

NextGenProteins

Impact statement

nextgenproteins.eu

TABLE OF CONTENTS

- Introduction
- Why do we need alternative proteins?
- The NextGenProteins Value-Chain Approach
- Spirulina
- Single Cell Proteins
- Insect Proteins
 - Edible Insect Proteins
 - Feedable Insect Proteins
- Regulations, Safety and Legal Requirements
- Alternative Protein Production and Optimisation
- Application in Food Products
- Application in Feed Products
- Market Opportunities and Business Potential
- Sustainability Assessment
- Stakeholder Involvement and Dissemination
- Horizon4Proteins
- Engaging with Stakeholders
- Project Documents
- NextGenProteins flyer

INTRODUCTION

NextGenProteins was a Horizon-2020-funded project focusing on optimizing the production and application of three alternative proteins in food and feed production. The project addressed environmental concerns by exploring sustainable protein sources and ensuring consumer acceptance. It specifically focused on proteins derived from microalgae, single cells, and insects, assessing their viability as substitutes or additions to traditional protein sources.

The project's objectives included assessing the regulatory landscape, identifying production barriers, and contributing to future EU policies regarding alternative proteins. NextGenProteins also aimed to deliver high-quality, safe, nutritious, and sustainable protein sources by utilizing industrial waste streams that are currently discarded. Practical trials were conducted to demonstrate the potential applications of these proteins in various food products and animal feed. Market opportunities for alternative proteins was explored through consumer and stakeholder engagement, with a focus on building trust and acceptability. The project also analyzed and verified the sustainability advantages of alternative protein production processes, including their environmental and economic impacts, production efficiency, and resource utilization.

In the eyes of Birgir Ö. Smárason, NextGenProteins coordinator, the project was remarkably successful, timely and important as it came at a time when food sustainability and food system transformation is increasingly being discussed at high levels. The goal of demonstrating the suitability and economic viability of the ingredients developed by project partners within food and feed value chains was indeed a significant step in advancing the adoption of alternative protein sources. Technical potential for food or feed applications was a positive outcome, as it suggests that these proteins can contribute to more sustainable and diverse food sources.



Birgir Örn Smárason, the project coordinator

The success of initiatives like NextGenProteins can pave the way for innovative solutions to global food challenges. The future of proteins is intertwined with our future food systems; the requirement of being sustainable in terms of economy and providing affordable products with considerably lower environmental impacts than current production. The NextGen proteins, that is the ones under consideration in this project, put less strain on natural resources and will have lower environmental impacts than many traditional proteins. These issues are important when considering how the increased protein demand of a growing global population will be met.

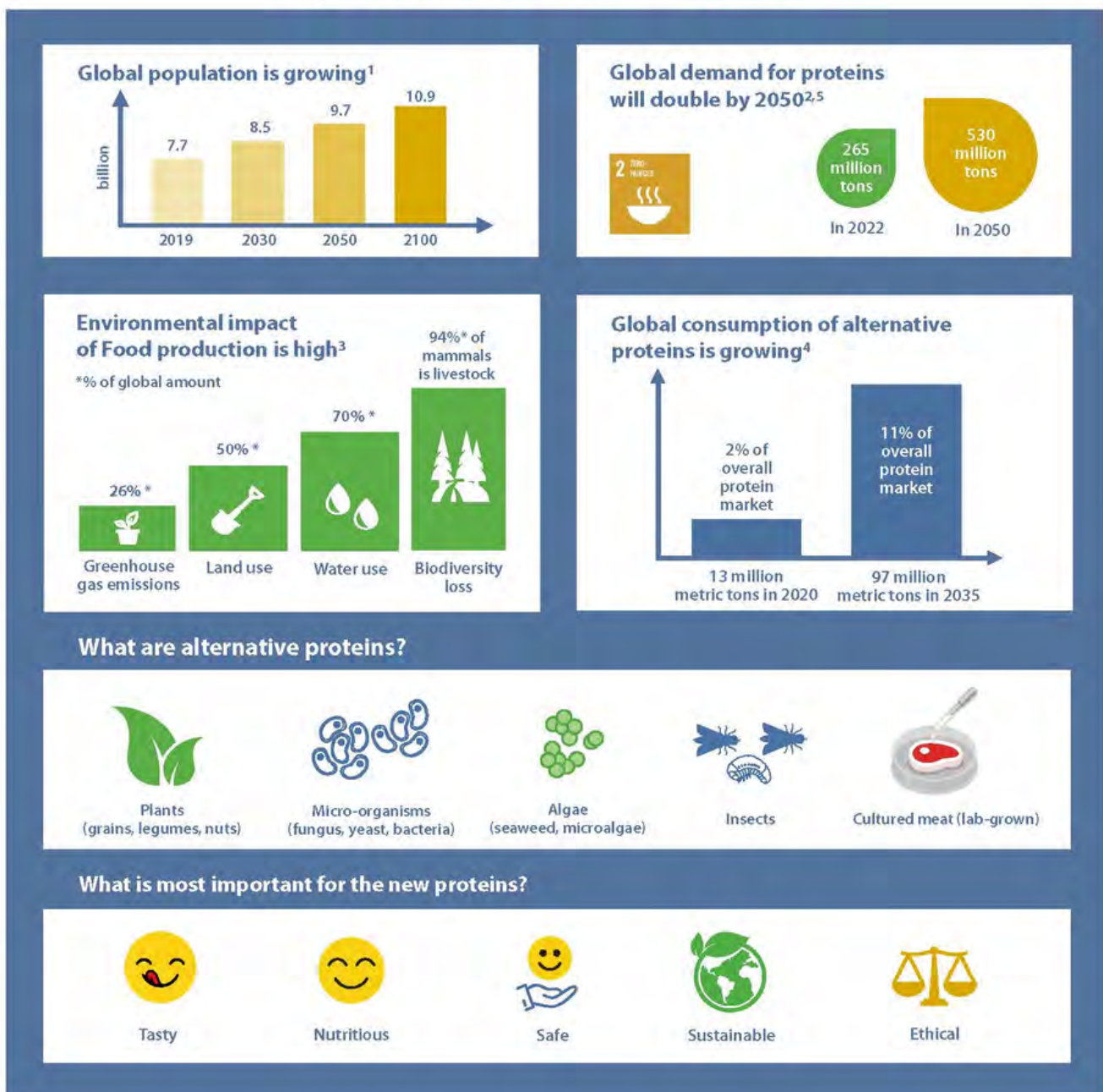
Broadening the production and consumption of alternative proteins could play a crucial role in ecosystem restoration and reducing the global carbon footprint of agrifood systems, which, according to recent FAO estimates, are responsible for 31% of human-induced greenhouse gas emissions. Therefore, exploring these alternative protein sources is not just about dietary changes, but it represents a fundamental shift towards a more sustainable future for our planet and its growing population.



The NextGenProteins consortium at the final conference in Bremerhaven

WHY DO WE NEED ALTERNATIVE PROTEINS?

Access to high quality, sustainably produced proteins is becoming increasingly restricted due to a growing world population, increased pressure on natural resources and climate change, while at the same time the global protein demand has never been higher. To meet the increasing demand, current protein production will have to double by 2050. It is therefore of vital importance to find sustainable alternative protein sources that can be economically produced in quantities that meet the growing food and feed industry demand.



