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Abstract

This study aimed to examine the quality characteristics of fermented milk, mozzarella cheese, and gouda cheese from Jersey and Holstein milk. The fermented milk, mozzarella cheese, and gouda cheese made from the Jersey breed exhibited higher fat, calcium, and phosphorous contents than those from the Holstein breed. The proportion of saturated fatty acids such as palmitic acid and stearic acid was higher in dairy products made from Jersey than those made from Holstein, as was the component ratio of unsaturated fatty acids containing oleic acid and linoleic acid. In the sensory evaluations of fermented milk and mozzarella cheese, the preference scores of products from Jersey were lower in color, flavor, texture, taste, and general preference than those from Holstein. In terms of sensory preference, it is considered that Jersey milk may be more appropriate for ripened cheese than fermented milk and fresh cheese. Therefore, Jersey milk is expected to contribute to the diversification of dairy products and to provide consumers with high quality nutrition.

Keywords: Jersey, Holstein, fermented milk, mozzarella cheese, gouda cheese

Introduction

Jersey breed cattle require smaller living quarters and consume less feed than Holsteins because of their smaller frames. Although the Jersey cattle are smaller than Holstein cattle, and their feed intake is about 80% that of Holstein, this breed is the second important dairy breed in the world (Bland *et al*., 2015). In addition to the space required for breeding, the fecal output and emissions of carbon gases of Jersey cattle are lower than those of Holstein, so breeding Jersey cattle is relatively beneficial for dairy farmers. Further, milk from Jersey cattle has a higher content of milk solids than that from Holstein. The fat, protein, and casein content are higher in Jersey milk than in Holstein milk (Auldist *et al*., 2002; Bland *et al*., 2015; Frederiksen *et al*., 2011; Jensen *et al*., 2012). In terms of fatty acid, Jersey milk has higher contents of medium chain fatty acids such as hexanoic acid, caprylic acid, decanoic acid, and α-tocopherol (Han and Heon, 2013). In addition, Jersey milk has a higher content of neutral fucosylated oligosaccharide, which can be effectively used by *Bifidobacteria* (Sundekilde et al., 2012). This relatively high total solids content in Jersey milk leads to increased manufacturing efficiency, specifically in terms of reduced cutting time, increased coagulation strength, and increased cheese yield when made into cheese (Auldist *et al*., 2002; Bland *et al*., 2015; Custer, 1979; Jensen *et al*., 2012; Okigbo *et al*., 1985). The yield of cheese made from Jersey milk has an average value of 12.0~12.8%, which is higher than that of Holstein of 9.5~10.7% (Auldist *et al*., 2002; Bland *et al*., 2015; Custer, 1979).

In spite of the gradually increasing interest in Jersey cows from dairy farmers in Korea, which is currently in the introduction stage of Jersey, there has been little study regarding the milk and dairy products of Jersey cattle. In this respect, the objective of this study is to determine the quality characteristics, such as general composition, textural characteristics, fatty acid proportion, and sensory properties, of fermented milk, mozzarella cheese, and gouda cheese made from Jersey milk produced in Korea.

Materials and Methods

Manufacture of fermented milk

In order to make fermented milk, raw milk from Holstein and Jersey was pasteurized at 92°C for 10 min. After cooling the raw milk to 40°C, 0.002% of starter (FD-DVS ABT-5, Chr. Hansen A/S, Denmark) was added and incubated for 8 h at 40°C. The fermented milk was then cooled to 4°C and stored under refrigeration.

Manufacture of mozzarella cheese

Mozzarella cheese was made from Jersey and Holstein milk produced in the dairy cattle division of National Institute of Animal Science (NIAS). Following 30 min of pasteurization at 65°C, the raw milk was cooled to 34°C. Then, 0.003% of starter (TCC-3, Chr. Hansen A/S, Denmark) was added and left for 40 min. In order to coagulate the milk, rennet (Chr. Hansen, New Zealand) was added at 0.23 mL/kg of milk and left for 45 min. After cutting for 1 cm in each dimension, the curd was stirred and cooked at 43°C. Then, whey was drained after 40 min and curd was kneaded and stretched by hand in 80°C water. Each cheese sample was brined for 15 min in a 20% salt solution, then dried and stored in vacuum-sealed pouches at 4°C.

