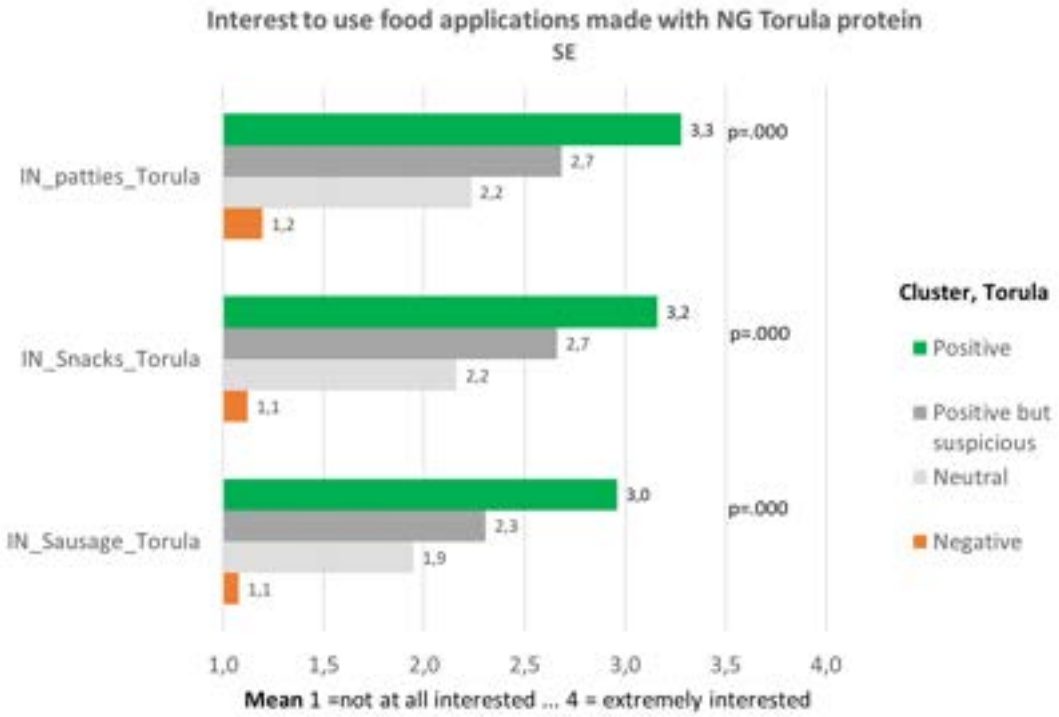


Figure 194. Interest to use food applications by consumer clusters based on their views towards NextGen Torula protein concept. SE. (The levels of significance of differences in means between the clusters are marked).

12 Appendix B5 – POLAND survey report

12.1 Summary of results from Poland (PL)

In the survey in Poland n = 1000 consumers participated. About 3 % of them were vegetarians. In addition, only few consumers tend to reduce meat mainly due to heath reasons and well-being (55,6%), environmental reasons and ethics.

Alternatives for animal proteins are known by the polish consumers and they are familiar with different protein sources. Most of the consumers eat legume vegetable (nearly 90%), and products made of peas (88,3) and fava beans (71,9%) very often. Also, soya-based meat substitutes are eaten by 50% of the consumers at least once a month. Proteins from insects are not unknown in Poland, but consumers did not try them yet. More than 55% have not heard about fungi-substitutes yet.

In Poland the trust in the different food actors of the value chain is very diverse, but in contrast to Germany much lower. The consumers have trust in farmers and small food producers (36% each), but do not trust the food industry. Only 9% say, that they trust them. Consumer associations and food scientist enjoy confidence of the consumers by 22% respectively 35%. 20% trust regulatory supervising authorities and only 11% trust in retailers. For the consumers in Poland most important motives for daily food selection are “taste pleasure (87%)”, “healthy (85%)”, “natural (68%)”. The use frequency of convenience food is low.

NextGenProtein concepts were evaluated by the consumers. Different aspects such as general acceptance, perceived benefits, risks and their views to use them in the sample foods sausages, patties and salty snacks were rated. The evaluation of the protein concepts shows a high amount of uncertain people, even though they are highly educated.

The algae concept and the torula concept have been rated better than the insect concept.
Based on the acceptance values, k-means cluster analysis has been conducted. For algae and insects three cluster have been identified and for the torula protein ingredients four clusters were found.

The cluster are very often described as positive (low risk perception), negative (high risk perception) and indifferent.

The positive and negative cluster have a similar, rather small cluster size, the third cluster is the indifferent or sceptical cluster. The characteristics of the negative cluster can be described as stereotype. Mainly elderly men, mainly omnivore, no kids, and more people with primary education are represented here. The positive cluster can be described as more women than men, middle age, high percentage of tertiary education and the highest proportion of vegans

or vegetarians. In the third cluster, the indifferent cluster we find high educated younger people, more omnivores, with some vegans/vegetarians.

In general, a transparent food production could increase the acceptance of new protein sources. Information and educational programmes would lead to a different view on new protein sources. Applications in the food industry will be accepted only, if taste and sensory attributes fit the consumers demands.

12.2 Participants characteristics

12.2.1 Participants demographics, PL

In Poland, in total 1000 consumers have participated in the survey. The basic demographic background of the Poland sample is shown in Table 72. Like in the case of other countries, respondents' answers have been weighted in the analysis so that the results represent the country population.

Table 72 Demographic background of PL respondents

	Count	Percent
Gender		
1. Male	485	48,50%
2. Female	515	51,50%
3. Other	0	0,00%
4. Prefer not to say	0	0,00%
Total	*1000*	*100,00%*
Age Group		
1. 18-24 years	90	9,00%
2. 25-34 years	176	17,60%
3. 35-44 years	216	21,60%
4. 45-54 years	171	17,10%
5. 55-64 years	194	19,40%
6. 65-75 years	153	15,30%
Total	*1000*	*100,00%*
Living Area		
1. I live in the capital city / area	172	17,20%
2. I live in a large city that is not in the capital area	391	39,10%
3. I live in a small city/town or municipality	273	27,30%
4. I live in a rural area	164	16,40%
Total	*1000*	*100,00%*
Region		
1. Lódzkie	61	6,10%
2. Mazowieckie	138	13,80%
3. Dolnoslaskie	82	8,20%
4. Opolskie	31	3,10%
5. Lubuskie	32	3,20%
6. Malopolskie	87	8,70%

7. Slaskie	120	12,00%
8. Wielkopolskie	86	8,60%
9. Zachodniopomorskie	43	4,30%
10. Kujawsko-Pomorskie	47	4,70%
11. Pomorskie	58	5,80%
12. Warminsko-Mazurskie	41	4,10%
13. Lubelskie	58	5,80%
14. Podkarpackie	50	5,00%
15. Podlaskie	32	3,20%
16. Swietokrzyskie	32	3,20%
Total	*998*	*99,80%*
Education		
1. Basic education or lower	10	1,00%
2. Upper secondary vocational qualification	6	0,60%
3. Upper secondary degree	49	4,90%
4. Tertiary degree or vocational qualification	8	0,80%
5. First stage of tertiary education	165	16,50%
6. Tertiary education, university, bachelor degree	264	26,40%
7. Tertiary education, university, master's degree or higher (MA/MSc, PhD, MD)	491	49,10%
8. Other / I do not know	7	0,70%
Total	*1000*	*100,00%*
Education summarised		
1. basic education	10	1,00%
2. secondary education	492	49,60%
3. tertiary education	491	49,40%
4. others	0	0%
Total	*1000*	*100,00%*
Household		
1. I live at home with my parents	115	11,90%
2. I live alone	110	11,40%
3. I live alone with my child / children	42	4,40%
4. I live with my spouse	265	27,40%
5. I live with my spouse and child / children	353	36,50%
6. I live with other adults (other than spouse or family members)	81	8,40%
Total	*966*	*100,00%*
Children		
1. no children	375	38,80%
2. with children	395	40,90%
3. something else	196	20,30%
Total	*966*	*100,00%*

12.2.2 Participants' dietary habits and attitudinal background, PL

Almost 80 % (79,80%) of the participants follow an omnivore diet and just 11,40% reduced their meat consumption and only 8,7 % of the participant follow some form of vegetarian or even vegan diet (see Table 73). In contrast to other countries, e.g. Germany, only 36,3 % of the consumers want to reduce their meat consumption. Main reasons for most of these

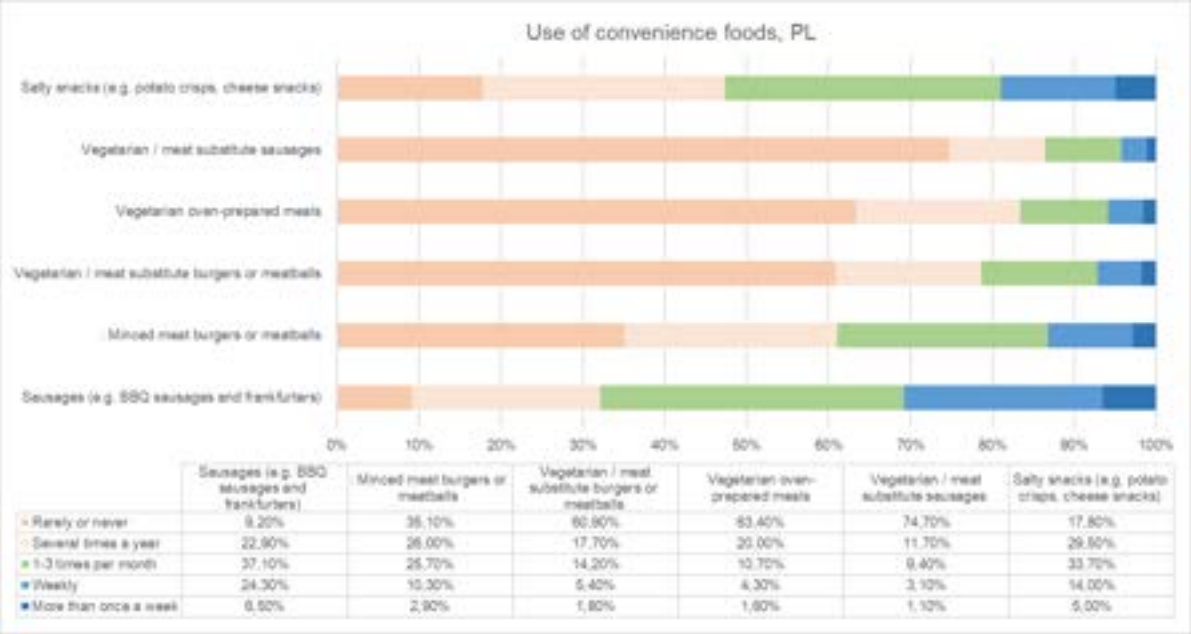
people are “my health and well-being” (55,6 %) and “Environmental sustainability, climate change” (28,8 %) and followed by “ethics, animal welfare” (20,5 %).

Table 73 Dietary habits of respondents in PL

	Count	Percent
Which of the following statements describe your diet and eating habits the best?		
I regularly eat products of animal origin and non-animal origin (omnivorous)	798	79,80%
I only eat meat sometimes (e.g. beef, pork, poultry, fish, seafood)	114	11,40%
I avoid red meat consumption (e.g. beef or pork), but eat other meat products like chicken or fish	56	5,60%
I do not eat meat (e.g. beef, pork or poultry), but I eat fish (I'm a pesco-vegetarian)	16	1,60%
I do not eat meat (e.g. beef, pork, poultry or fish), but I eat other products of animal origin (e.g. eggs, cheese, milk	15	1,50%
I do not eat any meat, eggs or dairy products (I'm a vegetarian)	0	0,00%
I do not eat anything of animal origin (I'm a vegan)	0	0,00%
Other, specify:	1	0,10%
Total	*1000*	*100,00%*
Diet_3		
ominovore	798	79,90%
meat sometimes or no red meat	170	17,00%
vegetarian	31	3,10%
	999	100,00%
Do you intentionally aim to reduce the amount of meat and / or other products of animal origin in your diet?		
Yes	331	36,30%
No	581	63,70%
Total	*912*	*100,00%*
Most important - What are your main reasons for reducing or avoiding the use of products of animal origin?		
Environmental sustainability, climate change	46	10,20%
Ethics, animal welfare	83	18,60%
My health and well-being	**249**	**55,60%**
High price of meat	23	5,10%
Taste and texture of meat	39	8,70%
Other, specify:	8	1,80%
Total	*448*	*100,00%*
Second most important - What are your main reasons for reducing or avoiding the use of products of animal origin?		
Environmental sustainability, climate change	**129**	**28,80%**
Ethics, animal welfare	**92**	**20,50%**
My health and well-being	83	18,50%
High price of meat	59	13,20%

Taste and texture of meat	76	16,90%
Other, specify:	9	2,00%
Total	*448*	*99,90%*

The use of convenience foods was not remarkable among the Polish respondents. Only sausages and salty snacks were consumed on a regular basis. All vegetarian convenience foods or meat substitutes were consumed by 4 % of respodents on a weekly basis.



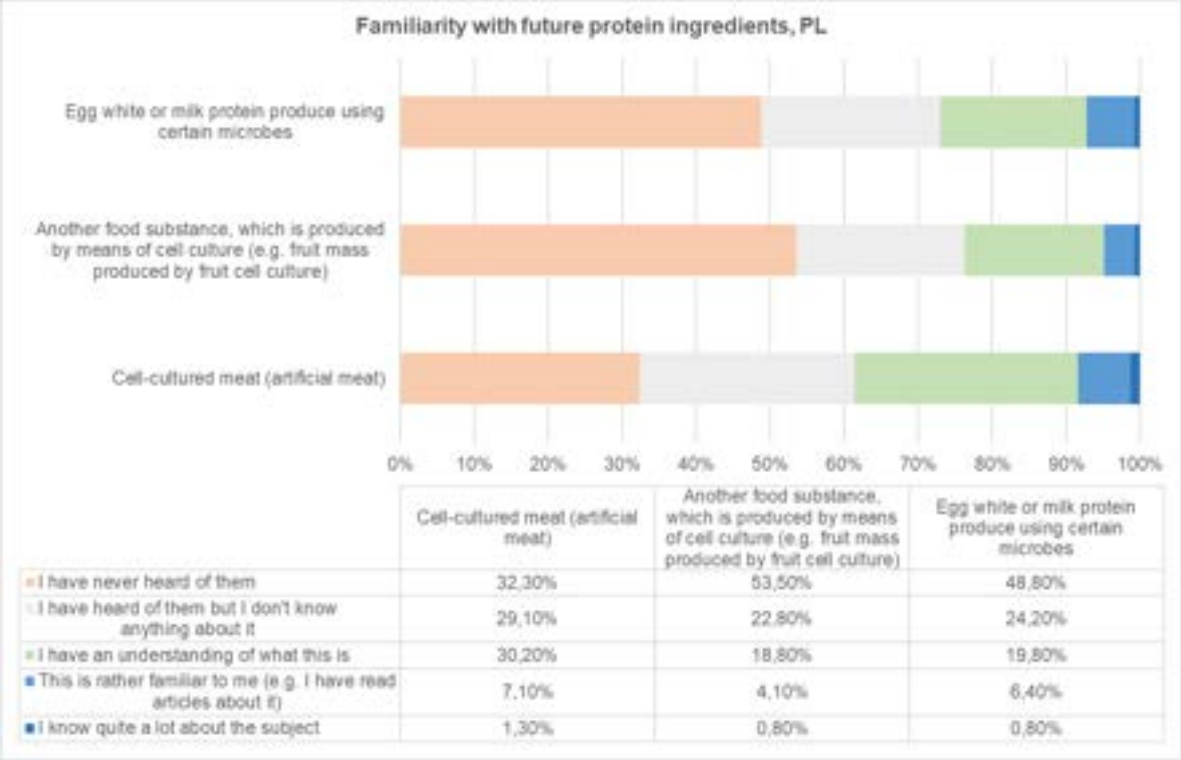
	Sausages (e.g. BBQ sausages and frankfurters)	Minced meat burgers or meatballs	Vegetarian / meat substitute burgers or meatballs	Vegetarian oven-prepared meals	Vegetarian / meat substitute sausages	Salty snacks (e.g. potato crisps, cheese snacks)
Rarely or never	9,20%	35,10%	60,90%	63,40%	74,70%	17,80%
Several times a year	22,90%	26,00%	17,70%	20,00%	11,70%	29,50%
1-3 times per month	37,10%	25,70%	14,20%	10,70%	9,40%	33,70%
Weekly	24,30%	10,30%	5,40%	4,30%	3,10%	14,00%
More than once a week	6,50%	2,90%	1,80%	1,60%	1,10%	5,00%

Figure 195. Use of certain convenience foods by the PL respondents

Consumers in Poland are familiar with different protein sources, alternative to meat. Nearly 90 % of the consumer say that they eat legumes very often, followed by peas (88,3 %) and fava beans 71,9 %. Soya based meat substitutes is consumed by 50 % of the consumers at least once a month. Interestingly, like in many other countries e.g. in Germany, Polish consumers answer that they have heard about insects, but did not tried them yet.

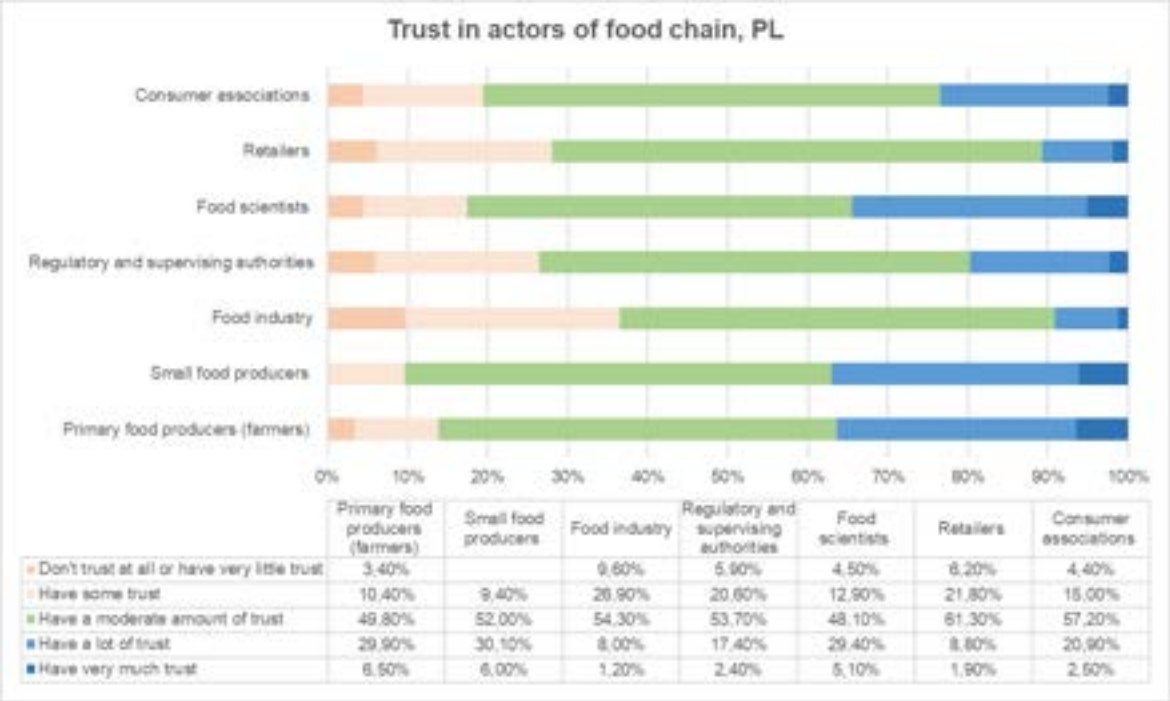
	Peas (or products derived from them)	Fava beans (or products derived from them)	Lupini beans (or products derived from them)	Other legume vegetables (peas, beans)	Insects or products containing insects	Soya-based meat substitutes such as tofu or tempeh	Wheat-based meat substitutes such as seitan	Fungi-based meat substitutes such as Quorn®	Other meat substitutes (produced using other protein sources such as oat, egg, etc.)
I have not heard of these	0,60%	0,70%	13,40%	0,00%	23,00%	6,60%	43,70%	55,10%	28,30%
I have heard of these, but I have not tried them	1,80%	8,30%	55,60%	3,90%	69,30%	37,90%	29,30%	27,60%	32,40%
I have tried these, but I do not use them	9,30%	19,00%	20,70%	5,90%	4,60%	27,80%	6,80%	9,00%	11,80%
I eat these occasionally	68,30%	61,90%	8,90%	62,60%	1,70%	23,10%	11,20%	8,90%	18,50%
I eat these often	20,00%	10,10%	1,40%	28,80%	0,80%	4,80%	9,00%	2,40%	9,00%

Figure 196. PL respondents' previous familiarity with alternative protein sources and meat substitutes made of these



	Cell-cultured meat (artificial meat)	Another food substance, which is produced by means of cell culture (e.g. fruit mass produced by fruit cell culture)	Egg white or milk protein produce using certain microbes
I have never heard of them	32,30%	53,50%	48,80%
I have heard of them but I don't know anything about it	29,10%	22,80%	24,20%
I have an understanding of what this is	30,20%	18,80%	19,80%
This is rather familiar to me (e.g. I have read articles about it)	7,10%	4,10%	6,40%
I know quite a lot about the subject	1,30%	0,80%	0,80%

Figure 197. Familiarity with future (emerging) protein sources, PL



	Primary food producers (farmers)	Small food producers	Food industry	Regulatory and supervising authorities	Food scientists	Retailers	Consumer associations
Don't trust at all or have very little trust	3,40%		9,60%	5,90%	4,50%	6,20%	4,40%
Have some trust	10,40%	9,40%	26,90%	20,60%	12,90%	21,80%	15,00%
Have a moderate amount of trust	49,80%	52,00%	54,30%	53,70%	48,10%	61,30%	57,20%
Have a lot of trust	29,90%	30,10%	8,00%	17,40%	29,40%	8,80%	20,90%
Have very much trust	6,50%	6,00%	1,20%	2,40%	5,10%	1,90%	2,50%

Figure 198. Trust in various actors of food chain in the PL sample.

Polish consumers tend to trust the various actors of the food chain. At least 60 % of the respondents had a moderate amount of trust. Highest trust is enjoyed by the primary food producers and small food producers as well as food scientist. On the other hand, food industry and retailers are less trusted. Figure 198.

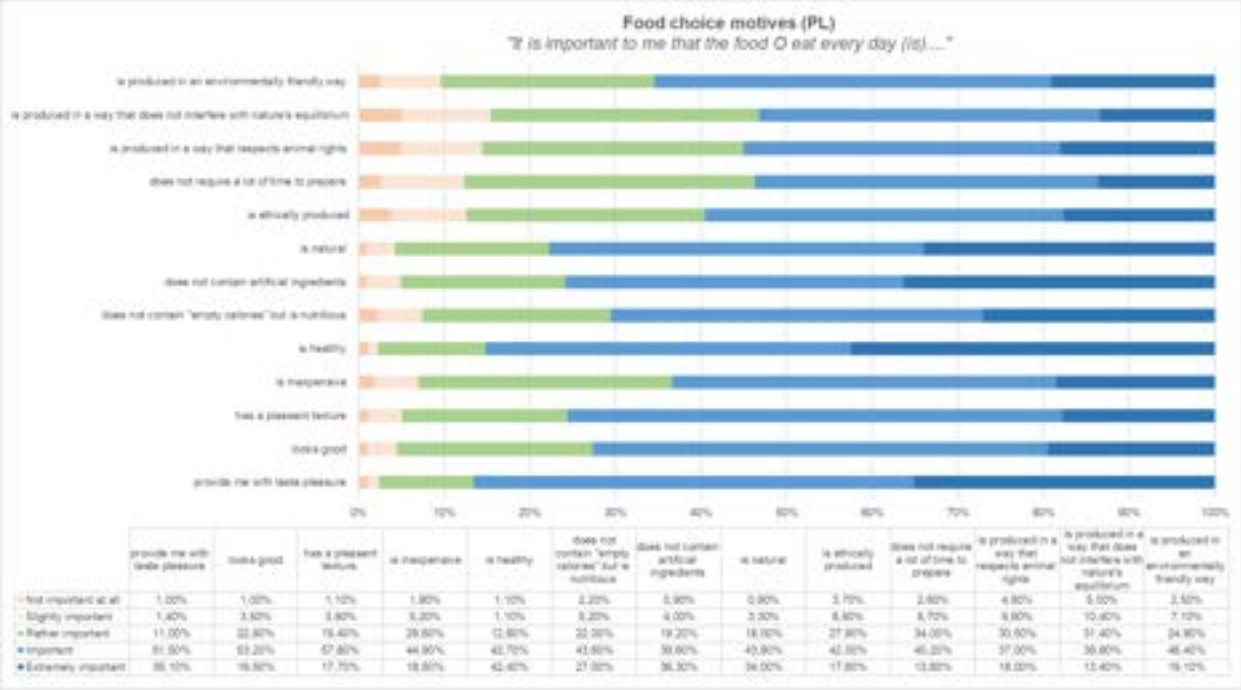


Figure 199. Perceived importance of food values (food choice motives) in the PL sample.

When the respondents are asked to rate how they value various issues in their daily food, most respondents placed the highest importance on food characteristics “natural”,

"healthy" and "taste". Compared to these, lower share of respondents rated the ethical, environmentally and animal friendly production method as important. (see Figure 199).

12.3 Forming the composite variables, PL

12.3.1 New variables describing respondents' background attitudes, PL

Factor analyses (principal axis factoring, varimax rotation) were performed to check the dimensionality of items for each scale. In the case of Food technology attitudes (Q9) and Meat attachment (Q7) the analysis yielded two factors with eigenvalues over 1. Based on the emerged dimensions. However, the two variables measured the opposite tendencies. Thus, using two variables instead one did not bring any additional information, so only one composed variable was created to measure Meat attachment.

Table 74 Composite variables describing Polish respondents' background attitudes. The measurement scale for all the listed composite variables is 1 – 5. PL

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.74
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	.84
Trust	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	.82
FTechnology_attitude	Attitude towards new food technology	Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV	.73
Meat_attachment	Attachment to meat eating	Q7r1, Q7r2, Q7r3_REV, Q7r4, Q7r5, Q7r6, Q7r8_REV (Q7r7_REV omitted)	.88
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.89
F_innovativeness	Food innovativeness (interest in new food products)	MEAN(Q11r2, Q11r3, Q11r4)	.83
Use_vege_convemience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.87
Use_meat_convenience	Mean frequency of use of meat based convenience foods	Q5r1, Q5r2	.62

Table 75 New variables to describe PL respondents' food values.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
M_Sensory	Good sensory characteristics	Q6r1, Q6r2, Q6r3	0,74
M_Healthy	Healthiness and naturalness	Q6r5, Q6r6, Q6r7	0,81
M_Environment_etics	Produced in ethical and environmentally friendly way	Q6r9, Q6r11, Q6r12, Q6r13	0,92
M_Inexpensive	Is inexpensive	Q6r4	
M_Natural	Is natural	Q6r8	
M_Convenience	does not require much time to prepare	Q6r10	

12.3.2 New variables measuring acceptance of the three NextGen concepts, PL

New variables were formed to reflect positivity or negativity of respondents' attitude towards each of the three NextGenProteins concepts (variables ATT_). In addition, composite variables were formed to measure respondents' beliefs in benefits of each of the NextGenProteins concept as well as to indicate the strength of respondents' concern about potential risks of the NextGenProteins concepts. All the resulting variables had high internal reliabilities. Finally, also respondents' ratings (views or pre-assumptions) about the characteristics of food products made using each of the NextGenProteins ingredient were averaged for each NextGenProteins concept to form a composite measure of how positively or negatively NextGenProteins microalgae, NextGenProteins insect and NextGenProteins Torula based food application are viewed. The latter are subsequently called food application views. Table 76.

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" are not included in the subsequent analyses, which apply these variables.

Table 76 Composite variables measuring acceptance, their contents and reliabilities (PL). The measurement scale for all the listed composite variables is 1 – 5

Composite variables	Explanation	Cronbach Alpha
ATTITUDES	*mean of 3 items (difficult – easy to understand – item not included)*	
ATT_Algae	Attitude towards NextGen microalgae protein	0,945
ATT_Insect	Attitude towards NextGen insect protein	0,949
ATT_Torula	Attitude towards NextGen Torula protein	0,931
PERCEIVED BENEFITS	*mean of all 5 items*	
BENEFIT_Algae	Perception of benefits from NextGen microalgae protein	0,941
BENEFIT_Insects	Perception of benefits from NextGen insect protein	0,939
BENEFIT_Torula	Perception of benefits from NextGen Torula protein	0,939
PERCEIVED RISKS	*mean of 3 items, "other risk" not included*	
RISK_Algae	Perception of risk relating to production of NextGen microalgae proteins	0,875
RISK_Insects	Perception of risk relating to production of NextGen insect proteins	0,856
RISK_Torula	Perception of risk relating to production of NextGen Torula proteins	0,864
FOOD APPLICATION VIEWS	*mean of all the 7 items*	
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein	0,949
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein	0,938
FOODVIEWS_Torula	Views towards foods made with NextGen microalgae protein	0,949

12.4 Comparison of the three NextGenProtein production concepts and applications, PL

12.4.1 Which of the NextGen ingredients is most positively viewed in PL?

The overall acceptance of the protein concepts is Poland differs between the NextGen concepts. Torula and algae was rated best and the insects were rated worst.

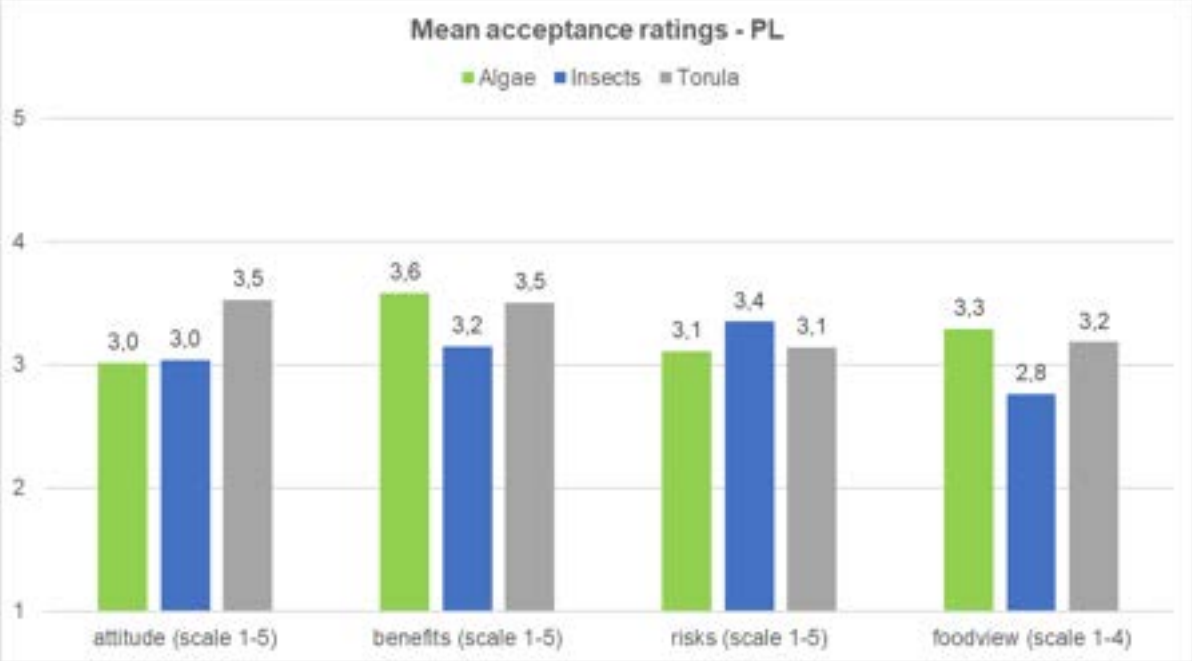


Figure 200 Means of composite variables measuring acceptance towards each of the three NextGenProteins concepts in PL sample

Figure 200 shows that the torula concept received best values for attitude. The algae concept received the highest values for benefits and use of interest. Out of the three concept consumers rated the torula and algae concept not very differently. The insect concept received the lowest values, except risks where it received the highest values in comparison to the other ingredients.

Table 77 Comparison of means of acceptance ratings (composite variables) between the three NextGenProteins protein concepts. Significance of difference tested with repeated measures analysis of variance. PL

Composite variables:	Algae	Insect	Torula	df	F	Sig.
Attitudes (scale 1 – 5)	3,0	3,0	3,5	2	104,57	.000
Benefits (scale 1 – 5)	3,6	3,2	3,5	2	95,5	.000
Risks (scale 1 – 5)	3,1	3,4	3,1	2	23,65	.000
Foodviews (scale 1 – 4)	3,3	2,8	3,2	2	187,0	.000

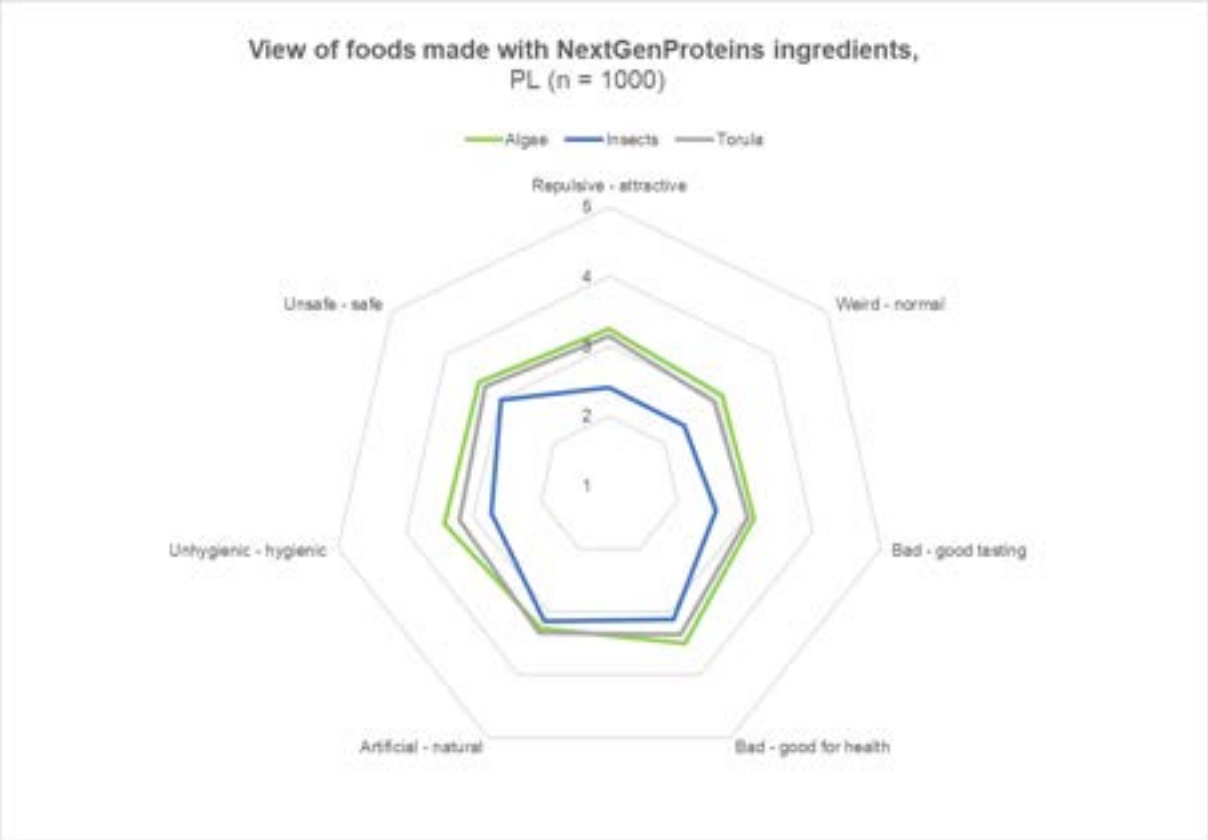


Figure 201 Means of respondents' preconceptions about the characteristics of imaginary food made using the NextGenProteins ingredients, PL

The results of the "views of food made with NextGenProteins ingredients" support the conclusion based on acceptance ratings. Food made with microalgae proteins and torula proteins received the best ratings in this bipolar rating. (Table 74, Figure 201.)

Table 78 Means of food views and statistical significance of differenced in means between the three NextGenProteins ingredient (repeated measures analyses of variance), PL

	Algae	Insect	Torula	df	F	Sig.
Repulsive – Attractive	3,3	2,4	3,2	2	282,77	.000
Weird - Normal	3,1	2,4	2,9	2	163,75	.000
Bad – good tasting	3,1	2,6	3,0	2	145,60	.000
Bad - good for health	3,5	3,1	3,4	2	67,30	.000
Artificial – Natural	3,3	3,2	3,3	2	10,78	.000
Unhygienic – Hygienic	3,4	2,7	3,2	2	180,72	.000
Unsafe - Safe	3,4	3,0	3,3	2	76,27	.000

The respondents in Poland were interested to use products made from micro algae and torula yeast, but not very strongly interested to use products made from insects. The interest in snacks and vegetable protein patties was highest. Instead, the consumers were not keen to use these NextGenProteins protein concepts for sausages.

12.4.2 What is the most interesting food application of NextGen in Poland?

Regardless of the NextGen ingredient type, the respondents were less interested in buying NextGen food applications in the form of sausages than in the form of snacks or vegetable-protein patties. In the case of all food types, the ones with insect -based protein were always rated as less interesting to use.

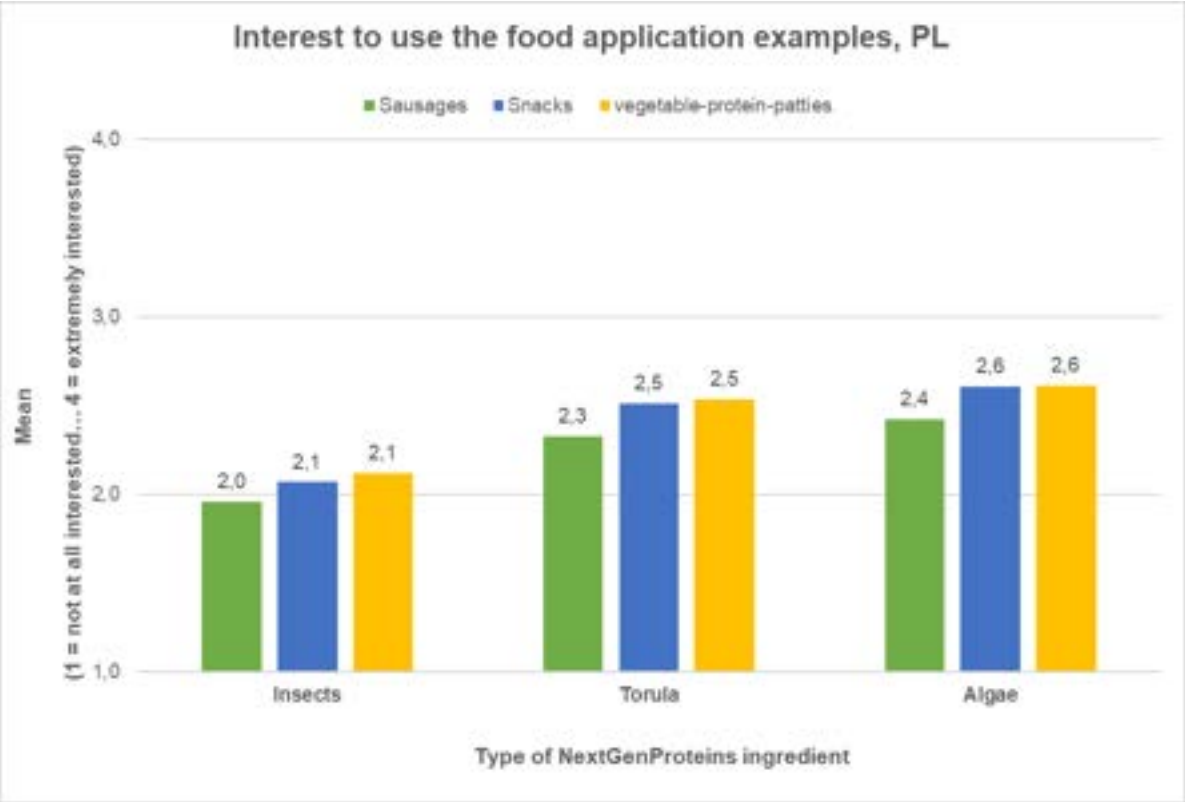


Figure 202 Means of interest to use the examples NextGenProteins food applications by product type and NextGenProteins ingredient type in PL. Significance of differences in means between the food types.

Table 79. Respondents' interest to use the examples of NextGen protein food application. Means ans significance of differences of mean between the concepts (ingredients) tested with reapeated measures analysis of variance.

	Algae	Insect	Torula	df	F	Sig.
sausages	2,4	2,0	2,3	2	147,22	.000
snacks	2,6	2,1	2,5	2	201,97	.000
Vegetable-protein-patties	2,6	2,1	2,5	2	166,41	.000

12.5 Acceptance of NextGen microalgae protein concept

This chapter starts with presentation of the percentage distributions of answers to each individual survey question measuring consumer views towards the **NextGen microalgae** concept as it was described to the respondents in the survey.

After that, the respondents were clustered into groups based on their views Towards the NextGen microalgae concept, and the characteristics of these clusters are described. This will provide information e.g. about what kind of consumers had positive or negative views towards NextGen microalgae method and foods.

12.5.1 The level of acceptance of NextGen microalgae protein, PL

In Poland, half the respondent rated the micro algae protein concept as a good idea, wise and also as easy to understand. However, 30 % of the respondents answered the questions using the neutral scale point. Only 13,8 % felt the microalgae concept difficult to understand, 52,5 % feel they are able to understand the concept. More than 50 % see the positive aspects of the concept and are in favour of the concept and describe it as wise or a good idea. 21,% are against the concept.

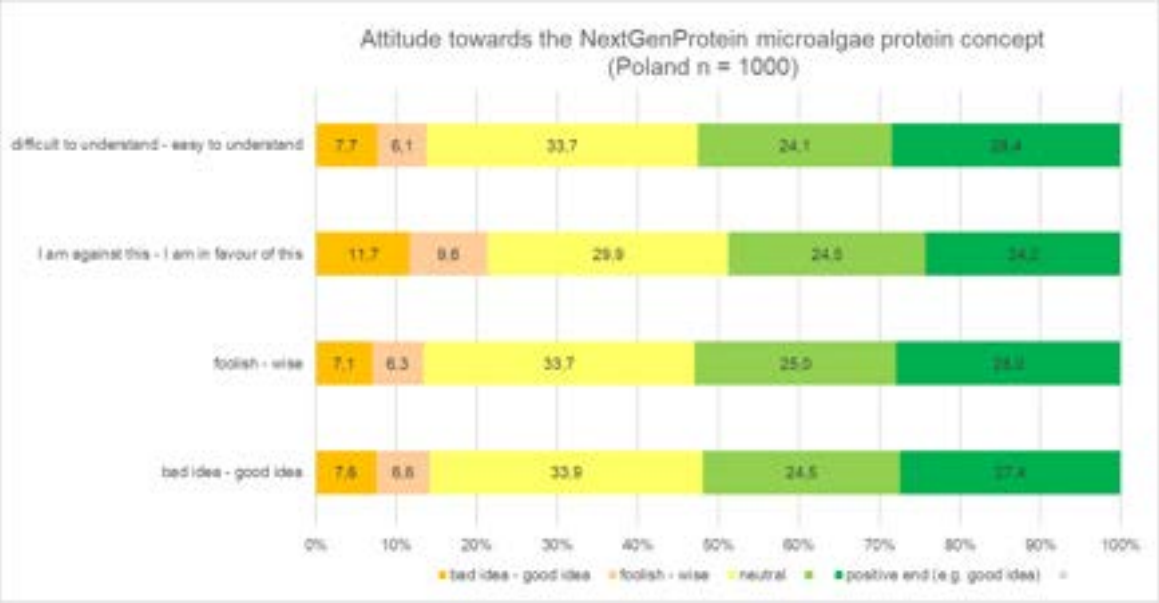


Figure 203 Attitudes towards the NextGenProteins microalgae concept. Percentages of the PL respondents.

Half of the consumers see the benefits that the micro algae proteins are environmentally sustainable and able to reduce suffering of livestock. They do not see clearly the benefits for themselves and for human health. It is noteworthy that for each item at least 11 % up to 17,5 % were unable to give an answer (Figure 204.).

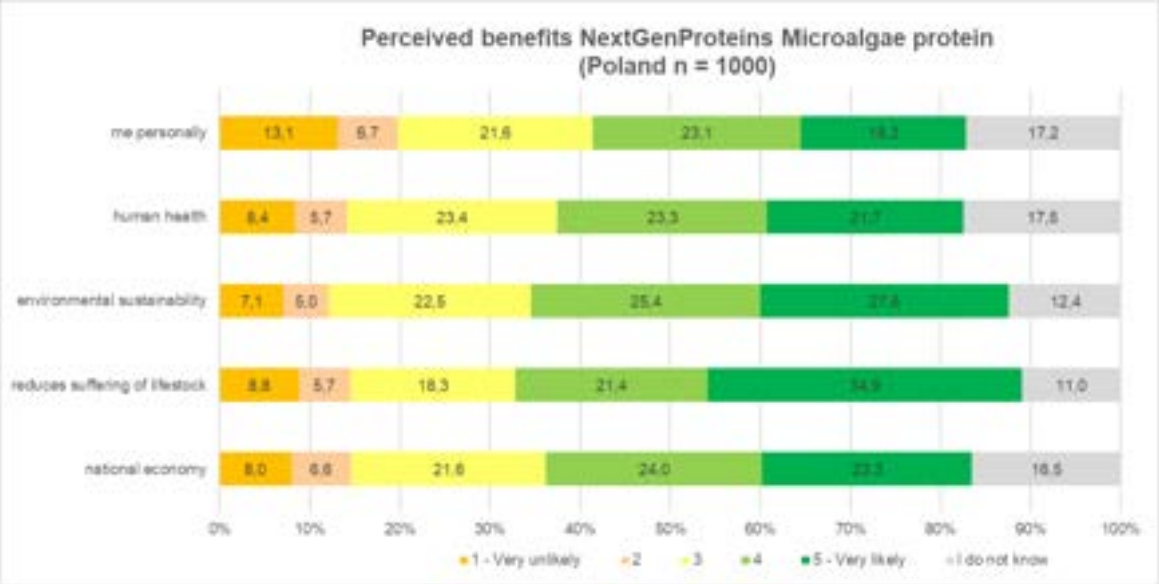


Figure 204 Perceived benefits of the NextGenProteins microalgae protein concept. Percentages of the PL respondents.

About 42 % of the respondents were concerned about the risk of being misled by food companies. Over 27 % were also concerned of unpredicted negative effects on the environment and of risks of human health and food safety.

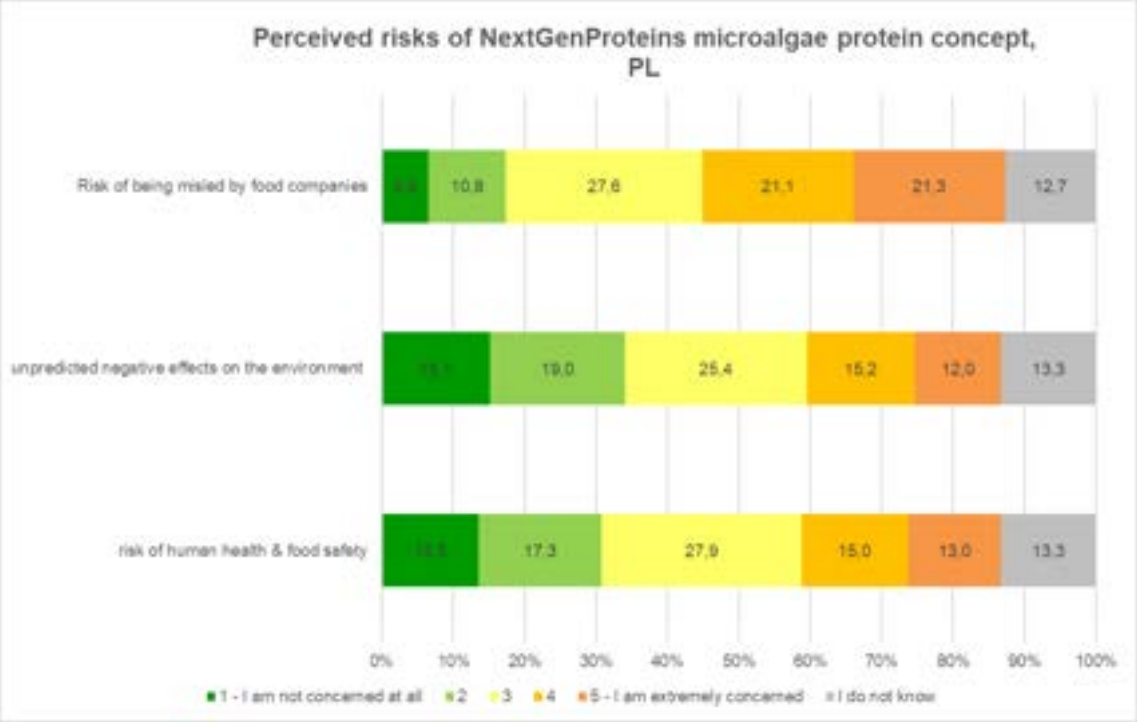


Figure 205 Perceived risks of the NextGenProteins microalgae protein concept. Percentages of PL respondents.

About 40 - 50% of the respondents expected the food applications of NextGen microalgae proteins to be safe, hygienic, and attractive. Half (50 %) of the consumers rated those as good for health rather than bad for health. Approx. 40 % of the consumers did not have either positive or negative preconceptions about the quality of these foods. (Figure 206)

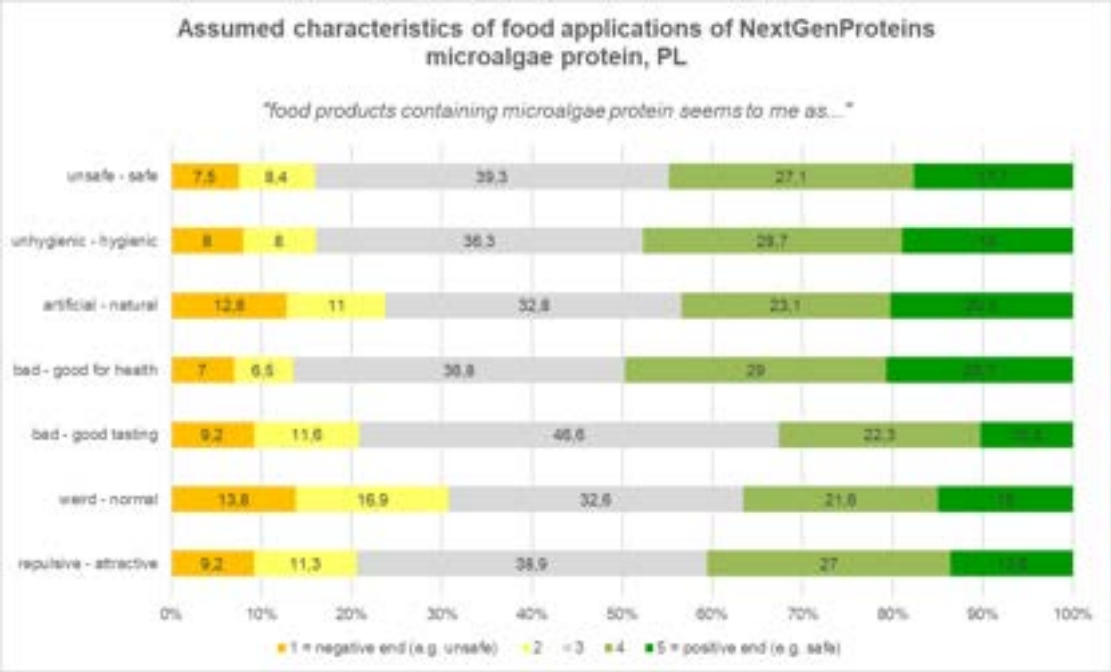


Figure 206 Characteristics associated by respondents with the imaginary food applications made with NextGenProtein microalgae protein. Percentages of PL respondents.

Consumers expect 34,6 % of people they know not to have interest in purchasing these food products and 39,5 % would not appreciate such foods. Uncertain are here approx. 40 % of the consumers are uncertain. Figure 207.

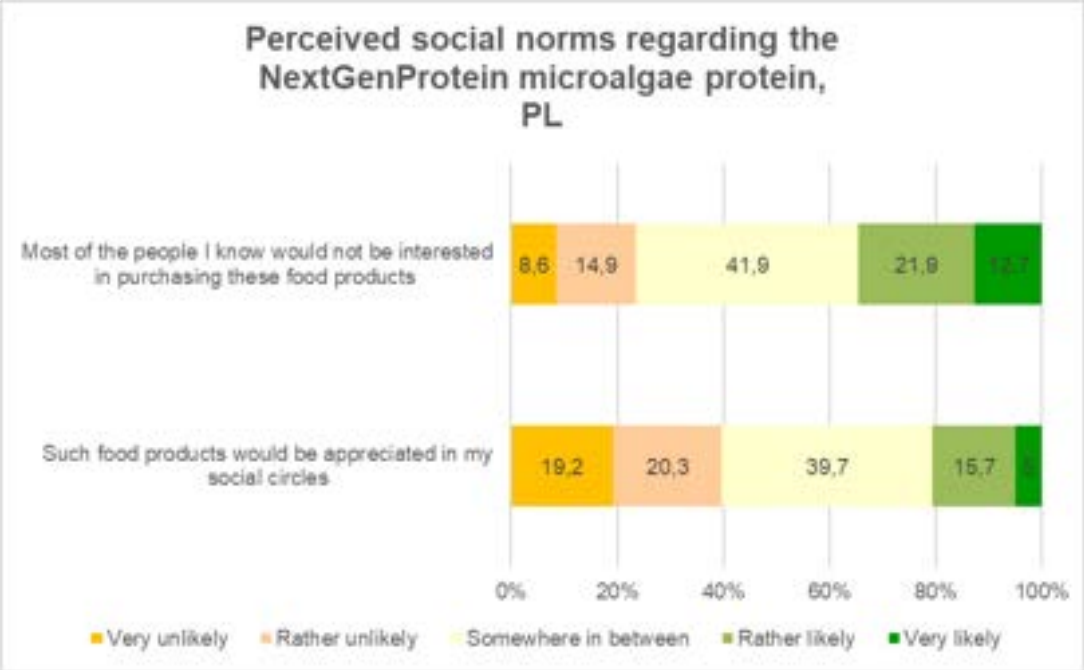


Figure 207 Perceived social norms regarding NextGenProteins microalgae protein food products. Percentages of PL respondents.

More than 50 % of the Polish respondents were to some extent interested in using the NextGen microalgae protein applied in patties, snacks or sausages. The share of not interested respondents was 39,4 % (patties) - 46,4 % for sausages. Figure 208.

Compared to respondents' interest to use the conventional versions of similar foods (Figure 209.), their claimed interest to use the NextGen applications, is quite high.

