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The impact of casein micelle size, calcium and citrate content on coagulation properties; A model study

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Milk coagulation is an important functional property in cheese making. A model study was designed to link the coagulation properties of milk and the interaction effects of the casein micelle size (CMS), citrate and calcium content. Individual milk samples from 4 mid lactating Swedish Holstein cows were selected based on screening of CMS in milk from 60 cows. Modified milk samples were prepared by adding ~10% of calcium and citrate or both to the milk, based on their initial calcium and citrate content. Compositional data and protein profile of the individual cow milk samples were recorded and CMS was measured. Calf rennet (75/25 chymosin/bovine) was added to the skimmed milk at a concentration of 0.18 IMCU/ml. Coagulation properties were measured as rennet coagulation time (RCT) and gel strength (Pa) at 20 min (G20). Microstructures of the gels were observed at 20 min after rennet addition using confocal laser scanning microscope (CLSM). Coagulum resulting with smaller CMS had significantly ($P < 0.05$) longer RCT and lower G20 than larger CMS. Addition of calcium decreased mean CMS and RCT, while G20 increased. Addition of citrate reduced G20 and increased RCT, than adding calcium or both in combination. The effect of citratre is explained by the less dense structure of the gel as visualised by CLSM. The combination of calcium and citrate resulted in the largest mean CMS. RCT was interactively affected by mean CMS x calcium ($P = 0.014$) and mean CMS x citrate ($P = 0.011$). Milk with smaller CMS had proportionally higher whey proteins than larger CMS, whereas milk with larger CMS had proportionally higher β-casein, total casein, total protein and total solid content. Thus, the functional properties of the milk coagulum can be modified by the level of calcium, citrate and the CMS, from their main or interaction effects.

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