Manufacture of gouda cheese

Gouda cheese from Jersey and Holstein was made by pasteurizing raw milk at 65°C for 30 min. Following pasteurization, the raw milk was cooled to 32°C, and 0.0015% of starter (CHN-11, Chr. Hansen A/S, Denmark) was added. Following incubation for 50 min, rennet (Chr. Hansen, New Zealand) was added at 0.19 mL/kg of milk and left for 40 min. Then, ensuring the proper state of coagulation, curd was cut into 0.7 cm in each dimension. The curd and whey were stirred and cooked for 20 min and 40% of total whey was drained. Thereafter, water was added twice and whey was drained twice. After draining all the whey, the curds were put into mold and pressed overnight. The following day, the gouda cheese was soaked in brine for 8 h/kg and ripened for 4 mon in a ripening room.

Physicochemical analyses

For analyzing the compositions of the products, the contents of fat, protein, and moisture salinity were measured using a FoodScan analyser (Foss, Hillerød, Denmark) according to the method described by Anderson (2007).

The mineral contents of fermented milk and cheese from Jersey as well as Holstein milk were measured according to the AOAC (2006) method. The sample in crucible was ashed in an electric ashing furnace (JSMF-270T) at 600°C for 12 h, then 10 mL of a hydrochloric acid solution (HCl : H_2O = 1 : 1) was added. The optical density of the filtered liquid sample was analyzed using an atomic absorption spectrophotometer (ICP Spectrophotometer, Spectroflame, Spectro Company, Germany) and the content of mineral containing calcium, phosphorous, iron, sodium, and potassium was calculated by drawing standard calibration curves.

Fatty acids composition analysis

Forty five milliliter of folch solution (chloroform : methanol = 2 : 1) was added to 15 g of the chopped cheese sample by Folch et al. (1957) and homogenized for 10 min. Then, the mixture was filtered, and following centrifugation (3000 rpm, 10℃, 10 min), Na_2SO_4 was added to the lower layer; after filtration, chloroform was blown off with a centrifugal concentrator in order to acquire lipids. Next, 1 mL of 0.5 N NaOH was added to the extracted lipids using the method described by Morrison and Smith (1964). The mixture was then heated at 100 ℃ for 20 min and cooled. Following the addition of 2 mL of boron trifluoride methanol solution (BF_3 methanol, Sigma, USA), heating, and cooling, 8 mL of NaCl solution and 1 mL of Heptane were added, and the supernatant was analyzed by gas chromatography (Varian star 3600, USA). The column of the equipment used for the analysis was an Omegawax 205 fused-silica bond capillary column with 30 m x 0.32 mm dimensions and a 0.25 μm film thickness, as well as a 1 mL/min flow rate of the column. A flame ionization detector was used and nitrogen gas was applied in order to carry the gas.

Texture analyses

In order to analyze the textures of cheeses from Jersey milk and Holstein milk, the samples were made cylindrical using a 1 cm diameter core, and cut uniformly at a length of 2 cm. Following the method of Bourne (1978), the hardness, cohesiveness, and springiness were measured by twice pressing the samples at the same time and repeating this process five times with Instron (Model 5543, USA).

Color measurement

The colors of the fermented milk and cheese from Jersey milk and Holstein milk were analyzed using a chroma meter CR-400 (Konica Minolta, Tokyo, Japan) in a cold room not affected by light. The L* (lightness) and b* (yellowness) parameters were measured following the method of Kim et al. (2013). The values of the parameters for calibration standardization of the white standard plate was as follows: lightness, 97.46; redness, 0.08; and yellowness, 1.81.

