Milk protein concentrates (MPC) are high-protein ingredients with unique functional and nutritional properties that can be tailored through modifying processing conditions, including temperature, pH, filtration conditions, and drying. MPC is typically dried to produce powdered ingredients. However, the effect of the processing conditions on structural and functional properties of liquid MPC remains to be thoroughly understood. In this study, the pH of liquid MPC (13% protein and 18.5% total solids) was adjusted to either 6.5, 6.7, or 6.9, followed by heat treatment at 85°C/5min or 125°C/15s. The extent of whey protein denaturation was analyzed by HPLC. Heat treatment at all studied pHs resulted in substantial denaturation of whey proteins, with β-lactoglobulin denatured more extensively than α-lactalbumin. More extensive whey protein denaturation was also observed for MPC heated at 125°C/15s compared with 85°C/5 min, irrespective of pH. Changes in liquid MPC structural properties were monitored over time; 1, 4 and 8 d after the process. Viscosity increased over time, regardless of temperature/time and pH, suggesting the role of whey proteins denaturation and aggregation, and their interaction with casein micelles. MPC at pH 6.9 had a significantly higher viscosity than MPC at pH 6.5 or 6.7, at both temperature/time conditions. Mean particle size of the MPC samples did not change significantly over time. However, the particle size distribution showed the formation of larger particles after 4 and 8 d of cold storage in samples heat treated at pH 6.9. This study showed that the degree of whey protein denaturation and aggregation, and their interaction with casein micelles was affected by pH 6.9. This study showed that the degree of whey protein denaturation was significantly bigger (206.3 ± 8.8 nm) than non- and slightly-calcium depleted MPC concentrates (172.0 ± 2.1 and 174.8 ± 8.1 nm), which were not significantly different in their sizes.

Key Words: solubility, calcium depletion, casein concentrate

In the typical milk protein concentrate (MPC) manufacturing process skim milk is ultrafiltered using spiral wound membrane to produce MPC with 20% total solids (TS) and more than 80% total protein (TP) based on solids. This MPC is then further concentrated before spray drying using reverse osmosis or nanofiltration. In this study we had attempted to concentrate MPC using a plate-and-frame filtration (PF) system instead of spiral wound system. Three replicates of MPC80 having TS 20.01, 19.70 and 20.65% from the ultrafiltration of skim milk were concentrated in a PF system fitted with flat sheet membranes (Alfa Laval M37; surface area 3.3 m² with a 10 kDa molecular weight cut-off). Three different PF settings were utilized including: PF at 22°C (PF22); PF at 50°C for medium solids (PF50MS); PF at 50°C for high solids (PF50HS). Filtration was continued until the transmembrane pressure difference was 9 bar for PF22 and PF50HS. For the PF50MS, filtration was stopped when the TS achieved was 30%. The average flux, final TS and TP/TS ratio were 8.76, 10.50 and 11.18 L/m²hr, 26.83, 29.92 and 34.24% and 0.83, 0.88 and 0.87 respectively for the PF22, PF50MS and PF50HS treatments. The average flux, final TS and TP/TS ratio were significantly (P < 0.05) higher for the treatments conducted at 50°C as compared with 22°C. The viscosity of the retentates corresponded to the final TS and was 577, 1513 and 12805 cP for the PF22, PF50MS and PF50HS treatments, respectively. The permeate from the PF50HS treatment had significantly (P < 0.05) higher solids and TP as compared with the other treatments. The standard plate count (SPC) of the retentate before drying was significantly (P < 0.05) higher for the treatments at 50°C and was 3.54 to 4.41, 5.17 and 5.28 log10cfu/g for the PF22, PF50MS and PF50HS treatments, respectively. The loose and capped density of MPC powders after spray drying were significantly (P < 0.05) lower for the PF50MS and PF50HS treatments. This study determined that, increasing the PF temperature improves filtration performance and the level of TS achieved but also increase the SPC count of the final retentate.

