PhD Project Advertisement

Project title: Novel, biodegradable, active packaging: Natural polymers, nanoparticles and extrusion process development

Project No: FBS2023-11-Charalampopoulos-rc

Lead supervisor: Dimitris Charalampopoulos, Food and Nutritional Sciences, University of Reading

Email: d.charalampopoulos@reading.ac.uk

Co-supervisors:

Natalia Falagan, Cranfield University, Sameer Khalil Ghawi, University of Reading, Federico Trotta, Metalchemy

Project description:

This DTP PhD project brings together a multidisciplinary team from the Department of Food and Nutritional Sciences at the University of Reading and the Centre for Soil, Agrifood and Biosciences at the University of Cranfield, as well as Metalchemy, a green nanotechnology start-up company. The project will study the development of novel biodegradable food packaging with active properties that can be used to extend the shelf life of fresh-produce products.

Nowadays, a considerable number of petrochemically derived non-biodegradable and non-renewable synthetic plastics are produced and utilised daily for single-use food packaging applications. These end up as waste in landfills or incineration, resulting in considerable greenhouse gas emissions and major degradation of aquatic and terrestrial environments. As a result, there is significant impetus for the development of biodegradable bio-based materials to replace conventional plastics; these include microbially derived biopolymers and biodegradable natural polymers (BNPs) such as polysaccharides and proteins derived from biomass and agri-food resources. The downside of BNPs is that their physical properties do not match those of synthetic plastics. To this end, the use of nanoparticles (NPs) is explored as the means for enhancing the properties of BNP-based packaging. The research hypothesis is that nanotechnology innovation can lead to effective, scalable and economically viable food biodegradable packaging solutions that utilise abundant, natural polymers. The project aims to generate fundamental understanding on how NPs influence the properties of BNPs and their blends, and know-how on enhancing the physical and thermal properties of the packaging and its bioactivities (e.g. antimicrobial, activity) leading to increased shelf life for various fresh produce. The research objectives:

1) To assess the physical, antimicrobial and antioxidant properties of novel metal NPs.
2) To produce packaging sheets through small-scale extrusion using several BNPs including polysaccharides (e.g. cellulose, starch, alginate) and proteins (e.g. hordein, zein) singly and in mixtures in order to develop in-depth structure/function understanding.
3) To obtain a range of novel packaging materials where NPs are incorporated and understand from a mechanistic/molecular perspective the influence of the latter on the thermal, mechanical, barrier, antimicrobial and antioxidant properties.
4) To optimise the conditions (shear, temperature, pressure) to produce prototype packaging sheets through an extrusion process using a pilot scale food-grade twin-screw extruder.
5) To evaluate the effectiveness of the produced prototype sheets singly and in combination (e.g. multilayer packaging sheets using adhesives) for the storage of fresh produce.

A variety of experimental methods that draw from biomaterial science, food science, process engineering and design, will be used to advance innovation in this area. These include BNP (proteins, polysaccharides) characterisation by size exclusion and ion exchange chromatography, NP characterisation by dynamic light scattering, infrared and UV-Vis spectrophotometry and scanning electron microscopy, extrusion processing at small and pilot scale to produce biodegradable, active packaging sheets, analysis of mechanical properties of packaging materials (thermal, tensile strength, thickness, gas and water vapour barrier) and preservation studies of fresh-produce packaged using the prototype materials, under various storage conditions.

Training opportunities:

The student will be trained to become an expert on biodegradable food packaging, extrusion processing and biomaterial characterisation. The student will have access to facilities and expertise at the University of Reading (food science, extrusion, biomaterial characterisation), and at the University of Cranfield (food preservation, storage and quality). The three-month placement at Metalchemy (based in London) will enable the student to undertake application-focused research and understand innovation at a dynamic SME environment. We will ensure that there is enough flexibility (e.g. placement visits in blocks or daily travel, relocation) to accommodate students' personal circumstances.

Student profile:

The project is suitable for students with experience in food science, food processing, chemical/biochemical engineering, chemistry, polymer science or a closely related subject.

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.
The 4-year CASE studentship, in collaboration with Metalchemy, includes payment of tuition fees, a stipend for each year of the studentship, and a Research Training Support Grant.

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:

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