SENSORY PROPERTIES OF DRINKABLE YOGURT MADE FROM MILK OF DIFFERENT GOAT BREEDS

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ABSTRACT

Drinkable yogurts made from different goat breed milk and made with normal and probiotic cultures were evaluated for their sensory characteristics. Milk of Turkish Saanen, Maltese and Turkish Hair goats obtained during the beginning, middle and end of lactations were used to produce drinkable yogurt. Using descriptive sensory analysis technique, common terms were developed as "goaty," "creamy," "fermented," "cooked," "throat burn," "sweet," "salty," "sour" and "astringent." Breeds, lactation periods and using regular and probiotic types of starter cultures affected the sensory characteristics of drinkable yogurts. Drinkable yogurts made by cow milk had weaker intensities of flavor attributes including goaty, creamy, throat burn and salty than that made by goat milks of the three breeds. Drinkable yogurts made from Turkish Saanen breed had more goaty flavor than those made from Turkish Hair and Maltese goat breeds. The products made by milk provided at the end of lactation period had the highest intensities of goaty flavor. In addition, the intensities of goaty, creamy and cooked flavors in the products made by regular yogurt cultures were higher than those of drinkable yogurts with probiotic cultures.

INTRODUCTION

Drinkable yogurt called "Ayran" is a traditional fermented dairy beverage in Turkey. It is generally described as stirred yogurt of low viscosity. The traditional process includes production of nonsugary yogurt from whole milk with yogurt culture (*Streptococcus salivarius* ssp. *thermophilus*, *Lactobacillus*

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delbrueckii ssp. *bulgaricus*). After the incubation period, the yogurt is cooled, stirred, diluted with water and then some salt is added (TS 1982; Tamime and Robinson 1989). Generally, cow's milk is used to produce drinkable yogurt.

There is a worldwide interest in fermented milk products with probiotics, because they have beneficial effects on human health. It is revealed in many publications that the main therapeutic and health benefits of probiotics are prevention of gastrointestinal disorders, diarrheal disease and colon cancer, and improvement in lactose utilization and immune enhancement (Kailasapathy and Chin 2000; Rolfe 2000). Drinkable yogurt may be more health-promoting when produced with probiotic cultures (*Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacterium bifidum*, *Bifidobacterium longum*, etc.) and goat milk.

Goat milk has many benefits on human health, even more than cow milk. Goat milk and its products such as cheese and yogurt have an important role in human nutrition because of higher digestibility (small fat globules) and less allergic reactions (low αs_1-casein content). The benefits are also attributed to biofunctional components such as medium-chain triglycerides, polyunsaturated fatty acids and some serum proteins (Park 1994; Haenlein 2004; Rampilli and Cortellino 2004). Recent studies showed that goat milk has important and beneficial effects on bioavailability of copper, zinc, selenium and iron (Alferez *et al.* 2003; Barrionuevo *et al.* 2003; Campos *et al.* 2004; Haenlein 2004).

In Turkey, goat milk is produced and consumed locally. Turkish Saanen, Maltese and Turkish Hair goats are the predominant breeds in Canakkale province. The objective of this study was to explore effects of goat breeds, lactation periods and using probiotic cultures on sensory characteristics of drinkable yogurts.

MATERIALS AND METHODS

Milk and Cultures

Turkish Saanen breed's milk was obtained from the Canakkale Onsekiz Mart University Uvecik Yahya Cavus Research Center. Maltese and Turkish Hair breeds' milk were obtained from local farmers in Canakkale. Lactation periods were the beginning of lactation, which was right after colostrum, midlactation, which was after weaning, and end of lactation. Ultra-heat-treated sterilized 3% fatty milk purchased from the local supermarket was used as the cow milk.

To produce drinkable yogurt, yogurt cultures (YO-FLEX YC-350[Y]) and probiotic cultures (BB-12, *B. bifidum* and LA-5, *L. acidophilus* [NU-TRISH]) were obtained from Peyma-Chr. Hansen's (Istanbul) and used as recommended by the manufacturer.

Chemical Analysis of Goat Milk

The pH was measured with pH meter (Hanna H 211, Germany) and titratable acidities in Soxhlet-Henkel degree (°SH) of raw goat milks were analyzed by the methods explained in Turkish Standard (TS) 1018 (TS 1981). Nonfat dry matter, fat, protein and lactose levels of raw goat milks were measured by Milk Analyzer (Lactoscan 90, Bulgaria).

