

NEXTGEN

PROTEINS

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Proteins in Food and Feed in Europe

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Table of content

0	Document Information	II
1	Abstract	4
2	Introduction	5
3	Goal	6
4	Methods	7
5	Findings of Interview Study	9
5.1	Views on Sustainability Aspects	9
5.2	Views on NextGen Proteins	10
5.2.1	Spirulina microalgae	10
5.2.2	Insects (crickets and black soldier flies)	11
5.2.3	Torula yeast (single cell protein)	13
5.3	Expectations towards NextGen Proteins	14
6	Findings of Survey	16
6.1	Views on Sustainability Aspects	16
6.2	Views on NextGenProteins	17
6.2.1	Spirulina microalgae	18
6.2.2	Crickets	20
6.2.3	Black soldier flies	23
6.2.4	Torula yeast	26
7	Discussion	30
8	Conclusions	32
9	References	33
10	ANNEXES	34
10.1	ANNEX I Fact Sheets of NextGen Proteins	34
10.2	ANNEX II Interview Findings: Views from Food Producers on NextGen Proteins	37
10.3	ANNEX III Interview Findings: Views from Feed Producers on NextGen Proteins	38
10.4	ANNEX IV Interview Findings: Views from Retail, Restaurant & Catering Sectors on NextGen Proteins	39
10.5	ANNEX V Interview Findings: Views from Fish Farming on NextGen Proteins	40
10.6	ANNEX VI Questions of Stakeholder Survey	41
10.7	ANNEX VII Background Information about the Respondents of the Stakeholder Survey	47
10.8	ANNEX VIII Data Tables of Answers to Survey Questions: All Respondents, Food Producers, Feed Producers, Retail & Restaurant	48

1 Abstract

Consumption of protein in food and feed is on the increase. In order to meet the growing demand, it is of vital importance to find sustainable alternative protein sources that can be economically produced in quantities meeting the growing demand of food and feed industry. This has been the basis for the NextGenProteins project, which considers four alternative proteins and their production: spirulina microalgae using CO₂ emissions and waste heat for its growth, crickets and larvae of black soldier flies, whose production are based on the use of plant-based wasted food biomass, and torula yeast cultivated on forest biomass.

This study aims to gain a European view on the attitudes and expectations of business stakeholders within the value chains for food and feed towards the four NextGen proteins and their production processes. The study covers topics of market opportunities and business potential, barriers to overcome, risks, and sustainability of the proteins. The stakeholders include potential customers of alternative protein applications, such as food producers, retailers, restaurants and catering service providers, feed producers, and fish farmers. The results of the study are based on an interview study with stakeholders in Finland, Germany and Italy, and a European online survey on stakeholders' attitudes and expectations.

According to the results, the business stakeholders have an open mind set towards the alternative proteins. The NextGen proteins were thought to be beneficial for environment, but it was underlined that their sustainability must be proven. Many stakeholders were concerned about the prices of the alternative protein ingredients saying that environmental sustainability is not enough: their use must be sustainable also economically. There were many stakeholders with positive expectations, but also lots of those who were concerned about potential risks related to the production and use of the proteins. In addition, many stakeholders did not know how to react to these new protein ingredients. A major concern, shared by several stakeholders, was the risk of consumers not accepting the new protein ingredients.

It can be concluded that there is business potential for each NextGen protein, but the business may not be found in mainstream applications. Instead, a niche business will be the most likely in a short run. Boosting of consumer trust and acceptance towards alternative proteins will be of crucial importance.

2 Introduction

It has been forecasted that the world population will exceed nine billion people by 2040 (UN, 2019). In order to feed the people, a huge increase in protein consumption will take place. The increasing demand of protein is not only driven by the growing population, but also socio-economic changes such as urbanisation, increased incomes, aging population and recognition of proteins' role in healthy diets are having impacts to the global need of proteins. The increase of protein production to meet the future demand, however, will not be straightforward. Today's protein production is mostly linked to animal-based production, which causes extensive global greenhouse gas emissions, excessive land and water use, as well as biodiversity loss. It is therefore of vital importance to find sustainable alternative protein sources that can be economically produced in quantities that meet the growing demand of food and feed industry (Forum for the Future, 2019).

At a European level, an important aspect comes from the fact that the EU is not self-sufficient when it comes to protein production. A large proportion of the current protein demand is met with imported proteins and the protein deficit has been fluctuating between 70% and 80% in the past forty years (Martin, 2014). That creates severe concerns regarding food security.

Microalgae, certain microbes and insect species can contribute to global food and feed security as they hold great potential as sources of nutrients for various applications (Van Huis et al., 2013; Gamboa-Delgado et al., 2016; Gorry et al., 2018). NextGenProteins has identified these three organisms as promising sources of alternative proteins produced through innovative bioconversion processes using waste streams. These alternative proteins have a potential to be produced in large quantities with substantially lower environmental footprint, if compared to current mainstream proteins for food and feed applications.

The microalgae protein raw ingredient and its production process considered in the NextGenProteins project 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). Fact sheets of the NextGenProteins and their production methods are given in Annex I.

The use of alternative proteins in food and feed applications has so far been prohibited or limited by a few barriers, such as production scalability and optimisation, production costs, value chain risk, safety, regulations, and consumer trust and acceptance. All these barriers are being addressed in the NextGenProteins project. This report considers the attitudes of business stakeholders of food and feed value chains towards the NextGen proteins.

3 Goal

This study aims to gain a European view on the attitudes and expectations of business stakeholders within the value chains for food and feed sectors towards alternative proteins, especially towards the NextGen proteins and their production processes. The study covers topics of market opportunities and business potential, limitations, risks, and sustainability of the proteins. The stakeholders include potential customers of alternative protein applications, such as food producers, retailers, restaurants and catering service providers, feed producers, and fish farmers.

Similar study has been done on the attitudes of European consumers towards the NextGen proteins (Arvola et al., 2021). Understanding of the consumer and business stakeholder attitudes will then be used later in the project to create actions to overcome the barriers prohibiting or limiting a broad business use of alternative proteins and to design business models for the NextGen proteins.

4 Methods

The work was designed to be done in two stages. At first, a qualitative interview study on attitudes and expectations of business stakeholders within the value chains for food and feed sectors (potential customers, such as food producers, retailers, restaurants and catering service providers, feed producers, and fish farmers) towards alternative proteins. The idea of this first stage was to explore stakeholder attitudes and, by this way, to get a general view on how different stakeholders see alternative proteins, especially the NextGen proteins. This knowledge was applied to design of the second stage of the study: a larger online survey. Questions of the survey were influenced by findings of the interview study. Through the survey, it was aimed to gain quantitative understanding on stakeholder attitudes and expectations towards the NextGen proteins.

In the interview study, in total 38 stakeholders were interviewed representing people in different organizational positions in the areas of feed production, food production, retail, restaurant & catering service providers, fish farmers. Interviews were done in Finland (13), Germany (12) and Italy (13) so that researchers of VTT, TTZ and UNIBO carried out the interviews in their own countries. In feed production, the focus was on fish and poultry, but the German interviews included also a pet food provider. Only Italian interviews included fish farmers. In Finland, for example, fish farmers rely on the opinion of feed producers and, thus, were not interested to join the study.

The interviews were semi-structured and covered the following themes: sustainability and responsibility in the business of company and among their customers, NextGen proteins and their production processes (this theme was accompanied with a short introduction to each protein and its production process), future expectations towards the new proteins sources. The NextGenProteins theme targets to explore what kind of benefits would the alternative proteins offer for the stakeholder and what kind of risks could they identify related to the use of these proteins? The duration of an interview was 30-45 minutes. Most interviews were done using a Teams or Skype connection. All interviews were recorded and transcribed. They were carried out during the period of October 2020 - February 2021.

The interview data was, at first, analysed on a country level by grouping the data under the following stakeholder categories: food production, feed production, retail, restaurants & catering, fish farmers. For each category, statements of interviewees were placed under themes: sustainability in the business of stakeholder, possibilities (strengths & opportunities) of NextGen proteins, barriers to overcome (doubts & challenges), and expectations to alternative proteins. After doing all that, the data of country level reports was compiled and analysed in order to produce a summary of interview study. The criteria for interviewee statements to enter the summary report were that the statements should represent common attitudes of stakeholders but, on the other hand, bring versatility to the results, in line with the general principles of qualitative studies. Findings to be presented in Chapter 5 of this deliverable report are from the summary report. More interview findings can be found in the Tables of Annexes II-V, where views from the sectors of food producers, feed producers, retail & restaurant, and fish farming towards the NextGenProteins concepts are given. The findings in the Annexes are also from the summary of the interview study.

In the second stage of the study, a European survey of stakeholder attitudes was done. The design of the survey was based on the results of the interview study. Concerning sustainability, the interview study revealed that one should go beyond environmental aspects when considering the sustainability of alternative proteins. Therefore, the approach was adopted where sustainability is having three dimensions: environmental, economic and social (Hart & Milstein, 2003). In order to study the role of each dimension in the business of respondent's company, a framework introduced by Baumgartner & Ebner (2010) was applied. NextGen protein specific questions in the survey were mostly based on the findings of interview study, to which results it was targeted to gain quantitative understanding. A few questions were taken from a survey of consumer attitudes towards the NextGen proteins (Arvola et al., 2021) in order to enable comparison, in a later stage of the project, between consumer and business stakeholder attitudes and expectations towards NextGen proteins, and by this way to plan actions to overcome barriers limiting a wide use of alternative proteins in food and feed applications. The NextGen proteins specific questions were supported by the fact sheets of each protein and their production process (Annex I). The survey was online, and it was constructed by using Webropol (2021). The questions of the stakeholder survey are given in Annex VI.

The stakeholder survey was executed in summer 2021. Respondents for the survey were recruited through an email campaign, where NextGenProteins partners directly contacted their own business stakeholders within the value chains of food and feed. The email campaign was supported by a visibility in social media. In total of 42 respondents answered the survey. The largest group of respondents was food production companies with 19 respondents (44%). Seven respondents (16%) represented feed production companies (fish, poultry, and other kind of feed), six respondents retail, and one respondent represented restaurants and catering. Ten respondents (23%) placed themselves under category 'other companies', which category includes, among other things, companies having multiple roles in the value chain of food and feed. The background information of the respondents is given in more detail in Annex VII (including geographical, market and other information).

The low number of answers limited the way how the results of the survey could be analysed. For example, an in-depth comparison between the attitudes of different stakeholder groups was not feasible. The same applies for a comparison between answers on a country level. Therefore, the result analysis of the survey remained mainly on a general level. The findings will be reported in Chapter 6. In Annex VIII we will give answers from three business sectors of food and feed value chain: food producers, feed producers (fish, poultry and other feed combined), and retail and restaurant combined. Although an in-depth analysis of sectoral attitudes towards the NextGen proteins was not feasible, some indicative highlights could still be done and these are given in Chapter 6. Finally, the survey findings will be shortly discussed in Chapter 7 in connection with the findings of the interview study, and conclusions given in Chapter 8.

5 Findings of Interview Study

5.1 Views on Sustainability Aspects

The first theme in the interviews was sustainability and responsibility in the business of the company of interviewees and among the customers of the company. Highlights from the interview findings are reported below sector by sector.

In food producing companies, the strategic importance of sustainability seems to be crucial. The representatives of food production sector highlighted the meaning and importance of sustainability throughout an entire value chain. Carbon and water footprints have been calculated and analysed to reduce environmental effects. Interviewees of the sector reported that sustainability aspects will become more and more important in the future, and their customers in the retail sector are already requiring sustainable certification of food production. The consumption of meat is seen to decrease in the future, and plant-based raw materials were seen to increase. Also traceability of food was anticipated to increase.

Representatives of feed production companies value sustainability very high, and they addressed that sustainable business includes, in addition to environmental aspects, also economic and social/ethical standpoints. There is a constant search for novel ingredients for feedstock, and everything based on the utilization of side streams were considered very interesting. They reported that sustainability is especially crucial for their advanced customers, who are increasingly driving the interest of markets towards sustainable products. Traceability, certifications, sustainability of raw materials (ingredients) and their production are becoming increasingly important. However, the environmental sustainability cannot take place at the expense of economical sustainability. Price is important.

Sustainability in terms of environmental, social and economic dimensions were regarded as a central strategic theme also by interviewees from retail, restaurant and catering. Their customers were seen to have great interest in products that guarantee environmental sustainability. However, it was mentioned that the price of a product is more important than sustainability aspects. Covid-19 pandemic has led consumers to pay even closer attention to product prices. Vegan diet was seen as a trend that will grow in the future. Some interviewees saw a possibility that someday meat, poultry and plant-based food choices would be equally common with each other.

Interviewees from fish farming made no difference to the representatives of other sectors in stating the importance of sustainability to them and to their customers. Their customers were reported to choose sustainable and bio-certified products. The interviewees constantly work on increasing sustainability by promoting short supply chains and making customers aware of environmental issues. They saw that taking sustainability into consideration in terms of environmental aspects and the welfare of animals is essential. However, also they reported that, due to Covid-19, in the end the price of product matters most for their customers.

5.2 Views on NextGenProteins

In this section, selected views of the interviewees regarding NextGen proteins and their production technologies will be presented. The views are grouped to strengths and opportunities and to doubts and challenges related to the protein questions. The views are reported sector by sector, like above. More findings from the interviews can be found in Annexes II-V.

5.2.1 Spirulina microalgae

Strengths and opportunities

Interviewees from food production companies regarded spirulina microalgae to have a positive image, as it is already used in food. Because it is already familiar, it was seen very likely to reach consumer acceptance. In terms of composition, spirulina microalgae was seen to have good amino acid composition. The production method was considered to be good and sustainable in terms of energy efficiency and the use of natural resources. Several interviewees expressed their interest in using spirulina microalgae in food applications.

Representatives of feed production sector, in general, expressed microalgae to be an interesting source of protein. They stated that it has a good status, it is already accepted by the EU, it has already been in use, and it has a trendy image. Spirulina microalgae was seen as a good source of nutrition and an alternative to replace soy. Its potential for fish feed was especially mentioned due to its good profile of fatty acid for fish. Interest in using it in feed was commonly mentioned if the production will be sustainable.

Interviewees representing retail, restaurant and catering saw spirulina microalgae as a protein source of the future. It was seen as a good source of nutrition, and it could be available in a form with higher degree of processing than powder. Some already had positive experiences with the ingredient, and it has an image of natural product because algae occur in nature. A sustainable circular production system was seen interesting, and there was interest in working on a pilot project with the spirulina microalgae.

Interviewed representatives of fish farming sector from Italy reported that spirulina microalgae has already been used and that is a good alternative source of protein and fatty acids. It was seen to bring benefits in reducing environmental impact. For the interviewees, it was important that the ingredient positively affects the growth performance and the quality of final product, and they saw no major risks related to the use of microalgae in fish farming.

Doubts and challenges

Regarding doubts and challenges related to spirulina microalgae, representatives of food production expressed their concern on price issue: microalgae was seen expensive to acquire. They saw a risk in consumer acceptance because algae do not give a delicious mental picture. They were also unsure about the greenish colour of microalgae and highlighted that taste and texture play an important role in consumer acceptance. If it will be offered in the form of pill or powder, it will remain as an additive. Communication was seen essential to explain how the product can be used and what are the benefits of spirulina microalgae.

Interviewees from feed production companies expressed their concern on the cost of spirulina microalgae for feed applications: economical sustainability in feed production should be supported. Also the availability of the alternative protein arose concerns. Volumes of protein demand are high in the feed sector. Some interviewees were worrying whether the production technology would be resource efficient (energy for light, CO₂ and heat) outside Iceland.

Representatives of retail and restaurant sectors saw that spirulina microalgae may become a marginal product and will be seen only as a health product. They were also concerned about the production process and its sustainability, because the process requires a lot of energy. All environmental impact factors should be counted. Interviewees also highlighted that products including spirulina microalgae should be economically sustainable, which could become a big barrier for entry to global markets. Communication was seen essential in promoting products including spirulina microalgae.

Quantities of protein ingredient to be needed in fish farming will be high. Therefore, economical sustainability, i.e. price, was of high concern among the interviewees from fish farming. For them the real potential of the protein source depends on its price. They also stressed the importance of communication when entering markets.

5.2.2 Insects (crickets and black soldier flies)

Strengths and opportunities

Interviewees from food production saw the production method (farming with underused plant food biomass) interesting. Many expressed their interest in using the protein source in food applications, if the production is completely sustainable. Insects were seen as a fast way of protein production. Reflecting on previous experiences with food applications of crickets by some of the interviewees, they said that their comeback into the business of cricket food could be possible but somebody else should first do a successful market entry.

Interviewed representatives of feed production highlighted that insect are good quality sources of protein and fatty acids. The production method was found interesting, and many expressed their interest in using insects if the production is made completely sustainable. If the nutrient content is good and legislation allows their usage in feed, they saw no ethical risks. The potential of insects for fish feed was also seen, and the protein source is already being used in pet feed.

Also representatives of retail and restaurant sectors considered the insects farming with underused plant food biomass as an interesting and sensible way of protein production. Some interviewees were familiar with insect protein and had have collaborations with producers. Previous experiences with food products including insects were seen being ahead of time, but they could indicate that it may become a phenomenon in the future. Insects were regarded to be one of the protein sources of future, as planet's resources will be overexploited. Further piloting with the insect protein was seen as an interesting possibility to understand the yield and possibilities in large-scale distribution. Powder was seen to be the most probable form of insect protein for consumers to accept.

In fish farming interviewees saw insect protein very promising and interesting from a nutritional point of view. They regarded it as a good alternative protein source to partially replace fish meals in farming. Some testing had already been done with excellent results of performance. They highlighted positive effect to growth performance of farmed fishes and to the quality of final product.

Doubts and challenges

Regarding doubts and challenges related to insect protein, the interviewees pointed out several factors of concern. Representatives of food production expressed their concern related to the legislative framework. They highlighted challenges of attaining consumer acceptance. Insects are not seen as a part of culinary culture, and they do not bring a delicious image. Regarding the production process, some interviewees mentioned that consumers may see this as industrial farming, which is energy and resource intense. Some were concerned about possible allergens. It should be exactly known what has been fed to the insects. Interviewees were also concerned that for some consumers the description of production technology, i.e. is food and waste (by-product) in a same sentence, can be disgusting. Consumers might also see insects as pests, which affects negatively impacts their attitude towards these proteins. Insects were seen difficult from a marketing point of view – a lot of communication is needed to convince the consumers. Producers of these proteins need to create a convincing commercial story on why consumers should change their habits and starts to eat insect ingredients. The logic of sustainability behind the method needs to be storified to demonstrate the benefits of growing insects on bio-waste (to save natural resources).

Representatives from the feed production sector were also concerned about legislation aspects related to the use of insect protein, and whether the legislation will allow utilizing of food waste stream in the production process. Other doubts concerning the production process were related to the costs of production, energy to be needed, ensuring of hygiene during the process. Some mentioned challenges in utilizing all parts of crickets as raw material. The use of larvae of black soldier flies was seen easier in this sense. The availability and cost of insect protein were commonly seen as challenges and potential barriers. The acceptance of consumers was also mentioned as a concern. German interviewees brought up a barrier that insects are not within the Halal certification of Muslims, meaning that Muslims will hardly ever use insect protein in food or feed.

Interviewees from retail and restaurant sectors shared the major concern of other interviewees and were doubtful about the cost of the protein source. They also highlighted challenges with consumer acceptance in the case of insect protein. Consumers consider insects odd. Insects are not delicious or a part of culinary culture. Eating of insects could be seen as eating animals, which makes them unsuitable for vegans. Insects were seen to fall somewhere in the middle; not suitable for vegans, but neither meat eaters like to eat them. Earlier trials with food applications of insect protein were reported to have failed to produce long term benefits. There were also prejudices on the quality of insect and their nutritional value, and interviewees pondered the shelf life of insect products. Regarding the production of protein, it was seen important to utilize underused plant food biomass instead of soy, but some were concerned on what is fed to the insects.

