Project number: 6724
Funding source: Enterprise Ireland
Date: June, 2020
Project dates: Jan 2015 – June 2019

Novel Technologies: Applications of hydrodynamic cavitation for instant rehydration of high protein milk powders

Key external stakeholders:

Dairy industry,
Dairy ingredient manufacturers,
Infant formula manufacturers,
Food manufacturers.

Practical implications for stakeholders:

The aim of this study was to evaluate the effectiveness of an in-line hydrodynamic cavitation (HC) system, for rehydration of milk protein concentrate powders (MPC) at semi-industrial pilot scale. MPC powder was dispersed in water at 50 °C at 20% (w/w) dry matter (DM) with two commonly used high shear powder inductors/mixers. The MPC dispersions created were then passed through the HC system to assess subsequent hydration behaviour of the MPC powders. Particle size distribution (PSD) of MPC dispersions prepared using conventional high-shear mixing indicated that complete rehydration of MPC powders was not achieved, with an average D90 and D[4,3] values of 21.17 mm and 5.62 mm respectively, observed in MPC dispersions. In contrast MPC dispersions subjected to HC had a PSD indicative of complete rehydration, with an average D90 and D[4,3] values of 0.45 mm and 0.19 mm, respectively. Apparent viscosity decreased significantly post HC compared to dispersions subjected to conventional high shear mixing. Phase separation profiles showed that HC treated MPC dispersions had increased stability to sedimentation compared to high-shear treated samples. Wetting, immersion, dissolution and solubilisation of high protein powders occurred instantaneously (and simultaneously) during HC. This emerging technology has the potential to achieve complete rehydration of powders in significantly less time than conventional rehydration processes employed by dairy and other industries.

Main results:

Hydrodynamic cavitation is a novel, scalable and robust process technology, which improves the rehydration performance of difficult-to-solubilise, high-protein powders such as MPC. This study has demonstrated that HC is suitable for the instantaneous hydration of MPC at DM contents up to 20% (w/w), a level similar to that used in many commercial applications. Compared to conventional high-shear mixing technologies, particle size analysis of HC treated MPC solutions revealed a complete absence of the secondary peaks associated with residual, insoluble powder particles, and had size distributions exclusively in the micellar region. This is indicative of complete powder rehydration. Complementary reductions in viscosity compared to conventional high-shear mixing technologies, were observed following a single pass through the HC system.

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Opportunity / Benefit:

This technology allowed wetting, immersion and dissolution of high-protein powders take place almost instantaneously and effectively simultaneously during HC treatment. This emerging technology has the potential to achieve complete rehydration of powders in significantly less time than conventional rehydration processes employed by dairy and other industries.

Collaborating Institutions: Dairy Processing Technology Centre

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1. Project background:

The challenges surrounding hydration of high protein powders is well known. In parallel with studies surrounding optimization of protein powder functionality this project has assessed a technological solution (hydrodynamic cavitation) to manipulate hydration behaviour.

2. Questions addressed by the project:

The project developed a process for instant hydration of high protein powders using an emerging technology based on hydrodynamic cavitation

3. The experimental studies:

Semi commercial pilot scale studies were carried out in Moorepark Technology Limited (MTL) using the hydrodynamic cavitation system supplied by SPX ìn conjunction with mixing technologies supplied by Crepaco and Y-tron for comparative purposes. Studies focused on hydration of MPC80 at 20% w/w dry matter content at a protein content of 16% w/w, conditions which are particularly challenging to ensure full solubilisation has been achieved.

4. Main results:

Study 1 major findings:

- The process has been developed and was able to be replicated and validated at pre-commercial scale on multiple occasions.
- Hydrodynamic cavitation is a novel, scalable and robust process technology, which improves the rehydration performance of difficult-to-solubilise, high-protein powders such as MPC.
- This study has demonstrated that HC is suitable for the instantaneous hydration of MPC at DM contents up to 20% (w/w), a level similar to that used in many commercial applications.
- Compared to conventional high-shear mixing technologies, particle size analysis of HC treated MPC solutions revealed a complete absence of the secondary peaks associated with residual, insoluble powder particles and had size distributions exclusively in the micellar region,indicative of complete powder rehydration.
- Wetting, immersion and dissolution of high-protein powders take place almost instantaneously and effectively simultaneously during HC treatment.
- This emerging technology has the potential to achieve complete rehydration of powders in significantly less time than conventional rehydration processes employed by dairy and other industries

5. Opportunity/Benefit:

- Utilisation of cost-effective equipment for hydration of high protein powders.
- No requirement for temperature cycling and long storage periods to ensure full hydration of MPC powders
- The process was demonstrated to have good reproducibility and scalability and could find uses in the manufacture of nutritional formulations such as infant formula or medical nutrition products

6. Dissemination:

Main publications:

Applications of hydrodynamic cavitation for instant rehydration of high protein milk powders (2018); S Pathania, QT Ho, SA Hogan, N McCarthy, JT Tobin. Journal of Food Engineering 225, 18-25

7. Compiled by: John Tobin

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