Production of Drinkable Yogurt

Drinkable yogurts without salt and sugar were made from: (1) goat milk; (2) mixed milk of equal amount of goat and cow milk; and (3) cow milk as a control according to TS 3810 (TS 1982) drinkable yogurt (Ayran) standard. In all of the lactation periods, 14 kinds of drinkable yogurts (3 goat breeds × 2 blends [goat and 50/50 goat/cow] + cow milk as control = 7 basic treatments × 2 starter cultures = 14 yogurts at each lactation) were produced using the milk of three different goat breeds and cow milk and using normal yogurt and/or probiotic cultures. All drinkable yogurts were produced in duplicate.

Sensory Analysis

Identification and Development of Descriptive Terms. A roundtable discussion with a six-member panel was carried out to identify descriptive terms using the Spectrum method (Meilgaard *et al.* 1999a). Panelists were selected from volunteer undergraduate/graduate students and academic staff of the Department of Food Engineering. The panelists ($n = 6$: 3 women, 3 men, aged 20–37 years old) received a 30-h training session on descriptive analysis technique including basic tastes and flavor identification, and using a 15-point product specific scale with references (Meilgaard *et al.* 1999b). During the review session, potential references (food or chemical) were presented to the panelists. Then, they selected the best references (Table 1) to represent the identified descriptive terms.

Evaluation of Drinkable Yogurts. Drinkable yogurts with normal ($n = 7$) and probiotic ($n = 7$) cultures produced in each lactation period were presented to the panelists in two sessions. The panelists evaluated drinkable yogurts using a 15-point product specific scale (Meilgaard *et al.* 1999a). Each drinkable yogurt was evaluated in duplicate.

Statistical Analyses

Descriptive statistics including means and frequencies were obtained using SAS V8 (SAS Institute, Inc. 1999). Three approaches were used in

TABLE 1.
DESCRIPTIVE TERMS OF DRINKABLE YOGURTS AND PREPARATION OF REFERENCE MATERIALS

Flavor/Taste	References	Preparation of references
Creamy	Heavy cream	–
Goaty	Goat cheese	–
Fermented	Acetaldehyde	40 ppm
Cooked	Heated milk	Heat milk to 85C for 45 min
Throat burn		Assignment by panel
Sweet	Sucrose	2% sucrose solution
Salty	NaCl	0.2% NaCl solution
Sour	Citric acid	0.05 % citric acid solution
Astringent	Tea	Soak six tea bags in water for 30 min

statistical analyses. The first approach used the generalized linear model (GLM) procedure of SAS to perform univariate and multivariate analyses (MANOVA). The model was:

$$Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, Y_7, Y_8, Y_9 = \mu + A_i + B_k + C_l + D_m + e_{iklm}$$

where:

Y_1 = goaty, Y_2 = creamy, Y_3 = fermented, Y_4 = cooked Y_5 = throat burn, Y_6 = sweet, Y_7 = salty, Y_8 = sour, Y_9 = astringent;
μ = Overall mean;
A_i = fixed effect as a result of drinkable yogurt group (normal or probiotic culture);
B_k = fixed effect as a result of trial block (1 or 2);
C_l = fixed effect as a result of drinkable yogurt from different breeds/species (Cow, Turkish Saanen, Maltese, Turkish hair, Turkish Saanen mixed with equal amount of cow, Maltese mixed with equal amount of cow milk and Turkish hair mixed with equal amount of cow milk);
D_m = fixed effect as a result of lactation period (beginning, middle and end of lactation);
e_{iklm} = random element assumed to be normally and independently distributed with mean of zero and variance σ^2_e.

The error element was assumed to be normally distributed only in the GLM analyses. All two-way interactions and the three-way interaction of breed by lactation period by drinkable yogurt group were included in the model. Because there were excessive number of contrasts to be made, the difference tests were adjusted by the Tukey (1953) method. Because the data were unbalanced, adjustments were approximated using a method defined by Kramer (1956).

