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Research Article

A study of the reproductive performance, milk yield, milk constituents, and somatic cell count of Holstein-Friesian and Montbeliarde cows

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Abstract: The aim of this study was to compare the reproductive performance, milk yield, milk constituents, and somatic cell count of Montbeliarde (M) and Holstein-Friesian (HF) cows. The number of data points used for the first calving age (FCA), calving interval (CI), milk traits, and milk constituents were 87, 264, 270 and 108 for M cows and 167, 450, 491, and 114 for HF cows. The effects of herd on FCA, CI, 305-day milk yield (305-dMY), and protein content (PC) were determined to be statistically significant ($P < 0.05$), as were the effects of breed on FCA, 305-dMY, fat content (FC), and somatic cell count (SCC). For M cows, the average FCA, CI, 305-dMY, FC, PC, and SCC were found to be 952.2 ± 14.67 days, 391.6 ± 5.75 days, 5956.5 ± 84.73 kg, 3.55 ± 0.07%, 2.93 ± 0.04%, and 138,644 cells/mL, respectively. When determined for HF cows, the average values of the same characteristics were shown to be 909.1 ± 13.66 days, 399.6 ± 5.93 days, 6655.3 ± 109.57 kg, 3.26 ± 0.10%, 2.85 ± 0.06%, and 199,022 cells/mL, respectively. M cows had lower 305-dMY values but higher milk constituents and SCCs than the HF breed. The high temperatures and humidity observed in the summer season caused a significant decrease in the reproduction and milk constituents of cows subject to Mediterranean climatic conditions.

Key words: Calving interval, 305-day milk yield, fat content, protein content, somatic cell count

Siyah-Alaca ve Montbeliarde ırkı sığırların döl verimi, süt verimi, süt içeriği ve somatik hücre sayısı üzerine bir araştırma

Özet: Bu çalışmada Siyah-Alaca (SA) ve Montbeliarde (M) ırkı sığırların döl verimi, süt verimi, süt içeriği ve somatik hücre sayısının karşılaştırılması amaçlanmıştır. M ırkı için ilkine buzağılama yaşı (İBY), buzağılama aralığı (BA), süt verim özellikleri ve süt içeriğine yönelik olarak sırasıyla 87, 264, 270 ve 108 adet SA ırkı için ise sırasıyla 167, 450, 491 ve 114 adet veri kullanılmıştır. İşletme etkisi İBY, BA, 305-gün süt verimi (305-gSV) ve süt protein oranı (SPO) için önemli ($P < 0,05$) ırk etkisi ise İBY, 305-gSV, süt yağı oranı (SYO) ve somatik hücre sayısı (SHS) için istatistik olarak önemlidir ($P < 0,05$). İBY, BA 305-gSV, SYO, SPO ve SHS ortalamaları M ırkı için sırasıyla 952,2 ± 14,67 gün, 391,6 ± 5,75 gün, 5956,5 ± 84,73 kg, % 3,55 ± 0,07, % 2,93 ± 0,04 ve 138.644 hücre/mL, SA ırkı için sırasıyla 909,1 ± 13,66 gün, 399,6 ± 5,93 gün, 6655,3 ± 109,57 kg, % 3,26 ± 0,10, % 2,85 ± 0,06 ve 199.022 hücre/mL bulunmuştur. M ırkı ineklerin süt verimleri SA ırkından daha düşük olmasına karşın, süt içeriği ve somatik hücre sayıları SA ırkından daha yüksektir. Akdeniz iklim koşullarında, yaz mevsiminde görülen yüksek hava sıcaklığı ve nemi sığırların döl verimi ve süt içeriğinde önemli azalışlara neden olmaktadır.

Anahtar sözcükler: Buzağılama aralığı, 305-gün süt verimi, süt yağı oranı, süt proteini oranı, somatik hücre sayısı

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Introduction

Small-scale family farms are predominant in Turkey. The milk produced on these farms is mainly used for personal consumption, a situation that restricts both the quantity and quality of dairy produce. Large-scale dairy farms, on the other hand, satisfy food safety standards better than small-scale farms, and the daily milk yield per cow on large-scale farms is higher than that on small-scale farms (1). Efforts to enhance the managerial factors, nutrition, barn conditions, and hygiene, regardless of the size of the farm, help to improve reproduction, milk quality, and milk yield per cow.