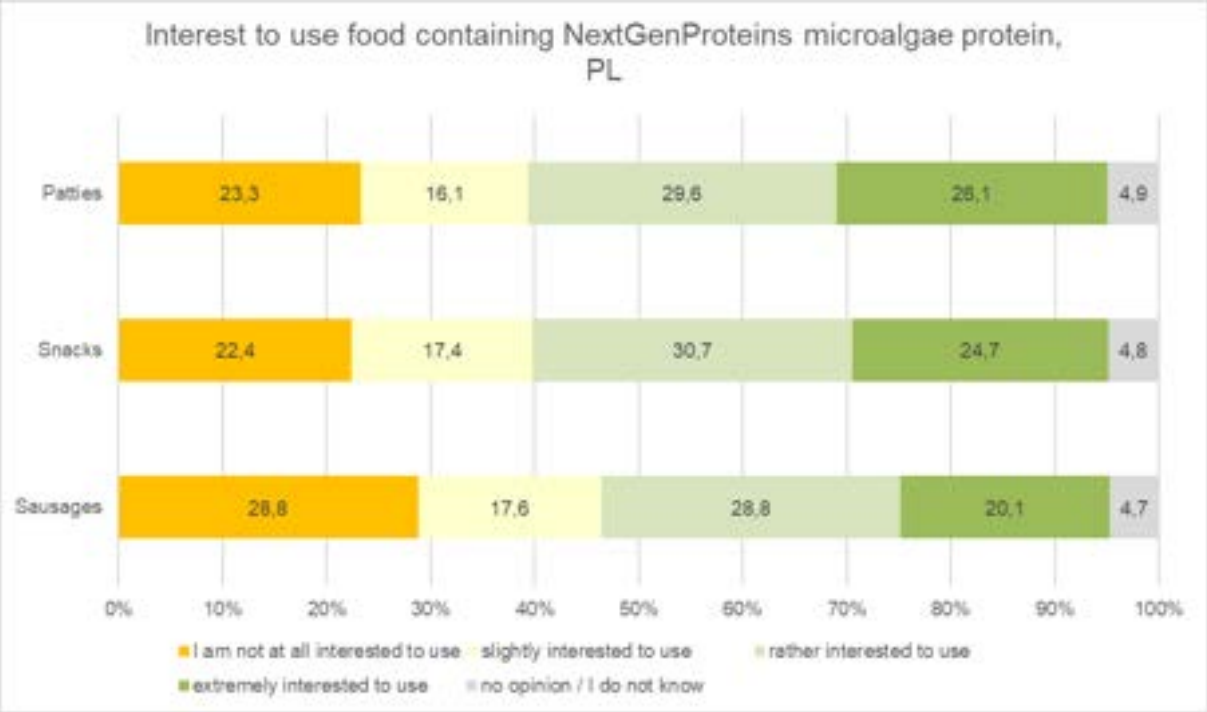


Figure 208 Interest to use the food application examples of NextGenProteins microalgae protein. Shares of PL respondents with each answer alternative.

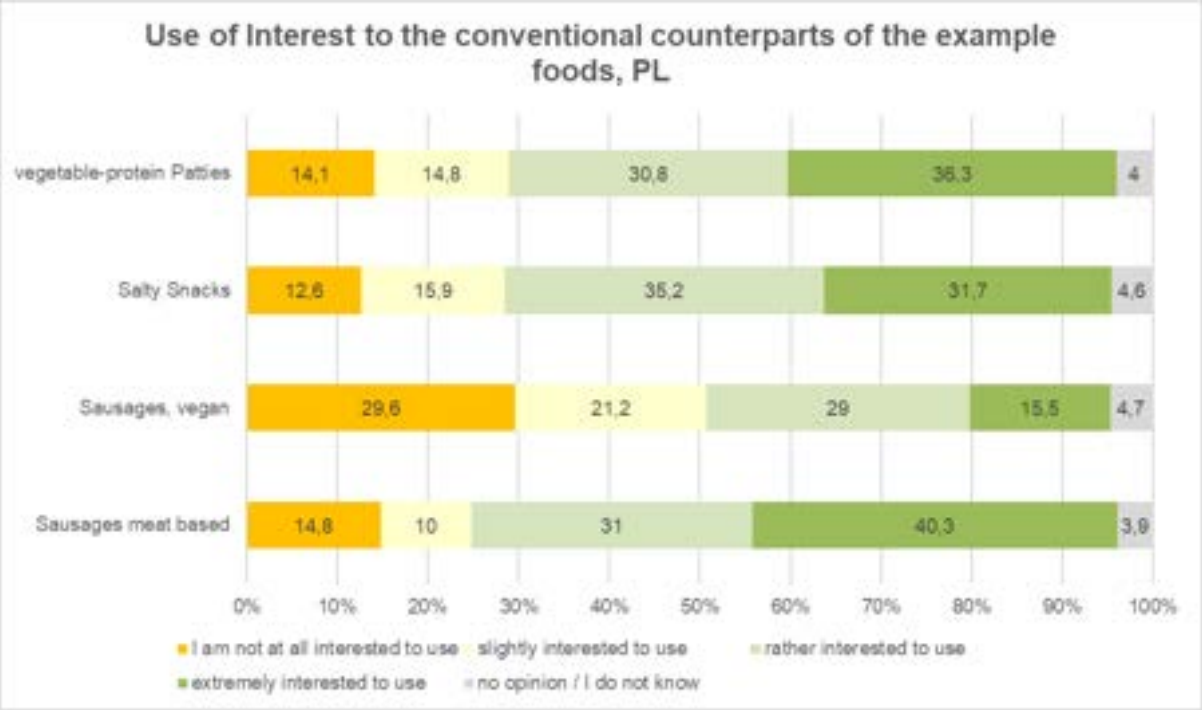


Figure 209 Use interest of the conventional counterparts of the food application examples. Percentages of PLrespondents.

12.5.2 Consumer clusters based on views towards Nextgen microalgae concept, PL

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGenProteins microalgae concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 2 – 3 clusters. Subsequent K-means clustering, run with 2 to 4 clusters, confirmed that 3 cluster solution best brings out the differences in the sample.

The cluster with highest belief in the benefits and highest food quality ratings of NextGen Microalgae concept, moderate attitudes, and lowest concers for risks was named as Positive. The cluster. The cluster fro which all of the acceptance measured pointed towards negative views, was named Negative. The third clusters had moderately high beliefs in benefits, neutral food quality ratings, but they were also concerned about the risks. This group was named Sceptics.

Table 80 Consumer clusters based on respondents' views towards NextGenPrpteins microalgae protein concept. The result of K-means cluster analysis with 3 clusters. Means of acceptance variables in each cluster. PL

Cluster	Positive	Negative	Sceptics	Total	F	Sig.
Number of cases	276	125	479	880		
Percent of cases	31,4 %	14,2%	54,4%	100%		
Variables applied as basis of the clustering						
ATT_Algae	3,1	2,7	3,0		8,23	.000
BENEFIT_Algae	4,5	1,7	3,6		800,70	.000
RISK_Algae	1,9	4,3	3,5		608,97	.000
FOODVIEWS_Algae	4,3	1,9	3,2		605,97	.000

12.5.2.1 Demographic profile and eating habits of NextGen microalgae consumer clusters, PL

In the following, the characteristics of the clusters are summarised. Significant differences exist in education level and general eating habits. In case of the other attributes, only tendencies exist. See Table 81. for more detail.

Cluster 1: 31,4 % of the consumers positive

- More women
- Majority between 35-54 years
- Majority living in a large city
- Mainly secondary education, but the highest proportion of tertiary education in comparison to the other clusters
- Mainly omnivore, highest amount of vegetarians (5%)
- No kids/ kids evenly

Cluster 2: 14,2 % of the consumers negative

- More men
- Majority between 55-75 years
- Majority living large city, but highest amount living in rural areas
- Mainly tertiary education, but highest amount in lower education grades
- Mainly omnivore eating habits to the other clusters
- Mainly no kids

Cluster 3: 54,4 % of the consumers sceptical

- Gender-balanced
- Majority between 35-44 years, otherwise nearly balanced
- Majority living in a large city, highest amount living in the capital area
- Mainly tertiary education
- Mainly omnivore eating habits
- No kids/ kids evenly

Table 81. Demographic profile of consumer clusters based on views towards NextGenProteins microalgae protein concept, PL. Percentages of respondents. Statistical significance of differences within each background variable has been tested with Pearson Chi2 – tests

	Positive	negative	sceptical	Pearson Chi2	Sign.	Total N
Gender				2,71	n.s.	880
Male	46,40%	**55,20%**	48,50%			
Female	**53,60%**	44,80%	51,50%			
Age				32,95	,000	880
18-24 years	**13,40%**	4,80%	8,40%			
25-34 years	15,30%	13,60%	20,20%			
35-44 years	20,30%	16,00%	22,40%			
45-54 years	20,90%	15,10%	14,70%			
55-64 years	18,10%	23,30%	19,80%			
65-75 years	11,90%	**27,10%**	14,40%			
Education				13,04	0,01	880
basic education	0,70%	**4,00%**	2%			
secondary education	49,1%	48,5%	48,60%			
tertiary education	50,2%	47,5%	51,00%			
others	0,00%	0,00%	0,00%			
Living Area				6,39	n.s.	880
I live in the capital city / area	15,60%	15,30%	**19,40%**			
I live in a large city that is not in the capital area	40,80%	39,00%	41,10%			
I live in a small city/town or municipality	26,50%	23,20%	25,10%			
I live in a rural area	17,10%	**22,40**%	14,40%			
Household				10,17	0,038	847
no children	36,60%	48,90%	36,50%			
with children	40,80%	40,20%	42,10%			
semoething else	22,50%	10,90%	21,40%			
Diet				7,81	n.s.	879
ominovore	74,70%	**82,40%**	79,90%			
meat sometimes or no red meat	19,90%	16,80%	17,20%			
vegetarian	5,40%	0,80%	3,00%			

The familiarity with different alternatives and use of different convenience foods is different between the clusters. The cluster with positive attitude has the highest familiarity when it comes to different proteins alternative to meat, but the sceptic cluster (having neutral attitude towards the concept) shows a similar picture. That is, consumers with the most negative views towards NextGen microalgae concept are less familiar with alternative and future proteins than the other two clusters. (Figure 210.)

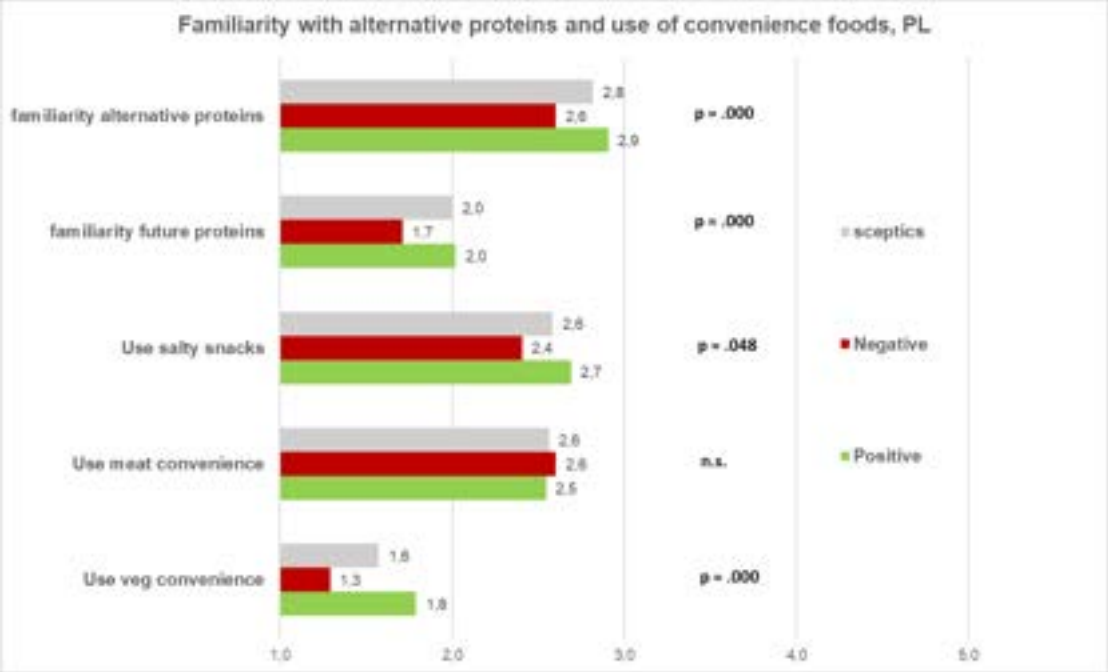


Figure 210 Use of certain convenience food types and familiarity with alternative proteins by NextGen microalgae consumer clusters in the PL sample. Means. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

12.5.2.2 Attitudinal background of NextGen microalgae protein clusters, PL

Figure 208. shows the attitudinal background of the participants. The cluster Negative is more attached to meat eating, and tend to be more taste neophobic than the other two clusters. The cluster Negative is also less positive towards new food technologies and are less interested in novel foods (lower food innovativeness). This is not surprising, because in this cluster, the share of omnivores is the highest. The positive cluster has positive attitude towards new food technologies and food innovativeness in general. The sceptical cluster has similar attitudes like the positive cluster, except for taste neophobia and meat attachment. This cluster seem to be open-minded towards new technologies, but they tend to be more taste neophobic than the positive cluster.

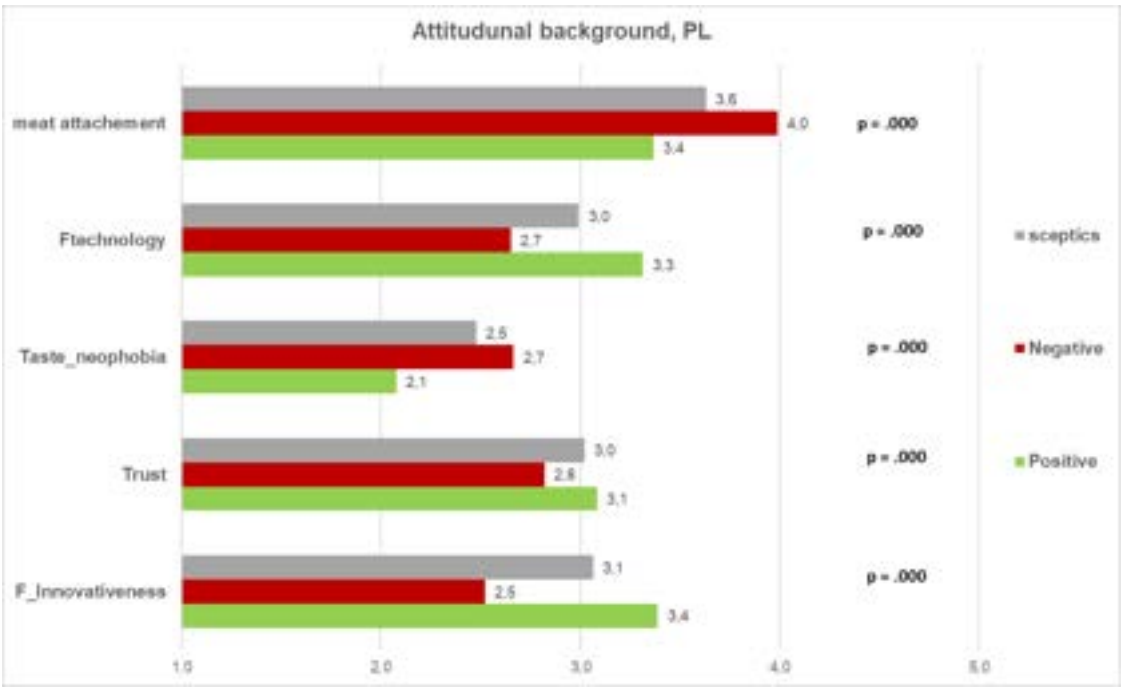


Figure 211 Background attitudes of the respondents in the clusters based on their views towards NextGenProteins microalgae concept. PL (The level of significance of differences in means between the clusters is marked; ns = no significant differences)

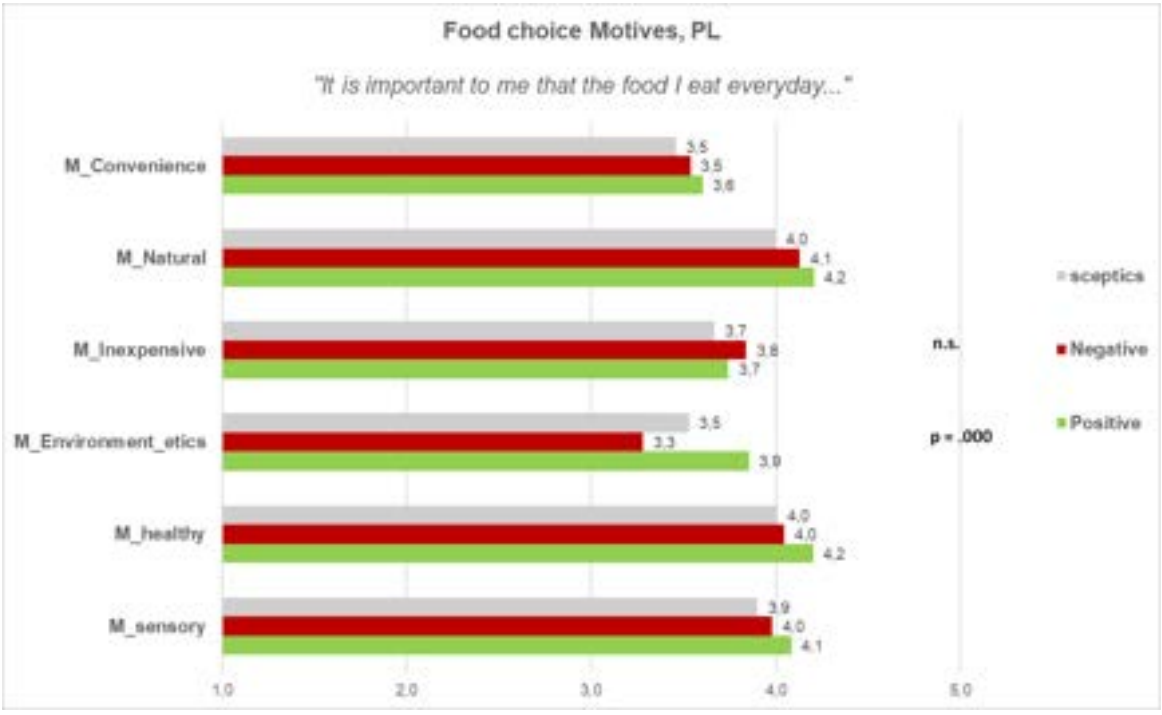


Figure 212 Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins microalgae concept. PL. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

The difference in mean values between the clusters for the food choice motives are significant for sensory properties, healthy, environment and ethics, inexpensive, natural and convenience. Cluster positive rated highest in all motives expect inexpensive (highest value Cluster 2). In other words, Polish consumers, who were most positive towards the NextGen

microalgae concept, valued naturalness, healthiness and environmental sustainability of their foods more than the other clusters. (Figure 212.)

12.5.2.3 Interest to use the food applications by NextGen microalgae consumer clusters

Consumers different views towards the Nextgen microalgae concept are strongly reflected in their interest to use the food applications. Only the positive cluster has an interest to use either patties, snacks or sausages made from microalgae proteins (Figure 213).

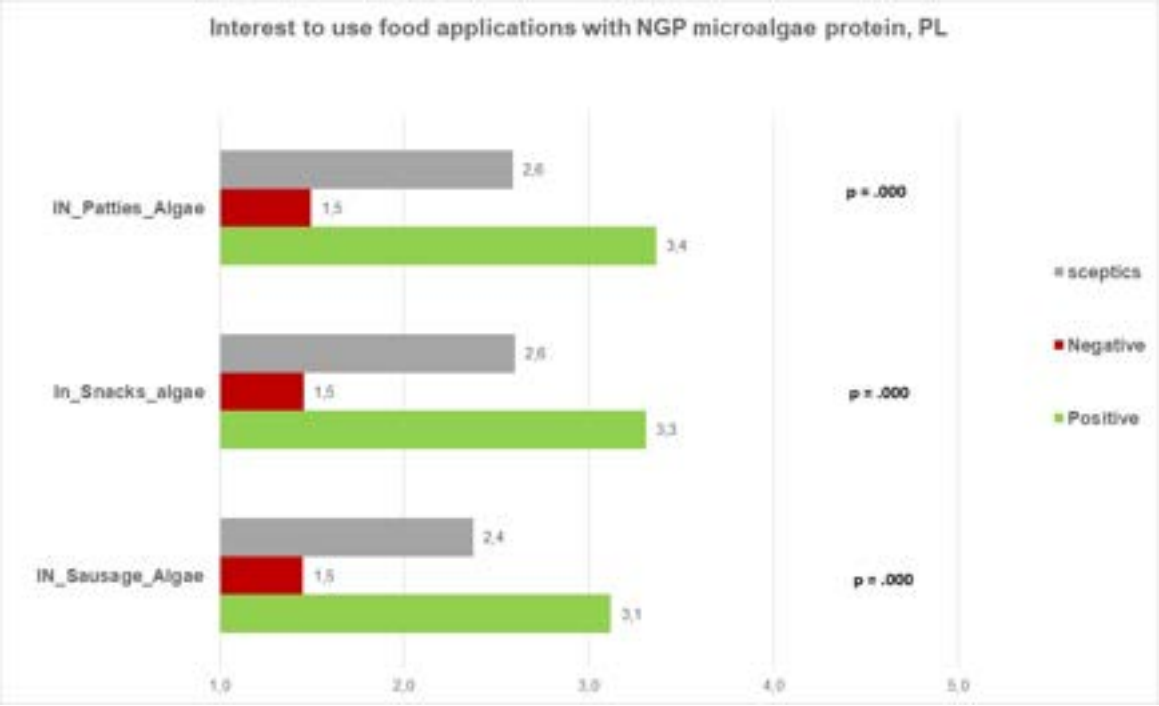


Figure 213 Respondents' mean interest to use vegetable – protein patties, salty snack and sausages made with NextGenProteins microalgae. Means, and significance of differences between clusters. PL

12.6 Acceptance of NextGen insects protein concept

12.6.1 The level of acceptance of NextGen insect protein concept, PL

In contrast to the algae protein is the acceptance towards the insect protein much lower. Only 50,3 % think, that it is a good idea. Even though 51,9 % are in favour of this idea, 22,7 % think that it is difficult to understand. Figure below shows that more than 30 % of the consumers have a neutral attitude.

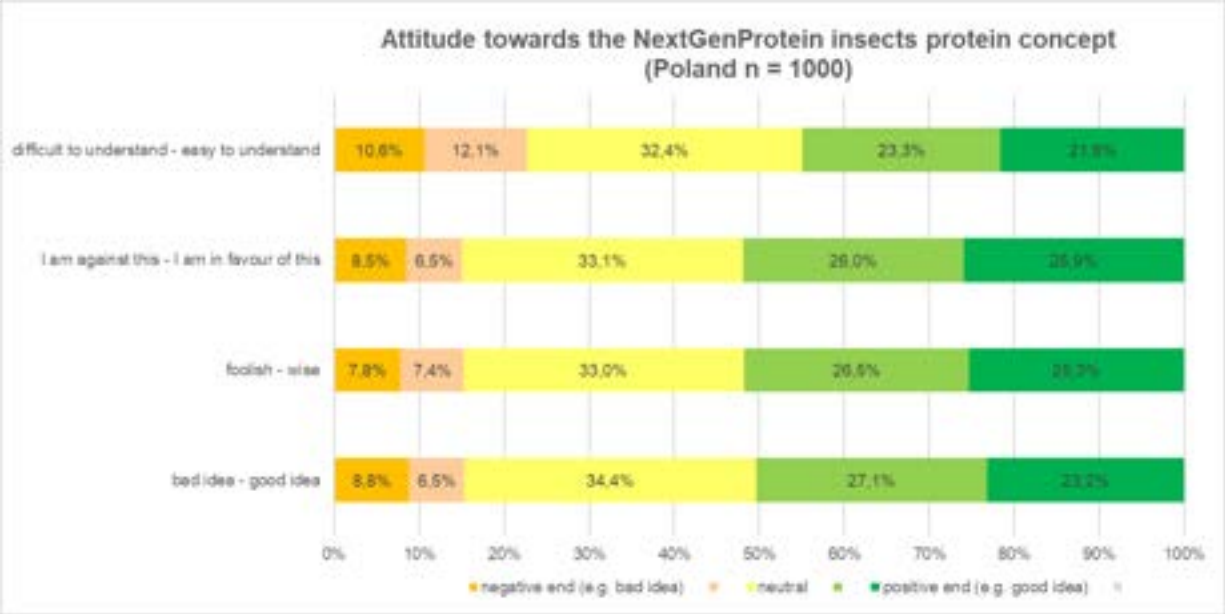


Figure 214 Attitudes towards the NextGenProteins insect protein concept. Percentages of PL the respondents.

Figure 215 shows the perceived benefits of the insect protein concept. 56,1 % of the consumers believe, that it reduces the suffering of livestock. 49,9 % of the consumers think that this concept is beneficial to environmental sustainability. Consumers think that it is less beneficial to the national economy, to human health or to themselves personally.

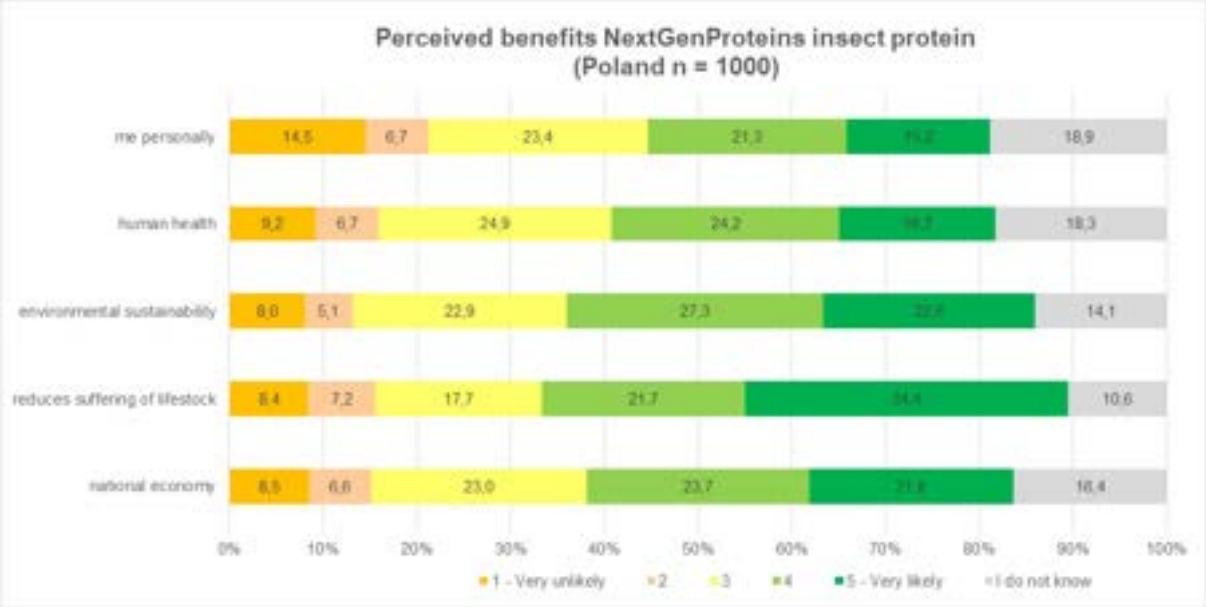


Figure 215 Perceived benefits of the NextGenProteins insect protein concept. Percentages of PL the respondents

Out of Polish respondents, 41% were concerned about the risk of being misled by food company, which reflects the low trust in the food industry. The risk for human health and food safety was seen by 28,6 %.

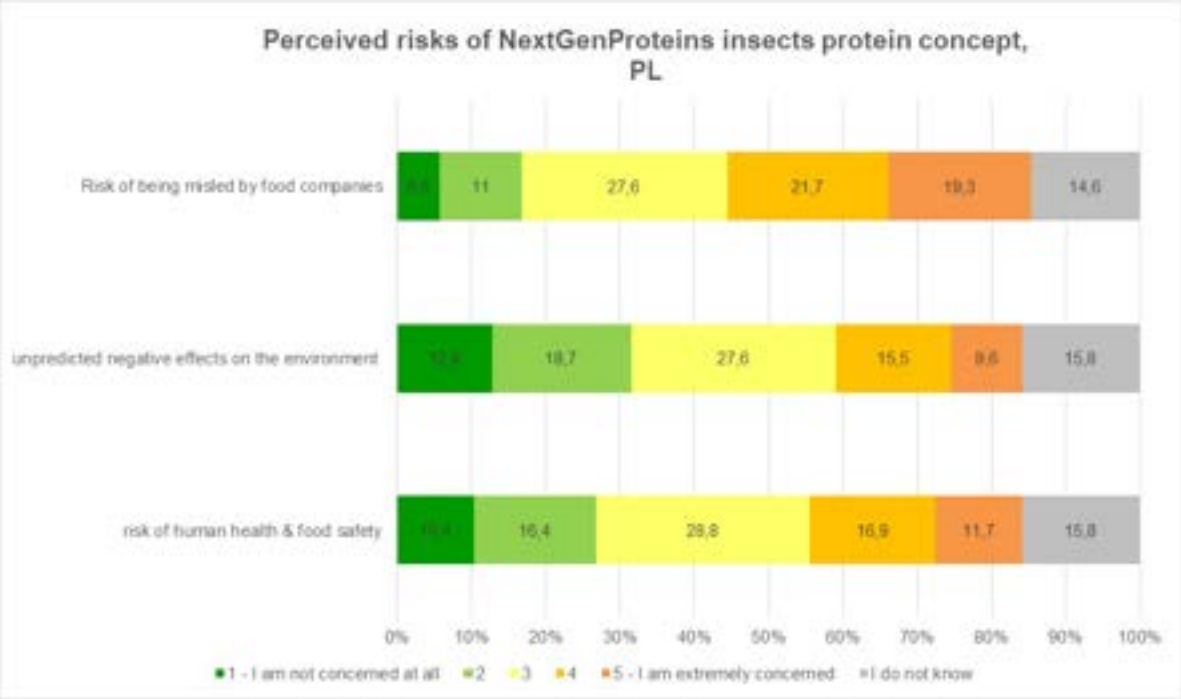


Figure 216 Perceived risks of the NextGenProteins insect protein concept. Percentages of PL the respondents.

About half (49,7 %) of Polish respondents would assume food products made from insects to be good for the health. Below half of them believe these foods to besafe (44,8 %) and hygienic (47,7 %). Figure 217 shows that for all characteristics a large number of consumers answer in the middle of the scale. This is understandable, as the respondents do not yet have any experience about these foods, don't know how they look or taste.

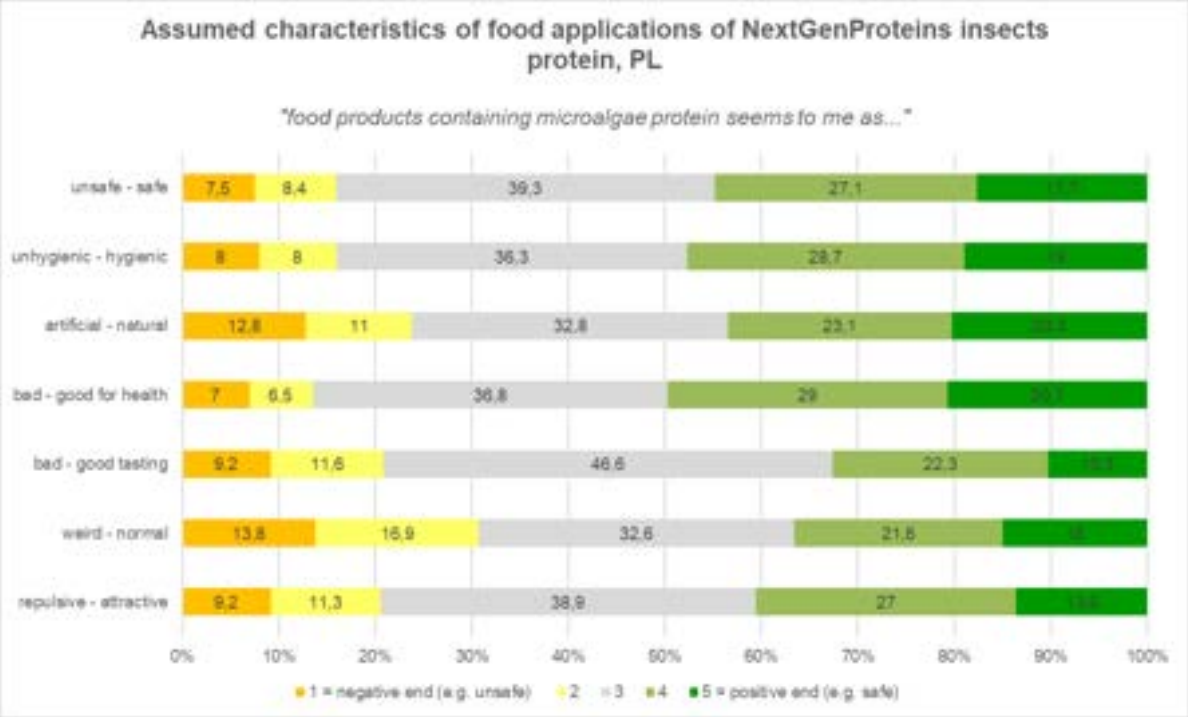


Figure 217 Characteristics associated with food applications made with NextGenProteins insect protein. Percentages of PL respondents.

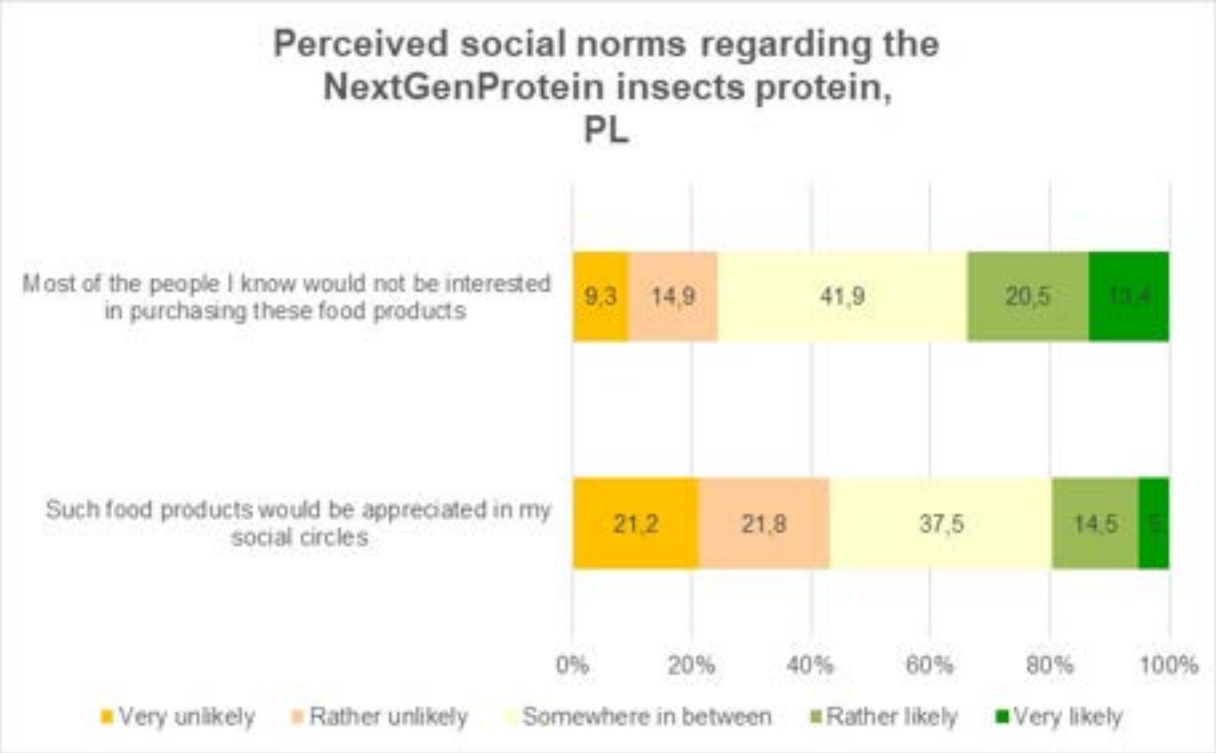


Figure 218 Perceived social norms regarding NextGen insect protein food products. PL

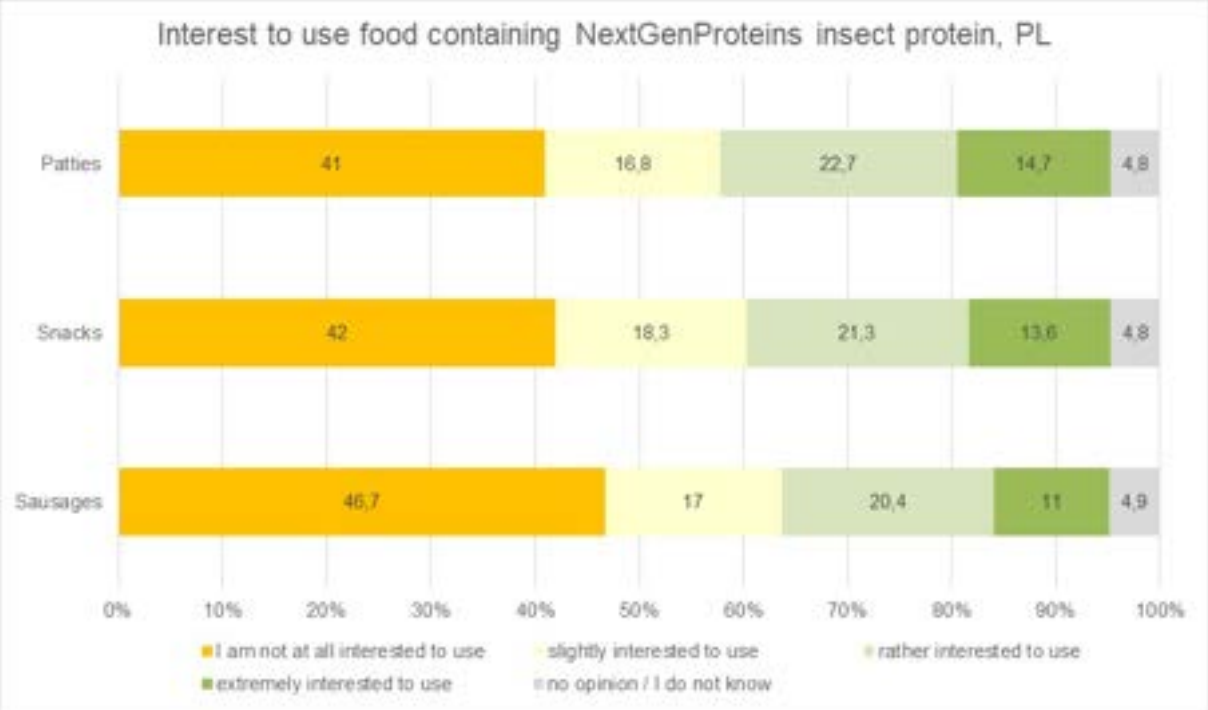


Figure 219 Interest to use the food application examples of NextGenProteins insects protein. Shares of PL respondents with each answer alternative.

At first glance (Figure 219), it becomes obvious that the majority of consumers are not interested to use insect protein in one of the sample food products, especially sausages (46,7%). The highest potential have patties (37,4 % interested users), followed by snacks (34,9 %) and sausages (31,4%).

12.6.2 Consumer clusters based on their views towards NextGen insect protein concept, PL

The clustering was made on the basis of the four acceptance measures the NextGen insect concept yielded three clusters.

Table 82 Consumer clusters based on respondents' views towards NextGenProtein insect protein concept. The result of K-means cluster analysis with 3 clusters. PL

Cluster	Sceptics	Negative	Positive	Total	F	Sig.
Number of cases	381	202	288	871		
Percent of cases	43,7%	23,2%	33,1%	100%		
Variables applied as basis of the clustering						
ATT_insects	2,9	1,5	4,4	3,1	1248,31	.000
BENEFITS_insects	3,2	1,5	4,3	3,2	1151,03	.000
RISKS_insects	3,3	4,3	2,6	3,3	232,87	.000
FOODVIEWS_insects	2,8	1,5	3,8	2,8	832,87	.000

Table 82 shows the cluster sizes and their mean responses towards the concept. Cluster 1 consists of consumers having a **Sceptical** attitude, as they regard benefits as likely, but are also concerned about the risks. The second cluster is called **Negative**, because they have very negative attitude towards the concept, very low beliefs in the benefits and high concern for risks. In addition, they expect the food applications made using this protein to be of low quality (foodviews). The cluster 3 will be called **Positive**, since they have positive attitude, can see the benefits, have low concern for risks, and have positive expectations about the quality of the food applications.

12.6.2.1 Demographic profile and eating habits of NextGen insect consumer clusters, PL

The demographic characteristics of the consumer clusters for NextGen insect concept are summarised below. More detailed results are shown in Table 83.

Cluster 1: 43,7 %% of the consumers "the sceptical"

- More female
- 35-75 years evenly distributed
- Majority living in a large city
- Mainly tertiary education
- Mainly omnivore eating habits, but also 17,8 % of consumers trying to reduce meat
- kids

Cluster 2: 23,2 % of the consumers "the negative"

- More women
- Oldest cluster in comparison to the other clusters

- Majority living in a small city/town or municipality
- Mainly tertiary education, but highest proportion of primary education
- Mainly omnivore eating habits
- Mainly no kids

Cluster 3: 33,1 % of the consumers "the positive"

- More female
- Age evenly distributed
- Majority living in a large city
- Majority tertiary education in comparison to the other clusters
- Mainly omnivore eating habits, but the highest proportion of people who wants to reduce meat in their diet
- kids

Respondents' familiarity with alternative or future proteins is significantly higher in the positive cluster than in the other two clusters. No difference can be found in the use of meat containing convenience food, but the mean differences between the negative and positive cluster for the use of vegetarian convenience cluster is significant. Figure 220.

Table 83 Demographic profile of consumer clusters based on views towards NextGenProteins insects protein concept, PL. Percentages of respondents. Statistical significance of differences within each background variable has been tested with Pearson Chi2 – tests.

	sceptics	negative	positive	Pearson Chi2	Sign.	Total N
Gender				3,41	n.s.	871
Male	47,40%	46,00%	**53,40%**			
Female	**52,60%**	**54,00%**	46,60%			
Age				17,84	n.s.	871
18-24 years	10,80%	5,50%	10,10%			
25-34 years	18,40%	15,30%	18,80%			
35-44 years	22,10%	20,40%	18,80%			
45-54 years	17,20%	15,80%	17,60%			
55-64 years	20,30%	20,30%	18,70%			
65-75 years	11,20%	22,70%	16,00%			
Education				11,28	0,024	871
basic education	0,30%	3,00%	0,70%			
secondary education	50,40%	46,50%	46,20%			
tertiary education	49,30%	50,50%	53,10%			
others	0,00%	0,00%	0,00%			
Living Area				7,01	n.s.	871
I live in the capital city / area	16,00%	15,90%	19,10%			
I live in a large city that is not in the capital area	**40,10%**	**36,10%**	**43,90%**			
I live in a small city/town or municipality	26,10%	30,20%	23,30%			
I live in a rural area	17,80%	17,90%	13,70%			

Household				5,9	n.s.	839
no children	36,10%	**45,40%**	37,90%			
with children	**42,00%**	39,20%	41,00%			
something else	21,90%	15,40%	21,10%			
Diet				9,83	n.s.	870
ominovore	**80,60%**	**81,20%**	**75,20%**			
meat sometimes or no red meat	17,80%	14,80%	19,20%			
vegetarian	1,60%	4,00%	5,60%			

Similar to the cluster of the microalgae concept, familiarity with alternative or future proteins is significantly higher in the positive cluster than in the other two clusters. No difference can be found in the use of meat containing convenience food, but the mean differences between the negative and positive cluster for the use of vegetarian convenience cluster is significant.

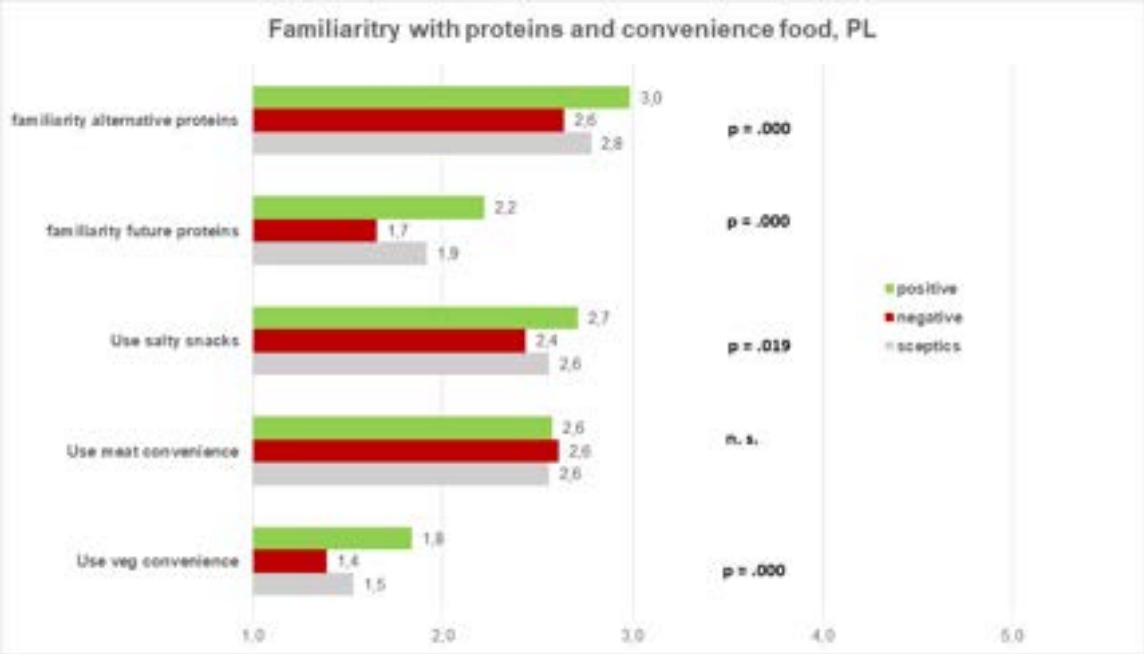


Figure 220 Mean use frequencies of certain convenience foods and familiarity with alternative proteins by consumer clusters based on their views on NextGenProteins insect protein concept. PL. (The level of statistical significance of differences in means between the clusters has been marked with p -values, ns = not significant)

12.6.2.2 Attitudinal background of NextGen insect clusters, PL

The consumer clusters differ significantly in all attitudinal background variables measured in the survey. The negative cluster have the highest meat attachment, which is very likely, because this cluster consists of consumers who are mainly omnivore and in contrast to the other clusters, this group has also the lowest amount of people open for meat reduction. The positive cluster seem to be more open to new food technologies than the other two clusters (FTechnology). They are also more interested in new food products coming into the market (food innovativeness). Further, the cluster with positive attitude towards the

Nextgen insect concept is clearly more opten and less afraid of new food tastes (taste neophobia is lower). The negative cluster is the most neophobic one and the sceptical are in between (see Figure 221).

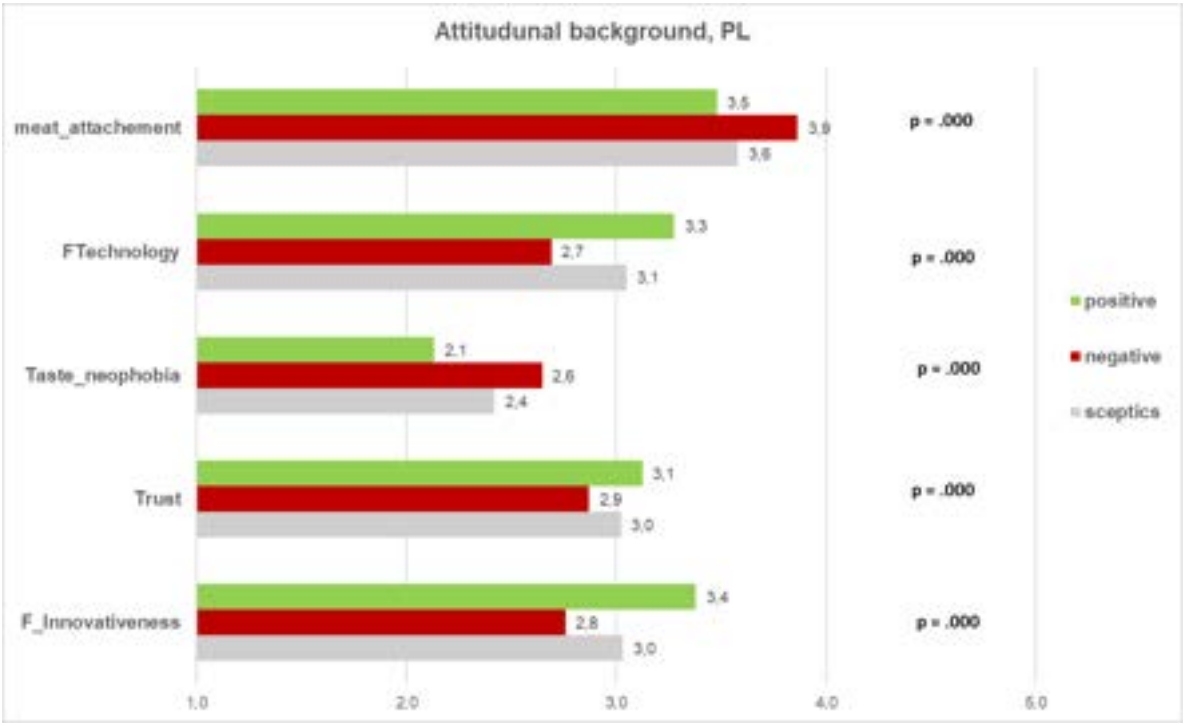


Figure 221 Background attitudes of the respondents in the clusters based on their views towards NextGenProtein insect concept. PL (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

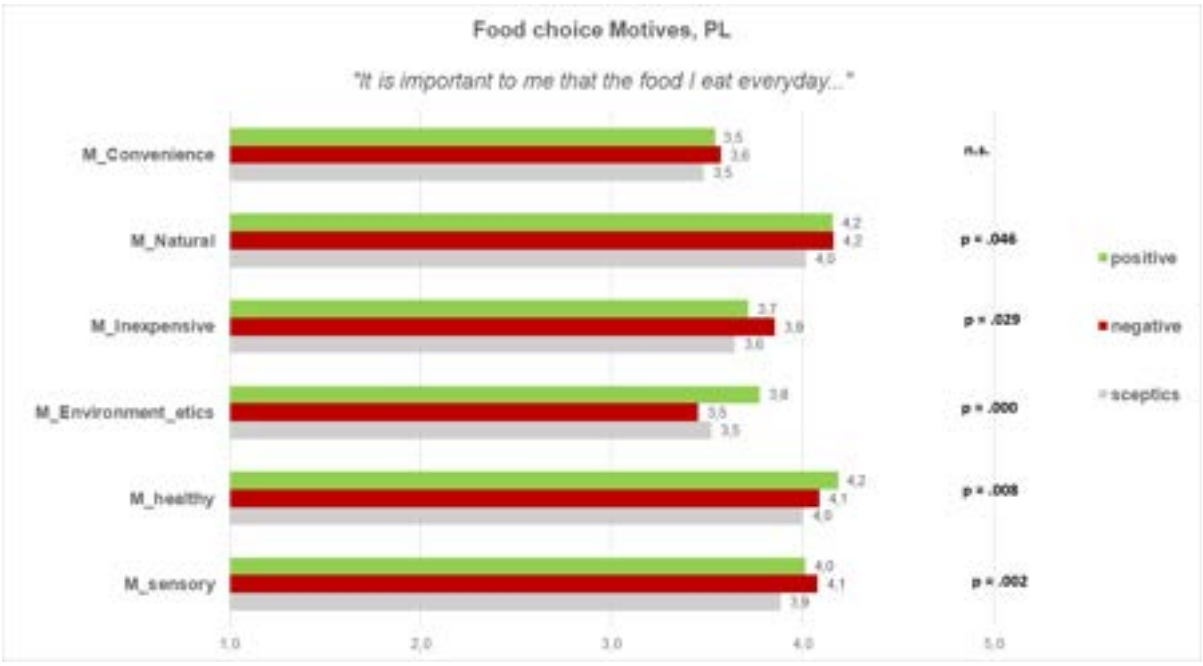


Figure 222 Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins insect concept. PL. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

In relation to respondents' food choice motives (food values), the consumer clusters differ significantly on all other attributes except convenience. Interestingly, the negative cluster rated higher in healthy, natural and sensory than the sceptic cluster. Sustainable and ethical production of food is, however, most important to the cluster positive, compared to the other clusters. Figure 222.

12.6.2.3 Interest to use the food applications by NextGen insect consumer clusters

The interest to use food products made with NextGen insect protein varies significantly between the clusters. Highest interest to use the products have positive, followed by sceptical and nearly no interest to use the products have the negative consumers.

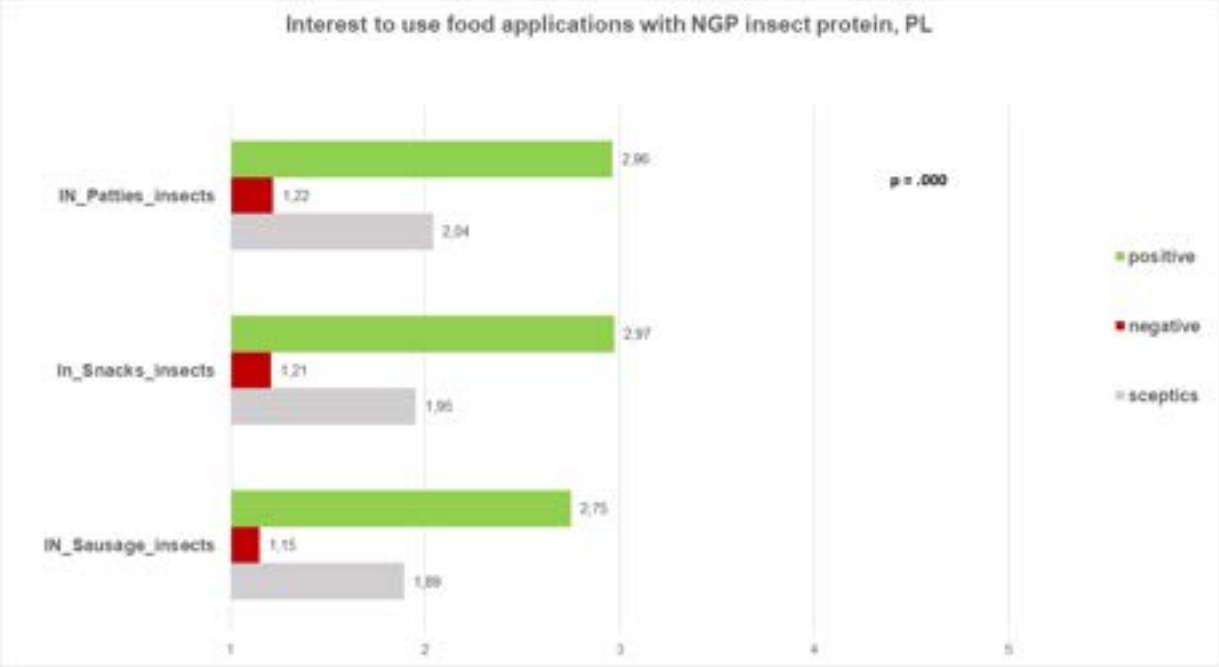


Figure 223 Interest to use food applications by consumer clusters based on their views towards NextGenProteins insect protein concept. PL. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences)

12.7 Acceptance of NextGen torula yeast protein concept

12.7.1 The level of acceptance of NextGen torula protein concept, PL

The concept of production and applying protein based on torula yeast for food products was perceived by 51,8 % as wise and 50,3 % think that it is a good idea. It is notheworthy, that high amounts of consumers have a neutral opinion for each of these attitude variables. About half of the respondents (51,9 %) feel that this concept is easily understandable for them.

