



RESEARCH PAPER

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Textural and sensory properties of lowfat concentrated flavored yogurt by using modified waxy corn starch and gelatin as a fat replacer

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Abstract

The aim of the present research was to incorporate different concentrations of gelatin (0.025, 0.05 and 0.1 w/w) and modified starch (1 and 1.5 w/w) into low fat concentrated flavored yogurt and control sample was full-fat concentrated flavored yogurt and to compare physicochemical (titratable acidity, dry matter, viscosity), textural (hardness and adhesiveness) and sensory (mouth feel, texture, stickiness, flavor, odor and overall acceptability) properties of such yogurts prepared to full-fat flavored concentrated yogurt, control, on day 1 of storage. Rheological measurements were performed and flow curves were modelled according to the Herschel–Bulkley rheological model. Also, sensory evaluation was carried out using a trained panel. The addition of gelatin and starch significantly affected the instrumental texture parameters (Herschel–Bulkley's model parameters) and the perceived sensory texture of yogurts. All sensory descriptors were well predicted by the partial least squares regression of the instrumental parameters. It could be concluded that gelatin and modified starch can improve the texture and sensory properties of fat free concentrated yogurt and that preferred sample is fat-free flavored concentrated yogurt containing 0.1% gelatin and 1.5% modified starch.

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Introduction

The alleged hypercholesterolemic effect of milk fat (Ney, 1991), and the desire to ensure overall good health (Sloan, 2000) have led consumers to demand reduced milk-fat dairy products, including yogurt, in order to reduce the risk of coronary heart disease. Fat solids reduction in yogurt has been associated with poor texture, where commonly the fat removed is substituted by gelatin, starch, pectin, alginate, carrageenan, derivatives of methylcellulose, gum arabic, tragacanth, karaya, locust bean gum (LBG) or guar (Tamime & Robinson, 1999). The amounts required of these ingredients to achieve the total solids content similar to that of the full-fat yogurt can lead to a powdery taste, excessive acid development from lactose fermentation, excessive firmness, higher whey expulsion, and grainy texture (Guzmán-González, Morais, & Amigo, 2000; Mistry & Hassan, 1992). Reduced-fat yogurts can be produced by replacing partially the fat content of the milk base with lowcalorie products known as fat replacers (Barrantes, Tamime, Muir, & Sword, 1994). Tamime, Kalab, Muir, and Barrantes (1995).

The addition of stabilizer to low fat yogurts improves body and texture, appearance (Kumar & Mishra, 2004) and mouth feel (Kumar & Mishra, 2004; Arno *et al.*, 2009) and delays whey separation of them. Stabilizers have two basic functions in yogurt: the binding of water and improvements in texture (Kumar & Mishra, 2004).

Gelatin is a well-known ingredient in low-fat yogurts, due to its melting behavior at body temperature (Arno *et al.*, 2009).

Gelatin has a natural taste and does not have an E additive number. The results of Fiszman *et al.* (1999) demonstrated the suitability of the use of gelatin to improve the quality of milk products. The addition of gelatin to the milk during preparation of the yogurt changed the microstructure of the product by the formation of flat sheets or surfaces which interacted with the casein matrix, enclosing granules of casein in several zones. The gelatin seemed to connect the

granules and chains of milk proteins, and consequently create a continuous, fairly homogeneous double network structure with no free ends. This more interconnected network would retain the aqueous phase more efficiently, reducing the drainage of liquid.

Starch is used in yogurt to increase its viscosity, improve its mouthfeel, and prevent syneresis. It is one of the most frequently used thickening agents in yogurt production due to its ease processing, and low cost when compared with other hydrocolloids (Foss, 2000).

The objective of this work was to use different concentrations of modified starch (1, 1.5 %, w/w) and gelatin (0.025, 0.05 and 0.1%, w/w) with milk protein concentrate (2 and 2.5%, w/w) and pectin (0.05%, w/w) in the production of fat-free concentrated flavored yogurt; then, determine the influence of various concentrations of these additives on textural and sensory characteristics of final product; and compare the properties of experimental samples to each other and control, full-fat concentrated flavored yogurt, for selecting the preference sample.

