

Effect of Bacteria Exopolysaccharide on Milk Gel Formation

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The main objective of this study was to determine effect of exopolysaccharide (EPS) from bacteria on formation of milk gel. Milk gel was made from 10%, 15% and 20% Reconstituted Skim Milk (RSM). EPS at different concentrations (0%, 0.2%, 0.4%, 0.6%, 0.8% and 1.0% according to our previous study) were added to RSM, heated at 60°C for 30 minute and 85°C for 30 second and cooled to 5°C before viscosity and pH were examined using viscometer and pH-meter. Viscosity was dependent on the concentrations of skim milk, increasing as the concentration of RSM increased. Lower concentration of EPS, viscosity showed a slight increase, but at 0.4% EPS, viscosity of milk gel increased rapidly and continued to increase up to 1%. Microstructure was determined using scanning electron microscope to evaluated milk gel formation. Interaction between milk protein and EPS was showed as network aggregate one and another. EPS function as binding agent between one molecule of casein and another. These results indicated that EPS could be used to increase quality of milk gel.

Keywords: Exopolysaccharide; Viscosity; Milk Gel

Introduction

Many processing problems, such as low viscosity or high syneresis, which occur during milk product manufacture, are often solved by increasing the total solid or adding stabilizers, such as modified starch, carrageenan, guar gum, pectin, gelatin and sodium caseinate. However, some feel that these additives adversely affect the true milk product (yoghurt, cheese, ice cream) taste, aroma and mouth feel.

The name exopolysaccharide (EPS) is a general term for all these form of bacterial polysaccharide found outside the cell wall (Sutherland, 1977). EPS isolated from bacteria have been claimed to have antitumor activity. On the other hand a number of polysaccharide bacteria indicated have potent inhibitory effect on AIDS infection (Yoon et al., 1996). Microbial polysaccharides are also produced as food additive that can use as stabilizer in fermented milk and increase the quality of milk product (Malaka, 1997).

Interaction between milk protein and polysaccharide is important in relation with the milk gel quality. Electrostatic attraction between charged polysaccharide and protein molecular is generally the major driving force for these interactions, some of mixture polysaccharide and milk showed that k-casein particle are absorbed on the polysaccharide chain (Snoeren et al., 1976), EPS also stabilizes β -casein and para casein.

Although EPS have been investigated as food stabilizer, there is little information exist on how effect of EPS on milk gel formation.

Materials and Methods

Preparation of Milk Gel

Milk gel was made from 10%, 15% and 20% Reconstituted

Skim Milk (RSM). EPS extracted from *Alcaligenes faecalis* var. *myxogenes* were added to RSM in different concentration (0%, 0.2%, 0.4%, 0.6%, 0.8% and 1.0%). The suspensions were heated at 60°C for 30 minutes and 85°C for 30 seconds.

Physical Properties Measurement

Viscosity of milk gel was measured using a viscometer (Tokimec Inc., Visconic EDModel). Steady shear rate of 100/second along with a MK 50 rotor assembly and NV sensor system operating at 25°C. Viscosity is expressed as millipascals per second.

After the determination of the viscosity, sample was homogenized with a mixer (Nikon Seiki BM-3 Model) and pH values were measured by using a TOAHM-30 pH-meter.

Microstructure of Milk Gel

Skim Milk Agar plate was made for making sample that examines microstructure. Gluing 4 × 10 mm glass rods to inside surface of a petridish cover made a template. A 3% agar solution (60°C) was poured to depth of 13 mm into the petrel dish. The template was then placed into the agar solution. The template was removed after the agar had solidified, which resulted in the formation of cylindrical pores in the agar. The milk gel was then pipetted into the pores. The surface was overlaid with 3% agar, which had been tempered to 45°C. After the agar overlay had solidified, 6 mm cubes containing a single cylindrical pore of milk gel were cut out of the agar. The agar cubes were fixed in 2.5% glutaraldehyde solution buffered at pH 7.0 with 0.1 M phosphate buffer, and then post fixed in 1% osmium tetroxide solution. Samples were dehydrated in a graded alcohol series (50%, 60%, 70%, 80%, 95%, and 99.5%), and the dried in Hitachi HCP-2, ion type sputter coated (Hitachi Ltd,

Tokyo), and viewed in a Hitachi s-4 100 type scanning electron microscope.

Results and Discussions

The term “milk gel” refers to EPS was suspended in reconstituted skim milk and treated by heat treatment to form gel before cooling.

Figure 1 is a typical viscosity of curdlan milk gel as a function of EPS concentrations at different concentrations of skim milk. Lower concentration of EPS, viscosity showed a slight increase, but at 0.4% of EPS concentration, viscosity increased rapidly and continued to increase up to 1%. This model is the same as that in the **Figure 2** (heated at 85°C) showing that the viscosity increased linearly with increased EPS concentrations. Viscosity was also dependent on the concentration of RSM increased. This is probably as a result of globular proteins such as bovine serum albumin, β -lactoglobulin, and aalbumin can form gel on heating, indicating that there are some interaction forces that cause gelation. This formation was suspended by EPS, that is an important contribution by hydrophobic interaction to heat induced gelation.

