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Effects of Feeding Management on Milk Yield and Composition Traits in Crossbred Jersey Cows

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ABSTRACT

This aim of this study was to determine the effect of some different feeding and management practices on milk production and traits in Jersey crossbred cows. A total of 78 smallholder dairy farms in the Middle Black Sea region province of Turkey was investigated by raw milk composition (fat (F), protein (P), lactose (L)), density (D), freezing point (FP), somatic cell count (SCC) and daily milk yield (DMY) according to the different feeding applications (grazing (G), silage usage (S), compound feed usage (C), number of milking cow (NMC), calf suckling period (CSP)). Average F (3.144±1.931%), P (3.022±0.448%), L (4.475±0.669%) and logSCC (5.386±0.529) values were within acceptable ranges. The present investigation revealed that feeding practices had an important role on both milk quality and quantity of Jersey crossbred cows. Therefore, it is suggested that procedures including proper feeding implementations should exactly be managed on the herds.

INTRODUCTION

Milk yield and composition is of importance for raising economical incomes of dairy farms and also for meeting the nutrional requirements of humans. Milk quality, which is closely related to milk composition, is significant at least as milk yield and for this reason it should be taken into consideration. Milk composition is also important for processing of raw milk to produce milk products such as cheese, butter and yogurt etc (Ahn *et al*., 2011; Contarini and Povolo, 2013). All these factors put forth the importance of pricing of milk and its products based on their quality.

There are several factors apart from heredity affecting the milk yield and quality. Among these factors are feeding regime, season, diseases, age, lactation stage and milking interval. While some of these factors affect the lactation milk yield, others lead to diurnal effects in milk yield and quality. These factors also can lead to some drawbacks on milk hygiene quality. In this case, total bacteria and somatic cell counts in milk increase and consequently both human health and milk product quality are negatively affected.

The most important factors affecting the milk yield and milk quality are the nutrition level of animals and also ration composition. Under normal nutritional conditions, cows have capacity or ability of producing milk of average quality and yield specific to their races.The feeds with unbalanced composition lead to decrease in milk yield and also, some changes in fat, protein and dry matter contents of milk. Consequently, technological traits and quality of milk is impaired and economical losses can be occurred.

Fat is the mostly affected component of milk by different feeds and feeding practices. The more forage is in ration, the more acetic acid production is in rumen. As acetic acid is the precursor of milk fat, the simplest way of increasing milk fat percentage is to enhance the forage proportion in total ration. But, high amount of forage or low quality forage increase milk fat percentage but decrease milk yield and milk fat yield. Protein is another milk component which is affected by nutritional factors. Use of easily degradable carbohydrates such as starch can lead to increase in milk protein content, but also decreases ruminal acetic acid production and consequently milk fat percentage.

Somatic cell count (SCC), which is a significant milk quality indicator, affects milk composition. The increase in SCC leads to losses in farm economy by decreasing the milk yield (Peeler *et al*., 2002; Atasever and Erdem, 2009). The increased SSC levels lead to occurrence of undesired taste and aroma in milk and also reduce shelf life of milk and milk products. Furthermore, increased SCC decreases the protein, fat and lactose contents of milk (Rekik *et al*., 2008).

Freezing point (FP) and density (D) are generally used for determination of adulteration (water addition) or tricks in raw milk (Ayaşan *et al*., 2011). Both parameters

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are affected by various factors such as nutrition and milking time (Roca-Fernandez, 2014). It was reported that D should be ranged between 1.028 and 1.039 g/cm^3 for Turkey standards (Ayaşan *et al*., 2011). The minerals found in milk have many vital roles such as bone formation, water balance maintenance, enzyme functions and oxygen transport. Also, organic trace mineral supplementation can improves the production and fertility in lactating dairy cows (Rabiee *et al*., 2010). While seasonal and regional differences in terms of mineral contents were found significant by some authors (Lindmark-Mansson *et al*., 2003), feeding of mineral complex to milking cows decreased SCC, increased milk production and improved integrity of hoof tissue (Ramos *et al*., 2012).