Representatives of fish farming highlighted the need for large quantities and expressed concern on the availability of the protein for their needs. Current price of insect protein

ingredient was also seen to be too high. Regulatory risks were mentioned. Good quality has to be ensured, otherwise products can become unsafe. Interviewees reported prejudices about the quality and expressed their need for more information. They also saw that, in the case of insect protein, there are more benefits to the environment than to the growth performance of fishes.

5.2.3 Torula yeast (single cell protein)

Strengths and opportunities

Regarding the torula yeast protein, representatives of food production saw torula yeast as an interesting protein source with an obvious market potential. It has potential to enrich plant-based products and, in the form of powder, to increase protein level in food applications. It was seen to be a good option for vegans, but also to have potential to become something more. From a nutritional point of view, it was seen to have an interesting amino acid spectrum and high nutritional value. Finnish interviewees highlighted a branding possibility of forest food due to the close relationship of Finnish people with forests. Domestic protein sources replacing meat were considered very valuable.

Interviewees from the feed production sector regarded torula yeast to be the most interesting and potential alternative protein for feed applications, especially for fish feed. Torula yeast was seen to have high nutritional value and a very good amino acid profile, and it was regarded easy to digest, especially for fish. It was identified as a good source of protein also for poultry from a nutrition point of view. Some interviewees expected that the cost of torula yeast protein would be competitive, and they were optimistic that high enough of volumes could be produced. Feed regulation was mentioned of not being a major issue. Many expressed interests in using it in feed applications, if the production is sustainable. Some experimental work was already going on. Like Finnish interviewees from food production, Finnish feed producers saw torula yeast to have a great brand value, as Finland was seen to live from the forest. They also regarded it as a good domestic protein source to replace soy.

Interviewed representatives of retail, restaurant and catering sectors saw torula yeast as an interesting alternative protein source of future, especially in the context of meat substitutes. Some interviewees were familiar with it and had contacts with producers and their suppliers. There was also eagerness to work on pilot projects and to test the final product. The bioconversion process was seen interesting and the by-product aspect was highlighted – not to take something directly from wood but utilizing available by-products. The potential was (again) seen especially by Finnish interviewees due to the close relationship with forest.

Representatives of fish farming regarded torula yeast to be the best alternative protein source from a nutritional point of view and saw it as an excellent protein source to partially replace meals of fish in farming. The bioconversion process in the production was seen very interesting. Some experience of utilizing the protein source was mentioned. Interviewees did not believe that there are special risks in using the torula yeast protein source in farming as long as it positively affects the growth performance and, thus, the quality of the final product.

Doubts and challenges

Regarding doubts and challenges related to torula yeast single cell protein, representatives of food production sector saw the legislative framework as a potential challenge. They were concerned about a possible negative impact on sensory and functional properties. Consumer acceptance was also seen as a potential barrier. In this context, it was seen important to ensure the deliciousness of final product. Taste, texture, appearance and cost are important factors to consider from the perspective of consumers. Some interviewees were worried about how consumers associate with wood. Special attention should be paid to the way of communication to consumers: talking about biomass could make a hurdle of communication too high. Regarding the production method, there were concerns about the use of alcohol in the yeast extract, which could affect certifications (e.g. Halal for Muslims). Some interviewees were unsure about the extraction process, and the production method was seen very abstract. There was also concern of having pesticides or unhealthy substances in the raw material of wood, and a need for safety studies was expressed.

Although some interviewees from feed production were not concerned about the price of torula yeast, there were others who have a fear that the price could become too high. Some also had doubts about the possibility to produce torula yeast on an industrial scale - the availability of the protein was seen as a possible bottleneck. Interviewees considered it important that the real impact of the production process in terms of CO₂ is determined. Some were concerned about the possibility of accumulating unhealthy substances from the raw material (wood biomass). One interviewee reported farmers being suspicious of feed containing single cell protein, because that had not been of good quality in the past.

For some interviewees from retail and restaurant sectors, the protein source and its market price were unfamiliar. Some reported that the availability of protein and its price could be possible bottlenecks. They were also curious about the shelf-life of products containing torula yeast. In a short term, some interviewees did not see it possible to utilize products made from torula yeast, because the production method requires explanation. In order food applications of torula yeast to broadly enter markets, communication and explanation of the protein and its production to restaurant keepers and consumers will be needed.

Low availability of torula yeast protein was seen as a big challenge by interviewees from fish farming. Their need is for large quantities. They highlighted the importance of price and supporting economical sustainability. Some interviewees were unfamiliar with torula yeast and did not know what to think about it.

5.3 Expectations towards NextGenProteins

Generally, interviewees had an open mind to utilize and implement NextGen proteins. Interviewees from retail, restaurant and catering went even one-step further by saying that being a forerunner in this is beneficial for the brand of actors having sustainability in focus. Each NextGen protein was seen to have business potential.

NextGen proteins were seen to open opportunities to create a new range of food products and to enrich plant-based products. The whole food system will change: field production of

food will be accompanied by reactors to save natural resources. NextGen proteins were expected to provide a way to reduce carbon footprint. Due to the COVID-19 pandemic and consequent problems in global supply chains, it was seen important that these kinds of solutions could be produced in a home country to ensure the security of supply. In particular, insect protein was seen attractive in this context, because it could be produced locally in small batches.

It was seen important that both producers and consumers fully understand nutritional and environmental benefits related to the alternative proteins. A lot of information is to be needed in a near future to raise awareness throughout the supply chain of food. Without sufficient information, there will be no interest into the alternative protein sources, even though they would have brilliant nutrient content. The change in the minds of consumers will be the most important factor in the acceptance of new protein sources. Massive marketing and communicating will be needed to reduce prejudices. In relation to this, branding of NextGen proteins was seen as one tool to increase consumer acceptance (for example, chicken fed by Torula). The clarity of consumer acceptance in advance was seen highly important. Until it is established, there may not be high interest in investing to the development of applications with alternative proteins.

Food producers as well as representatives of restaurant and catering underline the importance of taste and daily routines related to food. Taste is the most important thing, and it cannot be too different from what the consumers are used to. Oat milk was brought up as a good example – nothing in the routines or cooking methods of consumer have to change, only the ingredient is different. Alternative proteins were mentioned to bring versatility to recipes created in restaurant and catering business. Ready-made meals were seen as a good approach for institutional kitchens, for example in the form of vegan steaks.

Interviewees from food production expect that details in the specification (like stability and microbiology, thermophilic spores) will be more sufficient and comprehensive. The nutritional and sensory properties of alternative proteins should be as good as in existing proteins, or even superior. The impact on sensory properties was seen important to clarify. Also safety studies on possible pesticides, heavy metals and plant substances with hormonal effect were seen necessary, especially for insect and torula yeast proteins.

The safety aspects were mentioned also by feed producers. In addition, they said that the fusibility of protein must be good and no extra phosphorus should be included. Functionality of the proteins should be clear and effective. The behaviour of proteins in the case of heating should be clarified.

The availability of the proteins should be guaranteed to avoid supply difficulties. Scaling up of protein production was seen as a major challenge. For large food and feed corporations high volumes and consistent production are essential. The price of the final product will also play an important role. The reality is that consumers will not pay more for products from alternative proteins, unless the product is essentially better than the old one. The same applies for the producers of feed and for farmers. Finally, it was underlined that the legal framework must be clear to make the utilization of NextGen proteins for human consumption attractive.

6 Findings of Survey

6.1 Views on Sustainability Aspects

The first substance questions in the survey (after the background questions) were designed to understand the importance and role of sustainability in the business of respondents. This knowledge on business stakeholders' attitudes is very important for the design of business from alternative proteins, as one of the fundamental ideas behind the alternative proteins is to increase the environmental sustainability of protein production for food and feed. The interview study revealed that, in order just to focus on environmental sustainability, one should have a more holistic approach to sustainability. Therefore, we asked the attitudes of stakeholders to three dimensions of sustainability: environmental, economic and social.

Concerning the set of questions, how important the different dimensions of sustainability are for respondents' companies, almost all respondents mentioned that they are either very or extremely important, Figure 1. Most respondents said that both environmental and economic dimensions are extremely important for them. All respondents from the retail and restaurant sectors mentioned that economical sustainability is extremely important for them. Note that sectoral answers to the survey can be found in Annex VIII for three combined business sectors of food and feed value chain: food producers, feed producers, and retail and restaurant.

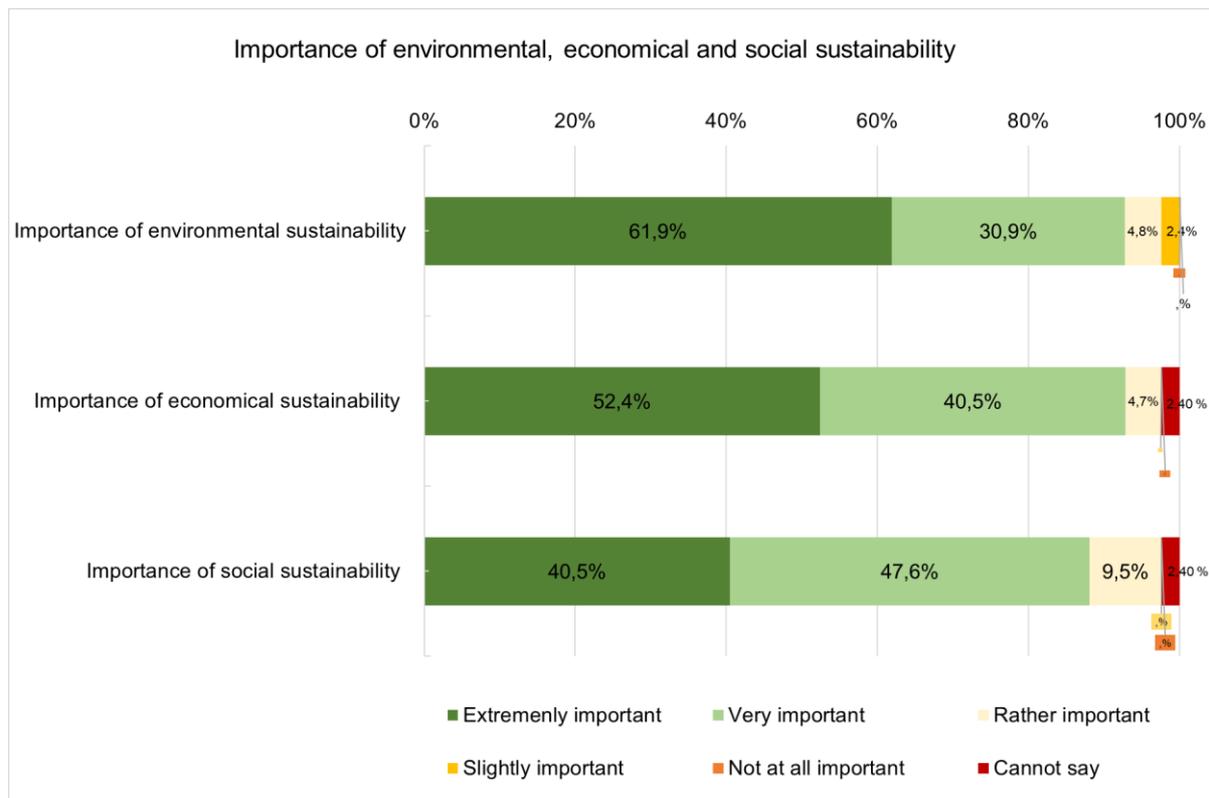


Figure 1. The importance of environmental, economical and social sustainability at respondent's company.

In the next set of questions in survey, it was asked that what is the role of sustainability (all three dimensions separately) to the company of respondent. Here the alternatives of answers were directed to receive understanding on the strategic role of different sustainability dimension in the practices of company: do the companies just respect mandatory rules and laws, do they think of being at a basic level of integrating sustainability to their business and considering the impact of sustainability to their business activities, do they actively consider the sustainability aspects beyond industry average, or have they done outstanding efforts towards sustainability.

The answers to the role questions were quite independent on the dimension of sustainability, Figure 2. About half of the respondents actively consider sustainability aspects beyond industry average, and around 30% said that they have done outstanding efforts in all three dimensions of sustainability. Regarding sector-specific answers (Annex VIII), no major deviation to this could be observed (taking into account the low number of sectoral answers).

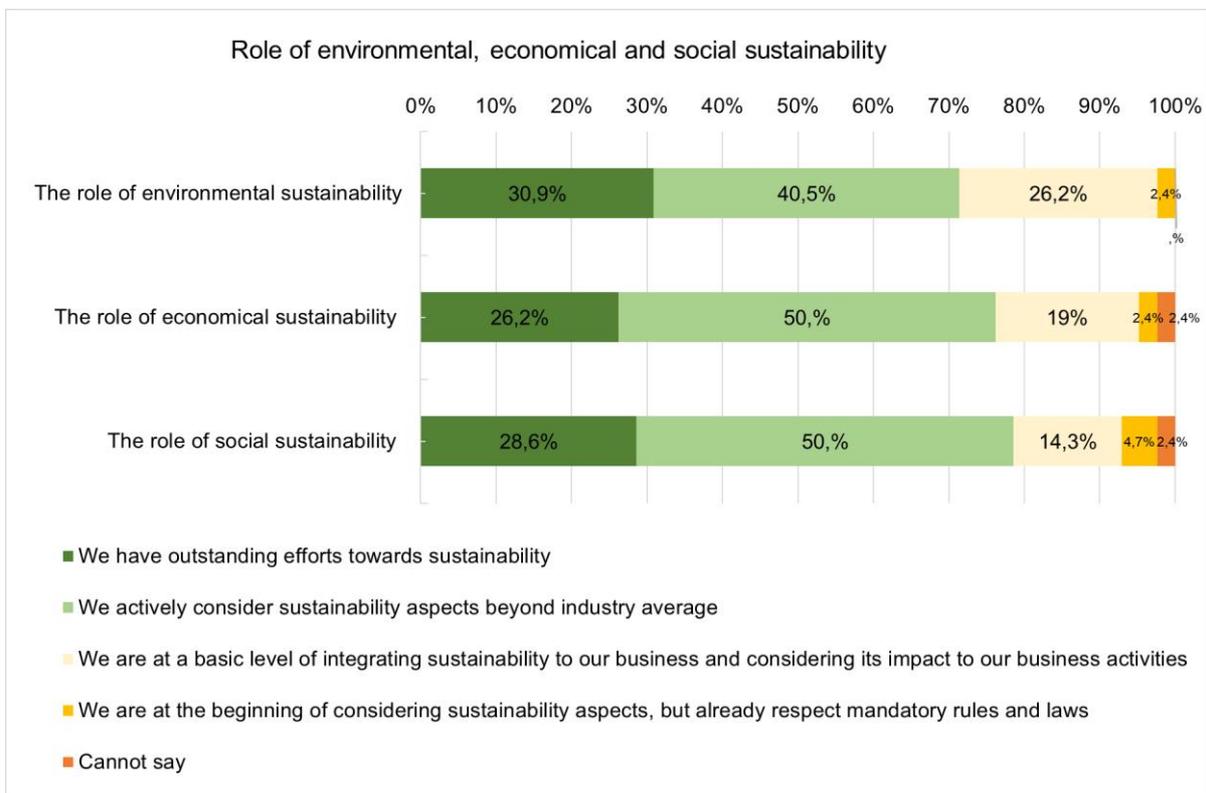


Figure 2. The role of environmental, economical and social sustainability at respondent’s company.

6.2 Views on NextGen Proteins

In this section, respondent’s views on each NextGen protein will be described. The questions regarded the familiarity with the protein and its production process/technology, as well as perceptions of benefits and risks related to each of alternative protein. The NextGen proteins and their production methodologies were briefly described before each set of questions. The results are presented below.

Spirulina microalgae was recognized by most of the respondents, Figure 3. Respondents reporting to have tested or are already using spirulina microalgae or a similar protein source came mostly from food production (Annex VIII). Regarding the production technology, most respondents had heard about it and some were familiar with it, Figure 4.

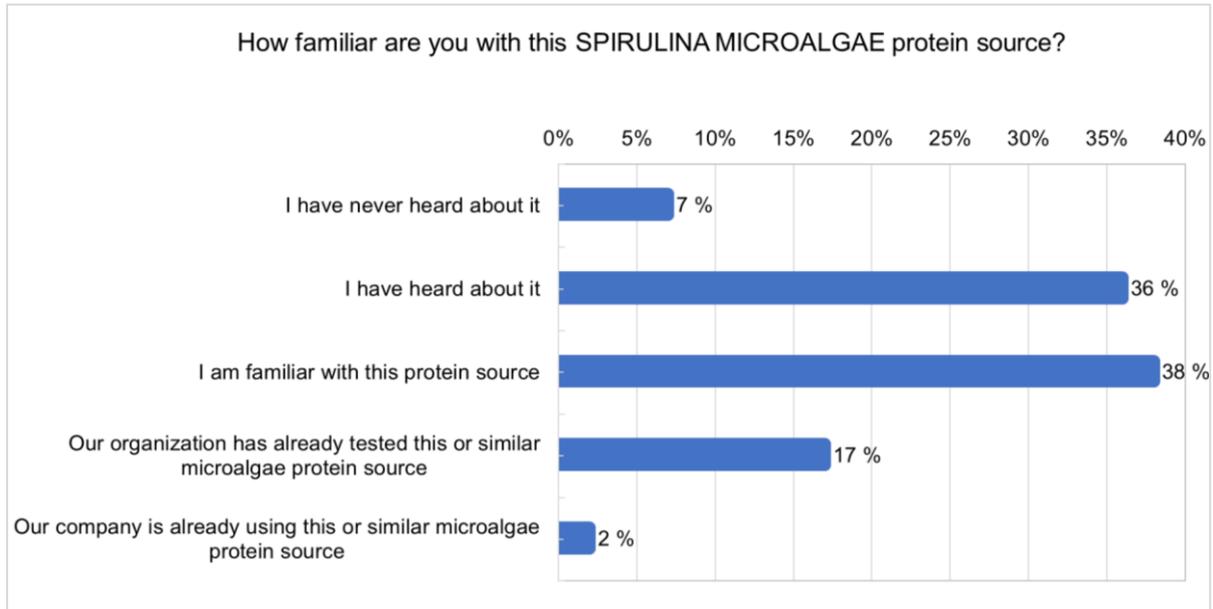


Figure 3. The familiarity of spirulina microalgae.

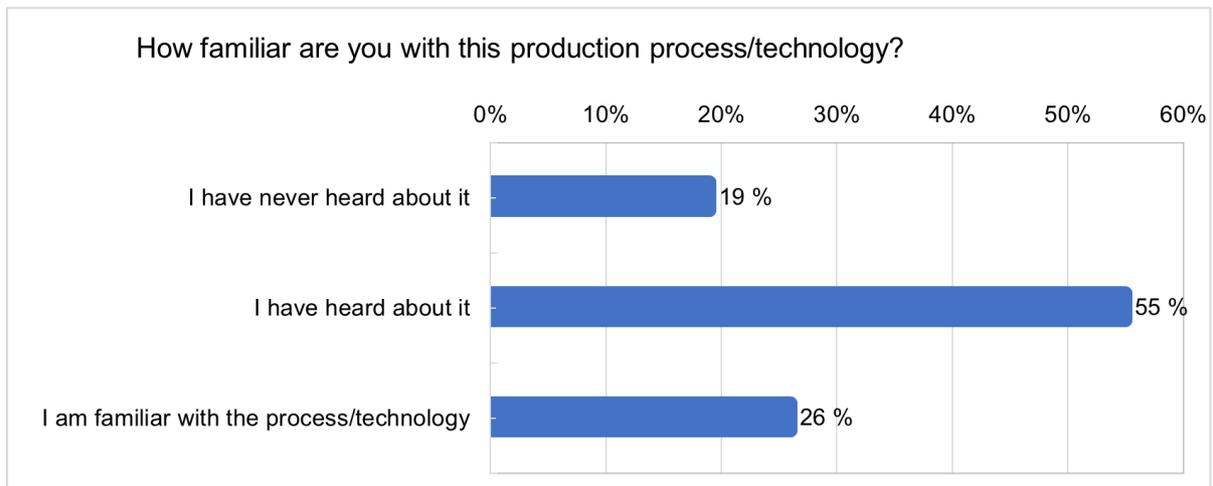


Figure 4. Familiarity with the production technology of spirulina microalgae.

