PhD Project Advertisement

Project title: A reverse engineering approach to sucrose replacement in biscuits: modelling texture
Project No: FBS2023-51-Rodriguez Garcia-rq

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Project description:

This project will develop a modelling tool to predict the textural properties of biscuits when sucrose is replaced with healthier alternatives. This tool will help manufactures design novel ingredients and reformulation strategies to improve the nutritional profile of bakery products. The project takes an integrated approach across the food system: from resources (sucrose replacers), to processing, storage, and consumption. You will develop of a holistic understanding of the kinetic (water distribution) and thermodynamic changes in the biscuit systema (plasticising and hygroscopic properties of ingredients, phase transitions) and how these define the physical and sensorial textural properties (hardness, oral processing and mouthfeel) of biscuits.

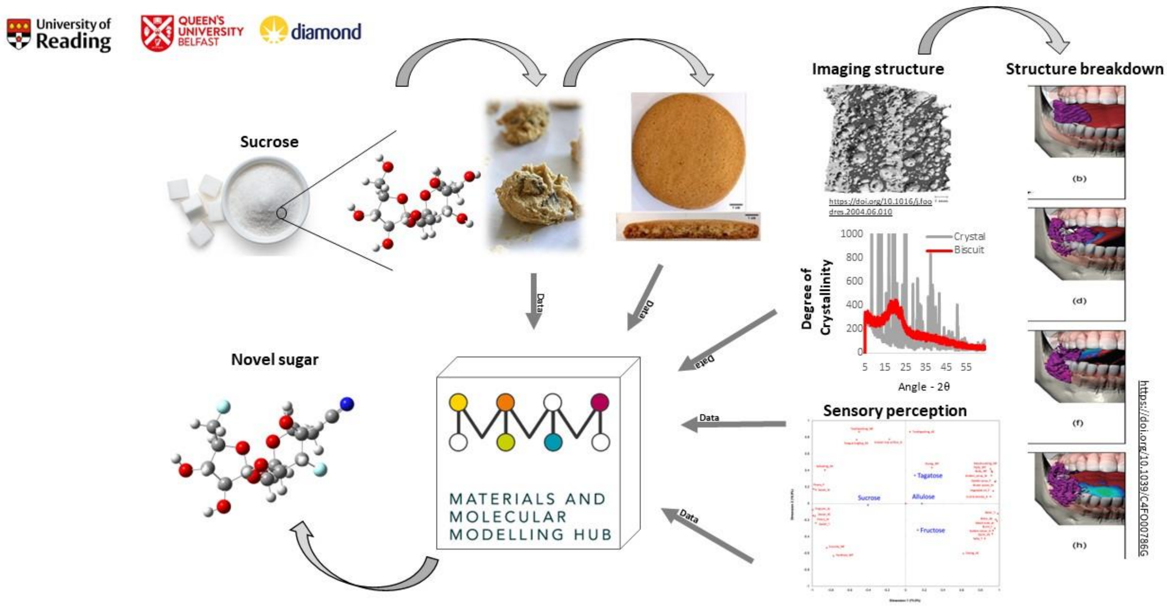
The hypothesis of this study is that the thermodynamical and kinetic changes in a biscuit system (sugar-water-biopolymer) that happen during processing operations (mixing, baking and storage) could be modelled to design novel sucrose replacers and reformulation strategies that allow one to decrease sucrose in biscuits while achieving targeted textural properties.

The research objectives are:

1) To evaluate the thermodynamical processes and kinetic changes during mixing, baking and storage of biscuits made with sucrose or sucrose replacers.
2) To characterise the evolution of the structures from initial mixing to final product over molecular to micron length scales and to assess physical properties of dough and biscuits made with sucrose or sucrose replacers
3) To analyse the sensory perception of biscuits mouthfeel (oral processing and descriptive qualitative methods) and sweetness (in vitro and in vivo sugar diffusion). Correlations between perception and instrumental results will be assessed.
4) To use both quantum chemical models and classical molecular dynamics to calculate physical and phase properties of sucrose replacers at the single molecule, small to medium cluster and bulk levels.
5) To create a Quantitative Structure Activity Relationships (QSARs) by correlating sucrose replacers' properties (objective1), textural descriptors (objective2&3). The QSAR models will be developed and tested to predict biscuit physical and sensorial textural properties.

The global rise in chronic non-communicable diseases such as obesity, type 2 diabetes, and coronary disease has been linked to high intake of sugar and excessive energy consumption. The main dietary source of added sugars in UK are soft drinks, bakery and confectionary products. In particular, biscuits, with around 30-40% sugar content, are a highly popular and versatile products, commonly consumed by all groups of society, particularly children. Owning to concern over increasing childhood obesity rates and with the aim to facilitate a healthier lifestyle for adults and children a new UK Government policy has come partially into force in October 2022. This policy restricts the location and in-store promotion of high fat, sugar, and salt products. This has driven further efforts from the food industry into reducing sugars in bakery and confectionary products. However, the reduction or replacement of sucrose with healthier alternatives in bakery products such as biscuits has proved to be challenging because of the multifunctional role of sucrose in these products – sucrose is not only there to provide sweetness.

Therefore, the development of understanding and tools that could facilitate reformulation projects in terms of time, resources and successful outcomes are needed for a sustainable and innovative food industry.



Graphical Abstract - A reverse engineering approach to sucrose replacement in biscuits: modelling texture

Training opportunities:

The student will receive multidisciplinary training in thermodynamics, food chemistry, food physics, sensory science, imaging techniques, data analysis and molecular modelling. The project combines the development of fundamental understanding with the development of a tool to solve real world issues in the food industry. At UoR the student will have access to facilities and gain expertise in food science (bakery science, food physical properties, sensory science, oral processing), thermal and microstructural properties (Chemical Analysis Facility), and quantum chemical modelling (Young, the National Tier 2 High Performance Computing Hub). At QUB the student will be trained in classical molecular simulation and suitable methods for analysing the trajectories that are generated from such simulations some of which rely on machine learning algorithms.

Through collaboration with Diamond Light Source, training and access into their diffraction and imaging techniques (X-ray scattering/tomography/diffraction) will be provided to assess changes in molecular, nano and microstructures through processing to develop a formulation model that maps the texture phase space. There will be training in statistical design of experiments, data analysis and preparation of ethics application when human trials and collection of human tissues are involved. The student will undertake the project under research integrity principles and open research practices.

Student profile:

The applicant should hold a BSc honours degree at upper second class level (or equivalent) in Physics, Chemistry, Biochemistry, Chemical Engineering, Food science, or related subjects. Applicants with expertise in statistics, modelling, physical-chemistry are particularly welcome. The applicants should have an interest in the improving the nutritional quality of food products, the design of modelling tools to predict the results of food processes and the creation of certain physical and chemical structures, and in working at the interface between fundamental science and the food industry.

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. van der Sman et al. Food Hydrocoll 133, 107966 (2022), https://doi.org/10.1016/j.foodhyd.2022.107966.
2. Bolger et al. LWT- Food Sci. Technol. 150, 111989 (2021), https://doi.org/10.1016/j.lwt.2021.111989
3. van der Sman and Renzetti. Crt Rev Food Sci Nutr 59(14), 2225 (2019), https://doi.org/10.1080/10408398.2018.1442315

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