Circular protein

TEAGASC researchers are looking at how wastewater from dairy processing can be used in the cultivation of duckweed, a plant with great potential as a food source.

What is a circular economy?

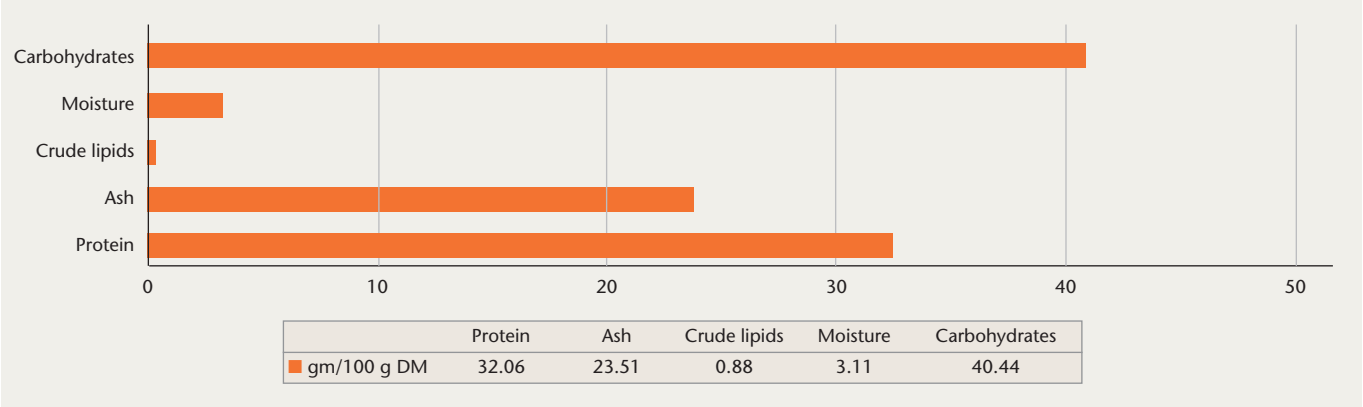
A circular economy is a comprehensive approach to economic growth with a vision to mutually benefit businesses, society and the environment by eliminating unnecessary waste while also enabling the continual use of resources. Considering the circular economy perspective, the food industry is now seeking alternative methods for food processing and new sources of ingredients. This is more crucial now than ever as there is an increasing population and a consequent increase in demand for food. One key area that has shown great promise is the redirection of materials that may have been previously labelled as food waste or wastewater for the production of valuable materials. For example, in certain areas in the food industry such as dairy processing, significant amounts of wastewater can be generated. Previously, this wastewater would be treated in a wastewater treatment plant, at considerable expense. However, this waste stream could actually be highly valuable, containing important nutrients including ammonia, nitrate and phosphate, with lower concentrations of other important elements such as iron, magnesium and calcium. Duckweed requires nitrogen and phosphorous for growth, and the high concentrations of nitrate, ammonia and phosphate present in dairy processing wastewater makes it a medium suitable for plant growth. Growing duckweed will rapidly take up nutrients, and break down other environmentally damaging products such as lipids and sugars. Duckweed, which is a source of high-quality aquatic-based protein, can then be used as a feed supplement for animals and/or as fish feed.

Duckweed: circular protein

Duckweeds are aquatic floating plants belonging to the family of *Lemnaceae* consisting of five genera (*Landoltia*, *Lemna*, *Spirodela*, *Wolffia*, and *Wolffiella*) with 38 species, which thrive in freshwater or brackish water bodies. Several species of *Lemnaceae* are native to Ireland. Duckweed displays some highly interesting advantages over terrestrial plants such as: high growth rates (under ideal conditions biomass could double in one day); high biomass yields (20-30 t/ha on a dry basis, displaying a more than 10-fold higher protein yield compared to soya crops); and, a high amount of proteins (up to 45 %) and micronutrients. Duckweed is a very promising source for animal/fish/human nutrition. Its growth in aquatic environments negates the need for fertile and arable land; thus, there is no competition for land and water compared to conventional food production systems. Cultivation in constructed ponds increases the water and nutrient application efficiency by reducing losses to the environment. Simple harvest by sieving or other methods is possible due to duckweed's relatively large size (2-20 mm), and it grows on still or slow running water, and therefore does not require the use of powerful agitation, which results in less energy consumption. The nutritional value of duckweed is shown in **Figure 1**.