MATERIALS AND METHODS

The study was carried out at seventy eight small-scale dairy farms in Samsun province, which is located in the Black Sea region of Turkey. The farms had Jersey crossbred cows which were milked two times a day. To evaluate raw milk composition and SCC, 30 ml bulk milk samples were aseptically collected from each farm after morning milking and laboratory analyses were performed in the same day. Contents of fat (F), non-fat dry matter (NFDM), protein (P), lactose (L) and mineral (M), and values for density (D) and freezing point (FP) were analyzed by an automatic milk analyzer (Funke Gerber, Germany). SCC analyses were made with DeLaval cell counter DCC (DeLaval, Sweden). To ensure homogeneity of variance, all SCC values were transformed into log scale (log10) for statistical work.

Information related to feeding practices [grazing (G), silage usage (S), compound feed usage (C) daily feed intake (DFI)], milking practices [number of milking cow (NMC), calf suckling period (CSP) and daily milk yield (DMY)] were collected by questionnaires. To evaluate parameters by effective feeding factors; two groups were allocated for each factor and the means were compared on the 0.05 level of probability. The data were tested by independent-simple *t*-test and correlation coefficients among investigated parameters were estimated using Pearson correlation method. All statistical analyses were performed using SPSS 17.0 packet program.

RESULTS

As seen in Table I, F increased (P<0.05) and NFDM, P, L and DMY decreased (P<0.05) in milk samples collected from farms in which cows grazed. The NFDM, P, L, D, FP and SCC were found lower in milk samples obtained from farms in which cows were fed silage (P<0.05). Interestingly, all parameters decreased in first group and this difference was significant (P<0.05) except for F, M and DMY, statistically. While no significant effect of FF determined on F, M and SCC, other parameters determined in the second groups were higher than those calculated for the second groups (P<0.05). From milk components, F, NFDM, P, L and D decreased in milk of cows consumed higher feed, however, FP, M, SCC and DMY were not affected by TFC, statistically. Using more staff in feeding (SF) elevated (P<0.05) NFDM, P, L, D, FP and SCC. In NMC groups, F, FP and SCC were found to be lower, but D was determined to be higher in the second group. Conspicuously, only logSCC was significantly (P<0.05) affected by CSP in the study, and it could be seen from Table I that cows with shorter suckling period had higher SCC in milk.

In the present study, average F (%), NFDM (%), P (%), L (%), D, FP, M (%), logSCC and DMY (kg) were determined to be 3.14±1.93, 8.194±1.14, 3.02±0.44, 4.47±0.66, 1.02±0.005, 0.46±0.04, 0.77±0.07, 5.386±0.529 and 8.10±3.13, respectively.

The correlation coefficients among the investigated parameters are presented in Table II. As seen, F negatively correlated with D (P<0.01) whereas positively correlated with FP (P<0.01), M (P<0.05) and SCC (P<0.01). Besides, NFDM correlated with P, L, D and FP (P<0.01). Similarly, correlation coefficients of P with L, D and FP were highly significant (P<0.01). While L correlated with D and FP (P<0.01), D also correlated with FP, significantly (P<0.01). In addition, significant correlations were determined between FP and M (P<0.01) or SCC (P<0.05). Intercalarily, DMY only correlated with M (P<0.05) and SCC (P<0.01).

As seen from Figure 1, highest milk production was obtained in the first SCC group (P<0.05). After a drastic reduction of DMY by 44.73%, production slightly elevated in the last group (SCC >500x10^3 cells/ml).

