DAIRYDRY

TEAGASC researchers are developing protein-enriched spray-dried dairy powders with enhanced hydration properties.

The global dairy market is continuing to expand at an estimated annual growth rate of 5 % per annum, amounting to ~ $ 703.5 billion by 2024 (Cobbe, 2019). High-protein dairy powders have gained popularity as an essential ingredient in value-add nutritional products and beverages to improve both functionality and nutritional properties, particularly in products designed for early-stage life and healthy ageing. Aside from the requirement for high-protein ingredients, the move towards low-lactose products is also expanding rapidly, with an estimated turnover of €9 billion by 2022. However, there are a number of challenges associated with high-protein ingredients, one of which is their poor solubility, causing major problems both in manufacturing and with the end user. Poor hydration of high-protein powders is a generic problem and frequently results in the presence of surface flecks or sediment in the final product. Despite much research into milk composition, seasonality, functional properties and spray-drying technology, little is known of the mechanism of dairy powder hydration at the molecular and microstructural scale and the relationship between processing conditions and final product functionality. Issues regarding powder solubility usually commence when manufacturing powders with a protein content > 65 %, w/w, dry matter, and are likely to be a result of greater hydrophobic interactions between casein proteins and a lower concentration of lactose and soluble minerals. Typically, high-protein powder particles have a compact shriveled surface morphology (**Figure 1**), which can further hinder the transfer of water into and through particles during rehydration.

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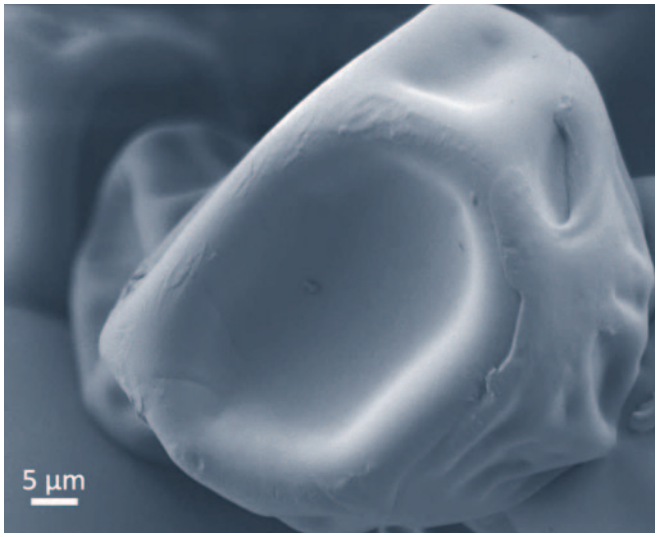

FIGURE 1: Scanning electron microscope image of a dense/compact high-protein powder particle produced using the Niro Tall-Form spray dryer at Moorepark Technology Limited.

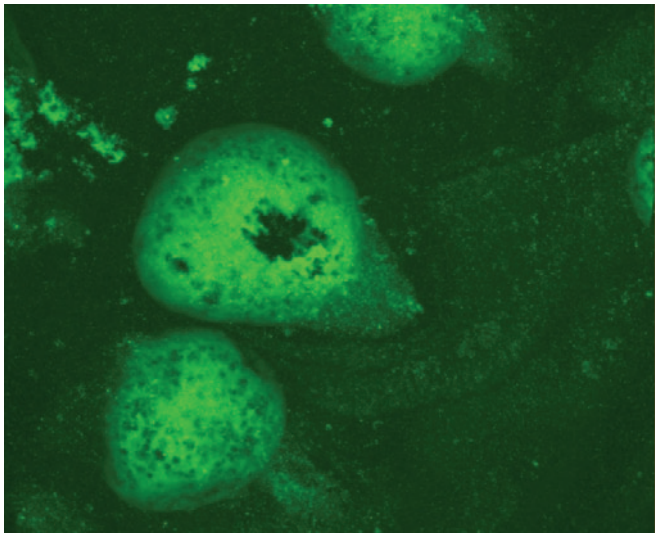

FIGURE 2: Confocal laser scanning microscope image of high-protein milk powder particles after hydration.

A complex interplay

New methodologies and data are needed to study the complex interplay between physical and chemical events that occur during particle wetting, dispersion and hydration (**Figure 2**). The standard industry-accepted test for powder solubility is based on crude sedimentation and there is a need to develop more accurate and informative standard tests for powder hydration. This project is an innovative major collaboration bringing together Ireland's leading research centres in the areas of dairy science, ingredient and process dehydration technology, photonics, and imaging expertise. Projects to date have focused on protein chemistry and bulk functionality; however, the DAIRYDRY project, through an integrated approach, is combining existing food chemistry expertise (Teagasc and University College Cork), advanced imaging expertise (Teagasc, University of Ulster and Waterford Institute of Technology), new processing technology (Teagasc), and sensors leveraged from the ICT industry (Centre for Advanced Photonics & Process Analysis (CAPPA) at Cork Institute of Technology). The project aims to identify the precise cause of insolubility in high-protein powders and to address issues both in the liquid concentrate and during spray drying. Considering the difficulties associated with hydrating high-protein powders, the project is investigating the effects of solvent composition, calcium chelating salts, electrodialysis, ion exchange, inlet/outlet drying temperatures, and modification of particle structure through air porosification. A unique focus of the project is capturing the nano/microstructural changes that occur for individual particles in real time using state-of-the-art imaging techniques.

Spectroscopy

In parallel with this work, CAPPA-CIT has been developing new photonics-based spectroscopic tools to characterise powder hydration in real time by infra-red and Raman fingerprinting. Advanced nano-imaging techniques (University of Ulster) and 3D X-ray microtomography (Waterford Institute of Technology) are being used to characterise powder hydration events at nano- and micro-scales. Results will eventually be used to reverse engineer easily dispersible protein-enriched powder formulations optimised for hydration by the end user.

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