¹ United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019: Highlights (ST/ESA/SER.A/423)

² <https://www.buhlergroup.com/content/buhlergroup/global/en/industries/Extrusion-solutions/Alternative-Proteins.html>

³ <http://ourworldindata.org/environmental-impacts-of-food>

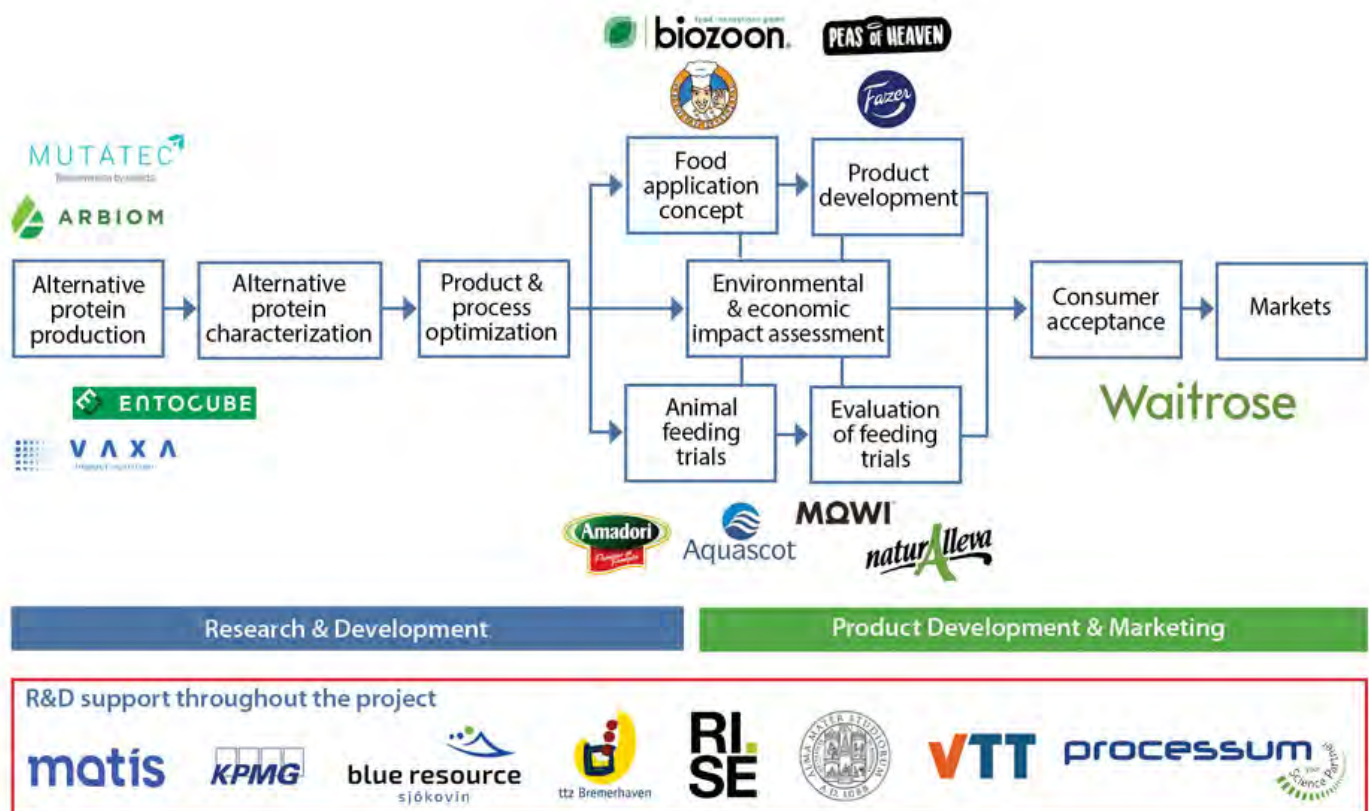
⁴ Morach, Benjamin, et al. "Food for Thought: The Protein Transformation." Industrial Biotechnology 17.3 (2021): 125-133

⁵ <https://www.un.org/sustainabledevelopment/hunger>

THE NEXTGENPROTEINS VALUE-CHAIN APPROACH

NextGenProteins addressed value chain considerations in several ways. The project consortium was strategically selected to reflect food and feed value chains from different angles, from production to retailing, ranging from local SMEs to large, international corporations with extensive market shares. Work packages and work flow in the project were developed to accelerate and support upscaling and market adoption of the three alternative proteins, and to acquire a holistic picture of their current and future potential as part of current supply chains, including risks and vulnerabilities.


The project studied the economic dimension of value chains with the intention of understanding how shifting from traditional protein production to alternative proteins may impact the economic systems they operate in. Social effects, such as on job creations and the job market, were explored as well as the social and economic effects that price fluctuations of traditional proteins might have on the demand for alternative proteins. Resource availability was also analyzed, where resource availability was used as an upper boundary for the productivity of alternative protein production.




SPIRULINA

VAXA, a technology and microalgae production company located in Iceland, aims to overcome key technical challenges and take microalgae production to the next level. VAXA uses highly concentrated CO₂ waste streams from a geothermal power plant for phototropic cultivation of microalgae. During the project, they optimised the production process and further developed its processing methods to yield a sustainable product with consistent nutritional quality.

What are proteins from microalgae?




spirulina




VAXA
impact nutrition


Sustainable production¹



No pesticides / no herbicides




Controlled, indoor production in bioreactors




Use natural CO₂ and waste heat from geothermal power plant


*for 1 kg of wet edible microalgae



Reduced use of land*: 0,0378m² (<1% compared to beef²)

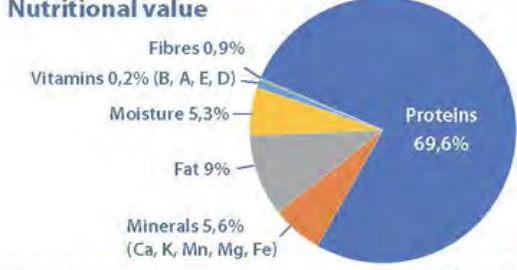


Reduced use of fresh water*: 8,36m³ (<1% compared to beef²)

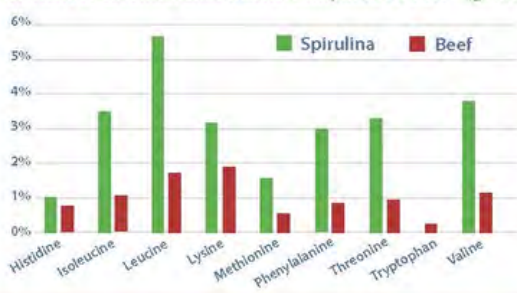


Reduced greenhouse gas emissions*: -0,008 kgCO₂eq CO₂-eq GHG emissions (<1% compared to beef²)

Nutritional value



Content of essential amino acids compared to beef² (g/100g)




Amino Acid	Spirulina (g/100g)	Beef (g/100g)
Histidine	1.0	0.8
Isoleucine	3.5	1.0
Leucine	5.5	1.8
Lysine	3.0	1.8
Methionine	1.5	0.8
Phenylalanine	3.0	0.8
Threonine	3.2	1.0
Tryptophan	0.5	0.2
Valine	3.8	1.2


Regulation Approved in food and feed

How does it taste? Carrot-like, grassy, sweet, not fishy, neutral


Applications tested in the NextGenProteins project




Ready meals




Bakery products




Meat alternative



Food supplements



Poultry feed



Fish feed

2-5% in food
6% in poultry feed
10% in fish feed

Possible Nutrition claims^{3,4,6,7,8,9}

1. High phosphorus
2. High iron
3. High manganese
4. High vitamin K
5. Source of B2
6. Source of B3
7. High B12

Possible Health claims^{3,5,6,7,8}

Magnesium contributes to (1) reduction of tiredness and fatigue, (2) electrolyte balance, (3) energy-yielding metabolism, (4) functioning of nervous system, (5) muscle function, (6) protein synthesis, (7) psychological function, (8) maintenance of bones, (9) maintenance of teeth and (10) has a role in cell division.

Vitamin K contributes to (1) normal blood clotting and (2) maintenance of bones.

Vitamin B12 contributes to (1) energy-yielding metabolism, (2) functioning of nervous system, (3) homocysteine metabolism, (4) physiological function, (5) red blood cell formation, (6) functioning of immune system, (7) reduction of tiredness and fatigue and (8) has a role in cell division.

