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Effects of Somatic Cell Count in Goat Milk on Some Physical, Chemical and Sensory Properties of Vanilla Ice Cream*

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Absract: In this study, the effects of somatic cell count (SCC) in goat milk on some physical, chemical and sensory properties of vanilla ice cream were investigated. Milk samples with low (1200 x 10^3 cells/ml), medium (1500 x 10^3 cells/ml) and high (1800 x 10^3 cells/ml) SCC were used for ice cream manufacture. The composition and some properties of raw milk (pH, fat content, non-fat solid content, titratable acidity) and ice cream mix (pH, titratable acidity, viscosity) were recorded. Fat content, total solid content, overrun, melting rate and sensory properties of ice cream samples were also analyzed. Results indicated that raw milk with high SCC had low fat content and high pH and titratable acidity ($P<0.01$). However, non-fat milk solid contents were not different ($P>0.05$). Ice cream mix was not affected (pH, titratable acidity, viscosity) by SCC variations. Overrun, melting rate, fat and total solid contents of ice cream samples were similar among 3 groups. Appearance and texture scores were not different. However, flavor score decreased as SCC in milk increased ($P<0.05$). In conclusion, SCC in goat milk affected some properties of raw milk and flavor of vanilla ice cream.

Keywords: Goat milk, Somatic cell count, Vanilla ice cream.

Keçi Sütü Somatik Hücre Sayısının Vanilyalı Dondurmanın Bazı Fiziksel, Kimyasal ve Duyusal Özellikleri Üzerine Etkileri

Öz: Bu çalışmada keçi sütü somatik hücre sayısının (SHS) vanilyalı dondurmanın bazı fiziksel, kimyasal ve duyusal özellikleri üzerine etkileri araştırılmıştır. Dondurma üretiminde düşük (1200 x 10^3 hücre/ml), orta (1500 x 10^3 hücre/ml) ve yüksek (1800 x 10^3 hücre/ml) SHS'ye sahip süt örnekleri kullanılmıştır. Çiğ sütün (pH, yağ içeriği, yağsız kuru madde içeriği, titrasyon asitliği değeri) ve dondurma miksinin (pH, titrasyon asitliği değeri, viskozite değeri) bileşim ve bazı özellikleri kaydedilmiştir. Ayrıca, dondurma örneklerinin yağ içeriği, toplam kuru madde içeriği, hacim artışı, erime oranı ve duyusal özellikleri belirlenmiştir. Sonuçlar, yüksek SHS'ye sahip çiğ sütün yağ içeriğinin düştüğünü, pH ve titrasyon asitliği değerinin arttığını göstermiştir ($P<0.01$). Ancak, sütlerin yağsız kuru madde içerikleri farklılık göstermemiştir ($P>0.05$). Dondurma miksleri (pH, titrasyon asitliği değeri, viskozite değeri) SHS değişiminden etkilenmemiştir. Dondurma örneklerinin hacim artışı, erime oranı, yağ ve toplam kuru madde içeriği 3 grup arasında benzer bulunmuştur. Görünüş ve tekstür skorları farklılık göstermemiştir. Ancak, SHS arttıkça aroma skorunun azaldığı belirlenmiştir ($P<0.05$). Sonuç olarak, keçi süt SHS çiğ sütün bazı özelliklerini ve vanilyalı dondurmanın aromasını etkilemiştir.

Anahtar Kelimeler: Keçi sütü, Somatik hücre sayısı, Vanilyalı dondurma.

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INTRODUCTION

Dairy goat industry has been growing rapidly for the past few years, and the consumer demand on goat milk and milk products has been increasing (1). Somatic cell count (SCC) has become a worldwide accepted milk quality criterion and a management tool. In many of industry type goat milk producing countries, milk quality criteria have been established and quality payment systems are implemented at national and regional scale (2).

