Influence of hygiene status of cows on somatic cell count and milk components during summer season

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SUMMARY

Introduction - Keeping cows in clean and healthy condition is one of the most important management practices for obtaining quality milk. Therefore, cleaning and hygiene processes have great importance for dairy farms. Although the bacterial count of raw milk has been accepted as the most reliable parameter, somatic cell count (SCC) has widely been used to detect milk quality or mastitis. In addition, hygiene score (HS) scales are used to determine cow hygiene status. Many publications are available on milk SCC in dairy cows. However, the number of studies on the association of HS with SCC and milk components in dairy cows has been limited. Therefore, further investigations are required to determine the effect of HS on SCC and milk components in dairy cows.

Aim - The objective of this study was to determine the relationships of hygiene status of udders and teats with SCC and milk components in cows.

Materials and methods - Holstein (n = 32), Simmental (n = 46) and Holstein x Simmental crossbred (n = 37) cows reared at the private dairy farm in the Samsun region of Turkey were scored by sanitary conditions of udders (UHS), rear legs (LHS) and flanks (FHS) using a scale with 1 to 4 points (1 = very clean and 4 = very dirty). The SCC data were obtained by a portable cell counter (DeLaval, Tumba, Sweden), and fat (F), total dry matter (TDM), protein (P), lactose (L) and total minerals (M) were analyzed using an automatic milk analyzer (Lactostar, Funke-Gerber, Berlin, Germany).

Results and discussion - The most frequent scores for UHS, LHS and FHS were 1 (59.0%), 2 (44.4%) and 1 (68.4%), respectively. Raw milk samples were analyzed by TDM, F, P, L, M and SCC. It was determined that L and M differed ($P<0.01$) by breeds and that all components were affected ($P<0.01$) by sampling months and hygiene scores, except for F. The greatest dirtiness by UHS and FHS was recorded from Holstein cows ($P<0.01$) in June and July, and June, July and August, respectively.

Conclusion - Results of the study show that the hygienic status of cows is crucial to ensure high quality bovine raw milk. It is suggested that cows with UHS≥3 points should be avoided in the herds.

KEY WORDS

Cow, Hygiene, Management, Milk composition, Milk quality.

INTRODUCTION

Keeping cows in clean and healthy condition is one of the most important management practices for obtaining quality milk. Bovine raw milk may be discarded due to structural properties, severity of contamination and environmental conditions. Financial loss due to udder inflammation in the U.S. has been reported to be 1.7 billion dollars per year.[1] That is why cleaning and hygiene processes are important to prevent environmental contamination in dairy farms. An animal's body counteracts microbial contamination via somatic cell count (SCC) in the milk. This defense mechanism is one of the most important factors that reduces the quality and consumable level of raw milk. Normally, dairy cattle are exposed to pollution in wetlands and muddy areas where intensive husbandry has been performed. Therefore, milk quality is highly influenced by this environmental pollution. In other words, hygienic milk production requires more effort due to increased microorganism population in hot and humid months.[2] Udder and leg hygiene are among the most important causes of intramammary infections and also affect the hygienic quality of milk.[3] Reports state that elevated levels of dirtiness or high hygiene scores are correlated with high SCC in milk.[4,5] Actually, high SCC and hygienic conditions can be expected to adversely affect an animal's health. This situation also affects the possibility of processing milk products because of the increase of the acidity of raw milk due to increases in the number of microorganisms. Furthermore, this case causes large economic losses in dairy farms. In Turkey, lactation milk yield (LMY) and financial losses due to high SCC per Holstein cow were estimated to be 11.62% and 217.8 USD, respectively.[6] This case clearly indicates that the basic way to obtain hygienic and quality raw milk is closely related to clean and healthy dairy cows. In this context, hygiene score (HS) scales may be used to determine cows' hygiene status.

Recently, increased demands for hygienic and safe foods revealed the relationship of hygiene with SCC, which has been assumed to be a reliable parameter to detect milk quality. Some studies have been focused on milk SCC in dairy cows.[7] Nevertheless, reports on the relationship of hygienic scores with SCC and milk components in different bovine breeds are still limited. Revealing these associations will add important information to the literature.

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The objective of this investigation was to determine the associations of hygiene status with SCC and milk constituents in three cattle breeds.

