254 Effects of added plasmin on the rheological properties of rennet-induced skim milk gels.
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Elevated activity of plasmin enzyme (EC 3.4.21.7) results in reduced cheese yields and texture defects and this can occur in mastitic and late-lactation milks. The effects of exogenous plasmin on the rheological properties, at small and large deformations, of rennet-induced skim milk gels were studied. Rennet gels were made from 9% (w/w) NFDM, which was reconstituted for 3 h at 32C. Porcine plasmin (0.01 mg/ml milk) was added to milk and samples incubated for 1, 2, 3, 4, 6 and 8 h at 37C. The reaction was terminated using soy bean trypsin inhibitor. Samples with no added plasmin were also incubated (controls). Extent of degradation of caseins was determined by SDS-PAGE. Gelation properties were determined at 32C using dynamic low amplitude oscillation and rheological parameters were monitored for a period of 6 h after rennet addition. Extent of breakdown of α_s- and β-caseins increased with incubation time with plasmin. After 8 h of incubation, the amounts of intact α_s- and β-casein were 24.30.5 and 13.60.3%, respectively. Rennet gels made from milk with no added plasmin had storage moduli of 751 Pa. Storage moduli of rennet gels decreased with increasing degradation of caseins. After incubation of milk with plasmin for 8 h, storage moduli decreased to 102 Pa. Loss tangent values of rennet-induced gels after 8 h incubation increased to 0.61 from 0.35 in control milk, indicating a more liquid-like gel character. In contrast to previous studies, we found that storage moduli of gels decreased even when a small amount of breakdown of caseins occurred, e.g. after 1 h incubation with plasmin the amounts of intact α_s- and β-caseins were 84 and 80%, respectively, and this resulted in 20% reduction in the storage modulus. Gelation time hardly changed until 3 h of incubation, thereafter gelation time increased considerably. Fracture properties were determined by subjecting the gels to a low shear rate (0.01 s^{-1}). Fracture stress (force required for fracture) of gels decreased with increasing casein breakdown and after 8 h incubation with plasmin the fracture stress was only 103 Pa, whereas control milk was 786 Pa. Low levels of plasmin activity influences the texture of rennet gels which could have significant effects on the yield and texture of cheese.

Key Words: Plasmin, Rennet coagulation, Rheology

255 Effect of Homogenization Pressure and Selected Additives on Particle Size Properties of Retort Sterilized Dairy Beverages During Storage.
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The objective of this study was to determine the effect of homogenization pressure and six mineral salts and hydrocolloids on the particle size properties of dairy beverage processed in a retort. Skim milk, cream, nonfat dry milk, and sucrose were mixed to make beverages containing either 0.1% sodium salts (sodium citrate, sodium tripolyphosphate, or sodium hexametaphosphate), 0.05% hydrocolloids (locust bean gum, iota-carrageenan, or kappa-carrageenan), or combinations of the salts and hydrocolloids. The mixtures were heated, homogenized at either 20, 50, or 90 MPa, canned, and sterilized with a retort at 121C for 6 min. The processed products were stored at 36C and tested after 1, 10, 20, and 30 days of storage. Particle size distribution of the sample was determined with a Coulter LS130 particle size analyser. Particle size index was calculated as the ratio of mean particle size (D(4,3)) of the top and bottom layers. Both mineral salts and hydrocolloids significantly affected particle size index. Samples containing sodium tripolyphosphate or iota-carrageenan had the particle size index values closest to 1.00 but samples that contained sodium citrate or locust bean gum had the smallest mean particle size. Nevertheless, samples that contained both sodium tripolyphosphate and kappa-carrageenan had a better particle size index than samples that contained sodium tripolyphosphate and iota-carrageenan. The mean particle size decreased as the homogenization pressure was increased. This effect became more apparent as storage time increased. The mean particle size increased as storage time increased for samples homogenized at 20 MPa but did not change significantly in samples homogenized at 90 MPa.

Key Words: Homogenization Pressure, Hydrocolloids, Particle Size

256 The Effect of Stabilizers and Emulsifiers on the Rheological Properies of Ice Cream Model Systems.
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Ice cream contains many ingredients that influence quality of the final product. Locust bean gum (LBG) and guar gum (GG) are two stabilzers used in ice cream to modify texture and enhance shelf life. Emulsifiers help create ice cream structure because they form a thin interface around fat globules, which allows fat to partially coalesce during whipping. During homogenization and aging, emulsifiers adsorb to the fat globule surface, displacing milk proteins and thus leaving more proteins in the aqueous phase. The purpose of this research was to determine the rheological properties of model ice cream mixes to understand how different ingredients affect aqueous structure formation during freezing, and ultimately ice crystal growth during ice cream storage. A controlled stress rheometer measured yield stress and frequency sweeps for solutions comprised of skim milk powder (SMP) (4% protein), sucrose (10%) and LBG or GG (0.25%), with or without fat (10%) and emulsifier (0.1%). Measurements were made at -1°C after being quiescently frozen and temperature cycled (-15°C to -1°C to -15°C) for a total of five cycles. Rheological data showed that LBG/SMP/sucrose solutions developed a more elastic network during temperature cycling, as shown by significantly increasing yield stress and decreasing tan δ values ($P \leq 0.05$), while GG/SMP/sucrose solutions did not. Emulsifiers enhanced solution rigidity after temperature cycles. Junctions form more easily between LBG molecules than GG molecules because of their structures, which may explain why LBG forms weak networks during temperature cycling. When LBG or GG are mixed with milk proteins, concentrations of both stablizer and protein increase because LBG and GG are thermodynamically incompatible with milk proteins. This effect is further enhanced when water is frozen out of solutions at subzero temperatures or when protein concentration in solution is increased. The above evidence suggests that freezing and phase separation with milk proteins enhances the ability of LBG to form weak networks, which may explain why LBG has been shown to slow down recrystallization rates better than GG.

Key Words: stabilizer, emulsifier, rheology

257 Measurement of temperature dependent changes in process cheese viscosity.
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A ten-minute test which measures temperature dependent changes in the viscosity of process cheese was developed utilizing a rapid visco analyzer (Newport Scientific, Warriewood, Australia). The rapid visco analyzer is capable of adjusting sample temperature between 0 and 99°C with stirring speeds of 0 to 2000 rpm and measures viscosity from 50 to 50,000 cps. During the test the sample is heated to a set temperature in five min, held for three min, and cooled to a set temperature in 2 min. The sample is stirred from four minutes until the end of the test. The initial hot viscosity, time at minimum viscosity, change in viscosity during holding at maximum temperature and change in viscosity during cooling were determined. Three commercial samples (14 g cheese and 1 g propylene glycol) were evaluated in triplicate utilizing a variety of operating conditions including stirring speeds of 100, 200, and 300 rpm, maximum temperatures of 80, 85, and 90°C and cooling temperatures of 65, 70, and 75°C. Initial hot viscosity, change in viscosity during holding at maximum temperature, and change in viscosity during cooling were significantly ($p \leq .05$) affected by stirring speed, maximum temperature, and cooling temperature. Suggested operating conditions are heating from 25 to 85°C in five min, holding for 3 min, and cooling to 65°C in two min with a stirring speed of 200 rpm. Under these operating conditions significant ($p \leq .05$) differences in initial hot viscosity, change in viscosity during holding at maximum temperature, and change in viscosity during cooling were observed between the three samples. The rapid visco analyzer can be used to measure temperature dependent changes in viscosity of process cheese and has potential as a quality control technique.

Key Words: process cheese, viscosity