Sustainable Protein Technology

An outlook for further research

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With a growing world population and changing diets, the global demand for animal proteins for human consumption is expected to increase. However, the production of animal proteins has a significant impact on the environment. As a consequence, we need a durable protein supply for humans and animals.

Agricultural products can contain substantial amounts of proteins. Protein-rich ingredients derived from certain plants and animals, have been produced commercially for a long time. By far, the largest amount of proteins is being used in feed, followed by food consumption. Only, a limited amount of proteins is applied for specific technological use, for example as emulsifiers, in several food formulations, while even smaller amounts are valorised for more chemical applications.

In 2013 a new STW research programme started on sustainable protein recovery. The programme challenged scientists and entrepreneurs to force a breakthrough in the field of sustainable protein production with new knowledge, technological inventions and practical applications. Five projects were granted that concerned the development of innovative methods to obtain proteins from plant materials, micro-algae and insects to meet the growing need for food for humans and livestock. Finalizing the STW Protein Programme, an overview was given on knowledge on protein use, on technologies for recovery, on the research conducted within the programme, and an outlook for future research was given1. The latter is summarized here.

Approaches for Future Research

Direct improvements by optimized use of traditional protein crops

Optimisation of current systems facilitates quick developments in protein use efficiency. Improvements can be on using existing technologies in a new or better way, or by using innovative technologies. Technology development was key in the previous STW protein projects, and aided to developments that can be relatively easily applied by industry.

Comparing new green sources with traditional crops

A general conclusion from most of the projects was that a better a priori choice of the biomass under investigation could make research on biorefinery more efficient. Such choice on biomass should be based on criteria such as a) protein availability b) availability of current processing methods for protein extraction c) volume of the biomass and d) a priori knowledge of potential applications of the proteins and other fractions in a product. Better use of traditional crops through new technologies can lead to improvements that allow fast implementation.

For protein from green plant materials and from green sources in general, further investigation is required to significantly improve the protein purity and protein yields. It is important to gain more knowledge concerning the extraction of proteins from green fresh biomass in relation to conventional biomass. One aspect to involve is the biological architecture of the green biomass and the function of the different proteins in the biomass. Further, more knowledge is needed to be acquired on the type of protein, and the requirements in different end applications. The current bulk application for green proteins is often considered to be feed, but will find better use in the future as a direct source of protein in food.

Whole biomass or protein products

When using protein from biomass, separation should not become a goal by itself. First, total use of protein-rich materials should be investigated and if possible for the main application, being solely nutritional. Animal feed can act as a bench-mark application. For instance, in case of whole algae, the application in fish feed should be further investigated, given the oil content. In several cases, nutritional quality requires removal of certain minor components, giving design rules for novel fractionation techniques.

Sustainable and economical extraction of proteins at high purity and/or yield still needs technological improvement. This improvement can be obtained by steering away from high purity isolates, and focus more on functional fractions, in which the additional components might even have potential synergistic effects. Important scientific aspects are then a better understanding of the interactions between proteins and other components in plants, before, during and after extraction. This aids in improving current extraction techniques and in developing new ones.

Also the functionality of the obtained extracts should be studied. Not only on a product scale, but also on a microscale, to better understand structure-function relationships. Aspects like colour and taste, and basic functionalities such as solubility should not be neglected, as most protein products are mainly used for their nutritional value, and not for e.g. their technological properties.

Developing fundamental knowledge

Next to solving today’s societal and environmental problems, science should aim at the development of more fundamental knowledge.

Knowledge on plant morphology and cell biology
To better understand the fractionation behaviour of green material, plant sciences should be involved. For the separation of biomolecules from solid substrates, like leaves and algae, knowledge on biomass structure and component interactions is essential. As a basis, the in-situ interaction between the different components in their micro-environment (intrinsic factors) have to be unravelled.

