FoodBioSystems DTP - PhD Project Advertisement

Project Title:

FBS2021-44-Niranjan: Machine learning and Ensemble approaches to model transient lipid deterioration in ambient stored particulate infant food systems.

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Project Description:

Lipids are a major constituents of infant and children foods. Unsaturated lipids e.g. (C18:1 n-9), linoleic (18:2 n-6), arachidonic (AA, 20:4 n-6), eicosapentaenoic (EPA, 20:5 n-3) and docosahexaenoic (DHA, 22:6 n-3) acids tend to undergo oxidation due to heat and light which severely impacts on food quality and shelf-stability through flavour and taste deterioration and decreases in nutritive value.

During long-life ambient stored particulate product development, the product shelf life is determined by storing it either at room temperature or higher (37-40°C) to reflect accelerated conditions for 12-24 months. Periodically (every 2/3 months), the product is evaluated by trained sensory panels and off-flavours such as metallic, fishy and rancid notes are monitored. If the product is considered to be acceptable, its storage is continued, whereas, if it is not acceptable, the storage ends and the product is discarded. Therefore, the shelf life evaluation through the storage study can potentially end after 3, 6, 9 12, 15 or 21 months - thus wasting valuable food material, time and resources.

This project hypothesises that the use of Machine learning (MLI), and Ensemble approaches that include phenomenological models, will yield practically usable solutions to either predict the transient quality changes occurring in a given product, or to formulate new food products which are stable and efficacious.
Such models can predict stability and quality of infant product containing unsaturated lipids, which will allow quick establishment of the product shelf life and result in a substantial reduction in food waste, time and resources.

The project consists of 4 main activities:

1) Optimization of analytical method to monitor lipid oxidation. Gas and liquid chromatography methods coupled with mass spectrometry are normally used. However, optimization of sample preparation and of chromatography conditions is necessary for the food matrix under consideration.
2) Storage study of infant products at room temperature and at 37°C (accelerated conditions) which includes acquisition of sensory and nutritional composition data, and monitoring lipid oxidation products as functions of head space gas composition and packaging barrier properties.

Phenomenological models for the extent of oxidation occurring under different sets of conditions will be developed employing theories of mass transfer combined with chemical (oxidation) reaction kinetics

3) Machine learning (ML) approaches will be used to complement phenomenological modelling of the process described in (2). Such complementarity can be achieved in different ways. For instance, the simulation results can be used as a clean dataset for training machine learning algorithms, so that a number of relatively simple simulation models can be used for training a complex ML model. Alternatively, or in addition to the above, ML modelling can be employed to expedite the validation process of the simulation models, refine the models if needed, and enhance their reliability.
4) While the approach mentioned in (3) attempts to combine phenomenological modelling with ML, it will also be possible to use a decoupled approach and develop sub/models for individual or groups of reactions and then link with key variables like product acceptability and shelf life.
5) Thus, there are different strategic options available to integrate phenomenological understanding which is necessary to gain scientific insights, with machine learning which makes the models more usable from an industry perspective. This final part of the project will involve validation of phenomenological as well as ML models, and critically assess the best options for integrating the two.

Training opportunities:
Nestlé Research Center based in Lausanne, Switzerland, will host the student for some time which will give to the student the opportunity to be trained and use the state-of-the-art analytical techniques, i.e.:

- liquid chromatography coupled with high resolution mass spectrometry to identify lipid oxidation markers
- gas chromatography coupled with mass spectrometry to monitor to quantify selected lipid oxidation markers
- electron spin resonance spectroscopy to monitor early lipid oxidation

The student will also gain considerable training in experimental and mathematical modelling methods used in the area of shelf-life and keeping quality assessment at the University of Reading, especially accelerated tests for long-life food products. Last but not the least, the student will be trained in the use of latest Machine learning and AI methods at Cranfield University and apply these to food systems – which is still an area in its infancy. The student will also be given the opportunity to do a range of short courses at Reading and Cranfield.

Student profile:
This project would be suitable for a student with a background in Chemical, Biochemical or Food Engineering. Mature students, who hold an acceptable Bachelors or Masters degree, with industrial experience, are encouraged to apply.

Funding particulars:
This project is a CASE studentship with Nestle, who will provide training placement and additional financial to support the project and doctoral student maintenance.
This project is part of the FoodBioSystems BBSRC Doctoral Training Partnership (DTP), it will be funded subject to a competition to identify the strongest applicants.
The studentship is open to UK and international students (including EU countries) however due to funding rules, no more than 30% of the projects can be allocated to international students.
The funding will include a tax free stipend (minimum £15, 285 per year), support for tuition fees at the standard UK rate (currently £4,407 per year) and a contribution towards research costs. **Please note** that the host universities have not yet confirmed the level of fees charged to international students funded by the DTP. Fee levels may vary across the institutions. This information will be shared on the FoodBioSystems DTP website as soon as it becomes available.

To apply
Please go to FoodBioSystems DTP website for information on how to apply for this studentship. The closing date for applications will be 8 February 2021.