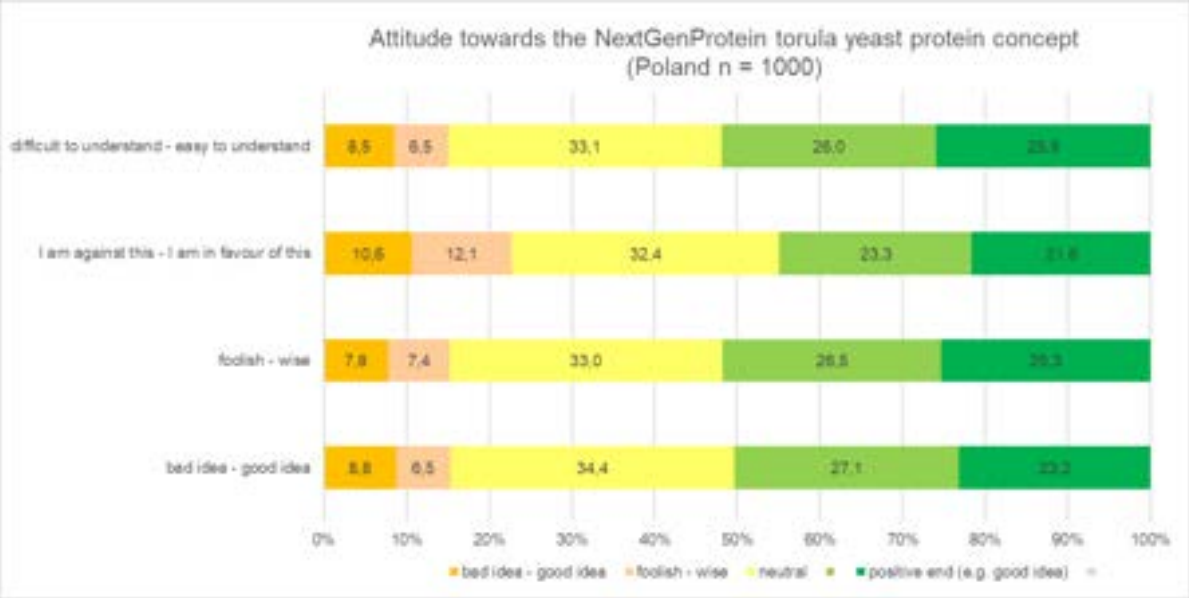


Figure 224 Attitudes towards the NextGenProteins Torula concept. Percentages of PL respondents

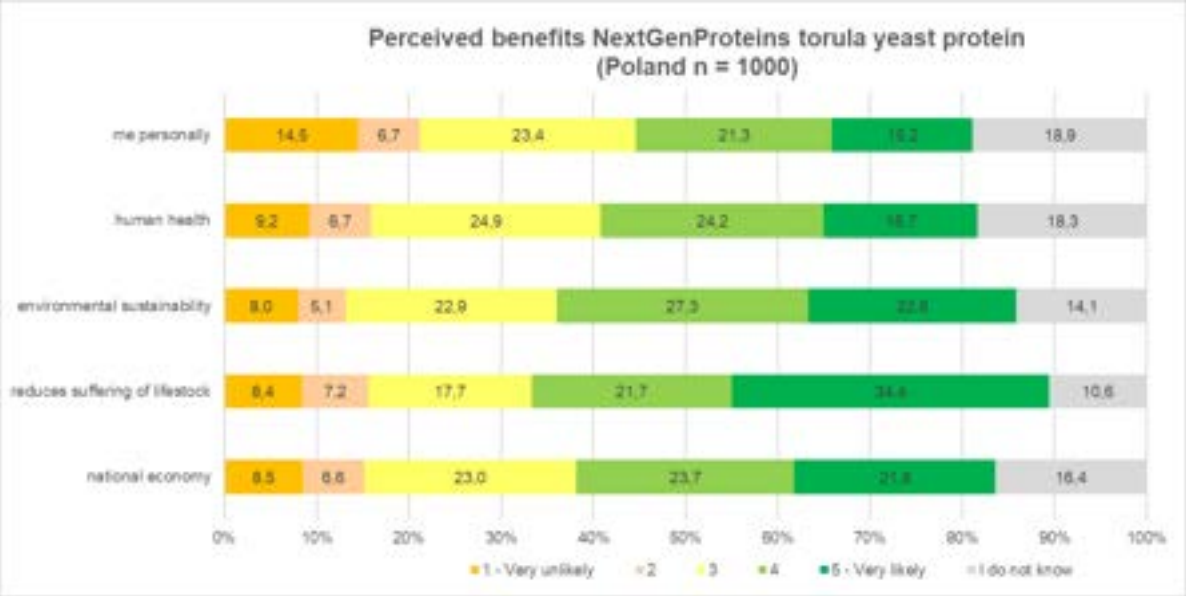


Figure 225 Perceived benefits of NextGenProtein Torula protein concept. Percentages of PL respondents.

The benefit perception (see Figure 225) supports the observations made above. Over half or the Polish respondents (56,1 %) are likely to believe in, that the concept reduces suffering of

livestock, and 49,9 % that it benefits environmental sustainability. Also, a large share of respondents (45,5 %) perceived benefits for the domestic economy, but only 38,9 % believed in benefits for the human health.

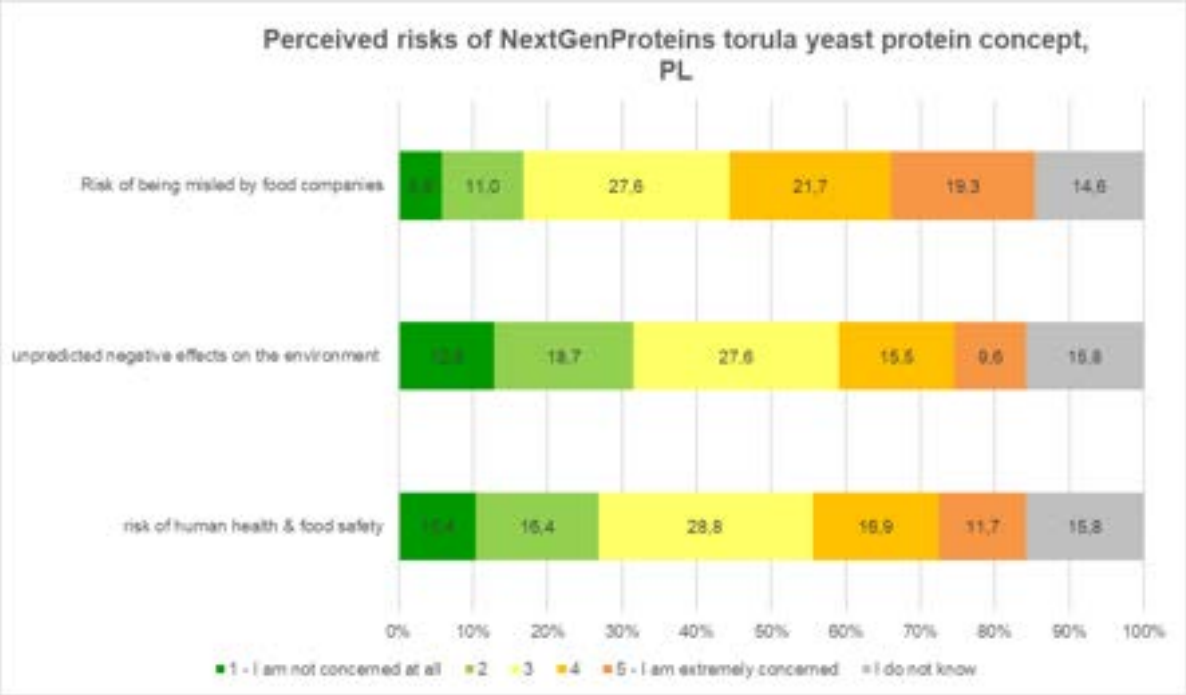


Figure 226 Perceived risks of NextGenProteins Torula protein concept. Percentages of PL respondents.

Out of the respondents, 41 % were concerned about being misled by food companies in relation to this concept. A risk for human health and food safety was expected by 28,6 % of the consumers. Again, a large share consumers were uncertain in their evaluations and marked the middle of the scale 3 or answered “I don’t know”.

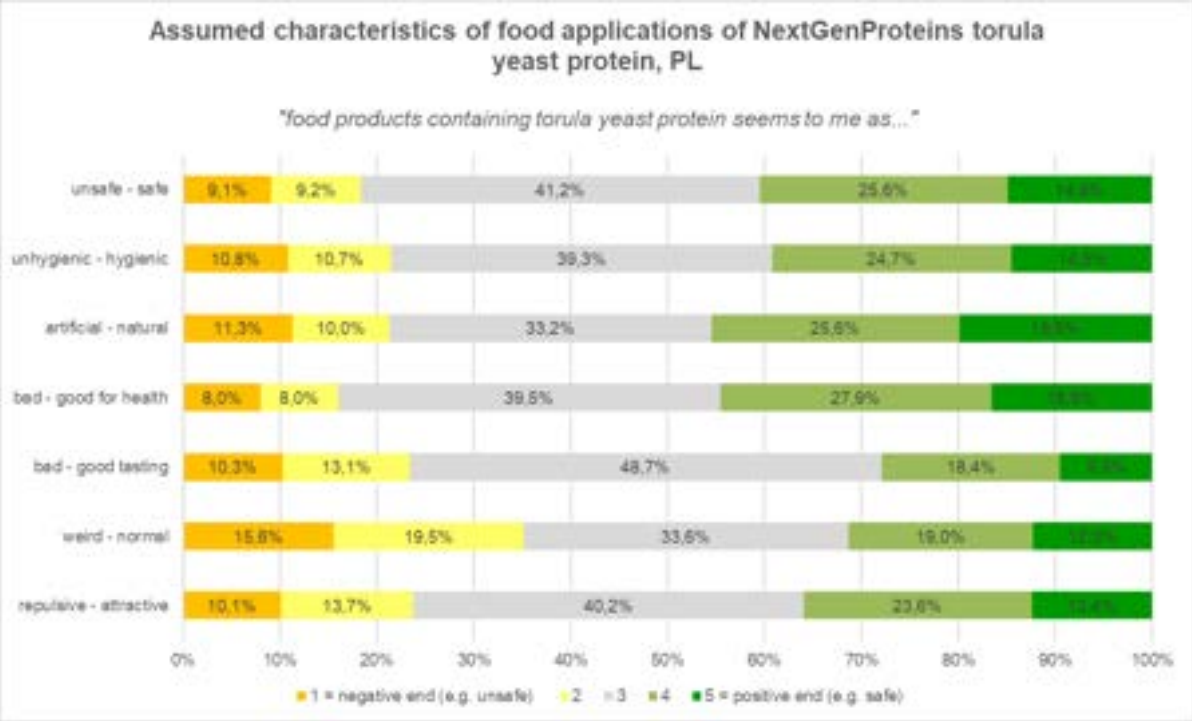


Figure 227 Characteristics associated with food applications of NextGenProteins Torula protein. Percentages of PL respondents.

Consumers' unfamiliarity with the concept and lack of experience with these foods was again reflected in the preconceptions about the food applications made with NextGen torula. Depending on the semantic pair, up to more than half of the consumers answer the questions on the scale point 3. By the majority, foods made with NextGen Torula protein, were perceived as good for health, natural and attractive. However, 35,1% perceived the idea of foods made with NextGen Torula protein as weird, 21,3 % as artificial and 23,8 % as repulsive.

Only 15 % of the respondents assumes that these foods would be appreciated in their social circles. Figure 228.

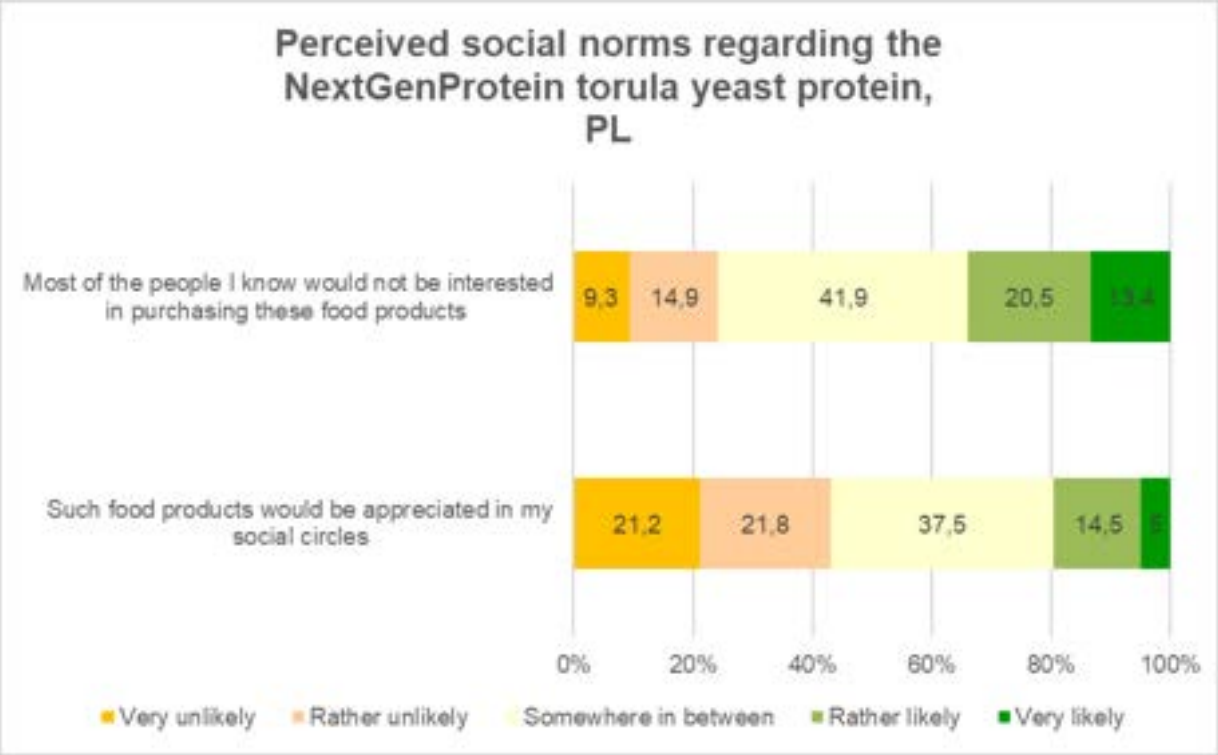


Figure 228 Perceived social norms related to NextGenProteins Torula protein foods. Percentage of PL respondents.

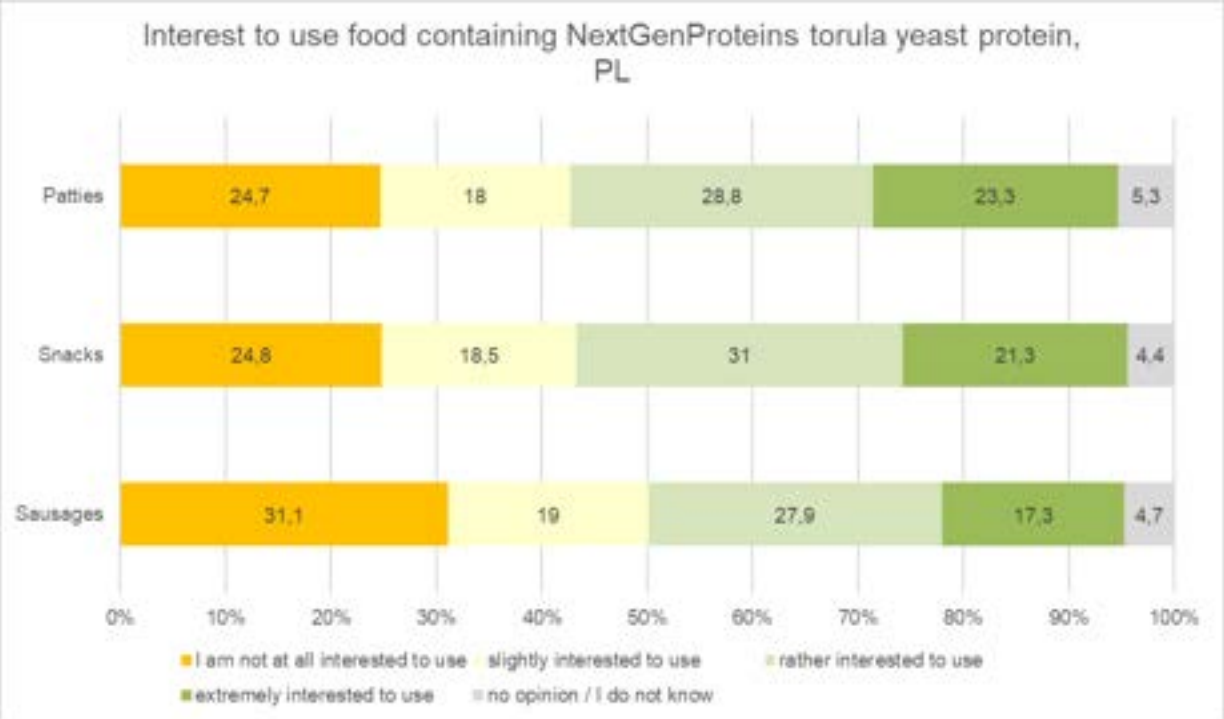


Figure 229 Interest to use the food application examples of NextGenProteins Torula protein. Shares of PL respondents with each answer alternative.

Half of the Polish respondendes were interested in using patties and salty snacks made with NextGen torula protein. However, the interest to use the sausage application was lower, only 35,2 % was interested in such a product. Figure 229.

12.7.2 Consumer clusters based on their views towards the NextGen Torula concept

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGenProteins Torula concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 3-4 clusters. Subsequent K-means clustering, run with 2 to 4 clusters, confirmed that 4 cluster solution best brings out the differences in the sample.

Table 84 Consumer clusters based on respondents' views towards NextGenProteins Torula protein concept. The result of K-means cluster analysis with 4 clusters. Means of acceptance variables in each cluster PL.

Cluster	**Positive**	**Negative**	**Sceptical**	**Indifferent**	Total	F	Sig.
Number of cases	183	121	238	340	881		
Percent of cases	20,7%	13,74%	27,0%	38,60%	100%		
Variables applied as basis of the clustering							
ATT_insects	4,66	1,79	4,25	3,19	3,59	676,1	,000
BENEFITS_insects	4,51	1,66	4,21	3,18	3,52	673,0	,000
RISKS_insects	1,73	4,38	3,47	3,20	3,13	405,2	,000
FOODVIEWS_insects	4,36	1,64	3,67	2,91	3,24	676,5	,000

The clusters were named as Positive (comprising 20,7 % of the respondents), Indifferent (38,6%), Negative (13,7 %) and Sceptical (27,0 %). Main difference between indifferent and sceptical cluster is, that the sceptical cluster rated significantly higher in benefit perception, but also in risk perception and food views. They seem to be more positive than the indifferent ones, but are also more concerned about the risks related to the nextgen torula concept.

12.7.2.1 Demographic profile and eating habits of NextGen torula clusters, PL

The demographics characteristics of the clusters are summarised below. See more details in the Table 85.

Positive cluster: 20,7 %

- Gender evenly
- Highest amount of age 35-44 years
- High in tertiary education
- Highest proportion of vegetarians

Negative cluster: 13,7 %

- More men
- 46% 55 years and older
- Highest proportion of primary education, even though high in tertiary education
- omnivores
- no vegetarians

Sceptical cluster: 27 %

- More female tester
- Age evenly distributed
- Highest proportion of tertiary education
- Mainly omnivores, 20% reduce meat

Indifferent cluster: 38,6 %

- Slightly more men
- 42% 25-44 years old
- Mainly tertiary education, highest amount secondary education
- Mainly omnivores

Table 85 Demographic profile of the consumer clusters based on views towards NextGenProteins Torula concept, PL

	Positive	negative	sceptical	Indifferent	Pearson Chi2	Sign.	Total N
Gender					6,25	n.s.	882
Male	47,50%	53,00%	43,60%	53,50%			
Female	52,50%	47,00%	56,40%	46,50%			
Age					23,81	n.s.	881
18-24 years	11,50%	3,30%	12,20%	9,20%			
25-34 years	14,80%	16,50%	17,20%	20,70%			
35-44 years	23,10%	17,40%	20,20%	21,00%			
45-54 years	20,10%	16,50%	14,30%	17,00%			
55-64 years	18,60%	20,70%	19,80%	18,60%			
65-75 years	12,00%	25,60%	16,40%	13,60%			
Education					8,3	n.s.	876
basic education	0,00%	2,50%	1,70%	0,30%			
secondary education	48,8%	46,3%	48,8%	50,0%			
tertiary education	51,2%	51,1%	49,6%	49,7%			
others	0,00%	0,00%	0,00%	0,00%			
Living Area					6,95	n.s.	882
I live in the capital city / area	17,00%	18,20%	17,20%	17,10%			
I live in a large city that is not in the capital area	40,20%	34,70%	42,40%	40,90%			
I live in a small city/town or municipality	26,20%	23,90%	27,00%	27,20%			
I live in a rural area	16,60%	23,20%	13,40%	14,70%			
Household					14,32	0,026	847
no children	34,50%	50,00%	39,30%	36,80%			
with children	42,90%	41,10%	41,00%	39,80%			
semoething else	22,60%	8,90%	19,60%	23,40%			
Diet					17,88	0,007	880
ominovore	73,30%	85,90%	75,10%	81,00%			
meat sometimes or no red meat	20,20%	14,10%	20,60%	17,20%			
vegetarian	6,50%	0,00%	4,20%	1,80%			

Significant differences between the clusters exist in familiarity with alternative and future proteins. The clusters Sceptical and Positive were in average more familiar with different alternatives for animal protein as well as with the examples of future protein sources compared with the cluster Negative. In these same clusters the use of vegetarian convenience foods was more common than in the cluster Negative. This reflects their eating habits. In the positive and sceptical cluster the respondents tend to be more vegetarians and vegans than in the other clusters. Figure 230.

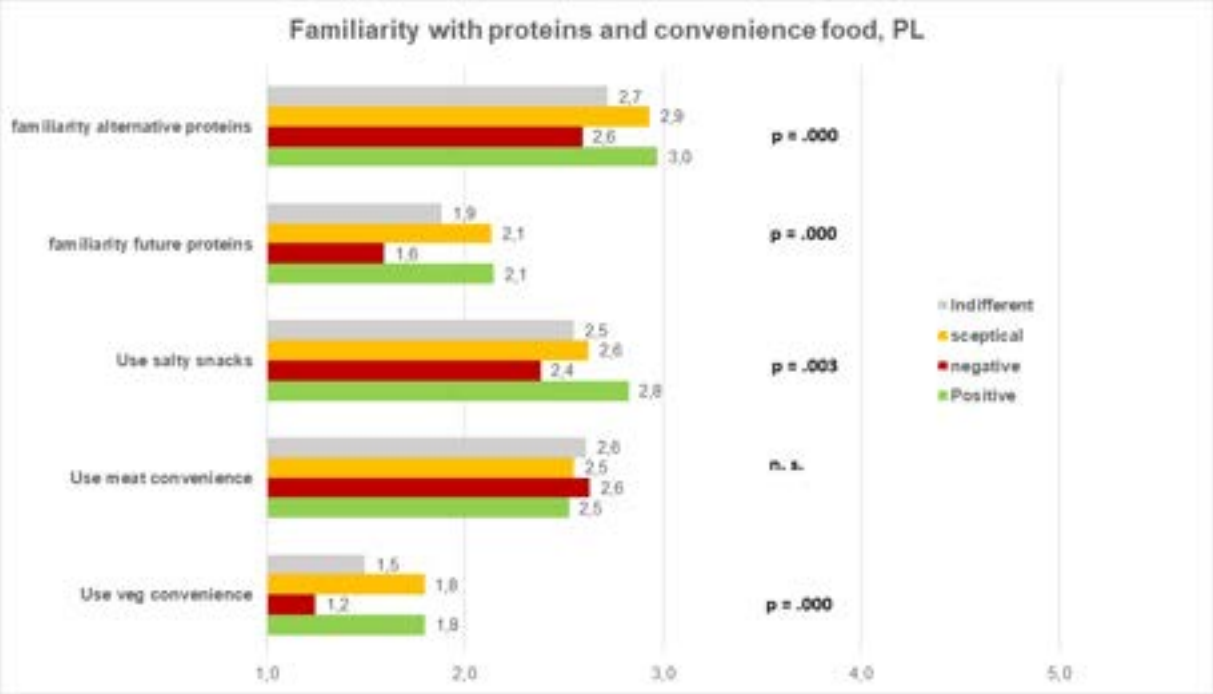


Figure 230 Use (mean use frequency) of certain convenience foods and familiarity with novel and alternative proteins compared between the consumer clusters based on their views towards NextGenProteins Torula concept. PL (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

12.7.2.2 Attitudinal background of NextGen torula clusters, PL

All means of attitudinal background variables significantly differ between the NextGen torula consumer clusters. In the clusters Negative and Indifferent, respondents mean attachment with meat is much higher than in the other clusters. The clusters Sceptical, Indifferent and Positive have more positive attitude towards the use of new technologies in food production (FTechnology) than the cluster Negative. In case of taste neophobia, the negative cluster seem to be most neophobic, whereas the positive cluster seem to be more neophilic. Further, the respondents in the cluster Positive are in average more interested in new food products than those in the negative or indifferent cluster. Finally, the respondents in the cluster Negative have the lowest trust in food chain actors. (Figure 231.)

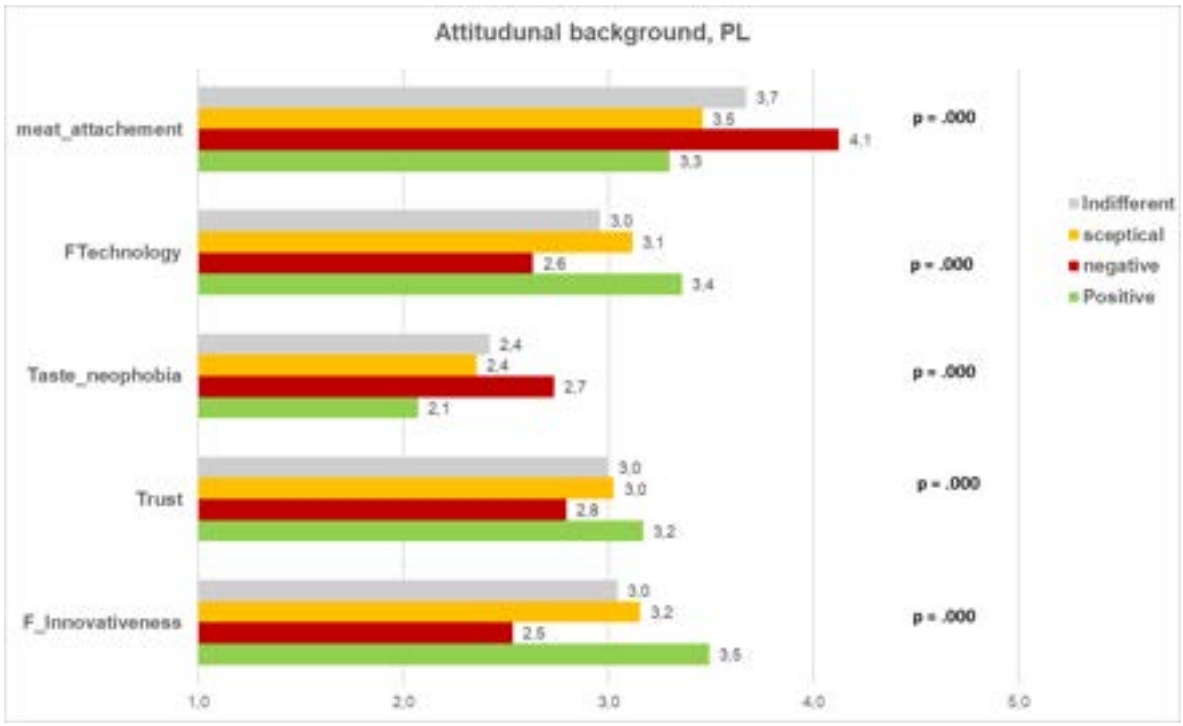


Figure 231 Background attitudes of the respondents in the clusters based on their views towards NextGenProteins Torula concept. PL (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

The meand differences between the clusters in ratings of the food choice motives are significant for convenience, natural, environment, healthy and sensory. In these motives the sceptical, positive and surprisingly negative rated higher than the indifferent (except environment for the negative). Compared to the other clusters, and especially to the negative clusters, the cluster positive values healthiness, environmental and ethical issues significantly more (see Figure 232).

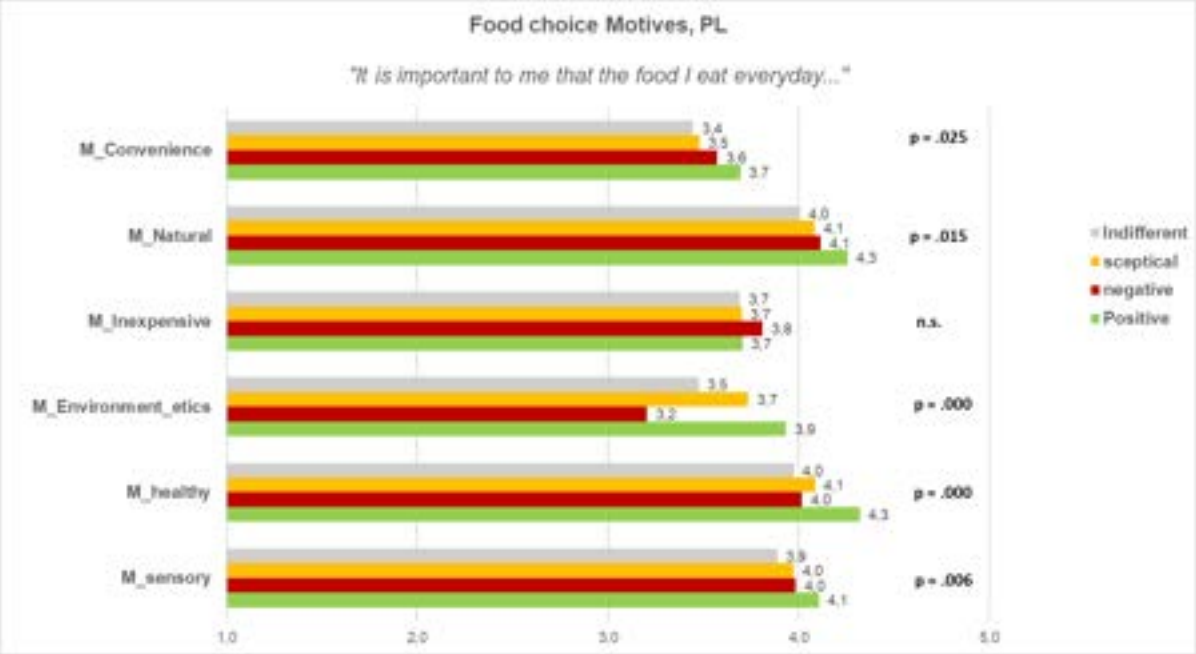


Figure 232 Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins Torula concept. PL. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences).

12.7.2.3 Interest to use the food applications by NextGen torula clusters

In terms of their interest to use the three examples of NextGen torula food applications, the cluster with negative views strongly differs from the other clusters with their extremely low interest ratings. As expected the cluster Positive, is also the most Positive towards the food applications, but also the cluster Sceptical (i.e. the one with also positive views, but a bit concerned about the risks) was interested in the food applications more than the cluster Indifferent and negative.

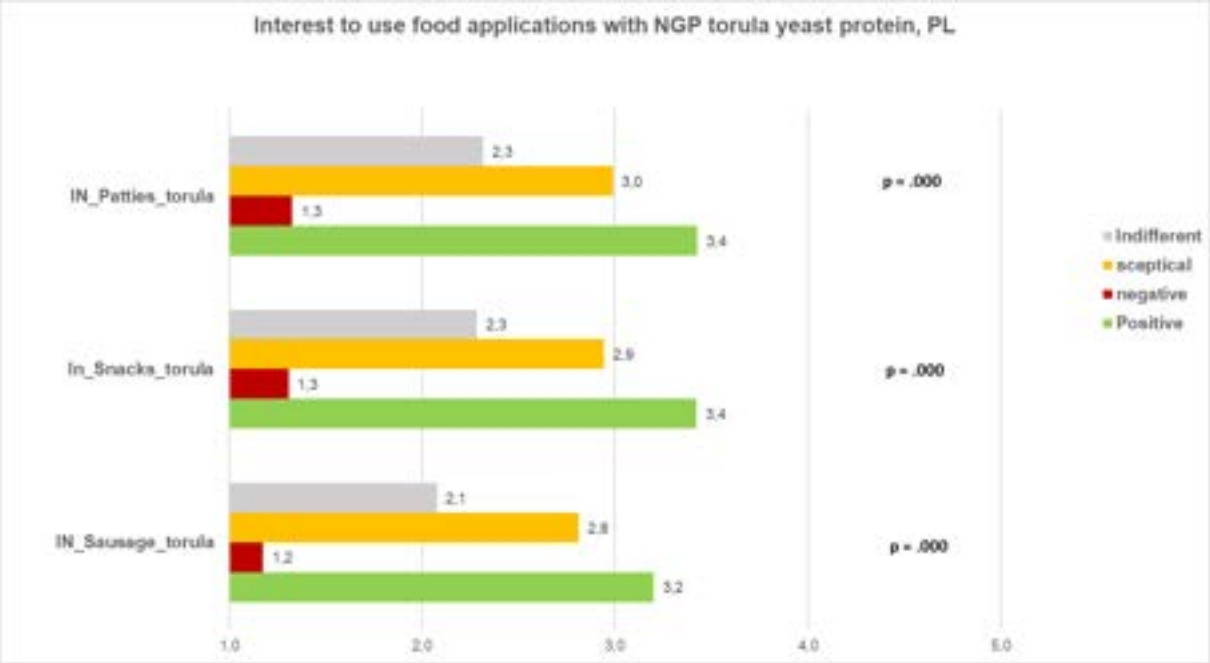


Figure 233 Interest to use food applications by consumer clusters based on their views towards NextGenProteins Torula protein concept. PL. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences)

13 Appendix B6 – GERMANY survey report

13.1 Summary of results from Germany (DE)

In the Germany survey n = 1000 consumers participated. The basic demographic background was representative to German population. About 93 % of the respondents had omnivorous diets and 7 % had some form of vegetarian diets. Out of the omnivores 56,30 % aim to reduce meat consumption. The main reasons they give for this relate to health and well-being and ethics and animal welfare.

Alternatives for animal proteins are already known and consumed in Germany. German consumers are familiar with several alternative protein foods. Most of the DE consumers eat legume vegetables (19 %) (peas, beans) or products made of peas (55 %). Also soya based meat substitutes are eaten occasionally or have tried them at least. Rather unknown are alternatives such as Fava beans and Lupini beans. About 73 % of the consumers in DE have heard about insect proteins, but have not tried them and 52 % have not heard of fungi-based substitutes.

In Germany the trust in the different food actors of the value chain vary depending on the actor. The consumers have trust (have a lot of trust/very much trust) in farmers (49 %) and small food producers (55 %) (have a lot of trust/very much trust), but do not trust the food industry. Only 10 % say, that they trust them. Consumer associations and food scientist enjoy confidence of the consumers by 40 % respectively 44 %. 27 % trust regulatory supervising authorities and retailers. For the consumers in Germany most important motives for daily food selection are “taste pleasure (86 %)”, “healthy (75 %)”, “natural (69 %)”.

In this survey, consumers rated the NextGenProtein concepts for general acceptance, perceived benefits, risk concerns and in terms of consumers preconceptions about the food application of them. Further, the survey included questions about respondents’ interest to use them in the sample foods sausages, patties and salty snacks. The German respondents considered benefits for the environmental sustainability, animal well-fare and human health as likely consequences form NextGenProtein concepts.

The evaluation of the protein concepts shows a high amount of uncertain people, even though they are highly educated. Overall, the micro algae concept have been rated best. Torula and insect protein were rated similar, with slightly better values for torula.

Based on the acceptance values, k-means cluster analysis have been conducted. For algae and insects three cluster have been identified and for the torula protein ingredients four clusters were found. The cluster are very often described as positive (low risk perception), negative (high risk perception) and indifferent ort sceptical. The people mainly differ

between their acceptance of food technology, meat attachment and food neophia. The demographic details revealed that the negative clusters are consumers who have less higher education, are older and ominivores (instead of being vegetarians or restricting their meat consumption). All together, the low level of trust towards the food industry and the higher proportion of people less educated, show a demand for consumer education and transparency.

In general, a transparent food production could increase the acceptance of new protein sources. Information and educational programmes would lead to a different view on new protein sources. Applications in the food industry will be accepted only, if taste and sensory attributes fit the consumer's demands.

13.2 Participants characteristics

13.2.1 Participants' demographics, DE

The basic demographic background of the German sample is shown in table 1. The sample in Germany has a size of 1000 participants and the gender is equally distributed. In most of the reported demographic variables the numbers are representative according to Federal statistic office [5]. Like in the case of other countries, respondents' answers have been weighted in the analysis so that the results represent the country population.

Table 86 demographic background of DE respondents

	Count	Percent
Gender		
1. Male	489	48,90%
2. Female	511	51,10%
3. Other	0	0,00%
4. Prefer not to say	0	0,00%
Total	*1000*	*100,00%*
Age group		
1. 18-24 years	86	8,60%
2. 25-34 years	159	15,90%
3. 35-44 years	181	18,10%
4. 45-54 years	229	22,90%
5. 55-64 years	174	17,40%
6. 65-75 years	170	17,00%
Total	*999*	*99,90%*
Type of living area		
1. I live in the capital city / area	135	13,50%
2. I live in a large city that is not in the capital area	268	26,80%
3. I live in a small city/town or municipality	361	36,10%

[5] https://www.destatis.de/EN

4. I live in a rural area	236	23,60%
Total	*1000*	*100,00%*
Region, DE		
1. Schleswig-Holstein	31	3,10%
2. Hamburg	22	2,20%
3. Niedersachsen	104	10,40%
4. Bremen	10	1,00%
5. Nordrhein-Westfalen	214	21,40%
6. Hessen	83	8,30%
7. Rheinland-Pfalz	49	4,90%
8. Baden-Wurttemberg	125	12,50%
9. Bayern	153	15,30%
10. Saarland	10	1,00%
11. Berlin	35	3,50%
12. Brandenburg	30	3,00%
13. Mecklenburg-Vorpommern	21	2,10%
14. Sachsen	51	5,10%
15. Sachsen-Anhalt	29	2,90%
16. Thüringen	32	3,20%
17. None of these	0	0,00%
Total	*999*	*99,90%*
Education		
1. Basic education or lower	42	4,20%
2. Upper secondary vocational qualification	215	21,50%
3. Upper secondary degree	164	16,40%
4. Tertiary degree or vocational qualification	276	27,60%
5. Tertiary education, university, bachelor degree	108	10,80%
6. Tertiary education, university, master's degree or higher (MA/MSc, PhD, MD)	182	18,20%
7. Other / I do not know	13	1,30%
Total	*1000*	*100,00%*
Education 2		
1. Basic education	42	4,20%
2. secondary education	655	65,50%
3. tertiary education	290	29,00%
4. something else	13	1,30%
Total	*1000*	*100,00%*
General Household type		
1. I live at home with my parents	59	6,00%
2. I live alone	265	26,90%
3. I live alone with my child / children	50	5,10%
4. I live with my spouse	348	35,30%
5. I live with my spouse and child / children	241	24,50%
6. I live with other adults (other than spouse or family members)	21	2,10%
Total	*984*	*99,90%*

Household type specified		
1. no childre	613	62,20%
2. with children	292	29,60%
3. other	80	8,20%
Total	*985*	*100,00%*

13.2.2 Participants' dietary habits and attitudinal background, DE

Nearly 70 % of DE participants were omnivores who eat meat regularly, while 24 % restrict their meat consumption either by avoiding red meat or eating meat only occasionally. The remaining 11,6 % follow some form of vegetarian diets.

Out of the consumers of red meat (diet 1 or 2), 56,3 % indicate that they intentionally aim to reduce their meat consumption. The most important reasons they have for this meat avoidance relate to their **own health and well- being** and secondly to **environmental sustainability**. Taken together, these results suggest that around 70 % of DE consumers are to some extent interested in obtaining more of their protein from other sources than mammal or poultry meat.

Table 87 Dietary habits of respondents in DE

	Count	Percent
Diet		
1. I regularly eat products of animal origin and non-animal origin (omnivorous)	687	68,70%
2. I only eat meat sometimes (e.g. beef, pork, poultry, fish, seafood)	198	19,80%
3. I avoid red meat consumption (e.g. beef or pork), but eat other meat products like chicken or fish	42	4,20%
4. I do not eat meat (e.g. beef, pork or poultry), but I eat fish (I'm a pesco-vegetarian)	18	1,80%
5. I do not eat meat (e.g. beef, pork, poultry or fish), but I eat other products of animal origin (e.g. eggs, cheese, milk	30	3,00%
6. I do not eat any meat, eggs or dairy products (I'm a vegetarian)	6	0,60%
7. I do not eat anything of animal origin (I'm a vegan)	13	1,30%
8. Other, specify:	7	0,70%
Total	*1001*	*100,10%*
Diet meat		
1. omnivore	687	69,10%
2. meat sometimes or no red meat	240	24,10%
3. vegetarians and vegans	67	6,70%
Total	*994*	*99,90%*
Do you intentionally aim to reduce the amount of meat and / or other products of animal origin in your diet?		
1. Yes	498	56,30%
2. No	386	43,70%
Total	*884*	*100,00%*

Most important - What are your main reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability, climate change	100	16,10%
2. Ethics, animal welfare	191	30,70%
3. My health and well-being	**269**	**43,20%**
4. High price of meat	26	4,20%
5. Taste and texture of meat	32	5,10%
6. Other, specify:	5	0,80%
Total	*623*	*100,10%*
Second most important - What are your main reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability, climate change	219	35,10%
2. Ethics, animal welfare	**167**	**26,70%**
3. My health and well-being	115	18,50%
4. High price of meat	58	9,20%
5. Taste and texture of meat	64	10,20%
6. Other, specify:	1	0,20%
Total	*624*	*99,90%*

At the moment, around 15 % of DE respondents use vegetarian sausages or oven-prepared ready meals at least monthly (Figure 234). Salty snacks, sausages and minced meat burgers are the most often consumed convenience food of German consumers in this context.

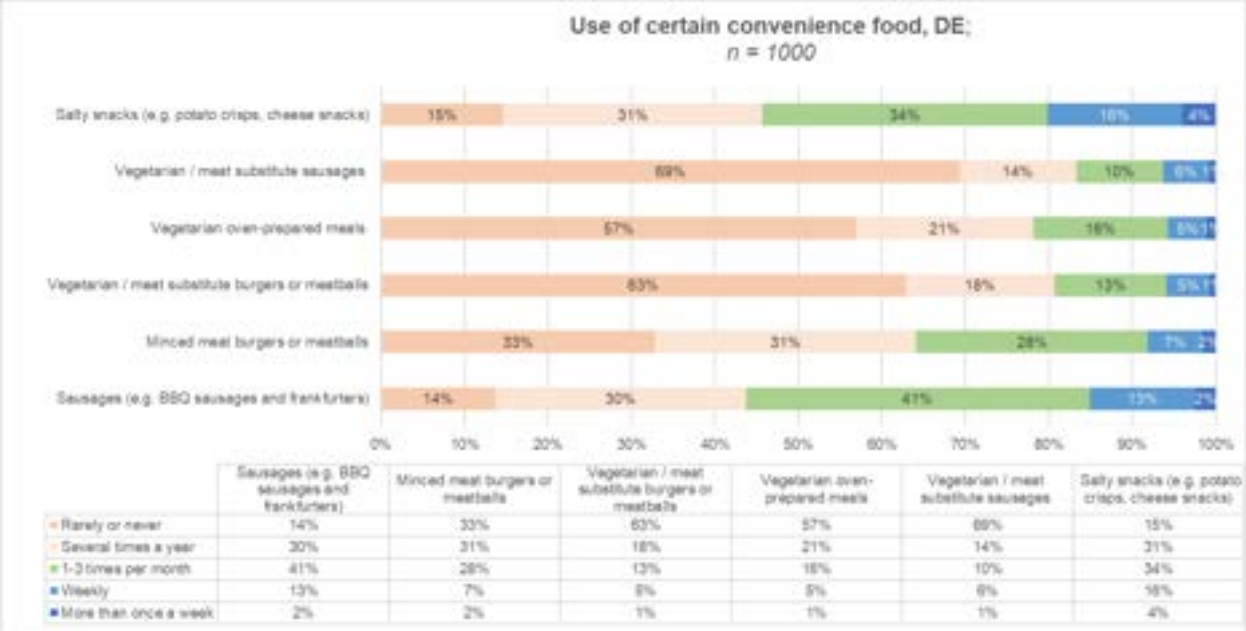


Figure 234 Use of certain convenience food by the DE respondents

German consumers are familiar with several alternative protein foods. Most of the DE consumers eat legume vegetables (19 %) (peas, beans) or products made of peas (55 %) (see Figure 235). Also, soya-based meat substitutes are eaten occasionally or respondents have tried them at least. Rather unknown are alternatives such as Fava beans and Lupini beans.

73 % of the consumers in DE have heard about insect proteins, but have not tried them. Further, 52 % have not heard of fungi-based substitutes. Figure 235.

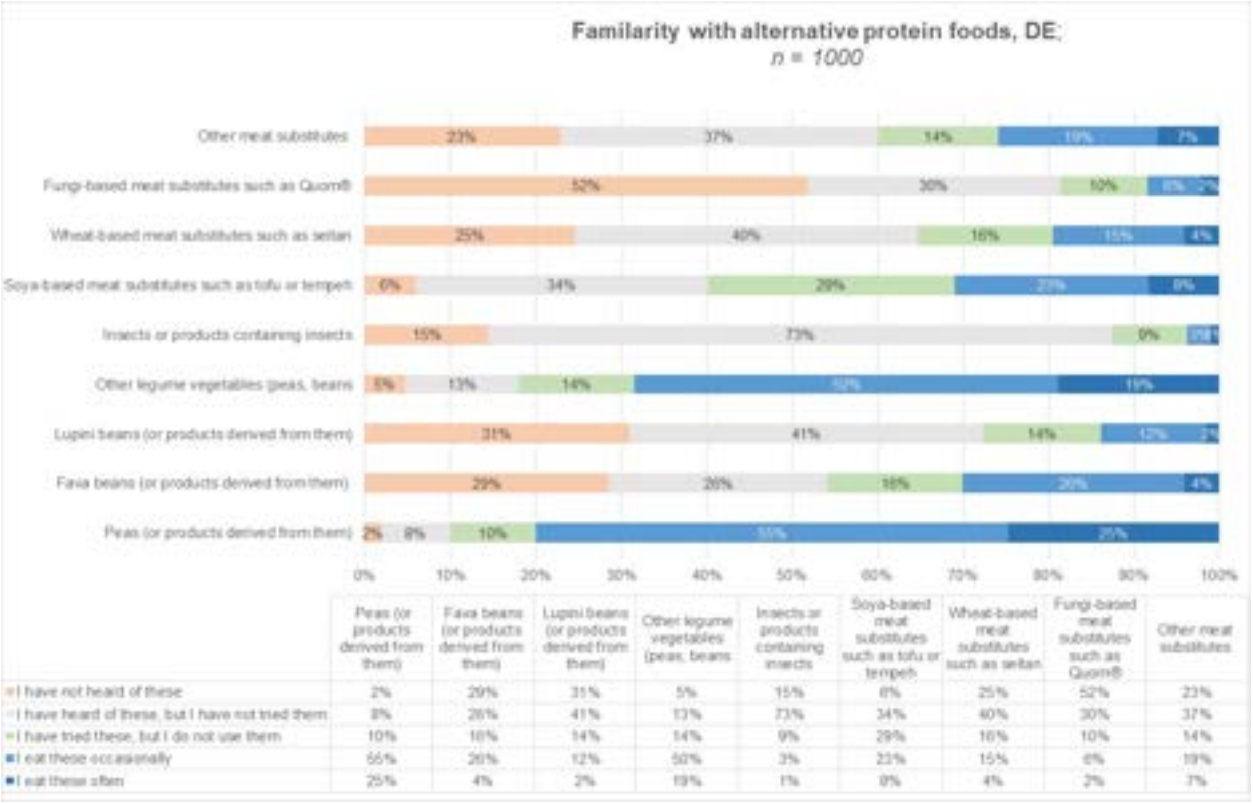


Figure 235 DE respondents' previous familiarity with alternative protein sources and meat substitutes made of these

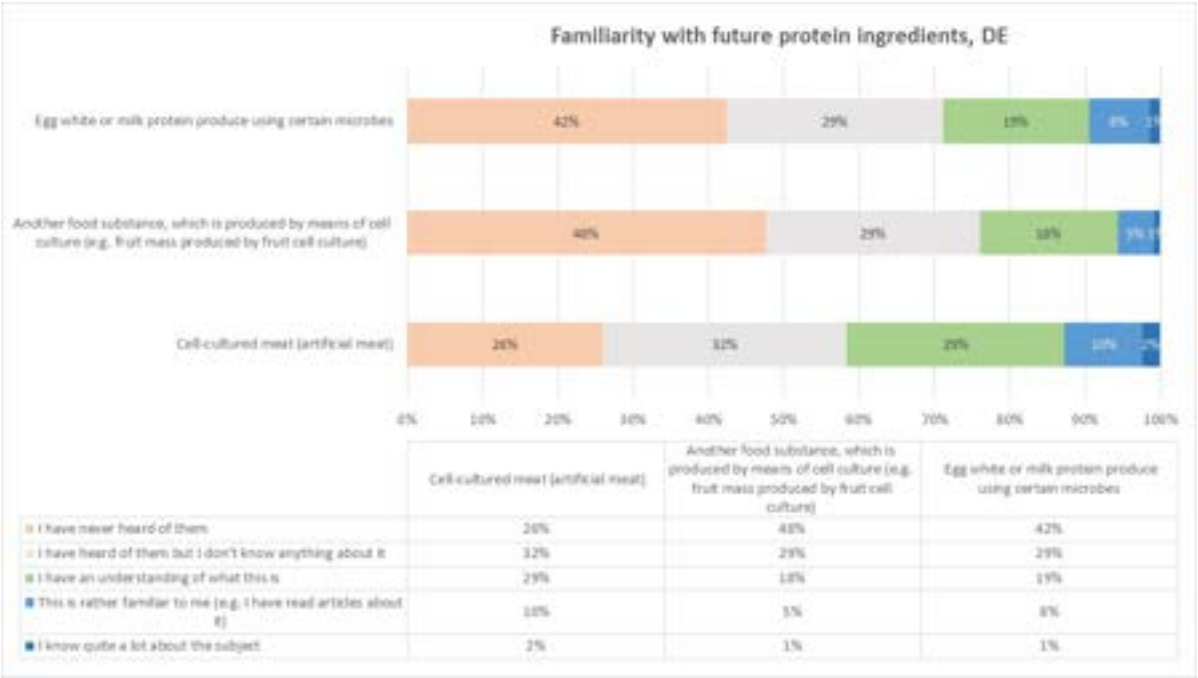
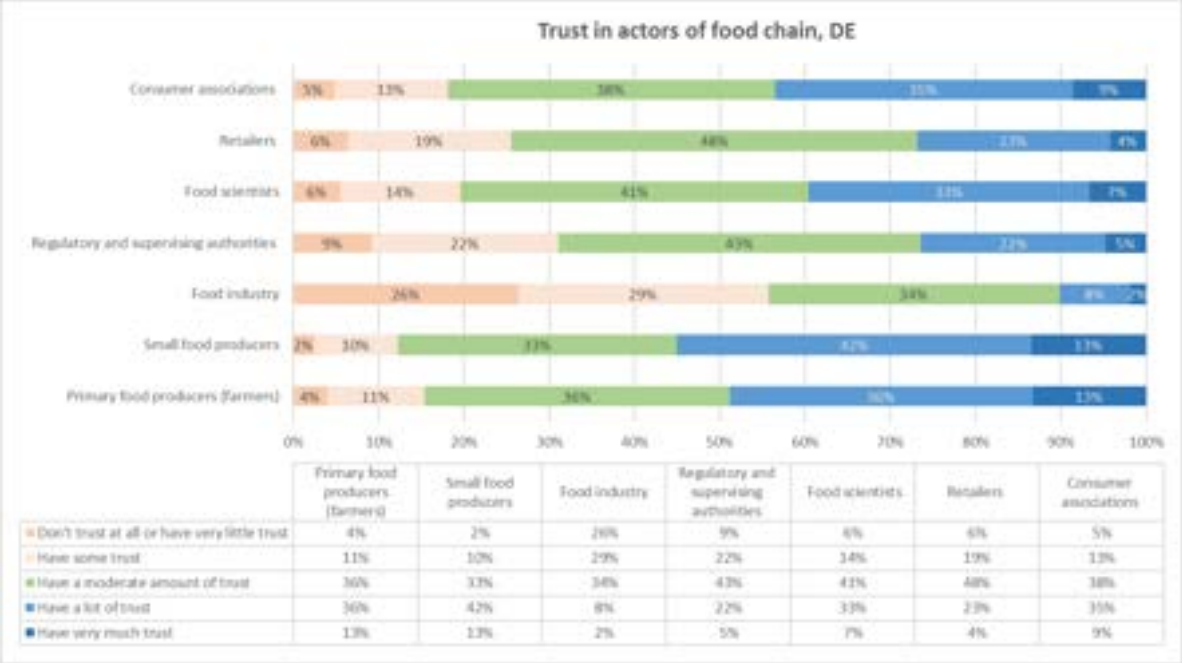


Figure 236 Familiarity with future (emerging) protein sources, DE

Regarding the familiarity with alternative proteins consumers in DE seem to be rather used to common proteins likes peas and beans and from other legumes. However 73 % have heard about insects, but have not tried them. Figure 235.

As the German respondents are mainly familiar with traditional alternative protein sources which are common in German traditional cuisine, it is not surprising that DE consumers are unfamiliar with future proteins (see Figure 236). The most known source is artificial meat. 29 % of the consumers mention that they have an understanding of what it is. Whereas the other two sources were unknown as the consumer have not heard of them.