Iron contributes to (1) cognitive function, (2) energy-yielding metabolism, (3) formation of red blood cells and haemoglobin, (4) function of immune system, (5) reduction of tiredness and fatigue and (6) has a role in cell division.

¹ Tzachor, A., Smidt-Jensen, A., Ramel, A., & Geirsdóttir, M. (2022). Environmental impacts of large-scale Spirulina (*Arthrospira platensis*) production in Hellisheidi geothermal park Iceland: life cycle assessment. *Marine Biotechnology*, 1-11.

² Disclaimers: Beef has been used as a comparison because of high protein content and high consumption around the world. NextGenProteins does not aim to discredit any protein source, but rather to inform about new sources.

³ https://ec.europa.eu/food/safety/labelling_nutrition/claims/register/public/?event=register.home

⁴ https://food.ec.europa.eu/safety/labelling-and-nutrition/nutrition-and-health-claims/nutrition-claims_en

⁵ Regulation (EU) No 432/2012 – List of permitted Health Claims.

⁶ Regulation No 1924/2006 on nutrition and health claims made on foods

⁷ Regulation (EC) No 1169/2011 on the provision of food information to consumers


⁸ Council Directive 1990, 90/496/EEC on nutrition labelling for foodstuffs.

⁹ Regulation (EC) No 1925/2006 on the addition of vitamins and minerals and on certain other substances to foods


SINGLE CELL PROTEINS

ARBIOM, which uses the power of fermentation for its wood to food technology is able to convert wood and wood residues into a nutritional, economical, traceable and sustainable source of protein for food and feed applications. The Arbiom process is based on a two-step approach where wood residues are converted into highly fermentable hydrolysates that are then converted into Single Cell Protein (SCP) via bioconversion with the yeast *Candida utilis*. During the project, ARBIOM further optimised its SCP production process, thus enhancing the nutritional properties of its product, and explored its suitability and market potentials.

What are Single Cell Proteins?




SylPro (Torula Yeast)¹




ARBIOM

Sustainable production²




Controlled, indoor production in bioreactors




Use carbon from sustainable feedstocks (e.g. branches, saw dust, wood chips and straw)


*for 1 kg single cell proteins



Reduced use of land*: 0,00027m²
(0,0003% compared to beef³)

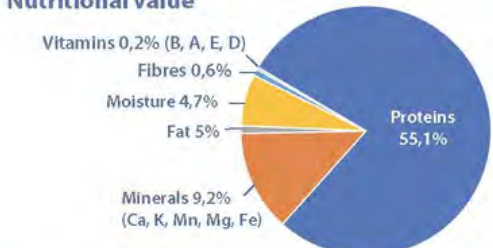


Reduced use of fresh water*: 0,29m³
(3% compared to beef³)

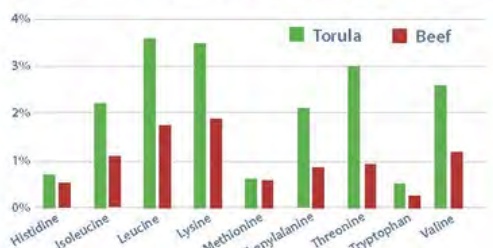


Reduced greenhouse gas emissions*: 12,3kgCO₂e/q
(11% compared to beef³)

Nutritional value




Content of essential amino acids compared to beef³ (g/100g)




Regulation Approved in food and feed

How does it taste? Umami/yeasty taste


Applications tested in the NextGenProteins project




Ready meals




Bakery products




Meat alternative



Food supplements



Poultry feed



Fish feed

3-15% in food

2-6% in poultry feed

5-10% in fish feed

Possible Nutrition claims^{4,5,7,8,10,11}

- Source of vitamin B12

Possible Health claims^{4,6,7,8,10}


Vitamin B12 contributes to normal (1) energy-yielding metabolism, (2) functioning of nervous system, (3) homocysteine metabolism, (4) physiological function; (5) red blood cell formation, (6) functioning of immune system, (7) reduction of tiredness and fatigue and (8) has a role in cell division.

1 NB: The properties below concern Arbiom's SylPro, not Torula Yeast in general
 2 NextGenProteins (2022) Deliverable No 6.3. Report on circular economy potential of alternative proteins available on: <https://zenodo.org/communities/nextgenproteins/?page=18&size=20>
 3 Disclaimers: Beef has been used as a comparison because of high protein content and high consumption around the world. NextGenProteins does not aim to discredit any protein source, but rather to inform about new sources.
 4 https://ec.europa.eu/food/safety/labelling_nutrition/claims/register/public/?event=register.home
 5 https://food.ec.europa.eu/safety/labelling-and-nutrition/nutrition-and-health-claims/nutrition-claims_en
 6 Regulation (EU) No 432/2012 – List of permitted Health Claims.
 7 Regulation No 1924/2006 on nutrition and health claims made on foods.
 8 Regulation (EC) No 1169/2011 on the provision of food information to consumers.
 9 Council Directive 1990, 90/496/EEC on nutrition labelling for foodstuffs.
 10 Regulation (EC) No 1925/2006 on the addition of vitamins and minerals and on certain other substances to foods.
 11 Scientific Opinion on Dietary Reference Values for cobalamin (vitamin B12) = EFSA Journal 2015;13(7):4150

INSECT PROTEINS


EntoCube, a Finnish start-up, are producing insects grown on pre-consumer waste or agro-food waste. They addressed key technical and market-related challenges in the development of novel, sustainable and cost-efficient production of crickets. NextGenProteins supported EntoCube to focus on development of more efficient automated cricket farming, that will enable competitive price of insect proteins for food applications.

What are edible insect proteins?




House cricket

Sustainable production¹



Automated indoor farms

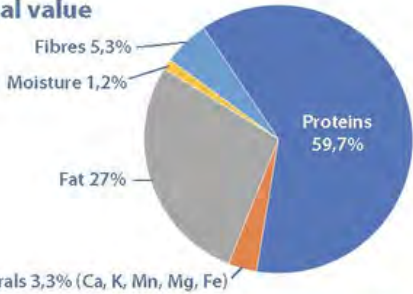


Use plant-based by-products from agriculture (e.g. vegetable peel to feed the insects)

*for 1 kg single cell proteins²

- Reduced use of land*: 0,00006m² (0,0001% compared to beef³)
- Reduced use of fresh water*: 0,15m³ (2% compared to beef³)
- Reduced greenhouse gas emissions*: 0,9kgCO₂eq (1% compared to beef³)

Nutritional value



Proteins 59,7%

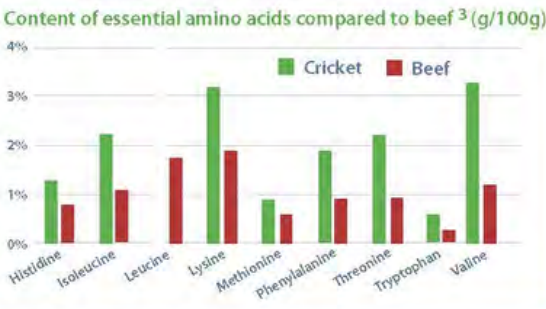
Fat 27%

Fibres 5,3%

Minerals 3,3% (Ca, K, Mn, Mg, Fe)

Moisture 1,2%

Content of essential amino acids compared to beef³ (g/100g)




Amino Acid	Cricket (g/100g)	Beef (g/100g)
Histidine	~1.3	~0.8
Isoleucine	~2.2	~1.1
Leucine	~1.8	~1.8
Lysine	~3.2	~1.9
Methionine	~0.9	~0.6
Phenylalanine	~1.9	~0.9
Threonine	~2.2	~0.9
Tryptophan	~0.6	~0.3
Valine	~3.3	~1.2


Regulation Approved in food⁴ and feed

How does it taste? Nutty, slightly bitter (dark chocolate)


Applications tested in the NextGenProteins project




Ready meals



Bakery products



Meat alternative



Food supplements

5-8% in food

No nutrition or Health claim possible considering the use of 5% cricket in food or drink.
Insects are part of traditional cuisine for 2 billion people around the world.