Several researchers have studied reproduction and milk production (2-4), the somatic cell count (SCC) (5-8), and the milk constituents (MC) (9-13) of Holstein-Friesian (HF), Brown Swiss (BS), Montbeliarde (M), and Jersey cows. HF cows generally had a higher SCC and incidence of clinical mastitis than the European breeds of M, Simmental, and BS cows (2,10,13-15). In terms of morning milking, HF cows produced lower fat and total dry matter content in milk but offered a higher milk yield and SCC than M cows (7,13). In France, the average lactation milk yield (LMY) of 340,000 heads of M cows was reported to be 7486 kg, and M cows demonstrated higher fat and protein contents, higher mastitis resistance, and a lower SCC than HF cows (www.coopex.com).

A genetic antagonism between milk production and mastitis (15) and an association between morphological conformations of udder and SCC were reported by Busato et al. (14) and Coban et al. (16). An important loss in milk yield due to high SCC was noted by Atasever and Erdem (17).

The purpose of this study was to determine the factors that influence the reproductive performance, milk yield (MY), milk constituents, and SCC of M and HF breeds raised together on the same dairy farms in Mediterranean climatic conditions in Turkey.

Materials and methods

Reproductive performances and milk yield data for HF and M cows from 19 dairy farms in Aydın Province, Turkey, were obtained from the records of the Cattle Breeders' Association of Turkey and the producers. The first calving age (FCA) and calving interval (CI) for reproductive traits were determined, as were lactation length (LL), lactation milk yield (LMY), and the 305-day milk yield (305-dMY) for milk traits. For the purposes of this study, 2 calving seasons were accepted for reproduction and milk traits. Cows giving birth between November and April were included in the winter season and cows giving birth between May and October were included in the summer season. In addition, 10 farms were visited during the morning milking time between July and August in 2007 and between March and April in 2008. The purpose of these visits was to measure the morning milk yield (MMY) and to collect milk samples from each cow for an analysis of the milk constituents and SCC. The milk samples used for the analyses had no visible abnormalities and came from normal udders. A total of 222 milk samples, 108 of them belonging to M and 114 of them belonging to HF cows, were analyzed for fat content (FC), protein content (PC), lactose content (LC), nonfat dry matter content (NFDMC), total dry matter content (TDMC), and SCC within 3 h of the sample collection. The samples were analyzed in a private laboratory using a Bentley 150 Infrared Milk Analyzer for determination of the milk constituents and a Bentley BactoCount IBCm for the SCC.

Before the statistical analyses of milk constituents and SCC, the herds were divided into 2 groups according to the number of cows in the herd. Herds of less than 10 cows were placed into Group 1 and herds of more than 10 cows were placed into Group 2. The cows in Group 1 were milked in the barn, mostly at the manger, with a pipe-line milking system or mobile milking machines, and were fed during milking. Teat-dipping, dry cow treatment, and postmilking udder massage were not used in Group 1. In Group 2, the cows were milked in the parlor and fed after milking. In Group 1, milk samples were taken from all lactating M and HF cows. However, in Group 2, the samples were taken from all lactating M cows and an equal number of lactating HF cows. As a result, the number of samples collected from Groups 1 and 2 was 66 and 156, respectively.

Our study made use of 5 parity groups. The cows having the fifth and larger lactation numbers were included in Parity 5. The cows were also grouped into 4 lactation stages. The first stage included those cows lactating for 4-100 days, the second stage for 101-200 days, the third stage for 201-300 days, and the fourth stage for 301 days or more.

