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RESEARCH ARTICLE

Effects of Starter Culture Types and Different Temperatures Treatments on Physicochemical, Microbiological and Sensory Characteristics, and Fattty Acid Compositions of Çökelek Cheese Made from Goat Milk

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Summary

Çökelek cheese produced with heated, filtrated and salted yogurt is a traditional cheese belong to Turkey. In this study, Çökelek cheeses were produced from the coagulums prepared by using cultures including *Lactobacillus helveticus*, yogurt culture or the mixture of *Lb. helveticus* and yogurt cultures (1:1). The Çökelek cheeses produced with the cultures were prepared after heating of the coagulums at two different temperatures, 85ºC or 95ºC for 30 min. The produced Çökelek cheeses were stored at 4ºC for 45 days. Therefore, in the Çökelek cheese production, using of *Lb. helveticus* (as a single or mix with yogurt starter cultures) as starter culture and heating at 85ºC may be proposed.

Keywords: *Çökelek cheese, Lactobacillus helveticus, Yogurt starter cultures, Goat milk*

Keçi Sütünden Üretilen Çökelek Peynirinin Fizikokimyasal, Mikrobiyolojik ve Duyusal Özellikleri ile Yağ Asidi Kompozisyonu Üzerine, Laktik Starter Kültür Tipi ve Farklı Sıcaklık Uygulamanın Etkisi

Özet

Çökelek peyniri, ısıl işlem uygulanıp, süzülen ve tuzlanmış yoğurttan yapılan Türkiye'ye özgü geleneksel bir peynirdir. Bu çalışmada, Çökelek peynirleri, kültür olarak (1) *Lactobacillus helveticus,* (2) yoğurt kültürü veya (3) *Lb. helveticus* ve yoğurt kültürü karışımlarının (1:1) eklendiği süt pıhtılarından üretilmiştir. Çökelek peynirleri, belirtilen kültürlerle elde edilen pıhtılarından 85ºC veya 95ºC'lik iki farklı sıcaklıkta ısıtılmasından sonra elde edilmiştir. Üretilen Çökelek peynirleri 4ºC'de 45 gün depolanmıştır. Sonuç olarak, çökelek peyniri üretiminde starter kültür olarak *Lb. helveticus*'un kullanımı (yoğurt bakterileri ile tek veya karışık olarak) ve 85ºC' lik ısıl işlem önerilebilir.

Anahtar sözcükler: *Çökelek peyniri, Lactobacillus helveticus, Yoğurt starter kültürleri, Keçi sütü*

INTRODUCTION

The dairy products produced from by yogurt such as yayik butter, tarhana and Çökelek cheese are very popular products in the Middle East where they are used in the preparation of some popular food dishes. Çökelek cheese is produced by heating of yogurts and then straining in a special cloth bag. It has been made from cow, goat milk and ewe milk for a long time. The goat milk production ranks third in the world after cattle and buffalo milk production. In the developing countries, dairy goat farming has an increasing important. Goat milks are very important for flavor and quality of Çökelek cheese [1].

Yogurt bacteria and *Lactobacillus helveticus* are homofermentative thermophilic lactic acid bacteria widely used

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in the dairy technology. In particular, yogurt bacteria is used in yogurt production [2]. Additionally *Lb. helveticus* being of highly proteolytic activity is used as primary natural whey starter for the manufacture of some Swiss and Italian cheese varieties [3-5]. Also *Lb. helveticus* can be used as starter culture in a variety of fermented dairy products and as a non-starter flavour enhancer, being capable of reducing bitterness and accelerating cheese flavour development [6-9].

The main role of lactic acid bacteria used as starter during cheese production is the production of lactic acid through metabolism of lactose. This action improves the milk coagulation process, makes the curd stronger and protects the final product against contamination. Furthermore, glycolysis, proteolysis and lipolysis produced by the enzymes of lactic acid bacteria contribute to the flavour development of the cheeses during the ripening process [10].

Heat has a great effect on proteins. Apart from denaturation, heat-induced chemical reactions involving amino acid residues can significantly alter protein properties. Such heat-induced chemical changes have not been characterized quantitatively so far [11].

Traditionally, in the production of Çökelek cheese does not use starter culture. However, thermophilic yogurt cultures can grow aroma and can be alive during the heating process if Çökelek cheese is produced from yogurt.