¹NextGenProteins (2022) Deliverable No 6.3. Report on circular economy potential of alternative proteins available on <https://zenodo.org/communities/nextgenproteins/?page=1&size=20>


²Disclaimer: considering the low amount and quality of data available, the figures presented are not directly comparable with other alternative protein sources studied in NextGenProteins.
³Disclaimer: Beef has been used as a comparison because of high protein content and high consumption around the world. NextGenProteins does not aim to discredit any protein source, but rather to inform about new sources.

⁴Commission Implementing Regulation (EU) 2023/5 of 3 January 2023 authorising the placing on the market of *Acheta domestica* (house cricket) partially defatted powder as a novel food and amending Implementing Regulation (EU) 2017/2470.


INSECT PROTEINS

MUTATEC, a French insect company, are producing insects grown on pre-consumer waste or agro-food waste. In NextGenProteins, they addressed challenges in developing novel, sustainable and cost-efficient value chain for black soldier flies, with support from the research partners. NextGenProteins supported MUTATEC in paving the way for industrialization of black soldier fly farming and commercialization of protein products for animal feed

What are feedable insect proteins?





Black Soldier fly



MUTATEC
Bioconversion by insects


Sustainable production¹






Automated indoor farms

Use plant-based by-products from agriculture (e.g. vegetable peel to feed the insects)

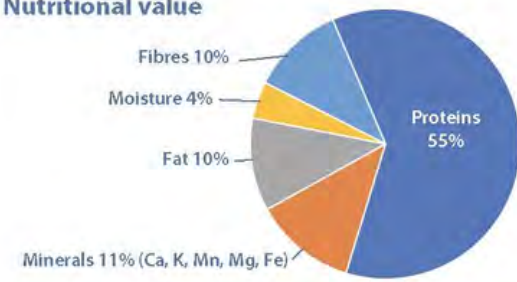
**for 1 kg single cell proteins*

 Reduced use of land*: 0,00074m²
(0,0008% compared to beef ²)

 Reduced use of fresh water*: 3,46m³
(38% compared to beef ²)

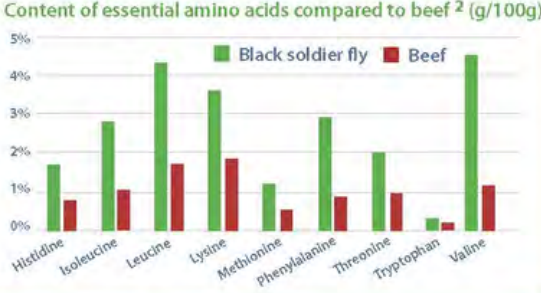
 Reduced greenhouse gas emissions*: 10,2kgCO₂eq
(9% compared to beef ²)

Nutritional value



Fibres 10%
Moisture 4%
Fat 10%
Minerals 11% (Ca, K, Mn, Mg, Fe)
Proteins 55%


Content of essential amino acids compared to beef ² (g/100g)




Amino Acid	Black soldier fly (g/100g)	Beef (g/100g)
Histidine	~1.5	~0.8
Isoleucine	~2.8	~1.0
Leucine	~4.5	~1.8
Lysine	~3.5	~1.8
Methionine	~1.2	~0.5
Phenylalanine	~2.8	~0.8
Threonine	~2.0	~0.8
Tryptophan	~0.5	~0.2
Valine	~4.5	~1.0

Regulation Approved for use in pet food, chicken feed, pork feed and aquafeed


Applications tested in the NextGenProteins project




Feed for turkey



Feed for broiler chicken



Feed for Salmon



Feed for Seabream

9-18% in poultry feed 5-15% in fish feed

¹ NextGenProteins (2022) Deliverable No 6.3. Report on circular economy potential of alternative proteins available on <https://zenodo.org/communities/nextgenproteins/?page=1&size=20>
² Disclaimers: Beef has been used as a comparison because of high protein content and high consumption around the world. NextGenProteins does not aim to discredit any protein source, but rather to inform about new sources.

REGULATIONS, SAFETY AND LEGAL REQUIREMENTS

Work Package 1

The main goals were to explore the EU regulatory framework for the production and use of alternative proteins in food and feed and to contribute to future EU policy work with recommendations for alternative proteins. Furthermore we wanted to carry out pre-market assessment for NextGenProteins for use in EU.

Summary of results

Main Policy Recommendations:

- Structure a comprehensive policy that restores parity between all sources of protein and accelerates the transition towards a more sustainable food system
- Introduce a better balance between the EU regulatory food framework and innovation
- Strengthen financial incentives and support for SMEs seeking authorisation for novel foods
- Develop a top-down approach by making public a list of novel foods identified as feasible for production, and the requirements and conditions that should be met in each case
- Globally harmonise the regulatory framework for novel food in Europe and other countries



Sveinn Agnarsson
sveinn@sjokovin.fo



Outputs

- Documentation on EU Regulatory landscape and Safety of alternative proteins for food
- Documentation EU Regulatory landscape and Safety of alternative proteins for feed
- Status of EU legal/regulatory landscape and safety of alternative proteins for feed and food identified
 - Video: Regulatory and Safety Challenges of applying alternative proteins in food products
 - Video: Regulatory and Safety Challenges of applying alternative proteins in feed products
- Policy recommendations

ALTERNATIVE PROTEIN PRODUCTION AND OPTIMISATION

Work Package 2

In terms of the production of alternative proteins our goal was to analyse and document functional and nutritional properties, as well as sensory characteristics of microalgae, SCP and insect proteins. In addition, optimisation and upscaling of production and downstream processes to meet requirements for food and feed applications in line with EU regulatory and safety framework was analysed. We also assessed the suitability of alternative proteins from microalgae, insects and SCP as high quality ingredients in food.

Summary of results

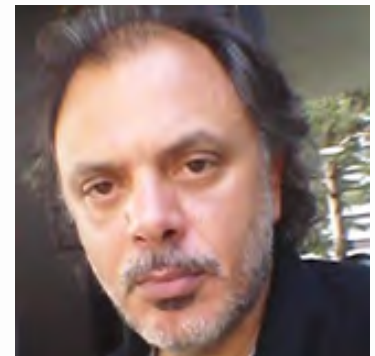
- NextGenProteins gave to all protein producers the opportunity to study, optimise, and upscale their production lines both upstream and downstream.
- The continuous feedback was important and allowed a targeted development process, enabling the commercial scale implementation of these technologies in the future.
- During NextGenProteins, properties of the different raw materials was established, and improvements made of functional, bioactive and sensorial properties of the products.
- For Arbiom, the SylPro® production process has been optimized on several aspects: Feedstock optimization, media preparation and recipe, and downstream processing. It has generated significant information and products to consolidate their industrial operations and scale-up to generate several tonnes of material. Data generated is valuable for future industrial operation by feeding the engineering plant design and will help conduct the TRL8.
- Rise Processum was able to optimize and upscale a process to produce single cell protein from forestry residues to TRL6, a feedstock we had not tried before at this scale.
- VAXA Technologies developed three new products and thereof two, Blue Ultraspirulina and Green UltraSpirulina are ready for marketing.
- MUTATEC successfully scaled up its operations with a capacity of 30,000 tons per year. MUTATEC developed a unique expertise in the knowledge, collection and optimal preparation of the resources, in order to make it a substrate perfectly adapted to the needs of black soldier fly larvae.