Preparation of low fat concentrated flavored yogurt samples

The following steps are involved in the production of concentrated yogurt samples:

Standardization of the fat and solids-non-fat contents to 2% and 8.73%, respectively. It was noted that standardization of the milk fat content in the control sample was conducted to 3.5% and homogenized in 180 bar/50°C, cooled to 2-5 °C. Gelatin, MPC, pectin, modified starch (Table 1) were added and mixed to 2-5°C in 5 min (Mixer Seven, 5000 rpm, Turkey), hydrated in 2-5 °C for 1 h. Heat treatment at 50-72°C for 15 min, and then; at 90 °C for 5 minutes. Cooled to 44°C. Inoculated with 2% (w/w) of yogurt culture in a freeze dried direct vat set (DVS). Incubation at 44 °C for 4 h, to pH 4.2. Cooled to the storage temperature, 5 °C. Added vegetables and garlic (0.5%, w/w), salt (0.5%, w/w) (Table 1). Mixed and Packed into 500-g

plastic cups. Flavored concentrated yogurt samples were produced in triplicate, and results were the averages of three replicates. (Table 1)

Physicochemical analyses

Concentrated flavored yogurt samples were analyzed for titratable acidity and dry matter according to Standard AOAC, 2002 and 1995, respectively. Viscosity of concentrated yogurts was measured at 4°C using a Brookfield DV-II+Pro viscometer (Brookfield Engineering Laboratories, USA). The Viscometer was operated at 20 rpm with spindle number 4 after 30s (Cinbas & Yazici, 2008). All analyses were conducted three times, on the 1st day of storage at 5°C.

Textural analyses

Textural properties were measured with a Texture Analyzer (M350-10CT, ROCHDAL ENGLAND, England). Hardness and adhesiveness were evaluated by Yazici and Akgun (2003) method. The measurements were performed three times, on the 1st day of storage at 5°C.

Sensory evaluation

Sensory evaluation was carried out using a five-point hedonic scale (1=very poor, 5= very good) by 5 trained panelists who for texture, stickiness, flavor, odor, mouth feel and overall acceptability of experimental concentrated yogurts.

Statistical analysis

Statistics on a completely randomized design were performed with the analysis of variance (ANOVA) procedure using SAS software (version 9.1; Statistical Analysis System Institute Inc., Cary, NC, USA). Duncan's multiple range tests were used to compare the difference among mean values at the significant level of 0.05 ($p < 0.05$). All experiments were replicated three times.

Results

Acidity of low fat concentrated flavored yogurt samples:

Values of lactic acid production in samples produced

are shown in figure 1. In all treatments, adding modified starch and increasing its content led to decline acidity ($p < 0.05$) (Figure 1).

(T2: S:1. P:2.5 G: 0.025%) , (T1: S:1. P:2.5 G: 0.025%) , (T4: S:1.5 P:2.5 G: 0.05%)
(T3: S:1.5 P:2.5 G: 0.05%) , (T6: S:1.5 P:2.5 G: 0.1%) , (T5: S:1.5 P:2.5 G: 0.1%)
(P:4TC:%) :

Dry matter of low fat concentrated flavored yogurt samples:

Adding fat replacers and increasing their content led to raise dry matter. The lowest and highest dry matter were observed in T1 and T6, respectively (Figure 2).

(T2: S:1. P:2.5 G: 0.025%) , (T1: S:1. P:2.5 G: 0.025%) , (T4: S:1.5 P:2.5 G: 0.05%)
(T3: S:1.5 P:2.5 G: 0.05%) , (T6: S:1.5 P:2.5 G: 0.1%) , (T5: S:1.5 P:2.5 G: 0.1%)
(P:4TC:%) :

Viscosity of concentrated flavored yogurt samples:

As the fat replacers content in yogurt increased, viscosity values increased (Figure 3). The control had higher viscosity than the other samples. The lowest viscosity was observed in T3 (Figure 3).

(T4: S:1. P:2.5 G: 0.025%) , (T3: S:1. P:2.5 G: 0.025%) , (T8: S:1.5 P:2.5 G: 0.05%)
(T7: S:1.5 P:2.5 G: 0.05%) , (T12: S:1.5 P:2.5 G: 0.1%) , (T11: S:1.5 P:2.5 G: 0.1%)
(P:4TC:%) :

Textural properties of fat-free concentrated flavored yogurt samples:

Hardness values were shown in Figure 4. Adding fat replacers and increasing their concentration resulted in increment of hardness ($p < 0.05$). This could be related to enhancement of dry matter content. So, the lowest and highest hardness were observed in T1 and T6, respectively.

(T2: S:1. P:2.5 G: 0.025%) , (T1: S:1. P:2.5 G: 0.025%) , (T4: S:1.5 P:2.5 G: 0.05%)
(T3: S:1.5 P:2.5 G: 0.05%) , (T6: S:1.5 P:2.5 G: 0.1%) , (T5: S:1.5 P:2.5 G: 0.1%)
(P:4TC:%) :

An increase in the concentration of fat replacers induced a significant decrease in adhesiveness ($p < 0.05$). Decreases in adhesiveness appear to be related to the formation of a weak three-dimensional network caused by increasing hydrocolloid concentration. Probably, the high content of gelatin was reflected in the low adhesiveness values for those samples and producing yogurt with soft and very low rubbing texture (Figure 5). The results revealed a

contrary relationship between adhesiveness and hardness. The lowest and highest adhesiveness were observed in T6 and T1, respectively.

