

Full Length Research Paper

Changes occurring in plain, straining and winter yoghurt during the storage periods

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In this study, winter yoghurt, straining yoghurt and yoghurt samples produced from homogenized and non-homogenized sheep and a mixture of sheep and cows milks were evaluated during the storage periods. Winter yoghurt, straining yoghurt and yoghurt samples were stored in sterile jars in the refrigerator (4°C). Some chemical and physical analyses were made to determine the effect of milk types (cow and sheep), homogenization (homogenized and nonhomogenized) and storage times in winter yoghurt samples on the 3rd, 7th, 15th, 30th, 60th, 90th, 120th, 150th and 180th days, in straining yogurt samples on the 3rd, 7th, 15th, 30th and 60th days and in plain yoghurt samples on 3rd, 7th, 15th and 30th. Contents of the average dry matter, fat, protein, pH, titratable acidity, lipolysis, proteolysis, clot firmness and stickiness in winter yoghurt samples were determined as follows respectively: 23.79, 9.29, 8.99, 3.96, 1.75, 0.72%, 97.91 mM, 9.44 N and 5.50 N. No serum separation existed in winter yoghurts.

Key words: Winter yoghurt, storage, milk type, homogenization.

INTRODUCTION

Yoghurt is a fermented dairy product obtained by lactic acid fermentation of milk by the action of yoghurt starter bacteria and is the most popular product through out the world. The highest production or consumption of yoghurt is in the Mediterranean, Asian countries and central Europe. The origin of yoghurt is not known definitely; however, the historical record says the origin of yoghurt was in the middle East (Tamime and Robinson, 1999). It was firstly made by Turks when they were in middle Asia and it was named as "yogurt" (Tamime and Deeth, 1980). Now, the product has gained an international recognition with this word and many other countries use "yoghurt" (Hayaloğlu et al., 2007).

Its popularity and high consumption is due to its nutritional value and the beneficial effects of yoghurt starter bacteria during the fermentation of milk into yoghurt. The shelf-life of yoghurt is 1 day at 25 to 30°C and 5 days at 7°C or 10 days at 4°C according to the

Turkish standards for plain yoghurt (Hayaloğlu et al., 2007). In spite of its acidic property, it is still prone to spoilage during storage and preservation because of high water content (85%). Therefore, attempts are made to produce different kinds of yoghurt which keep fresh for longer. For keeping quality, elimination of yoghurt whey is one of the most important factors. Traditional and new methods have been used in removing yoghurt whey for the manufacture of strained yoghurt. In the traditional method, yoghurt is strained in a special cloth bag. New methods of ultrafiltration and centrifugation, have recently been employed to produce strained yoghurt (Tamime et al., 1991). Several types of concentrated yoghurt have been produced traditionally in Turkey. They are known as kurut, torba yoghurt, tulum yoghurt, pesküten and winter yoghurt (Özdemir et al., 1995).

Winter yoghurt is one of the most popular varieties of traditional dairy products manufactured in Van (Köse, 2009). This yoghurt is known as "yoghurt cheese" or "salted yoghurt" in the Mediterranean and some regions of Turkey due to the high dry matter content and long shelf life. While no federal standards for winter yoghurt composition exist, small dairy plants as well as consumers

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are concerned with marketing a product with uniformity in composition and functional properties (Güler, 2007; Ocak, 1996).

Similar products are manufactured by different methods in other countries. These products are known as Labneh or Lebneh in the middle east, Leben Zeer in Egypt, Skyr in Iceland, Chakka and Shirkland in India, Than or Tan in Armenia and Ymer in Denmark (Nergiz and Seçkin, 1998).

On the other hand, compositional variations occur during the manufacturing of strained yoghurt. Water-soluble nutrients are especially lost from the cold yoghurt along with the whey. Although, strained yoghurt has been manufactured by the new methods in the industrial plants, consumers have preferred the product prepared by traditional methods for their sensorial properties in Turkey (Nergiz and Seçkin, 1998). In addition to this, strained yoghurt and winter yoghurt has not been manufactured in with industrial plants. In most regions of Turkey, sheep milk is mainly used as part of a mixture of cow milk for production of winter yoghurt, which is one of the most liked traditional dairy products (Köse, 2009).

Most of the sheep milk produced throughout the world is transformed into cheese. Some sheep milk yoghurt is produced in Greece, however, fresh sheep milk is rarely consumed. For this reason, when the quality of sheep milk is referred, its capability to be transformed into high quality dairy products and to produce high yields of these products from each litre of milk is mainly concentrated on. This is often described as the processing performance of the milk (Bencini and Pulina, 1997). As a consequence, the milk of sheep has a higher yield of dairy products than the milk of cows and goats because it has higher concentrations of protein, fat and total solids (Anifantakis, 1990). So, in eastern Anatolia, winter yoghurt and strained yoghurt are produced from sheep milk. When sheep milk is not enough, a mixture of cow and sheep milk was evaluated together.

