The Increase in Unsaturated Fatty Acid Content Affects the Crystallization and Rheological Properties of Milk Triacylglycerols.

Simon Bugeat [1,2,3], Marie-Hélène Famelart[2], Anne Ferlay[4], Philippe Pradel[5], Javier Perez[6] Claudie Bourgaux[3], Sylviane Lesieur[3] and Christelle Lopez[2]

[1]CNIEL, Paris, France; [2]INRA-STLO, Rennes, France; [3]CNRS, Châtenay-Malabry, France; [4]INRA, Theix, France; [5]INRA, Marcenat, France, [6]Synchrotron SOLEIL, Gif-sur-Yvette, France.

Simon.Bugeat@rennes.inra.fr

The nutritional quality of milk fat (70% saturated fatty acids) could be improved as regard to cardiovascular risk by increasing the unsaturated fatty acid (UFA) content, mainly ω3 derivatives. However, such changes in the FA composition may affect the technological, functional and sensorial properties of dairy products. This study aimed at relating the crystallization properties of triacylglycerols (TG, 98% of milk fat) to their rheological behavior, with focus on FA composition, using a multi-scale approach. Regular (32.0% UFA) and UFA-enriched (50.4% UFA) milks were produced by cows fed different diets: grass silage +/- linseed oil. Emulsions were prepared by homogenization of regular and UFA-enriched TG extracted from the milks at 3 droplet sizes (0.2 µm - 1.6 µm). The crystallization and melting properties of TG were investigated at a molecular level using time-resolved synchrotron X-Ray Diffraction (XRD, structural information) coupled to differential scanning calorimetry (DSC, thermal information) and at a macroscopic level using rheology. We showed that both the FA composition and size of emulsion droplets (curvature of the interface) affected the solid fat content and crystalline structures formed by TG. After 48-h storage at 4°C, storage temperature of dairy products, the coexistence of a double-chain length (2L 40.3 Å) and triple-chain length (3L 53.3 Å) lamellar organizations was revealed for regular TG, whereas a single 2L 42.8 Å structure was formed in the UFA-enriched TG. The coexistence of α, β'_1, β'_2 and β polymorphic forms was observed in both regular and UFA-enriched TG, in relative proportions depending on FA composition and droplet size. The stability of the structures formed was demonstrated during heating. As expected, a higher amount of UFA decreased the solid fat content at 4°C. Composition and crystallization behaviors of TG affected the viscoelatstic properties of TG as a function of temperature. Such study is important to increase the knowledge about crystallization in emulsion and to better understand and thus control the functional properties of dairy products enriched in UFA.

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