(T2: S:1, P:2.5, G: 0.025%) , (T1: S:1, P:2.5, G: 0.025%) , (T4: S:1.5, P:2.5, G: 0.05%)
(T3: S:1.5, P:2.5, G: 0.05%) , (T6: S:1.5, P:2.5, G: 0.1%) , (T5: S:1, P:2.5, G: 0.1%)
(P:4TC:%) ,

Sensory evaluation of concentrated flavored yogurt samples:

Figure 5 shows the organoleptic evaluation of the different treatments of flavored concentrated yogurt. According to results of ranking tests done by sensory panelists, samples containing higher amounts of fat replacer received the highest scores in mouth feel, texture, stickiness, flavor and odor. Panelists did not differentiate overall acceptability ($p>0.05$) between the control, T4 and T6. The average scores for overall acceptability were $4/80 \pm 0.44$, $5/00 \pm 0.00$ and 4.80 ± 0.44 , respectively, for control, T4 and T6. It revealed that these fat replacers within the ranges used can play the role of fat in fat-free concentrated yogurt. (Figure 6).

(T2: S:1, P:2.5, G: 0.025%) , (T1: S:1, P:2.5, G: 0.025%) , (T4: S:1.5, P:2.5, G: 0.05%)
(T3: S:1.5, P:2.5, G: 0.05%) , (T6: S:1.5, P:2.5, G: 0.1%) , (T5: S:1, P:2.5, G: 0.1%)
(P:4TC:%) ,

Discussion and conclusion

The current study showed the beneficial effect of gelatin and wheat fiber on the texture of fat-free concentrated yoghurt.

In all treatments, adding modified starch and increasing its content led to decline acidity ($p<0.05$). Increasing the buffering action of proteins, phosphates, citrate, lactate and other milk components raises the titratable acidity (Tamime and Robinson, 1999). It could be due to high absorption of water by gelatin and modified starch and the water becomes unavailable for starter cultures. For this, it resulted reducing activity of starter cultures (Tamime & Robinson, 1999) and lactic acid production. Gelatin these observations are in line with those of Pradyuman and Mishra (2003), who reported that stabilizer addition increased partially acidity of soy fortified set yogurt.

Table 1. The results of flavored concentrated yogurt samples.

Treatments	Milkproteinconcentrate (%w/w)	Modified starch (%w/w)	Gelatin (%w/w)	Pectin (%w/w)
T3	2.5	1	0.025	0.05
T4	2.5	1.5	0.025	0.05
T7	2.5	1	0.05	0.05
T8	2.5	1.5	0.05	0.05
T11	2.5	1	0.1	0.05
T12	2.5	1.5	0.1	0.05
TC (control)	4	-	-	-

Also Adding fat replacers and increasing their content led to raise dry matter. This result is in agreement with results obtained by Pradyuman and Mishra (2003), who observed type and rate of stabilizer affected significantly dry matter; and Yazici and Akgun (2003), who found that some protein based fat replacers in low fat yogurt led to an increase in dry matter (Figure 2).

As the fat replacers content in yogurt increased, viscosity values increased. Increased viscosity in the low fat samples containing fat replacers can be

explained by the binding of water and improvement in texture (Kumar and Mishra, 2004). Also, the viscosity increase has been attributed to interactions between the exogenous hydrocolloids and dairy proteins (Fernandez-Garcia & McGregor, 1997). The control had higher viscosity than the other samples. It is presumably due to the formation of a larger number of smaller fat particles during homogenisation when they are stabilized by milk proteins and interact with the protein matrix (McCann *et al.*, 2011; Arno *et al.*, 2009; Mandujano *et al.*, 2009). The increased protein content in the control

could be another reason for this.

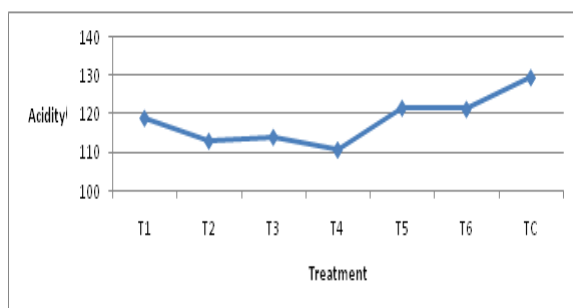


Fig. 1. Compare acidity Concentrated flavored yogurt samples include starch, milk protein concentrate, gelatin and pectin.

