PhD Project Advertisement

Project title: Nutritionally enhanced algal protein ingredients for food
Project No: FBS2023-40-Mills-sq

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Project description:

Microalgae are unicellular plants which are photosynthetic and have potential to be grown in areas of the world that are not tractable to conventional agriculture and are currently used for oil production which can be used as a vegetarian fish-oil replacement. A protein-rich biomass is produced as a by-product of oil extraction which could provide an alternative sustainable protein source. Using this by-product to manufacture value-added products, such as food ingredients, is a key step in assuring the long-term viability of the algal biotech industry. Algae are a very diverse group of organisms and only a few species have been consumed by humans for food. Consequently little is known about its nutritional value. AlgaeCytes, a small company based in the south of England, has developed a green and efficient downstream process to refine the pigments and omega-3 oils from its proprietary microalgal strain. The residual spent biomass comprises 30-45% protein, which contains a balance of all essential amino acids, including branched-chain and glutamine. Exploring both the species of algae and the way they are grown could provide a means of enhancing the nutritional quality of algal proteins.

In the UK, the National Dietary and Nutrition Survey monitors the nutritional quality of the food we eat. An analysis of this data showed that young adults had micronutrient intakes below the lower recommended nutrient thresholds for selenium in 40% of young adults and iron in 33% of young women aged 20–29 years (1). Therefore, if algal proteins are to be used in food it is important to understand how well they act as a protein source – in for example supporting muscle growth, or delivery of important micronutrients such as iron, calcium, selenium and iodine. The form in which selenium and iron are presented in foods is important as it determines its bioaccessibility – how it can be absorbed and used by the body. Selenium can be found in food as the amino acids selenomethionine and selenocysteine which are in turn incorporated into selenoproteins, such as glutathione perioxidase. Iron is also found in a protein bound form and when presented as haem has greater bioaccessibility. AlgaeCytes know that the spent algal biomass they produce is enriched in iron containing but it is not known what the form is or whether it is bioaccessible.

This project aims to find out whether protein-rich algal waste-streams could be used to provide value-added nutritional protein-based mineral ingredients. Working with a team of scientists at the University of Surrey, Queens University Belfast and AlgaeCytes we will investigate whether the nutritional value of protein-rich algal biomass can be enhanced. The iron-binding and selenoproteins in different algal species will be characterised using proteomics (4) and we will discover if their levels can be increased by growing the algae in different ways including supplementing their growth media with selenium and iron. Understanding how the algae absorb these minerals is important and at the University of Surrey there is some specialist imaging technology which allows elemental mapping at a cellular level. (2) We will use this technology to investigate how the iron and selenium are distributed in the algal species grown in different ways. As well as ensuring the algal protein is nutritious it is important to ensure it is safe. Working with the team and Queens University Belfast, the safety (3), including allergenicity, of the algal proteins will be assessed. The results of this investigation will show which combinations of growth condition and algal species is optimal for the levels of these important micronutrients. The bioaccessibility of the micronutrients will be assessed using an in vitro digestion system and a cell culture model of the gut epithelium (5). This will show whether the micronutrients are present in a form which

can be absorbed by the human body as well as allow a comparison with foods, like cow's milk, which are highly digestible. The results of this research will help pave the way to realising the potential of algal proteins for human nutrition.

Training opportunities:

You will have the opportunity to gain first-hand experience of working in some of the world leading laboratories with hands-on training provided on algal culture, harvesting and downstream processing (Algaecytes), protein characterization including proteomics analysis, elemental imaging and in vitro digestion systems and cell culture (Surrey), safety risk assessment and characterization (Queens University Belfast). You will also gain transferable skills such as project management, learn to identify potentially important commercial findings and how to protect or exploit them. You will be working with an academic team used to commercializing research, setting up start-ups and importantly have the chance to spend at least 3 months working at the AlgaeCytes laboratories at Sandwich, Kent, UK.

Student profile:

A BSc (Hons at least 2i) in biochemistry, biotechnology or biological science or equivalent experience. The candidate should have a desire to work in a multidisciplinary project and gain experience working in an innovative biotechnology SME, AlgaeCytes capitalizing on the (at least) 3 months placement with them during the four year project.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2022/23 this will be £17,668 and this will increase slightly each year at rate set by UKRI.

Equality Diversity and Inclusion:

The FoodBioSystems DTP is committed to equality, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the FoodBioSystems DTP website.

In accordance with UKRI guidelines, our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

References:

(1) Derbyshire Front. Nutrition. 2018;5:55; (2) de Jesus et al Anal Chem 2021 93;13450; (3) Kulabhusan, Campbell Trends Env Anal Chem 2021 32, e00150; (4) Johnson et al Anal Chem. 2016, 88:5689-95. (5) Daly et al Foods. 2022 11:2000.

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.