Sensory evaluation

The sensory properties of gouda cheese were evaluated after one, two, three, and four months of aging. Samples of fermented milk were prepared in 25 mL portions in disposable cups and cheese samples were prepared into cubes (1 x 1 x 1 cm). Each sample was graded in terms of color, flavor, texture, taste, and overall preference using a nine-point hedonic scale by 10 trained panelists (Wichchukit and O'Mahony, 2015). A scale of one to nine was used for the sample rating, where one is an undesirable flavor with a bad taste and nine is a desirable flavor and taste that is most preferred. Each panel member was supplied with natural water to rinse their mouths between tastings.

Statistical analyses

All experimental data were presented as means ± standard deviation (SD). Statistical significance for comparisons between dairy products made from Holstein and Jersey groups were assessed using student t-tests. Probability values of $p<0.05$ were considered to indicate significant differences.

Results and Discussion

General properties of dairy products made from Jersey and Holstein milk

Tables 1 and 2 show the general composition of fermented milk, mozzarella cheese, and gouda cheese from Jersey and Holstein milk. Regarding fermented milk, the fat and protein contents increased when using Jersey milk. In contrast, the moisture content was lower in fermented milk from Jersey cattle ($p<0.05$).

In mozzarella and gouda cheese, the fat content from Jersey milk was higher than that from Holstein milk. This is consistent with the findings of Bland *et al*. (2015), that the fat content of cheese from Jersey milk was 18% higher than that from Holstein milk. The moisture content of cheese from Jersey milk decreased when Jersey milk was used, and Whitehead (1948) also found that the moisture content was decreased in Jersey milk because of its higher syneresis.

Table 3 shows the mineral contents of fermented milk, mozzarella cheese, and gouda cheese from Jersey and Holstein milk. In terms of mineral content, all products from Jersey milk had higher contents of calcium and phosphorus. This result was consistent with the studies of Auldist *et al*. (2002) and Jensen *et al*. (2012).

Fatty acids profiling of dairy products made from Jersey and Holstein milk

Tables 4, 5, and 6 show the fatty acid compositions of fermented milk, mozzarella cheese, and gouda cheese from Jersey and Holstein milk. In all dairy products made from Jersey milk examined in this study, the ratios of saturated fatty acids such as palmitic acid and stearic acid were higher than those of Holstein, while the ratios of unsaturated fatty acids such as oleic acid and linoleic acid in the products of Holstein milk were higher than those of Jersey. White *et al*. (2001) reported that milk from Holstein had a higher content of oleic acid (C18:1) and CLA and a lower content of myristic acid (C14:0) than milk from Jersey. Auldist *et al*. (2002) reported that Jersey milk had higher proportions of long-chained saturated fatty acids and lower proportions of long-chain unsaturated fatty acids, which leads to harder fat from Jersey milk.

Textural properties of cheese made from Jersey and Holstein milk

The results of the textural analysis of mozzarella cheese and gouda cheese are shown in Tables 7 and 8. In mozzarella and gouda cheese, the hardness of cheese from Jersey milk was higher than that from Holstein. The cohesiveness and springiness were also higher in cheese from Jersey milk than that from Holstein. With the increased casein, total solids, and calcium levels affecting the condition of casein matrix in cheese, the hardness of the cheese can increase (Mistry, 2001). Additionally, according to Chen *et al.* (2004), fatty acid components affect the structures and textures of dairy products, and higher percentages of unsaturated fatty acids in the milk lead to the production of smoother dairy products.

Color analysis of dairy products made from Jersey and Holstein milk

The results of color analysis are shown in Table 9. There were notable differences in terms of yellowness (b*). All treatments derived from Jersey milk had higher values in yellowness, and the difference could also be recognized when observed with the naked eye. This result was slightly different from the study of Bland *et al*. (2015) that showed that although the cheese from Jersey milk had a numerically higher value of yellowness than that from Holstein, the difference was out of the range that can be observed by the naked eye. According to Fernández-Vázquez *et al*. (2011), when the difference between the figures of two materials is in the range of 2.8 ~ 5.6, the gap can be recognized visually.