The aim of this study was to determine the suitable starter culture and heating temperature combination to produce better Çökelek cheese. For the reason, goat milk and thermophil cultures were selected for Çökelek cheese production. Thermophilic cultures including *Lb. helveticus* and yogurt bacteria are more heat stabile than other lactic starter cultures [12]. Additionally *Lb. helveticus* has high proteolytic activity and it is a bacterium fast aroma-grown. Çökelek cheeses produced by using different starter cultures and two different temperatures were examined in respect of their physicochemical and microbiological properties, protein fractions, FFAs (free fatty acids), sensory properties during their ripening period. Additionally we added to the milk used in Çökelek cheese yogurt cultures and/or *Lb. helveticus* as thermophilic starter cultures.

MATERIAL and METHODS

Çökelek Cheese Production

Çökelek cheeses were produced in Ün-Süt Dairy Plant of Suleyman Demirel University. In yogurt production, the method proposed by Tamime and Robinson [13] was followed with the exception that the homogenization and solid standardization stages were ignored. Firstly, goat milk was analyzed for physicochemical, microbiological and sensorial properties and fatty acid compositions. Then, goat milk was standardized to 1.5±0.2% fat and heated up to 95°C with gentle stirring and kept at this temperature for 5 min. (the first pasteurization), followed by cooling to 42-45°C. The pasteurized milk was divided into three groups. Each group was inoculated with a yogurt culture (Y) (Yo-mix 502, Gemak-Danisco, Ankara, Turkey), *Lb. helveticus* (H) (LH-B02, Peyma-Chr. Hansen, Istanbul, Turkey) or mixture culture (M) of these (1:1) at a rate of 3% (w/w) ratio. These groups were incubated at 42-45°C until pH 4.6 and then cooled down to 4°C. After overnight refrigeration, the coagulums were manually stirred and then were heated up 85°C and 95°C for 30 min (the second pasteurization). In this respect, six treatment groups including control group were studied in this study: (1) Y95 (Control), (2) Y85, (3) H95, (4) H85, (5) M95, (6) M85 (Traditional Çökelek cheese usually made with yogurt bacteria. Then, yogurt is heated at high temperature. Therefore, the Y95 samples were evaluated as a control group in this study).

All of these treatment coagulums were cooled down to 25°C and then, poured into a layer cheese cloth bag. A drainage procedure was accomplished in a temperature controlled room, set at 25°C. Çökelek cheese treatments were filled into the containers, salted with 1% salt and mixed gently to achieve homogeneity. Obtained Çökelek cheeses treatment groups were packaged as the lots weighing 500 g. and stored at 4°C for 45 days until analysis. Çökelek cheese is a fresh cheese consumed, although the duration of 45 days for sensorial, microbiological and chemical changes that occur in the content of fatty acids stored in order to observe.

Physicochemical Analyses

The titratable acidity (TA, as lactic acid %, acidity of milk - AOAC Official Method 947.05), total solid (TS%, AOAC Official Method 990.20) was determined as outlined by AOAC methods [14,15]. Fat (%) of the raw milk was determined using the method of James [12]. pH values were measured using a HANNA pH meter (HANNA Instruments, Padova, Italy). Percentage of NaCl and fat of cheese was determined using the method of James [16]. NaCl content was expressed as salt concentration. Moisture contents of cheese were determined by AOAC methods (Official Method 926.08) [17]. Total nitrogen (TN) and water-soluble nitrogen (WSN) levels were determined according to the method of Grippon et al.[18]. Protein content was calculated by multiplication of TN content with 6.38. Ripening index of Çökelek cheese samples were calculated using following equation:

Ripening index (%) = (WSN/TN) ×100

Analysis of Fatty Acids

Fatty acid composition was determined using a modified fatty acid methyl ester method as described by Marquard [19]. The oil was extracted from 10 g sample by homogenisation with hexane. The reactive was 500 ml of total Na-metaoxid (0.5 g), isooctane (20 ml) and methanol (80 ml) added to the oil (50 µl). Isooctane (500 µl) was added

into the sample following waiting overnight. The fatty acids methyl esters were analyzed in a Hewlett-Packard 6890 series gas chromatograph (Perkin Elmer Auto System XL, San Jose, CA, USA) equipped with a flame ionizing detector (FID), a fused silica capillary column Cp SIL 88, 100 m × 0.25 mm i.d., film thickness 0.2 µm (Chrompack Inc, Bridgewater, NJ,USA). It was operated under the following conditions: oven temperature program, 60°C for 4 min. raised to 175°C at a rate of 13°C·min^{-1} and than kept at 175°C for 27 min; than at 215°C for 5 min. and raising to 240°C at a rate of 4°C·min^{-1} and then kept at 240°C for 15 min injector and detector temperatures, respectively. Carrier gas was helium at flow rate of 15 cm·s^{-1}; split ratio, 1/10 ml·min^{-1}. The contents of palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acids were determined by computing integrator.