ALTERNATIVE PROTEIN PRODUCTION AND OPTIMISATION

Work Package 2

Outputs

- Verification of current alternative protein characteristics and safety requirements
- First batch of alternative protein produced for food and feed applications
- Summary of functional, nutritional and sensory characteristics of current three alternative proteins
- Summary of functional, nutritional and sensory characteristics of three optimised alternative proteins
- Summary of the three optimised alternative protein production processes



Charilaos Xiros
charilaos.xiros@processum.ses

processum
PART OF RI SE



APPLICATION IN FOOD PRODUCTS

Work Package 3

The main objective was to assess the suitability of alternative proteins from microalgae, insects and SCP as high quality ingredients in food and to develop food concepts and products containing these proteins. Focus was placed on developing and demonstrating novel high-quality food products containing the alternative proteins, to pave the way for subsequent commercialisation of the proteins and food products. In this work, we strived to improve the sensory quality of products through formulation technologies for increased consumer acceptance.

Summary of results

- Innovations from four industry partners of NextGenProteins are visible on the Innovation Radar Platform, opening up new opportunities and the potential to trigger interest from potential customers or investors:
 - a. Vaxa: Carbon-neutral Spirulina (Icelandic Ultra Spirulina) to be used as an alternative protein for food and feed formulation
 - b. Grimur Kokkur: Risotto cakes containing Torula proteins for sustainable and healthy food choice; Vegetarian cakes with dates containing Torula proteins for sustainable and healthy food choice; Vegetarian cakes with spinach filling containing Torula proteins for sustainable and healthy food choice
 - c. Fazer: Extruded snacks containing single-cell protein for sustainable and healthy diets; Baked and extruded snacks containing cricket flour for sustainable and healthy diets; Baked snacks containing spirulina for sustainable and healthy diets
 - d. Biozoon: High protein powder formulated with Torula yeast for preparing vegan spreads
- Commercial exploitation of results is planned by Grimur Kokkur and Biozoon in near future, in upscaling and commercialization of foods containing alternative proteins, developed and tested within the NextGenProteins project
- Commercial exploitation of the products developed will ensure visibility of NextGenProteins beyond the project time (ensuring the NextGenProteins legacy within society?)
- Partners increased knowledge in product development of foods containing alternative proteins, and progress towards such foods towards market ready products, will increase variety and sales in general from industry partners to retailers, HoReCa and B2B
- Because of the progress towards foods containing the alternative proteins, society will have increased availability and variety of quality food proteins in foods

APPLICATION IN FOOD PRODUCTS

Work Package 3

Outputs

- Ethical clearance for sensory and consumer testing
- Prototypes ready for consumer testing
- Summary on development of ready meals containing alternative proteins
- Summary on development of bakery products containing alternative proteins
- Summary on development of imitation meat containing alternative proteins
- Summary on development of advanced functional food supplements for elderly people containing alternative proteins



Kolbrún Sveinsdóttir
kolbrun@matis.is

matis



APPLICATION IN FEED PRODUCTS

Work Package 4

The first goal was to analyse impact of feeding different levels of the three alternative protein sources to poultry and fish. Then we wanted to validate in field conditions the most promising alternative feed formulations. Finally we set out to test the effect of the alternative proteins on feed manufacturing and physical and technological characteristics of the feed.

Summary of results

- Ethical clearance for animal trials
- Feed for small scale animal trials ready
- Results from dose response trials of terrestrial animals
- Results from dose response trials of aquatic animals
- First Summary on feed formulation and processing
- Second Summary on feed formulation and processing
- Report on the effect of feeding alternative proteins on productive traits, physiological indicators, gut health and product quality and safety in chickens and turkeys
- Report on the effect of feeding alternative proteins on productive traits, physiological indicators, gut health, product quality and safety in salmon
- Report on the effect of feeding alternative proteins sources on productive traits, physiological indicators, gut health and product quality and safety in seabass and seabream



Alessio Bonaldo
Alessio.bonaldo@unibo.it



Outputs

- Validation of insect meal based aquafeed: Black soldier fly larvae meal can be successfully incorporated up to 15% in practical aquafeed diets to partially replace fish meal without any negative effects on growth and feed efficiency.
- Validation of *Candida utilis* based aquafeed: the 7.5 % inclusion level shows the best growth performance
- Validation *Paecilomyces variotii* can be successfully incorporated up to 10% in practical aquafeed diets to partially replace fish meal (37% of fish meal replacement) without any negative effects on growth and feed efficiency.
- Growth performance traits in broiler were only slightly affected by 9% black soldier fly meal administration when feed was provided in mash form, while no detrimental effect was observed with pelleted diet.
- Moderate amounts of *Candida utilis* meal (2-6%) in broiler feed did not affect broiler productivity, while higher dosages provided during the starter phase reduced the growth rate.
- 3% microalgae inclusion in broiler feed could be partially tolerated in term of growth performance

MARKET OPPORTUNITIES AND BUSINESS POTENTIAL

Work Package 5

The goal was to gain a European view on consumers' and stakeholders' attitude towards alternative protein sources and processes as well as food and feed containing alternative proteins. We set out to establish market potential for food and feed products containing the alternative proteins. Then we wanted to identify suitable approaches to boost consumer trust and acceptability towards the three alternative protein sources and processes and create business models for the three alternative proteins as ingredients in food and feed.

Summary of results

- The NextGen proteins may find applications in niche markets, a more fundamental social transformation is needed for the proteins to break into larger, more general markets.
 - Such a transformation may mean a new regime where sustainability is the main driver throughout the society (instead of economy) or a regime where severe scarcity of food is the driver.
- Price premium may not be achieved in current markets just because of sustainable production of proteins or products having sustainability credits.
 - Competitive edge must be found elsewhere, e.g., from special nutritional or sensorial characteristics.
 - In short term, it may be easier to find the competitive edge in food than in feed applications.
 - Sustainability credits will still help in entering the markets, but the price must be competitive.
- Overall perceptions of European consumers towards NextGen protein concepts are more positive than negative. However, there is a long way to go and work to be done before the positive overall perceptions will turn into personal buying behaviours.
- Defining five key recommendations to boost consumer acceptance towards alternative proteins and their use in foods:
 - 1. Products must be price competitive, 2. Promote sustainability, 3. Promote food products, 4. Continue development of products, 5. Marketing through social media influencers

MARKET OPPORTUNITIES AND BUSINESS POTENTIAL

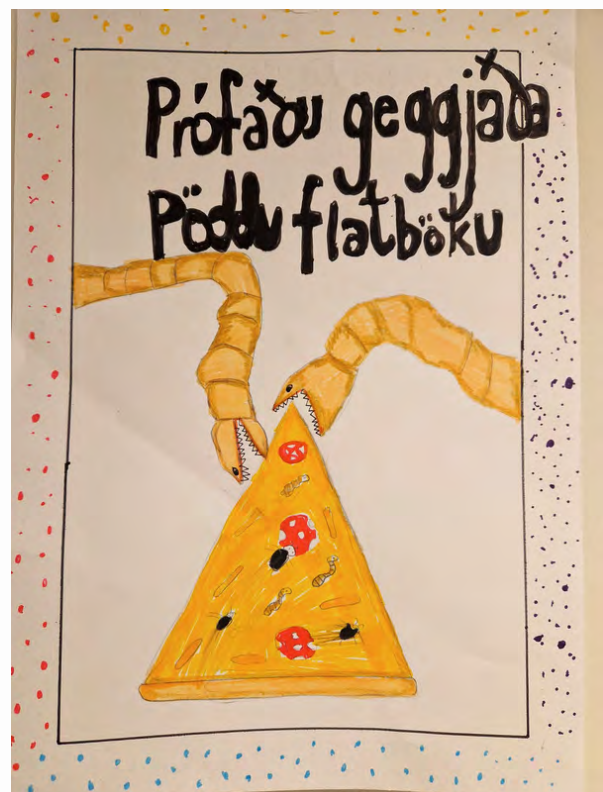
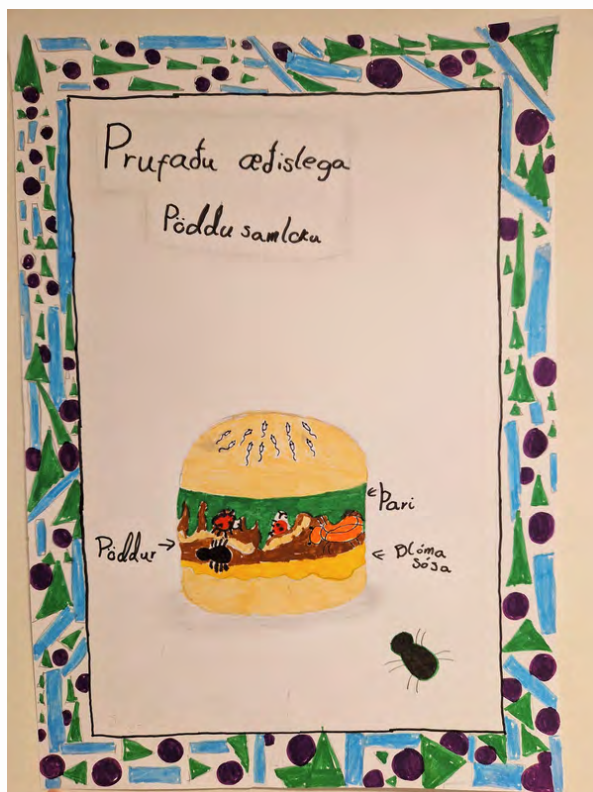
Work Package 5