Sensory properties of dairy products made from Jersey and Holstein milk

The results of the sensory property analysis of fermented milk, mozzarella cheese, and gouda cheese are shown in Tables 10 and 11. Fermented milk made from Jersey milk had lower scores in color, flavor, texture, taste, and overall preference. These results are similar to those of mozzarella cheese from Jersey milk. In gouda cheese, color and taste scores were high and flavor and texture scores were low in cheese made from Jersey milk after two months of ripening. The overall preference score showed no difference between Jersey and Holstein milk in two months. It is considered that the high viscosity of fermented milk and high hardness of fresh cheese such as mozzarella cheese contribute to the relatively low sensory preference, along with the unusual unique flavor of Jersey milk. These characteristics are consistent with the study of Cooper *et al*. (1911), which showed that if the fat content is high and the fat globule size is large, fat decomposition could be more likely to bring about rancid odor or bitterness. On the other hand, Bland *et al*. (2015) suggested that when manufacturers make cheddar cheese with Jersey and Holstein milk, as the content of Jersey milk increases, the yield of cheese can increase without decreasing the sensory preference. As a result, in terms of sensory properties, it is considered that Jersey milk is relatively unsuitable for fermented milk and mozzarella cheese, and it is recommended that manufacturers use Jersey milk to make cured cheeses rather than fresh cheeses.

Conclusions

This study was conducted to determine the quality characteristics of fermented milk, mozzarella cheese, and gouda cheese from Jersey milk in Korea. In fermented milk and cheese from Jersey, the fat content was higher than in those from Holstein. The calcium and phosphorus contents of dairy products of Jersey were also higher than those of Holstein in all dairy products. In terms of texture, the hardness, cohesiveness, and springiness of Jersey cheese were higher than those of Holstein. It is considered that this textural quality of cheese made with Jersey milk contributed to the decreased textural sensory property score. The preference of taste, color, flavor, and texture in the sensory analysis of fermented milk and mozzarella cheese from Jersey milk were lower than those of Holstein. However, in gouda cheese, color and taste scores were higher and flavor and texture scores were lower in cheese made from Jersey milk after two months of curing. In this respect, Jersey milk may be more suitable for ripened cheese rather than fermented milk or fresh cheese. As a result, we found that Jersey milk and dairy products have high contents of useful composition such as calcium and potential manufacturing efficiency because of the high contents of total solid and cheese production yield. It is considered that Jersey milk may contribute to the diversification of dairy products and provide consumers with high quality nutrition.

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Table 1. General composition of fermented milk and mozzarella cheese from Jersey and Holstein milk

		Fat (%)	Protein (%)	Moisture (%)	Salt (%)
Fermented milk	Jersey	6.18±0.35[a]	3.53±0.06[a]	83.17±1.15[b]	0.12±0.03[a]
	Holstein	3.39±0.53[b]	3.06±0.06[b]	88.36±0.45[a]	0.14±0.01[a]
Mozzarella cheese	Jersey	31.64±0.08[a]	21.49±0.50[a]	42.05±0.25[b]	1.03±0.13[a]
	Holstein	27.92±1.10[a]	22.17±0.86[a]	45.22±0.44[a]	1.08±0.04[a]

*Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 2. General composition of gouda cheese from Jersey and Holstein milk

		Ripening period (month)			
		1	2	3	4
Fat (%)	Jersey[1]	38.26±0.07[NS]	41.89±5.54[NS]	42.15±3.61[NS]	44.19±2.55[NS]
	Holstein[2]	35.07±0.06	35.92±0.12	36.55±0.45	39.10±0.49
Moisture (%)	Jersey[1]	32.42±0.00[NS]	29.92±3.28[NS]	28.99±1.33[NS]	27.31±0.34[NS]
	Holstein[2]	32.21±5.23	33.75±0.24	23.03±0.26	27.82±0.18
Protein (%)	Jersey[1]	25.51±0.05[NS]	26.23±0.74[NS]	26.93±1.29[NS]	26.71±1.61[NS]
	Holstein[2]	24.95±0.04	27.08±0.09	28.09±0.44	30.17±0.37
Salt (%)	Jersey[1]	1.49±0.01[NS]	1.65±0.12[NS]	1.78±0.03[NS]	1.79±0.04[NS]
	Holstein[2]	1.40±0.03	1.81±0.08	1.89±0.13	1.88±0.05

[1]Gouda cheese made with milk from Jersey; [2]Gouda cheese made with milk from Holstein.