Key Words: milk protein concentrate, plate-and-frame filtration, quality

The fermentation of preconcentrated milk is a challenging method to avoid acid whey during the manufacture of high-protein fermented milks like Greek yogurt and skyr. Since acid whey is undesired as a by-product due to environmental concerns, alternative processes that involve a concentration step before the fermentation, e.g., by microfiltration, are of economic and ecological interest. However, acid milk gels from concentrated milk (>8% protein) exhibit a high interconnectivity and an excessive firmness, resulting in technical and sensory problems. As the reduction of the microgel particle size is impaired, products are often not smooth and perceived as too viscous. The aim of our research was to improve...
the processing of high-protein yogurt from concentrates. For this purpose, power ultrasound (US) was applied as an innovative post-processing technology. Skim milk was fortified with milk protein powder to 10% protein, heated, and fermented at 43°C. Fermentations were stopped at pH 5.0, 4.8, and 4.6, respectively, by breaking up the gel with a perforated disc and immersing the containers in iced water. Yogurts were processed into stirred yogurt by shearing. Half of the samples were additionally treated with an US sonotrode for 5 s at a frequency of 20 kHz. Several physical properties were then analyzed. The short-term sonication considerably decreased the apparent viscosity of the yogurts by 30–40%, whereas the particle size and water-holding capacity were only slightly affected. Further experiments were performed by studying the effects of sonication time. Strong negative exponential correlations \((R^2 > 0.99)\) were found between the sonication time and various rheological properties (storage modulus, apparent viscosity, yield stress). Moreover, the visual smoothness of the yogurts increased with the sonication time. The application of power US is a highly effective tool to control the rheological properties of high-protein fermented milks from concentrates. This offers the potential to develop innovative products and will help to establish sustainable processes.

**Key Words:** Greek yogurt, ultrasound, fermented milk product


High-pressure-jet (HPJ) processing, a recent development in high pressure technology, has been shown to enhance foaming, emulsifying, and rheological properties in a variety of dairy systems including skim and whole milk. Recently, we showed a 400 MPa HPJ treatment of low fat ice cream mix resulted in an ice cream mix with an increased consistency coefficient and reduced apparent ice crystal growth compared with a non-HPJ-treated control due to the formation of fat-protein complexes at 400 MPa, which were visualized using confocal scanning laser microscopy (CSLM). These results suggest potential for eliminating the need for hydrocolloids and emulsifiers in an ice cream formulation, however these benefits have not been demonstrated in a dynamically frozen ice cream. The objectives of the current work were to characterize the physical properties (overrun, apparent viscosity, particle size) of HPJ-treated (100–500 MPa) low fat ice cream (6% fat) throughout dynamic freezing and to determine the melting rate, hardness, and microstructure of the final ice cream after hardening. At each pressure, triplicate low-fat ice cream batches were produced. All results were analyzed using one-way ANOVA to identify significance at a 0.05 level \((P < 0.05)\) with Tukey’s test applied for mean comparisons. A combination of CSLM and transmission electron microscopy revealed unique microstructural components in ice creams treated at HPJ pressures ≥400 MPa including coalesced milkfat coated with disrupted casein micelles. The ice creams treated at these pressures (≥400 MPa) also had an increased apparent viscosity (when melted, 26.2 mPa.s at 500 MPa), hardness (3,824 g at 500 MPa), and melting rate (2.6 g.min \(^{-1}\) at 500 MPa) compared with a non-HPJ-treated control (viscosity = 12.9 mPa.s, hardness = 2,506 g, and melting rate = 2.2 g.min \(^{-1}\)). These differences were attributed to the unique microstructure developed during HPJ treatment. By altering the microstructure, apparent viscosity, and hardness of a low fat ice cream, HPJ technology shows some promise for alleviating some common ice cream defects including ice cream shrinkage and iciness.

**Key Words:** high-pressure jet, ice cream, transmission electron microscopy