Determination of Lactic Acid Bacteria

Streptococcus thermophilus and lactobacilli were enumerated on M17 and MRS agars (Merck, Darmstadt, Germany), respectively, using the pour plate method with incubation at 30°C for 3 days [20,21]. Results were expressed as log cfu g^{-1}.

Sensorial Analysis

Çökelek cheeses were tested by a panel of 25 panelists familiar with cheese grading. They scored the cheeses for appearance (9 points), flavour (9 points), odour (9 points) and texture (9 points). The hedonic scale of 9 points was used (1 = dislike extremely; 5 = neither like nor dislike; 9 = like extremely). The panelists were provided with unsalted crackers and mineral water to rinse their palates when necessary. The panelists were asked to evaluate these cheeses and to record any unexpected or unpleasant flavour defects and total score [22].

Statistical Analyses

Analyses of variance for bacterial counts after a log transformation was performed on data obtained at different stages of production. Chemical, microbiological, fatty acids and organoleptic characteristics of the Çökelek samples were subjected to analyses of variance (one-way) using multivariate test using SPSS 15.0 Statistic Package (SPSS, Chicago, Illinois, USA). Statistical significance level was taken as 95%.

RESULTS

The pH, TA (%), TS (%), fat (%), density (g ml^{-1}) and protein (%) of the raw goat milk used in this study were as follows: 6.76±0.46, 0.19±0.01, 13.16±0.25, 3.37±0.49, 1.033±0.00 and 3.18±0.03, respectively.

Yield of cheese is basically important to cheese manufacturers to get large sums of money or profit. The yield values of Çökelek cheese treatment groups; Y95, Y85, M95, M85, H95 and H85 were found as 27.29%, 27.43%, 28.15%, 25.37%, 28.96% and 25.91%, respectively. Generally, the yield of Çökelek cheeses heated at 95 °C was higher than those of cheese heated at 85°C (except Y95 and Y85 samples), which was thought to be due to the whey proteins, being effective on yield of cheese in heating process at 95°C.

The physicochemical characteristics of Çökelek cheeses during the storage period are presented in *Table 1*. The pH value of the control sample (4.30±0.48) was higher than those of the other samples and the titratable acidity levels of the Çökelek samples ranged from 2.23 - 2.45% in the 45th day. During the ripening period, titratable acidity increased in each treatment groups. Reason for this increase during storage, the products formed as a result of microbial and enzymatic activity may be due to the acidic character. The total solid, fat, NaCl varied between 25.87% and 28.98%, 4.08% and 5.50%, and 1.64% and 1.83%, respectively. The total solid value of M85 samples was statistically different from others on first days and 15th days. In addition, this value of H95 significantly higher than other samples was identified in 45th day. In general, total solid values of the Çökelek cheese heated at 95°C were higher than those of the others.

Lb. helveticus and secondary pasteurization process applied to the product may have an effect on TS%. The TN% and WSN% increased throughout the ripening period. The ripening indices were determined as 13.59% -20.00% in the all samples. The ripening index of the Çökelek cheese produced with yogurt cultures (85°C) was the highest. In this regard, proteolytic activity of lactic acid bacteria used as starter cultures are thought to have played an effective role. In our study, high temperature led to reduction of bacterial content, this reduction has been effective in reducing the content of the enzymes. TS%, TN%, WSN% or % ripening indexes (RI) were statistically significant among groups for each parameter during storage ($P<0.05$).

Both lactococci and lactobacilli counts increased in the all samples during the storage period. While the log counts of lactococci were determined between 2.86 and 3.03, those of lactobacilli to ranged from 3.60-4.33 during the storage period *(Table 1)*. The differences between the log counts of lactococci and lactobacilli in the Çökelek cheeses were found significant for each lactic acid bacteria group during storage ($P<0.05$).