Next the respondents were asked about their views regarding possible benefits of spirulina microalgae protein produced using CO₂ emissions. The views were requested related to six given aspects. The results can be seen in Figure 5. In general, the most common answer (mode) was 'I do not know'. There were two exceptions. For the statement "beneficial to consumer choices, the most common answer was 'likely', and for the statement beneficial to environmental sustainability the mode answer was 'very likely'. From the results we can also see that the overall attitude towards the benefits of spirulina microalgae is much more

positive (likely) than negative (unlikely). Regarding sector-specific answers, representatives of food production saw more often benefits of spirulina microalgae for their company and their product than other sectors (the mode of these statements was ‘likely’ for the respondents of food production companies).

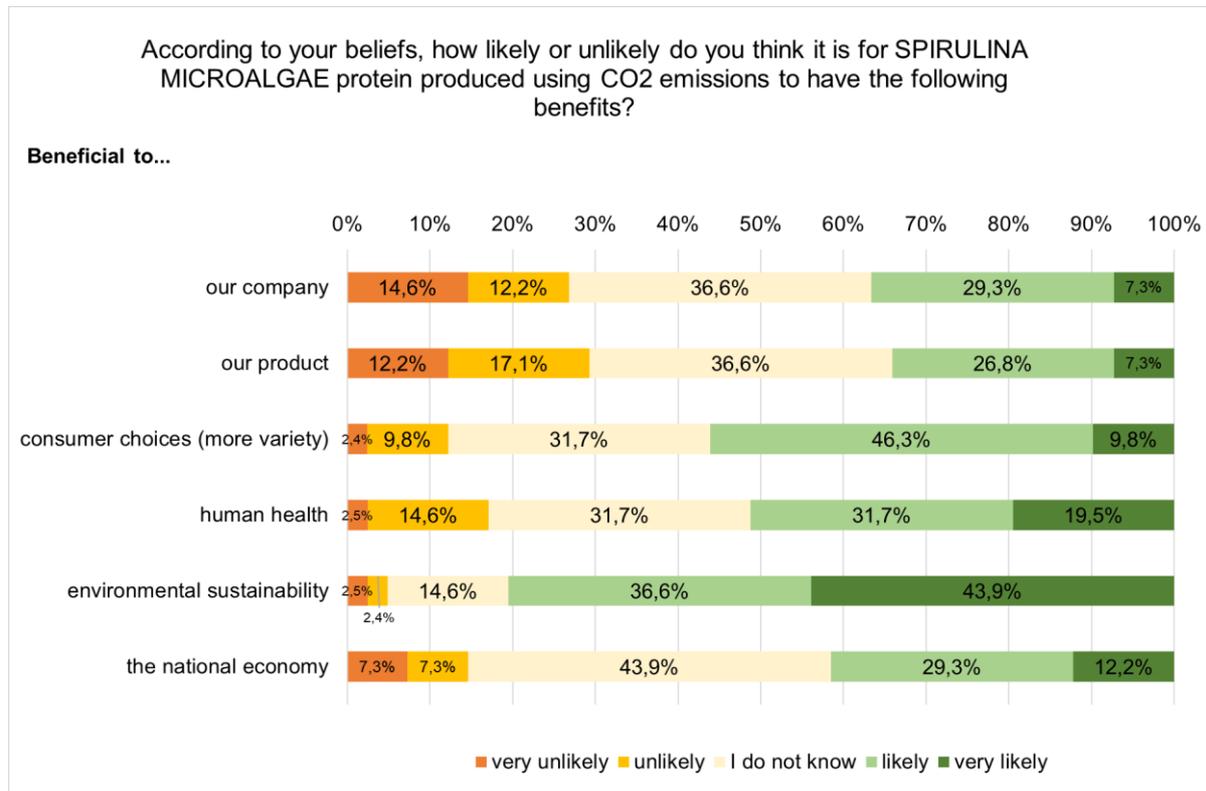


Figure 5. Perceptions of possible **benefits of spirulina microalgae** protein source.

The respondents were also asked to evaluate their concerns on possible risks of spirulina microalgae in respect to the aspects given in the survey. The results are presented in Figure 6. Perhaps the most important overall finding from the answers is that the dispersion of answers is large. There are roughly as many people who are concerned about risks related to spirulina microalgae protein produced using CO₂ emissions than those who are not concerned about the risks. The risk of not being accepted by consumers and that the price of the protein ingredient would be too high to be competitive were seen to be of most concern (there the mode was ‘I am concerned’). For the questions related to safety issues (both food and feed), the mode of answers was ‘I am not concerned’. From the sector-specific views on the risks of spirulina microalgae produced using CO₂ emissions (Annex VIII), it is worth to point out the particular concern of representatives of feed sector about the risk that the protein ingredient will be too high to be competitive for their company. There the mode of answers was ‘I am extremely concerned’.

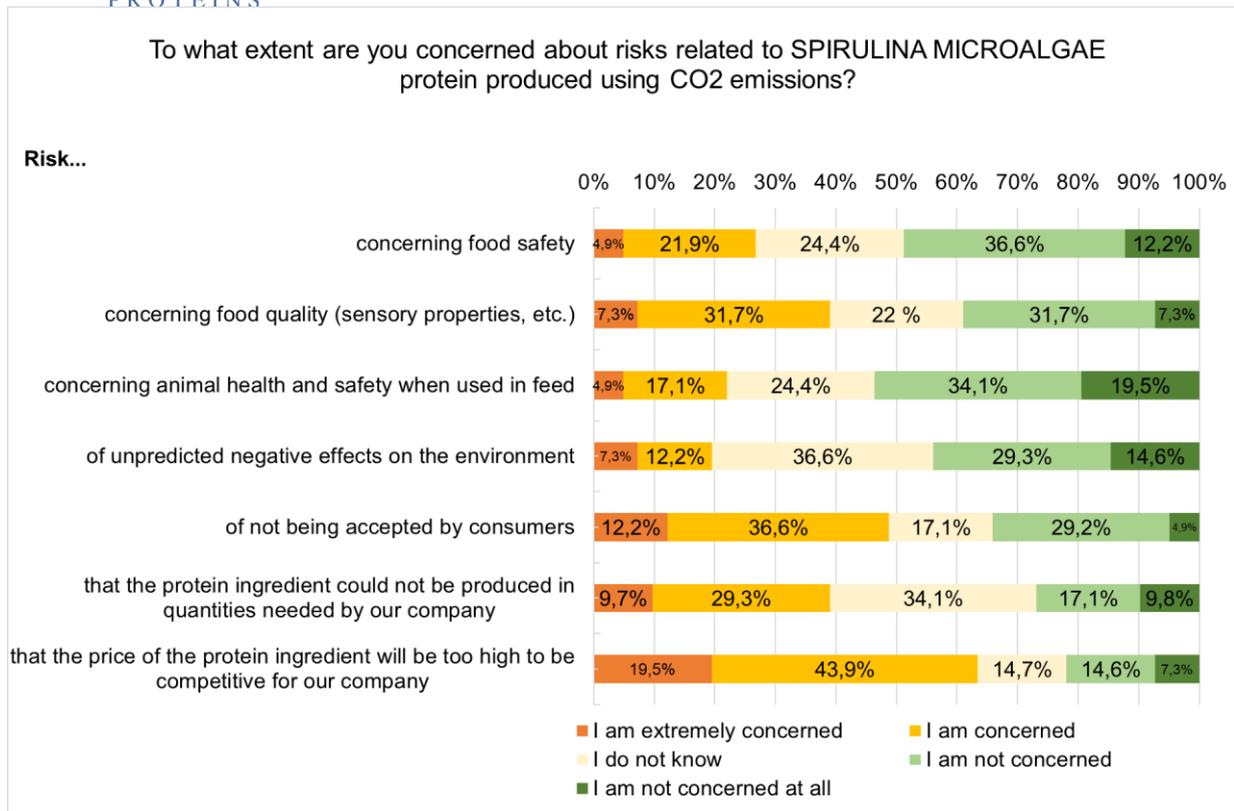


Figure 6. Perceptions of concerns regarding risks of spirulina microalgae protein source.

6.2.2 Crickets

Almost all respondents have at least heard about the cricket protein source, Figure 7. Most of the responses reporting to have tested the source came again from food production (Annex VIII). Regarding the production process/technology, the mode of answers is 'I have heard about it', as can be seen in Figure 8.

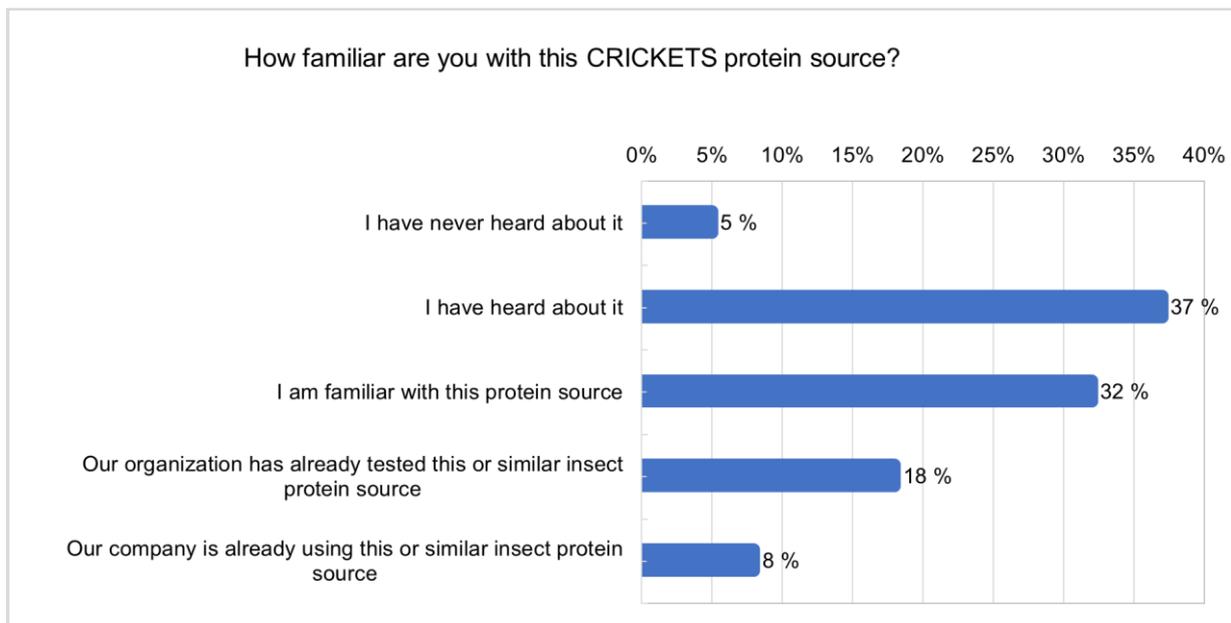


Figure 7. The familiarity of cricket protein source.

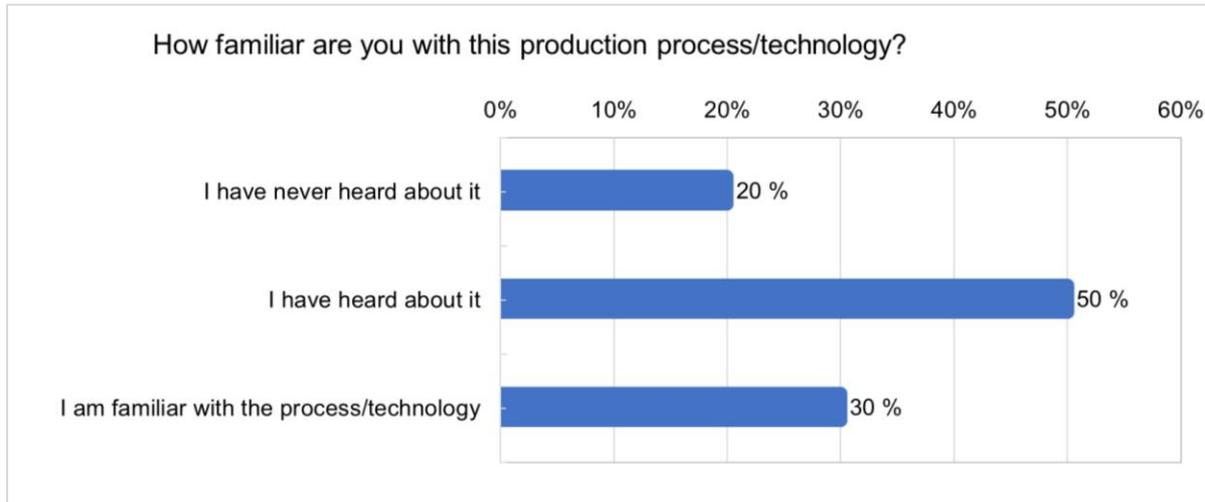


Figure 8. Familiarity with the production technology of cricket protein source.

Respondents' views regarding the possible benefits of the cricket protein produced using underused plant food biomass can be seen in Figure 9. The dispersion in answers was large. All the choices of answers were in active use. Only the benefits to environmental sustainability were recognized by most respondents (mode 'likely'). About half of the respondents saw it unlikely or very unlikely that cricket protein would be beneficial to their company or product. However, here it is important to point out that these two negative perceptions are, in part, due to very negative perceptions by feed producers, to whom the mode of answers to these two benefits was 'very unlikely' (Annex VIII). Among the food producing companies there were several who was looking forward to food applications from crickets. The retail and restaurant sector were really unsure about the benefits of cricket protein (Annex VIII).

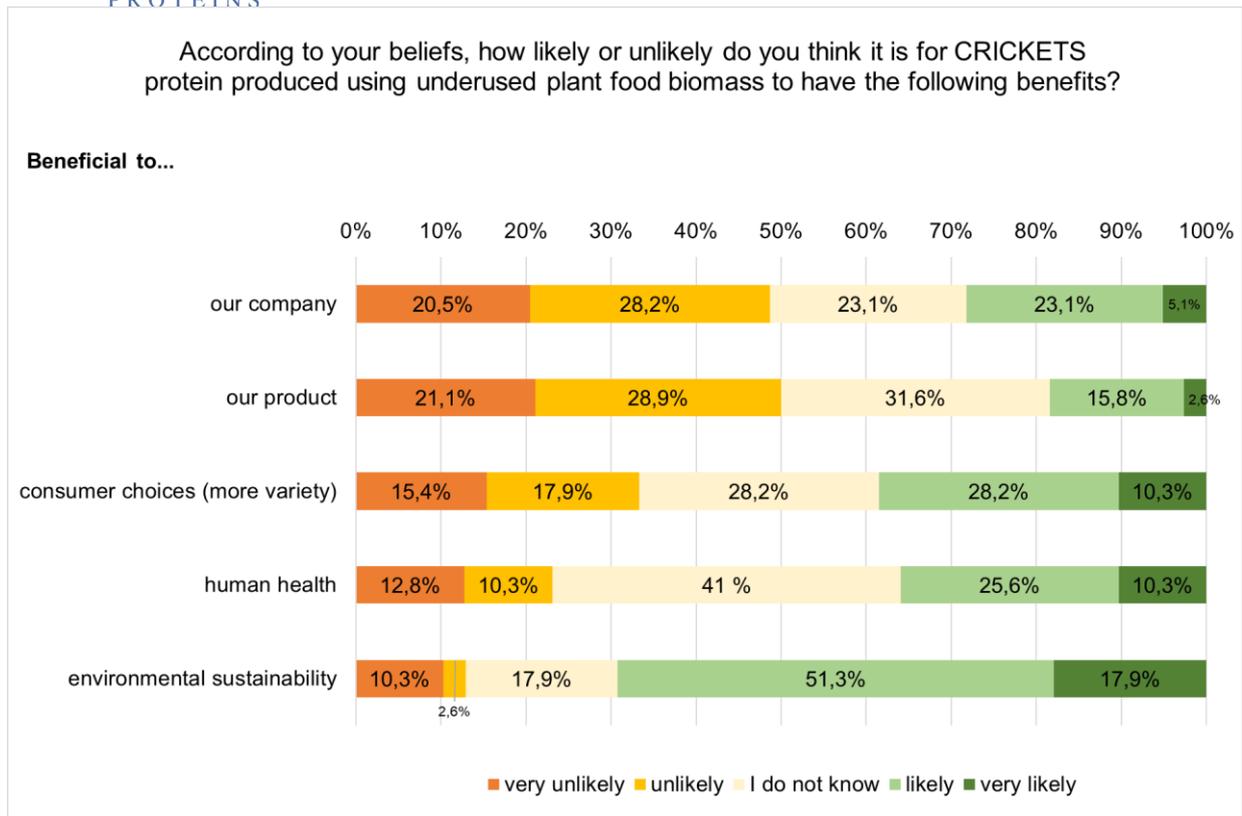


Figure 9. Perceptions of possible **benefits of the cricket** protein source.

Results regarding concerns the respondents have about the cricket protein source are presented in Figure 10. The overall impression from the figure is that the respondents are more concerned about the risks (negative attitudes) than of not being concerned (positive attitudes). Aspects where most respondents expressed to be concerned or extremely concerned were related to risks that the cricket protein will not be accepted by consumers and that the price of the protein ingredient will be too high. On the other hand, most respondents were not concerned about the risks related to animal health and safety when used in feed and to unpredicted negative effects on the environment (here the modes were 'I am not concerned'). From the sector-specific answers (Annex VIII), it could be highlighted that the retail and restaurant sector seem not to be concerned about food safety and quality related to cricket applications.

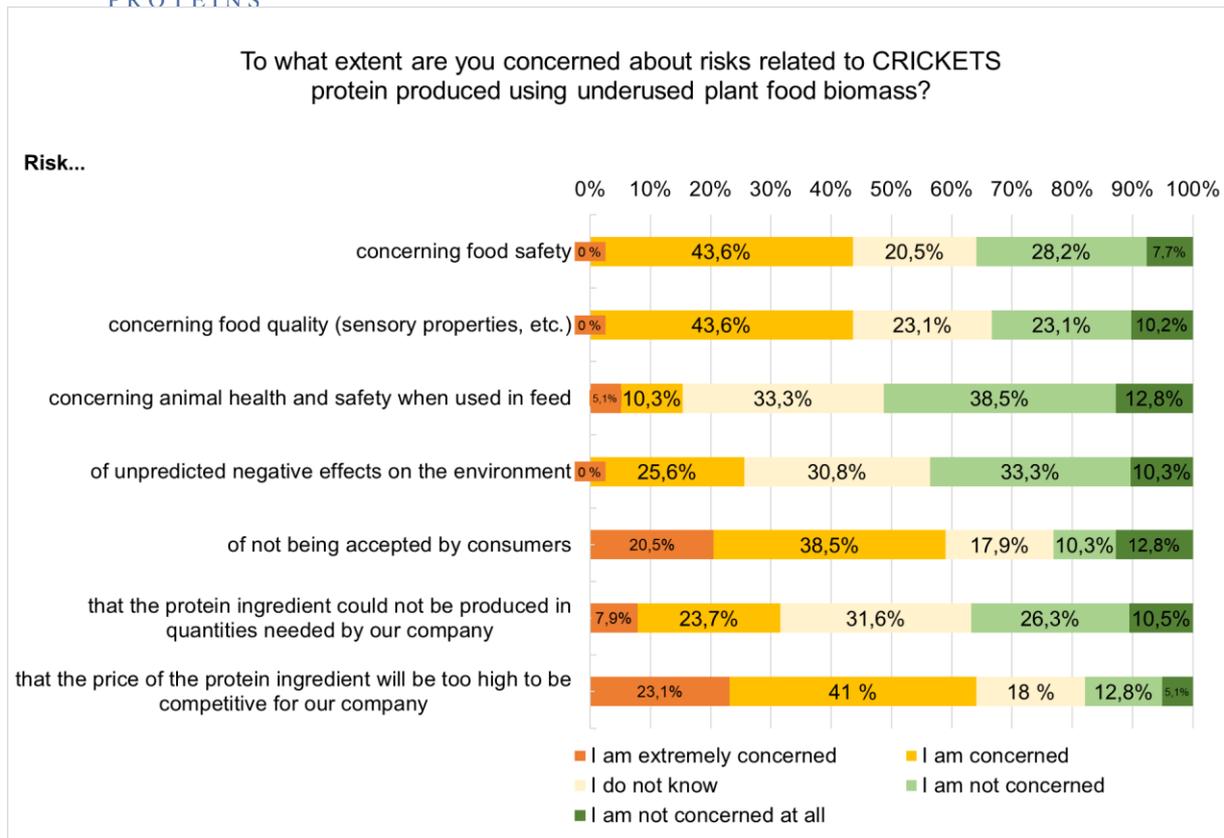


Figure 10. Perceptions of concerns regarding risks of cricket protein source.