Materials and Methods

Animal Selection

Holstein (n = 32), Simmental (n = 46) and Holstein x Simmental crossbred (n = 37) cows raised under small-sized farm conditions at a private dairy farm in Samsun, Black Sea region of Turkey and their milk samples constituted the study material. All cows were housed in closed barns with concrete ground under similar feeding conditions. The cows were milked by machine twice a day during the research period. In total, 115 milk samples were collected from the cows before morning milking processes in four sampling times between June and September 2015. The meteorological data obtained included monthly temperature, humidity and rainfall averages, which changed from 21.1-25.6°C, 63.8-70.4% and 16.0-80.3 mm/m^2, respectively, during this study. The dairy farm was visited once a month, hygiene scoring was performed before milking and then milk samples were taken.

Hygiene Scoring

To evaluate the hygienic status of the animals, each cow was scored for the sites of udder (UHS), rear legs (RHS) and flank hygiene (FHS). A 1 to 4 scale (1 = absolutely clean, 2 = clean, 3 = dirty and 4 = very dirty) was used.[3] If the body parts were free of soil or manure, the cow was scored as 1; if the parts were markedly contaminated, the cow was scored as 4. Scoring was applied by the same assessor prior to the morning milking process. In consecutive scoring time, the initial points of the cows were not ignored.

Milk Analysis

To test milk by SCC and milk components, approximately 50 ml milk samples were collected from each cow before morning milking in a closed bag and immediately transferred to a laboratory on the same day. The samples were thawed in a 30 °C warm water bath and then analyzed by fat (F), total dry matter (TDM), protein (P), lactose (L) and total minerals (M) using an automatic milk analyzer (Lactostar, Funke-Gerber, Berlin, Germany). The SCC data were obtained by a portable cell counter (DeLaval, Tumba, Sweden).

Statistical Analysis

In the statistical work, three body areas (udder, rear legs and flanks) and four months groups were assessed. Three groups were designed for the breed of cows (1 = Holstein, 2 = Simmental and 3 = crossbred). To ensure homogeneity and normality in variance, SCC data were transformed to log10 before the statistical evaluation. Then Kolmogorov-Smirnov test was performed for normality.

The linear model was as follows:

$$yijkl = \mu + ai + bj + ck + eijkl$$

where yijkl is the observation value, μ is the overall mean, ai is the effect of test month (i = 1, 2, 3 and 4), bj is the effect of breed (j = 1, 2 and 3), ck is the effect of HS (k = 1, 2, 3 and 4) and eijkl is random error.

Table 1 - Distribution of hygiene scores.

Hygiene score	Percentage (%)		
	UHS	LHS	FHS
1 (very clean)	59.0	23.1	68.4
2 (clean)	28.2	44.4	18.8
3 (dirty)	10.2	24.8	8.5
4 (very dirty)	2.6	7.7	4.3

UHS: udder hygiene score, LHS: rear leg hygiene score, FHS: flanks hygiene score.

To determine the relationships of UHS, LHS and FHS with SCC and milk components, Kendall's Tau-b correlation coefficients were determined. All statistical analysis were performed using SPSS 17.0.

RESULTS

Table 1 gives frequencies for UHS, LHS and FHS of cows according to score groups. HS scored as very clean and had the highest percentages by UHS and FHS, but the score of clean was the highest by LHS in the herd.

Table 2 presents changes of the components and SCC of milk by investigated factors. The means of the milk components were statistically significant ($P<0.01$) for all four sampling months. In evaluation of three different body areas, effects of HS for all areas were determined to be significant ($P<0.05$ or $P<0.01$) except for F (Table 2). The lowest TDM, protein and lactose percentage were found in cows with high UHS, LHS and FHS (cows with 4 points). Actually, the effect of HS elevated M and SCC but reduced the other components. Moreover, examined cows of the first group in this study had relatively low SCC (logSCC 4.321), which might be regarded as a positive case for milk quality.

This research determined that UHS and FHS were affected ($P<0.01$) by breeds and the means were higher in the Holstein breed compared to the other breeds (Table 3). The LHS and FHS of cows were statistically significant ($P<0.01$) for all four sampling months.

Table 4 shows correlations of the evaluated parameters. Briefly, positive and significant correlation coefficients ($P<0.01$) were estimated among three HS traits. While the association of HS with SCC was also significant ($P<0.01$), the highest correlation coefficient was calculated between UHS and SCC ($r = 0.543$). Furthermore, similar positive relationships were estimated between three HS data and SCC.