[*]Data are mean ± standard deviation values.

[NS]Not significantly different.

Table 3. Mineral content of fermented milk, mozzarella cheese and gouda cheese from Jersey and Holstein milk

		Ca (mg/kg)	P (mg/kg)	Fe (mg/kg)	Na (mg/kg)	K (mg/kg)
Fermented milk	Jersey	1486.40[a]	1206.81[a]	2.36	348.80	1094.82
	Holstein	1211.59[b]	1013.39[b]	2.48	342.30	990.21
Mozzarella cheese	Jersey	6378.00	4641.81	3.76	2277.71	565.13
	Holstein	5614.23	4197.83	11.01	2334.69	614.86
Gouda cheese	Jersey	9289.54	6096.40	1.52	5013.84	1352.34
	Holstein	8918.96	6073.48	1.74	5517.02	1520.84

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 4. Fatty acid composition of fermented milk from Jersey and Holstein milk

	Jersey[1]	Holstein[2]
C14:0 (Myristic acid)	13.33±1.74^{a}	13.53±0.35^{a}
C16:0 (Palmitic acid)	43.51±0.76^{a}	41.59±0.86^{a}
C16:1n7 (Palmitoleic acid)	1.76±0.24^{a}	2.14±0.07^{a}
C18:0 (Stearic acid)	15.34±0.55^{a}	12.86±0.11^{b}
C18:1n9 (Oleic acid)	23.62±2.46^{a}	26.37±1.49^{a}
C18:2n6 (Linoleic acid)	1.99±0.21^{a}	2.10±0.18^{a}
C18:3n6 (γ-Linoleic acid)	0.11±0.03^{a}	0.11±0.01^{a}
C18:3n3 (Linolenic acid)	0.28±0.01^{a}	0.29±0.03^{a}
C20:1n9 (Eicosenoic acid)	0.35±0.00^{b}	0.48±0.00^{a}
C20:4n6 (Arachidonic acid)	0.12±0.01^{a}	0.17±0.02^{a}
SFA[3]	71.78±2.50^{a}	68.36±1.65^{a}
USFA[4]	28.22±2.50^{a}	31.65±1.65^{a}
MUFA[5]	25.73±2.70^{a}	28.99±1.41^{a}
PUFA[6]	2.49±0.19^{a}	2.66±0.23^{a}

[1]Fermented milk made with milk from Jersey; [2]Fermented milk made with milk from Holstein.

[3]SFA: Saturated fatty acid; [4]USFA: Unsaturated fatty acid; [5]MUFA: Mono unsaturated fatty acid; [6]PUFA: Poly unsaturated fatty acid.

[*]Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 5. Fatty acid composition of mozzarella cheese from Jersey and Holstein milk

	Jersey[1]	Holstein[2]
C14:0 (Myristic acid)	14.35±0.03[a]	13.20±0.12[b]
C16:0 (Palmitic acid)	43.88±0.25[a]	41.00±0.02[b]
C16:1n7 (Palmitoleic acid)	1.63±0.05[b]	2.06±0.04[a]
C18:0 (Stearic acid)	15.04±0.13[a]	13.05±0.17[b]
C18:1n9 (Oleic acid)	22.14±0.37[b]	27.47±0.06[a]
C18:2n6 (Linoleic acid)	2.11±0.03[a]	2.19±0.06[a]
C18:3n6 (γ-Linoleic acid)	0.11±0.02[a]	0.11±0.01[a]
C18:3n3 (Linolenic acid)	0.28±0.01[a]	0.31±0.00[a]
C20:1n9 (Eicosenoic acid)	0.34±0.01[b]	0.47±0.01[a]
C20:4n6 (Arachidonic acid)	0.15±0.04[a]	0.17±0.01[a]
SFA[3]	73.26±0.42[a]	67.24±0.07[b]
USFA[4]	26.75±0.42[b]	32.76±0.07[a]
MUFA[5]	24.11±0.40[b]	29.99±0.00[a]
PUFA[6]	2.64±0.02[a]	2.77±0.07[a]