6.2.3 Black soldier flies

Before going into the answers to questions concerning the *Hermetia illucens* larvae of black soldier fly protein, it should be noted that the number of responses dropped to 36. This drop was because the questions related to black soldier flies were directed to those interested in feed applications of alternative proteins. If that was out of the scope of respondents, they were allowed to go directly to questions related to torula yeast. That was because the technology developers for the production of *Hermetia illucens* larvae are aiming mainly to feed production markets.

When asked about the familiarity of *Hermetia illucens* larvae (of black soldier fly) protein source, most of the respondents reported having heard of or were familiar with the protein, Fig. 11. One third of respondents, however, reported never having heard about it. This figure is higher than the corresponding figures of spirulina microalgae and cricket protein. All of the respondents from the feed sector had heard about it, were familiar with it, and some had tested it or were already using it or a similar insect protein. Respondents, who reported to never having heard about the protein source, came from food production and retail.

Regarding the familiarity with the production technology (Fig. 12), most of the respondents had heard about it or were familiar with it, though about one third reported to never having heard about it. Respondents that stated never having heard about it came (again) from the food production and retail.

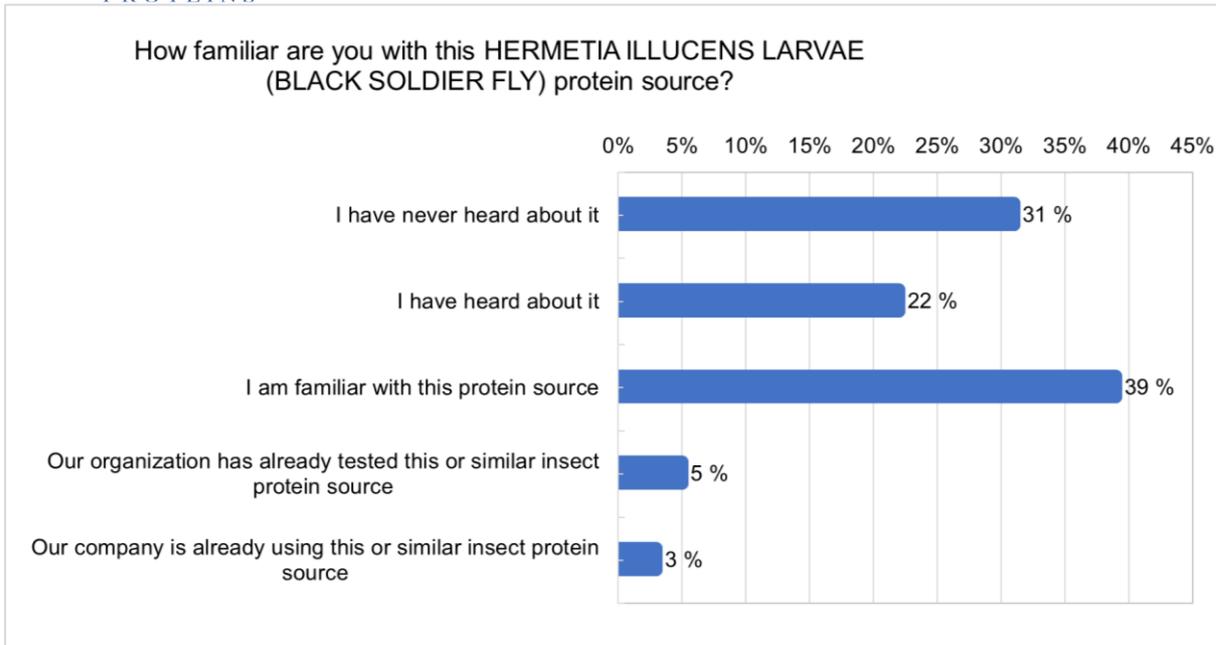


Figure 11. The familiarity of *Hermetia illucens* larvae (of black soldier fly) protein source.

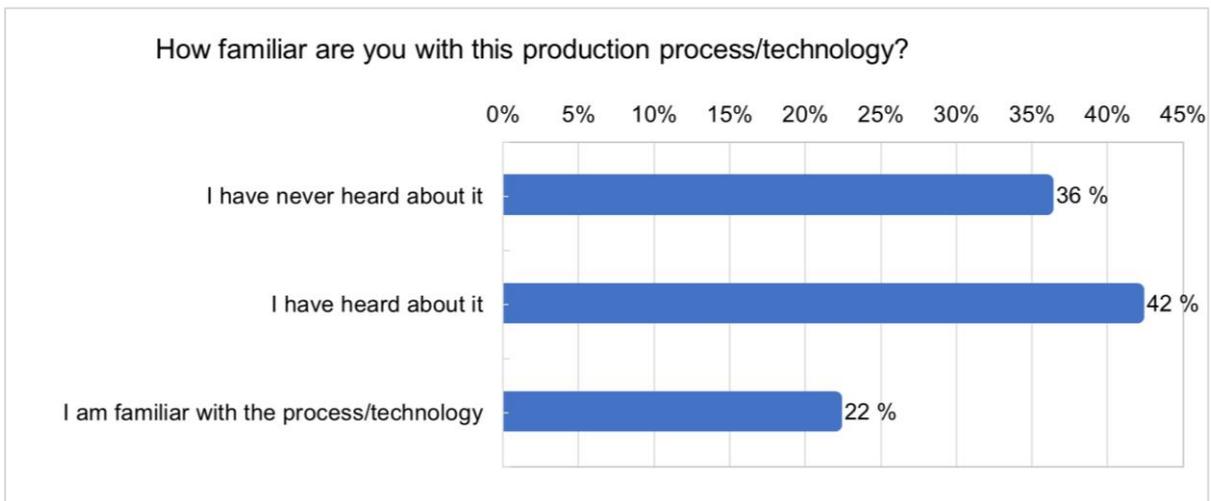


Figure 12. The familiarity of the production process/technology of *Hermetia illucens* larvae (of black soldier fly) protein source.

Concerning respondents' views on possible benefits of the *Hermetia illucens* larvae (of black soldier fly) protein produced using underused plant food biomass, a general unawareness is a statement expressing the status. The mode of answers was 'I do not know' to all other aspects than beneficial to environmental sustainability, where most respondents answered the benefits to be either likely or very likely, Figure 13. Representatives of food production companies have the most negative perceptions towards the benefits of this protein (Annex VIII). What is interesting is that representatives of feed production companies are very uncertain about the benefits of black soldier fly protein (the median of answers was 'I Do not know' to all the five aspects).

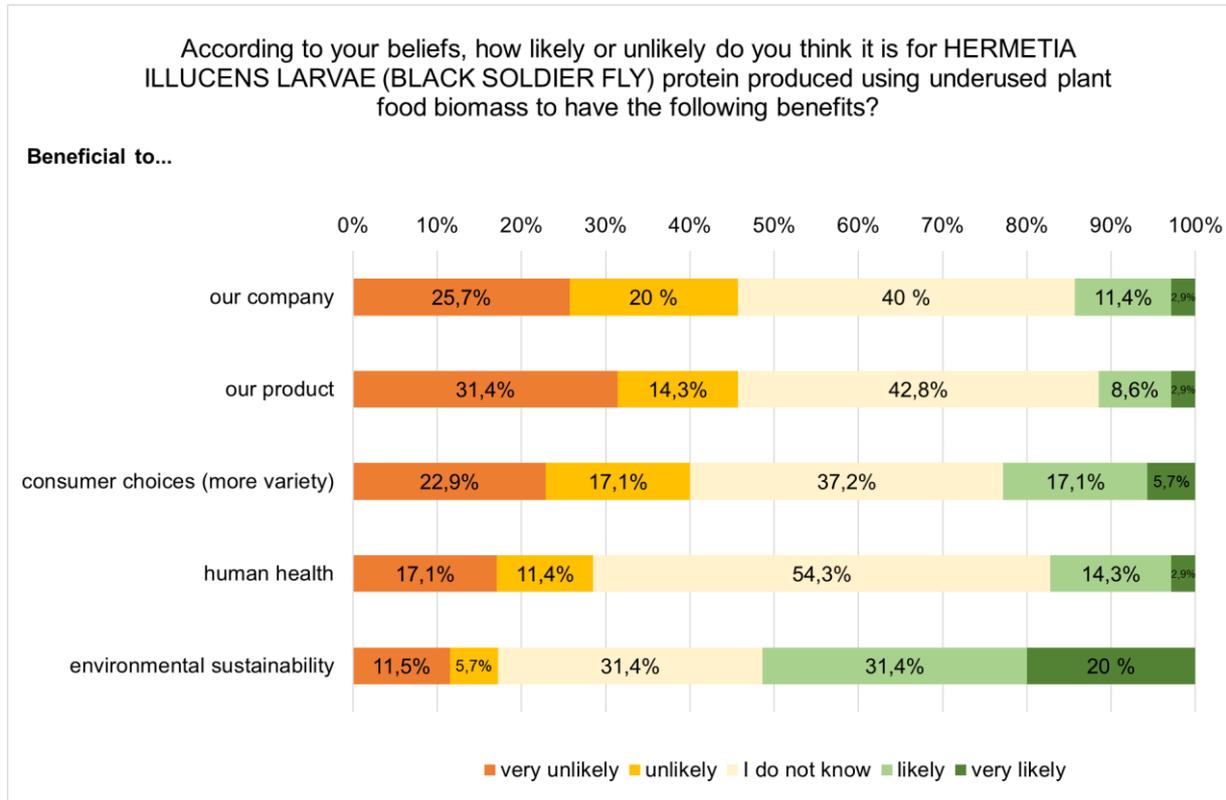


Figure 13. Perceptions of possible **benefits of the *Hermetia illucens* larvae** (of black soldier fly) protein source

The results regarding the concerns of respondents about the *Hermetia illucens* larvae (of black soldier fly) protein produced using underused plant food biomass are presented in Figure 14. The overall impression is quite similar to that of cricket protein. For both insect proteins, the respondents are more concerned about the risks (negative attitudes) than of not being concerned (positive attitudes). Perhaps the most important difference between the concerns related to these two insect proteins is that respondents are less concerned about the price of black soldier fly protein. In that aspect the mode of answers was 'I do not know'. Feed producers were, in general, less critical to this protein than food producers. The mode of feed producer answers was 'I do not know' for all the other potential risks than the risk concerning food safety, where the mode of answers was 'I am concerned' (Annex VIII).

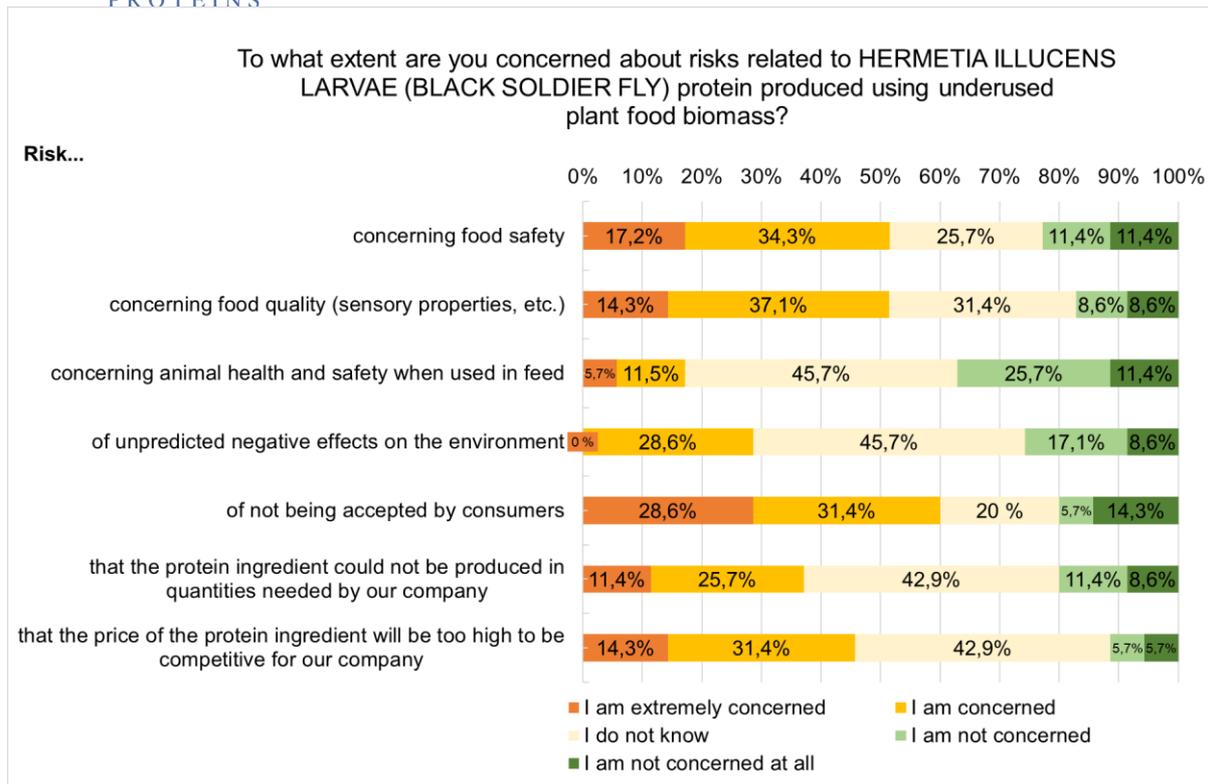


Figure 14. Perceptions of risks related to *Hermetia illucens* larvae (of black soldier fly) protein source.

6.2.4 Torula yeast

Regarding the torula yeast single cell protein source and its familiarity to the respondents, many reported to never having heard about it (41%). This was the highest number of responses related to the unfamiliarity of the protein sources. Still, most reported to either having heard about it, being familiar with the protein source or having tested it or a similar protein source or were already using it or a similar protein source (Fig. 15). When asking about the familiarity to the production process/technology, the figures were about similar, Fig. 16. The torula yeast protein as well as its production process/technology were more familiar to respondents from feed production than to respondents from other business sectors (Annex VIII).

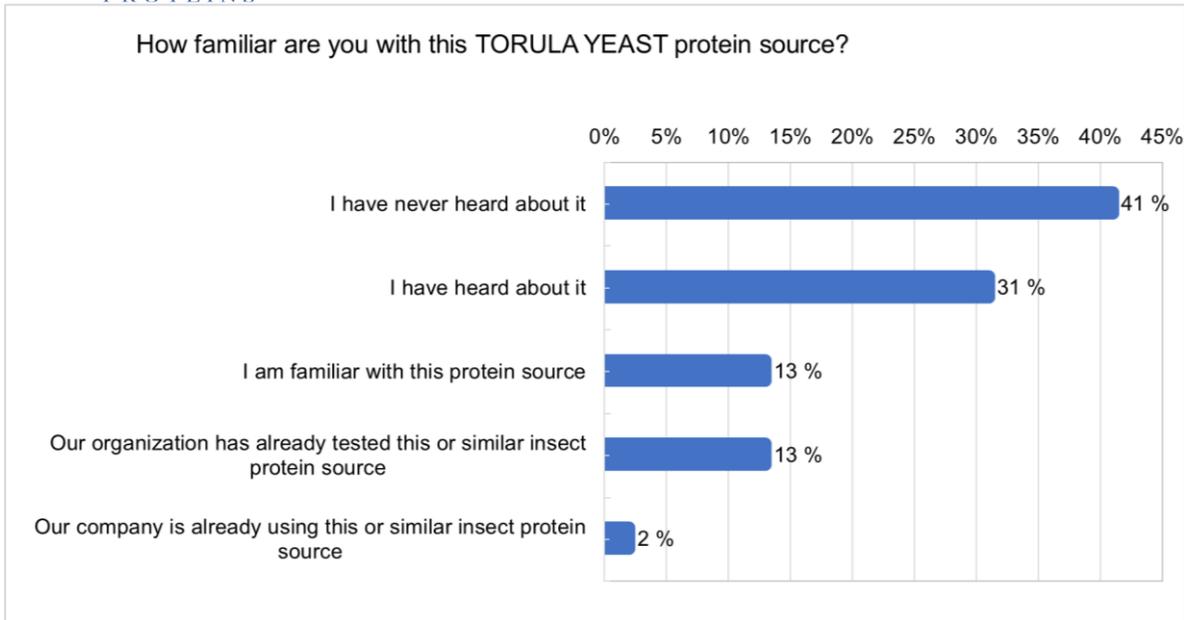


Figure 15. The familiarity of the torula yeast protein source.

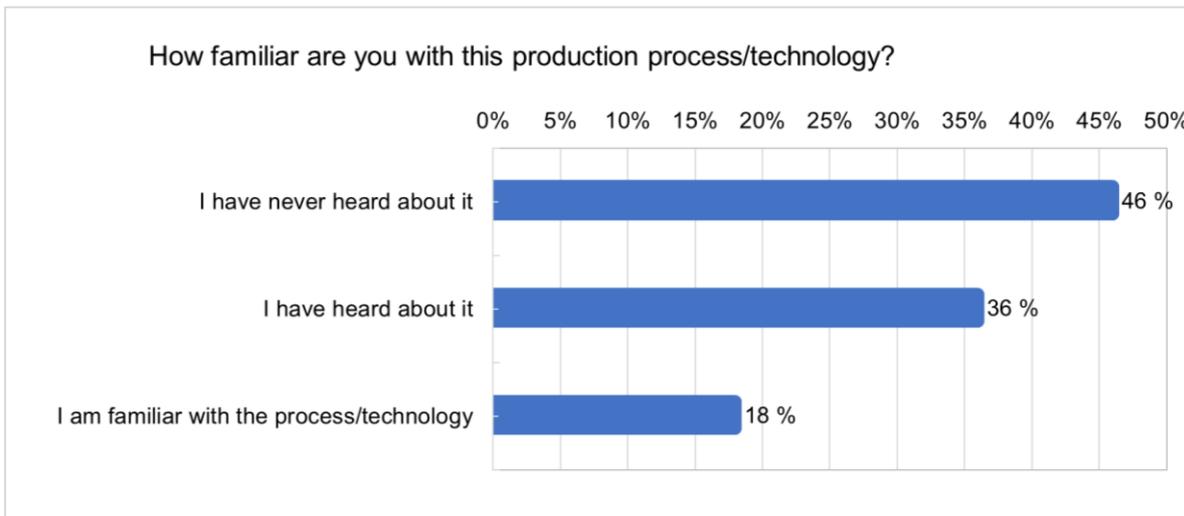


Figure 16. The familiarity of the production process/technology of the torula yeast protein source.

