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Effect of Gums on Yogurt Characteristics

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Abstract: The effects of xanthan and carrageenan gums at different concentrations on the rheological, microbiological, chemical and sensory properties of yogurt were studied. The viscosity of samples containing gums increased compared to the control sample. Yogurt samples with xanthan gum at a concentration of 0.01% showed the highest viscosity during ten days storage. Syneresis of yogurt samples was measured at 4° C and 25°C. The results showed that samples with gums had less syneresis during storage. Samples containing xanthan gum at a concentration of 0.01% exhibited high resistance to syneresis during all days. pH and total solids of the samples did not change using gums during storage. In addition, mould, yeasts and coliform groups were not detected in samples at the end of storage period. Yogurt treated with 0.005% xanthan gum gained the highest sensory score compared to the other treatments.

Key words: Yogurt · Syneresis · Viscosity · Xanthan · Carrageenan

INTRODUCTION

The central process in conversion of milk to yogurt is aggiomeration of casein Micells into a three-dimensional network structure. Casein constitutes about 80% of the total protein content of bovine milk and comprises four main components: α_{s1}, α_{s2}, β and κ [1]. Yogurt has been attributed nutraceutical, therapeutic [2] and probiotic effects [3], such as digestion enhancement, immune system boosting, anticarcinogenic activity and reduction in serum cholesterol [4, 5]. Yogurts are increasingly popular due to their nutritional and potentially therapeutic characteristics [6]. Yogurt may have two primary defects: variation in viscosity and/or expulsion of serum (syneresis). Processing, incubation and storage conditions have an effect on these changes. Dairy ingredients and hydrocolloids have sometimes been added to combat such defects [7-10]. In the realm of food development, combination of more than one type of hydrocolloids in commonly used in food product, modify rheological characteristic and satisfy processing requirement in the industry [11].

Xanthan gum has been used to improve the texture, increase the firmness and prevent syneresis in yogurt [12]. Carrageenan, synergistic with some other gums, could increase the gel strength and water binding capabilities as well as modify the gel texture [13]. Syneresis can be reduced by adding stabilizers that interact with the casein network. The viscosity of yogurt is affected by homogenisation, pH, processing parameters (stirred or set yoghurt) and heat treatment. A primary stabilizer, such as carboxymethyl cellulose (CMC), LBG, Alginate, or Guar, gum, can be used as a thickener in conjunction with a secondary stabilizer, such as Carrageenan to reduce syneresis [14].

Various studies have been reported the use of gums to improve some characteristics of yogurt [12, 15]. However, no information has been obtained on the effect of xanthan and carrageenan at 0.01% and 0.005% on yogurt characteristics. Therefore, this study was undertaken to study the effect of one adsorbing polysaccharide (carrageenan) and one non-adsobing polysaccharide (xanthan), at 0.01% and 0.005% on yogurt rheology and some properties (pH, Total solids, syneresis) after one, five and ten days of storage.

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MATERIALS AND METHODS

Materials: Commercial product Xanthan was purchased from Merk, Germany. Carrageenan was obtained from Ceamsa, Spain. *Lactobacillus delbrueckii ssp. bulgaricus* and *Streptococcus salivarius ssp. thermophilus* were obtained from Yc-X11 Chr. Hansen, Copenhagen, Denmark. The fresh whole cow´s milk used in this study was obtained from Beihagh factory of Sabzevar, Iran.

Preparation of Yogurt Samples: Xanthan and carrageenan gums were added to milk at two concentrations of each stabilizer, 0.005% and 0.01%. In all cases, except the control (without stabilizer), xanthan and carrageenan gums were dissolved in a small quantity of milk, then added to the rest. All treatments were heated to 90°C for ten minutes and rapidly cooled to 42°C, inoculated with 2% yogurt starter and were then distributed into 150 ml plastic cups and incubated at 42°C for four hours. The yogurt samples was placed in a refrigerator at 4°C and analyzed after one, five and ten days of storage.