Outputs

- Report on consumer attitudes towards the three alternative proteins for food in Europe
- Report on stakeholder analysis on the use of the three alternative proteins in feed in Europe
- Business models for alternative proteins
- Report on means to boost consumer trust and acceptability for the three alternative proteins
- Summary on potential business models for future products containing the three alternative protein Source



Jaakko Paasi
Jaakko.Paaso@vtt.fi



The winner (left) and runner up (right) in the NextGenProteins drawing competition among children in Iceland. The theme was: Food of the future

SUSTAINABILITY ASSESSMENT

Work Package 6

The four main objectives were to assess environmental and economic impacts, using life-cycle assessment methodologies. Assess the circular economy potentials of the alternative proteins production. Perform a multi-criteria value chain risk assessment and provide clear, relevant and comparable results on the sustainability of the three alternative proteins.

Summary of results

- Circular Economy Alignment: Alternative proteins align with waste reduction, recycling, and reuse principles.
- Reduced Environmental Footprint: The NextGen proteins show lower carbon, water, and land footprints than conventional protein production.
- Carbon Efficiency: NextGen proteins production processes emit significantly less carbon than conventional protein production.
- Water Conservation: Closed-loop systems in Nextgen protein production are water-efficient.
- Optimized Land Use: NextGen proteins can be produced on degraded or non-arable land.
- Economic Opportunities: Emerging sectors in NextGen proteins promise job creation.
 - Health and Nutrition: Focus on the nutritional adequacy of alternative proteins.
 - Environmental Benefits: Emphasized reduced environmental impact of NextGen proteins.
- Current Food System Flaws: The research highlighted issues like resource intensity and environmental degradation of conventional protein production
- Future Research: Need to delve deeper into production barriers for further optimization.

Outputs

- Summary on systems map and data gathering
- Report on economic impacts shifting protein production to NextGenProteins alternative proteins
- Delivery of preliminary results from LCA, economic system analysis and value chain risk assessment
- Report on circular economy potentials of the alternative proteins production processes
- Report on value chain risk assessment
- Report on LCA for the three alternative proteins



Hafþór Ægir Sigurjónsson
hsigurjonsson@kpmg.is



STAKEHOLDER INVOLVEMENT AND DISSEMINATION

Work Package 7

We strived to engage all relevant stakeholders and actors to the multi-actor approach of NextGenProteins. The goal was to enable active multi-channel communication and dissemination that addressed all stakeholders and actors in order to guarantee long-term use and impact of project results: Disseminating results to industry and society as well as the scientific community. Finally we generated exploitation and dissemination plans to maximise the impact of the project results and to promote the three alternative proteins at European and International level and develop a Data Management Plan and connect NextGenProteins to the H2020 Open Research Data Pilot.

Summary of results

- Commercial exploitation of the alternative proteins in applications for the participating companies in form of new product developments at a high TRL.
- New market opportunities for alternative protein producers
- Publication/Presentation of the project results in scientific as well as non-scientific journals, conferences and platforms.
- Establishment of a network with the sister – projects called „Horizon4Proteins“ in order to identify synergies and potentials of alternative Proteins. In the long term, this will support the collaboration of different actors and stakeholders on the topic of alternative proteins in Europe.
- Intensive involvement of different target groups (consumers, academics, companies and policy makers) through specific activities during the course of the project.

Outputs

- Identification of Stakeholders of the Food and Feed sectors, Policy makers and Consumers
- NextGenProteins website launched
- RRI Framework established
- RRI Framework – Matrix
- RRI framework communicated to the consortium
- Plan for dissemination and exploitation of results (PDER) including methodology and overview of stakeholder engagement actions
- NextGenProteins Data Management Plan



Marie Shrestha
mshrestha@ttz-bremerhaven.de



ttz Bremerhaven

HORIZON4PROTEINS



5 successful webinars

- Safety & Regulatory of Novel Protein Sources
- Novel Proteins for feed
- Sustainability of alternative proteins
- Novel Proteins – Food of the future
- European consumers' views on foods made of alternative proteins

Horizon4Proteins represents a rolling collaboration between projects funded under the theme of 'alternative proteins' within the EC's Horizon 2020 and Horizon Europe research programmes. The project consortia represent universities, research institutes, industries and NGOs.

The projects [NextGenProteins](#), [ProFuture](#), [smart_protein](#) and [SUSINCHAIN](#) launched Horizon4Proteins at the end of 2021 to work together in key aspects such as: Consumer acceptance of alternative proteins, Safety and Regulatory challenges, Food applications, and Sustainability. Beginning of 2023, the EU Horizon Europe funded projects [GIANT LEAPS](#), [LIKE-A-PRO](#) and [VALPRO Path](#) joined the collaboration. Here you can find the [H4P_policy_brief](#) along with more H4P information.



HORIZON4PROTEINS

NEXTGEN SUSIN PRO FUTURE smart protein

Sustainability of Alternative Proteins

Webinar | 22nd September 2022 | 3-4 PM CEST

Agenda

- Introduction
- Massimo Castellari
- OpenGate: Open environmental impact feed production
- Sergiy M. Smetana
- Daniel G. Connors: Perspective for Alternative Proteins
- Hafþór Egir Sigurjónsson
- DKA

Participation is free of charge
Registration is required prior to the event.



ENGAGING WITH STAKEHOLDERS

COP27

» November 2022

The aim of the session was to increase awareness on the importance of alternative proteins for the future of our food systems. Single cell protein, microalgae or insect have a lower environmental impact than traditional source of proteins and contribute to the protein need of our fast-growing world

population that current food system will not be able to handle. The session was a success, especially in term of feedback received. It revealed how much changes of current food systems are necessary and that coordinated joint actions are needed.

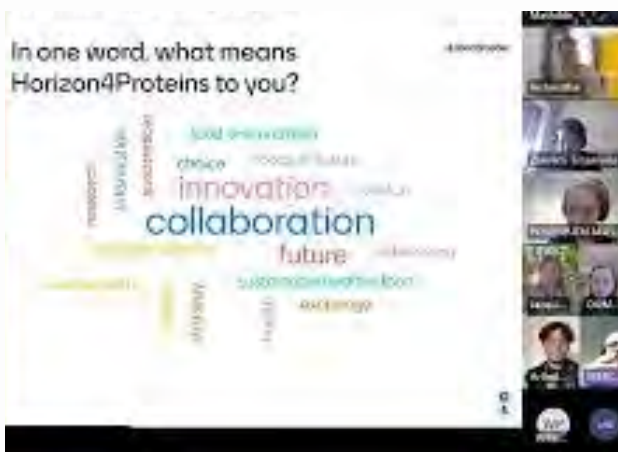


H4P Policy Roundtable event

» May 2023

An online Policy Roundtable event was held to facilitate discussion between researchers, policy makers and other stakeholders. In attendance were

representatives from the Horizon4Proteins collaboration. Also in attendance were the REA officers who work directly with these projects, representatives from EFSA, and representatives from a number of EC Directorate-Generals (DGs RTD, AGRI, GROW, SANTE, EMPL and CLIMA). All of the research project consortia partners were invited to join the audience to further contribute to the discussion.