The views of the respondents on the possible benefits of the torula yeast protein grown with underused by-products from the forest industry are presented in Figure 17. From the Figure it can be seen that the respondents were unsure about the benefits of torula yeast. The mode of answers was 'I do not know' to all the other aspects than the benefit to environmental sustainability, where the mode was 'likely'. The overall perception to the benefits, however, was much more positive than negative to all the given aspects. From the sectoral answers (Annex VIII) it can be concluded that representatives of feed production anticipated the benefits of the torula yeast protein to be realized with higher likelihood than the representatives of other business sectors.

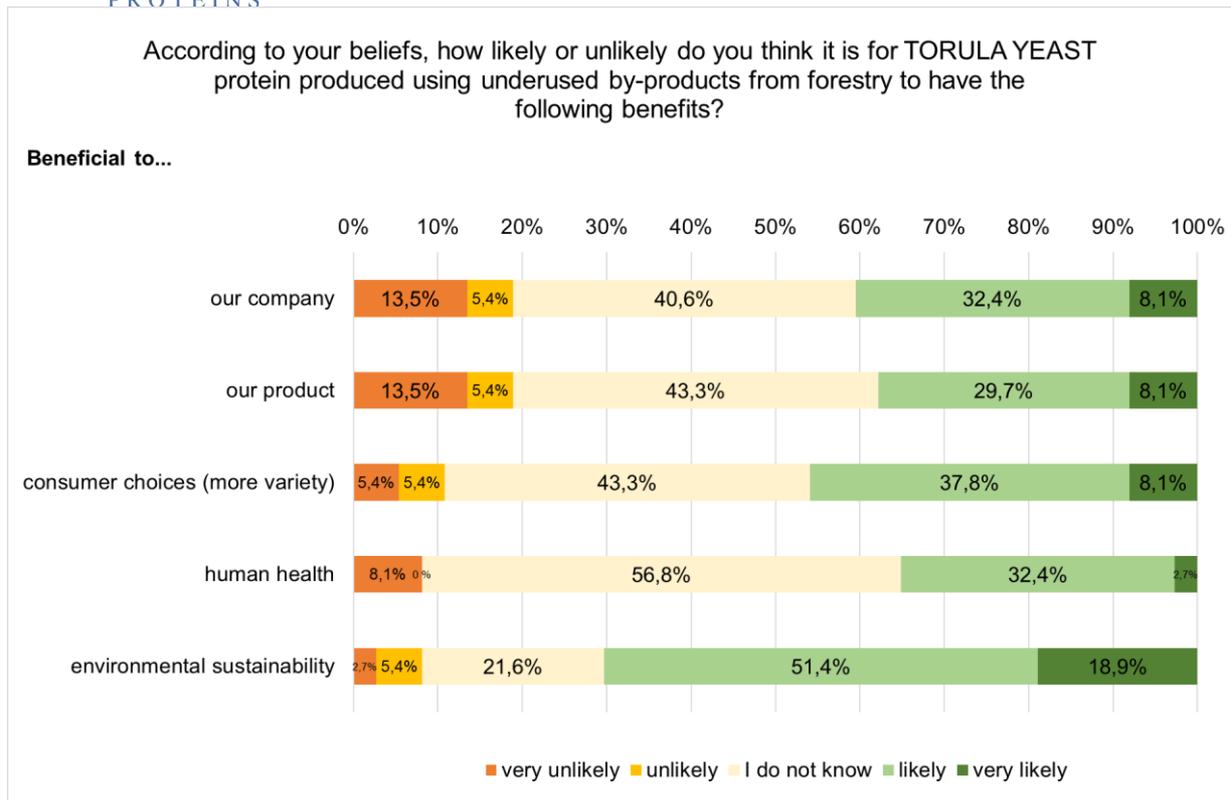


Figure 17. Perceptions of possible **benefits of torula yeast** protein source.

The results regarding the views on possible risks of the torula yeast protein grown with underused by-products from the forest industry are presented in Figure 18. An overall finding is that, for the potential risks related to the torula yeast, the respondents gave much less ‘I am concerned’ or ‘I am extremely concerned’ answers than to the other NextGen proteins. The exception to this was the question related to the risk that the price of the protein ingredient will be too high to be competitive for our company. Here most respondents expressed their concern about the price. Many respondents were also concerned about the sufficiency of production quantities using the described growth process for the torula yeast. Concerns on the food quality could also be mentioned, although here we are speaking about only one third of respondents. It is worth to point out that only one third of respondents expressed their concern (I am concerned or extremely concerned) that the torula yeast protein will not be accepted by consumers. This number is the lowest from all the NextGen proteins. Concerning the risk of consumer acceptance, the mode of answers for the torula yeast was ‘I am not concerned’. From the sector-specific views (Annex VIII) it can be highlighted that most feed producers were not concerned about the sufficiency of torula yeast production (mode ‘I am not concerned’).

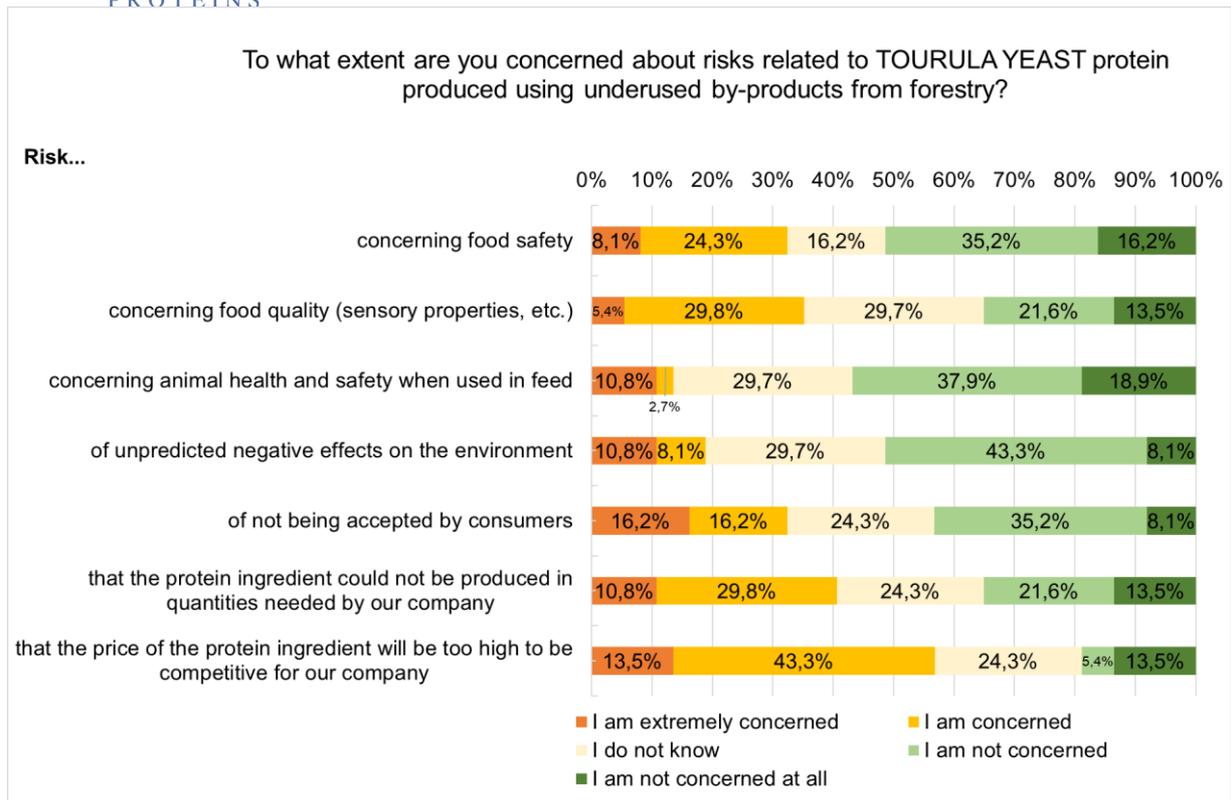


Figure 18. Perceptions of risks related to torula yeast protein source.

7 Discussion

The study on the attitudes of business stakeholders of food and feed value chains towards alternative proteins and, in particular, towards the proteins of NextGenProteins project was designed to be done in two stages: at first, a small interview study followed by a European online survey. The idea was that through the interview study the researchers will get insights to stakeholders' perceptions (both positive and negatives, opportunities, barriers, etc.). The survey will then give quantitative information on how common these perceptions are among different stakeholder groups and are there any regional differences in stakeholders' attitudes towards the selected alternative proteins.

The idea was fulfilled only in part. The interview study gave insights as expected, but due to a low response rate to the survey (low number of answers), the reliability of quantitative results did not become as good as hoped. Nevertheless, the survey still gives valuable quantified information on business stakeholders' attitudes towards the alternative proteins and their production, if we just understand the numbers as indicative. Plans for any regional analyses on stakeholders' attitudes had to be forgotten due to the low number of answers per country. Nevertheless, this would not cause any major setback for the project work. According to the study, consumer acceptance seems to play a high role in forming stakeholders' attitudes towards the alternative proteins. Knowledge on how the attitudes of consumers towards the alternative proteins are varying in different European countries can be achieved from another study of the NextGenProteins project (Arvola et. al., 2021).

The respondents of the survey do not represent an industry average of business stakeholders in the value chain of food and feed. This assumption is based on the way how potential respondents were contacted. Instead, we may assume that the respondents are actors actively searching for new products, technologies, business opportunities, and could be considered as some kind of forerunners or early adopters in the food and feed businesses. The opinions of such business actors, in general, are particularly interesting when designing and developing innovations into markets. Therefore, the findings of the study are valuable for the project work and the business design of NextGenProteins companies.

Environmentally sustainable production of proteins is a fundamental idea behind the NextGenProteins project. This study confirms that the stakeholders of food and feed value chains acknowledge the idea and believe that the NextGen proteins are beneficial to environment. At the same time, however, they address that the sustainability must be proven before really entering markets with these protein ingredients.

The stakeholders also address that environment sustainability must not be taken place at the expense of price of protein. In order to be truly sustainable, the production and use of alternative protein must be sustainable also economically. In respect to this economical sustainability, the concern of stakeholders is high, and this concern is valid for each NextGen protein. Markets will not accept the NextGen proteins, if the price of the protein ingredient will not be competitive in the food or feed application in question. If the production price will be high in respect to current mainstream protein ingredients, that challenges the protein

ingredient as well as food and feed producers to discover niche applications and business models where a premium price will be feasible. Branding may help in this, but still environmental sustainability alone would not be sufficient for markets to pay extra.

If considering the attitudes of stakeholders in respect to the benefits and risks of the NextGen proteins, two overall findings can be mentioned, in addition to the aspects of consumer acceptance and sustainability already discussed above. At the first, the dispersion in the answers of survey was high in the case of almost every statement and for each protein & technology. It means that, although there were many respondents who did not see the protein in question of being beneficial for them, or had great concerns towards the protein, there were always respondents who saw the potential of the alternative proteins, believed in their benefits, and were not concerned about their potential risks. It means that there will be potential business customers for each NextGen protein. Secondly, 'I do not know' was the most common answer to many questions in the survey. This is also a very important finding for the project, meaning that lots of fact-based dissemination to business stakeholders in food and feed value chains will be needed from the proteins, their production, benefits and potential risks related to the use of the protein ingredients in food and feed applications.

8 Conclusions

In this report, main findings of study on the attitudes and expectations of European business stakeholders within the value chains of food and feed towards alternative proteins are presented. The focus was on the proteins and production processes/technologies developed in the NextGenProteins project: spirulina microalgae, two kinds of insect proteins (crickets and black soldier flies), and torula yeast single cell protein. Finnish, German and Italian stakeholders were interviewed. The interviews were followed by a European online survey on stakeholders' attitudes and expectations. The stakeholders include potential customers of alternative protein applications, such as food producers, retailers, restaurants and catering service providers, feed producers, and fish farmers.

According to the results, the business stakeholders have an open mind set towards the development of alternative proteins and consider them to be necessary in the future. They thought that the NextGen proteins will be beneficial for environment. However, the sustainability of the proteins and their production must be proven. In addition to environmental sustainability, it is important for the stakeholders that the production and use of alternative protein ingredients in food and feed applications will be economically sustainable as well. Many stakeholders are concerned about the prices of the alternative protein ingredients.

The study reveals that the attitudes of stakeholders to benefits and potential risks related to the NextGen proteins varied. There were many stakeholders who had positive expectations and were looking forward to food and feed applications of NextGen proteins. However, there were also many who had reserved expectations and were concerned about potential risks related to the production of the proteins and their use. In addition, many stakeholders did not know how to react to these new protein ingredients and their production due to their insufficient knowledge on the proteins and their production. A major concern, shared by several stakeholders, was the risk of consumers not accepting the new protein ingredients. All these concerns call for correct, science based and comprehensive information to be broadly disseminated to all relevant stakeholder groups and, very importantly, to consumers.

Each of the NextGen proteins has their pros and cons, and, according to the study, they are not the same for all the proteins. Producers of protein ingredients as well as food and feed applications must actively search for applications, accompanied with proper business models that are built on the strengths related to the protein in question. This study will give support to the innovation work. There are business potential for each NextGen protein, but the business may not be found in mainstream applications and business models.

Next steps in the NextGenProteins work related to market opportunities and business potential for novel products containing alternative proteins include combining the findings from this study and a similar study on consumer attitudes towards the NextGen proteins, and by using this knowledge to find out ways to boost consumers' and stakeholders' acceptance and trust towards sustainable alternative proteins. Future work also includes the searching of potential food and feed applications for these proteins together with business model development.

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10 ANNEXES

10.1 ANNEX I Fact Sheets of NextGen Proteins

Protein raw ingredient made of spirulina microalgae using CO₂ emissions for its growth

New production method:

- Protein ingredient is made from the microalgae spirulina.
- Like any plant, spirulina needs CO₂, water, light and warmth in order to grow (photosynthesis).
- Natural carbon dioxide (CO₂) emitted from a geothermal power plant is used to grow the spirulina.
- LEDs are applied to produce the light using clean electricity, and the waste heat from the geothermal power plant is used for warmth.
- Controlled indoor cultivation conditions enable the production of consistent algal quality, year-round.
- The controlled cultivation produces microalgae with superior organoleptic (taste and smell) quality.

Nutritional value:

- Spirulina has been approved for use in food in the EU (European Commission and EFSA).
- Spirulina has a high content of high-quality protein (60-70%) and other nutrients. It contains bioactive compounds (e.g. antioxidants) as well as significant amounts of calcium; vitamins B, A, E and D; potassium, manganese, magnesium and iron.

Sustainability:

- The combined usage of clean, geothermal energy, waste heat and natural CO₂ creates a unique carbon negative production profile.
- This particular vertical algae farming technology uses less than 1% water and land compared to the standard methods of microalgae production, and no usage of pesticides or herbicides.

Status of legislation:

- Spirulina is approved for use in food and feed in the EU (European Commission and EFSA).

Protein raw ingredient made of crickets (insects) grown with underused plant food biomass:

New production method:

- Protein ingredient is made of House crickets.
- **Crickets are raised by feeding them with plant-based underused food biomass (by-products from agriculture or from food industry e.g. vegetable peel, apple cores).**
- Production takes place in efficient automated indoor farms.

Nutritional value:

- People have eaten insects for thousands of years, and they continue to be a part of traditional cuisine for 2 billion people around the world.
- Crickets contain a lot of high-quality protein and essential amino acids, a balanced amount of fatty acids (lots of unsaturated fats, such as Omega-6), vitamins, minerals and prebiotic fibre.
- Dry powder derived from crickets contains more than 60 % protein and is very high in antioxidants

Sustainability:

- Insects are an extremely sustainable protein source compared to meat because they require less feed, water and space. (The production of one kilogram of insect protein needs 1.7 kg of feed and 1 litre of water. The production of one kilogram of beef protein kilogram needs 10 kg of feed and 22 litres of water.)
- Because the crickets are fed on food industry by-products, we help to reduce the amount of food waste, which reduces our impact on climate change.

Status of legislation:

- People have eaten insects for thousands of years, and they continue to be a part of traditional cuisine for 2 billion people around the world.
- Novel food approval for cricket proteins is pending.

Protein raw ingredient made of larvae of black soldier flies (insects) grown with underused plant food biomass:

New production method:

- Insect meal is made of *Hermetia illucens* larvae (of black soldier fly).
- Insects are raised by feeding them with 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).
- Production takes place in efficient indoor farms. The traceability and the safety are guaranteed during the whole process.
- The insect meal is partially defatted thanks to a mechanical process. No additives are used during the transformation. Free of GMO.

Nutritional value:

- The black soldier fly (*Hermetia illucens*) meal represents a particularly adapted resource to feed farmed animals because it is natural, safe, sustainably produced and has a good nutritional quality. Into the wild, a lot of animals eat insects (fish, shrimps, birds).
- Black soldier fly meal contains a lot of high-quality proteins (at least 55% CM) with more than 90% of protein digestibility

Sustainability:

- Because the BSF larvae are fed on wasted food industry products, they help to reduce the amount of food waste, which reduces the impact on climate change
- The insects farms require less space than other protein sources production sites

Status of legislation:

- The use of black soldier fly proteins in pet food and aqua feed is authorised.

Protein raw ingredient made of Torula yeast grown with underused by-products from the forest industry:

New production method:

- Protein ingredient is made from a proprietary non-GMO strain of Torula yeast.
- **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).**
- In a fermentation process, Torula uses the carbon present in these materials to grow. This process produces food grade protein.
- Torula yeast is grown in a controlled indoor environment. The traceability and the safety are guaranteed during the whole process. It is available year-round.

Nutritional value:

- Torula is a single celled protein like other yeasts, bacteria and fungi. Many such organisms are good sources of human nutrition. You'll know baking yeast and the fungi-based protein Quorn®, which is a meat substitute.
- Torula contains more than 55% dry weight high-quality proteins and provides all the necessary amino acids and many other nutrients, such as vitamins B1 and B3, chromium and selenium. The cell walls contain a lot of beta-glucans, which are helpful as part of a high fibre diet.

Sustainability:

- Reduces greenhouse gas emissions as well as the use of water and soil compared to other protein sources (meat and e.g. soya)

Status of legislation:

- The use of Torula SCP is allowed in animal feed.
- The necessity of a novel food approval to use Torula SCP in food is currently on-going. The microorganism itself, Torula yeast, has GRAS status [in the US].