	Primary food producers (farmers)	Small food producers	Food industry	Regulatory and supervising authorities	Food scientists	Retailers	Consumer associations
Don't trust at all or have very little trust	4%	2%	26%	9%	6%	6%	5%
Have some trust	11%	10%	29%	22%	14%	19%	13%
Have a moderate amount of trust	36%	33%	34%	43%	41%	48%	38%
Have a lot of trust	36%	42%	8%	22%	33%	23%	35%
Have very much trust	13%	13%	2%	5%	7%	4%	9%

Figure 237 Trust in various actors of food chain in the DE sample

German respondents' trust in the actors of food chain vary depending on the actor in question (see Figure 237). They have trust in farmers (49 %) and small food producers (55 %), but do not trust the food industry. Only 10 % say, that they trust them. Consumer associations and food scientist enjoy confidence of the consumers by 40 % respectively 44 %. 27 % trust regulatory supervising authorities and retailers.

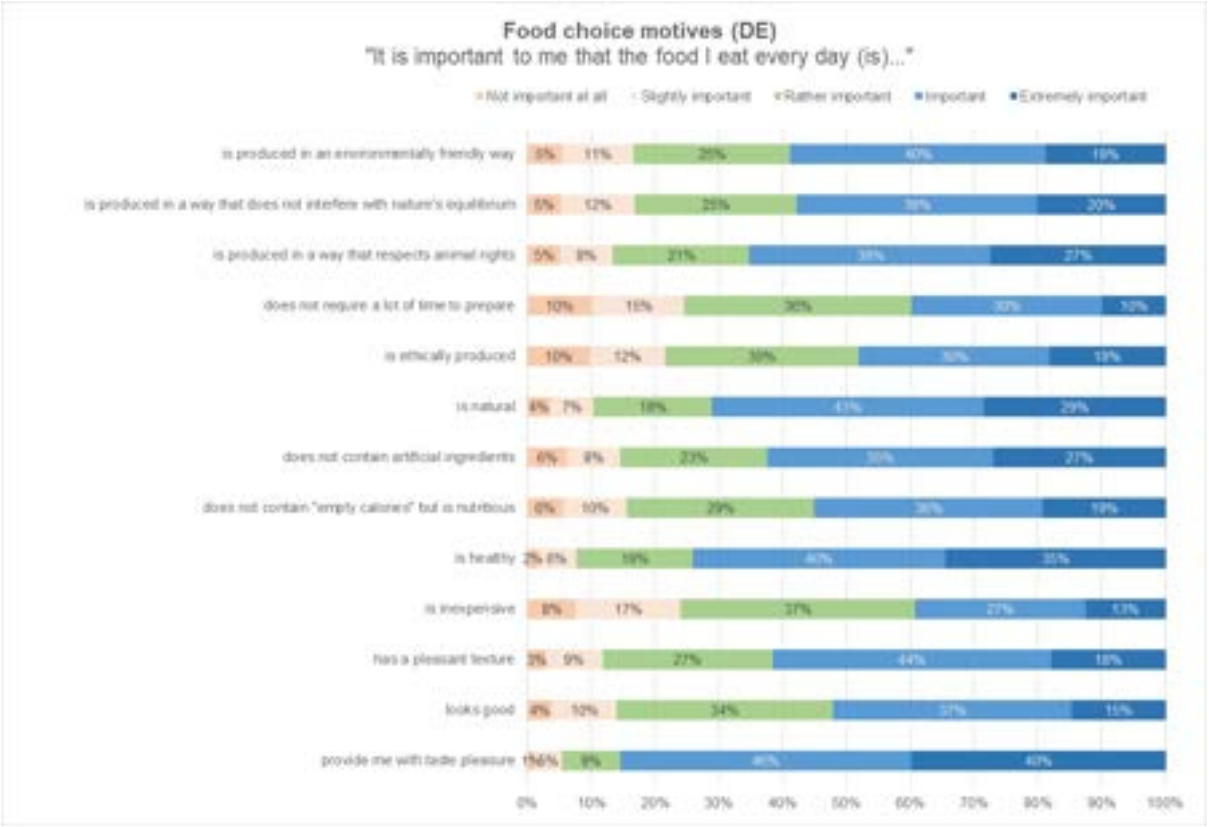


Figure 238 Perceived importance of food values (food choice motives in the DE sample

For the consumers in Germany most important motives for daily food selection are “taste pleasure (86%)”, “healthy (75%)”, “natural (69%)”. Figure 238.

13.3 Forming composite variables, DE

13.3.1 New variables describing respondents’ background attitudes, DE

Factor analyses (principal axis factoring, varimax rotation) were performed to check the dimensionality of items for each scale. Composite variables to measure respondents background characteristics were formed as presented in the Table 88 and Table 89.

Table 88 Composite variables describing Germany respondents’ background attitudes. The measurement scale for all the listed composite variables is 1 – 5. DE.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.81
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	,83
Trust	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	.83
FTechnology_attitude	Attitude towards new food technology	Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV	.75
Meat_attachment	Attachment to meat eating	Q7r1, Q7r2, Q7r4, Q7r5, Q7r6, Q7r3_REV, Q7r8_REV	.91
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.91

F_innovativeness	Food innovativeness (interest in new food products)	(all items) Q11r1_REV, Q11r2, Q11r3, Q11r4	.78
Use_vege_convemience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.85
Use_meat_convenience	Mean frequency of use of meat-based convenience foods	Q5r1, Q5r2	.73

Table 89 New variables to describe DE respondents' food choice motives

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
M_Sensory	Good sensory characteristics	Q6r1, Q6r2, Q6r3	0,74
M_Healthy	Healthiness and naturalness	Q6r5, Q6r6, Q6r7	0,81
M_Environment_etics	Produced in ethical and environmentally friendly way	Q6r9, Q6r11, Q6r12, Q6r13	0,92
M_Inexpensive	Is inexpensive	Q6r4	
M_Natural	Is natural	Q6r8	
M_Convenience	does not require much time to prepare	Q6r10	

13.3.2 New variables measuring acceptance of the three NextGenProteins concepts, DE

New variables were formed to reflect positivity or negativity of respondents' attitude towards each of the three NextGenProteins concepts. In addition, composite variables were formed to measure respondents' beliefs in benefits of each of the NextGenProteins concept as well as to indicate the strength of respondents' concern about potential risks of the NextGenProteins concepts. All the resulting variables had high internal reliabilities. Finally, also respondents' ratings (views or pre-assumptions) about the characteristics of food products made using each of the NextGenProteins ingredient were averaged for each NextGenProteins concept to form a composite measure of how positively or negatively NextGenProteins microalgae, NextGenProteins insect and NextGenProteins Torula based food application are viewed (See Table 90). The latter are subsequently called food application views.

In all countries, before calculation of the composite variables benefits and risks, the answers "I don't know" were recoded as system missing. That is, respondents who answered "I don't know" are not included in the subsequent analyses, which apply these variables.

Table 90 Composite variables measuring acceptance, their content and reliabilities (DE). The measurement scale for all the listed composite variables is 1 - 5

Composite variables	Explanation	Cronbach Alpha
ATTITUDES	*mean of 3 items (difficult – easy to understand – item not included)*	
ATT_Algae	Attitude towards NextGen microalgae protein	.93
ATT_Insect	Attitude towards NextGen insect protein	.93
ATT_Torula	Attitude towards NextGen Torula protein	.93
PERCEIVED BENEFITS	*mean of all 5 items*	
BENEFIT_Algae	Perception of benefits from NextGen microalgae protein	.92
BENEFIT_Insects	Perception of benefits from NextGen insect protein	.85
BENEFIT_Torula	Perception of benefits from NextGen Torula protein	.85
PERCEIVED RISKS	*mean of 3 items, "other risk" not included*	
RISK_Algae	Perception of risk relating to production of NextGen microalgae proteins	80
RISK_Insects	Perception of risk relating to production of NextGen insect proteins	.85
RISK_Torula	Perception of risk relating to production of NextGen Torula proteins	.82
FOOD APPLICATION VIEWS	*mean of all the 7 items*	
FOODVIEWS_Algae	Views towards foods made with NextGen microalgae protein	.94
FOODVIEWS_Insect	Views towards foods made with NextGen insect protein	.92
FOODVIEWS_Torula	Views towards foods made with NextGen microalgae protein	.93

13.4 Comparison of the three NextGenProtein production concepts and applications, DE

13.4.1 Which of the NextGen ingredients is most positively viewed in DE?

Figure 239 shows that the algae concept received most positive ratings for attitude, benefits, foodviews and use of interest. Out of the three concept consumers rated it best, followed by torula and insect protein received the lowest values, except risks where it received the highest values in comparison to the other ingredients.

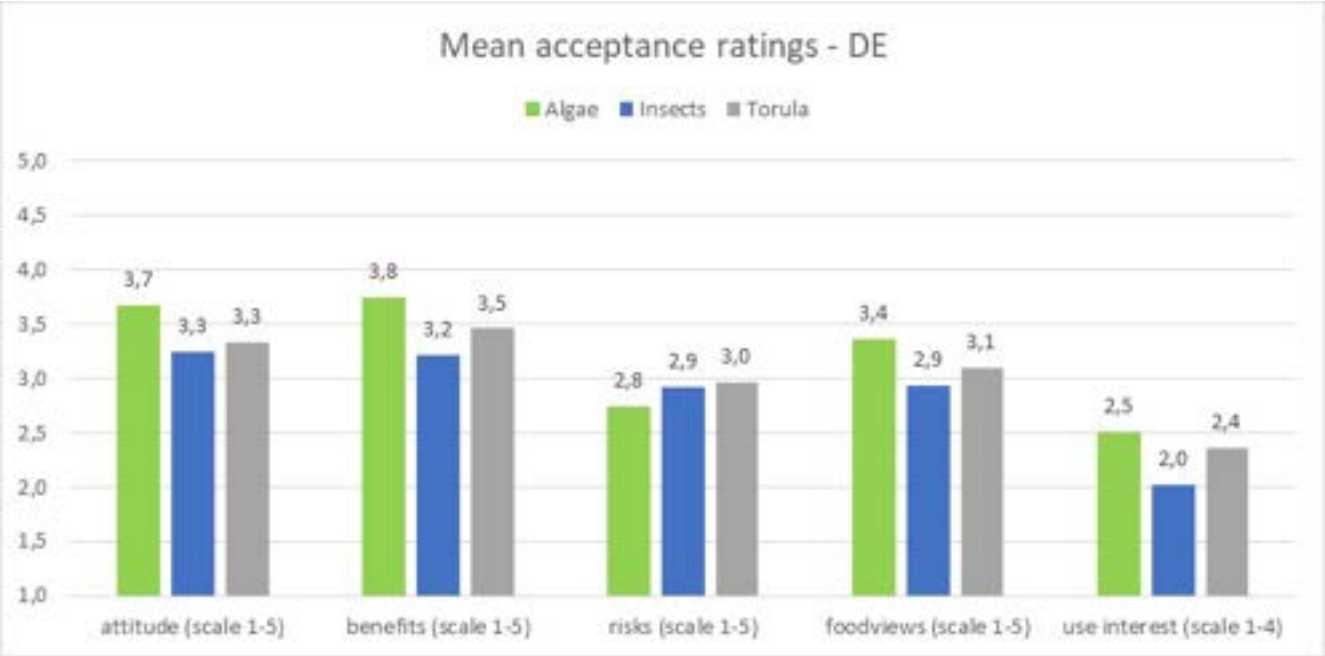


Figure 239 Means of composite variables measuring acceptance towards each of the three NextGenProteins concepts in DE sample

Table 91 Comparison of means of acceptance ratings (composite variables) between the three NextGenProteins protein concepts. Significance of difference tested with repeated measures analysis of variance. DE

Composite variables:	**Algae**	**Insect**	**Torula**	**df**	**F**	**Sig.**
Attitudes (scale 1 – 5)	3,7	3,3	3,3	2	91,54	.000
Benefits (scale 1 – 5)	3,8	3,2	3,5	2	135,34	.000
Risks (scale 1 – 5)	2,8	2,9	3,0	2	10,38	.000
Foodviews (scale 1 – 5)	3,4	2,9	3,1	2	137,76	.000

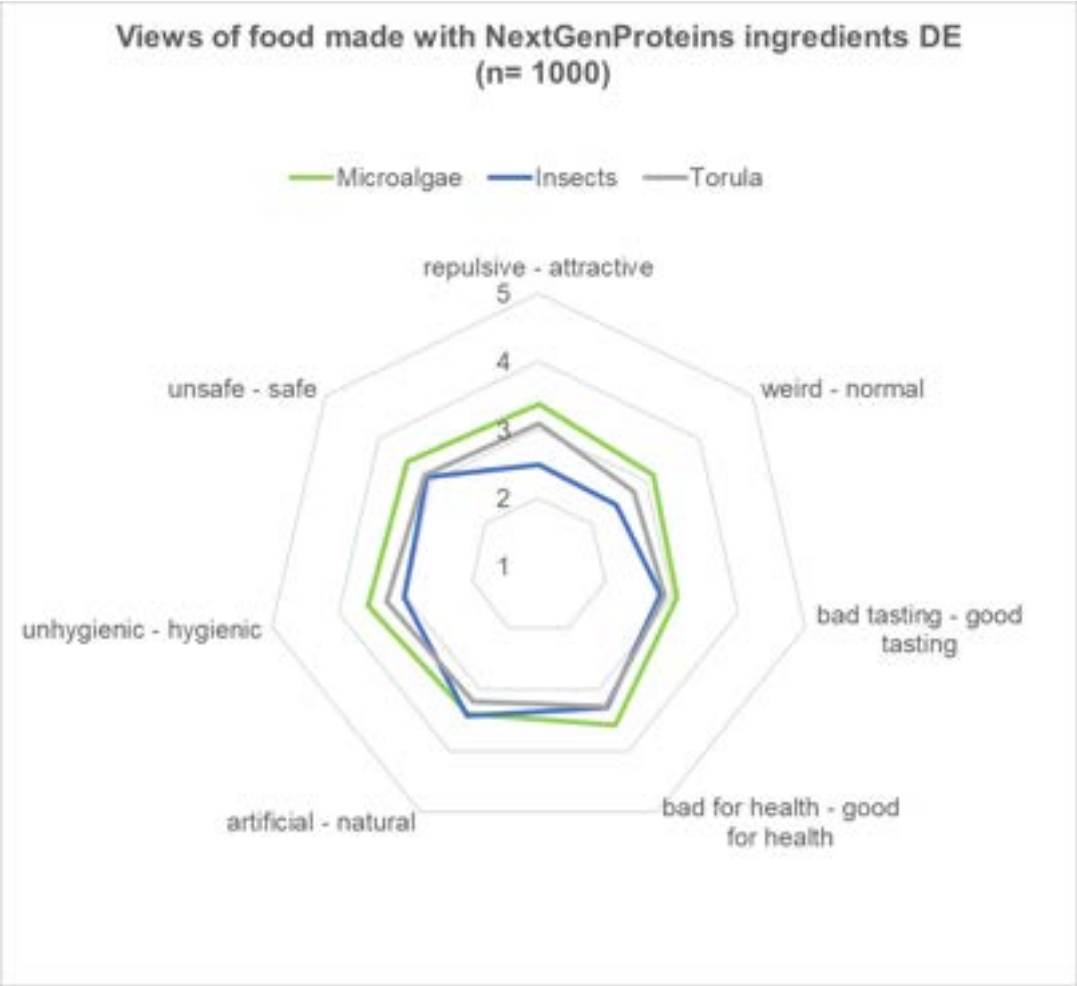


Figure 240 Means of respondents' preconceptions about the characteristics of imaginary food made using the NextGenProteins ingredients, DE

The results of the "views of food made with NextGenProteins ingredients" are very similar to acceptance ratings. Food made with microalgae proteins received the best ratings in this bipolar rating. Interestingly, insect protein is sensed as natural as algae protein. Based on the outcome from the qualitative study, consumer perceive the growing of insects as a natural process in comparison to converting wood into something eatable. However, the insects are perceived as repulsive and unhygienic. Likely due to internal connection of insects with this context.

Table 92 Means of food views and statistical significance of differenced in means between the three NextGenProteins ingredient (repeated measures analyses of variance), DE

	Algae	Insect	Torula	df	F	Sig.
Repulsive – Attractive	3,37	2,49	3,09	2	277,34	.000
Weird - Normal	3,15	2,45	2,77	2	163 ,88	.000
Bad – good tasting	3,08	2,82	2,89	2	33,97	.000
Bad - good for health	3,58	3,29	3,27	2	57,60	.000
Artificial – Natural	3,4	3,43	3,2	2	22,18	.000
Unhygienic – Hygienic	3,56	3,02	3,29	2	126,41	.000
Unsafe - Safe	3,46	3,09	3,14	2	65,41	.000

13.4.2 What is the most interesting food application of NextGen in DE?

Respondents in Denmark were interested in using products made with NextGen microalgae and torula yeast protein, but not very strongly interested in products made with NextGen insect protein. Snacks and vegetable protein patties gained most interest. Instead, the respondents were not keen on using these NextGen proteins in the form of sausages (see Figure 241).

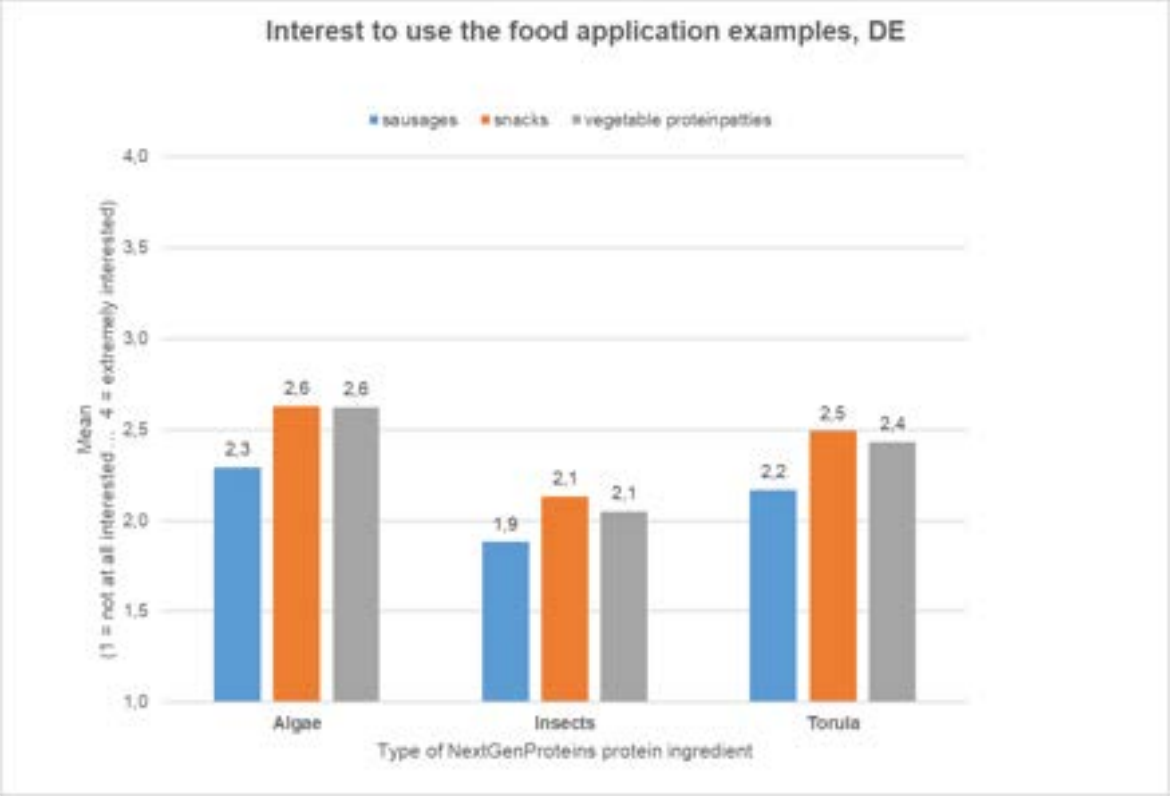


Figure 241 Means of interest to use the examples NextGenProteins food applications by product type and NextGenProteins ingredient type in DE. Significance of differences in means between the food types.

Table 93. Respondents' interest to use the examples of NextGen protein food application. Means and significance of differences of mean between the concepts (ingredients) tested with reapeated measures analysis of variance. DE

	Algae	Insect	Torula	df	F	Sig.
sausages	2,3	1,9	2,2	2	82,50	.000
snacks	2,6	2,1	2,5	2	116,50	.000
Vegetable protein patties	2,6	2,05	2,4	2	81,45	.000

13.5 Acceptance of NextGen microalgae protein

13.5.1 The level of acceptance of NextGen microalgae protein, DE

Overall, all attitude questions have been answered positively by over 50 % of the consumers. Out of the DE respondents 60,5 % were in favour of the idea of production of NextGenProteins microalgae protein food ingredient. About 25.8 % had neutral attitude, and the minority (13.6 %) was against the idea. Besides of the attitudes, we also asked about how understandable the concept was to the participants. This variable aims to reflect not only factual understanding and clarity of the information we provided to the consumers, but also the unvague feeling of not being quite able grasp the process how it is possible, or is it really possible to make food out of waste resources, (from saw dust, from food waste, from carbon dioxide emissions). Based on the focus-group discussions, this kind of vague feeling of not understanding, not being sure of what this is all about, was one of the important reasons for not being able to really evaluate these production methods; that is to not knowing what to think. Only 12,7 % felt the NextGenProteins microalgae concept as difficult to understand, the majority (58,4%) states that they are able to understand the concept of microalgae.

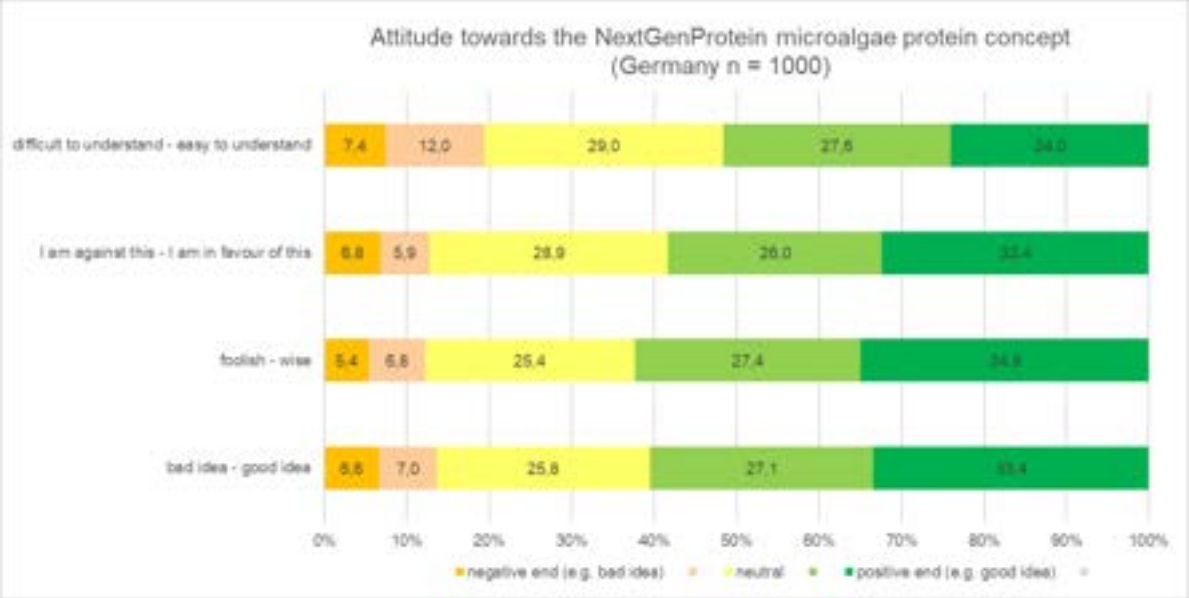


Figure 242 Attitudes towards the NextGenProteins microalgae concept. Percentages of the DE respondents.

Over half of the respondents in DE rated the benefits of NextGen microalgae concept for environment (65,4%), human health (61,1%) and animals (51.3%) as likely or very likely. Personal benefits are rated lower (47,7%), similar to beneficial effect to national economy (46,6%) (see Figure 243).

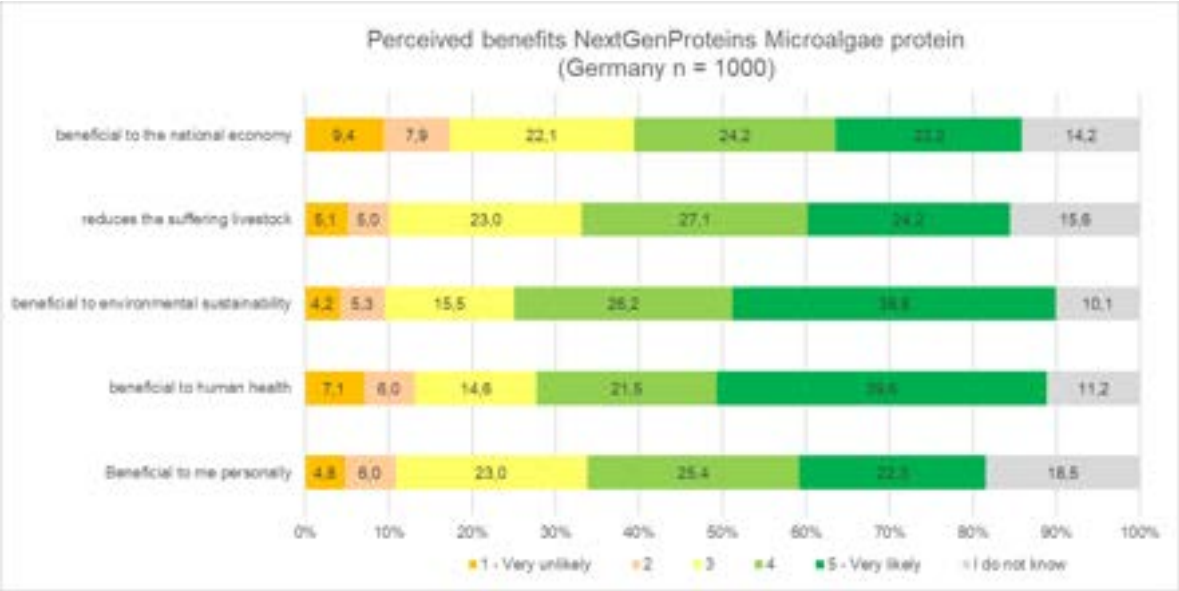


Figure 243 Perceived benefits of the NextGenProteins microalgae protein concept. Percentages of the DE respondents.

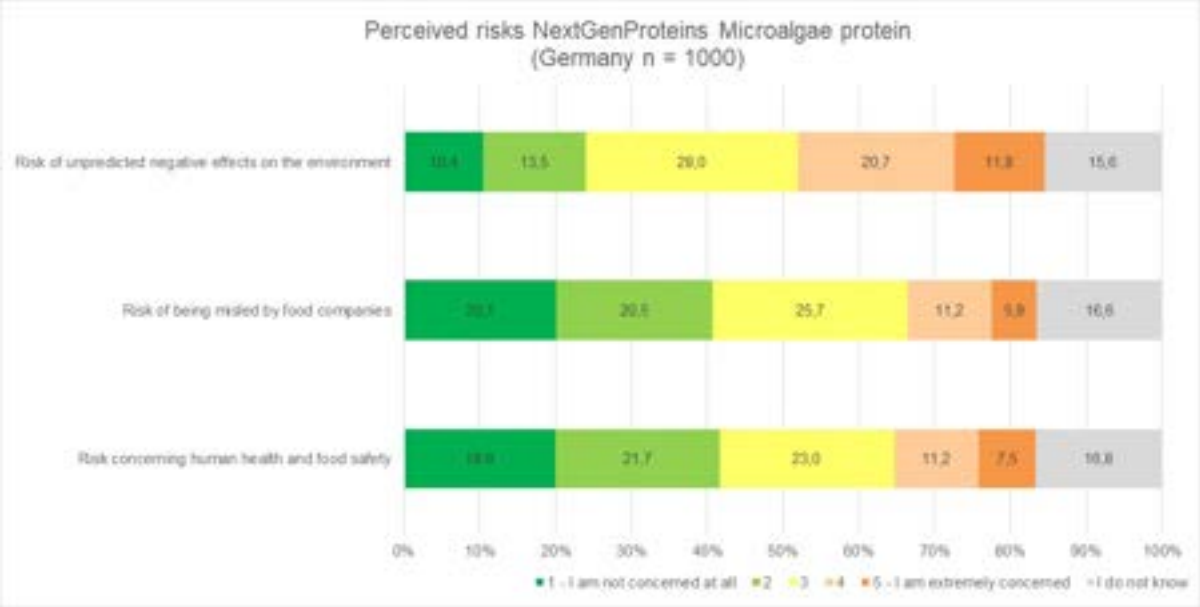


Figure 244 Perceived risks of the NextGenProteins microalgae protein concept. Percentages of DE respondents.

Interestingly, German consumers were mainly concerned (32,5 %) about that the protein production has negative effect on the environment. Even though the trust in food industry is very low, they are not additional afraid of being misled by food companies or any risk concerning human healthy and food safety.

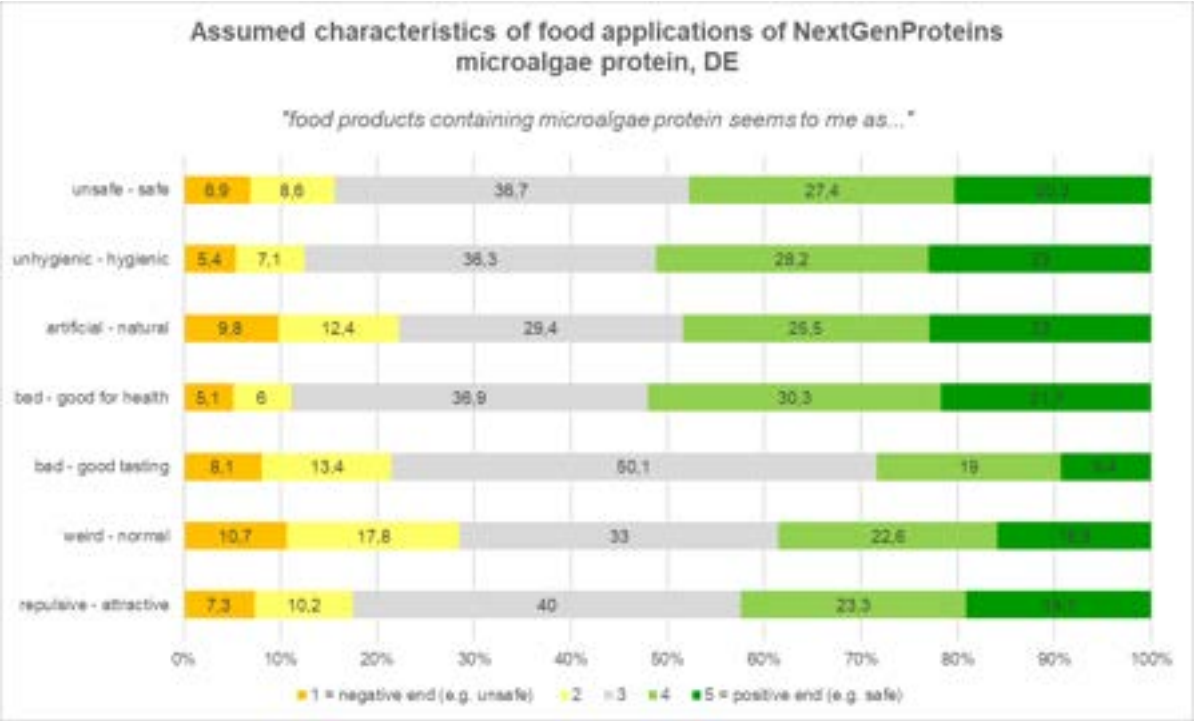


Figure 245 Characteristics associated by respondents with the imaginary food applications made with NextGenProteins microalgae protein. Percentages of DE respondents.

As the microalgae protein is new for the consumers, it is not surprinsing that the majority of consumers rated the characteristics on indifferent scalepoint 3. Highest rating on the positive end of the scale are on the attributes “safe”, “hygienic”, “natural” and “good for health” (see Figure 245).

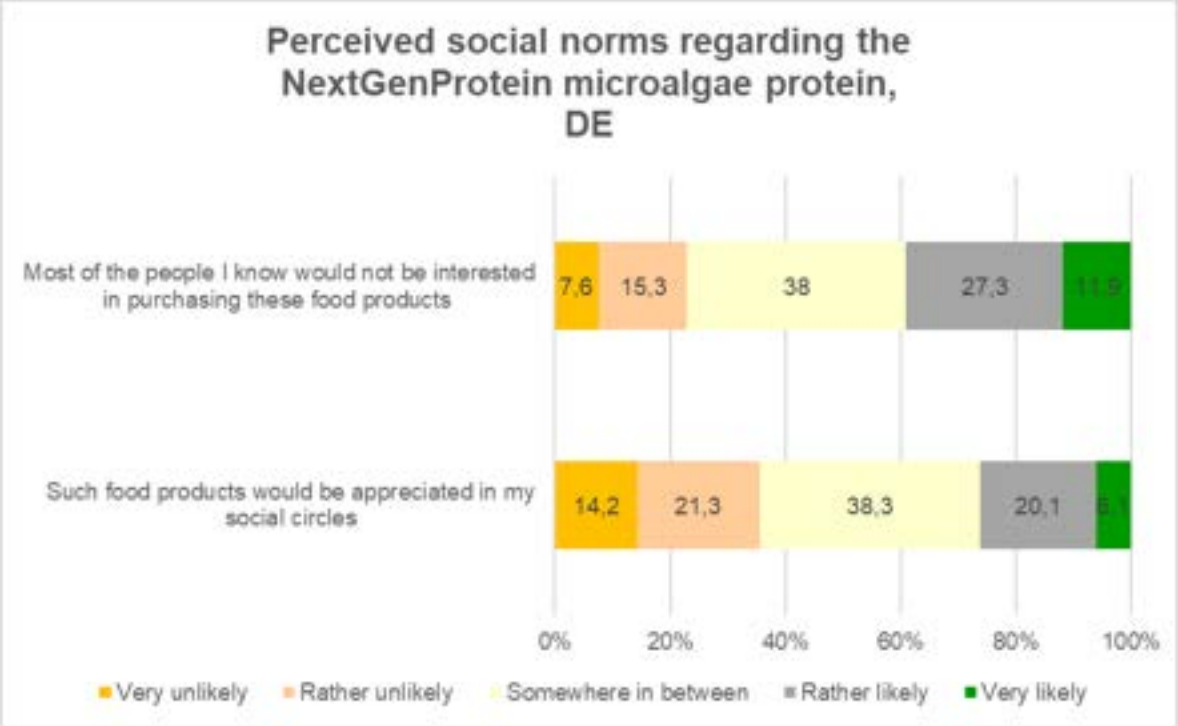


Figure 246 Perceived social norms regarding NextGenProteins microalgae protein food products. Percentages of DE respondents.

Regarding social norms, the respondents believe that in their circle of friends/family products made from the microalgae proteins are mainly not appreciated. Figure 246.

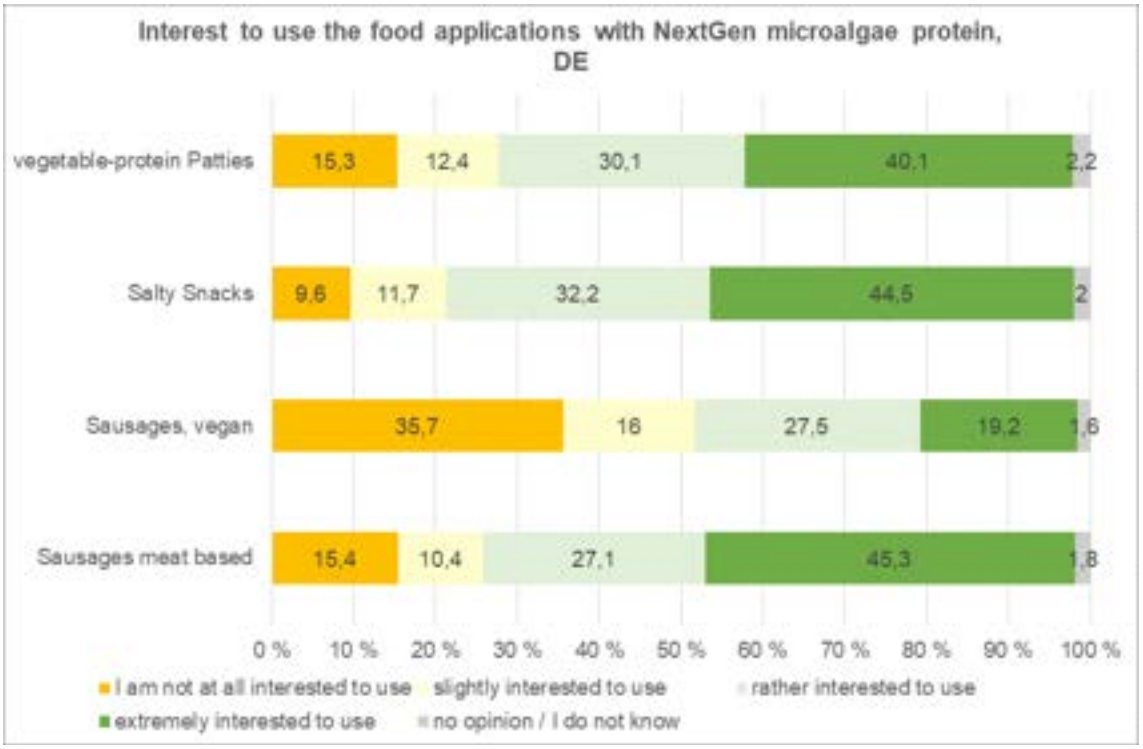


Figure 247 Interest to use the food application examples of NextGenProteins microalgae protein. Shares of DE respondents with each answer alternative

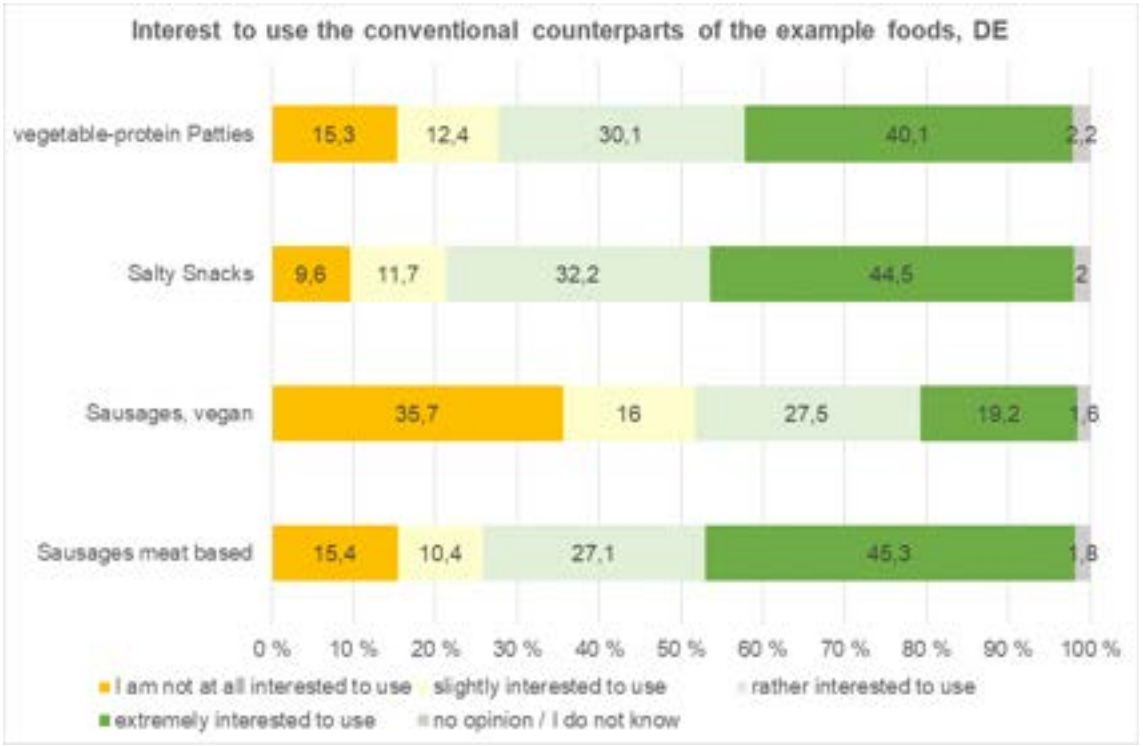


Figure 248 Use interest of the conventional counterparts of the food application examples. Percentages of DE respondents.

13.5.2 Consumer clusters based on views towards NextGenProteins microalgae concept, DE

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGenProteins microalgae concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 2 – 3 clusters. Subsequent K-means clustering, run with 2 to 4 clusters, confirmed that 3 cluster solution best brings out the differences in the sample.

Table 94 Consumer clusters based on respondents' views towards NextGenProteins microalgae protein concept. The result of K-means cluster analysis with 3 clusters (means of the variables in each cluster). DE

	Cluster 1	**Cluster 2**	**Cluster 3**	Total	F	Sig.
	Positive	**Indifferent, but not negative**	**Strongly Negative**			
Number of cases	366	410	107	884		
Percent of cases	41,4%	46,4%	12,1%	100%		
Variables applied as basis of the clustering						
ATT_Microalgae	4,62	3,54	2,09	3,77	877,33	0,000
Benefits_ Microalgae	4,54	3,59	2,19	3,78	673,01	0,000
RISK_ Microalgae	1,89	3,19	3,71	2,75	354,65	0,000
FOODVIEWS_ Microalgae	4,27	3,17	1,91	3,43	910,66	0,000

Table 94 shows the cluster sizes and their general acceptance towards the microalgae protein. **Cluster 1** consists of respondents with the most positive attitudes and highest beliefs in benefits of the concept. They also have the lowest risk perception and rate the quality of the imaginary food applications as the highest (foodviews) compared to the other respondets. In the **Cluster 2** the respondents have also quite positive attitudes, have the second highest beliefs in the benefits and in average the most neutral preconceptions about the quality of food applications. However, they are also a bit concerned abut the risks of this concept. In general, this group see the advantages and disadvantages and is more indifferent or neutral with a tendency of being negative. In contrast to that, Cluster 3 is strongly negative towards the microalgae protein and its application in food products.

13.5.2.1 Demographic profile and eating habits of NextGen microalgae consumer clusters, DE

As mentioned above the cluster are different in case of attitude, benefit and risk perception and in use in food. Significant differences exist also in education level and general eating habits. In case of the other attributes, only tendencies exist (see Table 92).

Cluster 1: 41,4% of the consumers

- More women
- Majority between 45-54 years
- Majority living in a small city/town or municipality

- Mainly secondary education, but the highest proportion of tertiary education in comparison to the other clusters
- Mainly omnivore eating habits, but also 23,9% of consumers trying to reduce meat consumption
- Mainly no kids

Cluster 2: 46,40 % of the consumers

- More men
- Majority between 45-54 years and younger, youngest cluster, nearly half of them below 45 years
- Majority living in a small city/town or municipality
- Mainly secondary education, but the second highest proportion of tertiary education in comparison to the other clusters
- Mainly omnivore eating habits, but the highest proportion of vegans/vegetarians in comparison to the other clusters
- Mainly no kids

Cluster 3: 12,10% of the consumers

- Gender-balanced
- Majority above 44 years old, oldest cluster in comparison to the other clusters
- Majority living in a small city/town or municipality or even in rural areas
- Mainly secondary education, but the highest proportion of only basic education and lowest proportion of tertiary education
- Mainly omnivore eating habits
- Mainly no kids

Table 95. Demographic characteristics of the microalgae consumer clusters in DE

	3 Cluster ALGAE					
	Positive	**Indifferent, but not negative**	**Strong Negative**	Pearson Chi^2	Sign.	Total N
Gender				**3,88**	**ns**	**884**
male	45,7%	52,5%	51,5%			
female	54,3%	47,5%	48,5%			
total	*100,0%*	*100,0%*	*100,0%*			
Age Groups				**11,30**	**ns**	**884**
18-24 years	8,7%	9,5%	4,7%			
25-34 years	16,4%	18,5%	10,2%			
35-44 years	15,6%	19,4%	21,3%			
45-54 years	23,8%	20,7%	24,4%			
55-64 years	17,5%	16,3%	18,1%			
65-75 years	18,0%	15,6%	21,4%			
total	*100,0%*	*100,0%*	*100,1%*			
Living Area				**7,16**	**ns**	**885**
I live in the capital city / area	13,5%	14,3%	10,1%			
I live in a large city that is not in the capital area	29,7%	26,3%	28,4%			

I live in a small city/town or municipality	37,0%	35,7%	30,8%			
I live in a rural area	19,8%	23,7%	30,7%			
total	*100,0%*	*100,0%*	*100,0%*			
Education_DE				**36,37**	**,000[a,*]**	**884**
Basic education	1,1%	5,4%	**11,1%**			
secondary education	63,5%	65,8%	65,6%			
tertiary education	**34,9%**	27,6%	19,6%			
something else	0,6%	1,2%	3,7%			
total	*100,1%*	*100,0%*	*100,0%*			
Eating habits				**35,70**	**,000[a,*]**	**879**
omnivore	60,6%	72,4%	**83,0%**			
meat sometimes or no red meat	27,1%	23,9%	13,3%			
vegetarians and vegans	**12,3%**	3,7%	3,8%			
total	*100,0%*	*100,0%*	*100,1%*			
Type of Household				**3,69**	**ns**	**874**
no children	64,8%	58,5%	60,0%			
1-2 with children	26,8%	31,6%	32,4%			
something else	8,4%	9,8%	7,6%			
total	*100,0%*	*99,9%*	*100,0%*			

13.5.2.2 Attitudinal background of NextGen microalgae consumer clusters, DE

The familiarity with different animal protein alternatives and the use of different convenience foods is significantly different between the clusters. The cluster positive has the highest involvement/familiarity when it comes to different proteins. (see Figure 249).

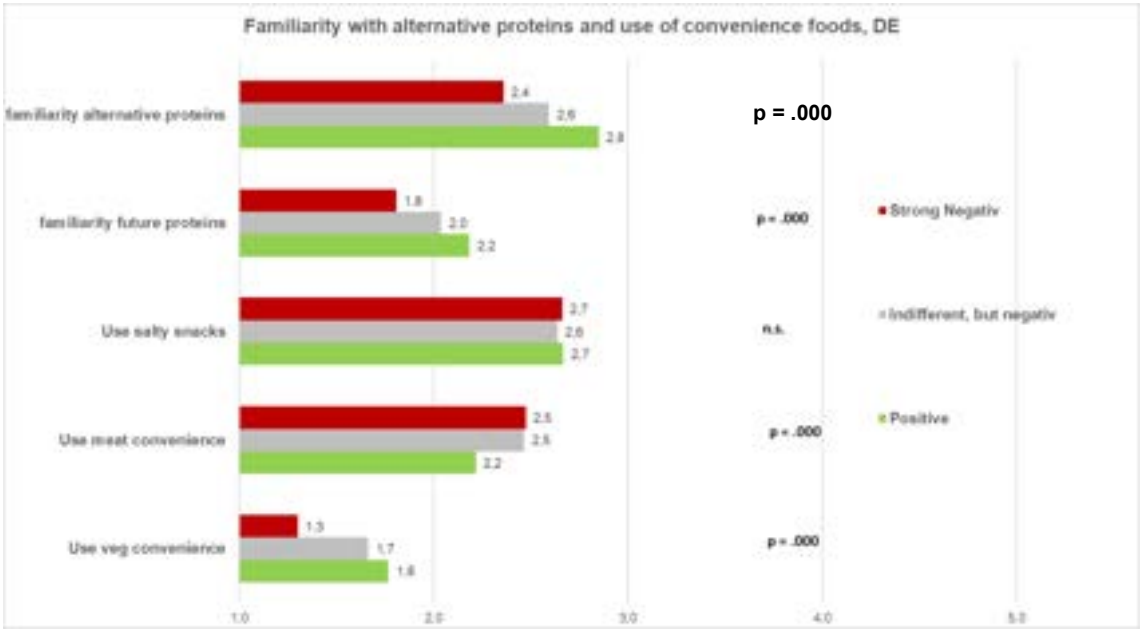


Figure 249 familiarity with alternative proteins by NextGen microalgae consumer clusters in the DE sample. Means. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

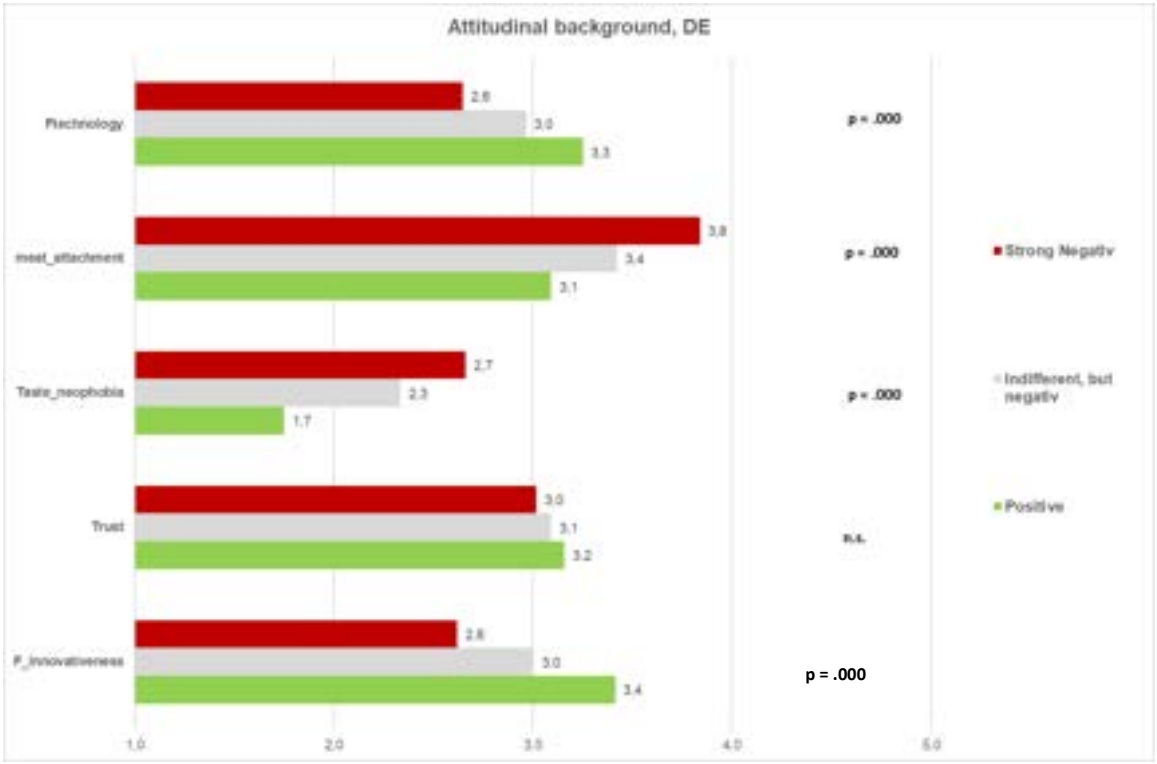


Figure 250 Comparing the consumer clusters of NextGen microalgae on their attitudinal background. Means of compositive variables measuring the background attitudes. Germany

The attitudinal background of the different clusters is shown in Figure 250. The strongly negative cluster has high attachment with meat and tend to be more taste neophobic than the other two clusters. The negative cluster is also less positive towards new food technologies and rate lowest in food innovativeness compared to the more positive clusters. This is not surprising, because in this cluster, proportion of omnivore is highest. The positive cluster has positive attitude towards new food technologies and has higher food innovativeness. The indifferent, but not negative cluster resembles the positive cluster, except for taste neophobia and meat attachment. This cluster seem to be open-minded towards new technologies, but they tend to be more taste neophobic than the positive cluster.

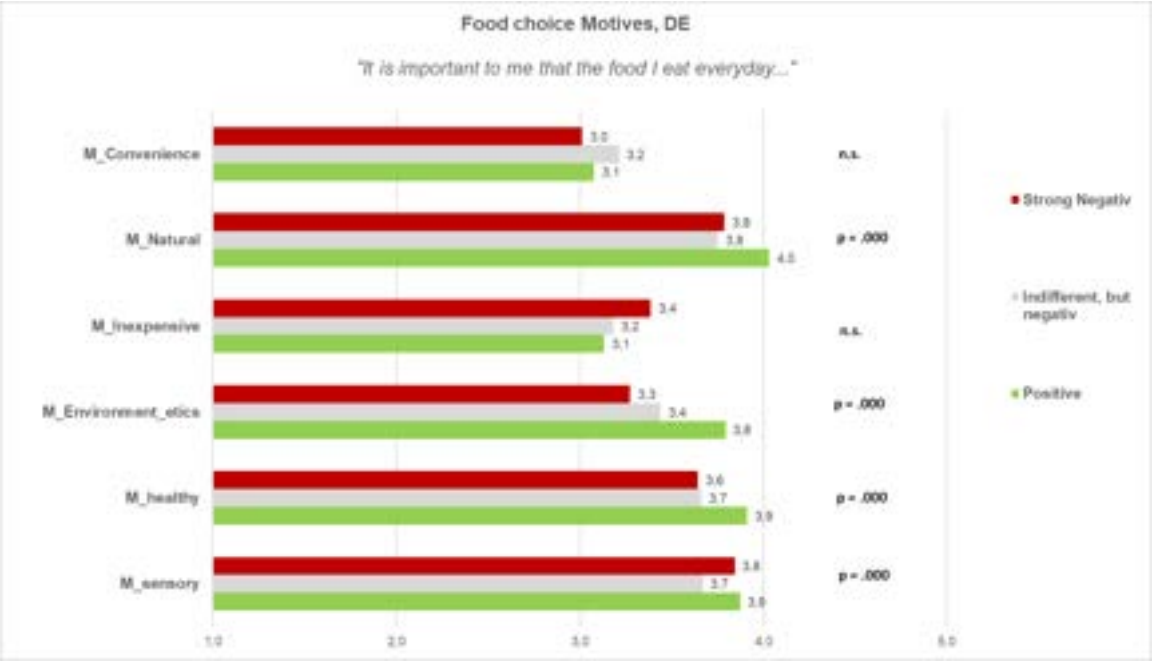


Figure 251 Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins microalgae concept. DE. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

The differences of mean values between the clusters for the food choice motives are significant for sensory properties, healthy, environment and ethics, inexpensive, natural and convenience. Cluster 1 rated significantly higher in all motives expect inexpensive (highest value in Cluster 3) and convenience (highest cluster Cluster 2). Figure 251.

13.5.2.3 Interest to use food applications by NextGen microalgae consumer clusters, DE

Only the positive cluster had an interest to use either patties, snacks or sausages made from microalgae proteins (Figure 252).