DISCUSSION

Some earlier studies (Neveu *et al*., 2013; Alstrup *et al*., 2015; Boerman *et al*., 2015) revealed that forage caused to increase in milk F and decrease in milk P percentages. Similar findings were found in our study (Table I). Indeed, the cows those grazed produced milk with rich F and poor P content. The higher F content of milk obtained from forage consuming cows can be due to the fact that forage consumption lead to increase in rumen acetic acid content, which is precursor of milk fat synthesis (Maxin *et al*., 2011). With regard to obtained F values, negative effect of forage for NFDM might be assumed to be an expected result. L content decreased due to the

Table I.- Means (±SD) of milk components, log SCC and DMY according to feeding management factors.

		n	F (%)	NFDM (%)	P (%)	L (%)	D (gr/cm3)	FP (0C)	M (%)	logSCC	DMY (kg)
FA	1	45	3.45±2.45[a]	7.85±1.33[a]	2.88±0.52[a]	4.27± 0.77[a]	1.02± 0.00[ab]	0.46± 0.04	0.76±0.07	5.42±0.59	7.80±2.32[a]
	2	33	2.72±0.59[b]	8.65±0.58[b]	3.20±0.22[b]	4.75± 0.33[b]	1.03±0.00[ab]	0.47± 0.03	0.77±0.08	5.33±0.41	8.51±3.99[b]
S	1	17	2.45±1.34	7.99±1.98[a]	2.96±0.75[a]	4.37±1.12[a]	1.02±0.00[a]	0.44±0.06[a]	0.71±0.07	5.08±0.66[a]	7.26±2.36
	2	61	3.33±2.03	8.25±0.79[b]	3.04±0.32[b]	4.50±0.48[b]	1.02±0.00[b]	0.47±0.03[b]	0.78±0.07	5.47±0.45[b]	8.33±3.29
FF	1	22	3.08±0.86	9.07±0.67[a]	3.36±0.26[a]	4.98±0.38[a]	1.03±0.00[a]	0.49±0.02[a]	0.78±0.08	5.41±0.45	6.50±2.21[a]
	2	56	3.16±2.22	7.84±1.11[b]	2.88±0.43[b]	4.27±0.65[b]	1.02±0.00[b]	0.45±0.04[b]	0.76±0.07	5.37±0.56	8.73±3.23[b]
TFC (kg)	1	45	3.11±0.83[a]	8.51±0.80[a]	3.14±0.31[a]	4.66±0.46[a]	1.03±0.00[a]	0.47±0.03	0.76±0.08	5.59±0.39	7.00±2.43
	2	33	3.18±2.83[b]	7.75±1.39[b]	2.84±0.54[b]	4.21±0.81[b]	1.02±0.00[b]	0.45±0.05	0.77±0.07	5.10±0.55	9.60±3.39
SF	1	48	2.87±1.89	7.88±1.19[a]	2.90±0.46[a]	4.30±0.69[a]	1.02±0.00[a]	0.45±0.04[a]	0.77±0.07	5.31±0.58[a]	8.65±3.43
	2	30	3.58±1.93	8.69±0.88[b]	3.21±0.35[b]	4.75±0.53[b]	1.03±0.00[b]	0.48±0.03[b]	0.76±0.09	5.49±0.40[b]	7.21±2.38
NMC	1	27	3.64±2.94[a]	7.95±0.97	2.92±0.40	4.32±0.60	1.02±0.00[a]	0.47±0.02[a]	0.78±0.06	5.45±0.39[a]	10.05±3.50
	2	51	2.87±1.01[b]	8.32±1.21	3.07±0.46	4.55±0.69	1.02±0.00[b]	0.46±0.05[b]	0.76±0.08	5.34±0.58[b]	7.06±2.37
CSP (d)	1	45	2.78±1.86	7.96±1.13	2.93±0.43	4.34±0.65	1.02±0.00	0.45±0.04	0.75±0.08	5.41±0.59[a]	9.22±3.23
	2	33	3.63±1.93	8.51±1.09	3.13±0.44	4.64±0.65	1.02±0.00	0.48±0.03	0.78±0.07	5.34±0.43[b]	6.57±2.26
Total		78	3.14±1.93	8.19±1.14	3.02±0.44	4.47±0.66	1.02±0.00	0.46±0.04	0.77±0.07	5.38±0.52	*8.10±3.13*

Different superscript letters in the same column indicate statistically significant differences (P<0.05).
FA, forage area (*1: yes, 2: no*); S, giving silage (*1: yes, 2: no*); FF, giving factory feed (*1: yes, 2: no*); TFC, total feed given per milking cow (*1=<7 kg, 2=≥7 kg*) SF= number of staff in feeding (*1=1 or 2, 2= ≥3*), NMC, number of milking cow (*1=1 or 2, 2= ≥3*); CSP, calf suckling period (*1=<120d, 2= ≥120d*) NFDM, non-fat dry matter; FP, freezing point; DMY, daily milk yield (kg)

Table II.- Correlation coefficients among milk components, DMY and SCC.