Although, several articles pertaining to chemical composition, physical properties and preparation of straining yoghurt and yoghurt samples have been published, winter yoghurt has not been available from the literature. Therefore, the objective of this study was, to obtain information on chemical and physical properties during the storage period of winter yoghurt, straining yoghurt and plain yoghurt samples which are produced from homogenized and non-homogenized sheep and mixture of sheep and cows milks.

MATERIALS AND METHODS

Milk samples

Whole cow and sheep milks were collected from Alaköy village in Van province in the first week of September, which refers to the beginning of late lactation stage. The sheep and cows were milked by hand twice a day, morning and evening and then, milk was mixed for yoghurt production. Morning milk was taken and then, the

experimental yoghurts were manufactured.

Starter culture

A commercial mixed of concentrated freeze-dried yoghurt starter culture was obtained from DSM food specialities dairy ingredients, in the Netherlands. The starter was a blend of *Streptococcus salivarius* spp., *thermophilus* and *Lactobacillus delbrueckii* spp. and *Bulgaricus* at a rate of 1:1. Milk was pasteurized at 90°C for 10 min and cooled at 43°C; from this culture a little was taken and inoculated into the milk, and was then incubated at 43°C.

Production of yoghurts

Winter yoghurt, strained yoghurt and plain yoghurt samples were made by a traditional method in the laboratory. 10 different yoghurt samples (2 plain yoghurt, 4 strained yoghurt and 4 winter yoghurt) were made; five of them were made from sheep milk and five of them were made from the mixture of cow (50%) and sheep milk (50%). In the production of plain yoghurt, half of the milk was heated to 55°C and was homogenized (200 kgf/cm²) and then, all milk samples (sheep milk and mixtures of cow and sheep milks) were heated at 90°C for 10 min, cooled at 43 to 44°C and inoculated with 1 to 3% starter culture as described earlier. The milk was incubated until the acidity reached pH 4.7 at 43°C. After fermentation, the coagulum were cooled to room temperature (21°C) and stored in a refrigerator at 4°C for 12 h. Yoghurt samples were transferred into bottles and stored in refrigerators until analysed. Then, fermented milk was mixed and transferred into a cotton American cloth bags in order to drain the serum at 4°C for 12 h. Then, it was packaged into bottles and some of them stored at 4°C until analysed. The other strained yoghurts were taken and melted margarine was transferred onto this yoghurt. The winter yoghurt samples were stored at 4°C until analysed.

Chemical analysis

The dry matter, titratable acidity and total protein were determined according to the association of official analytical chemists methods (AOAC, 1990). The fat content of the yoghurt samples was measured by the Gerber method described by Case et al. (1985). pH was determined by a pH meter (Hanna Instrument pH 211; Microprocessor pH meter, Germany) equipped with an electrode (H1 1131, Germany) (Kosikowski, 1982). All measurements were duplicated.

Determination of lipolysis

Lipolysis was measured as acid degree value (ADV). For this test, 10 g of finely ground sample was placed in a lipolysis butyrometer. 20 ml of BDI reagent (30 g triton x-100 70 g sodium tetra phosphate in 1 L distilled water) was added and the butyrometers were placed in a boiling water bath for 20 min to extract the fat. The mixture was centrifuged for 1 min and enough aqueous methanol was added to bring the fat into the neck of the butyrometer and was centrifuged for another 1 min. Then, the fraction of liquid fat was transferred into a 50 ml glass and weighed. 5 ml fat solvent (4:1 petroleum ether and n-propanal) was added to the flask. This was titrated with 0.01 N tetra n-butyl ammonium hydroxide and total free fatty were calculated (International Dairy Federation, IDF, 1991).

Determination of proteolysis

Yoghurt (1 g) was dispersed in 20 ml borate buffer (0.1 M Na₂B₄O₇

Table 1. Changes occurring in winter yoghurt samples during the storage periods.