The SCC data was transformed by using a base-10-logarithmic transformation in order to obtain normal distribution (18). The data were analyzed using the GLM procedure of SAS (19). The differences between least-squares means of fixed factor levels were considered to be statistically significant at P < 0.05 (2-tailed) based on Tukey's adjustment type I error rate. The statistical model used for the analysis is as follows.

$$Y_{ijklmno} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + (ab)_{ij} + (bd)_{jl} + (bf)_{jm} + (bg)_{jn} + e_{ijklmno},$$

where:

$Y_{ijklmno}$ is the observation of FCA, CI, LL, LMY, 305-dMY, MMY, FC, PC, LC, NFDMC, TDMC, and $\log_{10}$SCC;

μ is the overall mean;

a_i is herd effects (for FCA, CI, LL, LMY, and 305-dMY, i = 1, 2, 3,….,19; for MMY, FC, PC, LC, NFDMC, TDMC and $\log_{10}$SCC, i = 1, 2);

b_j is breed effects (j = M and HF);

c_k is year effects for FCA, CI, LL, LMY, and 305-dMY (for FCA, k = 1998, 1999, ….2003; for CI, k = 2000, 2001,….,2005; for LL, LMY, and 305-dMY, k = 2001, 2002, ….2006);

d_l is seasonal effects (1 = 1, 2);

f_m is parity effects, except for FCA (m = 1, 2,…..5+);

g_n is lactation stage effects, except for FCA, CI, LL, LMY, and 305-dMY (n = 1, 2, 3, 4);

$(ab)_{ij}$ is herd (X) breed interaction effects, except for FCA and CI;

$(bd)_{jl}$ is breed (X) season interaction effects for all traits;

$(bf)_{jm}$ is breed (X) parity interaction effects, except for FCA, CI, LL, LMY, and 305-dMY; $(bg)_{jn}$ is breed (X) lactation stage interaction effects, except for FCA, CI, LL, LMY, and 305-dMY; and $e_{ijklmno}$ is random error.

Results

Reproduction and milk traits

The least-squares means of FCA, CI, LL, LMY, and 305-dMY are shown in Table 1. The effects of herd on FCA (P < 0.01), CI (P < 0.05), LMY (P < 0.01), and 305-dMY (P < 0.01) were found to be statistically significant. The differences between the breeds were also statistically significant for FCA (P < 0.05), LMY (P < 0.01), and 305-dMY (P < 0.01). Analysis revealed that the effects of year on FCA (P < 0.01), LL (P < 0.05), LMY (P < 0.01), and 305-dMY (P < 0.01) were statistically significant. The effect of season was statistically significant (P < 0.01) only for FCA. The effects of parity were statistically significant for LMY (P < 0.01) and 305-dMY (P < 0.01), while herd (X) breed interaction was determined to be statistically significant (P < 0.05) only in terms of 305-dMY.

The averages of FCA, CI, LL, LMY, and 305-dMY for the M breed were 952.2 ± 14.67 days, 391.6 ± 5.75 days, 320.0 ± 5.35 days, 6297.9 ± 124.27 kg, and 5956.5 ± 84.73 kg. For the HF breed, the average figures for these measurements were 909.1 ± 13.66 days, 399.6 ± 5.93 days, 331.4 ± 6.92 days, 7084.6 ± 160.71 kg, and 6655.2 ± 109.57 kg, respectively (Table 1). The HF cows had a FCA that was 43.1 days shorter than that of M cows, and they also had a LMY that was 786.7 kg higher and a 305-dMY that was 698.7 kg greater than those of the M cows. Cows born in winter had a FCA that was 50.8 days longer than those born in summer season, a difference that was found to be statistically significant (P < 0.01).

LMY and 305-dMY increased gradually up to Parity 3 and then decreased slowly for the following parities. The average LMY of Parity 3 (7008.2 ± 156.69 kg) was 793.6 kg higher than that of Parity 1 (6214.6 ± 122.75 kg), and this difference was statistically significant (P < 0.01). For 305-dMY, the Parity 3 mean (6602.0 ± 106.83 kg) was 823.2, and 385.4 kg higher than the mean figures for Parity 1 and Parity 2 respectively; these differences were also shown to be statistically significant (P < 0.01).

