Rheological and electron-microscopical studies of structure formation in milk during acidification by GDL

Katrin Schrader[1]

[1]Department Safety Quality of Milk & Fish Products, Max Rubner-Institut, 24103 Kiel, Germany

Glucono-Delta-Lactone is a common tool to simulate the slow acidification of milk by microorganisms. Milk samples were acidified by GDL at varying concentrations and temperatures. The decrease of pH was recorded. It was found that the acidification rate follows a first order reaction and depends only on GDL concentration and temperature but not on fat content and thermal pre-treatment. The size of casein micelles and particles in skim milk during acidification was measured using laser diffraction (Beckmann Coulter). The size of the casein micelles in UHT milk is about 0.13 μm. Particle size is constant during the first phase of acidification independently of the GDL concentration. Only the temperature affects the growth of the particles but not the GDL concentration and the acidification rate. At 23°°C the start point of aggregation is at pH 5.0. At 42°C the aggregation starts at pH value 5.3. It was observed that these particles become bigger. For the investigation of the gel formation oscillation rheometry was chosen. The rheological measurements were carried out using a Physica UDS 200 (plate-plate measuring system). Storage modulus (G'), loss modulus (G") and loss angle ($tan\delta$) of tempered and inoculated milk were recorded at a frequency of 1 s^{-1} and a deformation of 1 %. As it is state of knowledge the gels develop after a phase of pre-acidification. G' and G" increase and $tan\delta$ decreases. The point of maximum, both of G' and G", is reached at the same pH value (4.6) At higher GDL concentration this point is reached earlier. During the initial phase of acidification the viscosity was measured by rotational mode (cone-plate system) since it is more sensitive. A slight decrease of the viscosity during this phase is an indicator for changes in the micellar structure. At a pH value of 5.2 the viscosity increases until the cone starts to slip due to syneresis. The gels were characterized by uniaxial compression (Texture Analyzer). The gels become stronger at higher acidification rates and temperatures. TEM micrographs show the conformational changes of the casein micelles during acidification.