The second approach used the GENMOD procedure of SAS to perform likelihood ratio statistics for Type III analysis and the ESTIMATE statement to calculate odd ratios (Ψ) for drinkable yogurt type (breed) and lactation period comparisons. The GENMOD procedure is a general statistical modeling tool that fits GLMs to categorical data. The GENMOD procedure does not require normal distribution and thus, it is a more flexible approach than classical analysis of variance (ANOVA). The normality assumption may not always be reasonable and different methodology must be used in the data analysis when responses are discrete (SAS Institute, Inc. 1999). The GENMOD analyses were run to verify the ANOVA results and obtain the odd ratios, which show the probabilities of contrasts. This procedure used the same fixed effects as the GLM. Cumulative logit function was used because the distribution was multinomial (McCullagh and Nelder 1989).

As a third approach, the data were analyzed in three dimensions using the multidimensional scaling (MDS) procedure in SAS V8 (SAS Institute, Inc. 1999), using breed as the subject effect. Three dimensions were used because the three components accounted for 59% of the total variance. Subsequent components contributed 10% or less each. MacKay and O'Mahony (2002) noted that MDS models represent objects as points and coordinates of the points provide the latent structure values of the sensory objects. MacFie and Thompson (1984), Bieber and Smith (1986), Lawless *et al.* (1995) and Popper and Heymann (1996) covered the use of multidimensional scaling in sensory analysis of foods. MDS analyses were used to provide a visual representation of the pattern of similarities or distances among flavor categories.

RESULTS AND DISCUSSION

Chemical Analysis of Goat Milks

Chemical compositions of raw goat milks used for production of drinkable yogurts are presented in Table 2. According to these results, more variation in fat contents of different breed milk was observed, compared to other major components such as lactose and protein. Fat content was high at the end lactation than at the beginning and midlactation periods. Guo *et al.* (2004) reported that the major components of goat milk are high in early lactation, then they decline rapidly, remain low for a variable length of time and increase again toward the end of lactation.

Sensory Evaluation of Drinkable Goat Yogurts

"Creamy," "goaty," "fermented," "cooked," "throat burn," "salty," "sweet," "sour" and "astringent" were the descriptive flavor and taste terms

TABLE 2.
CHEMICAL COMPOSITION* OF RAW GOAT MILKS

Lactation periods	Breeds	Fat (%)	NFDM (%)	Lactose (%)	Protein (%)	pH	Acidity (°SH)
Beginning	Turkish Saanen	3.34	9.83	4.86	3.25	6.64	5.60
	Maltese	4.60	10.35	5.25	3.45	6.49	8.00
	Turkish Hair	3.33	10.46	5.27	3.49	6.65	6.20
Middle	Turkish Saanen	3.41	9.66	4.77	3.20	6.60	6.15
	Maltese	4.36	10.36	5.14	3.42	6.52	7.20
	Turkish Hair	4.66	10.60	5.19	3.45	6.48	7.50
End	Turkish Saanen	5.77	8.74	4.77	3.21	6.65	6.52
	Maltese	6.63	9.78	5.43	3.59	6.54	7.68
	Turkish Hair	8.35	10.07	5.62	3.7	6.64	7.76

* Mean values of duplicate measurements.
NFDM, nonfat dry matter.

developed for the drinkable goat yogurts (Table 1). Based on the statistical analysis, three-way interaction of breed by lactation period by drinkable yogurt group was only significant for salty taste ($P = 0.03$). Two-way interaction of breed by lactation period was significant for goaty flavor ($P = 0.002$) and throat burn ($P = 0.0037$). Drinkable yogurt group by lactation period interaction was significant for throat burn ($P = 0.02$). Differences between periods of midlactation (2.01) and end lactation (1.5) in normal yogurts were large enough to be significant ($P = 0.014$).

Table 3 shows the overall comparisons of breeds, lactation periods and drinkable yogurt groups by descriptive terms. Breeds by descriptive terms showed that there were significant differences between drinkable yogurts made by cow milk and by goat milks of three breeds for the goaty, creamy, throat burn and salty terms. However, intensities of goaty flavor in drinkable goat yogurts from milk of Turkish Saanen and Maltese breeds were significantly higher than those for drinkable yogurt from milk of Turkish Hair breeds. Pizzillo *et al.* (2005), reported that ricotta cheese made from whey of Sirina and Maltese goat breeds were more goaty than Girgentana and local breeds in Italy ($P < 0.01$). In addition, breed did not affect the intensity of fermented flavor and sweet and astringent tastes. Overall comparisons of lactation periods by descriptive terms showed that intensities of creamy flavor in drinkable goat yogurts were high in the beginning of the lactation period. Intensities of goaty flavor in drinkable goat yogurts were higher in the end of the lactation period and sweety, salty, sour and astringent tastes had low scores in the end of the lactation period. Using regular yogurt or probiotic cultures to make drinkable yogurts significantly affected the intensities of goaty, creamy, cooked, throat burn and astringent attributes. Normal drinkable yogurt group