Rheological Analysis: Viscosity of yogurt was measured with a Brookfield rotational viscometer (Model DV_3PR, Austria), fitted with a R_3–spindle at 30 rpm and 25° C. For determination of syneresis, samples (30 g) were centrifuged at 222 × g for 10 min at 4°C and 25°C and the extent of trapped serum phase quantified and expressed as the volume of separated whey (milliliters whey). Syneresis measurements were made in triplicate and the average and absolute error range calculated [15].

Chemical Analysis: Total solids of yogurt were determined as described by AOAC [16]. A pH meter (Model MTT 65, Germany) was used to measure the pH values at 20°C.

Microbiological Analysis: Mould and yeasts were determined according to Harrigan and McCance [17] using malt extract. Coliform bacteria were determined according to Harrigan and McCance [17] using violet red bile agar medium.

Sensory Evaluation: An experienced taste panel of fifteen stuff judges evaluated the yogurt samples for flavor (50 points), texture (40 points) and appearance (10 points) [12].

Statistical Analysis: Experimental data was analyzed using analysis of variance (ANOVA) and significant differences among means from triplicate analyses at ($P < 0.05$) were determined by Duncan's multiple range test (DMRT) using the SAS System (SAS).

RESULTS AND DISCUSSION

Effect of the Gums on Rheological Properties of Yogurts: The results for the effect of various stabilizers and storage period on viscosity and syneresis are shown in Table 1. The results reveal that the use of xanthan and carrageenan gums at mentioned concentration rates noticeably increased the viscosity of yogurt as compared to the control during storage. Treatment with xanthan gum at a concentration of 0.01% exhibited the highest viscosity values during storage.

Xanthan and Carrageenan gums increased the viscosity and decreased the syneresis of samples, which was expected. This may be attributed to the interaction between the gum and the milk portion [18, 19]. The yogurts with the higher concentrations of gums had high viscosities. The syneresis of the yogurts after centrifugation at 4°C and 25°C, for the trials with xanthan and carrageenan revealed that the untreated yogurt samples had higher syneresis as compared to the yogurt samples treated with stabilizers. The mean for syneresis in case of untreated samples were 4 ml and 4.4 ml, at 4°C and 8.3 ml and 11.5 ml, at 25°C after one and ten days of storage, respectively. Yogurt samples containing xanthan gum at a concentration of 0.01% during storage had less syneresis at 4°C and 25°C compared to the other samples. In each case including control, the syneresis increased with increasing storage time. Generally, syneresis decrease with increasing gums. All experimental treatments had less syneresis than the control sample. Harwalker *et al*., 1986 [20] and Abd EI-Salam *et al*., 1996 [21] have reported that the use of thickening agents such as xanthan gum is being considered as a method of controlling syneresis of fermented milks. Anionic hydrocolloids (e.g. CMC, pectin, carrageenan) interact with the positive charges on the surface of casein micelles to strengthen the casein network and reduce syneresis and are classified as adsorbing polysaccharides. Neutral hydrocolloids (e.g. xanthan, guar, LBG) do so through a different mechanism by increasing the viscosity of the continuous phase and are classified as non-adsorbing polysaccharides [14].

Table 1: Viscosity and syneresis of yogurt during refrigerated storage

	Viscosity(cp) Storage period, day			Syneresis (ml/30 g) Storage period, day					
				1		5		10	
Stabilizer used%	1	5	10	4°C	25°C	4°C	25°C	4°C	25°C
Control(without)	2464[a]	2672[a]	2065[a]	4[a]	8.3[a]	4.1[a]	9.8[a]	4.4[a]	11.5[a]
Xanthan 0.01%	3438[b]	3557[b]	3791[b]	1[d]	3[d]	1[d]	3.7[d]	1.1[d]	4.5[d]
xanthan 0.005%	3084[b]	3243[b]	3456[b]	2[b]	7.6[b]	2[b]	9[b]	2.3[b]	9.7[b]
Carrageenan 0.01%	3194[b]	3343[b]	3554[b]	1.8[b]	7.1[b]	1.9[b]	8.4[b]	2.1[b]	8.9[b]
Carrageenan 0.005%	2884[b]	3047[b]	3206[b]	2.4[c]	7.9[c]	2.5[c]	9.3[c]	2.9[c]	10.2[c]