10.2 ANNEX II Interview Findings: Views from Food Producers on NextGenProteins

	 Spirulina microalgae	 Insects (crickets & black soldier flies)	 Torula yeast (single cell protein)
POSITIVE VIEWS (strengths & opportunities)	<ul style="list-style-type: none"> ▪ Production method seems good and sustainable (energy efficiency, using less natural resources) ▪ Concept is acceptable in principle ▪ Positive image, as Spirulina is already used in food ▪ Very likely to attain high consumer acceptance, as it is already familiar ▪ Good amino acid composition ▪ If the production is completely sustainable, very interested in using them in food 	<ul style="list-style-type: none"> ▪ Production method is interesting – using food waste (side stream) ▪ New players need to get interested but insects can make a comeback in places where it has already been tested ▪ Fast resource and protein ▪ Seems sustainable ▪ If the production is completely sustainable, very interested in using them in food 	<ul style="list-style-type: none"> ▪ Very encourageable and interesting thought ▪ A clear market for this ▪ Could be easily commercialized, especially in Finland: “Forest food”, due to close relationship with the woods ▪ Domestic protein sources replacing meat would be worth gold ▪ An option for vegans – but potential for becoming something more ▪ Could work as powder to increase protein levels and as an individual food product ▪ Maybe interesting to enrich plant-based products ▪ Interesting amino acid spectrum, high nutritional value ▪ If the production is completely sustainable, very interested in using them in food
NEGATIVE VIEWS (doubts & challenges)	<ul style="list-style-type: none"> ▪ Algae is expensive ▪ Consumer acceptance can be a barrier: <ul style="list-style-type: none"> ○ Does not give a delicious mental picture ○ Uncertainty due to the greenish colour ○ Taste and texture play an important role, no pills or powder, or it will remain as an additive ▪ Communication is essential: what is it used for, what is the equivalent, the benefit 	<ul style="list-style-type: none"> ▪ Legislative framework can become an issue ▪ The challenge of allergens: important to know exactly what is fed to the insects ▪ Consumer acceptance can be a barrier, very difficult from a marketing perspective ▪ Not part of our culinary culture, does not give a delicious image ▪ The thought of food and waste in the same sentence can be disgusting for some ▪ Consumer see this as industrial farming (energy and resource - intense) ▪ Insects are mainly recognised as pest, it is a high hurdle in the minds of the consumers, impact on the attitude ▪ A lot of marketing and communication will be needed ▪ Producers need to create a convincing commercial story on why consumers should change to this ingredient ▪ The logic behind the method needs to be storified: the benefits of growing insects on biowaste (to save natural resources) 	<ul style="list-style-type: none"> ▪ Legislative framework can become an issue ▪ Negative impact on sensory and functional properties ▪ Consumer acceptance can be a barrier: <ul style="list-style-type: none"> ○ Important to ensure deliciousness ○ Taste, texture, appearance and the cost are important factors to consider ○ Consumer association with wood and production of flavours ○ Special attention to communication - If it is called biomass – the communication bar is too high ▪ Production method: alcohol content in the yeast extract, afraid of its impact on certifications (e. g. halal) ▪ Uncertainty about the extraction process ▪ Very abstract production method – do consumers understand it? ▪ The dangers of pesticides/ unhealthy substances in the raw material wood ▪ There is a need for safety studies

10.3 ANNEX III Interview Findings: Views from Feed Producers on NextGenProteins

	 Spirulina microalgae	 Insects (crickets & black soldier flies)	 Torula yeast (single cell protein)
POSITIVE VIEWS (strengths & opportunities)	<ul style="list-style-type: none"> Good status, already accepted by the EU Very used already Algae has a trendy image A good alternative to soy Good source of nutrition High potential for fish feed Interesting and good fatty acid profile for fish Interest in using them in feed, if the production is sustainable 	<ul style="list-style-type: none"> Side stream (production method) –approach seems interesting Already used in pet food High potential for fish feed If the nutrient content is good and legislation allows their use, there is no ethical risk Insects have good quality protein source –the transformation potential is high Very interesting source, fatty acid profile If the production is completely sustainable– interest in using insects in feed 	<ul style="list-style-type: none"> The most interesting and potential alternative for fish feed -the cost could be competitive and enough volume could be produced Easy to digest for the fish, high nutritional value and very good amino acid profile If the content is similar to fishmeal, a good source of protein for poultry Good source from a nutrition point of view for fish and poultry –already used for marine fish No obstacle for using this from the viewpoint of feed regulation Great brand value (especially in Finland) A potential domestic protein source to replace soy Very interesting, already experimental work going on Interest in using this in feed, if the production is completely sustainable
NEGATIVE VIEWS (doubts & challenges)	<ul style="list-style-type: none"> Cost of the feed: the economic sustainability must be supported Availability of the source: need for larger quantities –can the volume demands be met? What is the real impact of the production in terms of CO2? Resource efficiency in producing the protein outside Iceland? 	<ul style="list-style-type: none"> Not efficient to feed fish with something gone through another living organism Legislation: will it allow utilizing food waste? Hygiene should be ensured in the process Raw material of the insects is not very often homogenous Cricket have many parts that cannot be utilized – black soldier flies could be easier The costs of insects can vary – depending on the energy used in production Price is important, currently costs are too high Availability of the protein source Insect protein often not accepted by Muslim countries (problems with halal Certification) Not accepted by consumers, neither in food nor feed 	<ul style="list-style-type: none"> What are the legislation aspects? Price is important and there is a need to ensure that the cost matches the quality of the product Could be too expensive because of the drying process Can this be done on an industrial scale? Is there a danger of accumulation of unhealthy substances from the raw material (wood biomass)? What is the real impact of the production in terms of CO2? Some farmers look suspiciously at SCP-containing feeds, as they were not of good quality in the past

10.4 ANNEX IV Interview Findings: Views from Retail, Restaurant & Catering Sectors on NextGenProteins

	 Spirulina microalgae	 Insects (crickets & black soldier flies)	 Torula yeast (single cell protein)
POSITIVE VIEWS (strengths & opportunities)	<ul style="list-style-type: none"> Protein source of the future Possibility to be developed to something more than powder Good source for protein, because it can be produced in a sustainable circular system Existing positive experience already with the ingredient Good source of nutrition Great and natural product - algae occurs in nature Interest in working on a pilot project with this protein 	<ul style="list-style-type: none"> One of the protein sources of the future – the planet’s resources are overexploited The form of powder is more acceptable to consumers The production method (utilizing food waste) sounds good and sensible – very interesting path Previous experiments with crickets has proved that it can become a phenomenon – was a bit ahead of its time Familiar protein source – contact with producers for several years already Interesting from a nutritional point of view A pilot project with this protein source would be interesting to understand the yield and use in large-scale distribution 	<ul style="list-style-type: none"> Very interesting alternative protein source One of the protein sources of the future Familiar protein source - some contacts with producers and their suppliers already Potential seen especially in Finland due to the close relationship with the forest Potential to become something bigger than powder The side stream – aspect is very important (not to take something straight from the woods) Interesting in the context of meat substitutes Bioconversion process is very interesting Eagerness to test it (depending on the final product) It would be interesting to work on a pilot project in order to understand what is the yield and its use in large-scale distribution
NEGATIVE VIEWS (doubts & challenges)	<ul style="list-style-type: none"> Potential to become marginal in terms of demand Seen only as a health product The process requires a lot of energy – is it truly sustainable? All environmental impact factors need to be counted Price and the world market view: sustainability must be economical as well; potential bottleneck Communication and explanation of the source is essential in promoting the product 	<ul style="list-style-type: none"> The cost is important to consider To spread, there is the need to explain the protein source production and give information to both restaurateurs and consumers Consumers consider insects odd: not delicious or part of the culinary culture Prejudice on the insect’s quality and nutritional value Earlier trials failed to produce long term benefits Eating insects could be seen as eating animals (for vegans) - insects fall in the middle: the vegans won’t eat them and neither will meat eaters The production method: attention must be paid to what is fed to the insects Important to utilize side streams (instead of soy) What is the shelf-life of insect products? 	<ul style="list-style-type: none"> The protein source and the market price are unknown – need for more information Challenge is the availability and price on the market To spread, there is the need to explain the protein source production and give information to both restaurateurs and consumers – adoption will take time What is the shelf-life of products made from this protein source?

10.5 ANNEX V Interview Findings: Views from Fish Farming on NextGenProteins

	 Spirulina microalgae	 Insects (crickets & black soldier flies)	 Torula yeast (single cell protein)
POSITIVE VIEWS (strengths & opportunities)	<ul style="list-style-type: none"> ▪ Already used –good source of protein and fatty acids ▪ A sustainable alternative source for protein; will bring benefits in reducing the environmental impact ▪ Important that they have a positive effect on growth performance and to the quality of the final product, no risks seen here 	<ul style="list-style-type: none"> ▪ Very promising and very interesting from a nutritional point of view ▪ Good alternative protein source to partially replace the meals of fish ▪ Some testing already going on ▪ In in vivo tests in which this protein source was used giving excellent performance results ▪ The important thing is that they positively affect growth performance and therefore the quality of the final product 	<ul style="list-style-type: none"> ▪ The best alternative protein source and the bioconversion process for their production is very interesting ▪ SCP meal is a very good source from a nutritional point of view ▪ Already present in feed that we use ▪ Good alternative protein source to partially replace the meals of fish ▪ No major risks seen in the use of these protein sources ▪ The important thing is that they positively affect growth performance and therefore the quality of the final product
NEGATIVE VIEWS (doubts & challenges)	<ul style="list-style-type: none"> ▪ Large quantities are needed ▪ Economic sustainability needs to be supported (price) – potential depends on the cost ▪ Communication is important –lack of information may prevent the spread on the market 	<ul style="list-style-type: none"> ▪ Low availability of the source –need for larger quantities ▪ Price is still too high ▪ More benefits to the environment than to fish growth performance ▪ Regulatory risks: currently insects have grown on high quality vegetal biomass → good quality has to be ensured, otherwise they become an unsafe product ▪ Prejudice about the quality – need for more information 	<ul style="list-style-type: none"> ▪ Low availability → a need for larger quantities ▪ There is the need to support the economic sustainability; the price is important ▪ The protein source should be cheaper ▪ To have an economic product, single cells should be cultivated on cheap substrates ▪ Need for more information to understand the protein source

10.6 ANNEX VI Questions of Stakeholder Survey

Background questions

1. The field your company operates in

Feed production (fish)
Feed production (poultry)
Feed production (other)
Fish farming
Poultry farming
Food production
Retail
Restaurant and catering
Other

2. Main location of your company

Finland
France
Germany
Iceland
Italy
Sweden
UK
Other/Central Europe
Other/Eastern Europe
Other/Northern Europe
Other/Southern Europe
Other/Western Europe

3. Main market areas of your company

Central Europe
Eastern Europe
Northern Europe
Southern Europe
Western Europe
Africa
Asia
Australia
North America
South America

4. Size of your company

SME (max. 250 employees and 50 M€ turnover)
Midcap (over 250 employees but max 300 M€ turnover)
Large (over 250 employees and 300 M€ turnover)

5. Your position at your company

Upper management
Sales and marketing
Production
R&D
Other

The next questions will be about sustainability at your company (environmental, economical and social sustainability, incl. ethics)

6. In your opinion, how important is environmental sustainability to your company

- 1 not at all important
- 2 slightly important
- 3 rather important
- 4 very important
- 5 extremely important
- Cannot say

7. In your opinion, what is the role of environmental sustainability to your company?

Answers to scale 1-4

1 = We are at the beginning of considering **environmental** sustainability aspects, but already respect mandatory rules and laws

2 = We are at a basic level of integrating **environmental** sustainability to our business and consider the environmental impact to our business activities

3 = We actively consider the **environmental** sustainability aspects beyond industry average

4 = We have outstanding efforts towards **environmental** sustainability

Cannot say

8. In your opinion, how important is economical sustainability to your company

- 1 not at all important
- 2 slightly important
- 3 rather important
- 4 very important
- 5 extremely important
- Cannot say

9. In your opinion, what is the role of economical sustainability to your organization/company?

Answers to scale 1-4

1 = We are at the beginning of considering **economical** sustainability aspects, but already respect mandatory rules and laws

2 = We are at a basic level of integrating **economical** sustainability to our business and consider the environmental impact to our business activities

3 = We actively consider the **economical** sustainability aspects beyond industry average

4 = We have outstanding efforts towards **economical** sustainability

Cannot say

10. In your opinion, how important is social sustainability to your company

- 1 not at all important
- 2 slightly important
- 3 rather important
- 4 very important
- 5 extremely important
- Cannot say

11. In your opinion, what is the role of social sustainability to your organization/company?

Answers to scale 1-4

1 = We are at the beginning of considering **social** sustainability aspects, but already respect mandatory rules and laws

2 = We are at a basic level of integrating **social** sustainability to our business and consider the environmental impact to our business activities

3 = We actively consider the **social** sustainability aspects beyond industry average

4 = We have outstanding efforts towards **social** sustainability

Cannot say

The rest of the questionnaire will focus on four INNOVATIVE PROTEIN RAW INGREDIENTS and their production methods:

- Spirulina microalgae
- crickets
- larvae of black soldier flies
- torula

Before the protein specific questions, the protein and its production method will be shortly described.

<data sheet of spirulina microalgae was placed here>

12. How familiar are you with this SPIRULINA MICROALGAE protein source?

1=I have never heard about it

2= I have heard about it

3=I am familiar with this protein source

4=our organization has already tested this or similar microalgae protein source

5=our company is already using this or similar microalgae protein source

13. How familiar are you with this production process/technology?

1=I have never heard about it

2= I have heard about it

3=I am familiar with the process/technology

14. According to your beliefs, how likely or unlikely do you think it is for SPIRULINA MICROALGAE protein produced using CO₂ emissions to have the following benefits?

1= very unlikely

2= unlikely

3= I don't know

4= likely

5= very likely

Beneficial to our company

Beneficial to our product

Beneficial for consumer choices (more variety)

Beneficial to human health

Beneficial to environmental sustainability

Beneficial to the national economy

15. To what extent are you concerned about risks related to SPIRULINA MICROALGAE protein produced using CO₂ emissions?

1= I am extremely concerned

2= I am concerned

3= I don't know

4= I am not concerned

5= I am not concerned at all

Risk concerning food safety

Risk concerning food quality (sensory properties, etc.)

Risk concerning animal health and safety when used in feed

Risk of unpredicted negative effects on the environment

Risk of not being accepted by consumers

Risk that the protein ingredient could not be produced in quantities needed by our company

Risk that the price of the protein ingredient will be too high to be competitive for our company

Questions 16-19 are directed to those interested in food applications of alternative proteins. If you are focused on feed applications, you may go directly to question 20.

<data sheet of crickets was placed here>

16. How familiar are you with this CRICKET protein source?

- 1=I have never heard about it
- 2= I have heard about it
- 3=I am familiar with this protein source
- 4=our organization has already tested this or similar insects protein source
- 5=our company is already using this or similar insects protein source

17. How familiar are you with this production process/technology?

- 1=I have never heard about it
- 2= I have heard about it
- 3=I am familiar with the process/technology

18. According to your beliefs, how likely or unlikely do you think it is for CRICKET protein produced using underused plant food biomass to have the following benefits?

- 1= very unlikely
- 2= unlikely
- 3= I don't know
- 4= likely
- 5= very likely

- Beneficial to our company
- Beneficial to our product
- Beneficial for consumer choices (more variety)
- Beneficial to human health
- Beneficial to environmental sustainability
- Beneficial to the national economy

19. To what extent are you concerned about risks related to CRICKET protein produced using underused plant food biomass?

- 1= I am extremely concerned
- 2= I am concerned
- 3= I don't know
- 4= I am not concerned
- 5= I am not concerned at all

- Risk concerning food safety
- Risk concerning food quality (sensory properties, etc.)
- Risk concerning animal health and safety when used in feed
- Risk of unpredicted negative effects on the environment
- Risk of not being accepted by consumers
- Risk that the protein ingredient could not be produced in quantities needed by our company
- Risk that the price of the protein ingredient will be too high to be competitive for our company

Questions 20-23 are directed to those interested in feed applications of alternative proteins. If these are out of your scope, you may go directly to question 24.

<data sheet of black soldier fly larvae was placed here>

20. How familiar are you with this HERMETIA ILLUCENS LARVAE (BLACK SOLDIER FLY) protein source?

- 1= I have never heard about it
- 2= I have heard about it
- 3= I am familiar with this protein source
- 4= our organization has already tested this or similar insects protein source
- 5= our company is already using this or similar insects protein source

21. How familiar are you with this production process/technology?

- 1= I have never heard about it
- 2= I have heard about it
- 3= I am familiar with the process/technology

22. According to your beliefs, how likely or unlikely do you think it is for HERMETIA ILLUCENS LARVAE (BLACK SOLDIER FLY) protein produced using underused plant food biomass to have the following benefits?

- 1= very unlikely
- 2= unlikely
- 3= I don't know
- 4= likely
- 5= very likely

- Beneficial to our company
- Beneficial to our product
- Beneficial for consumer choices (more variety)
- Beneficial to human health
- Beneficial to environmental sustainability
- Beneficial to the national economy

23. To what extent are you concerned about risks related to HERMETIA ILLUCENS LARVAE (BLACK SOLDIER FLY) protein produced using underused plant food biomass?

- 1= I am extremely concerned
- 2= I am concerned
- 3= I don't know
- 4= I am not concerned
- 5= I am not concerned at all

- Risk concerning food safety
- Risk concerning food quality (sensory properties, etc.)
- Risk concerning animal health and safety when used in feed
- Risk of unpredicted negative effects on the environment
- Risk of not being accepted by consumers
- Risk that the protein ingredient could not be produced in quantities needed by our company
- Risk that the price of the protein ingredient will be too high to be competitive for our company

<data sheet of torula yeast was placed here>

24. How familiar are you with this TORULA YEAST protein source?

- 1=I have never heard about it
- 2= I have heard about it
- 3=I am familiar with this protein source
- 4=our organization has already tested this or similar insects protein source
- 5=our company is already using this or similar insects protein source

25. How familiar are you with this production process/technology?

- 1=I have not heard about this before
- 2= I have heard about this before
- 3=I am familiar with the process/technology

26. According to your beliefs, how likely or unlikely do you think it is TORULA YEAST protein produced using underused by-products from forestry to have the following benefits?

- 1= very unlikely
- 2= unlikely
- 3= I don't know
- 4= likely
- 5= very likely

- Beneficial to our company
- Beneficial to our product
- Beneficial for consumer choices (more variety)
- Beneficial to human health
- Beneficial to environmental sustainability
- Beneficial to the national economy

27. To what extent are you concerned about risks related to TORULA YEAST protein produced using underused by-products from forestry?

- 1= I am extremely concerned
- 2= I am concerned
- 3= I don't know
- 4= I am not concerned
- 5= I am not concerned at all

- Risk concerning food safety
- Risk concerning food quality (sensory properties, etc.)
- Risk concerning animal health and safety when used in feed
- Risk of unpredicted negative effects on the environment
- Risk of not being accepted by consumers
- Risk that the protein ingredient could not be produced in quantities needed by our company
- Risk that the price of the protein ingredient will be too high to be competitive for our company

The questionnaire ends here.

Thank you very much for your time and valuable input!

10.7 ANNEX VII Background Information about the Respondents of the Stakeholder Survey

BACKGROUND INFORMATION	n	%
Field of respondent's company		
Food production	19	44,2
Other	10	23,3
Feed production (fish, poultry, other)	7	16,2
Retail	6	14%
Restaurant and catering	1	2,3%
Main location of respondent's company		
Finland	11	26,2
Germany	10	23,8
UK	7	16,7
Sweden	5	11,9
France	3	7,1
Italy	2	4,7
Other/Northern Europe	2	4,8
Other/Southern Europe	1	2,4
Main market areas of respondent's company		
	23	54,8
Northern Europe	15	35,7
Western Europe	13	31
Eastern Europe	12	28,6
Central Europe	8	19
Southern Europe	6	14,3
North America	2	4,8
South America	2	4,8
Africa	2	4,8
Asia	1	2,4
Australia		
Size of respondent's company		
Large (over 250 employees and 300 M€ turnover)	22	52,4
SME (max. 250 employees and 50 M€ turnover)	15	35,7
Midcap (over 250 employees but max 300 M€ turnover)	5	11,9
Respondent's position at their company		
R&D	15	35,7
Upper management	14	33,3
Other	7	16,7
Sales and marketing	5	11,9
Production	1	2,4

10.8 ANNEX VIII Data Tables of Answers to Survey Questions: All Respondents, Food Producers, Feed Producers, Retail & Restaurant

Question 6: In your opinion, how important is environmental sustainability to your company?

All respondents

	n	Percent
Not at all important	0	0,0%
Slightly important	1	2,4%
Rather important	2	4,8%
Very important	13	30,9%
Extremely important	26	61,9%
Cannot say	0	0,0%

Food producers

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	1	5,3%
Very important	6	31,6%
Extremely important	12	63,1%
Cannot say	0	0,0%

Feed producers

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	1	14,3%
Very important	2	28,6%
Extremely important	4	57,1%
Cannot say	0	0,0%

Retail & restaurant

	n	Percent
Not at all important	0	0,0%
Slightly important	1	14,3%
Rather important	0	0,0%
Very important	0	0,0%
Extremely important	6	85,7%
Cannot say	0	0,0%

Question 7: In your opinion, what is the role of environmental sustainability to your company?