Developing new systems for large impact

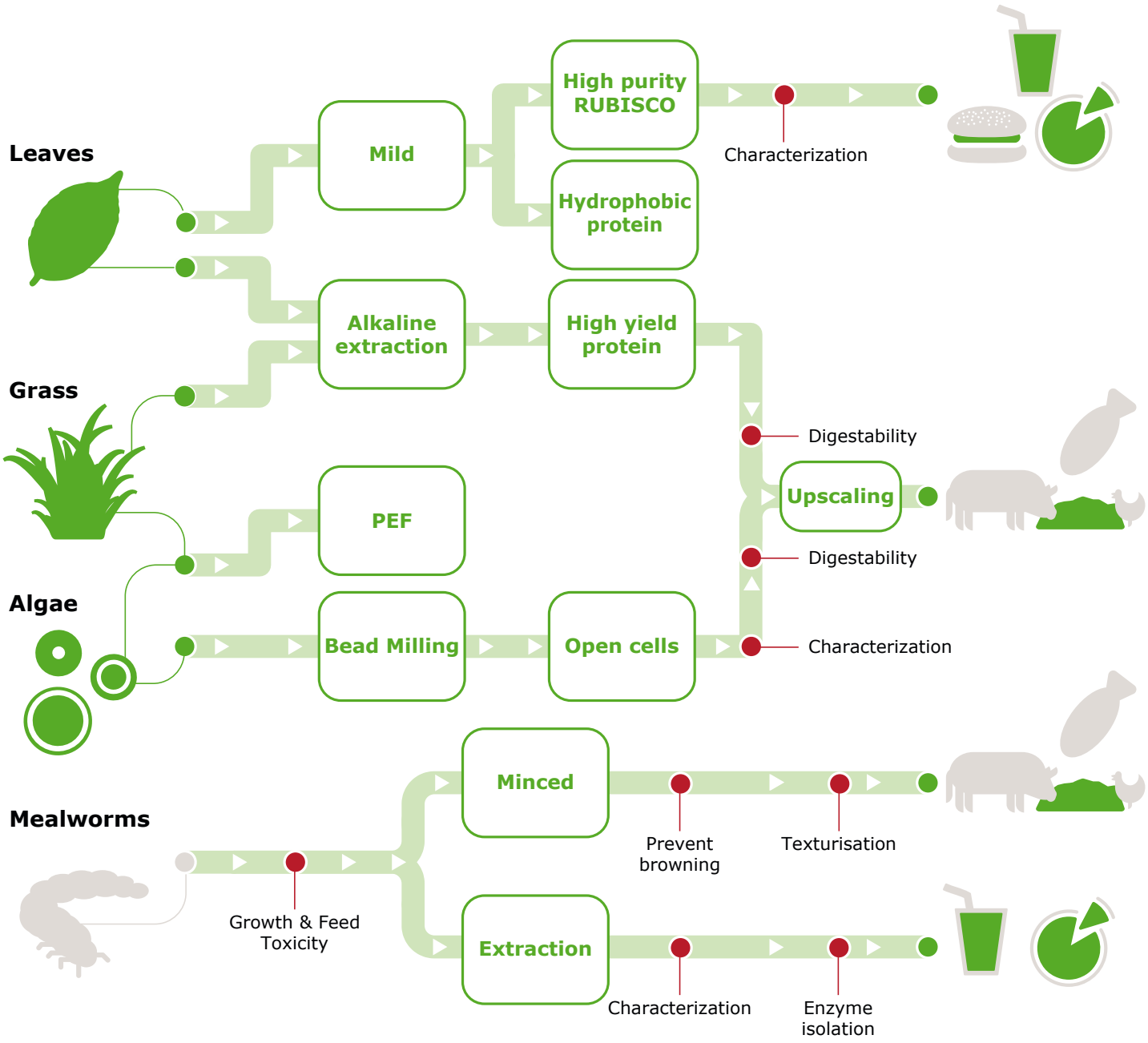
Development of new systems for more effective use of protein needs long term commitment that often outlasts a 4 year project. However, it is essential when we want to achieve major impact on sustainability. Complete systems can also include research on logistics and consumer acceptance, thus leading to faster implementation and thereby increasing research impact.

Chain design
To get to large improvements, bigger steps need to be taken and whole new chains may need to be developed. New technologies can give leverage for such developments. New chains are needed when new biomass sources are used, or when new products are made. The use of entirely new biomass sources, like algae or insects, has many scientific challenges but also needs e.g. a legislation procedure (EFSA) in which solid scientific data can help. But new chains can also face the challenge of multiple products in different application areas, which is often the case in biorefinery where products are produced not only for food, but also for fuel, materials or chemicals.

Process design
To complete the biorefinery concept, the (solid) residue obtained during protein extraction should also be used. The residue usage will reduce the overall processing costs for protein production, bringing protein biorefinery closer to industrial application. Although industry often likes to keep with existing technologies and processes, they might need to re-evaluate processes that previously focussed on other products like oil and starch, and did not consider protein yield and functionality.

Sustainability analysis
Sustainability is an important driver for the development of plant based protein products. It should therefore be an integral part of research. This will keep the focus on developing sustainable technologies and chains. Important aspects can be a limitation in processing steps, avoiding the use of (much) water, and the valorisation of all biomass components.

Full report available at
www.wur.eu/more-and-better-protein



Research on extraction methods, processing, and applicability of alternative protein sources as conducted in the STW Protein Programme from 2013-2018.

Interested in the possibilities of Sustainable Protein Technology

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