Impact factor	Factor description	N	Dry matter(%)	Fat (%)	Protein (%)	pH	Titrateable acidity (%)	ADV	Proteolysis (mM)	Firmness (N)	Stickiness (N)
Storage times (days)	3	8	24.40 ^b	9.35 ^b	9.65 ^a	3.99 ^d	1.50 ^g	0.50 ^e	32.95 ^h	8.94 ^d	6.22 ^{ab}
	7	8	23.63 ^{de}	9.38 ^b	9.02 ^b	3.96 ^e	1.72 ^e	0.53 ^e	40.57 ^g	9.72 ^c	4.36 ^d
	15	8	23.93 ^{cd}	9.05 ^b	9.09 ^b	3.96 ^e	1.67 ^f	0.60 ^d	51.05 ^f	9.59 ^c	5.13 ^{cd}
	30	8	24.01 ^c	9.15 ^b	9.07 ^b	3.92 ^f	1.67 ^f	0.77 ^b	60.41 ^e	10.82 ^b	6.75 ^a
	60	8	23.98 ^c	9.81 ^a	9.32 ^b	3.96 ^e	1.92 ^a	0.89 ^a	102.96 ^d	9.39 ^c	4.49 ^d
	90	8	23.85 ^{cde}	9.16 ^b	8.60 ^c	4.10 ^a	1.77 ^d	0.66 ^c	149.13 ^{ab}	7.48 ^f	5.76 ^{bc}
	120	8	23.66 ^{de}	9.20 ^b	8.14 ^d	4.03 ^b	1.84 ^{bc}	0.86 ^a	144.84 ^c	8.18 ^e	6.58 ^a
	150	8	23.59 ^e	9.15 ^b	8.55 ^c	4.00 ^c	1.83 ^c	0.90 ^a	151.66 ^a	8.86 ^d	4.69 ^d
	180	8	24.99 ^a	9.40 ^b	9.49 ^a	3.76 ^g	1.87 ^b	0.80 ^b	147.64 ^{bc}	11.95 ^a	5.53 ^{bc}
Types of milk	A	36	24.57 ^a	9.19 ^b	9.60 ^a	3.98 ^a	1.80 ^a	0.74 ^a	97.72 ^a	11.08 ^a	5.87 ^a
	B	36	23.44 ^b	9.39 ^a	8.38 ^b	3.95 ^b	1.71 ^b	0.71 ^b	98.10 ^a	7.80 ^b	5.13 ^b
Homogenization pressure	0	36	24.17 ^a	9.48 ^a	9.22 ^a	3.97 ^a	1.69 ^b	0.57 ^b	91.85 ^b	7.68 ^b	4.80 ^b
	200	36	23.84 ^b	9.11 ^b	8.76 ^b	3.96 ^a	1.82 ^a	0.88 ^a	103.97 ^a	11.20 ^a	6.20 ^a
General average		72	23.79	9.29	8.99	3.96	1.75	0.72	97.91	9.44	5.50

ADV, acid degree value; N, nitrogen.

in 0.1 M NaOH , pH 9.5) warmed at 45°C for 15 min with stirring and centrifuged at 3000 x g for 20 min. A portion (6 ml) of the supernatant was diluted to 100 ml with distilled water. From this extract, a portion (0.5 ml) was added to 0.5 ml of borate buffer and TNBS reagent (1 ml; 1 mg/ml) was added. After thorough mixing, the solution was incubated at 37°C for 60 min. Blanks were pre-prepared with 0.5 ml of H₂O instead of yoghurt extract. The reaction was stopped by adding 2 ml of 0.1 M NaH₂PO₄ containing 1.5 mM Na₂SO₃ and the absorbance at 420 nm was measured. When necessary, the blank value was subtracted from those of the samples (Polychroniadou, 1988) .

Texture analysis

Firmness and stickiness of yoghurt samples clots, were analysed. Texture features was determined using texture analyzer (TA.XT2 analyzer, Texture Technologies Corp., Scarsdale, NY / Stable Microsystems, Godalming, UK model). Measurement of the "back extrusion cell" and 5 kg "load cell" was used. 1 mm/s speed and distance of 10 mm

was built in the branches. Texture results was analyzed using expert exceed version 2V3 (Stable Micro Systems, 1998) (Fizman et al., 2000; Haque et al., 2001).

Statistical analysis

Statistical analysis of data for effects of three factors on dry matter, fat, pH, acidity, lipolysis, proteolysis, firmness, stickiness and serum separation were performed using SPSS computer program (Version 11.0). The factors were storage times (1, 7, 15, 30, 60, 90, 120, 150, 180 days), type of milk (sheep and mixture of sheep and cows milk) and homogenization pressure (homogenized and non-homogenized). The mean differences were analyzed using Duncan's multiple-range test (SPSS, 1998).

RESULTS AND DISCUSSION

Plain yoghurt, strained yoghurt and winter yoghurts

were analyzed for dry matter, total protein, fat, pH, titrateable acidity, lipolysis, proteolysis, clot firmness and stickiness. The results are given in Table 1.

Winter yoghurt had the highest dry matter in the yoghurt samples. Also, winter yoghurt, straining yoghurt and plain yoghurt samples produced from sheep milk had higher dry matter values than those produced from mixtures of sheep and cows milk. The dry matter value of winter yoghurts at the end of the storage period was 24.99% and this value was higher than those found in winter yoghurts (Ocak, 1996) and salted yoghurts (Say, 2001) and lower than that found in tulum yoghurt (Yaygın, 1998).