The fatty acid compositions of Çökelek cheeses are presented in *Table 2*. SFA contents in the treatment groups - (Y95, 85, M95, M85, H95, and H85) were 65.70, 66.88, 68.70, 67.62, 67.48 and 65.92 in the 45th day of storage, respectively. The lowest SFA content was in the control group. The myristic acid level of control cheese (9.56%) was the highest, while palmitic acid level of the sample made with yogurt cultures at 85°C (28.05%) was the highest.

Table 1. *Chemical and microbiological (log cfu g^{-1}) values detected in Cokelek cheeses*
Tablo 1. *Çökelek peynirinde saptanan kimyasal ve mikrobiyolojik (log kob g^{-1}) değerler*

Storage Time	No	pH*		TA* [%]		TS** [%]		Fat* [%]		Fat/TS* [%]		NaCl* [%]		NaCl/TS* [%]		WSN** [%]		TN** [%]		RI** [%]		Lactic Acid Bacteria (log cfu g^{-1})			
																						Streptococcus thermophilus **		Lactobacilli **	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
First day	Y95:C	4.34	0.48	2.30	0.10	27.15^{ab}	1.51	5.33	0.58	19.61	1.06	1.64	0.00	6.04	0.33	0.19^{fg}	0.04	2.19^{a}	0.04	8.52^{gh}	1.73	1.36^{gh}	0.25	2.53^{e-h}	0.20
	Y85	4.37	0.50	2.32	0.05	26.63^{ab}	1.20	5.50	0.25	20.68	1.33	1.64	0.00	6.16	0.27	0.15^{g}	0.01	2.05^{bc}	0.02	7.17^{h}	0.52	1.66^{e-h}	0.20	2.56^{e-h}	0.25
	M95	4.40	0.37	2.16	0.09	26.61^{ab}	0.16	5.25	0.25	19.73	1.00	1.64	0.12	6.16	0.48	0.14^{g}	0.03	2.10^{abc}	0.04	6.79^{h}	1.41	1.73^{e-h}	0.11	2.43^{fgh}	0.35
	M85	4.31	0.30	2.13	0.08	25.87^{b}	0.62	5.33	0.58	20.59	1.81	1.68	0.07	7.20	1.11	0.15^{g}	0.01	2.10^{abc}	0.05	6.99^{h}	0.61	1.43^{fgh}	0.30	2.20^{h}	0.26
	H95	4.40	0.24	2.21	0.29	27.08^{ab}	0.82	5.50	0.00	20.32	0.62	1.68	0.18	6.18	0.48	0.21^{fg}	0.02	2.09^{abc}	0.02	10.02^{gh}	0.77	1.30^{h}	0.10	2.30^{g-h}	0.30
	H85	4.38	0.17	2.20	0.32	26.38^{ab}	0.56	5.17	0.29	19.57	0.73	1.76	0.12	7.45	1.02	0.23^{ef}	0.02	2.09^{abc}	0.05	10.93^{fg}	0.71	1.73^{e-h}	0.11	2.33^{g-h}	0.28