	NFDM	Protein	Lactose	Density	FP	Mineral	SCC	DMY
Fat	-0.146	-0.191	-0.203	-0.548**	0.385**	0.290*	0.425**	-0.023
NFDM		0.998**	0.998**	0.906**	0.727**	0.148	0.215	-0.131
Protein			1.000**	0.924**	0.690**	0.107	0.197	-0.135
Lactose				0.928**	0.685**	0.107	0.193	-0.136
Density					0.452**	0.005	-0.002	-0.091
FP						0.707**	0.271*	0.011
Mineral							-0.054	0.229*
SCC								-0.406**

* P<0.05, ** P<0.01; NFDM, non-fat dry matter; FP, freezing point; SCC, somatic cell count; DMY, daily milk yield.

forage usage in present study. This finding was supported by some previous studies (Aguerre *et al*., 2011; Neveu *et al*., 2013), but not by another study (Machado *et al*., 2014), which report no difference in milk L content due to the forage usage. The increase in milk L content due to the use of compound feed in diet can be attributed to synthesis of propionic acid and glucose production in the intermediary metabolism. This formed glucose which then is converted to L in milk (Machado *et al*., 2014). Milk P content followed the same trend as milk L content. Normally, the increase in milk P content can be attributed to increase in consumption of concentrate feed. In an earlier study (Tarkowski, 2008) percentage of P and F was found to be higher by 4 -7% in group of cows which took factory feed. In addition, some authors (Gonzalez *et al*., 2015) indicated that rations with low fiber may lead to reduced milk fat content and to avoid fat depression of milking cows, minimum of 25% dietary neutral detergent fiber (NDF) was suggested. As known, all the dairy feeding strategies are performed by estimating feed intake capacity and performance of the dairy cows (Tarkowski, 2008). That's why, rations by forage and concentrate should be balanced according to milk test results and performances of the cows in each dairy farms. Interestingly, farms without any forage area had more DMY in our study. The overall DMY had been calculated to be 8.10±3.13 kg, and no wide variation among the investigated farms could be regarded as the possible reasons. Also, in spite of no FA allottment in the second group, it might be ensured to the farms by fodder sellers. This subject needs more information using detailed questionnaires with further investigations.

For normal process in rumen fermentation and obtaining more milk production, silage is greatly needed in dairy enterprises (Dewhurst, 2013). However, species of the forage used in silage had a great importance on feed intake and milk production of dairy cows (Steinhamn, 2010). In addition to observed elevation of milk components (NFDM, P, L, D and FP) in milk collected from cows reared in farms where no silage given in feeding applications, a significant increment in log SCC was also determined in the same group in our study (Table I). As a general expression, SCC is a principal marker for detecting raw milk and elevation in this number causes to drop in milk production (Mikone Jonas *et al*., 2016). The finding here indicates to positive effect of silage for SCC which has been assumed as a reliable criteria for quality of milk.

In farms where factory feed is given to milking cows, NFDM, P, L, D, FP of milk were found to be higher compared to those who did not get factory feeds (Table I). Essentially, this case clearly indicates that FF positively affected five milk components. However, DMY decreased with FF in the farms. In normal, concentrate feedstuffs stimulate cow's milk production. Selected cow breed of this study was not high producer, and also, relatively lower samples had been evaluated in the first FF group. Therefore, these cases might be assumed to be the possible reasons for this unexpected finding for DMY. In other words, because of the fairly low DMY mean for a dairy breed (8.102±3.137 kg) and a narrow variation by DMY of the cows in the study might be declared as the feasible reasons of this result.