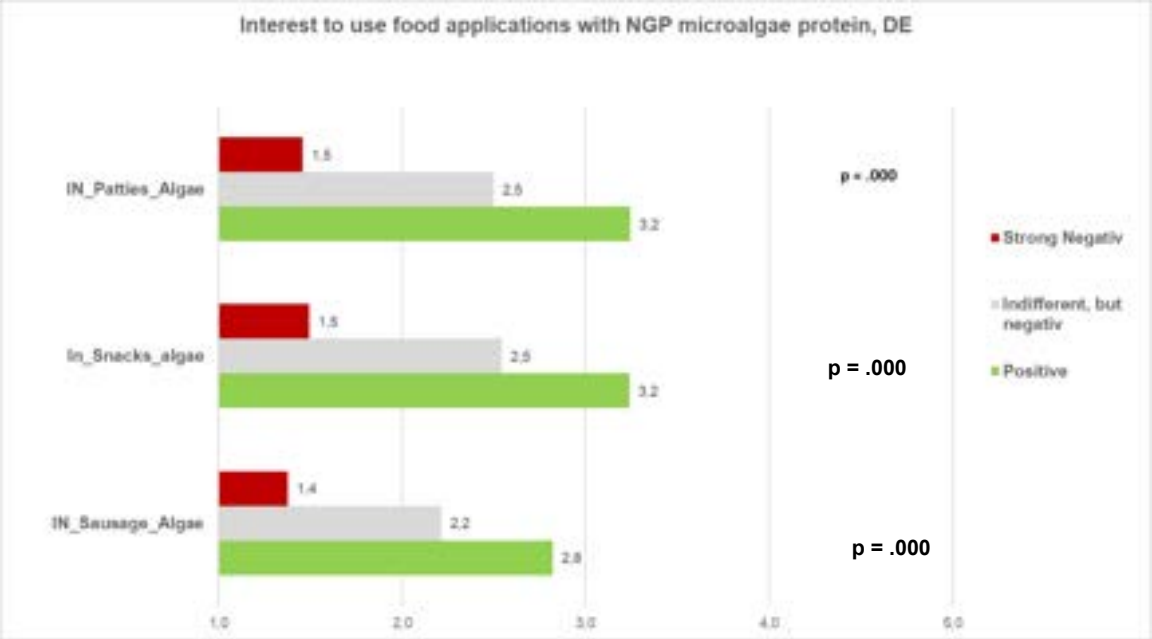


Figure 252 Interest to use food applications made with NextGenProteins microalgae protein and their conventional counterparts. Comparison of means between the consumer clusters for NextGenProteins microalgae concept. Germany

Table 96 Summarises characteristics of the three clusters for the microalgae concept with NextGen proteins

Cluster 1: Positive attitude 41,4 %	**Cluster 2: Indifferent, but not negative 46,4 %**	**Cluster 3: strong negative 12,1%**
• 41,4 % of consumers • Majority between 45-54 • Highest proportion of tertiary education • Highest proportion of Vegetarians vegetarians and vegans • Majority without kids • Familiar with alternative and future proteins • Neophilic (Food and technology) • Natural, healthy and environmental impact food of high importance for food choice	• 46,40% of consumers • Majority between 45-54 • High proportion of omnivores • Convenience, inexpensive have impact on food choice • Sensory characteristics are also important	• 12,10% of consumer • Oldest cluster • Highest proportion of primary education • Highest proportion of omnivore • Neophobic (food and technology) • Convenience, inexpensive and sensory attributes of high importance for food choice

Table 96 summarised the outcome of the cluster analysis for the micro algae protein concept of NextGen. K-means clustering reveals three clusters, one reflects 41,4 % of the consumers, one 46,4 % and the third consists of 12,1 % of consumers.

13.6 Acceptance of NextGenProteins Insect protein concept, DE

13.6.1 The level of acceptance of the NextGen insect concept

In contrast to the algae protein is the acceptance towards the insect protein much lower. Only 42,9 % think, that it is a good idea. Even though 55,2 % are in favour of this idea, 28,2 % think that it is difficult to understand. Figure 253 shows that more than 30 % of the consumers have neutral attitude.

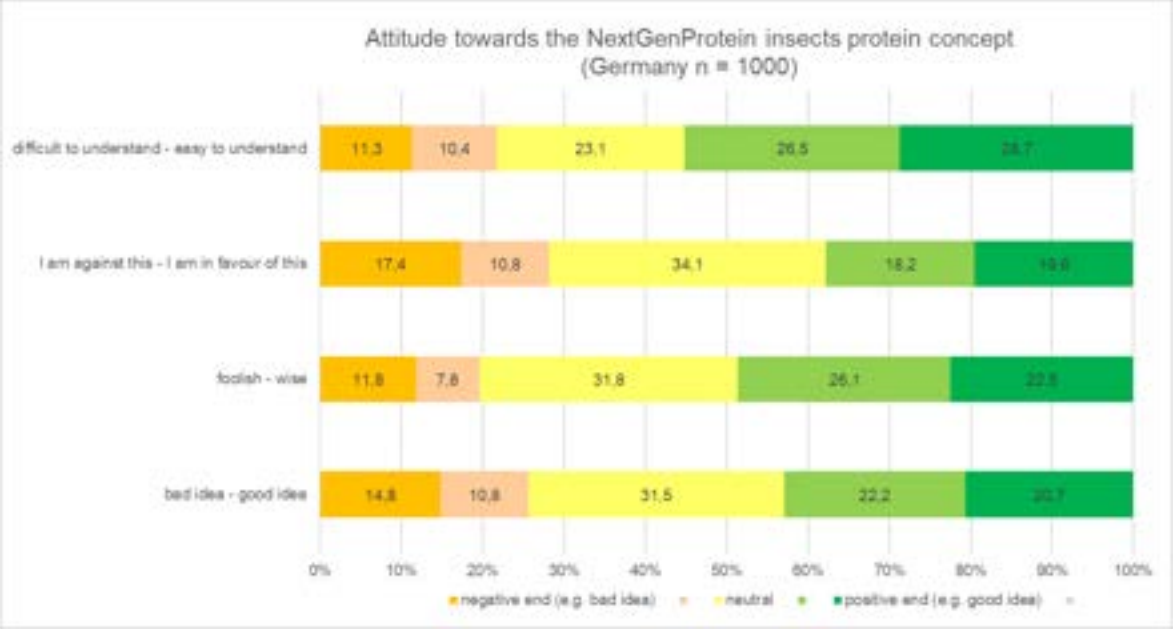


Figure 253 Attitudes towards the NextGenProteins insect protein concept. Percentages of DE the respondents.

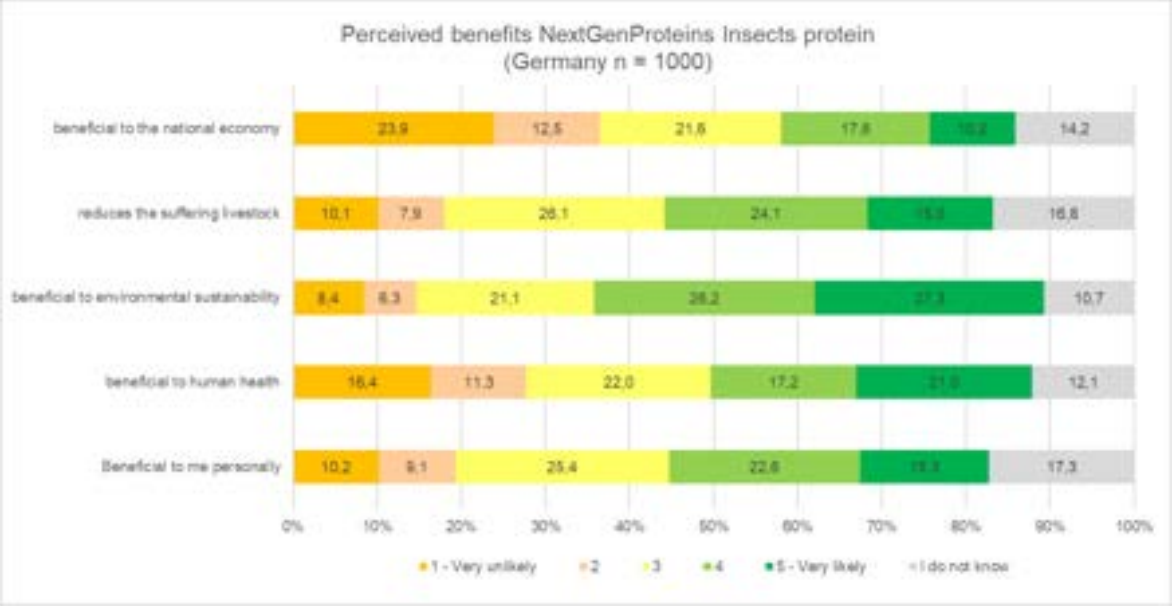


Figure 254 Perceived benefits of the NextGenProteins insect protein concept. Percentages of DE the respondents.

Figure 254 shows the perceived benefits of the insect protein concept by the German respondents. More than half of the them (53,5 %) think that this concept is beneficial to environmental sustainability. Consumers think that it is less beneficial to the national economy, to human health or to themselves personally.

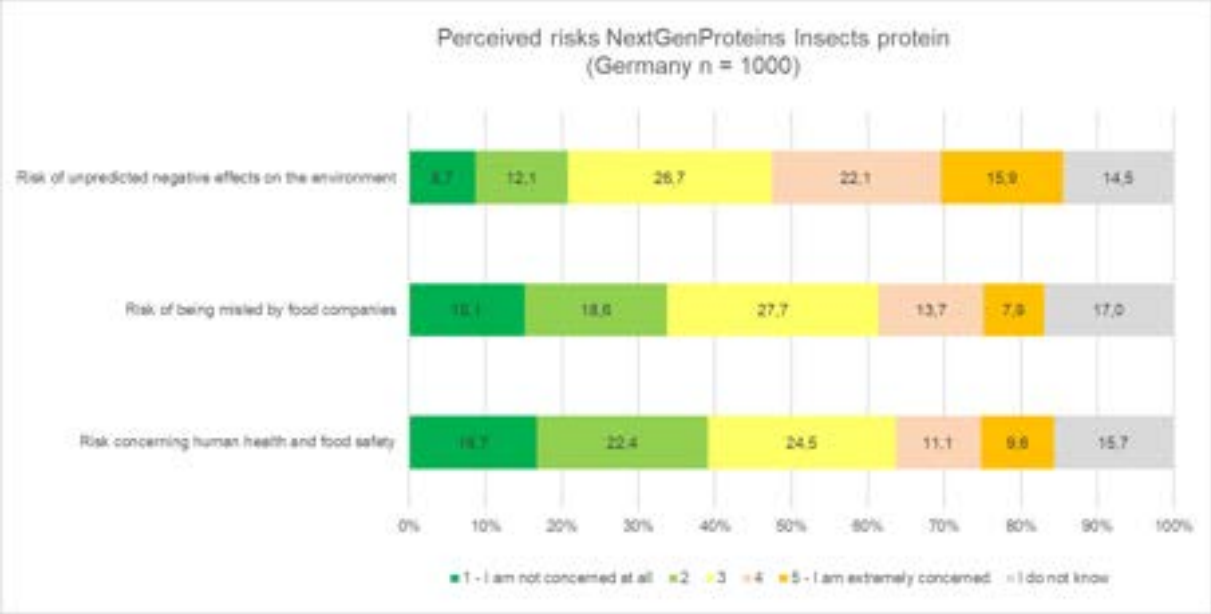


Figure 255 Perceived risks of the NextGen insect protein concept. Percentages of DE the respondents.

In contrast to the benefits, consumers can answer their concerns towards certain risks much better or clearer. Nearly 40 % of the respondents were concerned that human health and food safety is negatively influenced by this concept. In their opinion, it has less negative impact on environment.

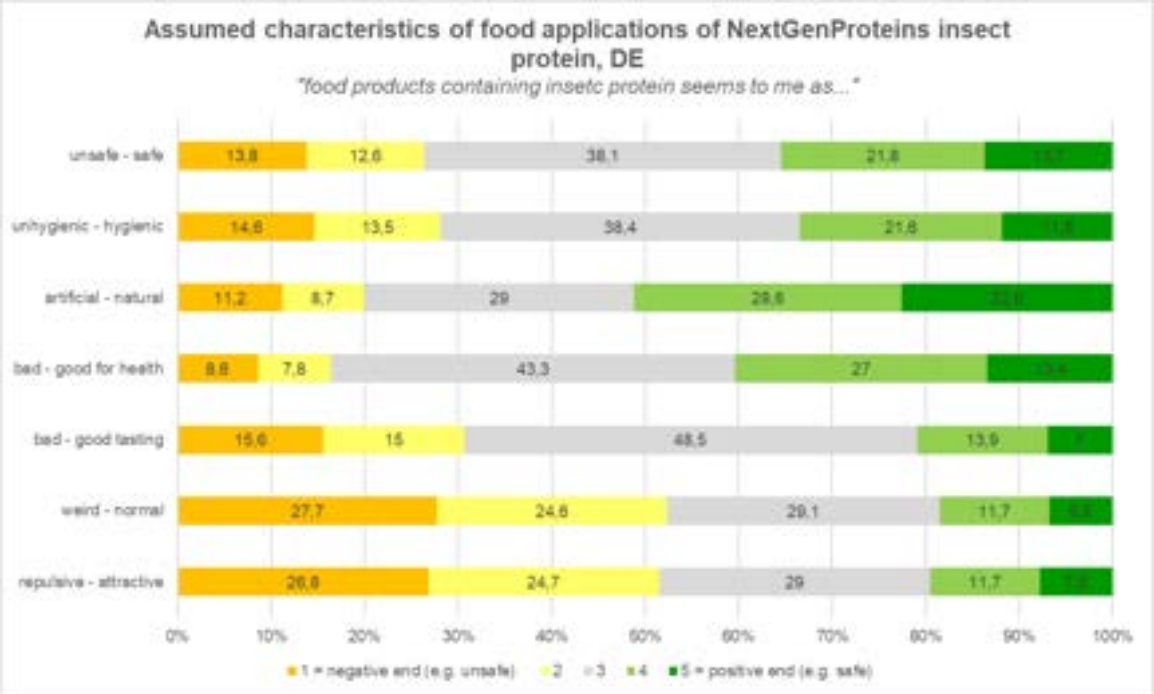


Figure 256 Characteristics associated with food applications made with NextGen insect protein. Percentages of DE respondents.

Over half (51,6 %) of the respondents perceived food products made from insects as natural and at least 40,4 % believe they are good for health. However, over half of the consumers perceive this concept as weird (52,3 %) and repulsive (51,5 %). Figure 256 shows that for all characteristics a large amount of consumers answer in the middle of the scale.

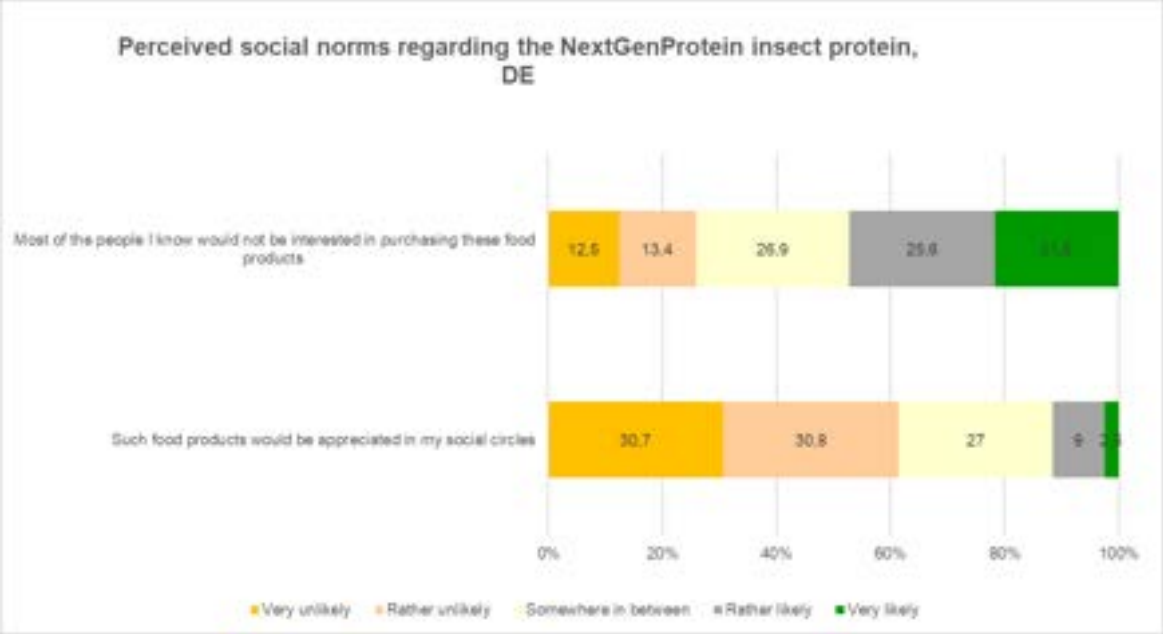


Figure 257 Perceived social norms regarding NextGen insect protein food products. DE

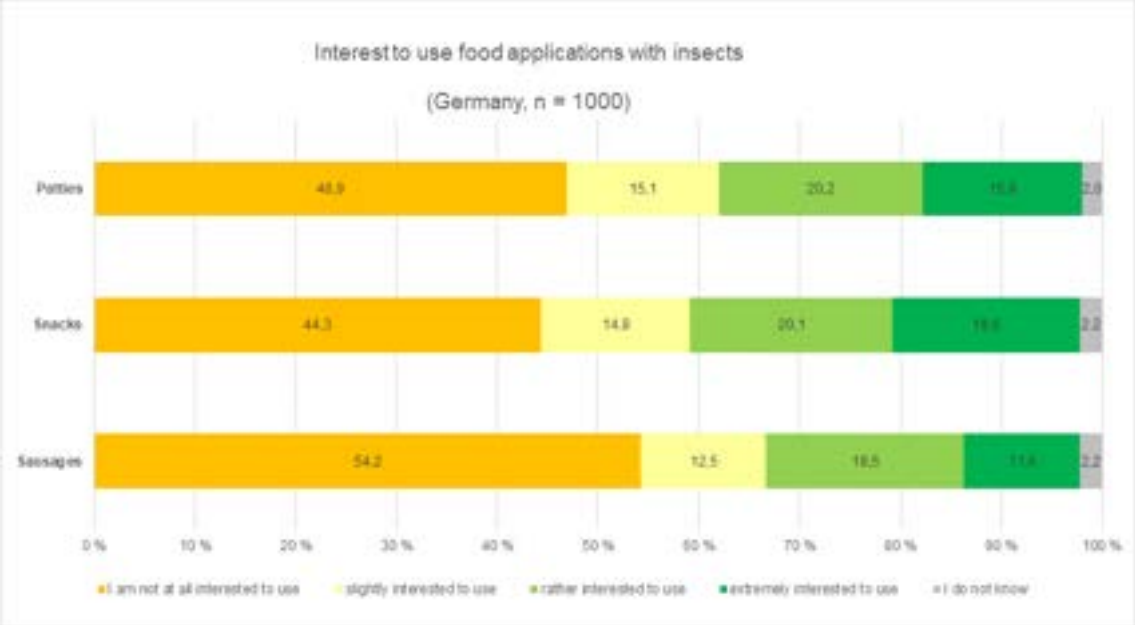


Figure 258 Characteristics associated with food applications made with NextGen insect protein. Percentages of DE respondents.

At first glance, it becomes obvious that the majority of consumers are not interested to use insect protein in one of the food product examples. Based on these results snack products appear to have highest potential (38,6 % interested users), followed by patties (35,8 %) and sausages (30,4 %). Figure 258.

13.6.2 Consumer clusters based on views towards NextGen insect concept,DE

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGenProteins insect concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 2 – 3 clusters. Subsequent K-means clustering, run with 2 to 4 clusters, confirmed that 3 cluster solution best brings out the differences in the sample.

Table 97 Consumer clusters based on respondents' views towards NextGenProteins insect protein concept. The result of K-means cluster analysis with 3 clusters. DE.

	sceptical	**positive**	**negative**	Total	F	Sig.
Number of cases	430	287	165	882		
Percent of cases	48,75%	32,54%	18,71%	100%		
Variables applied as basis of the clustering						
ATT_Insects	3,19	4,55	1,50	3,31	1247,99	.000
Benefits_Insects	3,18	4,26	1,68	3,25	817,86	.000
RISK_Insects	3,09	2,14	3,80	2,92	201,10	.000
FOODVIEWS_Insects	2,86	3,94	1,64	2,98	808,97	.000

Table 97 shows the cluster sizes and their general acceptance towards the insect protein as well as cluster means on each clustering variable. In the Cluster 1 (Sceptical) the respondents have quite neutral attitude (mean 3,19) towards the NextGen insect protein concept. Also their other ratings are quite neutral, such as beliefs in benefits and risks, as well as their preconceptions about the quality of the food applications (foodviews).

Cluster 2 (Positive) has very positive attitude, in average higher belief in benefits and lower belief in risks of the NextGen insect protein concepts. They also have the most positive preconceptions about the quality of food applications (Foodviews). In contrast to that, Cluster 3 (Negative) is very negative towards concept and to its application in food products. They perceive high risks with this food ingredient concept.

13.6.2.1 Demographic profile and eating habits of NextGenProteins Insect consumer clsters, DE

The demographic background characteristics of the consumer clusters fort he NextGen insect protein are summarised below. More detailed information is presented in Table 98.

Cluster 1: 48,75% of the consumers "the sceptical"

- Gender-balanced
- Majority above 45 years
- Majority living in a small city/town or municipality
- Mainly secondary education, but the highest proportion of tertiary education in comparison to the other clusters
- Mainly omnivore eating habits, but also 23,7% of consumers trying to reduce meat consumption

Cluster 2: 32,54 % of the consumers "the positive"

- More men
- Majority between 45-54 years
- Majority living in a small city/town or municipality
- highest proportion of tertiary education in comparison to the other clusters
- Mainly omnivore eating habits, but the highest proportion of people who wants to reduce meat in their diet
- Mainly no kids

Cluster 3: 12,10% of the consumers "the negative"

- More women
- Majority above 44 years old, oldest cluster in comparison to the other clusters
- Majority living in a small city/town or municipality
- High proportion of primary education
- Mainly omnivore eating habits, lowest proportion of consumers who want to reduce meat
- Mainly no kids

Like in clusters for the microalgae concept, familiarity with alternative or future proteins is significantly higher in the positive cluster than in the other two clusters. No difference can be found in the use of meat containing convenience food, but the mean differences between the negative and positive cluster for the use of vegetarian convenience cluster is significant (see Figure 259).

Table 98 Demographic and other characteristics of consumer clusters of NextGenProtein insect concept, Germany

	3 Cluster INSECTS					
	sceptical	**positive**	**negative**	Pearson Chi^2	Sign.	Total N
Gender				**4,19**	**n.s.**	**882**
male	50,30%	**53,30%**	43,10%			
female	49,70%	46,70%	**56,90%**			
	100,0%	*100,0%*	*100,0%*			
Age Groups				**22,78**	**0,012**	**883**
18-24 years	**10,30**%	9,40%	4,20%			
25-34 years	**21,60**%	14,40%	10,20%			
35-44 years	17,10%	16,80%	**19,80**%			
45-54 years	20,20%	23,30%	**26,80**%			
55-64 years	16,10%	17,70%	**19,10**%			
65-75 years	14,70%	18,40%	**19,80**%			
total	*100,0%*	*100,0%*	*99,9%*			
Living Area				**18,75**	**0,005**	**881**
I live in the capital city / area	12,5%	13,1%	17,1%			
I live in a large city that is not in the capital area	27,2%	29,3%	23,8%			
I live in a small city/town or municipality	34,6%	35,9%	**48,6%**			
I live in a rural area	25,7%	21,7%	10,5%			
total	*100,0%*	*100,0%*	*100,0%*			
Education_DE				**25,290**	**0,000**	**882**
Basic education	4,70%	1,00%	8,40%			
secondary education	64,20%	64,00%	68,70%			
tertiary education	29,80%	34,60%	20,60%			
something else	1,40%	0,40%	2,40%			
total	*100,1%*	*100,0%*	*100,1%*			
Eating habits				**8,570**	**ns**	**879**
omnivore	68,90%	65,00%	76,90%			
meat sometimes or no red meat	23,70%	28,40%	16,50%			
vegetarians and vegans	7,40%	6,60%	6,70%			
total	*100,0%*	*100,0%*	*100,1%*			
Type of Household				**10,56**	**0,032**	**870**
no children	57,70%	65,50%	65,00%			
1-2 with children	31,00%	27,00%	30,60%			
something else	11,30%	7,50%	4,30%			
total	*100,0%*	*100,0%*	*99,9%*			

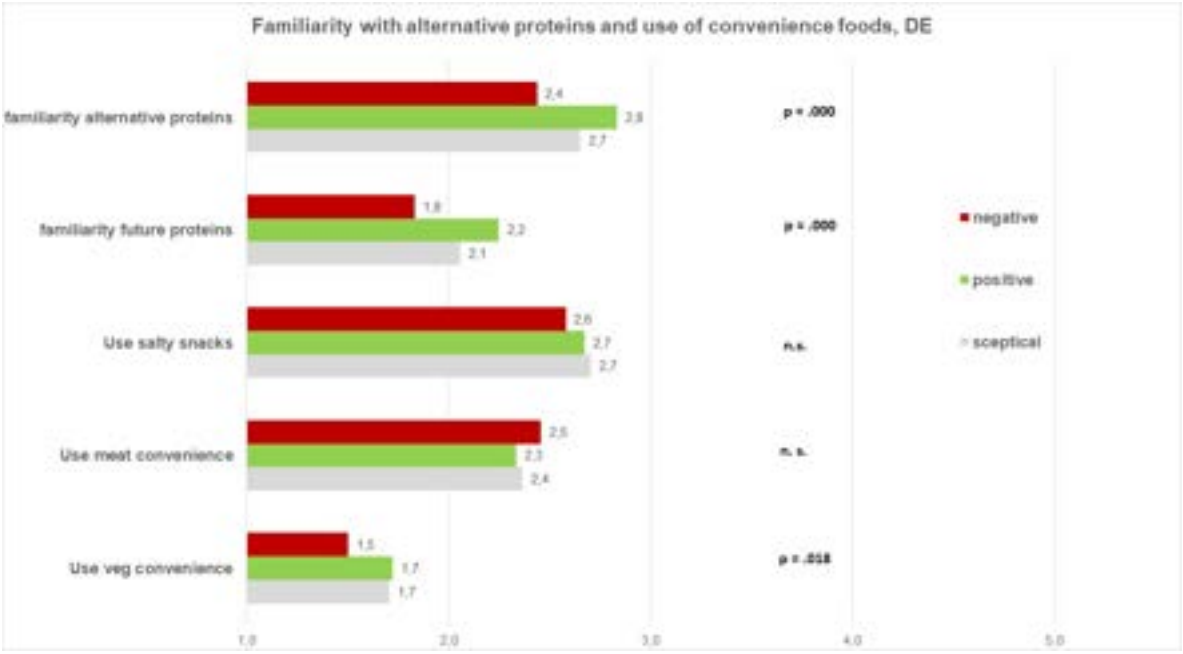


Figure 259 Mean use frequencies of certain convenience foods and familiarity with alternative proteins in consumer clusters based on their views on NextGenProtein insect concept, DE

13.6.2.2 Attitudinal background of NextGen insect consumer clusters, DE

The insect-clusters differ significantly from each other in all attitudinal background variables, except trust of food actors. The positive cluster have the highest meat attachment, and the positive cluster seem to be more open to new food technologies than the other two clusters. The same attitude can be found with the variable food innovativeness. In addition, the taste neophobia scale show, that the positive cluster has significantly lower level “phobia” towards new food tastes. The negative cluster are the most neophobic one and the cluster sceptical are in between (see Figure 260).

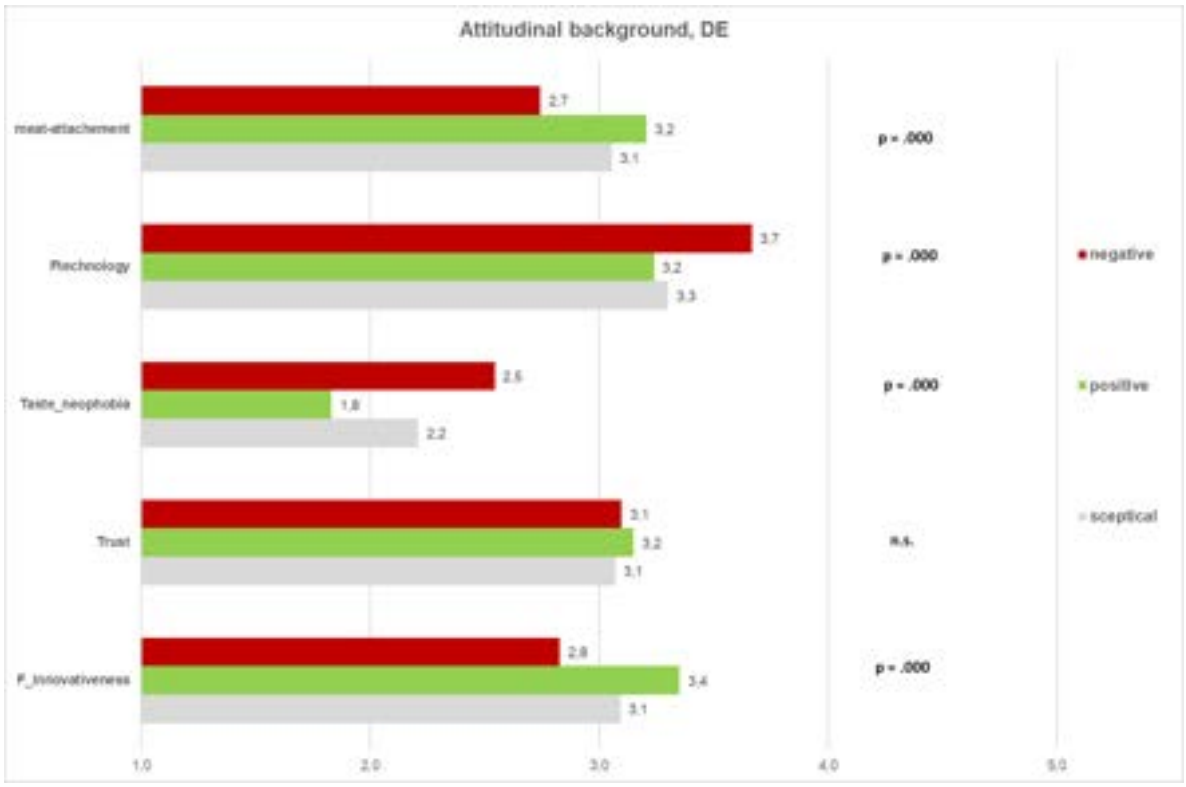


Figure 260 Means of background attitudes compared between the three clusters (based on their views on NextGenProtein insect concept) in Germany.

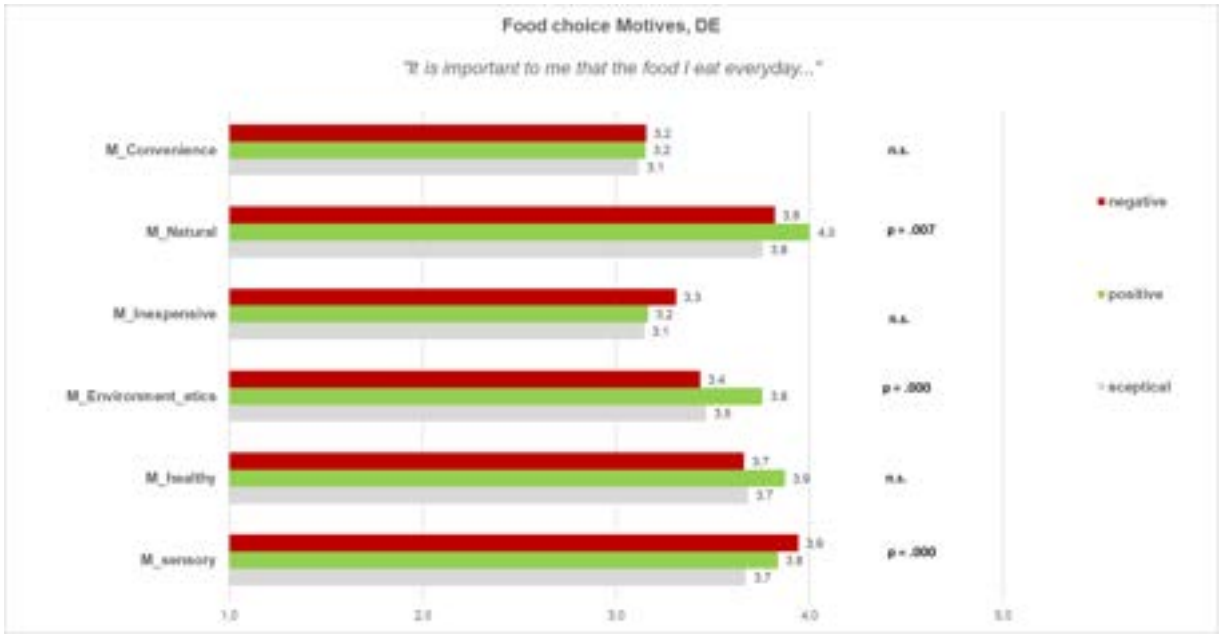


Figure 261 Means of food values compared between the consumer clusters (formed in the basis of their views towards NextGenProtein insect concept) in Germany. (ns = not statistically significant difference in means between the clusters)

In terms of what is important for the respondents in their food choice, significant differences can be found for naturalness, environment & etics as well as sensory properties. These issues were most important for the cluster positive. Even though not significant, it is interesting that the negative cluster rated the higher for the motive “inexpensive”.

13.6.2.3 Interest to use food applications by NextGenProteins insect consumer clusters, DE

The interest to use food products made with insect protein varies significantly between the clusters. In the cluster positive the use interest is highest, followed by sceptical. The cluster negative had close to no interest to use these foods.

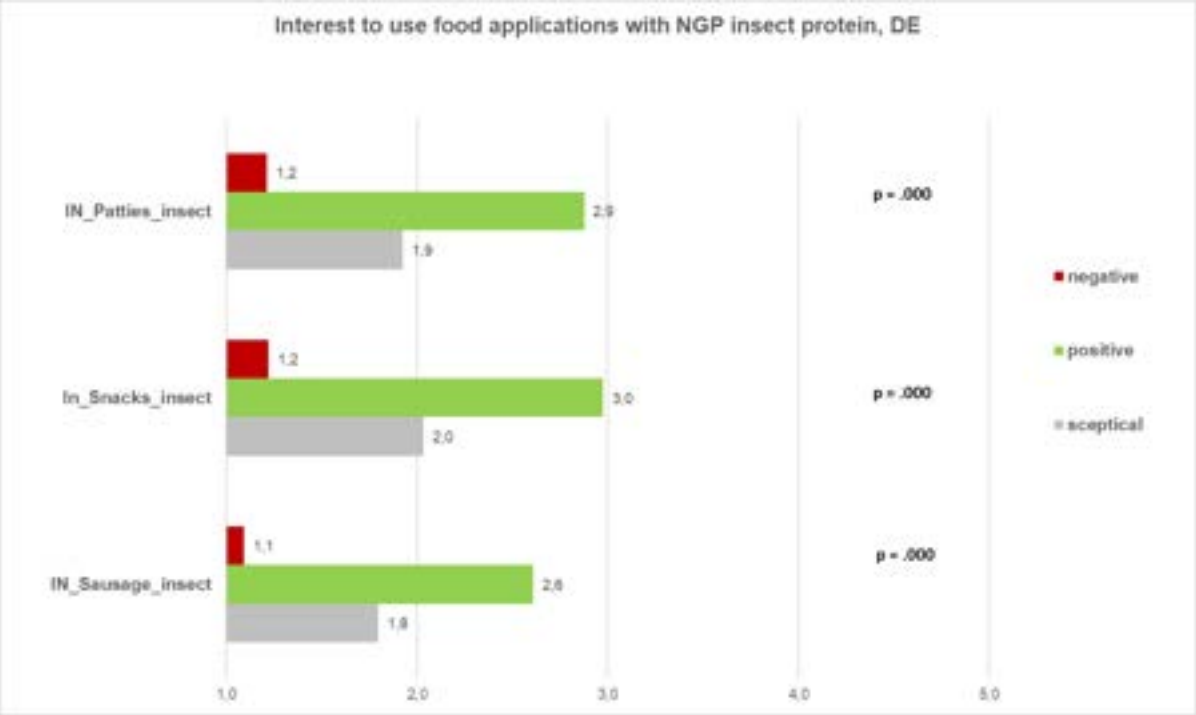


Figure 262 Mean interest to use the examples of NextGenProtein insect food applications compared between the NextGen insect clusters in Germany

13.7 Acceptance of NextGen Torula protein concept, DE

13.7.1 The level of acceptance of NextGenTorula protein, DE

The NextGen torula yeast protein concept was perceived by 50,4 % as wise, but only 46 % think that it is a good idea. It is noteworthy, that high amounts of consumers have a neutral opinion for each of these attitude variables. Very likely, this reflects the uncertainty when the consumer should rate the concept to be “a good idea” e.g.

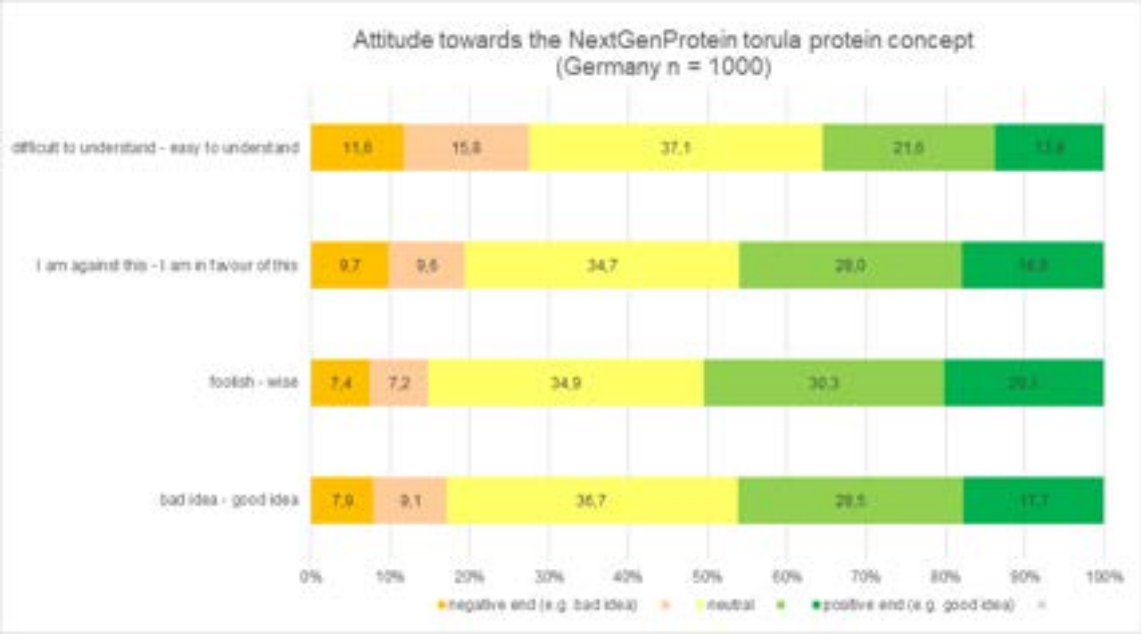


Figure 263 Attitudes towards the NextGen Torula concept. Percentages of DE respondents

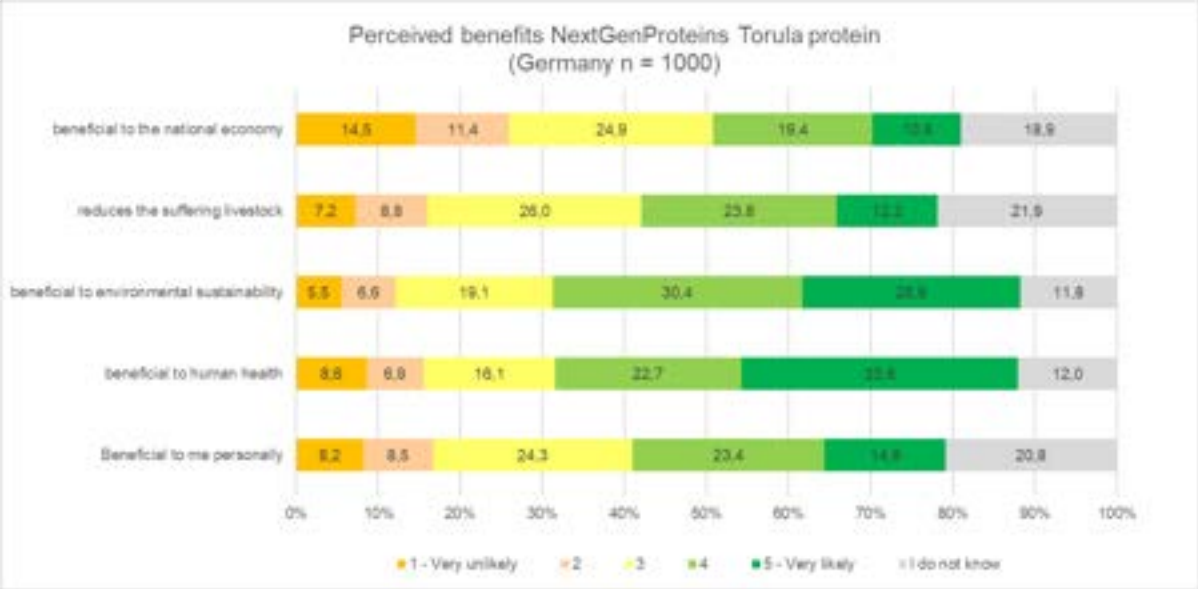


Figure 264 Perceived benefits of NextGenProteins Torula protein concept. Percentages of DE respondents.

The benefit perception (see Figure 264) supports the observations made above. Out of the German respondents, 56,6 % rated the benefits for the human health as likely, but only 38,2b% of them think that it is likely that it has benefits to them personally. About 57% think that this concept is likely to be sustainable for the environment. Up to 21 % of the consumers are not able to answer the questions and ticked “I do not know”.

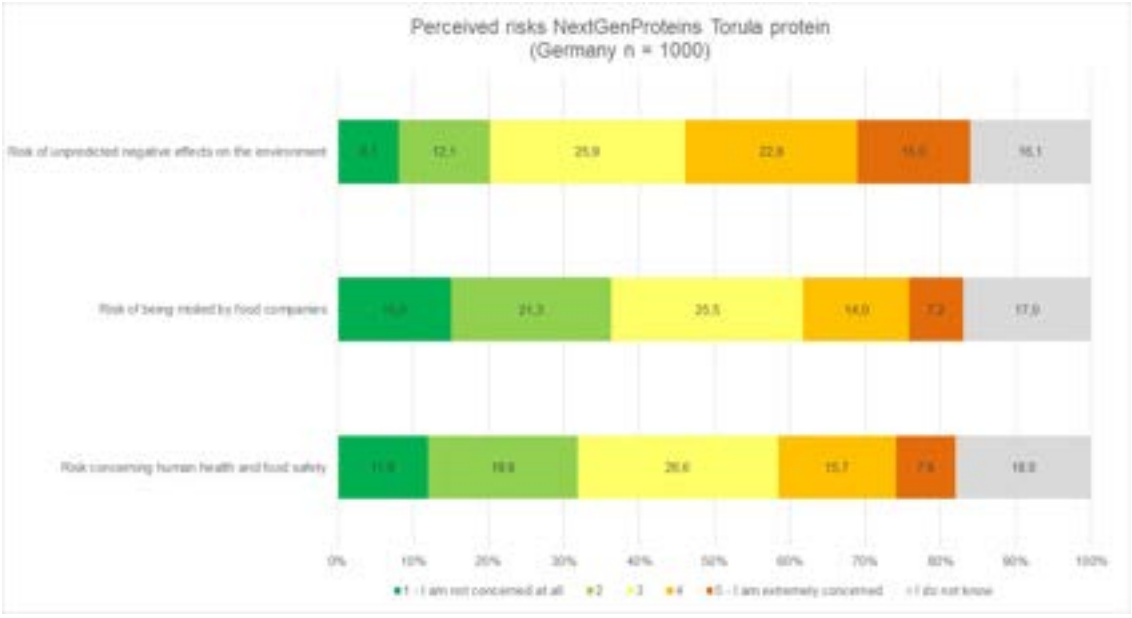


Figure 265 Perceived risks of NextGen Torula protein concept. Percentages of DE respondents.

The risk of unpredicted negative effects on the environment elicited most concern among the German respondets as 37,8 % of them was concerned about it. While 21,2% were concerned about being misled by companies, and 23,9 % of the consumers had the feeling that the human health and food safety is threaten. Like in the case of benefit ratings, a lot of consumers were uncertain in this question and marked the middle of the scale 3.

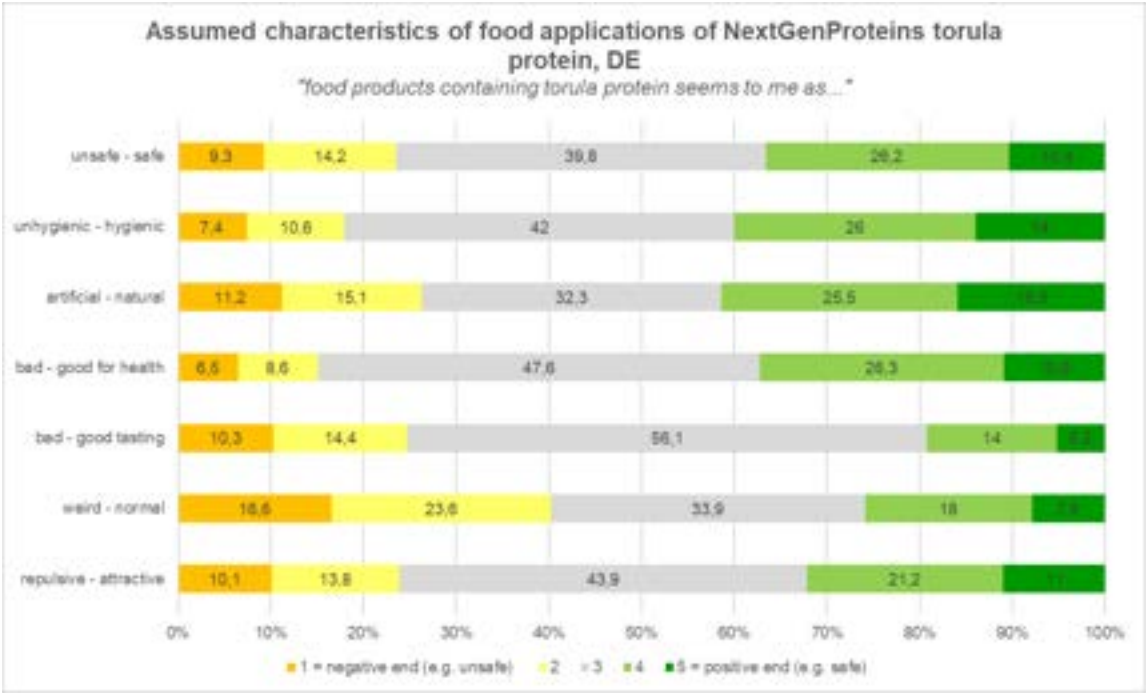


Figure 266 Characteristics associated with food applications of NextGen Torula protein. Percentages of DE respondents.

The uncertainty of the consumers is also reflected in their preconceptions about the characteristics of the food applications. Depending on the semantic pair, more than half of the consumers answer the questions on the neutral scale point 3. About 40 % consider foods made with nextGen torula protein to be weird, and 26,3 % as artificial.

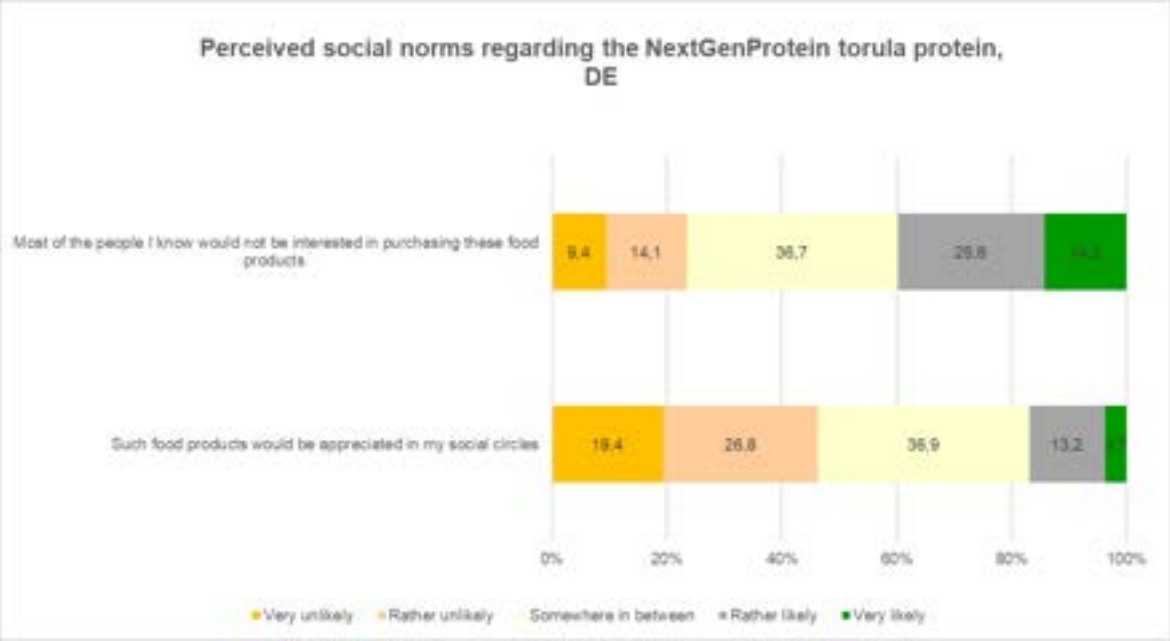


Figure 267 Perceived social norms related to NextGenProteins Torula protein foods. Percentage of DE respondents.

However, even if there seem to be an uncertainty towards this ingredient, half of the consumers can imagine to use it for patties and salty snacks. In relation to sausages the interest is much lower, only 40,4 % are interested.

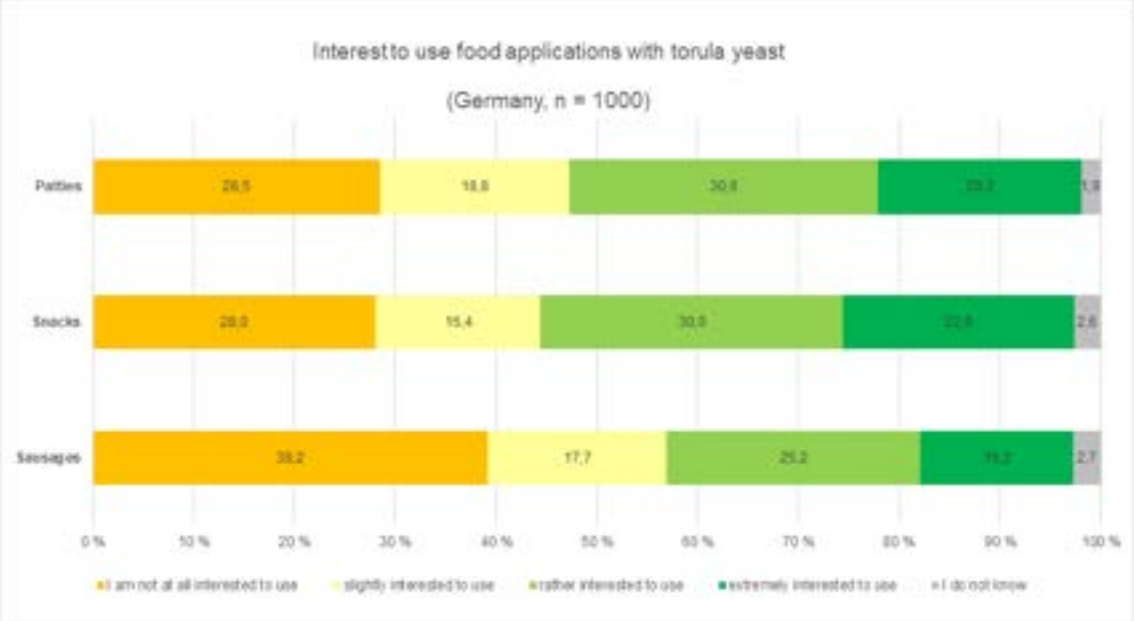


Figure 268 Interest to use the food application examples of NextGen Torula protein. Shares of DE respondents with each answer alternative.

13.7.2 Consumer clusters based on views towards NextGenTorula concept, DE

Consumer segments / clusters were formed as described in the method section, based on the four composite variables measuring acceptance towards NextGen Torula concept. The set of three hierarchical cluster analyses with sub-samples of 33 % of cases, all suggested 3-4 clusters. Subsequent K-means clustering, run with 2 to 4 clusters, confirmed that 4 cluster solution best brings out the differences in the sample.

Table 99 Consumer clusters based on respondents' views towards NextGenProteins torula protein concept. The result of K-means cluster analysis with 4 clusters. DE

	positive	**indifferent**	**negative**	**sceptical**	Total	F	Sig.
Number of cases	250	262	113	246	870		
Percent of cases	28,7 %	30,1 %	12,9 %	28,3 %	100%		
Variables applied as basis of the clustering							
ATT_Torula	4,4	3,0	1,7	3,6	3,4	664,03	.000
Benefits_Torula	4,4	2,9	1,9	3,9	3,5	551,11	.000
RISK_Torula	1,9	2,9	4,1	3,6	3,0	350,43	.000
FOODVIEWS_Torula	4,0	2,8	1,6	3,3	3,1	572,87	.000

The clusters have similar sizes from nearly 30 %, except for the negative cluster. Only 12.9 % of the consumers were grouped into this cluster.

The clusters can be described as positive (28,7 %), indifferent (30,1 %), negative (12,9 %) and sceptical (28,3 %). The main differences between indifferent and sceptical cluster are, that the sceptical cluster rated significantly higher in benefit perception, but also in risk perception and food views. They seem to be more positive than the indifferent ones, but also sense the torula as risky.

13.7.2.1 Demographic profile and eating habits of NextGenProteins torula consumer clusters, DE

The demographic characteristics of the clusters are summarised below. Table 100 shows more details of the clusters.