15th day	Y95:C	4.29	0.60	2.42	0.16	27.15^{ab}	1.51	5.25	0.66	19.29	1.33	1.76	0.12	6.48	0.63	0.32^{cd}	0.03	2.17^{ab}	0.09	14.80^{cde}	1.45	1.96^{c-e}	0.25	3.36^{bcd}	0.35
	Y85	3.93	0.11	2.39	0.15	26.63^{ab}	1.20	5.17	0.38	19.39	0.98	1.68	0.14	6.30	0.45	0.40^{ab}	0.06	2.07^{abc}	0.03	19.30^{ab}	2.61	2.33^{bcd}	0.41	3.23^{cde}	0.25
	M95	4.03	0.04	2.34	0.16	26.61^{ab}	0.16	5.08	0.52	19.10	1.88	1.68	0.07	6.30	0.26	0.25^{ef}	0.02	2.09^{abc}	0.04	11.70^{efg}	0.58	2.46^{abc}	0.05	3.16^{c-f}	0.40
	M85	4.01	0.09	2.33	0.16	25.87^{b}	0.62	5.17	0.72	19.94	2.37	1.79	0.14	6.94	0.56	0.33^{cd}	0.03	2.02^{c}	0.05	16.10^{bcd}	1.68	2.10^{cde}	0.36	2.86^{d-h}	0.23
	H95	4.09	0.19	2.32	0.22	27.08^{ab}	0.82	5.00	0.66	18.52	2.95	1.72	0.07	6.35	0.42	0.29^{de}	0.02	2.03^{bc}	0.05	14.30^{cde}	1.39	1.86^{d-g}	0.05	2.93^{d-h}	0.32
	H85	4.05	0.26	2.31	0.27	26.38^{ab}	0.56	5.08	0.76	19.23	2.51	1.79	0.18	6.79	0.53	0.32^{cd}	0.02	2.08^{abc}	0.04	15.25^{cd}	1.36	2.46^{abc}	0.11	2.96^{d-g}	0.20
45th day	Y95:C	4.30	0.48	2.40	0.04	27.78^{ab}	2.21	4.33	0.95	15.78	4.34	1.83	0.07	5.97	0.71	0.34^{bcd}	0.02	2.20^{a}	0.12	15.71^{cd}	1.85	2.86^{ab}	0.25	4.33^{a}	0.41
	Y85	4.23	0.48	2.45	0.17	27.69^{ab}	0.98	4.25	1.15	15.42	4.43	1.79	0.14	6.63	0.69	0.43^{a}	0.03	2.15^{abc}	0.06	20.00^{a}	1.17	3.03^{a}	0.35	4.23^{a}	0.20
	M95	4.26	0.39	2.30	0.07	27.33^{ab}	0.04	4.08	0.52	14.94	1.93	1.83	0.07	6.23	0.26	0.29^{de}	0.03	2.11^{abc}	0.06	13.60^{def}	1.16	3.00^{a}	0.00	4.06^{ab}	0.46
	M85	4.20	0.32	2.23	0.11	27.47^{ab}	1.16	4.17	0.58	15.13	1.52	1.79	0.00	6.71	0.26	0.36^{abc}	0.03	2.10^{abc}	0.12	17.30^{abc}	1.69	2.86^{ab}	0.30	3.76^{abc}	0.15
	H95	4.29	0.39	2.31	0.24	28.98^{a}	0.85	4.75	0.43	16.37	1.16	1.83	0.07	6.02	0.14	0.36^{abc}	0.03	2.08^{abc}	0.02	17.60^{abc}	1.37	2.50^{abc}	0.10	3.60^{a-d}	0.26
	H85	4.23	0.44	2.40	0.34	27.56^{ab}	0.42	4.25	0.75	15.44	2.86	1.78	0.14	6.32	0.57	0.40^{ab}	0.02	2.09^{abc}	0.07	19.10^{ab}	0.66	3.03^{a}	0.11	3.76^{abc}	0.30