High SCC in goat milk negatively affects some characteristics of cheese, the most consumed milk product, both during the manufacture and the storage stages (3,4). Although a considerable amount of goat milk is used for ice cream making, little is known about the relationship of SCC and the suitability of the milk for ice cream making and the quality of the finished product. We therefore, investigated the effect of SCC in goat milk on some properties of vanilla ice cream.

MATERIALS and METHODS

Somatic cell count of different batches of Saanen goat milk from a private farm (Tossaanen Goat Farm, Golbasi, Ankara-Turkey, Latitude 39º41' N, Longitude 32º47' E) was estimated by Fossomatic method (IBC-M Bactocount® Bentley Instruments, Inc., Chaska, USA) and milk samples with low (1200 x 10^3 cells/ml), medium (1500 x 10^3 cells/ml) and high (1800 x 10^3 cells/ml) SCC were prepared. One liter of milk per batch was used for ice cream manufacture in duplicate.

Non-fat vanilla ice cream mixes with the following compositions were prepared: >2% milk fat, 16% sucrose, 21% milk solids-not-fat (from goat skimmilk powder), 0.5% fully integrated blend of food-grade emulsifier and stabilisers (Danisco, Turkey). All ingredients were mixed into goat milk and heated to temperature of 85°C, held at that temperature for 20 minutes, mixed for 5 minutes with Ultra Turrax (Janke and Kunkel, Germany), cooled to 4°C and aged for one day at 4°C. Batches of ice cream mix (1 liter) were frozen in a batch ice cream freezer at -6°C (DëLonghi II Gelatatio ICK 5000, Italy). Ice cream samples were then hardened at -25 °C for at least 24 hours before further testing was performed.

The composition of raw milk (pH, fat content, non-fat solid content, titratable acidity) and ice cream mix (pH, titratable acidity, viscosity) were recorded. Fat content, total solid content, overrun, melting rate and sensory evaluation of ice cream samples were analyzed.

pH values of raw milk and ice cream mix were measured by using a pH-meter (Mettler Toledo, Switzerland). Titratable acidity was measured by titrating 9 grams of samples with 0.1 N NaOH solution. The total solids of samples were determined by drying samples at 105 ± 1ºC overnight to constant weight, using an air oven (Memmert, Germany). Fat contents of raw milk and ice cream were determined by Gerber method (5). Non-fat solid content of raw milk was determined by a refractometer (Reichert AR, USA). Viscosity was measured using a viscosimeter (Haake, Germany).

Overrun was calculated based on the weight of a certain volume of ice cream mix and ice cream. A container was filled with either ice cream mix or ice cream and the weight was recorded. Overrun measurements were taken using the equation below:

Overrun (%) = [(Weight of mix-Weight of ice cream) / (Weight of ice cream)] x (100)

Melting rate at 120 minutes were calculated at room temperature (~24°C) (6). Sensory quality was determined by consumer test using 5-point hedonic scale (7). Appearance, flavor and texture scores of ice cream samples were recorded by 100 panelists.

Statistical Analysis

All statistical analyzes were performed with SPSS 14.0 for Windows software (SPSS Inc) to check

if there was a difference between the samples at a 5% significance level (P≤0.05). Data were presented as means ± standard deviations (X ± SD). The assumptions of normality and homogeneity of variance of the data were tested using the Shapiro-Wilks test and the Levene's test, respectively. The results were evaluated using a univariate statistical analysis (analysis of variance - ANOVA) and Tukey's mean test.

RESULTS and CONCLUSION

The results of the current study indicated that raw milk properties changed when milk SCC varied from 1200 x 10^3 cells/ml to 1800 x 10^3 cells/ml. Milk with high SCC had a lower fat content and higher pH and titratable acidity (P<0.01). However, non-fat milk solids did not change (Table 1).

Table 1. Some properties of raw milk with different somatic cell counts (SCC).
Tablo 1. Farklı somatik hücre sayılarına (SHS) sahip çiğ sütlerin bazı özellikleri.