Researchers from Teagasc and University College Cork are trialling duckweed growth in conjunction with Bord Iascaigh Mhara. Furthermore, Teagasc researchers, with Irish and European partners, are currently developing novel, sustainable aquatic plant-based protein processing systems as part of the BlueBio-funded AquaTech4Feed project. AquaTech4Feed is involved with best use of food waste in boosting a zero-waste circular economy at local level. The biomass, including duckweed, is processed into feed ingredients, contributing to reduced resource depletion, and fostering long-term economic growth. Development of innovative protein ingredients for foods and feeds, compared to the current benchmarks, will result in a sustainable economic impact and business opportunity for European aquaculture producers, especially when residues and wastes are used. In fact, in this case they will benefit from reduced costs for their disposal.

Research at Teagasc is involved in developing a technology suite to process and develop protein-rich ingredients from duckweed by employing state-of-the-art cell disruption technologies (**Figure 2**). Various technologies are involved in the processing of duckweed, including drying, high-pressure processing, microwave and ultrasound-assisted extraction.



	Protein	Ash	Crude lipids	Moisture	Carbohydrates
gm/100 g DM	32.06	23.51	0.88	3.11	40.44

FIGURE 1: Nutritional composition of dried duckweed. DM = dry matter.

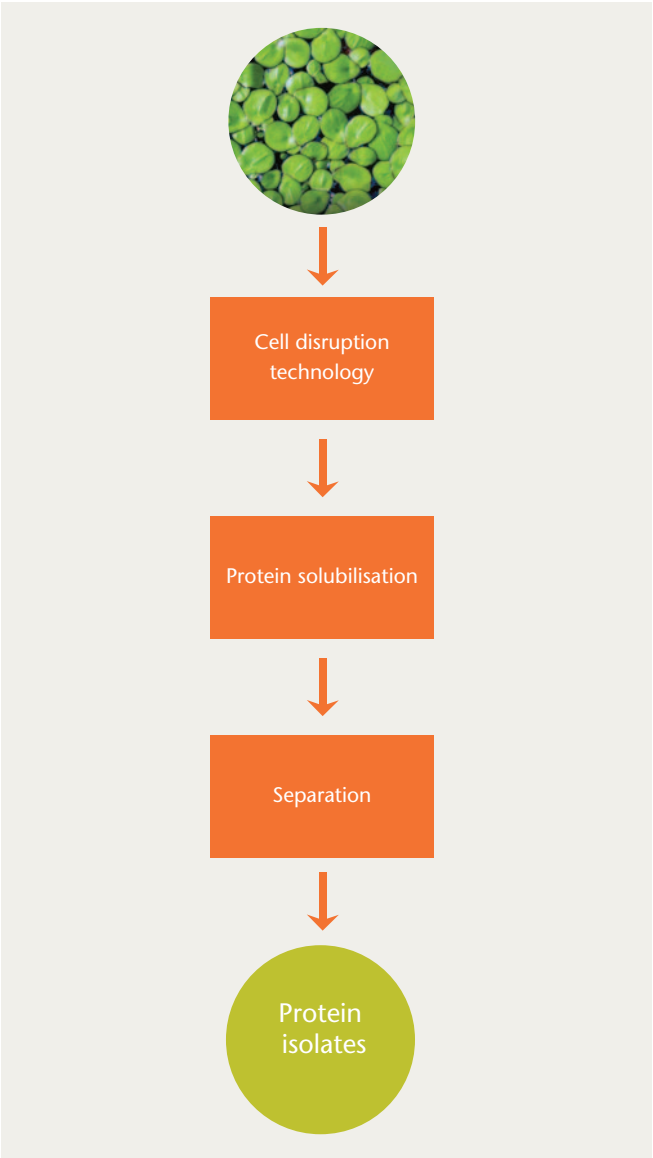


FIGURE 2: Duckweed protein production process.

Conclusions

Duckweed is one of the most promising novel sources of proteins for food and feed application. Novel extraction technologies will allow the development of a new value chain for commercial exploitation.

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