M - arithmetical mean, SD – standard deviation. Means in the same column with different letters show statistically significant differences
* statistically not significant different P>0.05, ** statistically significant different P<0.05
C - Control, Y85 and Y95 - inoculated with yogurt culture, and heated at 85°C and 95°C, respectively; M85 and M95 - inoculated with yogurt culture + Lb. helveticus (1:1), and heated at 85°C and 95°C, respectively; H85 and H95: inoculated with Lb. helveticus, and heated at 85°C and 95°C, respectively
TA - titratable acidity, TS - total solids, TN - total nitrogen, WSN - water-soluble nitrogen, RI-Ripening Index

Table 2. *Fatty acid values detected in Cokelek cheeses*
Tablo 2. *Çökelek peynirlerinde saptanan yağ asidi değerleri*

Fatty Acids (%)	First Day						45th Day					
	Y95: C	Y85	M95	M85	H95	H85	Y95: C	Y85	M95	M85	H95	H85
SFA	67.46	68.42	67.49	75.93	70.10	69.87	65.7	66.88	68.70	67.62	67.48	65.92
$C_{4:0}$	1.00	1.55	1.08	3.12	1.70	1.76	1.75	1.01	1.17	1.48	1.34	0.93
$C_{6:0}$	0.94	1.46	1.13	2.90	1.50	1.60	1.99	1.15	1.68	1.66	1.78	0.99
$C_{8:0}$	1.36	1.93	1.50	3.68	1.92	1.94	2.53	1.25	1.80	1.86	1.52	1.07
$C_{10:0}$	6.62	7.36	6.94	12.76	8.18	7.50	1.98	4.59	5.85	5.50	4.69	3.93
$C_{12:0}$	3.43	3.18	3.49	4.77	3.86	3.54	3.71	2.37	2.42	2.26	2.14	1.99
$C_{14:0}$	9.78	8.92	9.57	10.12	9.96	9.62	9.56	8.20	7.40	7.28	7.46	7.23
$C_{16:0}$	27.09	26.46	26.61	23.59	26.44	26.66	26.62	28.05	26.41	26.24	27.03	27.45
$C_{17:0}$	0.35	0.31	0.36	0.14	0.32	0.34	0.72	0.75	0.96	1.08	0.74	0.84
$C_{18:0}$	16.89	17.25	16.81	13.85	16.22	16.91	16.84	19.51	21.01	20.26	20.78	21.43
TUFA	24.25	23.55	23.81	18.63	23.11	22.29	23.47	27.61	26.01	24.67	26.76	27.47
MUFA	21.99	21.28	21.55	16.81	20.83	19.98	21.36	25.09	23.95	22.46	24.63	25.04
$C_{11:1}$	0.13	0.12	0.14	0.23	0.15	0.14	0.20	0.10	0.12	0.11	0.10	0.10
$C_{16:1}$	0.97	0.91	0.98	0.28	0.82	0.97	0.36	0.57	0.45	0.40	0.48	0.63
$C_{17:1}$	0.22	0.10	0.22	0.11	0.11	0.12	0.18	0.25	0.23	0.30	0.11	0.20
$C_{18:1}$ *trans*	1.29	1.34	1.16	1.06	1.28	1.25	0.50	1.00	0.60	0.76	1.00	0.85
$C_{18:1}$ *cis*	19.38	18.81	19.05	15.13	18.47	17.5	20.12	23.17	22.55	20.89	22.94	23.26
PUFA	2.26	2.27	2.26	1.82	2.28	2.31	2.11	2.52	2.15	2.21	2.13	2.43
$C_{18:2}$	1.84	1.85	1.84	1.52	1.81	1.82	1.63	1.91	1.48	2.08	1.93	1.84
$C_{18:3}$	0.42	0.42	0.42	0.30	0.47	0.49	0.48	0.61	0.67	0.13	0.20	0.59

SFA *- saturated fatty acids,* ***TUFA*** *- total unsaturated fatty acids,* ***MUFA*** *- mono unsaturated fatty acids,* ***PUFA*** *- poli unsaturated fatty acids*
C *- Control,* ***Y85 and Y95*** *- inoculated with yogurt culture, and heated at 85°C and 95°C, respectively;* ***M85 and M95*** *- inoculated with yogurt culture + Lb. helveticus (1:1), and heated at 85°C and 95°C, respectively;* ***H85 and H95:*** *inoculated with Lb. helveticus, and heated at 85°C and 95°C, respectively*

Table 3. *Sensorial values detected in Cokelek cheeses (points)*
Tablo 3.*Çökelek peynirlerinde saptanan duyusal değerler (puan)*

Sample	First Day				
	Appearance**	Odour*	Texture*	Flavour**	Total*
Y95:C	6.70±0.44^{ab}	6.17±0.76	6.70±0.85	5.97±0.78^{ab}	25.53±2.75
Y85	6.83±0.91^{ab}	6.36±0.80	6.60±0.95	6.33±0.78^{ab}	26.13±3.43
M95	6.63±0.47^{ab}	6.33±0.93	6.77±0.68	6.40±0.70^{a}	26.13±2.66
M85	6.90±0.70^{ab}	6.33±0.57	6.57±0.80	6.10±0.57^{ab}	25.90±2.55
H95	6.10±0.17^{b}	6.17±0.37	6.33±0.30	5.80±0.17^{ab}	24.40±0.26
H85	6.67±0.47^{ab}	6.27±0.70	6.47±0.61	6.07±0.37^{ab}	25.47±2.07
	15th Day				
Y95:C	7.07±0.51^{a}	6.60±0.56	6.23±0.75	6.50±0.46^{a}	26.40±2.25
Y85	6.90±0.34^{ab}	6.17±0.40	6.27±0.97	6.27±0.68^{ab}	25.60±2.16
M95	6.73±0.49^{ab}	6.13±0.42	5.87±1.07	5.67±0.57^{ab}	24.40±2.52
M85	6.70±0.60^{ab}	5.90±0.62	5.57±1.20	5.50±0.98^{ab}	23.67±3.30
H95	6.83±0.42^{ab}	6.30±0.26	6.00±0.30	5.37±0.38^{b}	24.50±0.75
H85	6.73±0.06^{ab}	6.30±0.10	6.13±0.37	5.60±0.87^{ab}	24.76±0.71