All respondents

	n	Percent
We are at the beginning of considering environmental sustainability aspects, but already respect mandatory rules and laws	1	2,4%
We are at a basic level of integrating environmental sustainability to our business and consider the environmental impact to our business activities	11	26,2%
We actively consider the environmental sustainability aspects beyond industry average	17	40,5%
We have outstanding efforts towards environmental sustainability	13	30,9%
Cannot say	0	0,0%

Food producers

	n	Percent
We are at the beginning of considering environmental sustainability aspects, but already respect mandatory rules and laws	0	0,0%
We are at a basic level of integrating environmental sustainability to our business and consider the environmental impact to our business activities	5	26,3%
We actively consider the environmental sustainability aspects beyond industry average	9	47,4%
We have outstanding efforts towards environmental sustainability	5	26,3%
Cannot say	0	0,0%

Feed producers

	n	Percent
We are at the beginning of considering environmental sustainability aspects, but already respect mandatory rules and laws	1	14,3%
We are at a basic level of integrating environmental sustainability to our business and consider the environmental impact to our business activities	1	14,3%
We actively consider the environmental sustainability aspects beyond industry average	2	28,6%
We have outstanding efforts towards environmental sustainability	3	42,8%
Cannot say	0	0,0%

Retail & restaurant

	n	Percent
We are at the beginning of considering environmental sustainability aspects, but already respect mandatory rules and laws	0	0,0%
We are at a basic level of integrating environmental sustainability to our business and consider the environmental impact to our business activities	0	0,0%
We actively consider the environmental sustainability aspects beyond industry average	4	57,1%
We have outstanding efforts towards environmental sustainability	3	42,9%
Cannot say	0	0,0%

Question 8: In your opinion, how important is economical sustainability to your company?

All respondents

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	2	4,7%
Very important	17	40,5%
Extremely important	22	52,4%
Cannot say	1	2,4%

Food producers

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	0	0,0%
Very important	8	42,1%
Extremely important	11	57,9%
Cannot say	0	0,0%

Feed producers

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	1	14,3%
Very important	4	57,1%
Extremely important	2	28,6%
Cannot say	0	0,0%

Retail & restaurant

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	0	0,0%
Very important	0	0,0%
Extremely important	7	100,0%
Cannot say	0	0,0%

Question 9: In your opinion, what is the role of economical sustainability to your company?

All respondents

	n	Percent
We are at the beginning of considering economical sustainability aspects, but already respect mandatory rules and laws	1	2,4%
We are at a basic level of integrating economical sustainability to our business and consider the environmental impact to our business activities	8	19,0%
We actively consider the economical sustainability aspects beyond industry average	21	50,0%
We have outstanding efforts towards economical sustainability	11	26,2%
Cannot say	1	2,4%

Food producers

	n	Percent
We are at the beginning of considering economical sustainability aspects, but already respect mandatory rules and laws	0	0,0%
We are at a basic level of integrating economical sustainability to our business and consider the environmental impact to our business activities	3	15,8%
We actively consider the economical sustainability aspects beyond industry average	10	52,6%
We have outstanding efforts towards economical sustainability	6	31,6%
Cannot say	0	0,0%

Feed producers

	n	Percent
We are at the beginning of considering economical sustainability aspects, but already respect mandatory rules and laws	1	14,3%
We are at a basic level of integrating economical sustainability to our business and consider the environmental impact to our business activities	2	28,6%
We actively consider the economical sustainability aspects beyond industry average	3	42,8%
We have outstanding efforts towards economical sustainability	1	14,3%
Cannot say	0	0,0%

Retail & restaurant

	n	Percent
We are at the beginning of considering economical sustainability aspects, but already respect mandatory rules and laws	0	0,0%
We are at a basic level of integrating economical sustainability to our business and consider the environmental impact to our business activities	0	0,0%
We actively consider the economical sustainability aspects beyond industry average	3	42,9%
We have outstanding efforts towards economical sustainability	4	57,1%
Cannot say	0	0,0%

Question 10: In your opinion, how important is social sustainability to your company?

All respondents

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	4	9,5%
Very important	20	47,6%
Extremely important	17	40,5%
Cannot say	1	2,4%

Food producers

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	1	5,3%
Very important	10	52,6%
Extremely important	8	42,1%
Cannot say	0	0,0%

Feed producers

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	1	14,3%
Very important	6	85,7%
Extremely important	0	0,0%
Cannot say	0	0,0%

Retail & restaurant

	n	Percent
Not at all important	0	0,0%
Slightly important	0	0,0%
Rather important	1	14,3%
Very important	0	0,0%
Extremely important	6	85,7%
Cannot say	0	0,0%

Question 11: In your opinion, what is the role of social sustainability to your company?

All respondents

	n	Percent
We are at the beginning of considering social sustainability aspects, but already respect mandatory rules and laws	2	4,7%
We are at a basic level of integrating social sustainability to our business and consider the environmental impact to our business activities	6	14,3%
We actively consider the social sustainability aspects beyond industry average	21	50,0%
We have outstanding efforts towards social sustainability	12	28,6%
Cannot say	1	2,4%

Food producers

	n	Percent
We are at the beginning of considering social sustainability aspects, but already respect mandatory rules and laws	0	0,0%
We are at a basic level of integrating social sustainability to our business and consider the environmental impact to our business activities	4	21,1%
We actively consider the social sustainability aspects beyond industry average	8	42,1%
We have outstanding efforts towards social sustainability	7	36,8%
Cannot say	0	0,0%

Feed producers

	n	Percent
We are at the beginning of considering social sustainability aspects, but already respect mandatory rules and laws	1	14,3%
We are at a basic level of integrating social sustainability to our business and consider the environmental impact to our business activities	1	14,3%
We actively consider the social sustainability aspects beyond industry average	4	57,1%
We have outstanding efforts towards social sustainability	1	14,3%
Cannot say	0	0,0%

Retail & restaurant

	n	Percent
We are at the beginning of considering social sustainability aspects, but already respect mandatory rules and laws	0	0,0%
We are at a basic level of integrating social sustainability to our business and consider the environmental impact to our business activities	0	0,0%
We actively consider the social sustainability aspects beyond industry average	4	57,1%
We have outstanding efforts towards social sustainability	3	42,9%
Cannot say	0	0,0%

Question 12: How familiar are you with this SPIRULINA MICROALGAE protein source?

All respondents

	n	Percent
I have never heard about it	3	7,1%
I have heard about it	15	35,7%
I am familiar with this protein source	16	38,1%
Our organization has already tested this or similar microalgae protein source	7	16,7%
Our company is already using this or similar microalgae protein source	1	2,4%

Food producers

	n	Percent
I have never heard about it	1	5,3%
I have heard about it	7	36,8%
I am familiar with this protein source	7	36,8%
Our organization has already tested this or similar microalgae protein source	4	21,1%
Our company is already using this or similar microalgae protein source	0	0,0%

Feed producers

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	1	14,3%
I am familiar with this protein source	4	57,1%
Our organization has already tested this or similar microalgae protein source	1	14,3%
Our company is already using this or similar microalgae protein source	1	14,3%

Retail & restaurant

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	5	71,4%
I am familiar with this protein source	2	28,6%
Our organization has already tested this or similar microalgae protein source	0	0,0%
Our company is already using this or similar microalgae protein source	0	0,0%

**Question 13: How familiar are you with this production process/technology?
(SPIRULINA MICROALGAE)**

All respondents

	n	Percent
I have never heard about it	8	19,0%
I have heard about it	23	54,8%
I am familiar with the process/technology	11	26,2%

Food producers

	n	Percent
I have never heard about it	6	31,6%
I have heard about it	9	47,4%
I am familiar with the process/technology	4	21,0%

Feed producers

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	4	57,1%
I am familiar with the process/technology	3	42,9%

Retail & restaurant

	n	Percent
I have never heard about it	1	14,3%
I have heard about it	5	71,4%
I am familiar with the process/technology	1	14,3%

Question 14: According to your beliefs, how likely or unlikely do you think it is for SPIRULINA MICROALGAE protein produced using CO₂ emissions to have the following benefits?

All respondents

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	14,6%	12,2%	36,6%	29,3%	7,3%	3,0	3,0	3
Beneficial to our product	12,2%	17,1%	36,6%	26,8%	7,3%	3,0	3,0	3
Beneficial for consumer choices (more variety)	2,4%	9,8%	31,7%	46,3%	9,8%	3,5	4,0	4
Beneficial to human health	2,5%	14,6%	31,7%	31,7%	19,5%	3,5	4,0	3;4
Beneficial to environmental sustainability	2,5%	2,4%	14,6%	36,6%	43,9%	4,2	4,0	5
Beneficial to the national economy	7,3%	7,3%	43,9%	29,3%	12,2%	3,3	3,0	3

Food producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	5,3%	21,0%	26,3%	42,1%	5,3%	3,2	3,0	4
Beneficial to our product	0,0%	31,6%	21,0%	42,1%	5,3%	3,2	3,0	4
Beneficial for consumer choices (more variety)	0,0%	10,5%	36,9%	42,1%	10,5%	3,5	4,0	4
Beneficial to human health	0,0%	15,8%	47,4%	26,3%	10,5%	3,3	3,0	3
Beneficial to environmental sustainability	0,0%	0,0%	10,5%	42,1%	47,4%	4,4	4,0	5
Beneficial to the national economy	5,3%	10,5%	47,4%	26,3%	10,5%	3,3	3,0	3

Feed producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	14,3%	14,3%	42,8%	14,3%	14,3%	3,0	3,0	3
Beneficial to our product	14,3%	14,3%	42,8%	14,3%	14,3%	3,0	3,0	3
Beneficial for consumer choices (more variety)	0,0%	0,0%	42,8%	42,9%	14,3%	3,7	4,0	3;4
Beneficial to human health	0,0%	28,6%	14,3%	42,8%	14,3%	3,4	4,0	4
Beneficial to environmental sustainability	0,0%	14,3%	0,0%	57,1%	28,6%	4,0	4,0	4
Beneficial to the national economy	14,3%	0,0%	42,8%	28,6%	14,3%	3,3	3,0	3

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	14,3%	0,0%	57,1%	14,3%	14,3%	3,1	3,0	3
Beneficial to our product	14,3%	0,0%	42,8%	28,6%	14,3%	3,3	3,0	3
Beneficial for consumer choices (more variety)	0,0%	28,6%	28,6%	42,8%	0,0%	3,1	3,0	4
Beneficial to human health	0,0%	0,0%	42,8%	42,9%	14,3%	3,7	4,0	3;4
Beneficial to environmental sustainability	0,0%	0,0%	42,8%	28,6%	28,6%	3,9	4,0	3
Beneficial to the national economy	0,0%	14,3%	42,8%	42,9%	0,0%	3,3	3,0	3;4

Question 15: To what extent are you concerned about risks related to SPIRULINA MICROALGAE protein produced using CO2 emissions?

All respondents

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	4,9%	21,9%	24,4%	36,6%	12,2%	3,3	3,0	4
Risk concerning food quality (sensory properties, etc.)	7,3%	31,7%	22,0%	31,7%	7,3%	3,0	3,0	2;4
Risk concerning animal health and safety when used in feed	4,9%	17,1%	24,4%	34,1%	19,5%	3,5	4,0	4
Risk of unpredicted negative effects on the environment	7,3%	12,2%	36,6%	29,3%	14,6%	3,3	3,0	3
Risk of not being accepted by consumers	12,2%	36,6%	17,1%	29,2%	4,9%	2,8	3,0	2
Risk that the protein ingredient could not be produced in quantities needed by our company	9,7%	29,3%	34,1%	17,1%	9,8%	2,9	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	19,5%	43,9%	14,7%	14,6%	7,3%	2,5	2,0	2

Food producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	31,6%	10,5%	47,4%	10,5%	3,4	4,0	4
Risk concerning food quality (sensory properties, etc.)	5,3%	42,1%	10,5%	36,8%	5,3%	2,9	3,0	2
Risk concerning animal health and safety when used in feed	0,0%	21,0%	21,1%	36,8%	21,1%	3,6	4,0	4
Risk of unpredicted negative effects on the environment	0,0%	15,8%	52,6%	15,8%	15,8%	3,3	3,0	3
Risk of not being accepted by consumers	15,8%	36,8%	15,8%	26,3%	5,3%	2,7	2,0	2
Risk that the protein ingredient could not be produced in quantities needed by our company	5,3%	31,6%	31,6%	21,0%	10,5%	3,0	3,0	2;3
Risk that the price of the protein ingredient will be too high to be competitive for our company	10,5%	63,1%	5,3%	15,8%	5,3%	2,4	2,0	2

Feed producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	14,3%	28,5%	28,6%	14,3%	14,3%	2,9	3,0	2;3
Risk concerning food quality (sensory properties, etc.)	14,3%	14,3%	42,8%	28,6%	0,0%	2,9	3,0	3
Risk concerning animal health and safety when used in feed	14,3%	14,3%	28,5%	28,6%	14,3%	3,1	3,0	3;4
Risk of unpredicted negative effects on the environment	14,3%	14,3%	28,5%	28,6%	14,3%	3,1	3,0	3;4
Risk of not being accepted by consumers	14,3%	28,5%	28,6%	28,6%	0,0%	2,7	3,0	2;3;4
Risk that the protein ingredient could not be produced in quantities needed by our company	28,6%	14,3%	42,8%	0,0%	14,3%	2,6	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	57,1%	14,3%	14,3%	0,0%	14,3%	2,0	1,0	1

Question 15: To what extent are you concerned about risks related to SPIRULINA MICROALGAE protein produced using CO2 emissions?

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	14,3%	42,8%	42,9%	0,0%	3,3	3,0	3;4
Risk concerning food quality (sensory properties, etc.)	0,0%	14,3%	42,8%	42,9%	0,0%	3,3	3,0	3;4
Risk concerning animal health and safety when used in feed	0,0%	14,3%	42,8%	42,9%	0,0%	3,3	3,0	3;4
Risk of unpredicted negative effects on the environment	14,3%	14,3%	28,6%	42,8%	0,0%	3,0	3,0	4
Risk of not being accepted by consumers	0,0%	14,3%	28,6%	42,8%	14,3%	3,6	4,0	4
Risk that the protein ingredient could not be produced in quantities needed by our company	0,0%	14,3%	57,1%	28,6%	0,0%	3,1	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	14,3%	28,5%	28,6%	28,6%	0,0%	2,7	3,0	2;3;4

Question 16: How familiar are you with this CRICKETS protein source?

All respondents

	n	Percent
I have never heard about it	2	5,0%
I have heard about it	15	37,5%
I am familiar with this protein source	13	32,5%
Our organization has already tested this or similar insects protein source	7	17,5%
Our company is already using this or similar insects protein source	3	7,5%

Food producers

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	9	47,4%
I am familiar with this protein source	4	21,0%
Our organization has already tested this or similar insects protein source	4	21,1%
Our company is already using this or similar insects protein source	2	10,5%

Feed producers

	n	Percent
I have never heard about it	1	14,3%
I have heard about it	3	42,8%
I am familiar with this protein source	2	28,6%
Our organization has already tested this or similar insects protein source	1	14,3%
Our company is already using this or similar insects protein source	0	0,0%

Retail & restaurant

	n	Percent
I have never heard about it	1	14,3%
I have heard about it	2	28,5%
I am familiar with this protein source	2	28,6%
Our organization has already tested this or similar insects protein source	1	14,3%
Our company is already using this or similar insects protein source	1	14,3%

**Question 17: How familiar are you with this production process/technology?
(CRICKETS)**

All respondents

	n	Percent
I have never heard about it	8	20,0%
I have heard about it	20	50,0%
I am familiar with the process/technology	12	30,0%

Food producers

	n	Percent
I have never heard about it	8	20,0%
I have heard about it	20	50,0%
I am familiar with the process/technology	12	30,0%

Feed producers

	n	Percent
I have never heard about it	1	14,3%
I have heard about it	4	57,1%
I am familiar with the process/technology	2	28,6%

Retail & restaurant

	n	Percent
I have never heard about it	3	42,8%
I have heard about it	3	42,9%
I am familiar with the process/technology	1	14,3%

Question 18: According to your beliefs, how likely or unlikely do you think it is for CRICKETS protein produced using underused plant food biomass to have the following benefits?

All respondents

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	20,5%	28,2%	23,1%	23,1%	5,1%	2,6	3,0	2
Beneficial to our product	21,1%	28,9%	31,6%	15,8%	2,6%	2,5	2,5	3
Beneficial for consumer choices (more variety)	15,4%	17,9%	28,2%	28,2%	10,3%	3,0	3,0	3;4
Beneficial to human health	12,8%	10,3%	41,0%	25,6%	10,3%	3,1	3,0	3
Beneficial to environmental sustainability	10,3%	2,6%	17,9%	51,3%	17,9%	3,6	4,0	4
Beneficial to the national economy	12,8%	10,3%	41,0%	28,2%	7,7%	3,1	3,0	3

Food producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	15,8%	42,1%	0,0%	36,8%	5,3%	2,7	2,0	2
Beneficial to our product	15,8%	42,1%	15,8%	21,0%	5,3%	2,6	2,0	2
Beneficial for consumer choices (more variety)	26,3%	31,6%	5,2%	31,6%	5,3%	2,6	2,0	2;4
Beneficial to human health	15,8%	10,5%	36,9%	26,3%	10,5%	3,1	3,0	3
Beneficial to environmental sustainability	15,8%	0,0%	10,5%	57,9%	15,8%	3,6	4,0	4
Beneficial to the national economy	15,8%	10,5%	42,1%	31,6%	0,0%	2,9	3,0	3

Feed producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	28,5%	28,6%	28,6%	14,3%	0,0%	2,3	2,0	1;2;3
Beneficial to our product	42,8%	14,3%	28,6%	14,3%	0,0%	2,1	2,0	1
Beneficial for consumer choices (more variety)	0,0%	0,0%	71,4%	28,6%	0,0%	3,3	3,0	3
Beneficial to human health	14,3%	14,3%	57,1%	14,3%	0,0%	2,7	3,0	3
Beneficial to environmental sustainability	0,0%	14,3%	42,8%	42,9%	0,0%	3,3	3,0	3;4
Beneficial to the national economy	14,3%	14,3%	42,8%	14,3%	14,3%	3,0	3,0	3

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	16,7%	0,0%	83,3%	0,0%	0,0%	2,7	3,0	3
Beneficial to our product	16,7%	0,0%	66,6%	16,7%	0,0%	2,8	3,0	3
Beneficial for consumer choices (more variety)	16,7%	0,0%	66,6%	16,7%	0,0%	2,8	3,0	3
Beneficial to human health	16,7%	0,0%	66,6%	16,7%	0,0%	2,8	3,0	3
Beneficial to environmental sustainability	16,7%	0,0%	33,3%	33,3%	16,7%	3,3	3,5	3;4
Beneficial to the national economy	16,7%	0,0%	66,6%	16,7%	0,0%	2,8	3,0	3

Question 19: To what extent are you concerned about risks related to CRICKETS protein produced using underused plant food biomass?