TABLE 3.
OVERALL COMPARISONS OF BREEDS, LACTATION PERIODS AND DRINKABLE YOGURT GROUPS BY LEAST SQUARE MEANS AND STANDARD ERRORS OF SENSORY ATTRIBUTES*

		Goaty	Creamy	Fermented	Cooked	Throat burn	Sweet	Salty	Sour	Astringent
Breeds	Cow	0.39 ± 0.19^{A}	1.77 ± 0.12^{A}	2.36 ± 0.12^{A}	1.42 ± 0.09^{A}	1.04 ± 0.12^{A}	1.51 ± 0.1^{A}	1.21 ± 0.08^{A}	1.87 ± 0.1^{A}	1.55 ± 0.14^{A}
	Turkish Saanen	3.59 ± 0.19^{BC}	2.38 ± 0.12^{B}	2.32 ± 0.12^{A}	1.72 ± 0.09^{A}	1.89 ± 0.12^{B}	1.77 ± 0.1^{A}	2.08 ± 0.08^{B}	2.18 ± 0.1^{AC}	1.98 ± 0.14^{A}
	Turkish Hair	2.62 ± 0.19^{BD}	2.73 ± 0.12^{B}	2.34 ± 0.12^{A}	1.93 ± 0.09^{B}	1.93 ± 0.12^{B}	1.67 ± 0.1^{A}	2.12 ± 0.08^{B}	2.38 ± 0.1^{BC}	1.99 ± 0.14^{A}
	Maltese	3.06 ± 0.19^{BC}	2.66 ± 0.12^{B}	2.46 ± 0.12^{A}	1.81 ± 0.09^{B}	1.78 ± 0.12^{B}	1.62 ± 0.1^{A}	1.97 ± 0.08^{B}	2.22 ± 0.1^{AC}	1.89 ± 0.14^{A}
Lactation periods	Begin	2.06 ± 0.12^{Y}	2.63 ± 0.08^{X}	2.44 ± 0.08^{X}	1.71 ± 0.06^{X}	1.72 ± 0.07^{X}	1.83 ± 0.07^{X}	2.24 ± 0.06^{X}	2.27 ± 0.07^{X}	2.09 ± 0.09^{X}
	Mid	1.78 ± 0.12^{Y}	2.34 ± 0.08^{Y}	2.49 ± 0.08^{X}	1.76 ± 0.06^{X}	1.78 ± 0.07^{X}	1.77 ± 0.07^{X}	2.07 ± 0.06^{X}	2.29 ± 0.07^{X}	1.81 ± 0.09^{XZ}
	End	2.53 ± 0.12^{X}	2.22 ± 0.08^{Y}	2.36 ± 0.08^{X}	1.84 ± 0.06^{X}	1.56 ± 0.07^{X}	1.38 ± 0.07^{Y}	1.29 ± 0.06^{Y}	1.93 ± 0.07^{Y}	1.55 ± 0.09^{YZ}
Yogurt groups	Normal	2.27 ± 0.10^{P}	2.56 ± 0.06^{P}	2.50 ± 0.06^{P}	1.88 ± 0.05^{P}	1.80 ± 0.06^{P}	1.68 ± 0.05^{P}	1.87 ± 0.05^{P}	2.21 ± 0.06^{P}	1.93 ± 0.07^{P}
	Probiotic	1.98 ± 0.10^{T}	2.24 ± 0.06^{T}	2.36 ± 0.06^{P}	1.66 ± 0.05^{T}	1.58 ± 0.06^{T}	1.63 ± 0.05^{P}	1.86 ± 0.05^{P}	2.12 ± 0.06^{P}	1.70 ± 0.07^{T}

Column values with different superscripts ($^{A,\ B,\ C\ and\ D;\ X,\ Y\ and\ Z;\ P\ and\ T}$) differ ($P < 0.05$).