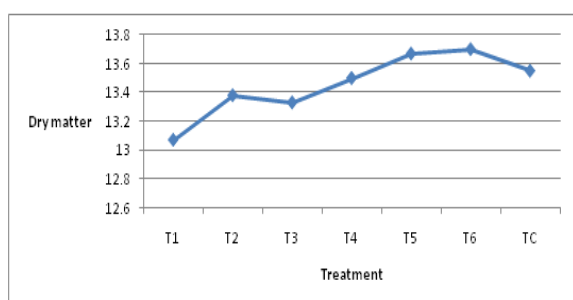


Fig. 2. Compare dry matter concentrated flavored yogurt samples include starch, milk protein concentrate, gelatin and pectin.

Adding fat replacers and increasing their concentration resulted in increment of hardness ($p < 0.05$). This could be related to enhancement of dry matter content. This result is in agreement with results obtained by Radi *et al.*, (2009), who found that wheat starch affected positively firmness of low-fat yogurt. Similar results were also observed by Fiszman *et al.* (1999), who demonstrated positive effect of gelatin on firmness of yogurt and acidified milk, and Pradyuman and Mishra (2003), who demonstrated positive effect of gelatin on soy yogurt.

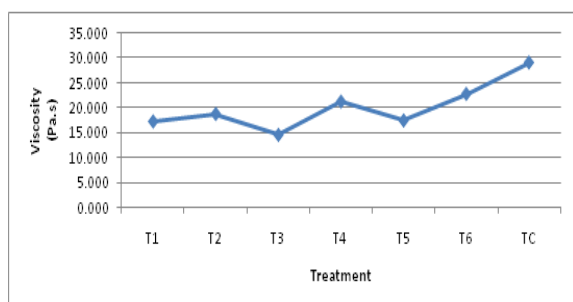


Fig. 3. Compare viscosity concentrated flavored yogurt samples include starch, milk protein concentrate, gelatin and pectin.

According to results of ranking tests done by sensory panelists, samples containing higher amounts of fat replacer received the highest scores in mouth feel, texture, stickiness, flavor and odor. Panelists did not differentiate overall acceptability ($p > 0.05$) between the control, T4 and T6. The average scores for overall acceptability were 4.80 ± 0.44 , 5.00 ± 0.00 and 4.80 ± 0.44 , respectively, for control, T4 and T6. It revealed that these fat replacers within the ranges used can play the role of fat in fat-free concentrated yogurt. This is in accordance with other studies, which have shown that sensory analysis did not detect any difference between yogurt fortified with starch and the control (Pradyuman and Mishra, 2003).

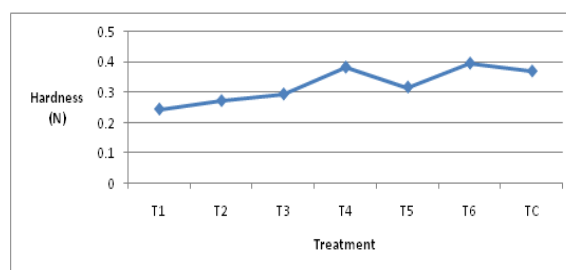


Fig. 4. Compare hardness concentrated flavored yogurt samples include starch, milk protein concentrate, gelatin and pectin.

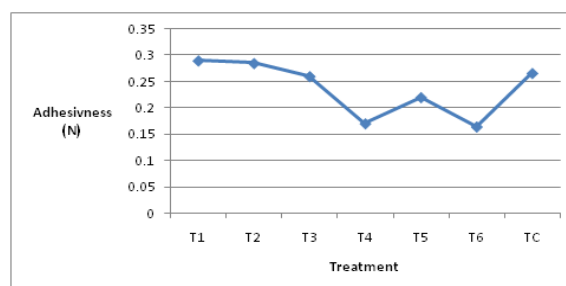


Fig. 5. Compare adhesiveness concentrated flavored yogurt samples include starch, milk protein concentrate, gelatin and pectin.

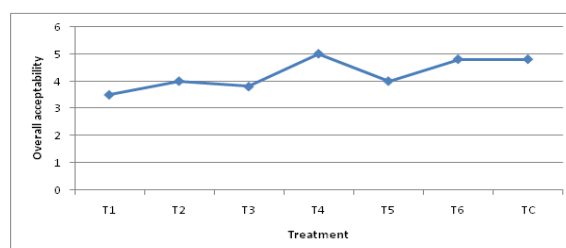


Fig. 6. Compare adhesiveness concentrated flavored yogurt samples include starch, milk protein concentrate, gelatin and pectin.

The fat-free concentrated flavored yogurt incorporation with 0.1% gelatin, 1.5% modified starch, 2.5% milk protein concentrate and 0.05% pectin was ranked the most preferred by panelists. Rheological measurements were performed and flow curves were modelled according to the Herschel–Bulkley rheological model the results showed that it was possible to make a fat-free concentrated flavored yogurt with physicochemical, textural and sensory attributes similar to those in the control, full-fat concentrated flavored yogurt.

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