Milk constituents and somatic cell count

The least-squares means of MMY, FC, PC, LC, TDMC, NFDMC, and $\log_{10}$SCC are shown in Table 2. The effects of herd on MMY (P < 0.01), PC (P < 0.01), TDMC (P < 0.05), and NFDMC (P < 0.01)

Table 1. Least-squares means of FCA, CI, LL, LMY, and 305-dMY.

Factor	FCA (day)		CI (day)		Milk traits			
					LL (day)		LMY (kg)	305-dMY (kg)
	n	- ± -	n	- ± -	n	- ± -	- ± -	- ± -
Herd (19 herds)	254	**	714	*	761	N.S.	**	**
Breed		*		N.S.		N.S.	**	**
M	87	952.2 ± 14.67^{Aa}	264	391.6 ± 5.75	270	320.0 ± 5.35	6297.9 ± 124.27^{Aa}	5956.5 ± 84.73^{Aa}
HF	167	909.1 ± 13.66^{Ab}	450	399.6 ± 5.93	491	331.4 ± 6.92	7084.6 ± 160.71^{Bb}	6655.2 ± 109.57^{Bb}
Year		**		N.S.		*	**	**
1998	40	1053.78 ± 21.921^{Aa}	-	-	-	-	-	-
1999	35	971.10 ± 22.683^{ABb}	-	-	-	-	-	-
2000	30	922.52 ± 24.619^{Bb}	30	411.75 ± 3.387	-	-	-	-
2001	50	940.02 ± 19.519^{Bb}	52	386.92 ± 10.481	46	335.8 ± 10.74^{Aab}	7436.7 ± 249.67^{Aa}	7075.1 ± 170.22^{Aa}
2002	62	898.18 ± 17.394^{Bb}	93	394.95 ± 8.054	81	328.0 ± 8.36^{Aab}	6450.0 ± 194.38^{BCbc}	6139.4 ± 132.52^{BCbc}
2003	37	798.31 ± 22.429^{Cc}	126	390.76 ± 6.929	125	321.0 ± 6.98^{Aab}	6104.8 ± 162.18^{BDbd}	5823.4 ± 110.57^{Bb}
2004	-	-	185	401.03 ± 5.726	185	331.8 ± 5.90^{Aa}	6805.8 ± 137.13^{ACac}	6291.3 ± 93.49^{Cc}
2005	-	-	228	388.01 ± 5.157	251	331.4 ± 4.96^{Aa}	6905.9 ± 115.30^{ACac}	6330.5 ± 78.61^{Cc}
2006	-	-	-	-	73	306.3 ± 8.57^{Ab}	6444.5 ± 199.07^{CDcd}	6175.6 ± 135.72^{BCbc}
Season		**		N.S.		N.S.	N.S.	N.S.
Winter	120	956.1 ± 14.14^{Aa}	446	395.5 ± 5.63	420	324.9 ± 5.24	6741.1±121.82	6372.2 ± 83.058
Summer	134	905.3 ± 13.35^{Bb}	268	395.6 ± 6.11	341	326.1 ± 5.54	6641.5±128.85	6239.5 ± 87.850
Parity	-	-		N.S.		N.S.	**	**
1	-	-	254	400.1 ± 5.22	257	329.0 ± 5.28	6214.6 ± 122.75^{Aa}	5778.8 ± 83.69^{Aa}
2	-	-	284	395.6 ± 6.20	197	325.3 ± 5.73	6608.0 ± 133.26^{ABb}	6216.6 ± 90.85^{Bb}
3	-	-	131	393.5 ± 6.97	134	324.6 ± 6.74	7008.2 ± 156.69^{Bb}	6602.0 ± 106.83^{Cc}
4	-	-	82	390.9 ± 8.91	94	323.0 ± 7.86	6857.9 ± 182.70^{Bb}	6508.4 ± 124.56^{BCbc}
5+	-	-	63	397.8 ± 10.16	79	326.5 ± 8.90	6767.7 ± 206.88^{ABb}	6423.7 ± 141.05^{BCbc}
Herd (X) breed	-	-	-	-	-	N.S.	N.S.	*
Breed (X) season	-	N.S.	-	N.S.	-	N.S.	N.S.	N.S.