* Attributes were scored on a 15-point universal Spectrum product specific scale where 0 = absence of the attribute and 15 = extremely high intensity of the attribute (Meilgaard *et al.* 1999a).

had higher goaty, creamy, cooked, throat burn and astringent intensities than probiotic drinkable yogurt group. However, no significant differences were observed in drinkable yogurt groups in terms of fermented flavor, sweet, salty and sour tastes intensities (Table 3). In the MANOVA, overall effects of breed, lactation period and drinkable yogurt group on descriptive terms were highly significant ($P < 0.01$).

According to GENMOD likelihood ratio statistics for Type 3 analysis, interaction of breed by lactation period was significant for goaty ($P = 0.0007$), throat burn ($P = 0.0004$) and cooked flavors ($P = 0.018$). Breed by drinkable yogurt group was significant for creamy ($P = 0.027$), and drinkable yogurt group by lactation period was significant for throat burn ($P = 0.01$). The GENMOD likelihood ratio statistics for Type 3 analysis and GLM (ANOVA) agreed for goaty and throat burn terms but disagreed for creamy and cooked flavors.

Odds ratio estimates for the breeds and lactation periods are given in Table 4 for each flavor attribute. The odds ratios indicate the relative differences between drinkable yogurts made by milks of cow and the goat breeds of Turkish Saanen, Turkish Hair and Maltese and the relative differences among the lactation periods.

The odds of drinkable cow yogurt being in lower goaty flavor categories were 436 times that of drinkable Turkish Saanen yogurt being in lower goaty flavor categories. Because the lower categories represent less goaty flavor; this indicates that drinkable Turkish Saanen yogurt had goatier flavor than the control, cow milk. Similarly, the odds of drinkable cow yogurt being in lower goaty flavor categories were 171 times that of drinkable Turkish Hair yogurt and 274 times that of drinkable Maltese yogurt being in lower goaty flavor categories.

The odds of drinkable Turkish Saanen goat yogurt being in lower goaty flavor categories were 0.39 times that of Turkish Hair goat and 0.62 times that of Maltese yogurt being in lower goaty flavor categories, which means that Turkish Saanen yogurt had more goaty flavor than both Turkish Hair and Maltese goat breeds. The goaty flavor originates from some free fatty acids such as 4-methyloctanoic acid and 4-ethyloctanoic acid in the goat milk (Morgan and Gabroit 2001; Carunchia Whetstine *et al.* 2003). These compounds are produced by lipolysis of lipid fraction of milk. Several genetic and environmental factors influence initial milk lipolysis, which has an important role in producing the typical flavor of goat milk (Morgan and Gabroit 2001). Odds ratios of pure goat yogurt versus cow yogurt were much higher (171- to 436-fold) than those of mixed goat yogurt versus cow yogurt (27–81, Table 4). This indicates that using a mixture of equal amounts of goat and cow milks for drinkable yogurt production improves the taste by decreasing goaty flavor.

TABLE 4.
ODDS RATIOS FOR SENSORY ATTRIBUTES* OF DIFFERENT DRINKABLE YOGURTS FROM FOUR BREEDS AND LACTATION PERIODS

	Goaty	Creamy	Fermented	Cooked	Throat burn	Sweet	Salty	Sour	Astringent
Cow*Turkish Saanen	436	4.32	0.97	2.56	7.53	1.79	12.8	1.96	2.31
Cow*Turkish Hair	171	8.43	0.97	4.22	8.32	1.65	14.0	2.82	2.81
Cow*Maltese	274	7.48	1.31	2.94	6.14	1.24	10.3	1.93	2.30
Saanen*Turkish Hair	0.39	1.95	0.99	1.65	1.10	0.92	1.09	1.44	1.21
Saanen*Maltese	0.62	1.73	1.34	1.15	0.81	0.69	0.80	0.98	0.10
Kil*Maltese	0.47	0.89	1.35	0.70	0.74	0.75	0.74	0.68	0.82
Cow*Turkish Saanen 50%	80.8	4.59	1.30	2.88	6.39	1.31	10.6	1.66	1.62
Cow*Turkish Hair 50%	26.9	6.32	1.60	2.89	3.62	1.81	6.29	1.77	1.84
Cow*Maltese 50%	38.0	4.01	1.32	3.28	6.85	1.49	7.19	1.96	2.17
Saanen*Turkish Hair 50%	0.33	1.37	1.23	1.00	0.57	1.38	0.59	1.07	1.13
Saanen*Maltese 50%	0.47	0.87	1.01	1.14	1.07	1.14	0.68	1.18	1.34
Turkish Hair*Maltese 50%	1.41	0.63	0.82	1.13	1.89	0.83	1.14	1.11	1.18
Lac per begin-mid	0.59	0.62	1.19	1.20	1.31	0.91	0.65	1.08	0.75
Lac per begin-end	1.74	0.52	0.91	1.45	0.81	0.37	0.07	0.47	0.52
Lac per mid-end	2.97	0.83	0.77	1.20	0.62	0.41	0.11	0.44	0.69