ENGAGING WITH STAKEHOLDERS

NextGenProteins final conference

» September 2023

The NextGenProteins conference in Bremerhaven presented innovative products, exciting projects and visionary ideas on how mankind will feed itself in the coming decades and what resources will be available for this purpose. More than 200 participants from all over the world got together to exchange ideas in sessions that were divided into the topics Food, Feed and Market & Consumer. Numerous keynote speeches and multifaceted topic sessions were the main focus and researchers and developers were able to give an intensive insight into their projects, results and development opportunities.



SCIENCE GOES CULINARY

» September 2023

The gastronomy is a good starting point for introducing new proteins to society, as it allows consumers to try new products and ingredients without having to know how to prepare them. In preparation for the final conference, a cookery campaign was carried out in Germany with restaurateurs and amateur chefs. A total of 30 people received a cookery box containing the three alternative protein ingredients and other ingredients. The task was to develop and cook at least one recipe. A total of over 65 recipes were received and the results were presented at the final conference in the form of posters and a [Recipe booklet](#). After the event, the participants were asked about the usability of the new proteins in detail. The results were made available to the companies in order to obtain new ideas for marketing.

» NextGenProteins around the world «

- EFFoST 21 & 22
- Aquaculture Europe 21 & 23
- New Food Conference 21
- EUROSENSE 22

NEXTGEN PROTEINS



7,8 billion
in 2020

Global
population
is growing



10 billion
in 2050



Global demand for proteins
will double by 2050

Environmental impact of
Food production is high:



Greenhouse
gas emissions
(26% of
global GHG)



Land use
(50% of
global habit-
able land)



Water use
(70% of global
freshwater
withdrawals)



Biodiversity loss
(94% mammal
biomass is
livestock)

Sources: <http://ourworldindata.org/environmental-impacts-of-food>

Need for sustainable proteins:



Microalgae Protein



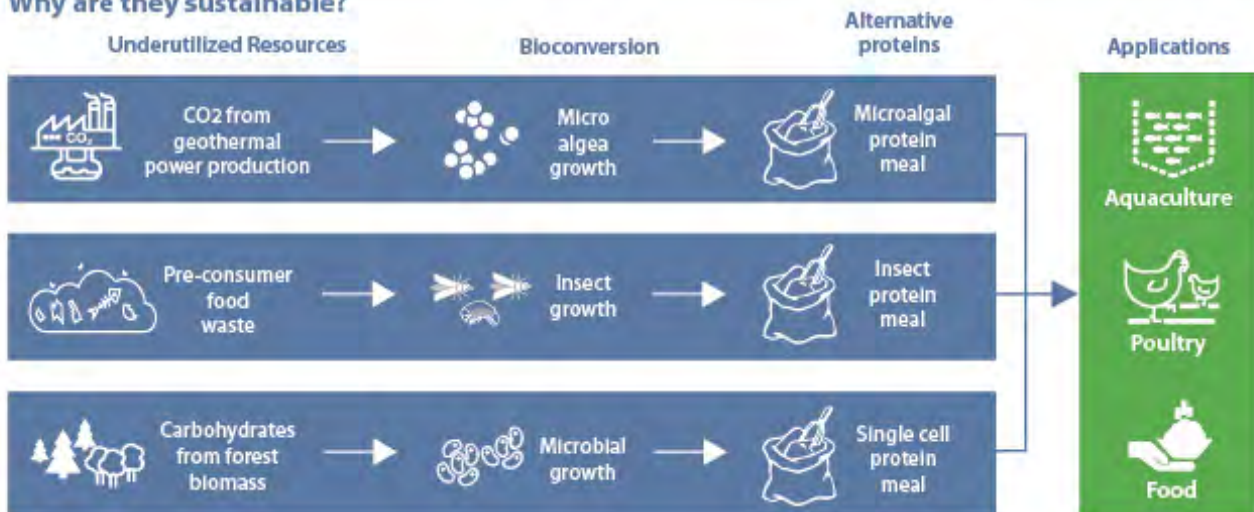
Insect Protein



Single Cell Protein

NEXTGEN PROTEINS

Why are they sustainable?



Why are they not on the market yet?



Production
scalability

New process =
small batch



Production
costs

Small batch =
high costs



Value chain
risks

Small batch =
high risk



Safety

New Proteins =
safety check



Regulations

New Proteins =
new regulation



Consumer
acceptance

New Proteins =
new taste & ethics

www.nextgenproteins.eu
#nextgenproteins

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement no. 862704.



Do the consumers eat alternative proteins?

Diet of Europeans¹

Most important reason for intentionally aiming to reduce meat consumption in EU¹



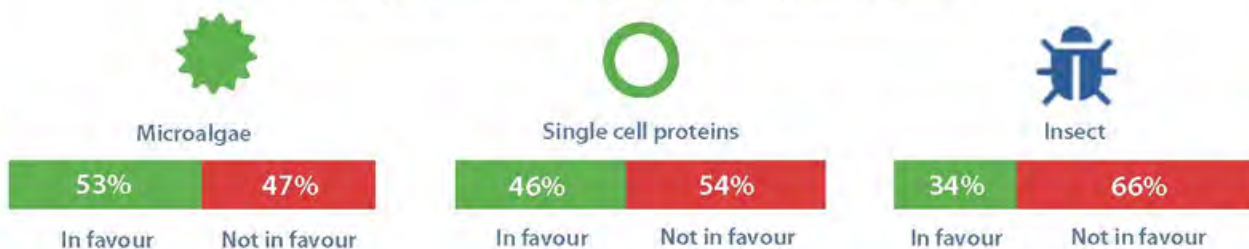
Most important reason for intentionally aiming to reduce meat consumption in EU¹



