Mixed kappa/beta caseins associates as a model to Milk casein micelle

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Milk is a complex emulsion composed of 50-500 nm fat globules in an aqueous solution of mineral salts, lactose and casein proteins. The milk proteins - alpha-s_1-casein (α_{S1}CN), alpha-s_2-casein (αs_2CN), beta-casein (βCN) and kappa-casein (κCN) - are arranged in aggregates called casein micelles. In cow milk, their ratio is ~40:10:40:10, respectively. Studies of a structure of the casein micelles show that α_{S1}CN, α_{S2}CN and βCN are embedded within the micelle interior, while the majority of κCN is displayed on the surface, forming a so-called "hairy layer"[1]. In vitro, each of the pure proteins self-assembles into core-shell micelles, and κ CN organizes further into amyloid-like fibrils. Recent studies indicated that fibrillization could be prevented by mixing βCN and κCN [2]. Examining the interactions of κCN with βCN by cryogenic-transmission electron microscopy (cryo-TEM), isothermal titration calorimetry (ITC), and ζ-potential measuring, we expose a competition between the mixed micellization and κCN fibrillization. The thermodynamic analysis reveals exothermic demicellization for βCN [3], as opposed to endothermic demicellization of κCN and its mixtures with βCN, at the same temperatures. These we connect to the organization of the sugar moieties of κCN oligomers, the "hairy layer", on the mixed micelles surface, similar to the organization of κCN in milk casein micelles.ζ -potential measurements of the pure proteins and their mixtures confirms this hypothesis. Indeed, in milk, association of the all caseins inhibits fibrils formation. Interestingly, in cow's milk from an infected udder degradation of milk micelles is observed, as well as fibrillization (Figure 1, panels C and D) [4].

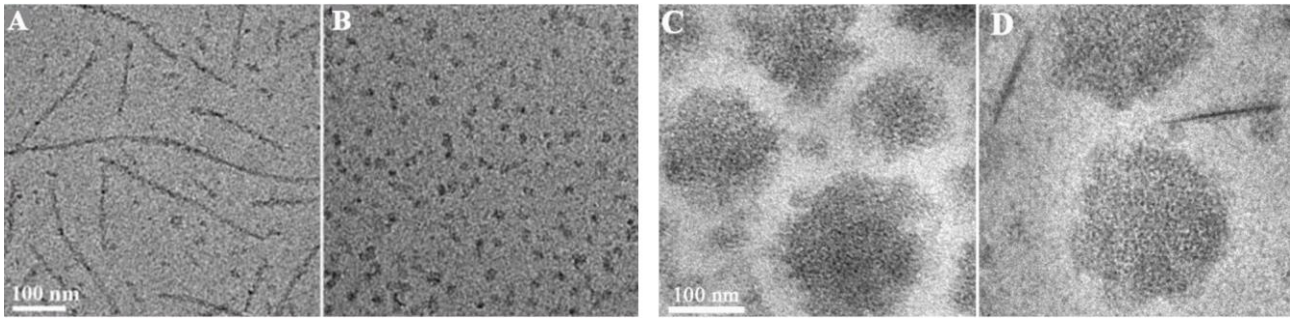

Figure 1 Cryo-TEM images of: (A) κCN fibrils and micelles; (B) mixed κCN/βCN micelles (1:1 mole ratio); (C) milk micelles from healthy cow, (D) milk micelles with κCN "needles" from an infected cow. T=25°C

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