Storage time, type of milk and homogenization had a significant effect on the fat contents of the samples (P < 0.01). The average fat value was

6.34% for normal yoghurts, 9.21% for strained yoghurt and 9.29% for winter yoghurts. The mean fat content of the winter yoghurt was higher than that reported by Ocak (1996) and was similar to that found by Tamime and Robinson (1978) and generally, higher than those reported in literatures.

Storage times, types of milk and homogenization had significant effect on the protein contents of the samples ($P < 0.01$). According to the findings obtained from the homogenized milk of winter yoghurt and straining yoghurt samples, protein contents were higher than those from non-homogenized milk. Protein levels of samples at the 7, 15, 30, 60, 90, 120, 150 and 180th day were not significantly different, but all were significantly lower than the samples at the 3rd day. Except for yoghurt samples at the 3rd day, protein contents of all the samples did not change throughout storage. The average protein content of 8.99% in the winter yoghurts was lower than that found in winter yoghurts by Gönç and Oktar (1973) and in labneh by Salji et al. (1983) and generally, lower than those reported in this work.

The pH values of yoghurt samples significantly decreased throughout storage. However, winter and strained yoghurt samples showed an irregular change throughout storage. The average pH value was 3.99 for winter yoghurts on the first day and 3.76 at the end of the storage period. The average pH values of winter yoghurts was 3.96 and this value is similar to that found in labneh (Salji et al., 1983), lower than that found in winter yoghurts (Ocak, 1996) and higher than that found in salted yoghurts (Şahan and Say, 1998).

The titratable acidity values of winter and strained yoghurt samples showed an irregular change throughout storage. Winter yoghurt, straining yoghurt and plain yoghurt samples produced from sheep milk had higher acidity than that produced from a mixture of sheep and cows milk (Table 1). The average titratable acidity value of winter yoghurt samples was similar to that found in the strained yoghurt (Seçkin and Nergiz, 1997) and lower than that found in the labneh (Salji et al., 1983) and tulum yoghurt (Yaygın, 1998).

Storage time, types of milk and homogenization had a significant effect on the lipolysis levels of the samples ($p < 0.01$). Winter yoghurt and strain-ing yoghurt samples produced from sheep milk had higher lipolysis values than that produced from a mixture of sheep and cow milk. According to the findings obtained from the homogenized milk of winter yoghurt and straining yoghurt samples, lipolysis values were higher than those of non-homogenized milk. The average ADV content of winter yoghurt was higher than that of strained yoghurt ($0.72 > 0.67$). In general, ADV values increased which was depended on the increase of acidity in yoghurt samples.

Table 1 shows the proteolysis contents of the winter yoghurt. Storage times, types of milk and homogenization had a significant effect on the proteolysis levels of the strained and plain yoghurt samples ($p < 0.01$). Storage time and homogenization had significant effect on the

proteolysis levels of winter yoghurt ($p < 0.01$). Proteolysis of the winter yoghurts were higher than those of strained and plain yoghurts. Proteolysis values of strained and plain yoghurt samples increased during the storage period. The average proteolysis value of winter yoghurts was found to be 97.91 mM, straining yoghurt was 0.67 mM, and plain yoghurt was 49.59 mM. There were no literatures to compare with the yoghurt samples in terms of proteolysis values.

The firmness values of winter yoghurts increased until the 30th day and decreased from the 30th until the 90th days. After the 90th day, the firmness of winter yoghurt samples increased again throughout storage. Generally, samples of higher acidity had more firmness.

According to the findings obtained from the homogenized milk of winter yoghurt and strained yoghurt samples, stickiness values were higher than those of non-homogenized milk. Winter yoghurt, strained yoghurt and plain yoghurt samples produced from sheep milk had higher stickiness values than those produced from a mixture of sheep and cows milks. Winter and strained yoghurt samples showed an irregular change throughout storage.

No serum separation was observed during the storage in the samples of winter yoghurt and this situation had been previously shown by Atamer et al. (1988) and Seçkin and Nergiz (1997) for strained yoghurts, which is comparable as their manufacturing processes are very similar. In addition, the amount of serum separation decreased during the storage in plain yoghurt samples, which is similar to what had been reported (Korkmaz, 2005).

Conclusion

According to the findings obtained from the homogenization milk of winter yoghurt and strained yoghurt samples, dry matter, fat, acidity, lipolysis, proteolysis and stickiness values were higher than those made from non-homogenization milk. Winter yoghurt, strained yoghurt and yoghurt samples produced from sheep milk had higher dry matter, ash, acidity, pH, consistence, stickiness and proteolysis values than those produced from a mixture of sheep and cows milks.

As a result, winter yoghurt prepared by straining yoghurt with no additives maintained freshness long enough. In addition, winter yoghurt prepared from sheep and cow milks mixture increased yield.

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