Positive cluster: 28,7 %

- Slightly more women
- 56,4 % older than 45 years
- High proportion of tertiary education
- High proportion of vegetarian / vegans

Indifferent cluster: 30,1 %

- Slightly more men
- Nearly half of them are younger than 45 years
- Mainly secondary education

- Mainly omnivores, only a few vegetarians / vegans

negative cluster: 12,9 %

- Slightly more women
- 75 % older than 45 years
- Highest proportion of primary education, even though the majority are in secondary education
- low proportion of vegetarian / vegans

sceptical cluster: 28,3 %

- gender-balanced
- Nearly half of them are younger than 45 years, highest proportion in the age range 18 – 24 years
- Mainly secondary education, but second highest proportion with tertiary education
- Mainly omnivores, only a few vegetarians / vegans

Table 100 Demographic and other characteristics of consumer clusters of NextGenProtein torula concept, Germany

	4 Cluster TORULA						
	positive	**indifferent**	**negative**	**sceptical**	Pearson Chi^2	Sign.	Total N
Gender					**1,60**	**ns**	**870**
male	48,0%	**52,8%**	47,2%	50,4%			
female	**52,0%**	47,2%	**52,8%**	49,6%			
	100,0%	*100,0%*	*100,0%*	*100,0%*			
Age Groups					**43,07**	**,000[a,*]**	**870**
18-24 years	7,3%	8,8%	2,7%	12,5%			
25-34 years	17,6%	17,2%	9,0%	19,9%			
35-44 years	18,7%	23,3%	13,2%	14,9%			
45-54 years	23,5%	23,7%	26,8%	20,5%			
55-64 years	13,2%	17,2%	20,9%	15,8%			
65-75 years	19,7%	9,9%	**27,4%**	16,3%			
total	*100,0%*	*100,0%*	*100,0%*	*100,0%*			
Living Area					**16,61**	**0,06**	**870**
I live in the capital city / area	13,5%	12,6%	14,0%	13,2%			
I live in a large city that is not in the capital area	30,4%	22,4%	27,3%	30,8%			
I live in a small city/town or municipality	39,7%	40,2%	32,0%	29,6%			
I live in a rural area	16,4%	24,8%	26,7%	26,4%			
total	*100,0%*	*100,0%*	*100,0%*	*100,0%*			
Education_DE					**36,080**	**,000[a,*]**	**870**
Basic education	1,2%	4,5%	9,7%	4,1%			
secondary education	60,9%	72,3%	65,2%	62,5%			
tertiary education	37,9%	22,0%	22,5%	32,2%			

something else	0,0%	1,1%	2,6%	1,2%			
total	*100,0%*	*100,0%*	*100,0%*	*100,0%*			
Eating habits					**34,830**	**,000[a,*]**	**866**
omnivore	60,5%	74,4%	82,9%	65,5%			
meat sometimes or no red meat	26,7%	21,8%	15,3%	28,0%			
vegetarians and vegans	12,8%	3,8%	1,8%	6,5%			
total	*100,0%*	*100,0%*	*100,0%*	*100,0%*			
Type of Household					**5,600**	**ns**	**874**
no children	67,7%	64,9%	69,5%	66,1%			
1-2 with children	32,3%	35,1%	30,5%	33,9%			
something else	0,0%	0,0%	0,0%	0,0%			
total	*100,0%*	*100,0%*	*100,0%*	*100,0%*			

13.7.2.2 Attitudinal background of NextGen Torula clusters, DE

Significant differences between the clusters exist in familiarity with alternative and future proteins. In both variables the sceptical and the positive clusters rated higher than the negative or the indifferent cluster (see Figure 269). That is, the sceptical and positive consumers seem to be more familiar with alternative and novel proteins than the other consumers. Not significant is the different in the use of salty snacks and meat convenience products. This is very similar in all clusters. However, the use of vegetarian products reflects also the eating habits. In the positive and sceptical cluster there tends to be more vegetarians and vegans than in the other clusters. Thus, the use of vegetarian convenience food is much higher than in the other clusters.

A deeper attitudinal background is shown in Figure 270. Except for the trust in actors of food chain, all background variables differ significantly between the groups. In meat attachment the negative and indifferent rated much higher, which reflects the higher use of meat in their diet. In relation to new food technologies, cluster sceptical and positive tend to be more neophilic than the other clusters. In case of taste neophobia, the negative cluster seem to be most neophobic, whereas the positive cluster seem to be more neophilic. Simillar to the ratings for new food technologies, food innovativeness (interest in new food products) is higher in the positive and sceptical than in the negative or indifferent clusters (see Figure 270).

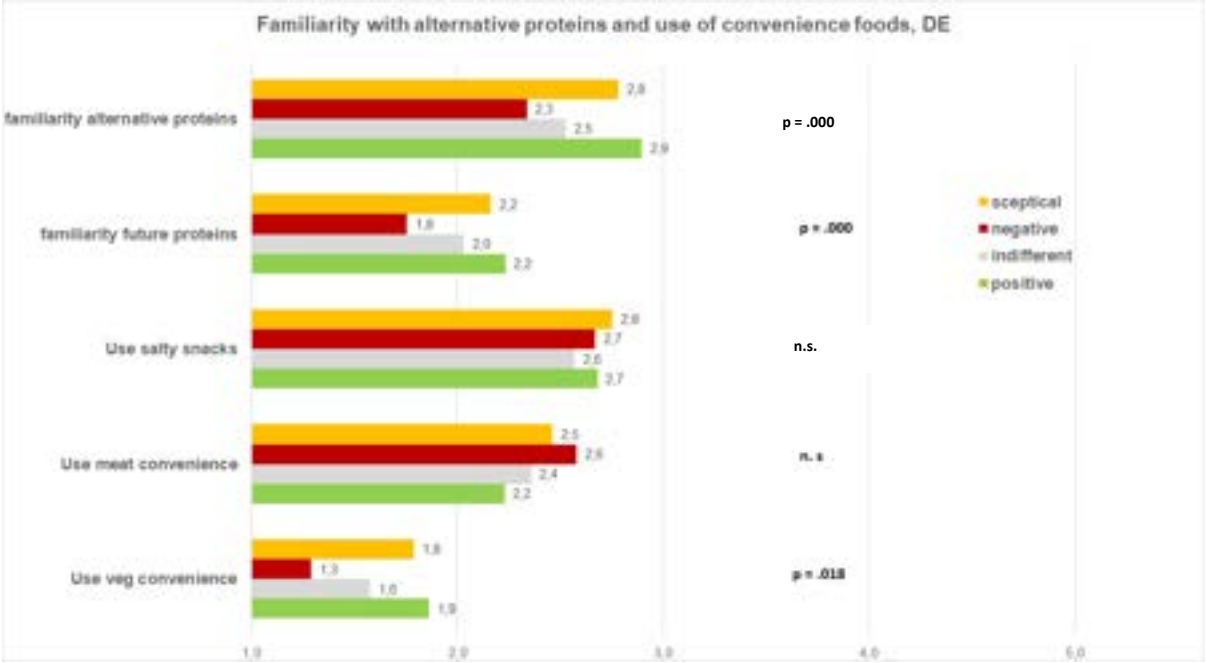


Figure 269 familiarity with alternative proteins by NextGen protein torula consumer clusters in the DE sample. Means. (The level of significance of differences in means between the clusters is marked; ns = no significant differences).

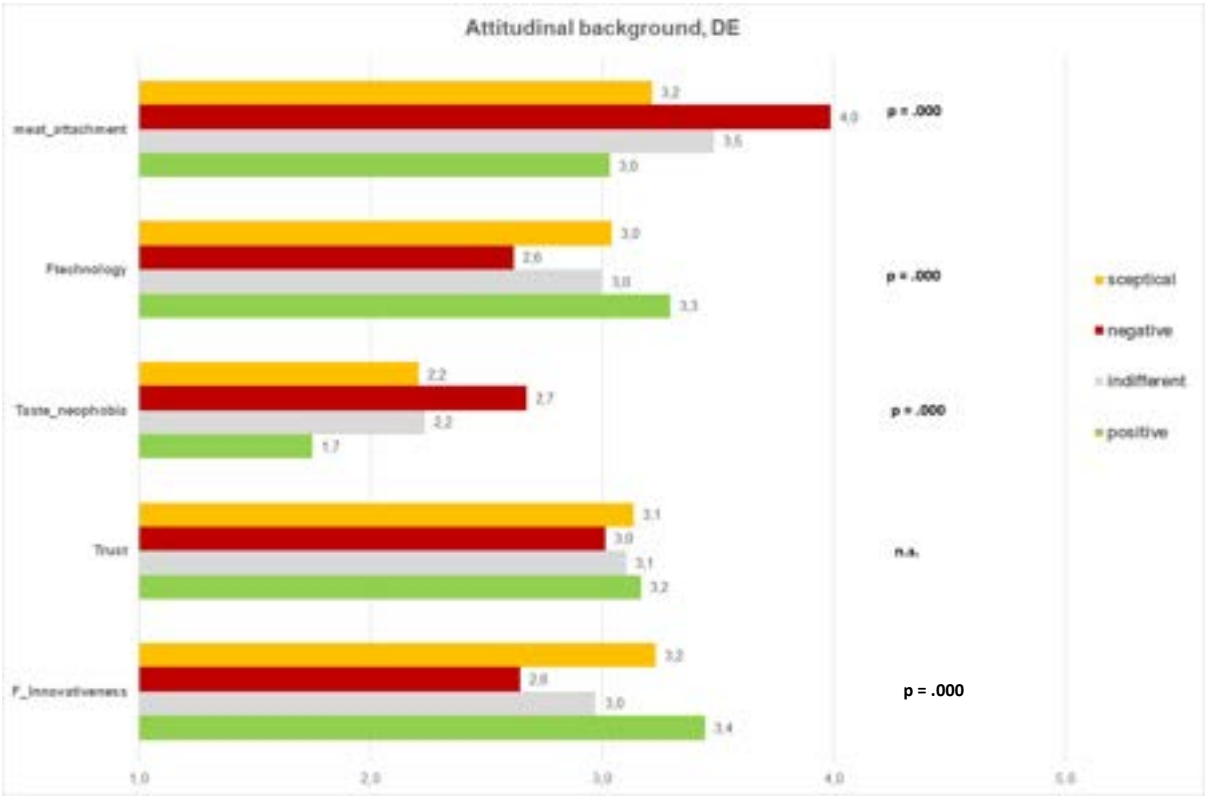


Figure 270 Means of background attitudes compared between the three clusters (based on their views on NextGenProtein toula concept) in Germany.

The consumer clusters for NextGen torula protein significantly differ in terms of what they generally value in their food choices. In the sceptical and positive clusters, environmental sustainability naturalness and healthiness of food were more important than in the the other clusters. Negative and indifferent tend to evaluate similar (see Figure 271 below).

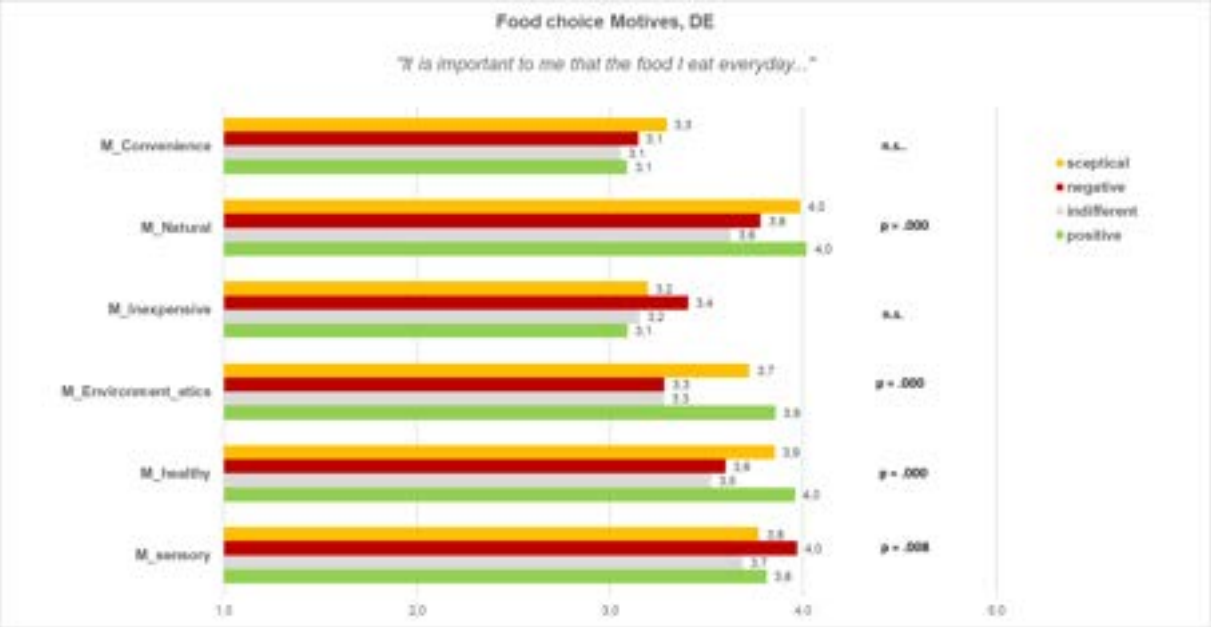


Figure 271 Means of background attitudes compared between the three clusters (based on their views on NextGenProtein torula concept) in Germany.

13.7.2.3 Interest to use the food applications by NextGen Torula consumer clusters, DE

Like in the case of the other NextGen concepts, German respondents' interest to use the three example food applications was highest in the positive cluster, and second highest in the sceptical cluster.

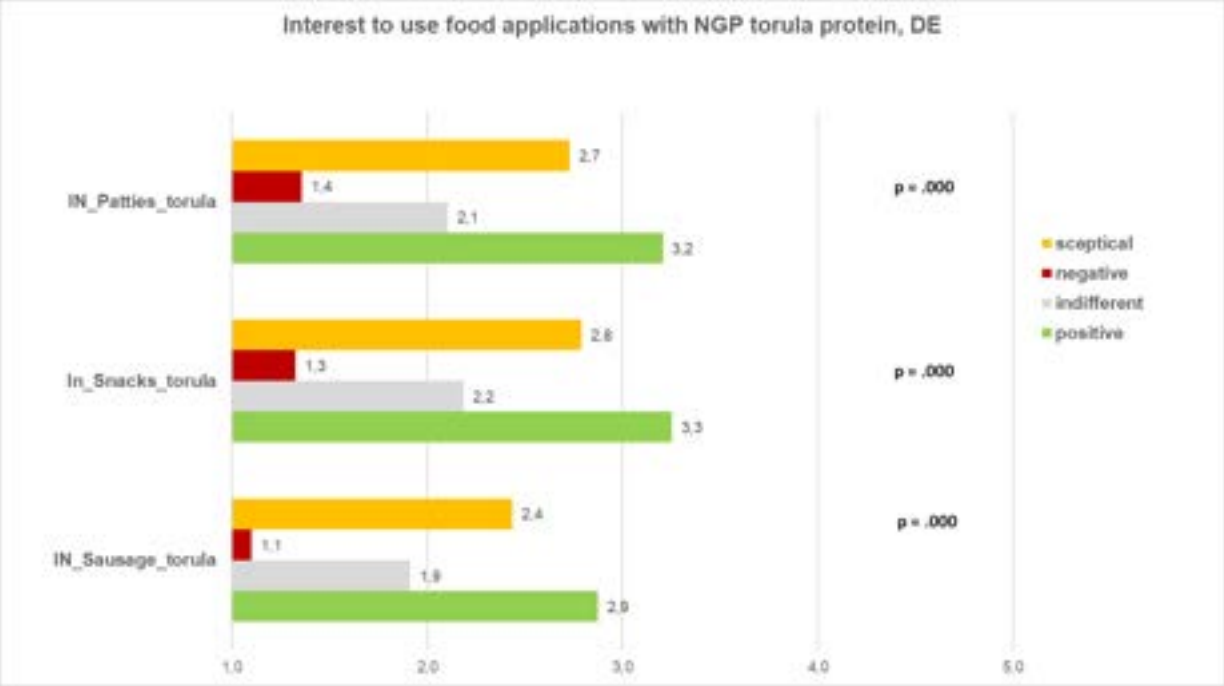


Figure 272 Figure 29 Mean interest to use the examples of NextGenProtein insect food applications compared between the NextGen torula clusters in Germany

14 Appendix B7 – ICELAND survey report

14.1 Summary of results from Iceland (IS)

The Icelandic respondents reflected to the population in Iceland with regard to gender, living area and education. However, the age distribution was skewed towards higher age.

Majority of the Icelandic respondents are omnivorous (85%). Although use of convenience food is generally not frequent as 70-75%, consume sausages, minced meat burgers or meatballs only several times a year or less frequently, vegetarian based convenience food types are even more rarely used as 86-96% of the respondents do not consume such foods more often than several times per year. This is in line with dietary habits of the respondents. **Only 15% claimed they aimed to or avoid the use of products of animal origin. Environmental concerns followed by animal welfare were main reasons doing so**.

Familiarity with alternative protein foods, except for legumes, is rather rare among the Icelandic respondents and about 90% of the respondents had not heard of or not tried foods made with insects or fungi-based ones. Similarly, familiarity with future protein ingredients was rare. Less than 10% were familiar with or knew a lot about any of the future protein ingredients mentioned, such as cell-cultured meat.

Regarding consumers' trust in food chain actors, **retailers seem to be the least trusted** (only 26% of respondents claimed they have lot of or very much trust in retailers) and the food industry in general and regulatory and supervising authorities are not well trusted (about 35% have lots of or very much trust). However, food scientists and consumer associations are trusted by more consumers (over 50% have lots of or very much trust) **and the primary and small food producers are trusted by most consumers** (over 70% have lots of or very much trust).

Food choicesseem mainly be **driven by health and taste pleasure** among the Icelandic respondents. **Ethical and environmentally friendly production** is important as well to about 50% of the respondents.

The NextGenProteins **insect-based protein ingredient concept** was the **most difficult to accept**, while the **microalgae-based protein concepts was most easily accepted** and interest to use the examples of food applications (sausages, vegetable-protein patties and salty snacks) is lower in the case of NextGenProteins insect protein ingredient, but highest for the microalgae protein ingredient.

The idea of **food** made with the NextGenProteins insect protein material was especially perceived as more repulsive, weird and unhygienic as compared to microalgae and Torula. The difference between the NextGenProteins proteins was less clear for "good for health", as

all three protein types were perceived positive with regard to health. Regardless of the NextGenProteins ingredient type, the respondents were **less interested** in buying NextGenProteins food applications in the form of **sausages** than in the form of **snacks**. However, **Torula and microalgae based sausages** were perceived as **more interesting than meat based sausages**.

Majority are in favour of NextGenProteins **microalgae protein food** ingredient production and the concept was **easily understood** by 50% of the respondents. Majority believe in the **benefits for economy, environment and human health**, while personal benefits are less expected, but though by 45%.

Concerns were related to the honesty and integrity of the food companies (27%) in relation to production and food application of NextGenProtein microalgae protein. Potential risks for the environment or human health caused the least concern and about 50% assumed it was good for health, safe and hygienic, while only 9% assumed it would be bad for health.

Although the attitudes towards the NextGenProteins **insect protein concept are positive among close to 50%** of the Icelandic respondents, 21-26% had negative attitudes. Despite of the few who considered the insect protein concept likely to be beneficial to themselves, about 50% considered it likely to be beneficial to environmental sustainability, and to human health. Also, few considered the insect protein concept likely to contain risk for human health and food safety or unpredicted negative effects on the environment. Main **concern was being misled by food companies**.

Attitudes towards the NextGenProteins Torula protein concept was more positive than for the insect protein concept but not as positive as towards the microalgae protein concept. **Fewer** respondents found this concept **easy to understand**, than microalgae and insect protein concepts. A majority considered the Torula protein concept likely to be beneficial to environmental sustainability, and about 50% thought it would be beneficial to human health, national economy and reduce suffering of livestock. Over 50% considered the Torula protein concept **unlikely to be a risk for human health and food safety or have unpredicted negative effects on the environment**. **Risk of being misled by food companies in relation to use of Torula protein was considered likely** by 34%. The respondents were more unsure about the characteristics of food applications of NextGenProteins Torula protein concept. Still, more than 30% thought such products would be accepted.

Icelandic consumer clustering based on acceptance measures, that is attitudes, believe in benefits, perceived risk and food views of 1) Microalgae, 2) Insect and 3) Torula protein concepts, showed that within each of these concepts, three consumer clusters could be identified, **in all cases, a) negative, b) neutral and c) positive attitudes**.

The consumers within the positive **microalgae cluster**, had very positive view of the microalgae concept. However, the neutral cluster is considered to be slightly positive as well, based on these same attitudes. The negative cluster scored on average, slightly below neutral poins, towards negative views. These clusters varied in several factors, and the **microalgae positive cluster consumers** can be characterised as being (as compared to the negative cluster):

- more likely to be meat reducers and vegetarian, and less meat attached
- more likely to use vegetarian convenience foods
- more likely to be more familiar with alternative and future proteins
- more positive towards food innovation
- more positive towards food technology
- place more emphasises on food environmental and ethical issues in their daily food choices
- much more interested in using food applications with microalgae proteins, regardless of food application type

The consumers within the positive **insect cluster** had rather positive view of the insect concept. The neutral cluster had neutral views, and the negative cluster negative to very negative views. However, insect clusters varied in several factors, and the **insect positive cluster consumers** can be characterised as being (as compared to the negative cluster):

- more likely to have finalised higher education (Tertiary/University level)
- more likely to be less meat attached
- more likely to use vegetarian convenience foods
- more likely to be more familiar with alternative and future proteins
- have a tendency to be more positive towards food innovation
- more positive towards food technology
- less likely to have taste neophobia
- place more emphasises on food environmental and ethical issues in their daily food choices
- place more emphasises on healthy food choices
- much more interested in using food applications with insect proteins, regardless of food application type

The consumers within the positive **Torula cluster** had positive to very positive view of the Torula concept. The neutral cluster had neutral and slightly positive views, and the negative cluster had rather negative views. The Torula consumer clusters varied in several factors, and the **Torula positive cluster consumers** can be characterised as being (as compared to the negative cluster):

- more likely to have finalised higher education (Tertiary/University level)

- more likely to be living in the capital city or capital area
- more likely to be meat reducers or vegetarians
- more likely to be familiar with alternative and future proteins
- more likely to use vegetarian convenience foods
- more likely to use salty snack
- less likely to use meat based convenience foods
- more likely to be less meat attached
- more positive towards food innovation
- more positive towards food technology
- less likely to have taste neophobia
- place more emphasises on food environmental and ethical issues in their daily food choices
- more tendency to place more emphasises on healthy food choices
- much more interested in using food applications with Torula proteins, regardless of food application type

14.2 Participant characteristics, Iceland

14.2.1 Participants' demographics, Iceland

The Icelandic sample consisted of 758 respondents. Respondents answering less than 50% of the questionnaire were omitted (n=127). Therefore, the data set was reduced to 631 respondents (Table 101).

About half of them are male and the other half female. Age distribution is skewed, as proportionally fewer in the younger age groups (18-44y =28%) and more respondents in the older age groups (45-87y =72%) completed the survey compared to actual age distribution of the Icelandic population within 18-44y (39%) and 45-87y (38%) (Statistics Iceland, 2021). Majority of the respondents live in the Capital city or area, representative of the inhabitation in Iceland. About half the respondents have university education, whereas close to 30% have basic education or lower. Children are included in households of close to 40% of the respondents.

Table 101. Demographic background of Icelandic respondents

	Count	Percent
Gender		
1. male	313	49,6%
2. female	318	50,4%
3. other / prefer not to say	0	0,0%
missing answer	0	0,0%
Total	*631*	*100,0%*

Age group		
1. 18 - 24 Years	22	3,5%
2. 25 - 34 Years	66	10,5%
3. 35 - 44 Years	88	13,9%
4. 45 - 54 Years	106	16,8%
5. 55 - 64 Years	130	20,6%
6. 65 - 75 Years	170	26,9%
7. 76 - 87 Years	49	7,8%
Total	*631*	*100,0%*
Type of living area		
1. Capital city / area	391	62%
2. Town with more than 2.500 inhabitants not a part of the capital area	112	18%
3. Town or municipality with less than 2.500 inhabitants not a part of the capital area	98	16%
4. Rural area	30	5%
Total	*631*	*100%*
Region in Iceland		
1. Capital area	393	62%
2. Reykjanes Penisula	45	7%
3. West region	40	6%
4. Westfjords	7	1%
5. North-West region	14	2%
6. North-East region	59	9%
7. East region	22	3%
8. South region	51	8%
Total	*631*	*100%*
Education		
1. Basic education or lower	53	8%
2. Secondary education	235	37%
3. Diploma university level	37	6%
4. University level (BA, BS or comparable)	144	23%
5. Higher university level (MA, MS, PhD or comparable)	140	22%
6. Something else	10	2%
Don’t know/Don’t answer	12	2%
Total	*631*	*100%*
Education_3		
1. Basic education or lower	170	28%
2. Secondary education	155	25%
3. University level	284	47%
Total	*609*	100%
Household type		
1. I live at home with my parents	15	2%
2. I live alone	93	15%

3. I live alone with my child / children	35	6%
4. I live with my spouse	274	43%
5. I live with my spouse and child / children	198	31%
6. I live with other adults (other than spouse or family members)	10	2%
Other	2	0%
Prefer not to say	4	1%
Total	*631*	*100%*
Household_Children/no children		
No children (options 2 and 4)	*367*	*59%*
With children (options 3 and 5)	*233*	*37%*
Other (options 1 and 6 – 7)	*27*	*4%*
Total	*627*	*100%*

14.2.2 Participants' dietary habits and attitudinal background, Iceland

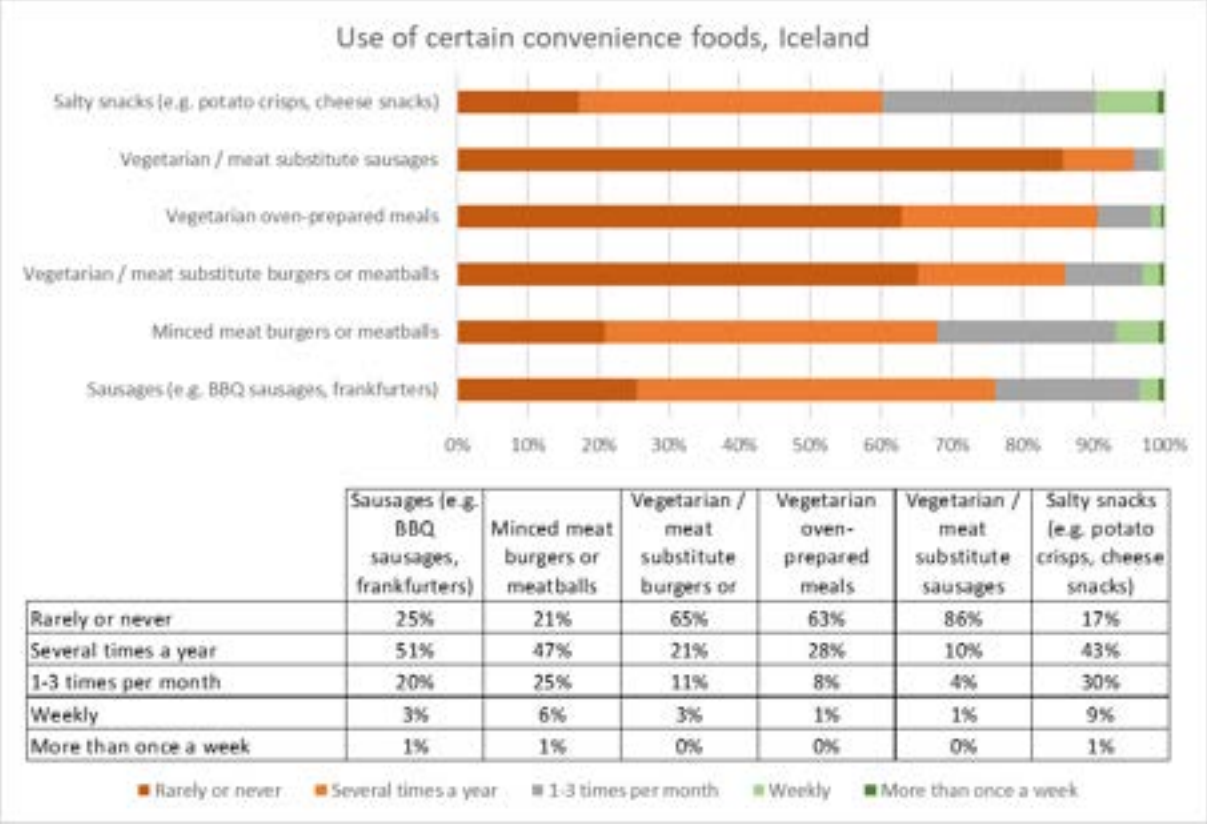
Majority of the Icelandic respondents are omnivorous (85%) and additional 10% sometimes consume meat or avoid consumption of red meat (Table 102). Only 15% claim they aim to, or avoid the use of products of animal origin. Reasons for doing so are mainly environmental concerns (48% as main reason, 43% as second most important reason) and animal welfare (34% as main reason, 33% as second most important reason).

Table 102. Dietary habits of respondents in Iceland

	Count	Percent
Diet		
1. I regularly eat products of animal origin and non-animal origin (omnivorous)	539	85%
2. I only eat meat sometimes (e.g. beef. pork. poultry. fish. seafood)	43	7%
3. I avoid red meat consumption (e.g. beef or pork) but eat other meat products like chicken or fish	19	3%
4. I do not eat meat (e.g. beef. pork or poultry) but I eat fish (I'm a pesco-vegetarian)	6	1%
5. I do not eat meat (e.g. beef. pork. poultry or fish) but I eat other products of animal origin (e.g. eggs. cheese. milk	4	1%
6. I do not eat any meat. eggs or dairy products (I'm a vegetarian)	3	0%
7. I do not eat anything of animal origin (I'm a vegan)	10	2%
8. Something else	7	1%
Total	*631*	*100%*
Diet_3		
1. Omivore (option 1)	539	85%
2. Meat sometimes / no red meat (options 2-3)	62	10%
3. Vegetarian (options 5-7)	17	3%
4. Something else (options 4, 70)	13	2%
Total	*631*	*100%*
Do you intentionally aim to reduce meat consumption? (question was targeted to respondents who described their diet with options 1 - 2 above)		

1. Yes	85	15%
2. No	466	85%
Total	551	*100%*
Main reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability. climate change	57	48%
2. Ethics. animal welfare	40	34%
3. High price of meat	5	4%
4. Taste and texture of meat	17	14%
Total	119	*100%*
Second most important reasons for reducing or avoiding the use of products of animal origin?		
1. Environmental sustainability. climate change	40	43%
2. Ethics. animal welfare	31	33%
3. High price of meat	18	19%
4. Taste and texture of meat	4	4%
Total	*93*	*100%*

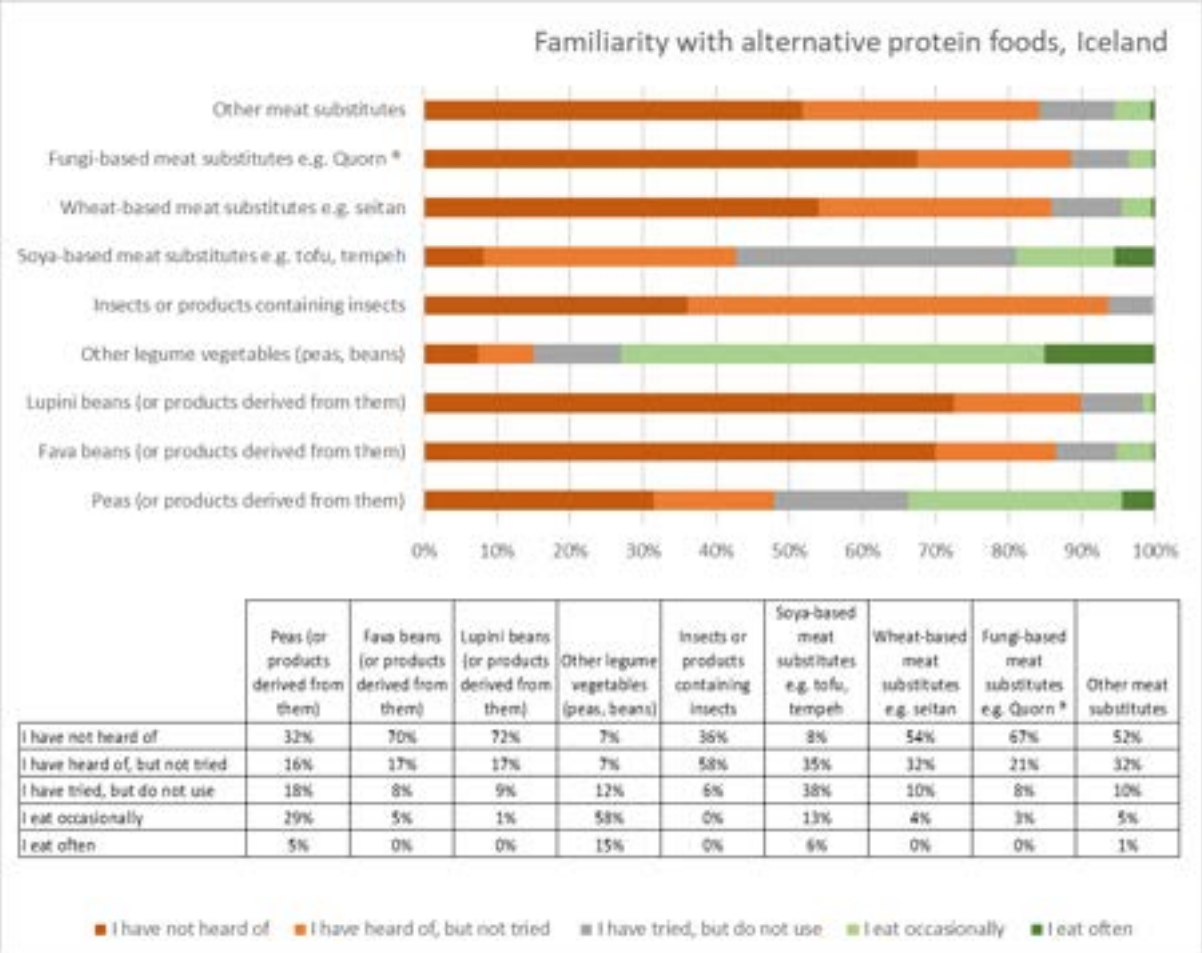
Use of convenience food is generally not frequent among the Icelandic respondents, at least not the foods listed in the NextGenProteins online consumer survey. A 60-96%, consume the types of certain convenience foods several times a year or less frequently (Figure 273). Vegetarian based convenience food types are rarely used as 86-96% of the respondents consume such foods. This is in line with dietary habits of the respondents, as only 10% sometimes consume meat or avoid consumption of red meat (Table 102).



	Sausages (e.g. BBQ sausages, frankfurters)	Minced meat burgers or meatballs	Vegetarian / meat substitute burgers or	Vegetarian oven-prepared meals	Vegetarian / meat substitute sausages	Salty snacks (e.g. potato crisps, cheese snacks)
Rarely or never	25%	21%	65%	63%	86%	17%
Several times a year	51%	47%	21%	28%	10%	43%
1-3 times per month	20%	25%	11%	8%	4%	30%
Weekly	3%	6%	3%	1%	1%	9%
More than once a week	1%	1%	0%	0%	0%	1%

Figure 273. Use of certain convenience foods by the Icelandic respondents (n = 630, 629, 629, 631, 629, 629 for each column respectively)

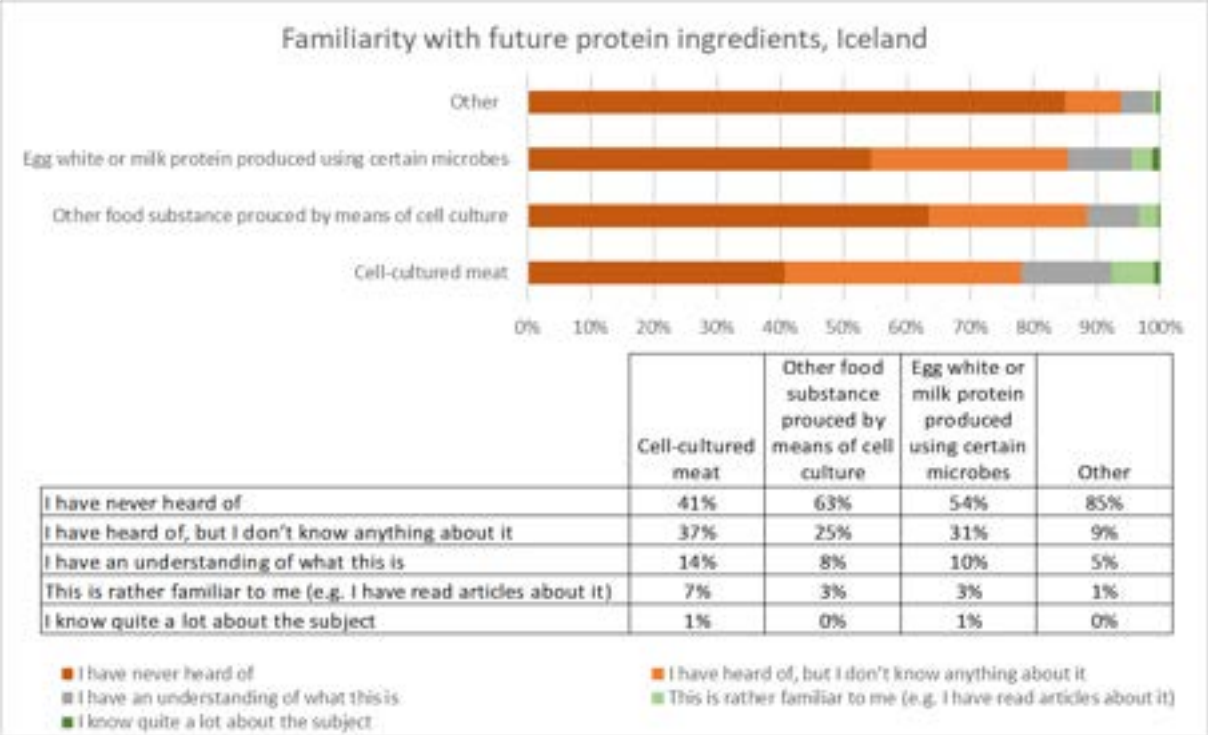
Familiarity with alternative protein foods is rather rare among the Icelandic respondents (Figure 274). About 90% of the respondents had not heard of or not tried foods made with Lupini beans, insects or fungi-based ingredients.



	Peas (or products derived from them)	Fava beans (or products derived from them)	Lupini beans (or products derived from them)	Other legume vegetables (peas, beans)	Insects or products containing insects	Soya-based meat substitutes e.g. tofu, tempeh	Wheat-based meat substitutes e.g. seitan	Fungi-based meat substitutes e.g. Quorn ®	Other meat substitutes
I have not heard of	32%	70%	72%	7%	36%	8%	54%	67%	52%
I have heard of, but not tried	16%	17%	17%	7%	58%	35%	32%	21%	32%
I have tried, but do not use	18%	8%	9%	12%	6%	38%	10%	8%	10%
I eat occasionally	29%	5%	1%	58%	0%	13%	4%	3%	5%
I eat often	5%	0%	0%	15%	0%	6%	0%	0%	1%

Figure 274. Icelandic respondents' previous familiarity with alternative protein sources and meat substitutes made of these (n = 622, 628, 628, 629, 624, 628, 626, 629, 625 for each column respectively)

Similarly, familiarity with future protein ingredients was rare among the Icelandic respondents (Figure 275). While 41% had never heard of cell-cultured meat, 63% had never heard of egg white or milk protein produced using certain microbes. Less than 10% were familiar with or knew a lot about any of the future protein ingredients mentioned.



	Cell-cultured meat	Other food substance prouced by means of cell culture	Egg white or milk protein produced using certain microbes	Other
I have never heard of	41%	63%	54%	85%
I have heard of, but I don't know anything about it	37%	25%	31%	9%
I have an understanding of what this is	14%	8%	10%	5%
This is rather familiar to me (e.g. I have read articles about it)	7%	3%	3%	1%
I know quite a lot about the subject	1%	0%	1%	0%

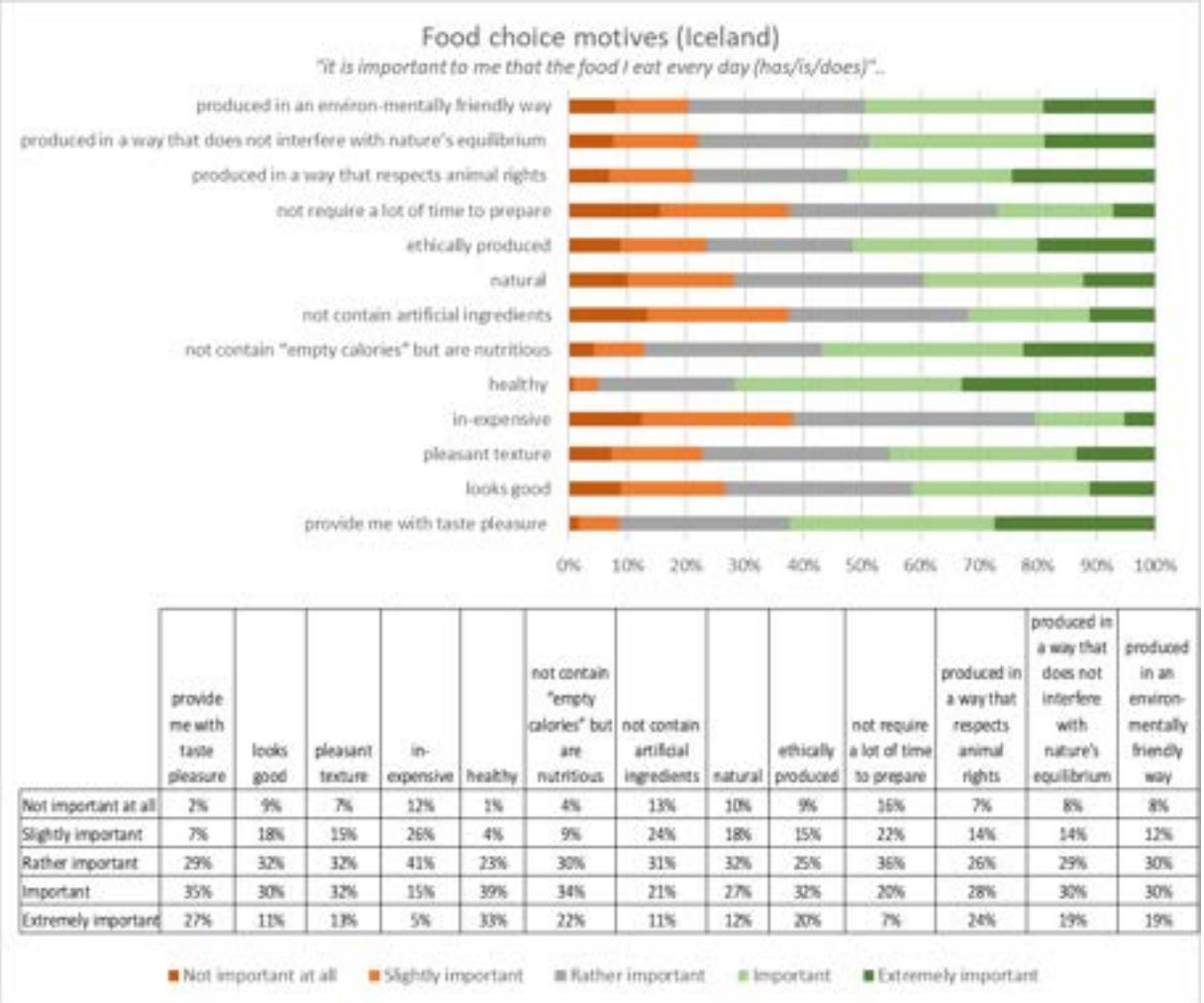
Figure 275. Familiarity with future (emerging) protein sources, Iceland (n = 535, 534, 533, 489 for each column respectively)

Retailers seem to be least trusted by the Icelandic respondents (Figure 276), as only 26% of respondents claimed they have lot of or very much trust in retailers. Primary and small food producers are more trusted (over 70% have lots of or very much trust) than the food industry in general and regulatory and supervising authorities (about 35% have lots of or very much trust). Over 50% have lots of or very much trust in food scientists and consumer associations.

	Primary food producers (farmers)	Small food producers	Food industry	Regulatory and supervising authorities	Food scientists	Retailers	Consumer associations
Don't trust/very little trust	2%	1%	2%	5%	2%	5%	4%
Some trust	2%	2%	10%	15%	6%	17%	7%
Moderate trust	21%	26%	52%	45%	36%	53%	36%
Lot of trust	39%	44%	29%	27%	44%	22%	37%
Very much trust	35%	27%	7%	8%	12%	3%	17%

Figure 276. Trust in various actors of food chain in the Icelandic sample (n = 625, 622, 621, 621, 618, 618, 618 in each column respectively)

Food choice motives seem mainly be driven by health and taste pleasure among the Icelandic respondents as 72% and 62% claim these motives to be important or extremely important (Figure 277). Ethical and environmentally friendly production is important or extremely important to about 50% of the respondents.



	provide me with taste pleasure	looks good	pleasant texture	in-expensive	healthy	not contain "empty calories" but are nutritious	not contain artificial ingredients	natural	ethically produced	not require a lot of time to prepare	produced in a way that respects animal rights	produced in a way that does not interfere with nature's equilibrium	produced in an environ-mentally friendly way
Not important at all	2%	9%	7%	12%	1%	4%	13%	10%	9%	16%	7%	8%	8%
Slightly important	7%	18%	15%	26%	4%	9%	24%	18%	15%	22%	14%	14%	12%
Rather important	29%	32%	32%	41%	23%	30%	31%	32%	25%	36%	26%	29%	30%
Important	35%	30%	32%	15%	39%	34%	21%	27%	32%	20%	28%	30%	30%
Extremely important	27%	11%	13%	5%	33%	22%	11%	12%	20%	7%	24%	19%	19%

Figure 277. Perceived importance of food values (food choice motives) in the Icelandic sample (n = 630, 630, 629, 629, 630, 618, 624, 626, 617, 627, 616, 614, 620 in each column respectively)

14.3 Forming the composite variables, Iceland

14.3.1 New variables describing respondents' background attitudes, Iceland

Factor analyses were performed to check the dimensionality of items for each scale. Table 103. describes the formation of composite variables and their reliabilities. Cronbach Alpha between 0.74 and 0.88 were obtained.

Table 103.Composite variables describing Icelandic respondents' background attitudes. The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	The scale has been calculated as mean of items	Cronbach Alpha
Familiarity_alt	Familiarity with alternative proteins	Q4r1, Q4r2 ,Q4r3, Q4r4, Q4r5, Q4r6, Q4r7, Q4r8, Q4r9	.74
Familiarity_fut	Familiarity with future proteins	Q30r1, Q30r2, Q30r3	,82
Trust	Trust in food chain actors	Q8r1, Q8r2, Q8r3, Q8r4, Q8r5, Q8r6, Q8r7	.77
FTechnology_attitude	Attitude towards new food technology	Q9r1, Q9r4, Q9r5, Q9r2_REV, Q9r3_REV, Q9r6_REV, Q9r7_REV	.81
Meat_attachment	Attachment to meat eating	Q7r1, Q7r2, Q7r4, Q7r5, Q7r6, Q7r3_REV, Q7r8_REV	.88
Taste_neophobia	Tendency to avoid novel foods because of taste neophobia	Q10r1, Q10r2, Q10r3, Q10r4, Q10r5	.88
F_innovativeness	Food innovativeness (interest in new food products)	(all items) Q11r1_REV, Q11r2, Q11r3, Q11r4	.76
Use_vege_convemience	Mean frequency of use of vegetarian convenience foods	Q5r3, Q5r4, Q5r5	.75
Use_meat_convenience	Mean frequency of use of meat based convenience foods	Q5r1, Q5r2	.75

14.3.2 New variables measuring acceptance of the three NextGen concepts, Iceland

Factor analyses were performed to check the dimensionality of items for each scale. Table 104. describes the formation of composite variables to measure acceptance of the NextGen concepts as well as the reliabilities of resulting variables. Cronbach Alpha between 0.83 and 0.94 were obtained.

Table 104. Composite variables describing Icelandic respondents' acceptance of the three NextGenProteins concepts. The measurement scale for all the listed composite variables is 1 – 5.

Composite variables	Explanation	Cronbach Alpha
ATTITUDES	mean of 3 items (difficult – easy to understand – item not included)	
ATT_Algae	Attitude towards NextGenProteins microalgae protein	.94
ATT_Insect	Attitude towards NextGenProteins insect protein	.91
ATT_Torula	Attitude towards NextGenProteins Torula protein	.92
PERCEIVED BENEFITS	mean of all 5 items	
BENEFIT_Algae	Perception of benefits from NextGenProteins microalgae protein	.92
BENEFIT_Insects	Perception of benefits from NextGenProteins insect protein	.89
BENEFIT_Torula	Perception of benefits from NextGenProteins Torula protein	.91
PERCEIVED RISKS	mean of 3 items, "other risk" not included	
RISK_Algae	Perception of risk relating to production of NextGenProteins microalgae proteins	.83
RISK_Insects	Perception of risk relating to production of NextGenProteins insect proteins	.85
RISK_Torula	Perception of risk relating to production of NextGenProteins Torula proteins	.84
FOOD APPLICATION VIEWS	mean of all the 7 items	
FOODVIEWS_Algae	Views towards foods made with NextGenProteins microalgae protein	.94
FOODVIEWS_Insect	Views towards foods made with NextGenProteins insect protein	.93
FOODVIEWS_Torula	Views towards foods made with NextGenProteins microalgae protein	.94

14.4 Comparison of the three NextGen protein production concepts and applications, Iceland

14.4.1 Which of the NextGen concepts is most positively viewed in Iceland?

Out of the three NextGenProteins concepts, the one with insect-based protein ingredient was clearly the most difficult to accept, while the microalgae-based protein concepts was most easily accepted in Iceland (Figure 278, Table 105). All the acceptance measures suggest the same result: attitudes towards NextGenProteins insects are more negative, respondents have in average lower belief in the benefits of it and higher risk concerns. They expect the quality of food products be lower i the food is made with NextGenProteins insect protein ingredient vs. the other two NextGenProteins protein ingredients. Finally, the mean interest to use the examples of food applications (sausages, vegetable-protein patties and salty snacks) is lower in the case of NextGenProteins insect protein ingredient, but highest for the microalgae protein ingredient.

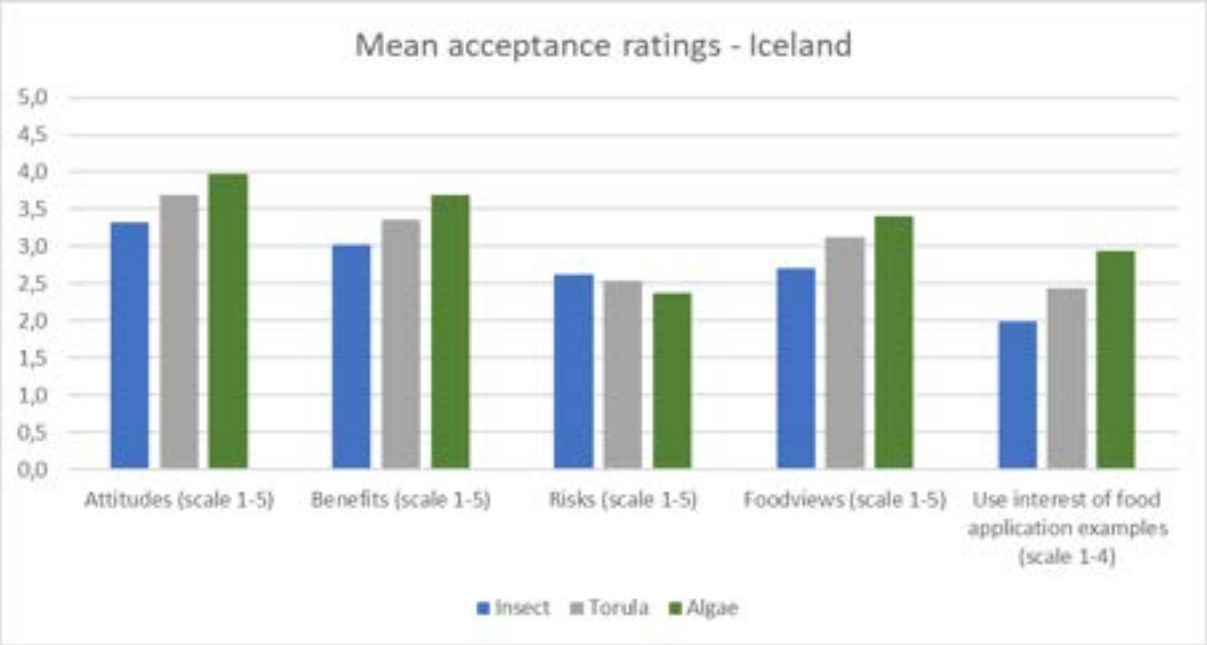


Figure 278. Means of composite variables measuring acceptance towards each of the three NextGenProteins protein concept in Icelandic sample.

Table 105. Differences in means of acceptance ratings (composite variables) between the three NextGenProteins protein concepts tested with repeated measures analysis of variance. Iceland

Composite variables:	Insect	Torula	Microalgae	df	F	Sig.
Attitudes (scale 1-5)	3.3	3.7	4.0	2	45.67	.000
Benefits (scale 1-5)	3.0	3.4	3.7	2	42.38	.000
Risks (scale 1-5)	2.6	2.5	2.4	2	7.22	.001
Foodviews (scale 1-5)	2.7	3.1	3.4	2	79.40	.000
Use interest of food application examples (scale 1-4)	2.0	2.4	2.9	2	57.76	.000

The respondents in Iceland expected the insect based NextGenProteins protein food applications[6] to be of inferior quality compared to those based on the microalgae or Torula (Table 106, Figure 279). The idea of food made with the NextGenProteins insect protein material was especially perceived as more repulsive, weird and unhygienic than microalgae and Torula. The difference between the NextGenProteins proteins was less clear for "good for health", as all three protein types were perceived positive with regard to health. Worthy of notice is that microalgae was the most positively perceived of the three protein ingredients.

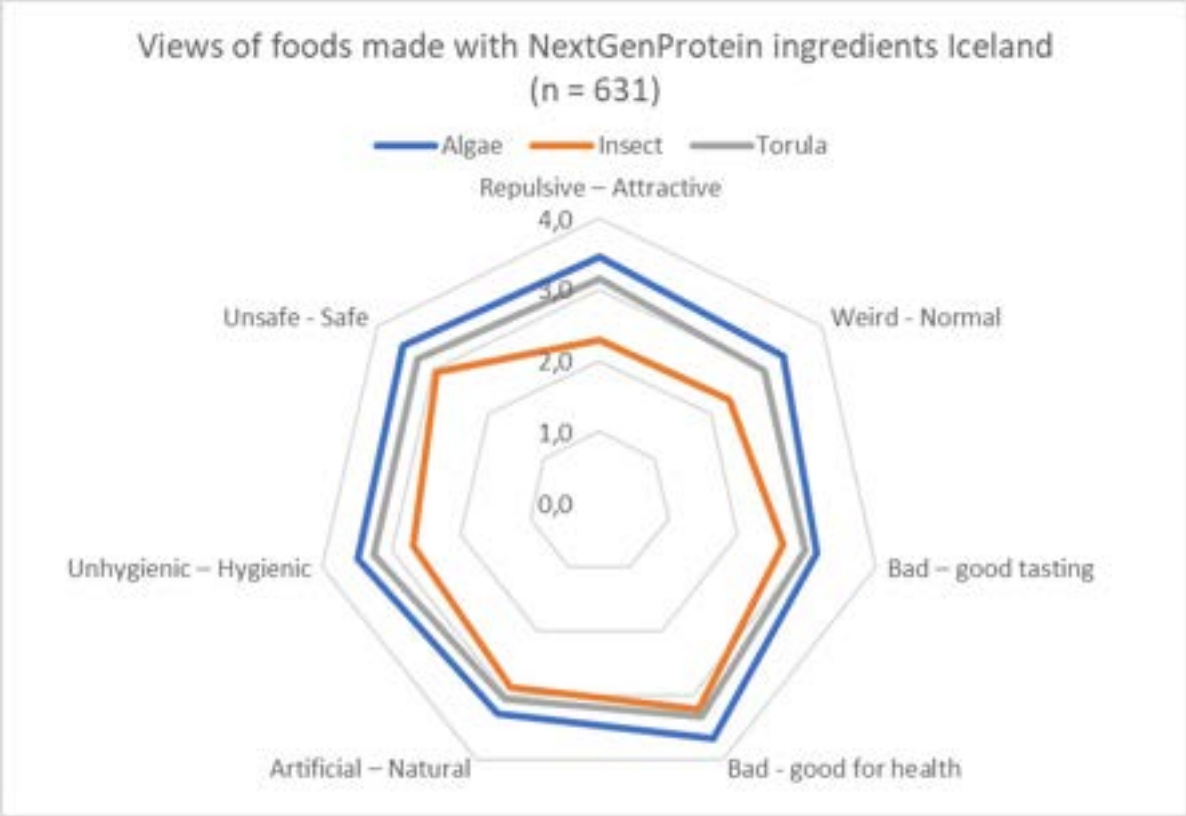


Figure 279. Means of assumed characteristics of imaginary food applications by Icelandic respondents

[6] The questions Q15, Q20 and Q25 asked the respondents to consider (imagine) any food products that would be made using this ingredient as one of the raw ingredients.