Elevated F with more TFC indicates that, intensively feeds with high energy content had been presented to the cows in the chosen farms (Table I). Actually, decreased NFDM, L, D and especially P at the same time support this finding. Thus, the main forages those allotted in lands of the region might be expressed as high F causing plants. At this point, primarily corn based rations might be given in the investigated herds; however, further works on the effects of different feed sources on milk composition should be conducted to confirm this opinion. In general, more and balanced feed might be expected to result more production. Here, in spite of about 2.6 kg/cow more DMY had been taken from second group, no statistical difference was observed between two groups. This finding might be stated to be the narrow variation of DMY values as discussed earlier.

F, NFDM, P, L, D, FP and log SCC increased with farms had more staff in feeding applications (Table 1). Especially, elevated SCC with SF was attractive in this point. As known well, working with more staff in dairy operations is a desirable point for each cattle operations. However, no relationship of staff of the smallholder farms in the same region with milk SCC has been reported (Atasever *et al*., 2012). In the current investigation, elevated SCC together with more staff indicates that employees might inexactly worked in daily practices such as cleaning, milking or other husbandrial activities those highly affecting SCC in dairy farms. Actually, similar results have also been emphasized in an earlier study that conducted in the region (Atasever *et al*., 2015).

The present study showed that when NMC increased; F, FP and log SCC dropped but NFDM and D increased (Table I). Approximately 3 kg more DMY was obtained in farms had lower milking cows but no significant effect of NMC on DMY was determined. As seen that, SCC decreased in relatively crowded herds. This result might be evaluated to be a positive notice for dairy farmers. However, to confirm these connections, further studies containing more farms should be carried out in different dairy breeds.

In this study, only SCC values affected by CSP (Table I). As seen, relatively short CSP positively affected milk SCC in terms of causing a low threshold. At the context, practicing sufficient CSP to the calves could be advised to the herd owner to achieve raw milk with lower SCC from their cows.

Estimated associations of parameters with each other could be seen an expected finding (Table II). Especially, determined moderate or high correlations of SCC with F and FP showed that FP or F could be used as the reliable reflectors to decide quality degree of raw milk similar to SCC. Besides, elevated M and decreased SCC levels might be seen as the important markers to produce more DMY from milking cows.

A dramatic change of DMY with elevated SCC is seen in Figure 1. As seen, cows with lowest SCC had 4.42 kg and 2.62 kg more DMY per milking cow when compared to second and third groups, respectively. However, in SCC examination, more than 2/3 of the total milk samples had lower than $500x10^3$ cells/ml which is the limit for human consumption of raw milk by Turkish Food Codex. This result may be evaluated as a favorable case in the present investigation. It can be noticed that, to obtain more quality milk from herds, taking some limitations especially on hygiene during the milking processes or keeping cows more wealthy conditions should be regarded as the major steps.

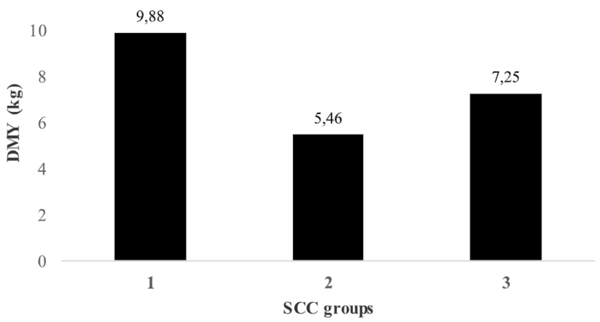

Fig. 1. Change of milk production (DMY) by SCC groups (1=SCC <200x $x10^3$ cells/ml; 2=SCC between $200x10^3$ and 500x $x10^3$ cells/ml; 3= SCC ≥$500x10^3$ cells/ml).

CONCLUSION

The research revealed that feeding applications have important role on more quality and quantity milk from crossbred Jersey cows. In this point, applying proper feeding management program and monitoring milk parameters can primarily be suggested to farm owners. Besides, further researches focusing each management factor should also be conducted using more dairy enterprises.

Statement of conflict of interest

The authors have no conflict of interest to declare.

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