The charges of pH as a function of EPS concentration in skim milk heated at 60°C and 85°C are shown in **Figure 3**. There was little change in pH with increasing EPS concentration in skim milk 10% and 15% but pH was constant in 20% skim milk. This result indicated that swelling enthalpy is independent of the concentration of EPS, so milk dissolved in water gave milk a pH of about 6, 7 (Walstra & Jennes, 1984). High concentrations of milk solid are known to produce an increase in the buffer capacity of milk. In general, the viscosity increased with lower pH and higher total solid.

The result above was supported by microstructure examination in **Figure 4**. Mixing EPS and casein particle result forma-

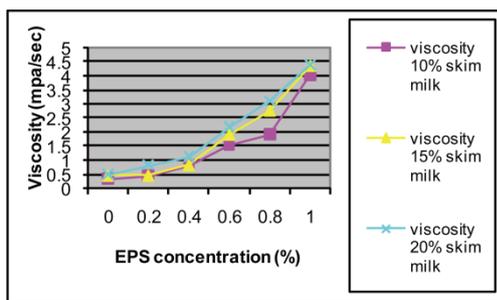


Figure 1. Viscosity of EPS-milk gels, heated at 60°C for 30 min.

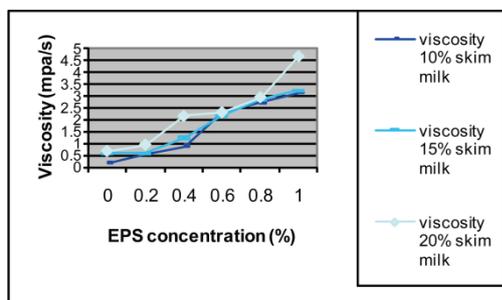


Figure 2. Viscosity EPS-milk gel, heated at 85°C for 30 s in different concentration of skim milk.

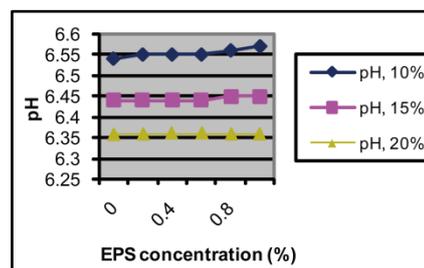
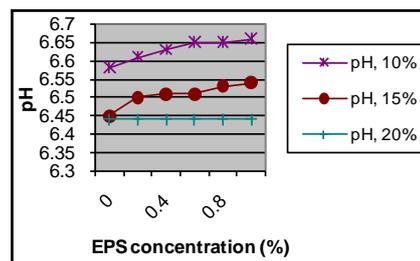


Figure 3. pH of EPS-milk gel, heated at 60°C for 30 min (upper) and 85°C for 30 s (below).

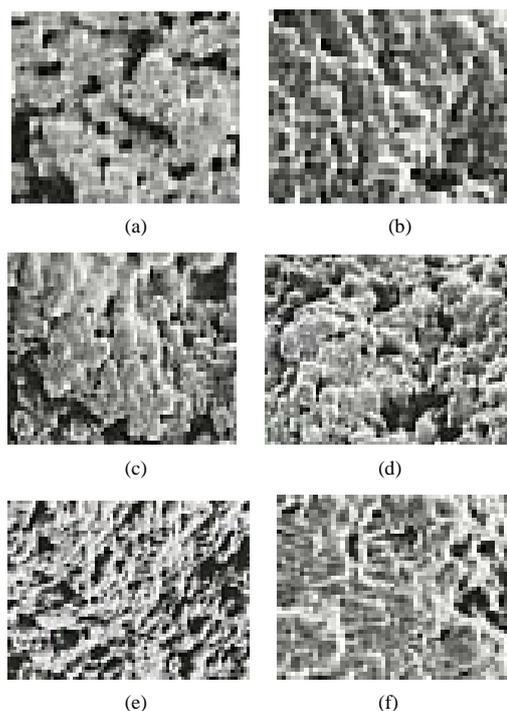


Figure 4. Microstructure of EPS milk gel in different concentration of EPS; (a) = 0% of EPS; (b) = 0.2% of EPS; (c) = 0.4% of EPS; (d) = 0.6% of EPS; (e) = 0.8% of EPS; (f) = 1.0% of EPS.

tion of necklace-like structure or aggregate like structure, where an extended network was formed with high molecular of EPS. A part of the EPS molecule is actually contacted with the surface of the casein particle. A part consisting of free loops and tails may interact with each other to form infinite network or aggregates. An adsorbed EPS molecules, as is necessary for the formation of the three dimensional network when short chain of

the molecules.

Goff *et al.*, (1993) has been observed the influence of polysaccharide on the glass transient in ice cream. Polysaccharide stabilizers such as locust bean gum, guar gum, sodium carboxy methyl cellulose, sodium alginate, carrageenan, and xanthan are commonly added to ice cream to control ice crystal growth during hardening and storage, especially in abusive temperature, to give body and stiffness during freezing for air incorporation, and to impart smoothness in body and texture.

Conclusion

Addition of EPS as stabilizer in milk gel formation can increase the quality of the product. EPS reacted with casein micelles that formed polysaccharide-protein network aggregations.

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