NEXTGEN PROTEINS

NextGenProteins 3rd Newsletter

Producing sustainable proteins from microalgae, fungi and insects

Interview with Charilaos Xiros, senior researcher, working in the fields of industrial biotechnology and applied microbiology at RISE Processum in Sweden. His role in the NextGenProteins project is to coordinate the production and optimisation of high-quality, safe, nutritious and sustainable proteins from microalgae, single cells and insect to meet the requirements for food and feed applications.

How are you producing proteins from microalgae, fungi and insects in the NextGenProteins project? And why are they sustainable?

Microalgae proteins are produced from Spirulina. Spirulina is approved for food consumption in EU (by EU commission and EFSA) and can therefore be used as ingredients for food and feed. Naturally occurring spirulina are usually found in too low densities and must therefore be cultivated. Production takes place in efficient vertical photo-bioreactors installed in controlled indoor environment with optimised growth and safety conditions. Like any plant, Spirulina needs carbon dioxide (CO_2), water, light and heat in order to grow (photosynthesis). The CO_2 needed to grow the spirulina is obtained from a local geothermal power plant. CO_2 is an emission from the energy production process. The water used is recycled. The light needed is produced using LEDs. The waste heat from the power plant is used to supply heat for the growth of spirulina. The microalgae use CO_2 to grow, releasing O_2 (oxygen), so that their production is overall carbon negative. The production of microalgae is using non-ammonia/urea-based fertilizers and is characterised by less than 1% land footprint and less than 1% of fresh water consumption compared to industry standards.

Single cell proteins (SCP) are produced from Torula yeast or filamentous fungi. Yeast and fungi are cultivated on substrate made of forest biomass, which is a by-product from the forest industry, e.g. branches, saw dust, wood chips and straw. The forestry residues are pre-treated using steam explosion methodologies. The generated slurries are enzymatically treated to generate the sugar stream, which is used as a substrate to grow torula yeast or filamentous fungi. The yeast or fungi are then washed, filtered, dried and grinded to provide the final protein product. The complete fermentation takes place in controlled indoor facilities. By producing SCP from forestry, pulp and paper residual streams, CO_2 emissions can be reduced significantly by up to 50%. Although a certain amount of forestry residues have to remain on the field to provide nutrients to the soil, forestry residues can be used for the production of valuable SCP providing a sustainable raw material fulfilling the requirements of a growing market. Using forestry residues for SCP production decreases the import of proteins and nutrients from third countries, decreasing Europe dependence on external resources, and decreasing costs and GHG emissions linked with transportation.

Insect proteins are produced from house crickets or black soldier flies depending on their use (food or feed applications respectively). Production takes place in efficient automated indoor farms. Crickets or black soldier flies are fed plant-based underutilised food biomass, which are side-streams from agriculture or food industry e.g. vegetable peel, apple cores. Insect protein flour is grinded from the farmed crickets and black soldier flies. Overall, insects are known to be very sustainable source of protein compared to meat as they need much less feed, water and space. E.g. to produce 1kg of insect protein 1,7 kg feed and 1L water are needed. To produce 1kg of beef proteins 10kg of feed and 22L water are needed. In addition, use of food production side-streams ensures efficient use of resources.

And how do you make sure that these proteins are suitable for food and feed applications?

The functional, nutritional and sensorial characteristics of the proteins are analysed. Regarding the nutritional properties, the proximate composition (water, protein, fat, ash), as well as amino acid and fatty acid composition, minerals, potential existence of toxins, allergens and antinutritional factors are analysed and the digestibility of proteins is assessed. The functional properties such as solubility, water and fat holding capacity, emulsion and gelling properties are assessed directly in solution and in model systems such as minced fish, meat and soya products to look at protein-protein interactions; alone, in mixture with each other and other food ingredients e.g. hydrocolloids. NMR techniques are used to yield information on protein structure, protein-protein interactions, types of water (loose or fast bound) and NIR. Electrophoresis (SDS), sulphur-bridges and microscopy methods are used to give more detailed information for food and feed formulations. Sensory properties such as taste, odour and texture parameters are tested directly in suitable solutions and in model systems.

Although the protein powders have good nutritional quality and are of excellent quality in view of toxicology and protein quality, their functional and sensorial properties need to be adapted to the requirements of the food and feed industry. Spirulina proteins for example have a very dark green colour and are difficult to apply as such in bakery products. Through various filtration processes, it is possible to reduce the intensity of the colour and increase the number application possibilities.

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