Table 106. Means of assumed characteristics of imaginary food applications in the Icelandic sample (food application views, questions Q15, Q20 and Q25, scale 1 – 5). Significance of differences in means between the NextGenProteins ingredients tested with repeated measures analysis of variances.

Food application views	Microalgae	Insect	Torula	df	F	Sig.
Repulsive – Attractive	3.45	2.28	3.14	2	157.38	.000
Weird - Normal	3.31	2.33	2.98	2	105.19	.000
Bad – good tasting	3.14	2.65	2.97	2	39.01	.000
Bad - good for health	3.68	3.22	3.34	2	27.79	.000
Artificial – Natural	3.29	2.88	3.06	2	17.22	.000
Unhygienic – Hygienic	3.49	2.68	3.25	2	75.84	.000
Unsafe - Safe	3.54	2.94	3.26	2	38.56	.000

14.4.2 What is the most interesting food application of NextGen proteins in Iceland?

Regardless of the NextGenProteins ingredient type, the respondents tended to be less interested in buying NextGenProteins food applications in the form of sausages than in the form of snacks. However, the differences between the product types were not significant, like in the other countries (Figure 280). In the case of all food types, the ones with insect -based protein were always rated as less interesting to use. Interestingly, sausages made with NextGen microalgae or torula protein appears more interesting than meat based sausages (significance not tested) (Figure 280, Figure 281).

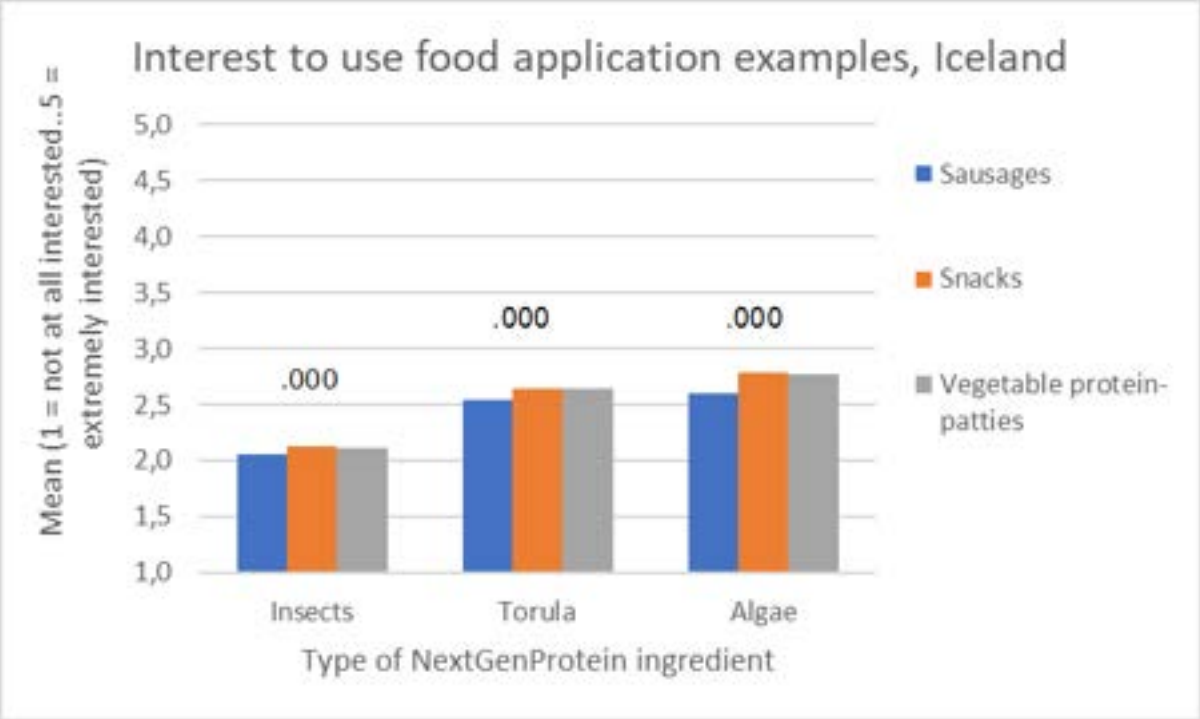


Figure 280. Means of interest to use the examples NextGenProteins food applications by product type and NextGenProteins ingredient type in Iceland. Significance of differences in means between the food types.

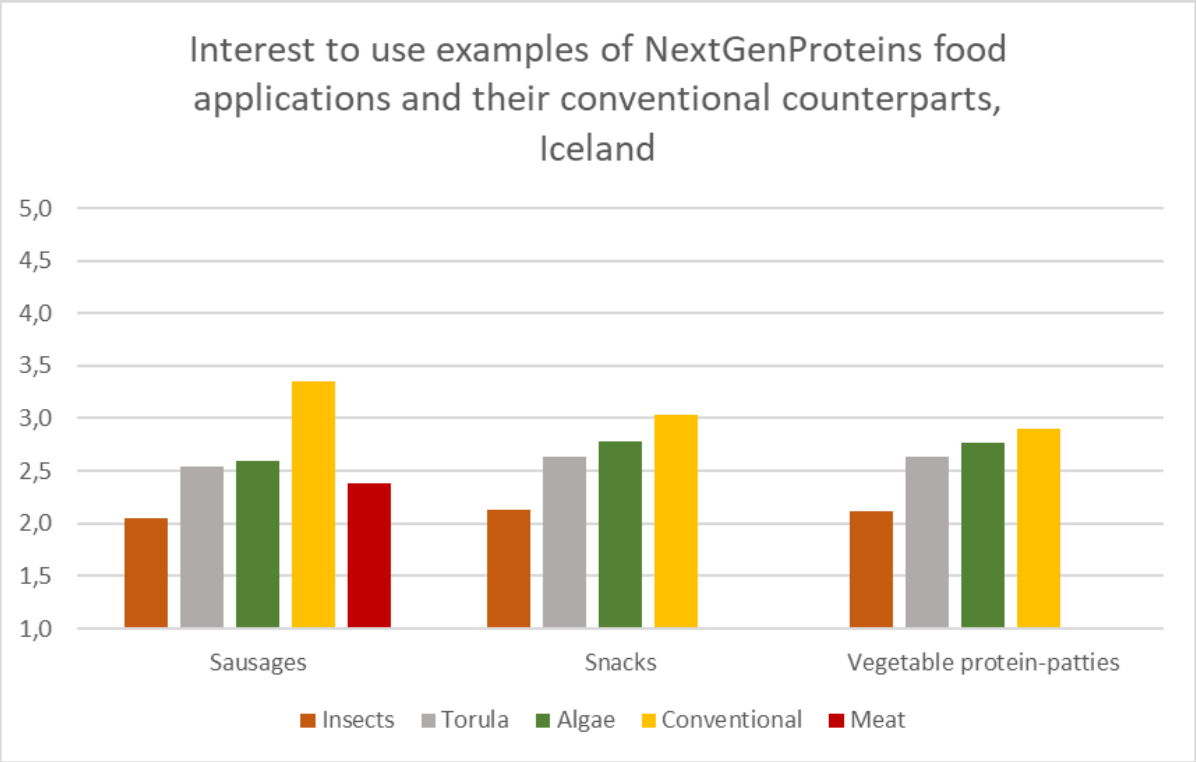


Figure 281. Means (1 =not at all interested…5=extremely interested) of use interest of the examples of NextGenProteins food applications and their conventional counterparts in Iceland.

14.5 Acceptance of NextGen Microalgae concept, Iceland

14.5.1 The level of acceptance of NextGen microalgae concept, Iceland

About 65% of the Icelandic respondents are in favour of the idea of production of NextGenProteins microalgae protein food ingredient and less than 10% are against the idea (Figure 282). These attitudes were well reflected in the that majority thought this was a wise and good idea. Over 50% considered the concept easy to understand.

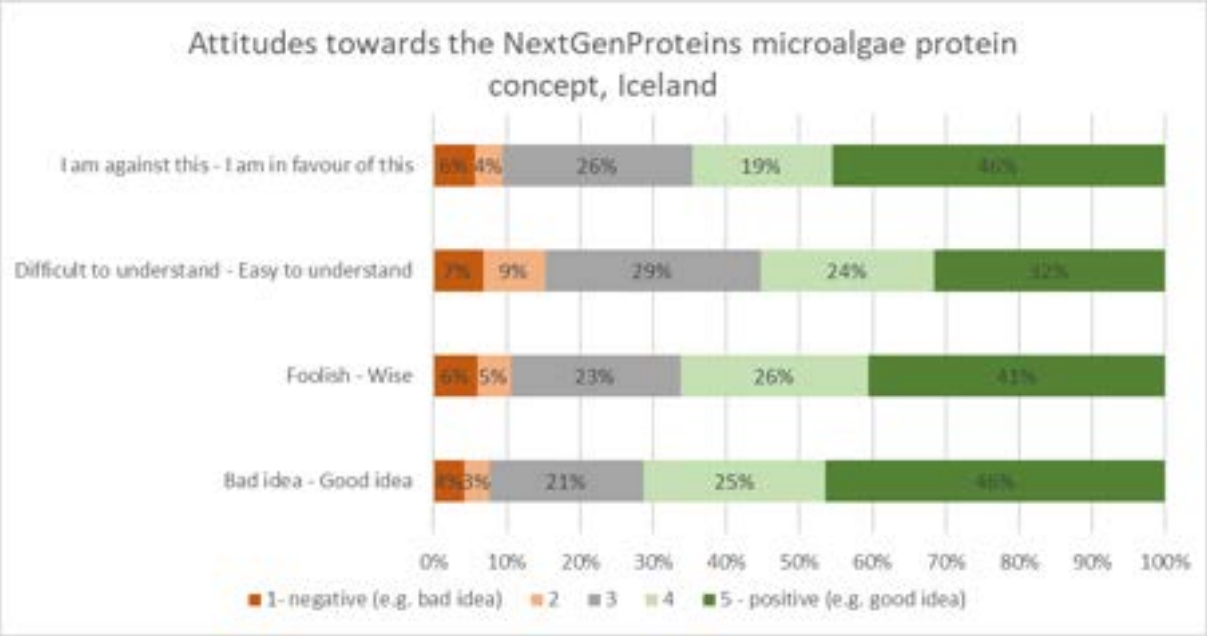


Figure 282. Attitudes towards the NextGenProteins microalgae concept. Percentages of the Icelandic respondents (n = 539, 533, 533, 529 for each item respectively from bottom-up)

Close to 70% of the respondents in Iceland believe in the benefits for economy (70%), environment (70%) and human health (66%), while personal benefits are less expected (45%) (Figure 283).

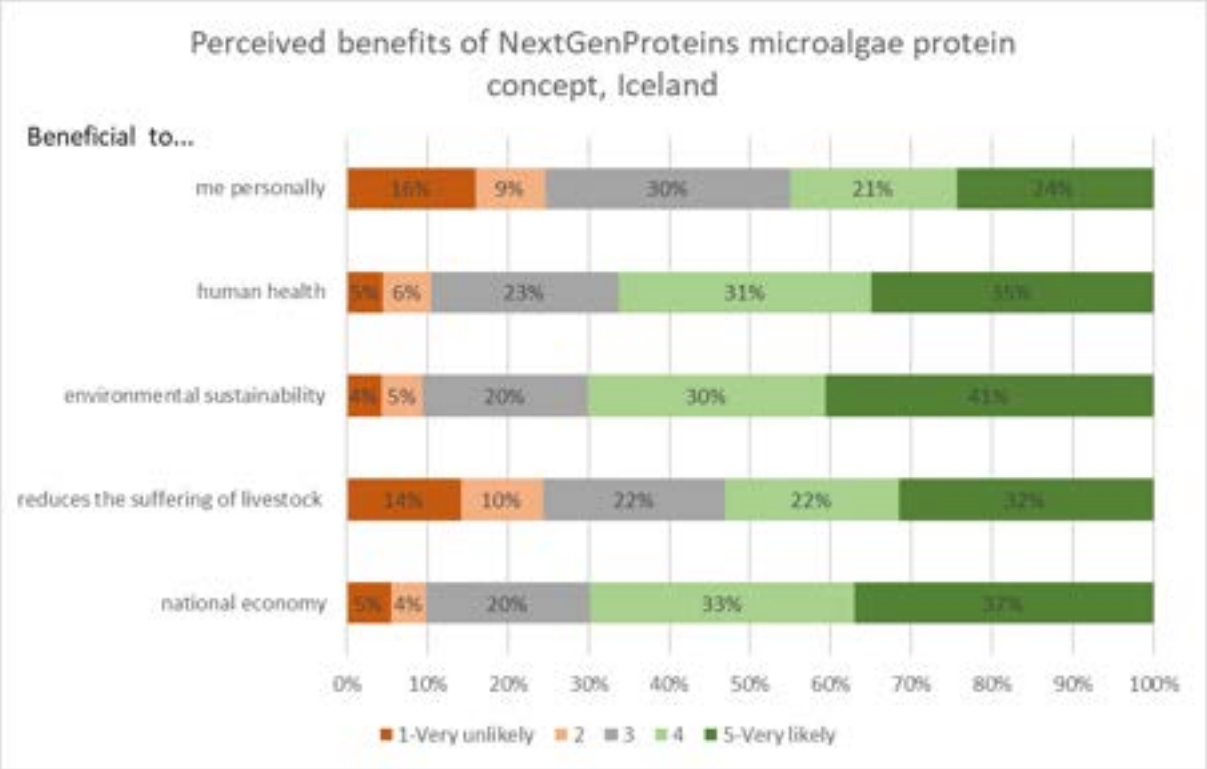


Figure 283. Perceived benefits of the NextGenProteins microalgae protein concept. Percentages of the Icelandic respondents (n = 438, 418, 456, 441, 414 for each item respectively from bottom-up)

Like in the other countries, the risks the Icelandic respondents were most worried about related to the honesty and integrity of the food companies (27%) in relation to production

and food application of NextGenProteins microalgae protein (Figure 284). Potential risks for the environment or human health caused the least concern, as well as any other risks.

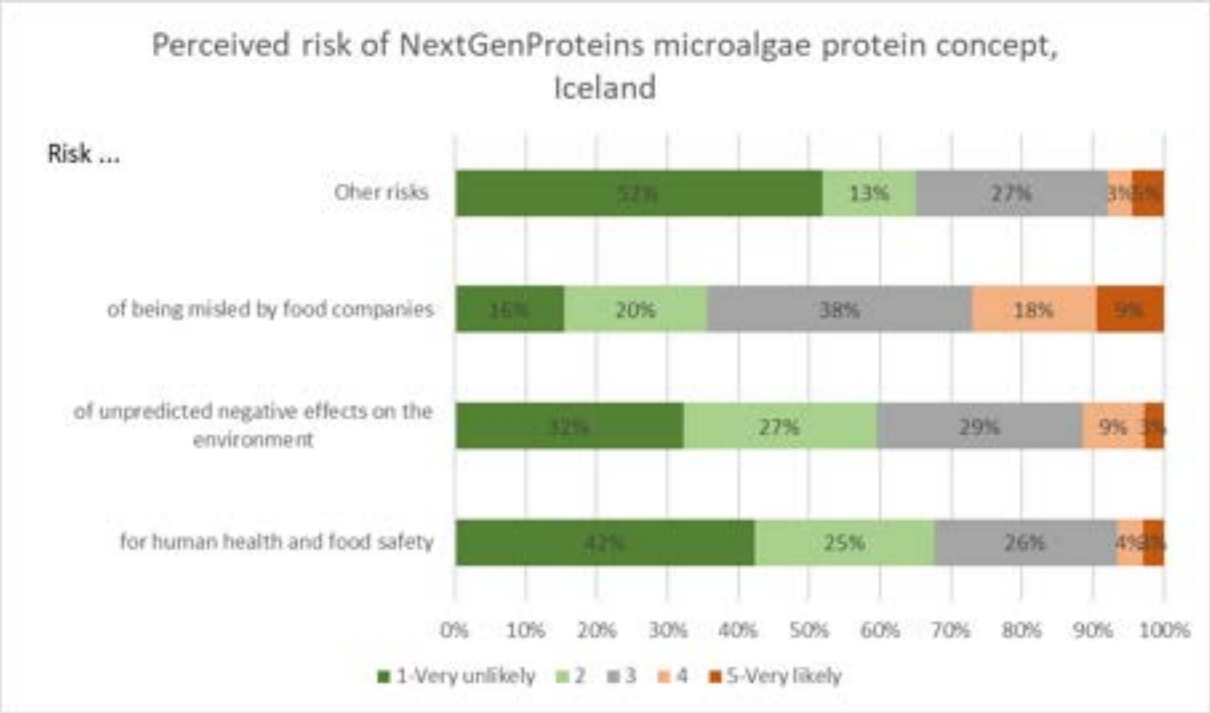


Figure 284. Perceived risks of the NextGenProteins microalgae protein concept. Percentages of Icelandic respondents (n = 441, 441, 445, 266 for each item respectively from bottom-up)

Assumed characteristics of food application of NextGenProteins microalgae protein ingredients was generally rather positive according to the Icelandic respondents (Figure 285). About 50% assumed it was good for health, safe and hygienic, while only 9% assumed it would be bad for health, though close to 20% assumed it was weird or artificial. About 46% assumed it would be appreciated in their social circles, but 38% thought most of the people they know would be interested in purchasing such products (Figure 286).

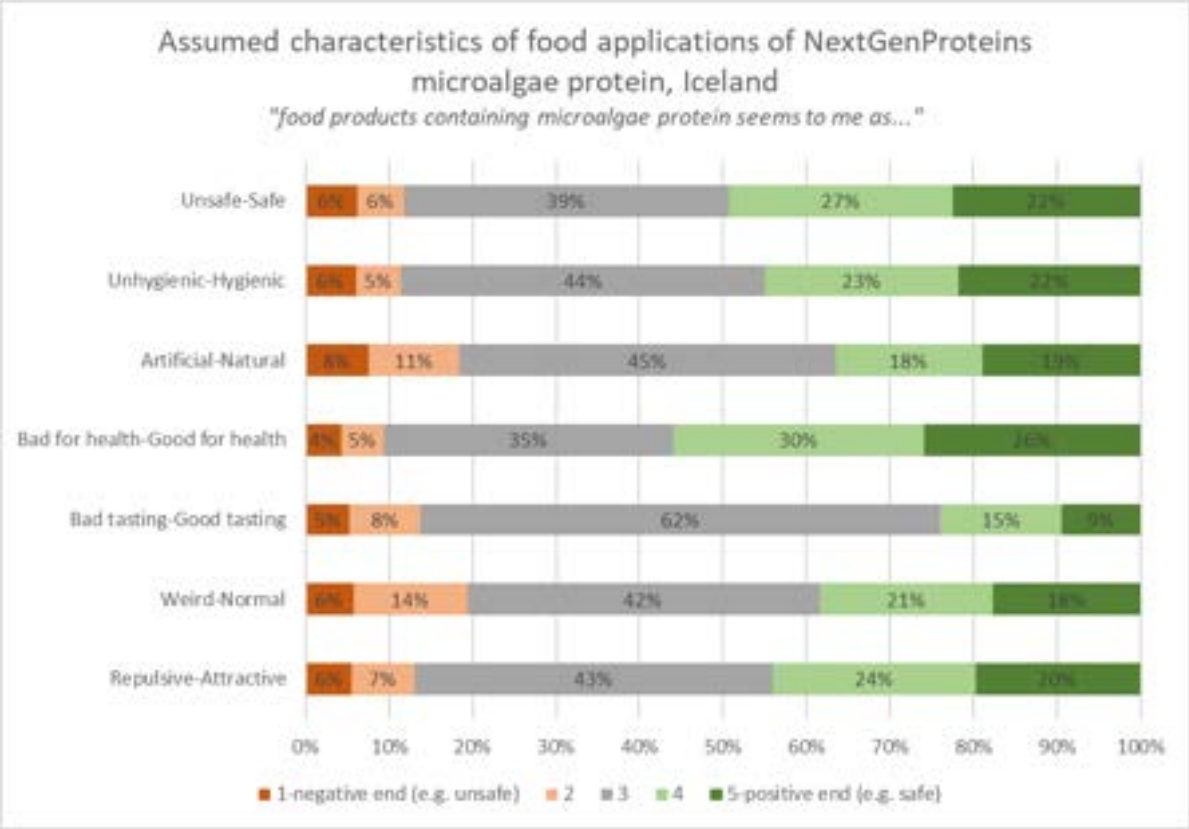


Figure 285. Characteristics associated by respondents with the imaginary food applications made with NextGenProteins microalgae protein. Percentages of Icelandic respondents (n = 521, 521, 510, 517, 515, 516, 518 for each item respectively from bottom-up)

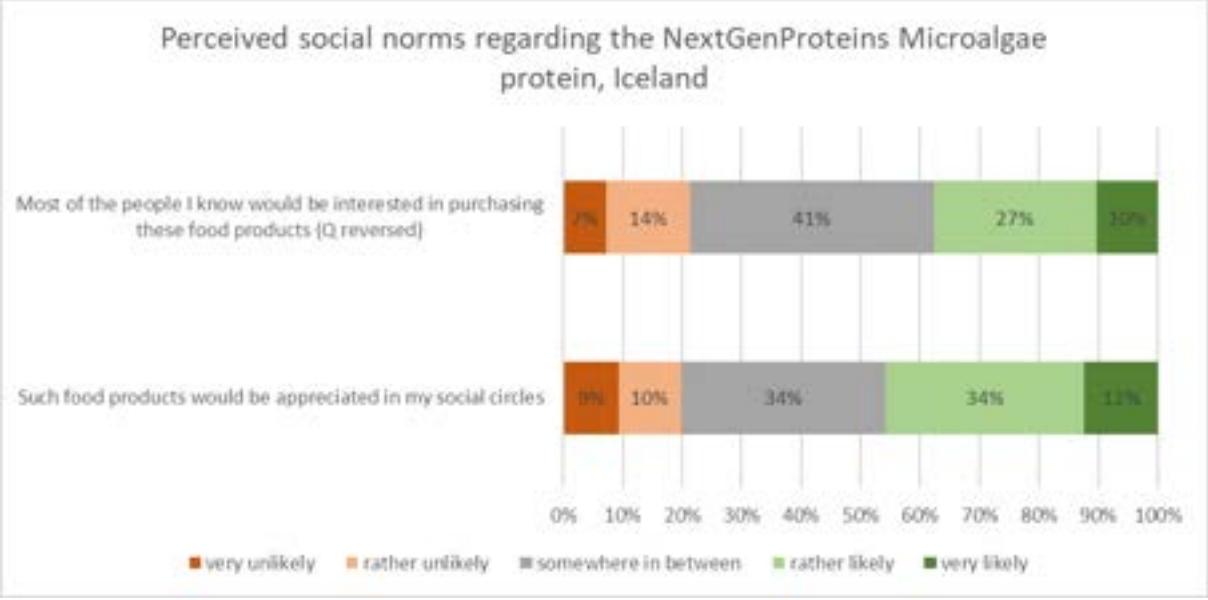


Figure 286. Perceived social norms regarding NextGenProteins microalgae protein food products. Percentages of Icelandic respondents (n = 471, 465 for each item respectively from bottom-up).

Of the Icelandic respondents, 27% were rather or extremely interested in using sausages and 30% in using salty snack or patties containing NextGenProteins microalgae protein ingredients (Figure 287). This seems rather low percentage, but when looking at their interest in using conventional counterparts, only 23% were rather or extremely interested in using such sausages, which is fewer than would like to try sausages with microalgae (Figure 288).

However, more respondents, or 38% and 36% were rather or extremely interested in using conventional salty snacks respectively.

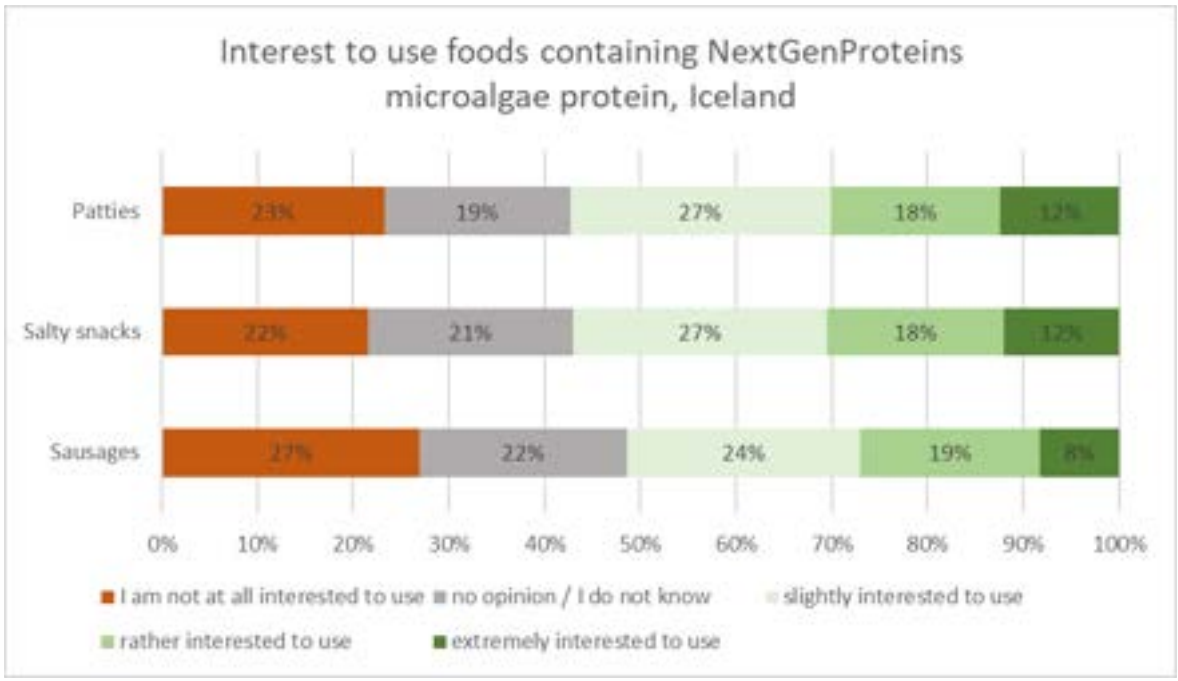


Figure 287. Interest to use the food application examples of NextGenProteins microalgae protein. Shares of Icelandic respondents with each answer alternative (n = 541, 542, 541 for each item from bottom-up).

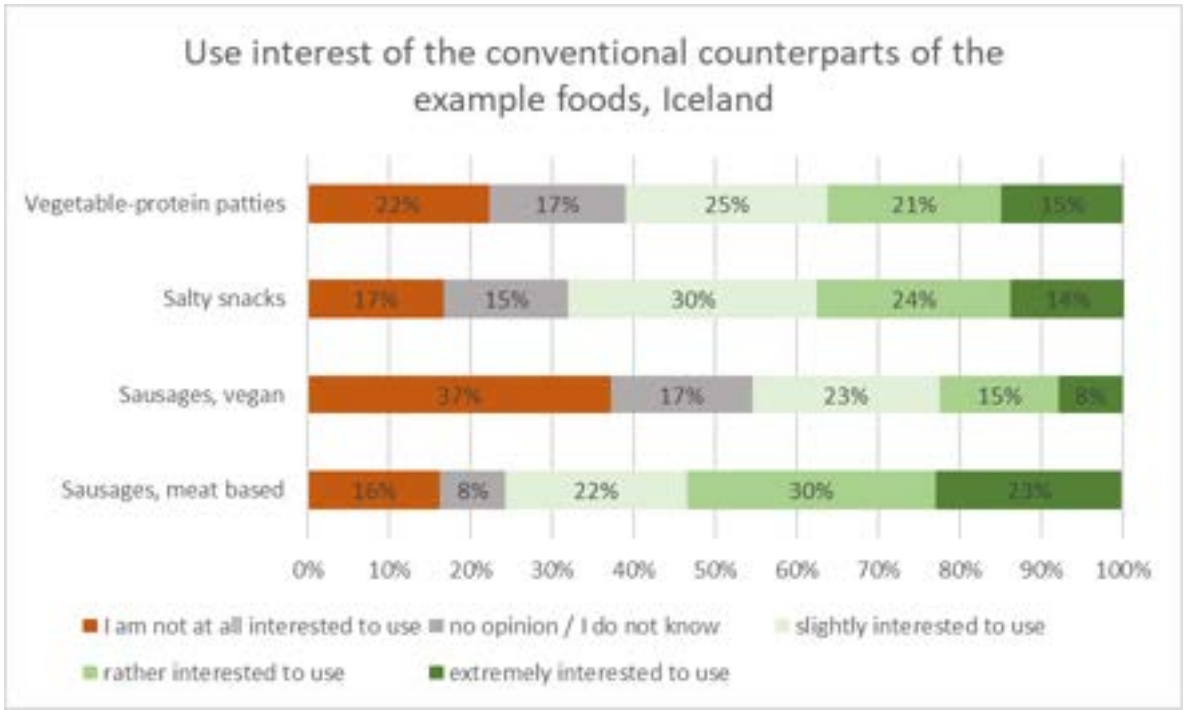


Figure 288. Use interest of the conventional counterparts of the food application examples. Shares of Icelandic respondents with each answer alternative (n = 541, 541, 542, 541 for each item from bottom-up).

14.5.2 Consumer clusters based on ratings of NextGen microalgae concept, Iceland

Hierarchical cluster analyses suggested 3 clusters. Subsequent K-means clustering confirmed that three cluster solution best brings out the differences in the sample. The three clusters were characterised as negative (28%), neutral (36%) and positive (35%), based on respondents' views towards microalgae protein concept, as shown in Table 107.

Table 107. Consumer clusters based on respondents' views towards NextGenProteins microalgae protein concept. The result of K-means cluster analysis with 3 clusters. Iceland

	1-Negative	2-Neutral	3-Positive	Total	F	Sig.
Number of cases	120	154	148	422		
Percent of cases	28%	36%	35%	100%		
ATT_Algae	2.98	4.52	4.86		416.957	***.000***
BENEFIT_Algae	2.57	3.93	4.54		278.798	***.000***
RISK_Algae	2.94	2.69	1.50		166.7	***.000***
FOODVIEWS_Algae	2.71	3.43	4.38		263.373	***.000***

14.5.2.1 Demographic profile and eating habits of NextGen microalgae consumer clusters, Iceland

The members of the microalgae positive cluster were less likely to be omnivore than the other clusters (Table 108). No other significant differences in demographic characteristics of these clusters were observed.

Table 108. Demographic profile of consumer clusters based on views towards NextGenProteins microalgae protein concept, Iceland

	1-Negative	2-Neutral	3-Positive	Total %	Pearson Chi²	Sign.	Total
Gender					2.864	.239	422
Male	58.3%	49.4%	57.4%	54.7%			
Female	41.7%	50.6%	42.6%	45.3%			
Total	*100%*	*100%*	*100%*	*100%*			
Age group					7.841	.797	422
18 - 24 Years	4.2%	5.2%	2.7%	4.0%			
25 - 34 Years	9.2%	7.1%	12.8%	9.7%			
35 - 44 Years	14.2%	15.6%	14.9%	14.9%			
45 - 54 Years	16.7%	14.9%	20.3%	17.3%			
55 - 64 Years	20.0%	18.2%	18.9%	19.0%			
65 - 75 Years	27.5%	27.9%	24.3%	26.5%			
76 - 87 Years	8.3%	11.0%	6.1%	8.5%			
Total	*100%*	*100%*	*100%*	*100%*			
Education					5.927	.205	414
Basic	9.6%	5.3%	5.4%	6.5%			
Secondary/first stage tertiary	71.1%	68.4%	64.2%	67.6%			
Tertiary/university	19.3%	26.3%	**30.4**%	25.8%			
Total	*100%*	*100%*	*100%*	*100%*			
Type of living area					3.280	.773	422
Capital city / area	55.8%	65.6%	61.5%	61.4%			

Town, more than 2.500 inhabitants	20.0%	15.6%	19.6%	18.2%			
Town or municipality, less than 2.500 inhabitants	17.5%	14.3%	14.2%	15.2%			
Rural area	6.7%	4.5%	4.7%	5.2%			
Total	*100%*	*100%*	*100%*	*100%*			
Household					1.174	.882	420
No children	60.0%	61.8%	56.1%	59.3%			
1-2 Adults with children	35.8%	33.6%	38.5%	36.0%			
Something else	4.2%	4.6%	5.4%	4.8%			
Total	*100%*	*100%*	*100%*	*100%*			
Diet					14.237	***.007***	418
Ominivore	**90.7%**	88.2%	78.9%	85.6%			
Meat sometimes or no red meat	9.3%	7.8%	**12.2%**	9.8%			
Vegetarian	0.0%	3.9%	**8.8%**	4.5%			
Total	*100%*	*100%*	*100%*	*100%*			

As shown in the table above and in Figure 289. compared with the Negative and Neutral clusters, the Icelandic consumer cluster with **positive views towards NextGenProteins microalgae concept** in Iceland, can be characterised as more often vegetarian, more likely to use vegetarian convenience foods and more familiar with alternative and future protein foods and sources.

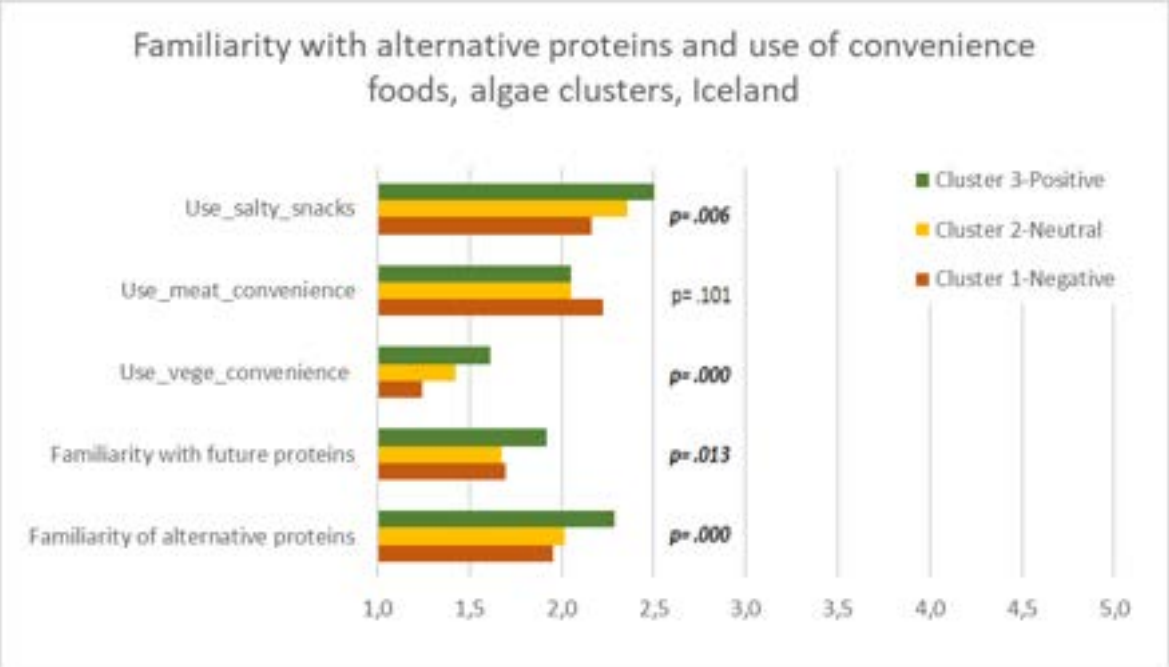


Figure 289. Use of certain convenience food types and familiarity with alternative proteins (means) by NextGenProteins microalgae consumer clusters in the Icelandic sample.

14.5.2.3 Attitudinal background of NextGen microalgae consumer clusters, Iceland

As shown in Figure 290., compared with the Negative and Neutral clusters, the Icelandic – like in the other countries - consumer cluster with positive views towards NextGenProteins microalgae concept can be characterised as:

- being more interested in food product novelties (Food innovativeness)
- having higher trust in different actors of food chain
- having lower taste neophobia (reluctance to taste unfamiliar tastes)
- having more positive attitudes towards food technology in general
- being less attached to meat

In terms of what they value in their daily foods, the consumers within the positive cluster more typically valued sustainability and ethical issues of food choice (Figure 291).

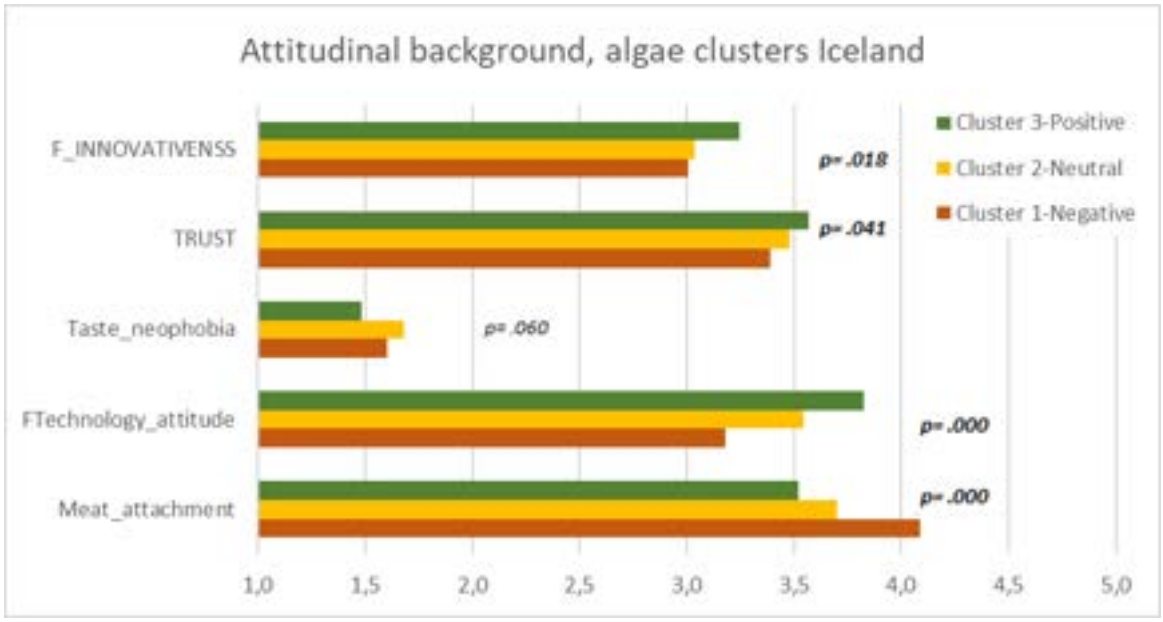


Figure 290. Background attitudes (means) of the respondents in the clusters based on their views towards NextGenProteins microalgae concept, Iceland

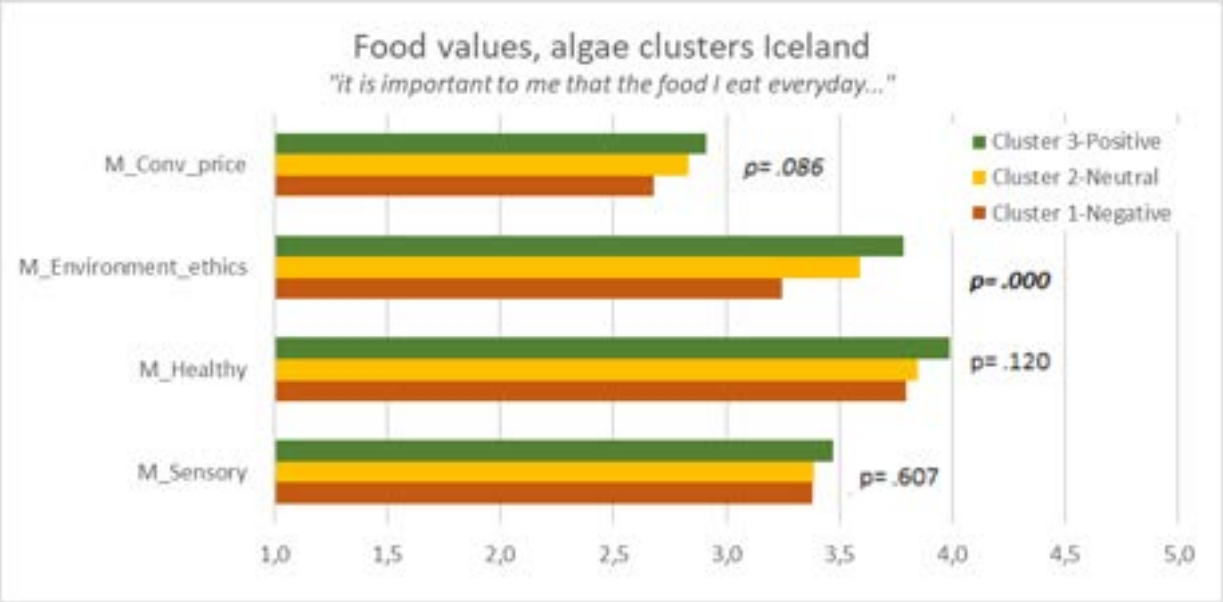


Figure 291. Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins microalgae concept Iceland.

14.5.2.4 Interest to use food applications by NextGen microalgae consumer clusters, Iceland

The interest to use all three types of foods was higher among consumers in the positive, as well as the neutral cluster compared to consumers within the negative algae cluster (Figure 292).

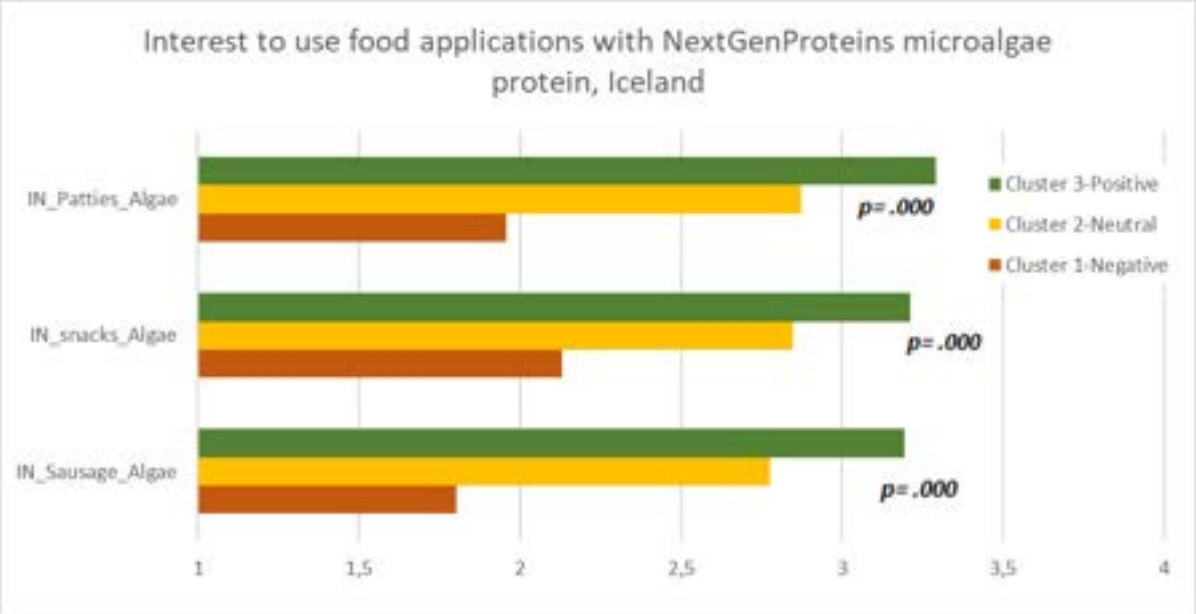


Figure 292. Means of interest to use food applications (values) of consumer clusters based on their views on NextGenProteins microalgae concept Iceland.

14.6 Acceptance of NextGen insect protein concept, Iceland

14.6.1 The level of acceptance of the NextGen insect protein concept

Although the attitudes towards the NextGenProteins insect protein concept was positive among close to 50% of the Icelandic respondents, 21-26% had negative attitudes towards it (Figure 293). Also, rather few (19%) considered the insect protein concept likely to be beneficial to themselves (Figure 294). However, 57% considered it likely to be beneficial to environmental sustainability, and 44% to human health.

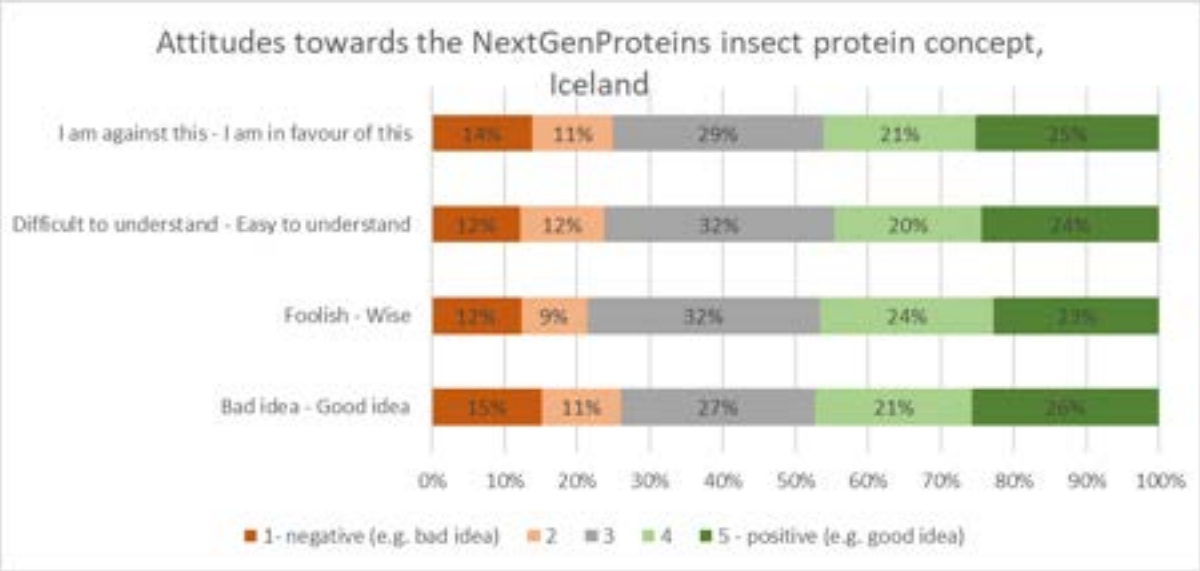


Figure 293. Attitudes towards the NextGenProteins insect protein concept. Shares of Icelandic respondents with each answer alternative (n = 550, 537, 544, 540 for each item from bottom-up).

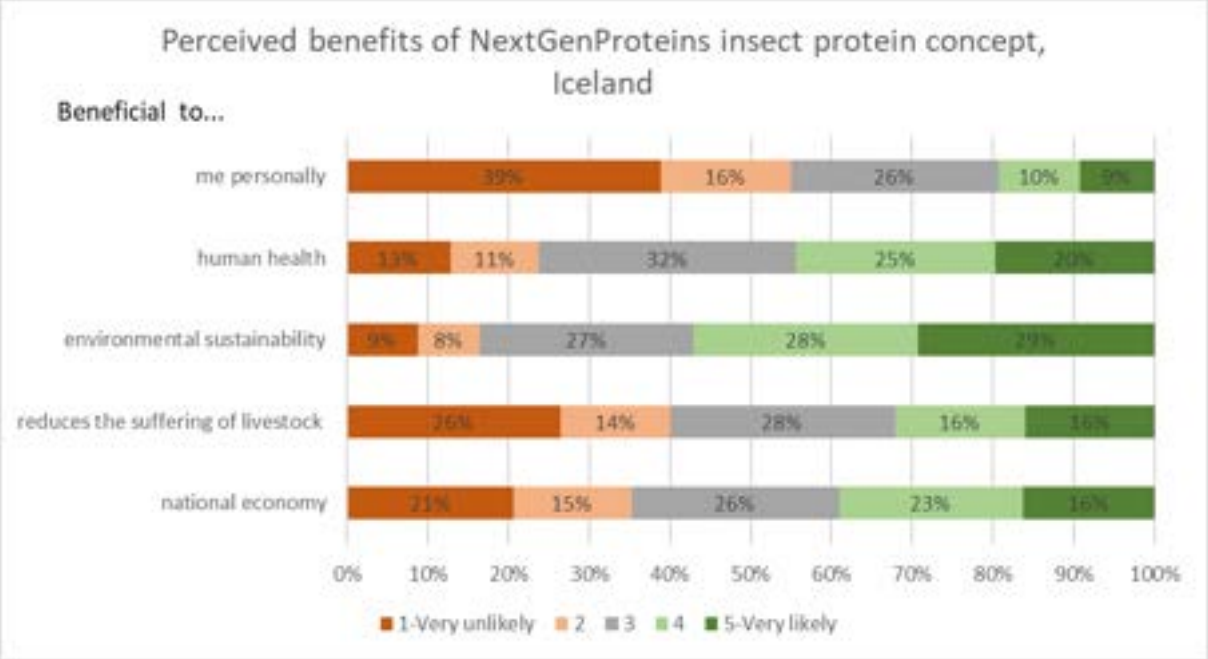


Figure 294. Perceived benefits of the NextGenProteins insect protein concept. Shares of Icelandic respondents with each answer alternative (n = 412, 420, 445, 421, 422 for each item from bottom-up).

Rather few considered the NextGenProteins insect protein concept likely to contain risk for human health and food safety (13%) or unpredicted negative effects on the environment (14%), but more were concerned about being mislead by food companies (37%) in relation to the insect protein concept (Figure 295).

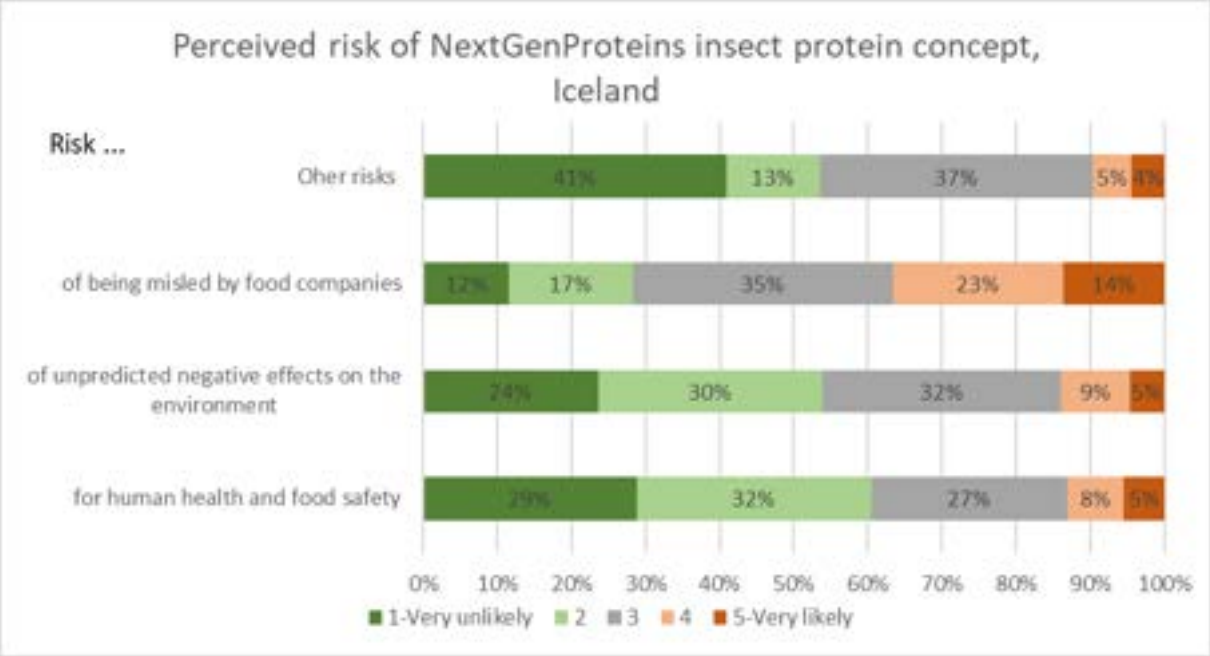


Figure 295. Perceived risks of the NextGenProteins insect protein concept. Shares of Icelandic respondents with each answer alternative (n = 455, 431, 449, 271 for each item from bottom-up).

Very few Icelandic respondents considered the insect protein concept to be attractive (15%) or good tasting (12%) although 39% thought it was good for health (Figure 296). Majority found it repulsive (55%) and Weird (56%), but 27% unsafe.

Only 15% thought products containing the NextGenProteins insect protein would be appreciated in their social circles, but 23% thought people they know would be interested in purchasing these food products (Figure 297).

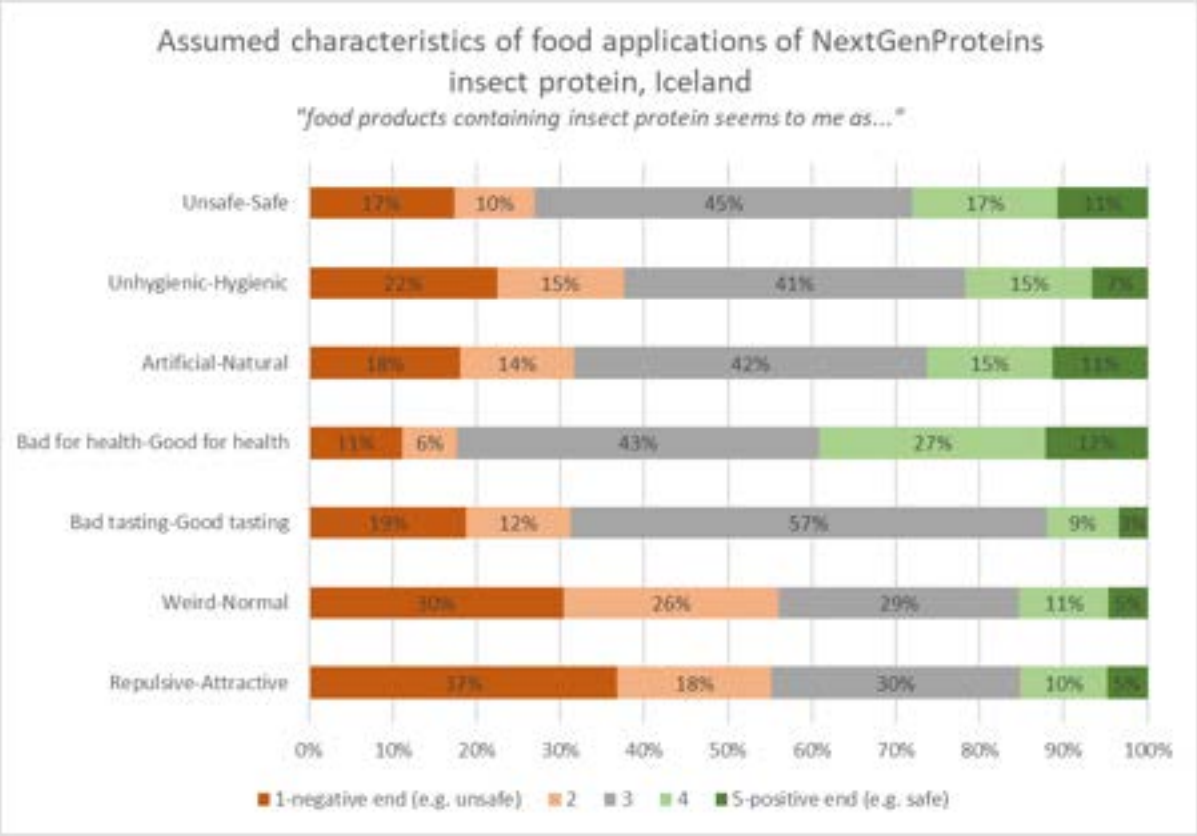


Figure 296. Characteristics associated with food applications made with NextGenProteins insect protein. Shares of Icelandic respondents with each answer alternative (n = 546, 544, 533, 539, 537, 535, 542 for each item from bottom-up).