[1]Mozzarella cheese made with milk from Jersey; [2]Mozzarella cheese made with milk from Holstein.

[3]SFA: Saturated fatty acid; [4]USFA: Unsaturated fatty acid; [5]MUFA: Mono unsaturated fatty acid; [6]PUFA: Poly unsaturated fatty acid.

[*]Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 6. Fatty acid composition of gouda cheese from Jersey and Holstein milk

	Jersey[1]	Holstein[2]
C14:0 (Myristic acid)	14.58±0.47^{a}	13.66±0.38^{a}
C16:0 (Palmitic acid)	45.05±0.26^{a}	41.64±0.27^{b}
C16:1n7 (Palmitoleic acid)	1.72±0.0^{b}	2.03±0.01^{a}
C18:0 (Stearic acid)	14.19±0.20^{a}	12.90±0.08^{b}
C18:1n9 (Oleic acid)	21.44±0.69^{b}	26.50±0.60^{a}
C18:2n6 (Linoleic acid)	2.05±0.03^{b}	2.18±0.04^{a}
C18:3n6 (γ-Linoleic acid)	0.12±0.01^{a}	0.13±0.02^{a}
C18:3n3 (Linolenic acid)	0.29±0.01^{a}	0.34±0.03^{a}
C20:1n9 (Eicosenoic acid)	0.42±0.06^{a}	0.47±0.01^{a}
C20:4n6 (Arachidonic acid)	0.16±0.05^{a}	0.18±0.01^{a}
SFA[3]	73.82±0.53^{a}	68.20±0.57^{b}
USFA[4]	26.19±0.53^{b}	31.81±0.57^{a}
MUFA[5]	23.58±0.62^{b}	28.99±0.60^{a}
PUFA[6]	2.61±0.08^{a}	2.83±0.02^{a}

[1]Gouda cheese made with milk from Jersey; [2]Gouda cheese made with milk from Holstein.

[3]SFA: Saturated fatty acid; [4]USFA: Unsaturated fatty acid; [5]MUFA: Mono unsaturated fatty acid; [6]PUFA: Poly unsaturated fatty acid.

[*]Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 7. Texture characteristics of mozzarella cheese from Jersey and Holstein milk

	Hardness (kg)	Cohesiveness (%)	Springiness (mm)
Jersey[1]	0.42±0.11[a]	1.68±0.04[a]	31.66±0.36[a]
Holstein[2]	0.28±0.04[b]	1.58±0.06[a]	31.14±0.44[a]

[1]Mozzarella cheese made with milk from Jersey; [2]Mozzarella cheese made with milk from Holstein.

[*]Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 8. Texture characteristics of gouda cheese from Jersey and Holstein milk

		Ripening period (month)			
		1	2	3	4
Hardness (kg)	Jersey[1]	0.85±0.49^{NS}	0.87±0.26^{NS}	0.84±0.15^{NS}	1.54±0.84^{NS}
	Holstein[2]	0.47±0.23	0.59±0.32	0.53±0.08	1.44±1.21
Cohesiveness (%)	Jersey[1]	1.50±0.03^{NS}	1.54±0.02^{NS}	1.68±0.08^{NS}	1.68±0.08^{NS}
	Holstein[2]	1.45±0.12	1.52±0.04	1.53±0.04	1.75±0.28
Springiness (mm)	Jersey[1]	32.64±0.54^{NS}	32.57±0.09^{NS}	32.67±0.20^{NS}	32.92±0.16^{NS}
	Holstein[2]	32.02±0.55	32.40±0.51	32.16±0.50	32.69±0.25

[1]Gouda cheese made with milk from Jersey; [2]Gouda cheese made with milk from Holstein.