All respondents

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	43,6%	20,5%	28,2%	7,7%	3,0	3,0	2
Risk concerning food quality (sensory properties, etc.)	0,0%	43,6%	23,1%	23,1%	10,2%	3,0	3,0	2
Risk concerning animal health and safety when used in feed	5,1%	10,3%	33,3%	38,5%	12,8%	3,4	4,0	4
Risk of unpredicted negative effects on the environment	0,0%	25,6%	30,8%	33,3%	10,3%	3,3	3,0	4
Risk of not being accepted by consumers	20,5%	38,5%	17,9%	10,3%	12,8%	2,6	2,0	2
Risk that the protein ingredient could not be produced in quantities needed by our company	7,9%	23,7%	31,6%	26,3%	10,5%	3,1	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	23,1%	41,0%	18,0%	12,8%	5,1%	2,4	2,0	2

Food producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	52,6%	10,5%	31,6%	5,3%	2,9	2,0	2
Risk concerning food quality (sensory properties, etc.)	0,0%	52,6%	5,3%	31,6%	10,5%	3,0	2,0	2
Risk concerning animal health and safety when used in feed	0,0%	10,5%	26,3%	47,4%	15,8%	3,7	4,0	4
Risk of unpredicted negative effects on the environment	0,0%	31,6%	31,6%	26,3%	10,5%	3,2	3,0	2;3
Risk of not being accepted by consumers	31,6%	31,6%	5,3%	21,0%	10,5%	2,5	2,0	1;2
Risk that the protein ingredient could not be produced in quantities needed by our company	10,5%	21,1%	15,8%	36,8%	15,8%	3,3	4,0	4
Risk that the price of the protein ingredient will be too high to be competitive for our company	26,3%	47,4%	10,5%	10,5%	5,3%	2,2	2,0	2

Feed producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	42,8%	42,9%	14,3%	0,0%	2,7	3,0	2;3
Risk concerning food quality (sensory properties, etc.)	0,0%	42,9%	57,1%	0,0%	0,0%	2,6	3,0	3
Risk concerning animal health and safety when used in feed	0,0%	14,3%	57,1%	14,3%	14,3%	3,3	3,0	3
Risk of unpredicted negative effects on the environment	0,0%	28,6%	42,8%	28,6%	0,0%	3,0	3,0	3
Risk of not being accepted by consumers	0,0%	28,6%	57,1%	0,0%	14,3%	3,0	3,0	3
Risk that the protein ingredient could not be produced in quantities needed by our company	14,3%	28,6%	42,8%	14,3%	0,0%	2,6	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	42,8%	14,3%	14,3%	28,6%	0,0%	2,3	2,0	1

Question 19: To what extent are you concerned about risks related to CRICKETS protein produced using underused plant food biomass?

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	16,6%	16,7%	50,0%	16,7%	3,7	4,0	4
Risk concerning food quality (sensory properties, etc.)	0,0%	16,6%	50,0%	16,7%	16,7%	3,3	3,0	3
Risk concerning animal health and safety when used in feed	16,7%	0,0%	33,3%	50,0%	0,0%	3,2	3,5	4
Risk of unpredicted negative effects on the environment	0,0%	16,7%	50,0%	33,3%	0,0%	3,2	3,0	3
Risk of not being accepted by consumers	0,0%	50,0%	33,3%	0,0%	16,7%	2,8	2,5	2
Risk that the protein ingredient could not be produced in quantities needed by our company	0,0%	16,7%	66,6%	16,7%	0,0%	3,0	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	0,0%	66,7%	33,3%	0,0%	0,0%	2,3	2,0	2

Question 20: How familiar are you with this HERMETIA ILLUCENS LARVAE (BLACK SOLDIER FLY) protein source?

All respondents

	n	Percent
I have never heard about it	11	30,5%
I have heard about it	8	22,2%
I am familiar with this protein source	14	38,9%
Our organization has already tested this or similar insects protein source	2	5,6%
Our company is already using this or similar insects protein source	1	2,8%

Food producers

	n	Percent
I have never heard about it	6	40,0%
I have heard about it	5	33,3%
I am familiar with this protein source	4	26,7%
Our organization has already tested this or similar insects protein source	0	0,0%
Our company is already using this or similar insects protein source	0	0,0%

Feed producers

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	2	28,6%
I am familiar with this protein source	3	42,8%
Our organization has already tested this or similar insects protein source	2	28,6%
Our company is already using this or similar insects protein source	0	0,0%

Retail & restaurant

	n	Percent
I have never heard about it	3	42,8%
I have heard about it	1	14,3%
I am familiar with this protein source	3	42,9%
Our organization has already tested this or similar insects protein source	0	0,0%
Our company is already using this or similar insects protein source	0	0,0%

**Question 21: How familiar are you with this production process/technology?
(BLACK SOLDIER FLY)**

All respondents

	n	Percent
I have never heard about it	13	36,1%
I have heard about it	15	41,7%
I am familiar with the process/technology	8	22,2%

Food producers

	n	Percent
I have never heard about it	7	46,7%
I have heard about it	6	40,0%
I am familiar with the process/technology	2	13,3%

Feed producers

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	4	57,1%
I am familiar with the process/technology	3	42,9%

Retail & restaurant

	n	Percent
I have never heard about it	4	57,1%
I have heard about it	2	28,6%
I am familiar with the process/technology	1	14,3%

Question 22 : According to your beliefs, how likely or unlikely do you think it is for HERMETIA ILLUCENS LARVAE (BLACK SOLDIER FLY) protein produced using underused plant food biomass to have the following benefits?

All respondents

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	25,7%	20,0%	40,0%	11,4%	2,9%	2,5	3,0	3
Beneficial to our product	31,4%	14,3%	42,8%	8,6%	2,9%	2,4	3,0	3
Beneficial for consumer choices (more variety)	22,9%	17,1%	37,2%	17,1%	5,7%	2,7	3,0	3
Beneficial to human health	17,1%	11,4%	54,3%	14,3%	2,9%	2,7	3,0	3
Beneficial to environmental sustainability	11,5%	5,7%	31,4%	31,4%	20,0%	3,4	4,0	3;4
Beneficial to the national economy	17,1%	8,6%	45,7%	22,9%	5,7%	2,9	3,0	3

Food producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	33,3%	33,3%	20,0%	13,4%	0,0%	2,1	2,0	1;2
Beneficial to our product	40,0%	26,7%	26,7%	6,6%	0,0%	2,0	2,0	1
Beneficial for consumer choices (more variety)	33,3%	33,3%	20,0%	13,4%	0,0%	2,1	2,0	1;2
Beneficial to human health	20,0%	13,3%	60,0%	6,7%	0,0%	2,5	3,0	3
Beneficial to environmental sustainability	20,0%	0,0%	26,7%	33,3%	20,0%	3,3	4,0	4
Beneficial to the national economy	20,0%	13,3%	66,7%	0,0%	0,0%	2,5	3,0	3

Feed producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	14,3%	28,6%	42,8%	14,3%	0,0%	2,6	3,0	3
Beneficial to our product	28,6%	14,3%	42,8%	14,3%	0,0%	2,4	3,0	3
Beneficial for consumer choices (more variety)	0,0%	0,0%	85,7%	14,3%	0,0%	3,1	3,0	3
Beneficial to human health	14,3%	14,3%	57,1%	14,3%	0,0%	2,7	3,0	3
Beneficial to environmental sustainability	0,0%	28,6%	42,8%	28,6%	0,0%	3,0	3,0	3
Beneficial to the national economy	14,3%	14,3%	28,6%	42,8%	0,0%	3,0	3,0	4

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	16,7%	0,0%	83,3%	0,0%	0,0%	2,7	3,0	3
Beneficial to our product	16,7%	0,0%	66,6%	16,7%	0,0%	2,8	3,0	3
Beneficial for consumer choices (more variety)	16,7%	16,7%	66,6%	0,0%	0,0%	2,5	3,0	3
Beneficial to human health	16,7%	0,0%	83,3%	0,0%	0,0%	2,7	3,0	3
Beneficial to environmental sustainability	0,0%	0,0%	66,6%	16,7%	16,7%	3,5	3,0	3
Beneficial to the national economy	16,7%	0,0%	50,0%	33,3%	0,0%	3,0	3,0	3

Question 23: To what extent are you concerned about risks related to HERMETIA ILLUCENS LARVAE protein produced using underused plant food biomass?

All respondents

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	17,2%	34,3%	25,7%	11,4%	11,4%	2,7	2,0	2
Risk concerning food quality (sensory properties, etc.)	14,3%	37,1%	31,4%	8,6%	8,6%	2,6	2,0	2
Risk concerning animal health and safety when used in feed	5,7%	11,5%	45,7%	25,7%	11,4%	3,3	3,0	3
Risk of unpredicted negative effects on the environment	0,0%	28,6%	45,7%	17,1%	8,6%	3,1	3,0	3
Risk of not being accepted by consumers	28,6%	31,4%	20,0%	5,7%	14,3%	2,5	2,0	2
Risk that the protein ingredient could not be produced in quantities needed by our company	11,4%	25,7%	42,9%	11,4%	8,6%	2,8	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	14,3%	31,4%	42,9%	5,7%	5,7%	2,6	3,0	3

Food producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	33,3%	33,3%	13,4%	13,3%	6,7%	2,3	2,0	1;2
Risk concerning food quality (sensory properties, etc.)	26,7%	40,0%	20,0%	6,6%	6,7%	2,3	2,0	2
Risk concerning animal health and safety when used in feed	0,0%	13,3%	53,4%	20,0%	13,3%	3,3	3,0	3
Risk of unpredicted negative effects on the environment	0,0%	33,3%	46,7%	6,7%	13,3%	3,0	3,0	3
Risk of not being accepted by consumers	40,0%	33,3%	13,3%	6,7%	6,7%	2,1	2,0	1
Risk that the protein ingredient could not be produced in quantities needed by our company	6,7%	26,7%	40,0%	13,3%	13,3%	3,0	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	6,7%	33,3%	46,6%	6,7%	6,7%	2,7	3,0	3

Feed producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	57,1%	14,3%	0,0%	28,6%	3,0	2,0	2
Risk concerning food quality (sensory properties, etc.)	0,0%	42,8%	28,6%	14,3%	14,3%	3,0	3,0	2
Risk concerning animal health and safety when used in feed	0,0%	14,3%	57,1%	14,3%	14,3%	3,3	3,0	3
Risk of unpredicted negative effects on the environment	0,0%	42,9%	57,1%	0,0%	0,0%	2,6	3,0	3
Risk of not being accepted by consumers	28,6%	14,3%	42,8%	0,0%	14,3%	2,6	3,0	3
Risk that the protein ingredient could not be produced in quantities needed by our company	14,3%	28,6%	42,8%	14,3%	0,0%	2,6	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	42,8%	0,0%	42,9%	14,3%	0,0%	2,3	3,0	1;3

Question 23: To what extent are you concerned about risks related to HERMETIA ILLUCENS LARVAE protein produced using underused plant food biomass?

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	16,6%	50,0%	16,7%	16,7%	3,3	3,0	3
Risk concerning food quality (sensory properties, etc.)	0,0%	16,7%	66,6%	0,0%	16,7%	3,2	3,0	3
Risk concerning animal health and safety when used in feed	16,6%	16,7%	50,0%	16,7%	0,0%	2,7	3,0	3
Risk of unpredicted negative effects on the environment	0,0%	16,7%	83,3%	0,0%	0,0%	2,8	3,0	3
Risk of not being accepted by consumers	0,0%	50,0%	33,3%	0,0%	16,7%	2,8	2,5	2
Risk that the protein ingredient could not be produced in quantities needed by our company	16,6%	16,7%	50,0%	16,7%	0,0%	2,7	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	16,7%	33,3%	50,0%	0,0%	0,0%	2,3	2,5	3

Question 24: How familiar are you with this TORULA YEAST protein source?

All respondents

	n	Percent
I have never heard about it	16	41,0%
I have heard about it	12	30,8%
I am familiar with this protein source	5	12,8%
Our organization has already tested this or similar insects protein source	5	12,8%
Our company is already using this or similar insects protein source	1	2,6%

Food producers

	n	Percent
I have never heard about it	7	38,9%
I have heard about it	7	38,9%
I am familiar with this protein source	3	16,7%
Our organization has already tested this or similar insects protein source	1	5,5%
Our company is already using this or similar insects protein source	0	0,0%

Feed producers

	n	Percent
I have never heard about it	0	0,0%
I have heard about it	2	28,5%
I am familiar with this protein source	2	28,6%
Our organization has already tested this or similar insects protein source	2	28,6%
Our company is already using this or similar insects protein source	1	14,3%

Retail & restaurant

	n	Percent
I have never heard about it	6	85,7%
I have heard about it	1	14,3%
I am familiar with this protein source	0	0,0%
Our organization has already tested this or similar insects protein source	0	0,0%
Our company is already using this or similar insects protein source	0	0,0%

**Question 25: How familiar are you with this production process/technology?
(TORULA YEAST)**

All respondents

	n	Percent
I have not heard about this before	18	46,2%
I have heard about this before	14	35,9%
I am familiar with the process/technology	7	17,9%

Food producers

	n	Percent
I have not heard about this before	6	33,3%
I have heard about this before	11	61,1%
I am familiar with the process/technology	1	5,6%

Feed producers

	n	Percent
I have not heard about this before	0	0,0%
I have heard about this before	3	42,9%
I am familiar with the process/technology	4	57,1%

Retail & restaurant

	n	Percent
I have not heard about this before	7	100,0%
I have heard about this before	0	0,0%
I am familiar with the process/technology	0	0,0%

Question 26 : According to your beliefs, how likely or unlikely do you think it is TORULA YEAST protein produced using underused by-products from forestry to have the following benefits?

All respondents

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	13,5%	5,4%	40,6%	32,4%	8,1%	3,2	3,0	3
Beneficial to our product	13,5%	5,4%	43,3%	29,7%	8,1%	3,1	3,0	3
Beneficial for consumer choices (more variety)	5,4%	5,4%	43,3%	37,8%	8,1%	3,4	3,0	3
Beneficial to human health	8,1%	0,0%	56,8%	32,4%	2,7%	3,2	3,0	3
Beneficial to environmental sustainability	2,7%	5,4%	21,6%	51,4%	18,9%	3,8	4,0	4
Beneficial to the national economy	8,1%	8,1%	37,9%	32,4%	13,5%	3,4	3,0	3

Food producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	11,1%	5,6%	44,4%	38,9%	0,0%	3,1	3,0	3
Beneficial to our product	11,1%	5,6%	50,0%	33,3%	0,0%	3,1	3,0	3
Beneficial for consumer choices (more variety)	5,5%	5,6%	50,0%	38,9%	0,0%	3,2	3,0	3
Beneficial to human health	5,5%	0,0%	66,7%	27,8%	0,0%	3,2	3,0	3
Beneficial to environmental sustainability	5,5%	0,0%	27,8%	50,0%	16,7%	3,7	4,0	4
Beneficial to the national economy	5,6%	11,1%	44,4%	33,3%	5,6%	3,2	3,0	3

Feed producers

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	14,3%	0,0%	14,3%	42,8%	28,6%	3,7	4,0	4
Beneficial to our product	14,3%	0,0%	28,5%	28,6%	28,6%	3,6	4,0	3;4;5
Beneficial for consumer choices (more variety)	0,0%	14,3%	28,6%	57,1%	0,0%	3,4	4,0	4
Beneficial to human health	14,3%	0,0%	42,8%	28,6%	14,3%	3,3	3,0	3
Beneficial to environmental sustainability	0,0%	14,3%	14,3%	71,4%	0,0%	3,6	4,0	4
Beneficial to the national economy	14,3%	0,0%	28,6%	57,1%	0,0%	3,3	4,0	4

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Beneficial to our company	20,0%	0,0%	80,0%	0,0%	0,0%	2,6	3,0	3
Beneficial to our product	20,0%	0,0%	60,0%	20,0%	0,0%	2,8	3,0	3
Beneficial for consumer choices (more variety)	20,0%	0,0%	80,0%	0,0%	0,0%	2,6	3,0	3
Beneficial to human health	20,0%	0,0%	80,0%	0,0%	0,0%	2,6	3,0	3
Beneficial to environmental sustainability	0,0%	0,0%	40,0%	40,0%	20,0%	3,8	4,0	3;4
Beneficial to the national economy	20,0%	0,0%	60,0%	20,0%	0,0%	2,8	3,0	3

Question 27: To what extent are you concerned about risks related to TORULA YEAST protein produced using underused by-products from forestry?

All respondents

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	8,1%	24,3%	16,2%	35,2%	16,2%	3,3	4,0	4
Risk concerning food quality (sensory properties, etc.)	5,4%	29,8%	29,7%	21,6%	13,5%	3,1	3,0	2;3
Risk concerning animal health and safety when used in feed	10,8%	2,7%	29,7%	37,9%	18,9%	3,5	4,0	4
Risk of unpredicted negative effects on the environment	10,8%	8,1%	29,7%	43,3%	8,1%	3,3	4,0	4
Risk of not being accepted by consumers	16,2%	16,2%	24,3%	35,2%	8,1%	3,0	3,0	4
Risk that the protein ingredient could not be produced in quantities needed by our company	10,8%	29,8%	24,3%	21,6%	13,5%	3,0	3,0	2
Risk that the price of the protein ingredient will be too high to be competitive for our company	13,5%	43,3%	24,3%	5,4%	13,5%	2,6	2,0	2

Food producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	11,1%	27,8%	16,7%	38,9%	5,5%	3,0	3,0	4
Risk concerning food quality (sensory properties, etc.)	5,5%	38,9%	22,2%	27,8%	5,6%	2,9	3,0	2
Risk concerning animal health and safety when used in feed	11,1%	0,0%	27,8%	55,5%	5,6%	3,4	4,0	4
Risk of unpredicted negative effects on the environment	11,1%	11,1%	27,8%	44,4%	5,6%	3,2	3,5	4
Risk of not being accepted by consumers	11,1%	22,2%	27,8%	33,3%	5,6%	3,0	3,0	4
Risk that the protein ingredient could not be produced in quantities needed by our company	0,0%	44,4%	27,8%	16,7%	11,1%	2,9	3,0	2
Risk that the price of the protein ingredient will be too high to be competitive for our company	5,6%	61,1%	22,2%	0,0%	11,1%	2,5	2,0	2

Feed producers

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	14,3%	28,5%	14,3%	14,3%	28,6%	3,1	3,0	2;5
Risk concerning food quality (sensory properties, etc.)	14,3%	42,8%	14,3%	14,3%	14,3%	2,7	2,0	2
Risk concerning animal health and safety when used in feed	14,3%	14,3%	28,6%	0,0%	42,8%	3,4	3,0	5
Risk of unpredicted negative effects on the environment	14,3%	14,3%	28,5%	28,6%	14,3%	3,1	3,0	3;4
Risk of not being accepted by consumers	14,3%	14,3%	42,8%	14,3%	14,3%	3,0	3,0	3
Risk that the protein ingredient could not be produced in quantities needed by our company	28,6%	14,3%	0,0%	42,8%	14,3%	3,0	4,0	4
Risk that the price of the protein ingredient will be too high to be competitive for our company	42,8%	14,3%	14,3%	14,3%	14,3%	2,4	2,0	1

Question 27: To what extent are you concerned about risks related to TORULA YEAST protein produced using underused by-products from forestry?

Retail & restaurant

	1	2	3	4	5	Average	Median	Mode
Risk concerning food safety	0,0%	20,0%	20,0%	40,0%	20,0%	3,6	4,0	4
Risk concerning food quality (sensory properties, etc.)	0,0%	20,0%	60,0%	0,0%	20,0%	3,2	3,0	3
Risk concerning animal health and safety when used in feed	20,0%	0,0%	60,0%	20,0%	0,0%	2,8	3,0	3
Risk of unpredicted negative effects on the environment	0,0%	0,0%	80,0%	20,0%	0,0%	3,2	3,0	3
Risk of not being accepted by consumers	0,0%	20,0%	20,0%	40,0%	20,0%	3,6	4,0	4
Risk that the protein ingredient could not be produced in quantities needed by our company	20,0%	0,0%	60,0%	20,0%	0,0%	2,8	3,0	3
Risk that the price of the protein ingredient will be too high to be competitive for our company	0,0%	40,0%	60,0%	0,0%	0,0%	2,6	3,0	3