DISCUSSION

It can be assessed as favorable that a high portion of cows had 1 UHS during the whole study period (Table 1). This result aligns with findings of some studies.[8,9,10] According to this finding, it can be suggested that hygienic measures on udder cleaning were adequate in the evaluated farm. UHS and LHS means were found to be 2.09 and 2.33, respectively, in an earlier study.[3] In another investigation,[8] FHS, LHS and UHS means were estimated to be 1.95, 2.42 and 1.77, respectively. Furthermore, Dohmen et al.[11] estimated UHS, FHS

Table 2 - Change of milk composition by breed, month and hygiene scores.

Breed	N	TDM (%)	Fat (%)	Protein (%)	Lactose (%)	Minerals (%)	LogSCC
		NS	NS	NS	P<0.01	P<0.01	NS
Holstein	32	11.51	3.45	2.95	3.98[a]	0.959[b]	4.894
Simmental	46	11.77	3.38	3.07	4.27[b]	0.836[a]	4.551
Crossbred	37	11.97	3.65	3.03	4.27[b]	0.871[a]	4.679
Month	N	P<0.01	P<0.01	P<0.01	P<0.01	P<0.01	NS
June	26	10.93[a]	2.98[a]	2.89[a]	3.97[a]	0.834[a]	4.566
July	32	11.78[b]	3.33[a]	3.08[b]	4.21[a]	0.911[ab]	4.815
August	29	12.37[b]	4.09[b]	2.99[ab]	4.08[a]	0.843[a]	4.728
September	28	11.89[b]	3.49[ab]	3.13[b]	4.47[b]	0.933[b]	4.612
UHS	N	P<0.01	NS	P<0.01	P<0.01	P<0.01	P<0.01
1	68	11.99[b]	3.56	3.12[b]	4.32[b]	0.852[a]	4.321[a]
2	32	11.63[b]	3.40	2.96[b]	4.09[b]	0.875[a]	4.983[b]
3	12	11.53[b]	3.60	2.86[b]	4.01[b]	0.953[a]	5.601[bc]
4	3	9.01[a]	2.46	2.23[a]	3.05[a]	1.353[b]	6.184[c]
LHS	N	P<0.01	NS	P<0.01	P<0.01	P<0.01	P<0.01
1	27	11.92[b]	3.43	3.14[b]	4.427[c]	0.877[a]	4.191[a]
2	52	12.08[b]	3.75	3.07[b]	4.22[b]	0.862[a]	4.750[b]
3	27	11.32[ab]	3.10	2.95[b]	4.07[ab]	0.881[a]	4.836[bc]
4	9	10.80[a]	3.37	2.64[a]	3.64[a]	1.016[b]	5.372[c]
FHS	N	P<0.05	NS	P<0.01	P<0.01	P<0.01	P<0.01
1	79	11.71[b]	3.33	3.07[b]	4.27[b]	0.864[a]	4.474[a]
2	21	12.14[b]	3.97	3.01[b]	4.14[b]	0.853[a]	4.884[ab]
3	10	12.15[b]	3.90	2.97[b]	4.10[b]	0.923[a]	5.433[bc]
4	5	10.16[a]	3.15	2.44[a]	3.32[a]	1.208[b]	5.746[c]
Overall	N	X±Sx	X±Sx	X±Sx	X±Sx	X±Sx	X±Sx
	115	11.76±0.12	3.49±0.10	3.02±0.03	4.19±0.04	0.882±0.0118	4.688±0.0661

NS: not significant. a,b,c: means with different letters in the same column differ significantly.

Table 3 - Change of hygiene scores by breed and months.

Breed	UHS		LHS		FHS	
	N	X±Sx**	N	X±Sx NS	N	X±Sx**
Holstein	32	1.94±0.168[b]	32	2.34±0.166	32	2.00±0.206[b]
Simmental	46	1.37±0.100[a]	46	2.13±0.138	46	1.26±0.079[a]
Crossbred	37	1.49±0.107[a]	37	2.03±0.119	37	1.32±0.095[a]
Month	N	X±Sx NS	N	X±Sx**	N	X±Sx**
June	26	1.88±0.160	26	2.81±0.167[b]	26	1.62±0.176[ab]
July	32	1.59±0.148	32	2.44±0.118[b]	32	1.81±0.198[b]
August	29	1.45±0.127	29	1.93±0.121[a]	29	1.34±0.090[ab]
September	28	1.36±0.138	28	1.46±0.141[a]	28	1.14±0.085[a]
Overall	N	X±Sx	N	X±Sx	N	X±Sx
	115	1.57±0.073	115	2.16±0.082	115	1.49±0.077

** P<0.01, NS: not significant. a,b: means with different letters in the same column differ significantly.

Table 4 - Correlation coefficients of hygienic scores and milk components.