[*]Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 9. Color of fermented milk, mozzarella cheese and gouda cheese from Jersey and Holstein milk

		Lightness (L^*)	Yellowness (b^*)
Fermented milk	Jersey	102.97±0.55[a]	10.55±0.83[a]
	Holstein	101.08±1.14[b]	6.62±1.14[b]
Mozzarella cheese	Jersey	102.22±1.11[a]	18.14±0.39[a]
	Holstein	101.44±0.75[a]	15.97±0.38[b]
Gouda cheese	Jersey	89.70±0.22[b]	20.92±0.30[a]
	Holstein	94.75±0.07[a]	19.34±0.06[b]

*Values are expressed as mean ± standard deviation.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 10. Sensory preference of fermented milk, mozzarella cheese from Jersey and Holstein milk

		Color	Flavor	Texture	Taste	Overall Preference
Fermented milk	Jersey	7.00 ± 1.00^{b}	5.33 ± 1.58^{b}	6.33 ± 1.58^{a}	5.22 ± 1.86^{b}	5.56 ± 1.50^{b}
	Holstein	7.67 ± 0.50^{a}	6.56 ± 0.73^{a}	6.89 ± 0.93^{a}	6.67 ± 0.71^{a}	6.89 ± 0.78^{a}
Mozzarella cheese	Jersey	7.31 ± 0.13^{a}	6.06 ± 0.08^{a}	6.57 ± 0.33^{a}	6.51 ± 0.56^{a}	6.36 ± 0.35^{a}
	Holstein	7.32 ± 0.17^{a}	6.42 ± 0.03^{a}	6.94 ± 0.23^{a}	6.93 ± 0.52^{a}	7.31 ± 0.28^{a}

[*]Values are expressed as mean ± standard deviation.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).

Table 11. Sensory preference of gouda cheese from Jersey and Holstein milk

		Ripening period (month)			
		1	2	3	4
Color	Jersey[1]	7.25±0.07^{Aa}	7.05±0.07^{Aa}	7.14±0.34^{Aa}	7.19±0.27^{Aa}
	Holstein[2]	7.30±0.28^{Aa}	6.85±0.07^{Ba}	6.83±0.60^{ABa}	7.28±0.04^{ABa}
Flavor	Jersey[1]	6.25±0.49^{Aa}	6.65±0.35^{Aa}	6.35±0.57^{Aa}	6.43±0.46^{Aa}
	Holstein[2]	6.70±0.00^{Aa}	6.80±0.14^{ABa}	6.20±0.07^{Ba}	6.38±0.18^{ABa}
Texture	Jersey[1]	5.65±0.21^{Ba}	6.45±0.21^{Aa}	6.23±0.04^{ABa}	6.43±0.25^{Aa}
	Holstein[2]	6.60±0.57^{Aa}	6.90±0.14^{Aa}	6.34±0.41^{Aa}	6.37±0.37^{Aa}
Taste	Jersey[1]	6.40±0.85^{ABa}	7.00±0.00^{Aa}	5.97±0.23^{ABa}	6.07±0.09^{Ba}
	Holstein[2]	6.85±0.21^{Aa}	6.88±0.39^{Aa}	6.39±0.01^{Aa}	6.49±0.1^{Aa}6
Overall Preference	Jersey[1]	6.05±0.78^{ABa}	6.75±0.07^{Aa}	6.04±0.13^{Bb}	6.02±0.16^{Cb}
	Holstein[2]	6.60±0.57^{Aa}	6.83±0.32^{Aa}	6.43±0.11^{Aa}	6.60±0.14^{Aa}

[1]Gouda cheese made with milk from Jersey; [2]Gouda cheese made with milk from Holstein.

[*]Data are mean ± standard deviation values.

[ab]Means with different superscripts in the same column are significantly different ($p<0.05$).