Means within a column with different superscript are significantly different ($P < 0.05$)

Table 2: Changes in pH and total solids (TS) contents of yogurt during refrigerated storage

	pH Storage period, day			Total solids (TS%) Storage period, day		
Stabilizer used%	1	5	10	1	5	10
Control(without)	4.4[a]	4.2[a]	4.15[a]	11.8[a]	11.7[a]	11.5[a]
Xanthan 0.01%	4.3[a]	4.1[a]	4[a]	12.4[d]	12.2[d]	12[d]
xanthan 0.005%	4.2[a]	4.1[a]	3.9[a]	12.1[b]	11.8[b]	11.6[b]
Carrageenan 0.01%	4.3[a]	4.1[a]	4[a]	12.1[b]	11.9[b]	11.8[b]
Carrageenan 0.005%	4.3[a]	4.1[a]	4[a]	11.9[c]	11.7[c]	11.6[c]

Means within a column with different superscript are significantly different ($P < 0.05$)

Table 3: Sensory evaluation of yogurt after 1 day

Stabilizer used%	Appearance (10)	Body and texture (40)	Flavor (50)	Total (100)
Control(without)	6[a]	30[ab]	35[a]	71[a]
Xanthan 0.01%	8[b]	25[b]	41[ab]	74[ab]
xanthan 0.005%	9[b]	34[c]	45[b]	88[b]
Carrageenan 0.01%	9[b]	35[c]	41[ab]	85[b]
Carrageenan 0.005%	8[b]	33[c]	40[ab]	81[b]

Means within a column with different superscript are significantly different ($P < 0.05$)

Carrageenan adopts a coil conformation under the ionic conditions used in this study [22]. It may absorb to the surface of casein micelles [23]. Adsorption of negatively charged carrageenan onto the casein micelle surface may take place by electrostatic interaction with the net positively charged moiety of κ- casein [24]. Apparent viscosity of xanthan showed similar trends to the non-adsorbing polysaccharides, indicating that the proposed casein interactive mechanisms may also be applicable to this stabilizer [25]. At higher concentrations, the casein aggregates may be trapped within the increasingly viscous polysaccharide solution, explaining the increase in apparent viscosity. From these results, it could be concluded that the use of xanthan and carrageenan gums as a stabilizer at concentrations of 0.01% and 0.005% in yogurt manufacture respectively improved their organoleptic and rheological properties and that these results support the application of gums in the production of fermented dairy products.

Effect of the Gums on Chemical and Microbiological Properties of Yogurts: The pH and total solids decreased throughout the storage period (Table 2). Results of the investigation on pH values and TS contents of yogurt samples showed that there was no significant difference between samples containing stabilizers and the control sample ($p<0.05$). The pH and the total solids of yogurt samples containing either xanthan or carrageenan gum had a normal decrease during storage as well as the control sample. The decrease of pH was due to the formation of lactic acid by certain bacteria of yogurt.

These results are consistent with findings of EI-Salam *et al*., 1996 [21], who reported that the type of stabilizer had no effect on the development of acidity and the trend of total solids content during the yogurt storage. No mould, yeasts or coliform groups were detected in any yogurt samples during refrigerated storage.

Sensory Characteristics: Table 3 gives the average scores for sensory evaluation of yogurt samples, as affected by using xanthan and carrageenan gums. The addition of xanthan and carrageenan gums had no effect on the yogurt flavor. No undesirable flavor was detected in any of the treatments. However, they had different effects on the texture of yogurt. The yogurt containing xanthan gum at a concentration of 0.005% gained the highest score, followed by the yogurt containing carrageenan gum at a concentration of 0.01%, while the control had the lowest total score.

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