N.S.: Not significant, *: $P < 0.05$, **: $P < 0.01$, LL: lactation length, LMY: lactation milk yield, 305-dMY: 305-day milk yield. A, B, C: significance at $P < 0.01$; a, b, c: significance at $P < 0.05$.

were statistically significant. The differences between the breeds were also statistically significant for MMY ($P < 0.01$), FC ($P < 0.05$), TDMC ($P < 0.05$), and $\log_{10}$SCC ($P < 0.01$). Analysis revealed that the effects of season on FC ($P < 0.01$), PC ($P < 0.05$), LC ($P < 0.01$), TDMC ($P < 0.05$), and NFDMC ($P < 0.01$) were also statistically significant. The effects of parity were statistically significant for MMY ($P < 0.05$), LC ($P < 0.05$), and $\log_{10}$SCC ($P < 0.01$). On the other hand, lactation stage had statistically significant effects on MMY ($P < 0.01$), FC ($P < 0.05$), PC ($P < 0.01$), LC ($P < 0.05$), TDMC ($P < 0.01$), NFDMC ($P < 0.01$), and $\log_{10}$SCC ($P < 0.01$). Herd (X) breed interaction for PC ($P < 0.05$) and NFDMC was significant ($P < 0.05$). Breed (X) season interaction for FC ($P < 0.05$) and $\log_{10}$SCC ($P < 0.05$) was found to be statistically significant. Breed (X) lactation stage interaction for MMY was also statistically significant ($P < 0.05$).

M cows had higher levels of FC and TDMC, and also had a SCC that was 60,378 cells/mL lower than that of the HF cows. The differences between the breeds were statistically significant ($P < 0.05$).

Cows producing milk in summer had a lower FC, PC, LC, TDMC, and NFDMC than those in winter, and all of the differences between the seasons were statistically significant ($P < 0.05$).

As parity increased, the SCC also increased. The highest SCC mean was observed for Parity 5 (289,001 cells/mL); this parity was different from the first 3 parities ($P < 0.05$).

For all milk constituents and SCC traits, the effect of the lactation stage was determined to be statistically significant ($P < 0.05$). MMY and LC decreased as lactation increased, in contrast to the gradual increase of PC, NFDMC, and SCC. For FC and TDMC, the means decreased in the second stage of lactation and then increased gradually until the end of lactation (Table 2).

Discussion

The statistically significant differences between the herds for FCA, CI, LMY, 305-dMY, MMY, PC, TDMC, and NFDMC indicate that the nutritional, managerial, and barn conditions of the farms were different. This finding agrees with the results of Çerçi and Koç (3).

The means of FCA, CI, and 305-dMY for the M breed were compared to the only similar previous study performed in Turkey (20), and the mean FCA for M cows found in this study was lower. The average CI and 305-dMY figures were higher in this study, however.

For HF cows, the mean FCA and CI found in this study were lower than the results of a previous study (4), although the LMY and 305-dMY means were found to be higher than the results of other studies (2,3). The MMY, FC, NFDMC, and SCC averages found in this study for HF and M cows were shown to be lower than those published in a previous study (7).

The mean FCA, LMY, FC, and PC figures determined for the M breed in this study were lower than the results of Pauly and Rieder (10). The higher MMY mean for HF than for M cows found in this study is in agreement with the results of Parrassin (9), but the lower FC mean for the HF breed in this study disagrees with those results. For MMY, FC, PC, and SCC, the significant differences between the M and HF breeds in this study agree with the results of Pomies et al. (12). However, the FC and PC averages found for both the HF and M breeds in this study were lower, while SCC means for both breeds were higher than the results of Pomies et al. (12). An increase was observed in SCC as parity increased, and this result agrees with Kul and Erdem's conclusions (8). On the other hand, the lower SCC found for M than for HF cows agrees with the results of Walsh et al. (13).

