PhD Project Advertisement

Project title: Development of novel, biodegradable, active food packaging
Project No: FBS2024-089-Charalampopoulos-rc

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Project description:

This DTP PhD project brings together a multidisciplinary team from the Department of Food and Nutritional Sciences and the School of Pharmacy at the University of Reading, the Centre for Soil, Agrifood and Biosciences at the University of Cranfield, and Metalchemy, a 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 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. Despite the significant commercial and public interest for such novel packaging solutions, there are considerable research challenges still to overcome across a conceptual multi-stage production process. This includes the development of novel NPs with multiple activities (e.g. antimicrobial, antioxidant) and compatible BNP blends, understanding of structure/function relationship of these novel packaging materials, process design and optimisation of scalable packaging production processes (e.g. extrusion), and applications in real food systems and storage conditions.

The hypothesis of this study is that enzyme-grafted metal nanoparticles can improve the functionality of biodegradable materials leading to the development of biodegradable active food packaging materials with advanced properties. The objectives are:

1. To develop and optimise the reactions for chemically grafting enzymes (oxidase, lysozyme) onto NPs and assess their physical, antimicrobial and antioxidant properties.
2. To produce packaging sheets through 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, chemistry, and process engineering,

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 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.

This is a 4-year CASE studentship, in collaboration with Metalchemy.

Training opportunities:

The student will be trained to become an expert on biodegradable food packaging, extrusion processing, nanotechnology and biomaterial characterisation. The student will have access to facilities and expertise at the University of Reading (food science, extrusion, biomaterial characterisation, nanotechnology), and at the University of Cranfield (food preservation, storage and quality). A 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 2023/24 this is £18,622 and it 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.

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