Classification*	pH	Fat (%)	Non-fat solid (%)	Titratable acidity (°SH)
Low SCC	6.71 ± 0.01^c	4.7 ± 0.07^a	10.00 ± 0.00^a	6.72 ± 0.01^b
Medium SCC	6.74 ± 0.01^b	4.1 ± 0.14^b	10.00 ± 0.00^a	6.71 ± 0.01^b
High SCC	6.79 ± 0.01^a	3.7 ± 0.14^c	10.00 ± 0.00^a	7.06 ± 0.03^a
P	P<0.01	P<0.01	P>0.05	P<0.01

Within columns, values with different superscripts (a, b, c) are significantly different.
*Somatic cell count was classified as low SCC (1200 x 10^3 cells/ml), medium SCC (1500 x 10^3 cells/ml) and high SCC (1800 x 10^3 cells/ml).
*Somatik hücre sayıları düşük SHS (1200 x 10^3 hücre/ml), orta SHS (1500 x 10^3 hücre/ml) ve yüksek SHS (1800 x 10^3 hücre/ml) olarak sınıflandırılmıştır.

There are conflicting reports in the literature concerning affect of SCC on goat milk fat content. In some reports it was indicated that SCC does not affect fat content of goat milk (8,9). On the contrary, significantly lower fat content in goat milk infected with *S. aureus* (mean SCC 4.650.000 cells/ml) compared to non-infected milk (mean SCC 1.030.000 cells/ml) was reported (10). In another study, a decrease in fat content for high SCC in goat milk was reported (11). A decrease of fat concentration during intramammary infection, which may result in high SCC, seems logical considering the reduced synthetic and secretory capacity of the mammary gland. Intramammary infection is the main factor affecting SCC in goat milk, however, the prediction of goat udder half infection by SCC is unreliable and even goat udder halves with high milk SCC may show sign of mastitis (12). It was reported that no histological and pathological differences in the mammary glands or other evidence of mastitis were detected on fresh udder half tissues of goats with low (950.000 cells/mL), medium (1.500.000 cells/mL), and high (3.300.000 cells/mL) SCC. The SCC in goat milk may be affected by numerous factors such as stage of lactation, estrus, milking routine (13,14). Therefore, regardless of intramammary infection status, high SCC in raw goat milk, which result in low fat content, might have cause economical losses during ice cream manufacture. The effect of SCC on fat composition was not evaluated in the current study however, in a study no difference was reported in fatty acid profiles in goat milk with different SCC (15).

The results of the current study indicate that raw goat milk pH significantly increases as SCC increase. Similar results were commonly reported in the literature (16). This effect is attributed to increased permeability of the mammary epithelium, which leads to transfer of components from blood to milk, including citrates, bicarbonates, and Na and Cl ions. Higher levels of citrate and bicarbonate were reported to be responsible for elevated pH levels (17). Titratable acidity plays a fundamental role and represents an important parameter for evaluation of the technological quality of milk (18). A correlation between the acidity and SCC that shows the direct effect of SCC on the acidity was reported for cow milk, as well (19).

Table 2. Some properties of ice cream mix obtained from milk with different somatic cell counts (SCC).
Tablo 2. Farklı somatik hücre sayılarına (SHS) sahip sütlerden elde edilen dondurma mikslerinin bazı özellikleri.

Classification*	pH	Titratable acidity (°SH)	Viscosity (cp)
Low SCC	6.62 ± 0.03[a]	6.22 ± 0.02[a]	172.5 ± 3.54[a]
Medium SCC	6.64 ± 0.02[a]	6.23 ± 0.13[a]	170 ± 0.00[a]
High SCC	6.63 ± 0.02[a]	6.25 ± 0.07[a]	172.5 ± 10.61[a]
P	P>0.05	P>0.05	P>0.05

*Somatic cell count was classified as low SCC (1200 x 10^3 cells/ml), medium SCC (1500 x 10^3 cells/ml) and high SCC (1800 x 10^3 cells/ml).
*Somatik hücre sayıları düşük SHS (1200 x 10^3 hücre/ml), orta SHS (1500 x 10^3 hücre/ml) ve yüksek SHS (1800 x 10^3 hücre/ml) olarak sınıflandırılmıştır.