	LHS	FHS	TDM	F	P	L	M	SCC
UHS	0.512**	0.435**	-0.169*	-0.070	-0.355**	-0.338**	0.238**	0.543**
LHS		0.293**	-0.166*	-0.085	-0.304**	-0.355**	0.037	0.291**
FHS			0.036	0.117	-0.206**	-0.227**	0.115	0.344**

* P<0.05, ** P<0.01.

and LHS to be 2.76, 2.54 and 2.40, respectively. In our study, UHS, LHS and FHS means were calculated as 1.57, 2.16 and 1.49, respectively. DeVries et al.[5] reported higher HS values compared to our findings. Observed variations among the obtained results can be explained by the multi-effects of the different geographical locations, management and housing of the cows.

The effect of breed was significant for L and M ($P<0.01$) (Table 2). Normally, it can be expected that components and SCC of milk are affected by the breed of the animal. Caraviello et al.[12] emphasized that breed was an important factor for SCC, but a variation could be observed by cow breeds for resistance to mastitis. In this study, L was determined to be relatively low, but M was higher in Holstein milk samples compared to Simmental and crossbred milk samples. Schreiner and Ruegg[3] reported similar differences in milk components depending on cow breeds, and in this context, these findings may be assumed to be common.

During the investigation period, components of milk generally tended to rise from June to September (Table 2). This can be explained because it was the season when dry matter of pasture increases, but watery-green forages decreases toward the end of the grazing period.[13] As UHS, LHS and FHS of cows rose, TDM, protein and lactose percentages tended to decrease. These results can be explained by the low number of examined cows in the latest HS groups. A remarkable increase of HS values was found in conjunction with elevated SCC in the study (Table 2). This case reflects the change of hygienic quality of bovine raw milk. Similar to this finding, many study results[3,4,5,11] indicated that increased SCC as an indicator of udder infection is a result of clinical and subclinical mastitis in dairy herds. At this point, the increased M percentage with high HS values in our study might be explained by alteration of milk composition parameters related to high SCC. Therefore, monitoring SCC within the minimal threshold may especially be advised to herd owners to achieve hygienic and quality raw milk in the herds.

This study determined that UHS and FHS were affected by breeds, and the means were higher in the Holstein breed compared to the other breeds (Table 3). In an earlier study,[3] significant differences were reported in Holstein and Jersey cows in terms of LHS and SCC. This case might be assumed to be a behavioral characteristic, and it should be separately investigated. However, the changes of LHS and FHS could be explained by climatic effects (monthly average temperature, humidity and rainfall differences) or a decline in dirtiness factors in the barn. In a study, Sant'anna and Paranhos da Costa[14] reported a lower amount of dirtiness of cows between August and November.

The high correlation coefficient between UHS and logSCC up to 0.543 might be explained by the increased SCC during the microorganism invasion with elevated UHS to combat them (Table 4). However, the significant correlations among the investigated three HS traits should also be regarded. In a parallel study,[9] statistically significant correlations were also calculated among LHS, FHS and UHS. In our study, all HS values negatively correlated with P and L, but correlated positively with M and SCC. Also, UHS and LHS negatively influenced TDM percentage of milk. Obtained results clearly point out the changes of ionic concentrations and important ingredients of milk related to the dirtiness of the animals. As a result of the damage of the udder tissue in the event of mammary gland infection, concentrations of F, P and L decreased, and concentrations of M, especially Na and Cl, increased.[15] Clearly, dirtiness has a great effect on milk components and SCC.

CONCLUSIONS

It can be concluded that the hygienic status of cows is important to ensure healthy and quality bovine milk. In this respect, microorganisms and SCC should be minimized in raw milk. Managing cows with clean conditions is beneficial to collecting more quality raw milk. Also, cows with UHS≥3 points should be avoided in the dairy herds.

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