** Statistically not significant different P>0.05, ** statistically significant different P<0.05*
C *- Control,* ***Y85 and Y95*** *- inoculated with yogurt culture, and heated at 85°C and 95°C, respectively;* ***M85 and M95*** *- inoculated with yogurt culture + Lb. helveticus (1:1), and heated at 85°C and 95°C, respectively;* ***H85 and H95:*** *inoculated with Lb. helveticus, and heated at 85°C and 95°C, respectively*

During 45 days of ripening period, TUFA contents of the all groups increased.

The sensory evaluation scores give to the treatment groups are shown in *Table 3*. We did not analysed sensory evaluation of the samples after 15th days, because of bad taste and odour. In control group, the mean values given for appearance, odours, and flavours were the highest at the 15th day. In addition, total sensory score of the samples made with yogurt culture in heating at 95°C was the highest (15th days). Panelists' preferred traditional Çökelek cheese produced from yogurt cultures. Statistical difference was found to be important for appearance and flavours during storage *(P<0.05)*. Total sensory score of the control group was higher than the others, but the difference is not statistically significant between the samples.

DISCUSSION

The properties of raw goat milk were suitable for yogurt production [1]. Cheese yield is of basic importance to cheese manufacturers as small differences in yield translate to large sums of money or profit. Kalantzopoulos [23] stated that the yield capacity of fresh cheese was related to the protein and fat contents of goat milk.

Our study is the first research on the Çökelek cheese produced with starter cultures Therefore, the Çökelek cheeses produced in the study were compared to results of Çökelek cheese produced by different ways in previous very few study.

The pH, TA%, TS%, NaCl%, TN% were relatively higher than the findings reported by some researchers [24-27]. Our results compared with the literature, different results were obtained. The reason for this difference, Çökelek cheeses raw material and/or production methods may be different.

Lactococci and lactobacilli counts were lower than those reported by some researchers [24,25]. The microbioligal quality of "Çökelek" cheese, which is sold without packaging in Diyarbakır (in Turkey), an average of total microorganism 8.49±0.79 log cfu g^{-1}, heterofermentative lactic acid bacteria 8.58±0.98 log cfu g^{-1} were determined [28]. Discrepancy in the results could be due to the variations in production methods of Çökelek cheeses (especially due to the heating process at high temperature like 95°C in this study).

Lipolysis plays an essential role in the sensory properties of cheese; some free fatty acids (FFAs) have been shown to contribute directly to the aroma characteristics of many types of cheese, or indirectly as precursors of aroma components [29]. The fatty acids hexanoic, octanoic and decanoic acids have long been considered responsible for the characteristic aroma of goat cheeses, giving rise to the popular terms caproic, caprilic and capric acids. Additionally, certain branched-chain FFAs contribute, by themselves, to the goaty flavour of cheese [30-32]. Consistent with the results of the previous studies, Myristic (C14:0), palmitic (C16:0), stearic (C18:0) and oleic (C18:1) acids were the main fatty acids present in the Çökelek cheeses [33,34]. Palmitic and myristic acid are considered hypercholesterolemic, oleic acid and stearic acid are considered hypocholesterolemic [33]. The findings of this study show similarity with recorded by Kondyli and Katsiari [35], and Dönmez [36]. But the degree of lipolysis undergone by the sample cheeses here was comparatively low, as might be expected, since ripening tends to be relatively short.

The results showed that *Lb. helveticus* (single or mixture) could be used as starter culture in Çökelek cheese made from goat milk; it did not produce very different results from the other samples. The yield and some physicochemical properties of the Çökelek cheese samples heated at 95°C were better than those of the samples heated at 85°C. However, it was found that the sensorial score, ripening index and lactic acid bacteria counts of the samples heated at 85°C were higher than those of the others. So, the heating of yogurt at 85°C may be preferred to another heating temperature. As a conclusion, both *Lb. helveticus* and yogurt cultures may be proposed as a starter culture (a single and mix) for Çökelek cheese production.

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