Ice cream mix was not affected (pH, titratable acidity, viscosity) by SCC variations (Table 2), probably due to the standardization of mix ingredients. Likewise, ice cream overrun, melting rate at 120 minutes, fat and non-fat milk solids among 3 groups were similar (Table 3).

Table 3. Some properties of ice cream samples obtained from milk with different somatic cell counts (SCC).
Tablo 3. Farklı somatik hücre sayılarına (SHS) sahip sütlerden elde edilen dondurma örneklerinin bazı özellikleri.

Classification*	Fat (%)	Total solid (%)	Overrun (%)	Melting rate at 120 minutes (%)
Low SCC	0.45 ± 0.07[a]	38.08 ± 0.25[a]	32.35 ± 0.99[a]	91.48 ± 1.03[a]
Medium SCC	0.4 ± 0.00[a]	38.07 ± 0.07[a]	31.175 ± 0.53[a]	90.965 ± 1.99[a]
High SCC	0.45 ± 0.07[a]	38.09 ± 0.16[a]	32.68 ± 0.68[a]	91.665 ± 0.71[a]
P	P>0.05	P>0.05	P>0.05	P>0.05

*Somatic cell count was classified as low SCC (1200 x 10^3 cells/ml), medium SCC (1500 x 10^3 cells/ml) and high SCC (1800 x 10^3 cells/ml).
*Somatik hücre sayıları düşük SHS (1200 x 10^3 hücre/ml), orta SHS (1500 x 10^3 hücre/ml) ve yüksek SHS (1800 x 10^3 hücre/ml) olarak sınıflandırılmıştır.

Although a non-significant effect of SCC was observed appearance and texture scores of ice cream samples were not different (P>0.05). However, flavor score decreased as SCC in milk increased (low SCC>medium SCC>high SCC; P<0.05). To our knowledge, this is the only study on the effects of SCC on sensory quality of ice cream. The effect of SCC milk on sensory characteristics of goat cheese is documented to some extent. Total sensory and texture scores for cheeses made from the high SCC milk were reported to be lower than those for cheeses made from the low and medium SCC milk (12). In another study with fresh lactic goat cheese, the proteolysis index (non-casein nitrogen/total nitrogen), which causes undesirable sensory changes was significantly higher for high SCC milk (20).

Table 4. Sensory characteristics of ice cream obtained from milk with different somatic cell counts.
Tablo 4. Farklı somatik hücre sayılarına (SHS) sahip sütlerden elde edilen dondurma örneklerinin duyusal özellikleri.

Classification*	Appearance	Flavor	Texture
Low SCC	3.26 ± 1.40[a]	3.71 ± 1.18[a]	3.28 ± 1.27[a]
Medium SCC	3.33 ± 1.26[a]	3.25 ± 1.26[b]	3.12 ± 1.22[a]
High SCC	3.05 ± 1.38[a]	2.38 ± 1.44[c]	3.01 ± 1.30[a]
P	P>0.05	P<0.01	P>0.05

Within columns, values with different superscripts (a, b, c) are significantly different.
*Somatic cell count was classified as low SCC (1200 x 10^3 cells/ml), medium SCC (1500 x 10^3 cells/ml) and high SCC (1800 x 10^3 cells/ml).
*Somatik hücre sayıları düşük SHS (1200 x 10^3 hücre/ml), orta SHS (1500 x 10^3 hücre/ml) ve yüksek SHS (1800 x 10^3 hücre/ml) olarak sınıflandırılmıştır.

In conclusion, SCC in goat milk affected some properties of raw milk and flavor of vanilla ice cream. High SCC results in a lower fat content and higher pH and titratable acidity in raw goat milk and the flavor score of vanilla ice cream decreases as SCC in milk increases.

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