Familiarity with alternative proteins¹



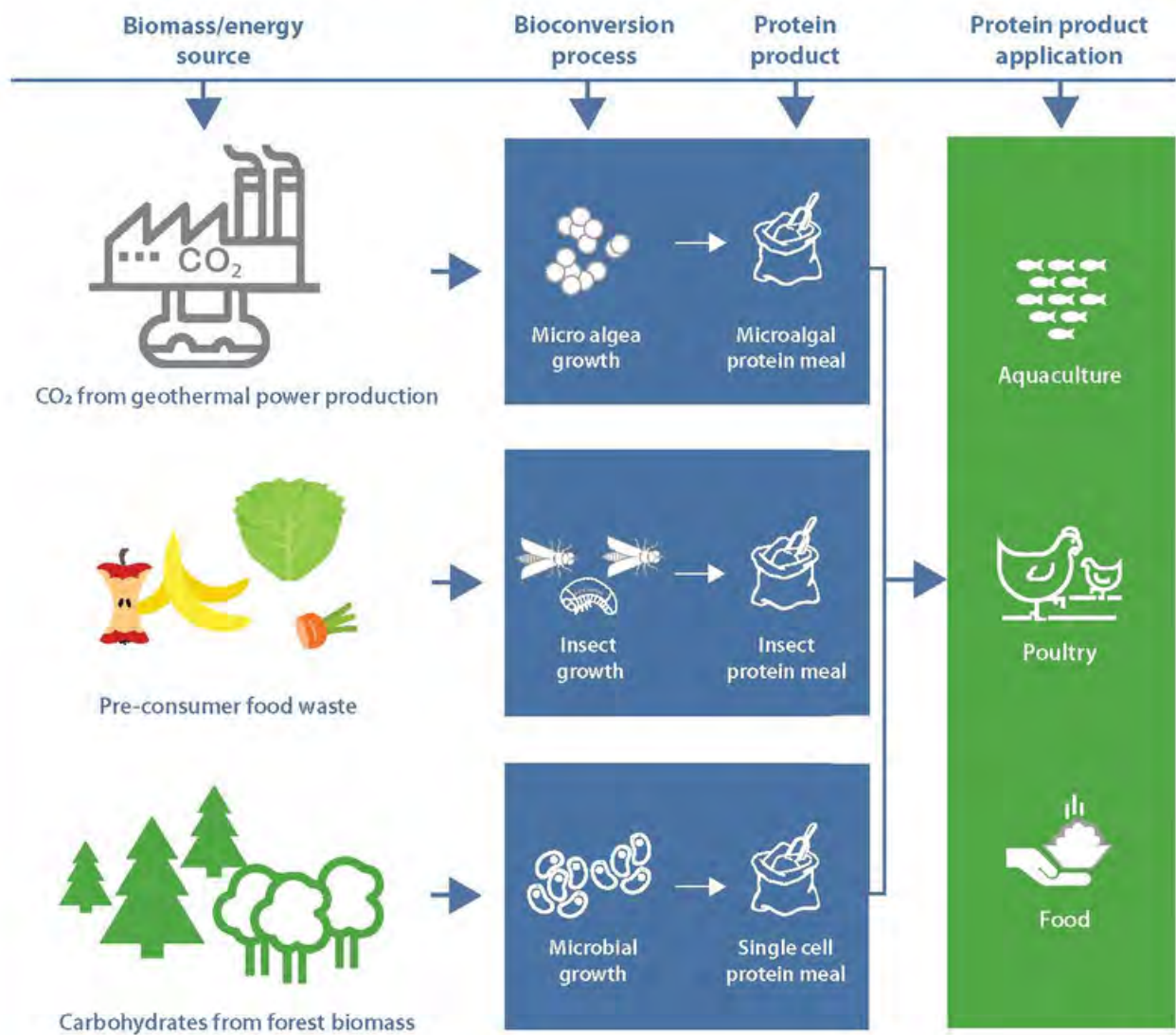
Are Europeans in favour of the NextGenProteins?¹



¹ Results of an online NextGenProteins survey implemented in Finland, Germany, Iceland, Italy, Poland, Sweden, and UK in May and June 2021 with 6600 respondents in total (without food tasting). NextGenProteins (2022) Deliverable No 5.1, Consumer views about the Next Generation proteins for food in Europe available on <https://zenodo.org/communities/nextgen-proteins/?page=1&size=20>

Why are NextGenProteins sustainable?

Use underutilised resources to support a circular economy approach







How does NextGenProteins take into account the impact of alternative proteins on environment and society?

Use Responsible Research and Innovation (RRI)^{1,2,3}

RRI is an interactive and mutually responsive process between scientists accountable for research and non-experts able to influence the Research and Innovation process and its outcomes.

Practical Application of RRI principles in NextGenProteins

	Process: How could we approach it differently?	Product: What are we working on?	Purpose: Why are we working on it?	People: Who might be affected in the future?
Anticipate & Analyze 	Theories Methodology	Ethics Regulations Safety IPRs	Protein challenge Climate change	Open access for increased Acceptance Desirability
Reflect & Reason 	Gender balance Risk assessment	People & Animals Welfare Food & Feed Quality	Availability of affordable food Quality of life	Democratic informed choice Income and working conditions
Engage & Include 	Researchers Food industry	Stakeholders & Animals	Society & living environment	Citizens
Act & Respond 	Data security Non-discriminatory practices	Regulation Animal welfare	Unpredictability of innovations Environmental issues Production costs	Cultural and religious barriers Ignorance Discrimination

So, what does RRI bring to me, as a consumer?

Responsible research and Innovation (RRI) ascertain that the researchers develop products adapted to my consumer needs and expectations. I can also expect that the products are developed in a responsible way.

¹ NextGenProteins (2020) Deliverable D7.2 RRI Framework established available https://nextgenproteins.eu/wp-content/uploads/deliverables/Submitted-NextGenProteins_deliverable-7.2-RRI-Framework-final.pdf

² NextGenProteins (2020) RRI Conceptual Framework Matrix available <https://nextgenproteins.eu/wp-content/uploads/deliverables/RRI-Conceptual-Framework-Matrix-Final2.pdf>

³ NextGenProteins Webinar (2020) NextGenProteins RRI Framework available https://nextgenproteins.eu/wp-content/uploads/2021/06/NextGenProteins_RRI_Framework.mp4

Innovation Booster

NextGenProteins will serve as a platform for industrial partners/entrepreneurs to take their innovations to the next level by turning them into relevant, credible products and thus, accelerate market-driven, customer- and consumer-responsive innovative EU alternative protein production. This will contribute to EU's food security and its goal of future proofing food and feed supply chains in a world faced with climate change, resource scarcity, increasing waste and aging population.

Demonstration Platform

NextGenProteins will demonstrate the suitability of alternative proteins in food and feed value chains.



Microalgae Protein

Microalgae will be grown on carbon dioxide (CO2) emission from a geothermal power plant in an efficient, indoor production process, transforming waste into microalgal protein meal.



Insect Protein

Black soldier flies and crickets will be grown on underutilised plant-food biomass, transforming waste into insect protein meal.



Single Cell Protein

Carbohydrates derived from wood biomass and biomass residues, will be transformed through microbial fermentation to turn non-food biomass into Single Cell Proteins.

Specialists and companies along the entire value chain, from producers in the forefront of alternative proteins development, through research institutes and university all the way to large and relevant businesses in feed and food production team up to produce the NextGenProteins.

Do you want to be part of it?

Contact us!



nextgenproteins@matis.is

Tel: +354 422 5111

www.nextgenproteins.eu

Photo: Shutterstock.com (matis41332)

NEXTGEN PROTEINS

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

Access to high quality, sustainably produced proteins is becoming increasingly restricted due to a growing world population, increased pressure on natural resources and climate change, while at the same time the global protein demand has never been higher for both food and feed.

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement no. 862704.

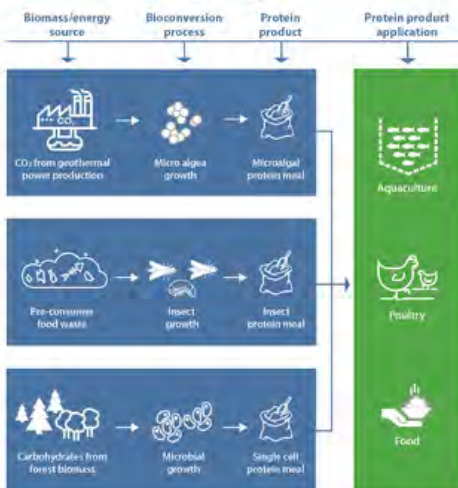


Objective

NextGenProteins will optimise the production of **three alternative proteins** through **resource efficient bioconversion** processes and demonstrate their suitability in an industrially relevant environment as addition to, or **substitute of traditional protein sources in various feed and food applications**.

NextGenProteins will contribute to strengthening food security, sustainability and self-sufficiency of EU protein production by demonstrating the suitability and economic viability of next-generation proteins as part of food and feed value chains with less strain on natural resources and reduced environmental impacts.

Concept



Methodology

NextGenProteins addresses key barriers that currently prohibit the industrial production of microalgae, insect and single cell proteins, such as scalability, production costs, value chain risks, safety, regulations and consumer acceptability.

21 PARTNERS, 10 EUROPEAN COUNTRIES, 8 MILLION EUROS, 48 MONTHS