* Attributes were scored on a 15-point universal Spectrum product specific scale where 0 = absence of the attribute and 15 = extremely high intensity of the attribute (Meilgaard *et al.* 1999a).
Lac per, lactation period.

TABLE 5.
MULTIDIMENSIONAL SCALING DIMENSIONS

	Dimension 1	Dimension 2	Dimension 3
Creamy	0.08	1.76	0.82
Goaty	0.41	–0.31	1.76
Fermented	1.91	0.56	–0.36
Cooked	–0.97	1.07	–1.00
Throat burn	–1.35	0.04	0.88
Sweet	0.24	0.00	–0.01
Salty	–1.32	–1.10	–0.54
Sour	0.76	–1.75	0.17
Astringent	0.24	–0.27	–1.73

The odds ratios showed that drinkable cow yogurt also had lower creamy flavor than all the drinkable goat yogurts. Fat content of cow milk was also lower than goat milks used to make drinkable yogurts.

The odds of drinkable cow yogurt and drinkable Turkish Saanen, Turkish Hair and Maltese yogurts presented in Table 4. The results showed that cow yogurt had less throat burn than the others. Abrahamsen and Rysstad (1991) reported that yogurt starters were able to produce some carbon dioxide and yogurt made from goat milk produced higher carbon dioxide than yogurt made from cow milk. Throat burn sensation may be associated with carbon dioxide found in yogurt.

The odds ratio estimates of drinkable Turkish Saanen, Maltese and Turkish Hair goat yogurts for salty taste clearly indicated that drinkable cow yogurt being in lower salty taste categories was higher compared with the others. All odds ratios for all comparisons and for all factors are given in Table 4. Cow milk was in lower categories for all the terms except for fermented flavor of Turkish Saanen and Turkish Hair.

Odds of different lactation periods were also calculated. The odds ratio of the beginning of lactation period of drinkable yogurt having less goaty flavor than midlactation drinkable yogurt was 0.59, which means that the starting lactation period milk tends to produce drinkable yogurt with goatier sensation (odds ratio less than 1). The odds ratio for starting period of lactation versus the end lactation was 1.74 and that for midlactation versus end lactation was 2.97. According to these, end lactation had the highest goaty flavor followed by beginning of the lactation and midlactation, which had the lowest score of goaty flavor. All other odds ratios related to lactation periods are given in Table 4.

MDS is a method similar to factor analysis. Using this method, clusters of variables can be visually plotted. In Table 5, the higher values indicate more contribution to the factor in question. The fermented flavor contributed more to the first underlying factor (or dimension) or principal component while creamy