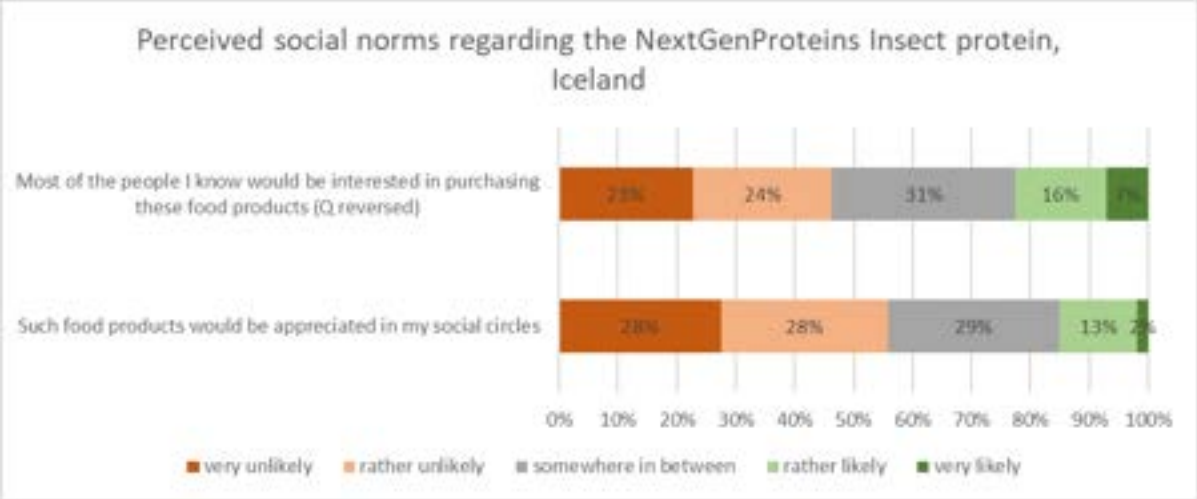


Figure 297. Perceived social norms regarding NextGenProteins insect protein food products. Shares of Icelandic respondents with each answer alternative (n = 475, 464 for each item from bottom-up).

Very few (15-16%) would be rather or extremely interested in using foods containing NextGenProteins insect proteins (Figure 298). This is considerably fewer, compared to conventional counterpart products (Figure 299).

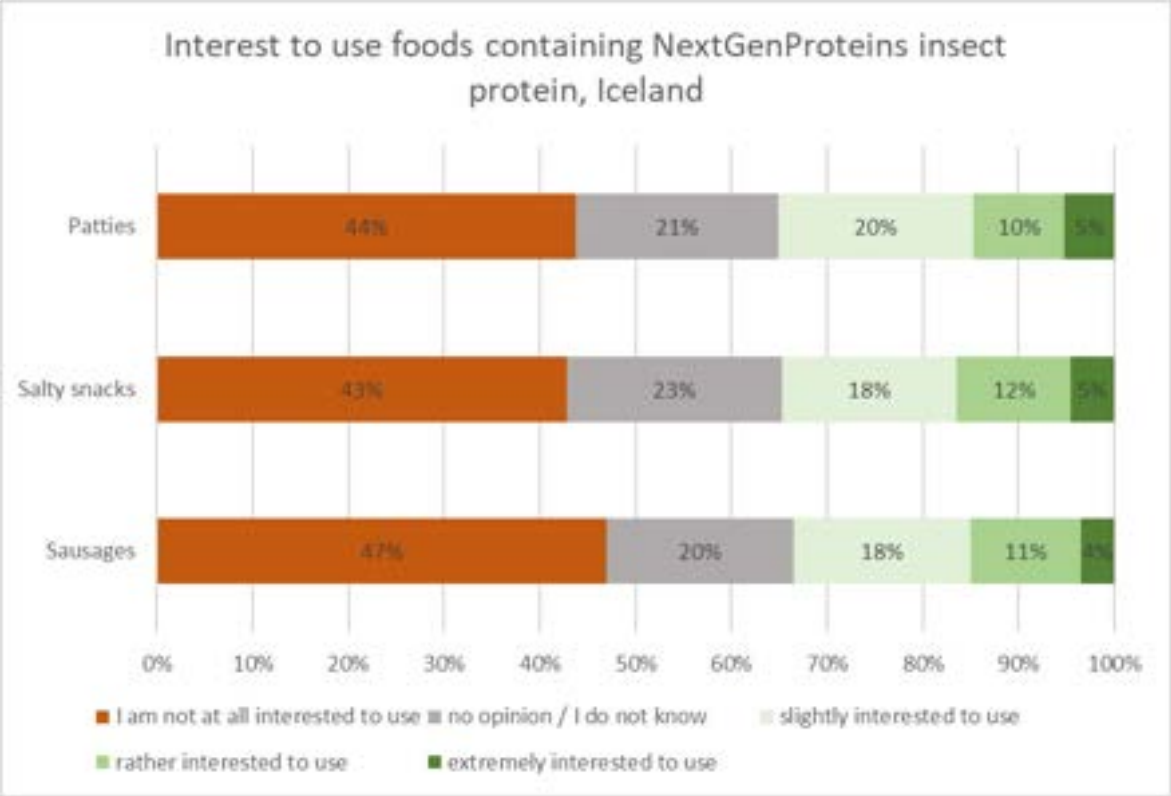


Figure 298. Interest to use the food application examples of NextGenProteins insect protein. Shares of Icelandic respondents with each answer alternative (n = 541, 542, 541 for each item from bottom-up).

14.6.2 Consumer clusters based on views towards NextGen insect protein concept, Iceland

Like in the previous cases, one of the clusters consists of respondents with negative views, another with neutral views and the third with positive views. As can be seen from the table below, respondents in the negative cluster were less likely to have positive attitudes towards the NextGenProteins insect concept, less likely to believe that it would have the benefits listed in the survey, but more likely to worry about the risks of it. Consistently with these negative views, they also expected the NextGenProteins insect food products to be of inferior quality compared to the more positive or neutral cluster. Only 21 % of the Icelandic respondents belong to the negative cluster. Majority of the respondents have neutral views.

Table 109. Consumer clusters based on respondents' views towards NextGenProteins insect protein concept. The result of K-means cluster analysis with 3 clusters. Iceland

	1 - Negative	2 - Neutral	3 - Positive	Total	F	Sig.
Number of cases	88	194	141	423		
Percent of cases	21%	46%	33%	100%		
ATT_Insects	1.81	3.47	4.67		547.307	***.000***
BENEFIT_Insects	1.67	2.96	4.08		327.981	***.000***
RISK_Insects	3.28	2.77	1.95		67.274	***.000***
FOODVIEWS_Insects	1.60	2.77	3.68		307.578	***.000***

14.6.2.1 Demographic profile and eating habits of NextGen insect consumer clusters, Iceland

The share of respondents with only basic education, was higher in the cluster with negative views towards NextGenProteins insect concept (Table 110). Demographic profile of consumer clusters based on views towards NextGenProteins Insect protein concept, Iceland). Otherwise the consumer clusters did not significantly differ from each other in terms of their demographic background.

The consumers within the positive Icelandic insect cluster were more likely to use vegetarian convenience foods and were more familiar with alternative and future protein foods and sources (Figure 299.).

Table 110. Demographic profile of consumer clusters based on views towards NextGenProteins Insect protein concept, Iceland

	1-Negative	2-Neutral	3-Positive	Total %	Pearson Chi²	Sign.	Total
Gender					3.476	.176	423
Male	46.6%	56.2%	58.9%	55.1%			
Female	53.4%	43.8%	41.1%	44.9%			
Total	*100%*	*100%*	*100%*	*100%*			
Age group					13.409	.340	423
18 - 24 Years	3.4%	4.1%	4.3%	4.0%			
25 - 34 Years	8.0%	8.2%	12.8%	9.7%			
35 - 44 Years	10.2%	16.5%	14.2%	14.4%			
45 - 54 Years	18.2%	16.0%	21.3%	18.2%			
55 - 64 Years	28.4%	20.6%	12.8%	19.6%			
65 - 75 Years	26.1%	26.8%	24.8%	26.0%			
76 - 87 Years	5.7%	7.7%	9.9%	8.0%			
Total	*100%*	*100%*	*100%*	*100%*			
Education					27.659	***.000***	414
Basic	**15.5%**	5.8%	0.7%	6.0%			
Secondary/first stage tertiary	67.9%	**70.2%**	63.3%	67.4%			
Tertiary/university	16.7%	24.1%	**36.0%**	26.6%			
Total	*100%*	*100%*	*100%*	*100%*			
Type of living area					7.465	.280	266
Capital city / area	52.3%	62.9%	**69.5%**	62.9%			
Town, more than 2.500 inhabitants	23.9%	18.0%	17.0%	18.9%			
Town or municipality, less than 2.500 inhabitants	17.0%	13.4%	9.9%	13.0%			
Rural area	6.8%	5.7%	3.5%	5.2%			
Total	*100%*	*100%*	*100%*	*100%*			
Household					2.455	0.653	420
No children	56.8%	57.8%	59.3%	58.1%			
1-2 Adults with children	40.9%	35.9%	35.7%	36.9%			
Something else	2.3%	6.3%	5.0%	5.0%			
Total	*100%*	*100%*	*100%*	*100%*			
Diet					7.212	.125	419
Ominivore	81.6%	89.1%	82.1%	85.2%			
Meat sometimes or no red meat	12.6%	6.8%	15.0%	10.7%			
Vegetarian	5.7%	4.2%	2.9%	4.1%			
Total	*100%*	*100%*	*100%*	*100%*			

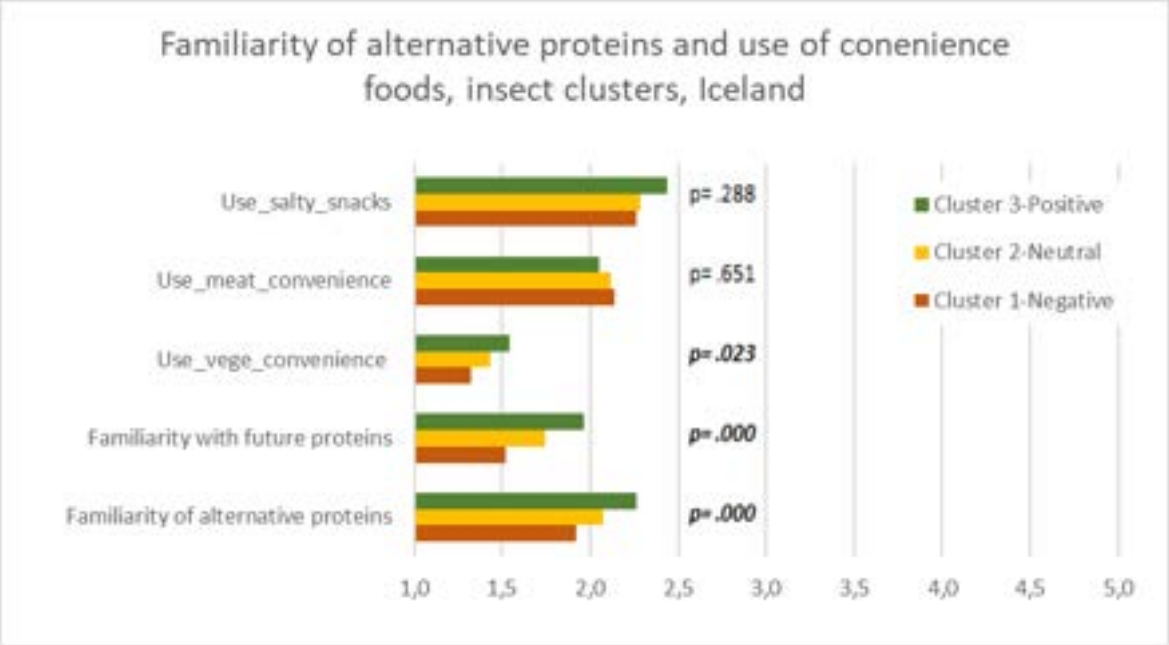


Figure 299. Mean use frequencies of certain convenience foods and familiarity with alternative proteins by consumer clusters based on their views on NextGenProteins insect protein concept Iceland.

14.6.2.2 Attitudinal background of NextGen insect concept clusters, Iceland

Compared with the Neutral, but especially the Negative cluster, the Icelandic consumer cluster with positive views towards NextGenProteins **insect** concept can be characterised as having more positive attitudes towards food technology in general, but being less attached to meat (Figure 300). The consumers within the positive cluster also have lower taste neophobia (reluctance to taste unfamiliar tastes) and are less attached to meat compared to the other two clusters. They also have a tendency towards being more interested in food product novelties (Food innovativeness).

In terms of what they value in their daily foods, the cluster Positive vs. Negative more typically valued sustainability and ethical issues of food choice and healthiness of food (Figure 301).

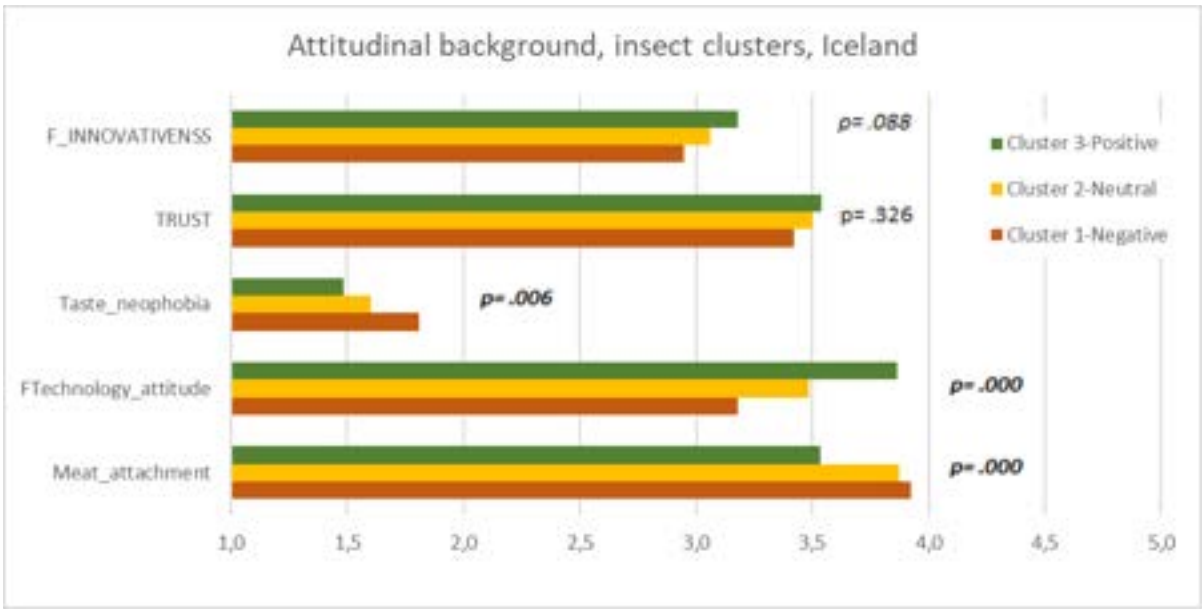


Figure 300. Background attitudes of the respondents in the clusters based on their views towards NextGenProteins insect concept, Iceland.

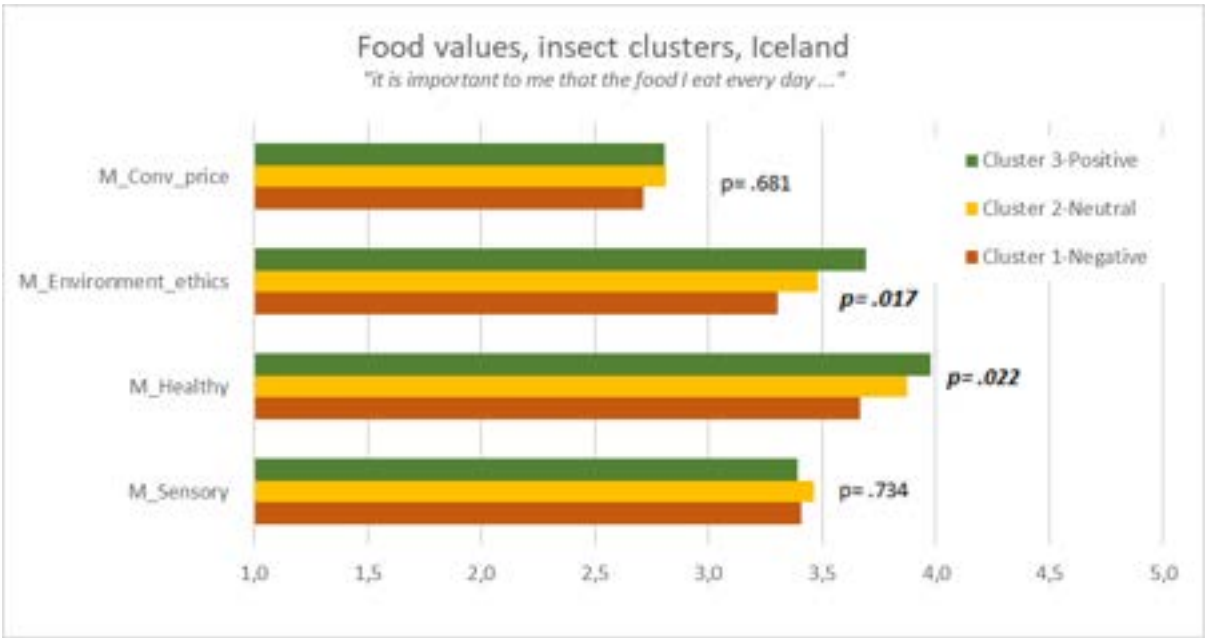


Figure 301. Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins insect concept, Iceland. (The levels of significance of differences in means between the clusters are marked; ns = no significant differences). (1=not important at all…5=extremely important).

14.6.2.3 Interest to use the food applications by NextGen insect consumer clusters, Iceland

There were clear differences between Icelandic consumers within the three insect clusters with regard to interest to use food applications containing insect proteins (Figure 302). Regardless of type of food application, the positive insect cluster consumers are generally interested, the neutral not so much, but the negative cluster consumers not at all interested.

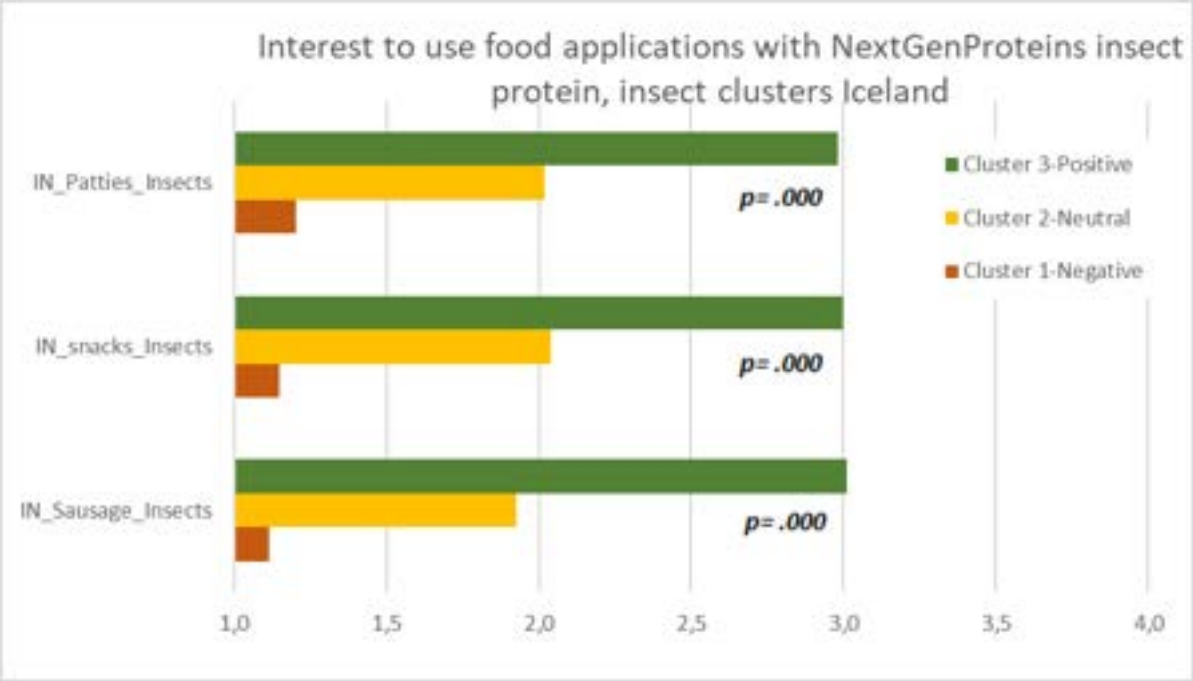


Figure 302. Interest to use food applications by consumer clusters based on their views towards NextGenProteins insect protein concept. Iceland. (1= not at all interested … 4= extremely interested)

14.7 Acceptance of NextGenProteins Torula protein concept, Iceland

14.7.1 The level of acceptance of NextGenProteins Torula protein, Iceland

The Icelandic respondents had more positive attitudes towards the NextGenProteins Torula protein concept as compared to the insect protein concept, but not as positive as towards the microalgae protein concept. About 58% considered the Torula protein concept a good idea, 53% Wise and 54% were in favour of it (Figure 303). However, only 43% found it easy to understand, which is a lower percentage compared to microalgae (55%) and insect (45%) protein concepts. Only 10% of the respondents thought the Torula protein concept to be a bad idea or were against it, but 13% found it foolish and 22% found it difficult to understand.

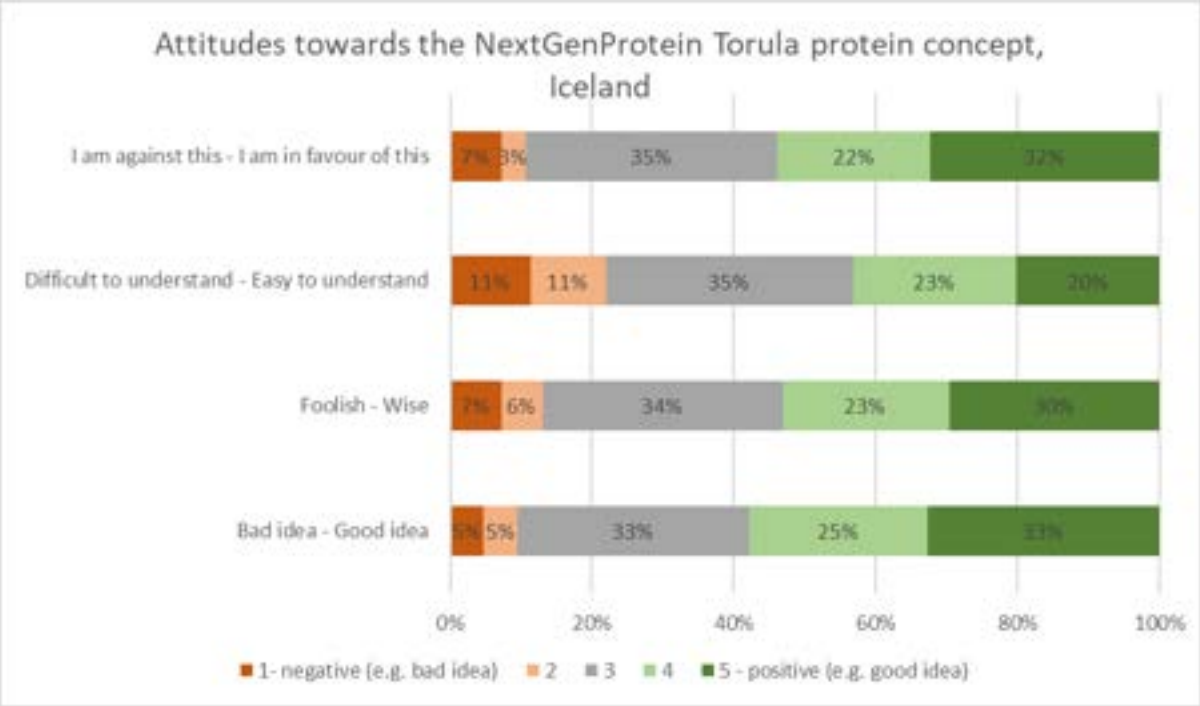


Figure 303. Attitudes towards the NextGenProteins Torula concept. Shares of Icelandic respondents with each answer alternative (n = 533, 529, 537, 527 for each item from bottom-up).

A majority (65%) of the Icelandic respondents considered the NextGenProteins Torula protein concept likely to be beneficial to environmental sustainability, and about 50% thought it would be beneficial to human health, national economy and reduce suffering of livestock (Figure 304). However, only 29% considered the Torula protein concept beneficial to them personally. However, over 50% considered the Torula protein concept unlikely to be a risk for human health and food safety or have unpredicted negative effects on the environment (Figure 305). Risk of being misled by food companies in relation to use of Torula protein was considered likely by 34%.

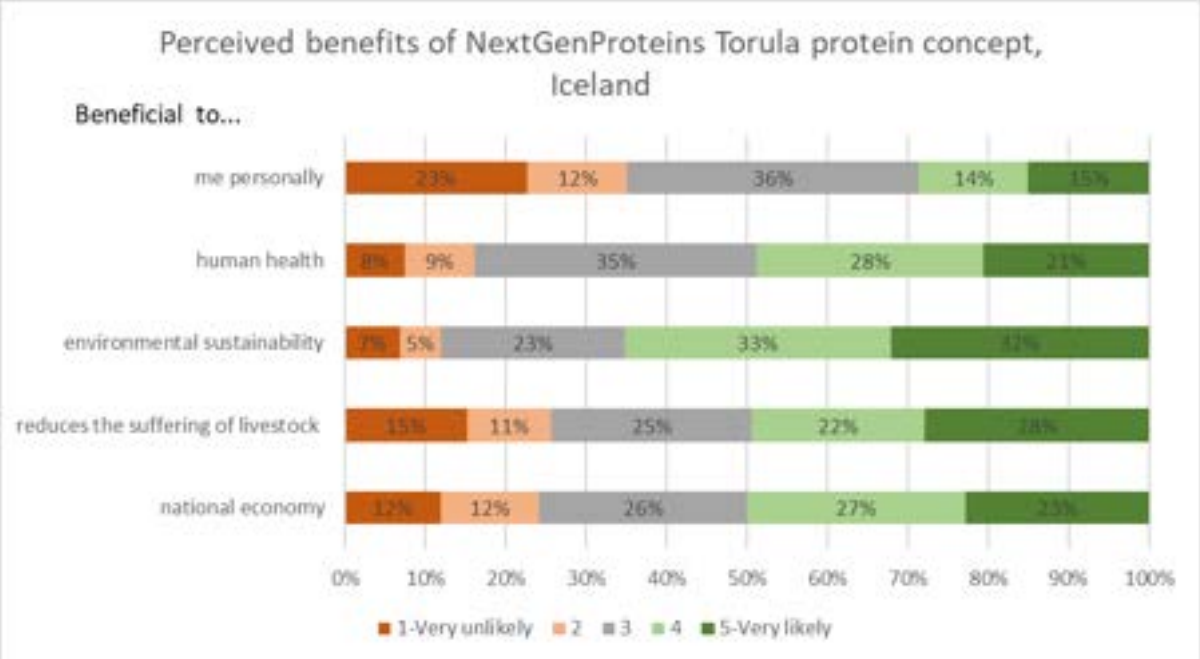


Figure 304. Perceived benefits of NextGenProteins Torula protein concept. Shares of Icelandic respondents with each answer alternative (n = 404, 409, 436, 398, 387 for each item from bottom-up).

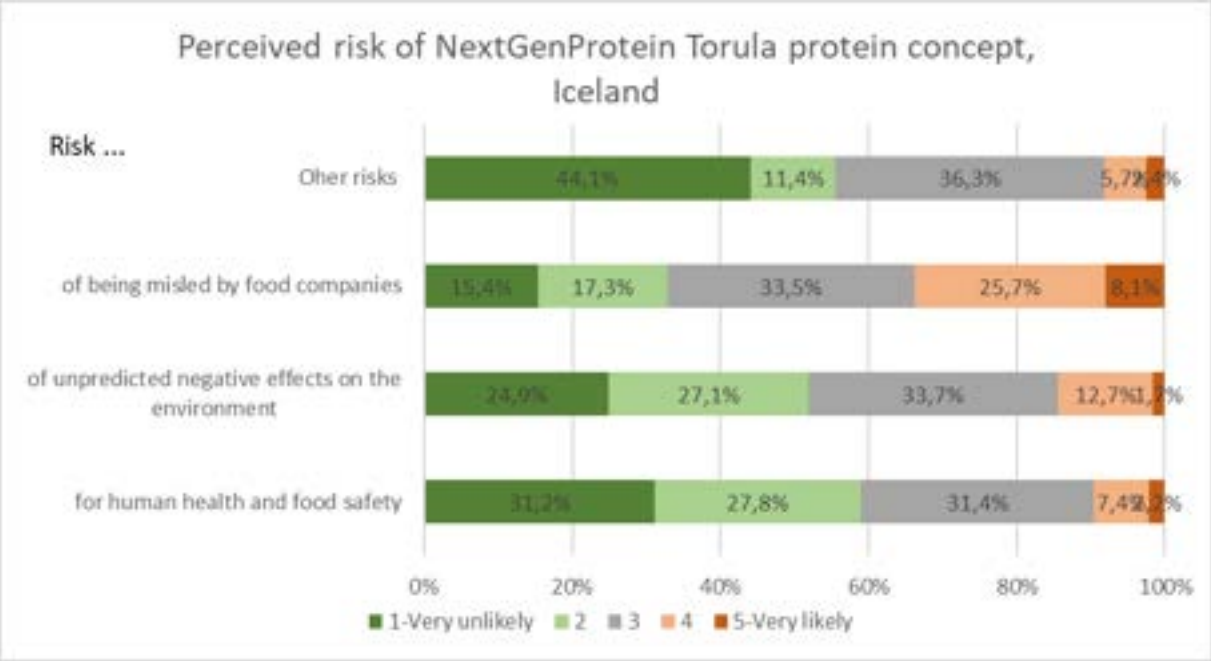


Figure 305. Perceived risks of NextGenProteins Torula protein concept. Shares of Icelandic respondents with each answer alternative (n = 417, 410, 421, 245 for each item from bottom-up).

Many Icelandic respondents were unsure about the characteristics of food applications of NextGenProteins Torula protein concept as about 50% responded neither positively nor negatively on any items related to characteristics of such products (Figure 306). This is a higher percentage compared to characteristics of products containing either microalgae or insect protein. However, 38% thought it was good for health, 35% safe and 33% attractive, while only 11% considered it bad for health and 14% either unsafe or unhygienic. About 40% were unsure if people they know would be interested in purchasing foods containing Torula or if such products would be appreciated in their social circles (Figure 307). Still, more than 30% thought such products would be accepted.

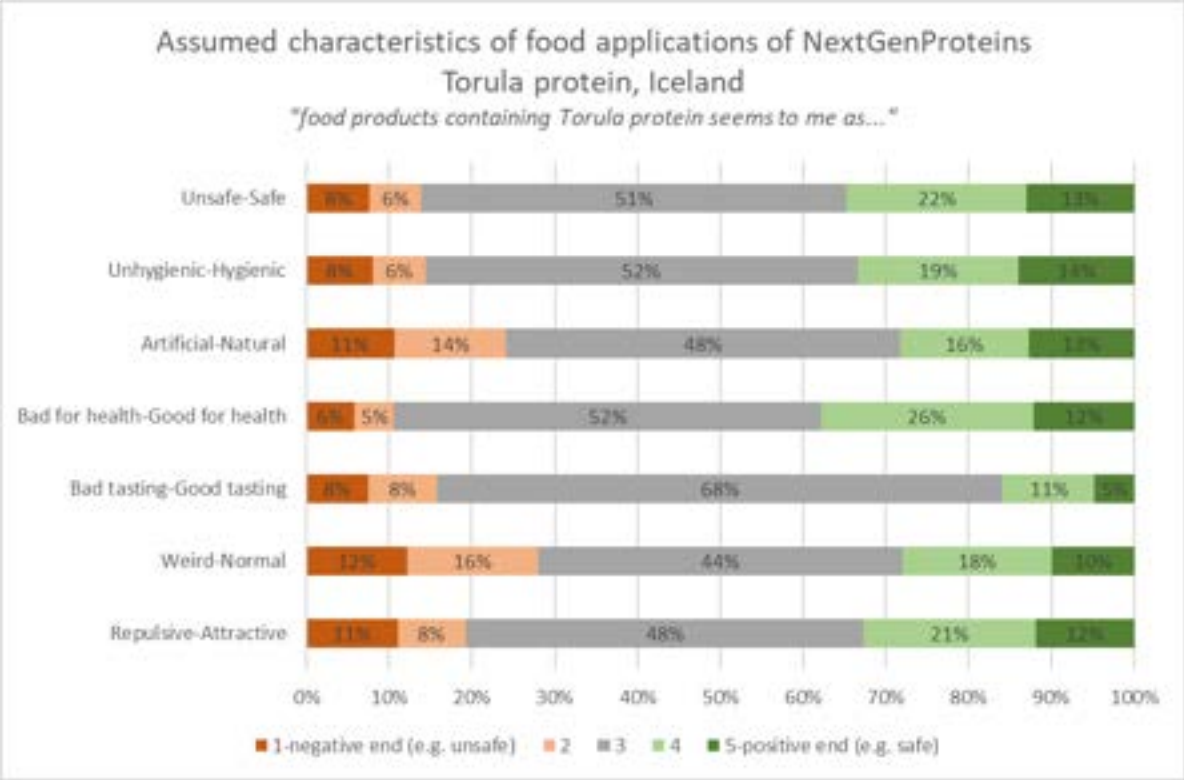


Figure 306. Characteristics associated with food applications of NextGenProteins Torula protein. Shares of Icelandic respondents with each answer alternative (n = 515, 514, 505, 510, 509, 509, 510 for each item from bottom-up).

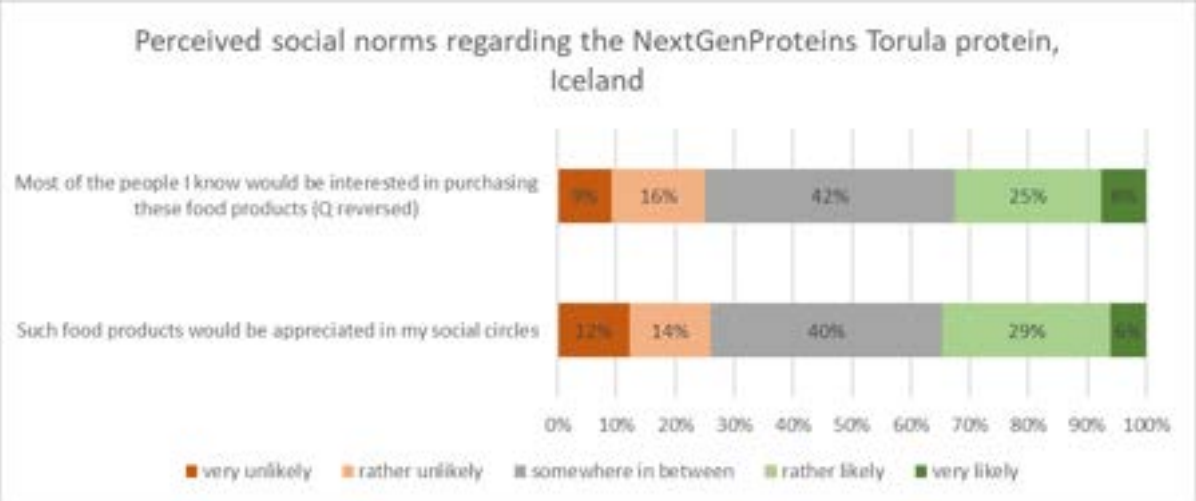


Figure 307. Perceived social norms related to NextGenProteins Torula protein foods. Shares of Icelandic respondents with each answer alternative (n = 448, 436 for each item from bottom-up).

The interest to use foods containing NextGenProteins Torula protein was slightly less than for microalgae, but higher than for insect foods. A 25% would be rather or extremely interested to use sausages containing Torula protein, 26% salty snacks containing Torula protein and 28% patties containing Torula protein (Figure 308). This is less than for conventional salty snacks or vegetable-protein patties, but slightly higher than for conventional sausages (Figure 288).

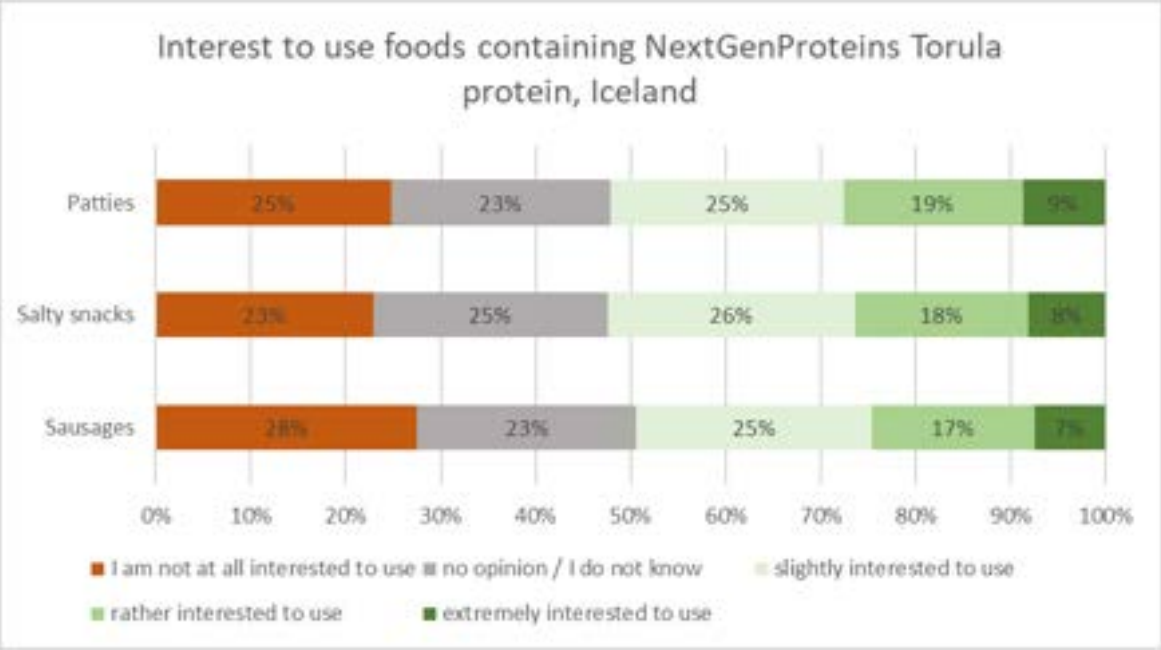


Figure 308. Interest to use the food application examples of NextGenProteins Torula protein. Shares of Icelandic respondents with each answer alternative (n = 541, 542, 541 for each item from bottom-up).

14.7.2 Consumer clusters based on views towards NextGen Torula protein concept, Iceland

Hierarchical cluster analyses, followed by K-means clustering, revealed three clusters as for previous microalgae and insect protein concepts; Positive, neutral and negative (Table 111). The positive cluster consisted of 35% of the participants, and neutral cluster of 47%, while the negative cluster consisted only of 18%.

Table 111. Consumer clusters based on respondents' views towards NextGenProteins Torula protein concept. The result of K-means cluster analysis with 3 clusters. Iceland

	1 - Negative	2 - Neutral	3 - Positive	Total	F	Sig.
Number of cases	73	187	142	402		
Percent of cases	18%	47%	35%	100%		
ATT_Torula	2.62	3.82	4.79		270.446	.000
BENEFIT_Torula	1.78	3.30	4.38		426.480	.000
RISK_Torula	2.71	2.96	1.75		104.243	.000
FOODVIEWS_Torula	2.26	3.12	4.02		229.049	.000

14.7.2.1 Demographic profile and eating habits of NextGenTorula consumer clusters, Iceland

The demographic profile of neutral and positive Torula clusters had more in common than the negative cluster (Table 112). Consumers within the neutral and positive cluster were more likely to have higher level of education and live in the capital city or capital area. These were also more likely to be vegetarian or meat reducers.

No differences were observed in gender, age or household between the three clusters.

The consumers within the positive Torula cluster, were more likely to use vegetarian convenience food and salty snacks, but the consumers within the negative cluster were the most likely to use meat convenience food. The consumers within the positive cluster were more likely to be familiar with future proteins and alternative proteins, but the consumers within the negative cluster the least likely (Figure 309).

Table 112. Demographic profile of the consumer clusters based on views towards NextGenProteins Torula concept, Iceland

	1-Negative	2-Neutral	3-Positive	Total %	Pearson Chi²	Sign.	Total N
Gender					0.788	.674	402
Male	58.9%	56.1%	52.8%	55.5%			
Female	41.1%	43.9%	47.2%	44.5%			
Total	*100%*	*100%*	*100%*	*100%*			
Age group					7.223	.843	402
18 - 24 Years	4.1%	4.3%	4.2%	4.2%			
25 - 34 Years	6.8%	8.0%	14.1%	10.0%			
35 - 44 Years	12.3%	16.6%	13.4%	14.7%			
45 - 54 Years	19.2%	17.1%	19.0%	18.2%			
55 - 64 Years	19.2%	21.9%	16.2%	19.4%			
65 - 75 Years	30.1%	25.1%	24.6%	25.9%			
76 - 87 Years	8.2%	7.0%	8.5%	7.7%			
Total	*100%*	*100%*	*100%*	*100%*			
Education					14.756	***.005***	395
Basic	**14.7%**	5.9%	4.3%	6.8%			
Secondary/first stage tertiary	**73.5%**	68.8%	65.2%	68.4%			
Tertiary/university	11.8%	25.3%	**30.5%**	24.8%			
Total	*100%*	*100%*	*100%*	*100%*			
Type of living area					14	***.028***	402
Capital city / area	49.3%	62.6%	**70.4%**	62.9%			
Town, more than 2.500 inhabitants	**21.9%**	19.3%	16.9%	18.9%			
Town or municipality, less than 2.500 inhabitants	**16.4%**	13.4%	9.9%	12.7%			
Rural area	**12.3%**	4.8%	2.8%	5.5%			
Total	*100%*	*100%*	*100%*	*100%*			
Household					3.739	.442	399
No children	63.9%	58.1%	56.0%	58.4%			
1-2 Adults with children	31.9%	38.7%	36.9%	36.8%			
Something else	4.2%	3.2%	7.1%	4.8%			
Total	*100%*	*100%*	*100%*	*100%*			
Diet					14	***.006***	398
Ominivore	**91.7%**	86.5%	76.6%	83.9%			
Meat sometimes or no red meat	8.3%	10.3%	**13.5%**	11.1%			
Vegetarian	0.0%	3.2%	**9.9%**	5.0%			
Total	*100%*	*100%*	*100%*	*100%*			

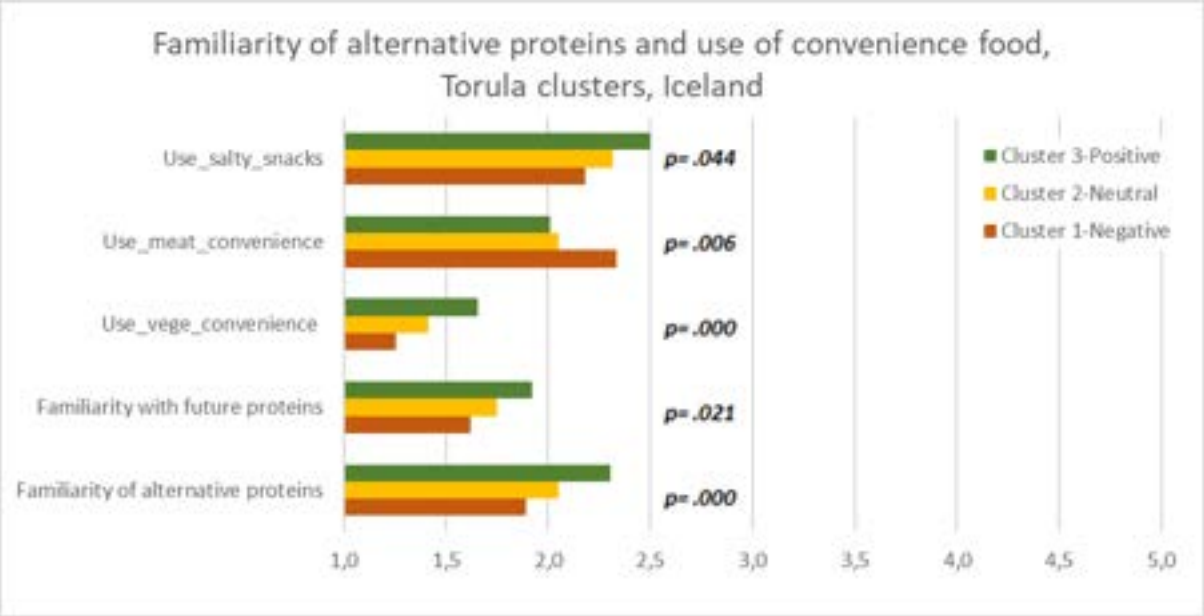


Figure 309. Background attitudes of the respondents in the clusters based on their views towards NextGenProteins Torula concept. Iceland

14.7.2.2 Attitudinal background of NextGenProteins Torula clusters, Iceland

Compared with the negative cluster, Icelandic consumer cluster with positive views towards NextGenProteins Torula concept can be characterised as being more interested in food product novelties (Food innovativeness) and having lower neophobia towards new food tastes, having more positive attitudes towards food technology in general and being less attached to meat (Figure 310).

In terms of what they value in their daily foods, the positive cluster more typically valued sustainability and ethical issues of food choice and had a tendency towards valuing more healthiness of food, especially compared to the negative cluster consumers (Figure 311).

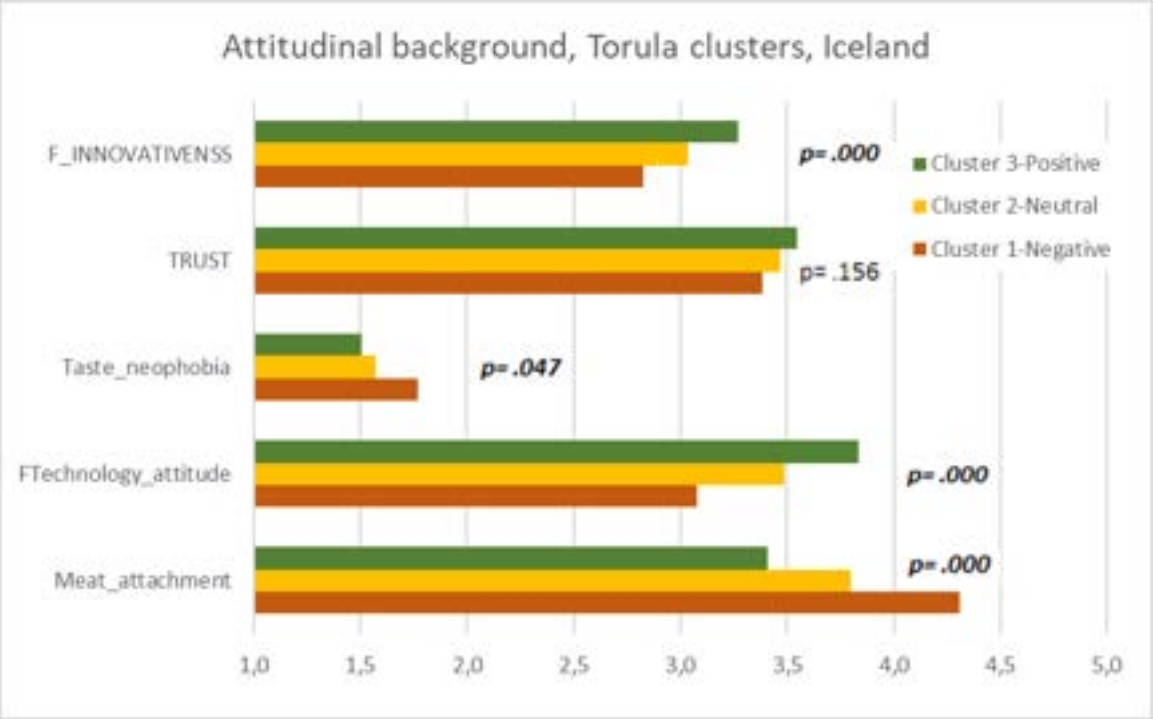


Figure 310. Background attitudes of the respondents in the clusters based on their views towards NextGenProteins Torula concept. Iceland.

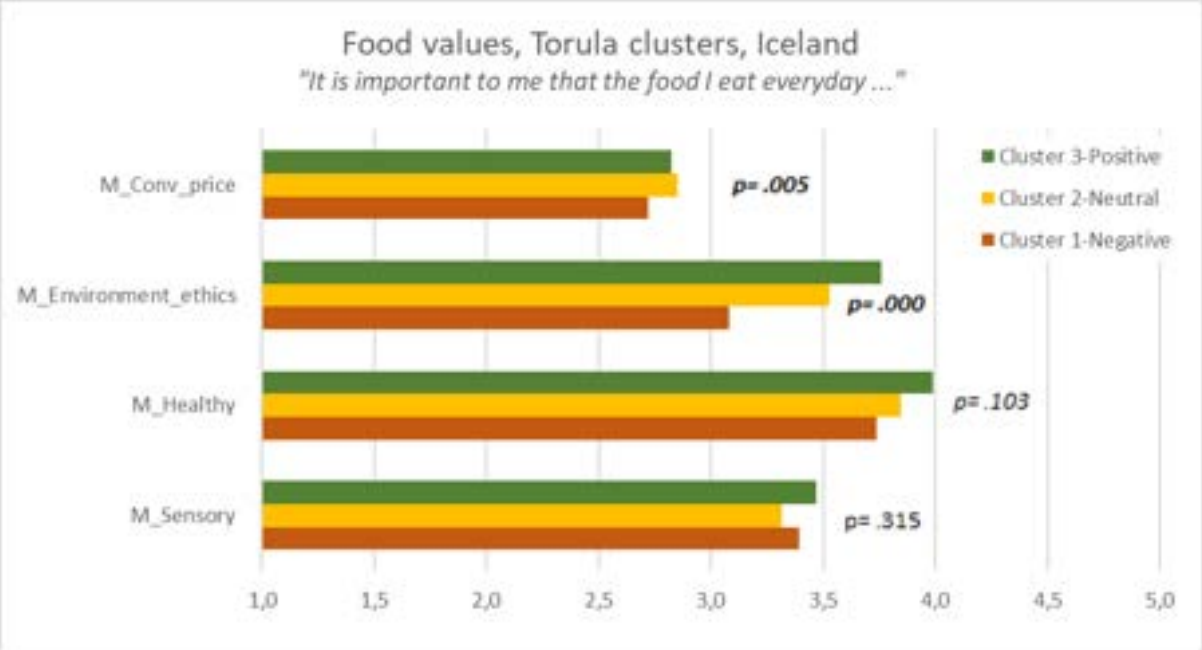


Figure 311. Means of food choice motives (values) of consumer clusters based on their views on NextGenProteins Torula concept. Iceland.

14.7.2.3 Interest to use the food applications by NextGenProteins Torula clusters, Iceland

The consumers in the positive cluster indicated high interest to use food applications made with NextGenProteins Torula protein, regardless of the food type. Also, the neutral cluster consumers had some interest to do so, especially patties. The Negative cluster consumers were generally not interested in food applications with Torula protein (Figure 312).

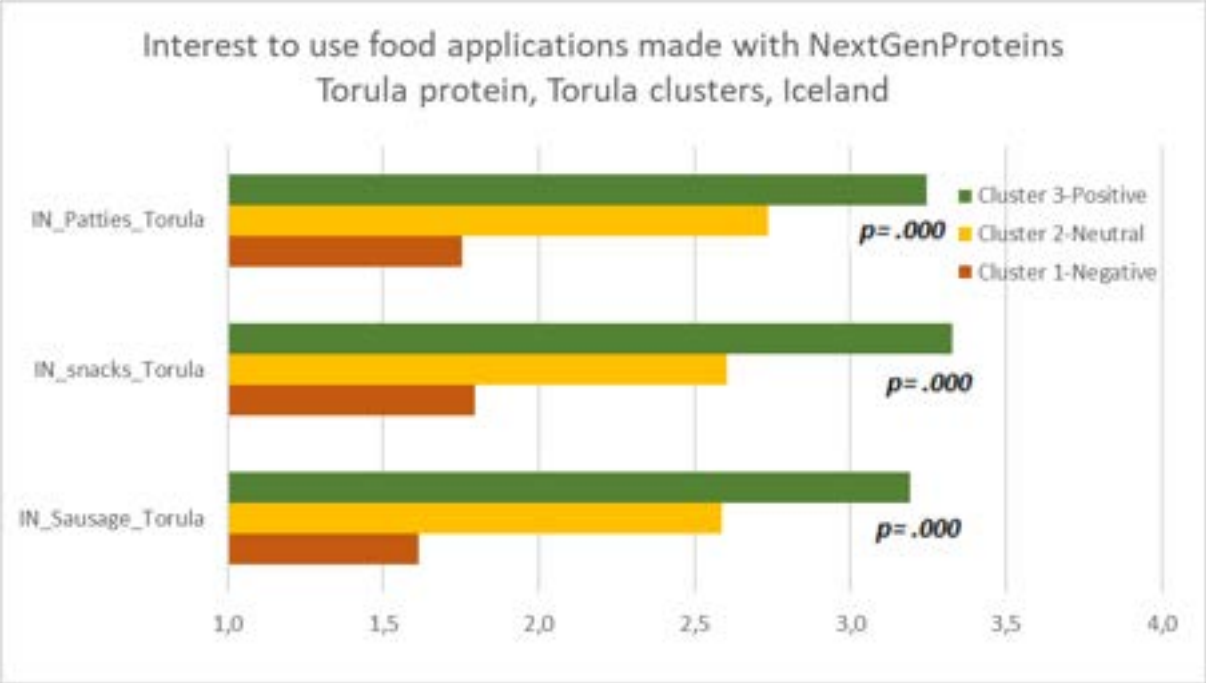


Figure 312. Interest to use food applications by consumer clusters based on their views towards NextGenProteins Torula protein concept. Iceland. (1= not at all interested…4= extremely interested)