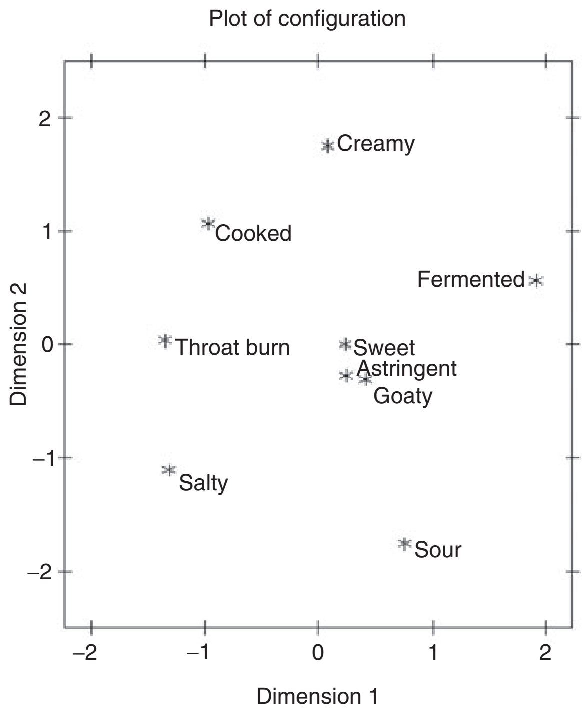

FIG. 1. VISUAL REPRESENTATION OF THE VARIABLES, WITH THE FIRST TWO DIMENSIONS

contributed more to the second underlying factor, and goaty flavor contributed more in the third dimension. In Figs. 1 and 2, the horizontal axis is the main principal component and the vertical axis is the second or third principal component.

In Table 5, the first dimension has a very high positive loading on fermented flavor, and high negative loadings on cooked, throat burn and salty taste. This indicates that the latent underlying factor symbolized with dimension 1 influences mostly the fermented flavor. The second dimension has high positive loadings on creamy and cooked flavors and high negative loadings on salty and sour tastes. Dimension 3 has high positive loadings on goaty, creamy and throat burn and negative loadings on astringent taste.

In Fig. 1, sweet, astringent, goaty and throat burn seem to be clustered together in the center, influencing the goat milk characteristics together in the different breeds. Dimension 1 separates cooked, throat burn and salty from fermented and sour. Dimension 2 separates cooked, creamy and fermented from salty and sour.

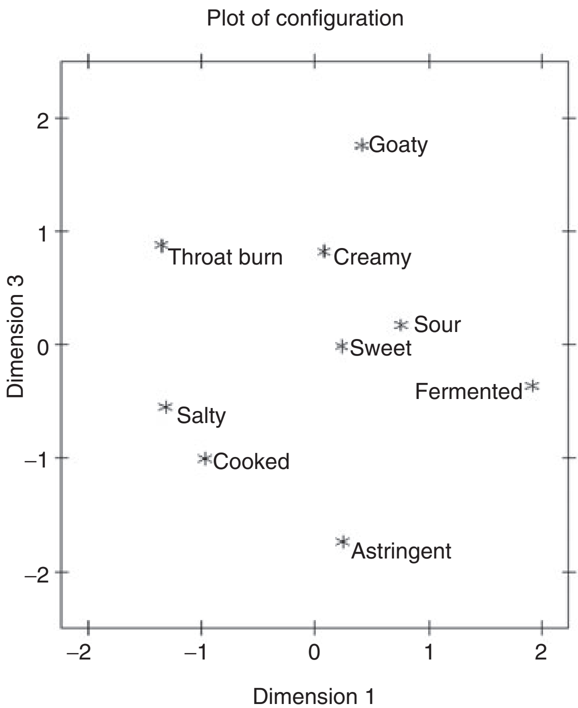

FIG. 2. VISUAL REPRESENTATION OF THE VARIABLES, WITH THE FIRST AND THIRD DIMENSIONS

Figure 2 shows the variables on a plot with the first and third dimensions. In this figure, goaty, throat burn and astringent terms were clearly separated from other descriptors; however, creamy, sour, sweet and fermented terms clustered together. In addition, salty and cooked terms clustered together. Dimension 1 separates throat burn, cooked and salty taste from fermented sour and goaty. Dimension 3 separates goaty, throat burn and creamy from salty, cooked and astringent.

CONCLUSION

Three approaches (GLM, GENMOD and MDS) were used to analyze the data. The effects of using different breeds' goat milk and probiotic cultures to produce drinkable yogurt in three lactation periods on sensory properties were investigated. Nine common descriptors were identified to describe drinkable goat yogurt. In general, drinkable yogurts made by cow milk had lower intensities of sensory attributes than drinkable yogurts of goat milk. In addition, different breeds, lactation periods and probiotic cultures affected the sensory attributes of the products. Drinkable yogurts produced at the end lactation period had the highest intensity of goaty flavor. Using a mixture of equal amount of goat and cow milks to produce drinkable yogurt improves the flavor by decreasing goaty flavor.

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