An insignificant difference for SCC between the herd groups shows the similarities of milking hygiene and management. This result agrees with the findings of Koç (7). Although the cows in the Group 2 herds were milked in the parlor, the SCC mean was not found to be different from that of Group 1. This result shows that the facilities used for the Group 2 herds did not cause any difference from the Group 1 herds. During the collection of milk samples, it was observed that postmilking massage was not used in any herds and the teat-dipping management was used only for a single herd in Group 2.

The higher SCC means for HF than for M cows shows that the intermammary infection rate in HF cows was higher than that of M cows. M cows may also be more resistant to mastitis and the 2 breeds' different morphological conformations of the udder

Table 2. Least-squares means of morning milk yield, milk constituents, and SCC.

Factor[1]	MMY (L) - ± -	FC (%) - ± -	PC (%) - ± -	LC (%) - ± -	TDMC (%) - ± -	NFDMC (%) - ± -	Log_{10}SCC - ± -	SCC (cell /mL)
Herd group	**	N.S.	**	N.S.	*	**	N.S.	
Group 1 (66)	8.06 ± 0.397^{Aa}	3.35 ± 0.110	2.78 ± 0.060^{Aa}	4.53 ± 0.041	11.50 ± 0.149^{Aa}	8.16 ± 0.068^{Aa}	5.1803 ± 0.0703	151,461
Group 2 (156)	9.39 ± 0.237^{Bb}	3.43 ± 0.066	3.00 ± 0.036^{Bb}	4.56 ± 0.025	11.84 ± 0.089^{Ab}	8.42 ± 0.040^{Bb}	5.2604 ± 0.0418	182,138
Breed	**	*	N.S.	N.S.	*	N.S.	*	
M (108)	7.69 ± 0.274^{Aa}	3.53 ± 0.076^{Aa}	2.93 ± 0.041	4.57 ± 0.029	11.88 ± 0.103^{Aa}	8.35 ± 0.047	5.1419 ± 0.0488^{Aa}	138,644
HF (114)	9.75 ± 0.392^{Bb}	3.24 ± 0.109^{Ab}	2.85 ± 0.059	4.53 ± 0.041	11.47 ± 0.148^{Ab}	8.23 ± 0.067	5.2989 ± 0.0717^{Ab}	199,022
Season	N.S.	**	*	**	**	**	N.S.	
Winter (97)	8.80 ± 0.327	3.84 ± 0.091^{Aa}	2.95 ± 0.049^{Aa}	4.73 ± 0.034^{Aa}	12.46 ± 0.123^{Aa}	8.62 ± 0.056^{Aa}	5.1814 ± 0.0578	151,845
Summer (125)	8.65 ± 0.277	2.93 ± 0.077^{Bb}	2.82 ± 0.042^{Ab}	4.36 ± 0.029^{Bb}	10.89 ± 0.104^{Bb}	7.95 ± 0.047^{Bb}	5.2593 ± 0.0489	181,677
Parity	*	N.S.	N.S.	*	N.S.	N.S.	**	
1 (64)	8.06 ± 0.388^{Aa}	3.43 ± 0.102	2.85 ± 0.058	4.65 ± 0.041^{Aa}	11.75 ± 0.146	8.38 ± 0.066	5.0505 ± 0.0686^{Aa}	112,331
2 (46)	9.15 ± 0.422^{Aab}	3.50 ± 0.110	3.00 ± 0.063	4.56 ± 0.044^{Aab}	11.94 ± 0.159	8.42 ± 0.072	5.1734 ± 0.0747^{ABa}	149,073
3 (31)	9.71 ± 0.527^{Ab}	3.38 ± 0.138	2.76 ± 0.079	4.55 ± 0.055^{Aab}	11.56 ± 0.198	8.17 ± 0.090	5.1628 ± 0.0932^{Aba}	145,479
4 (24)	7.77 ± 0.560^{Aab}	3.32 ± 0.149	2.93 ± 0.084	4.48 ± 0.058^{Aab}	11.51 ± 0.211	8.24 ± 0.096	5.2542 ± 0.0991^{ABab}	179,556
5+ (57)	8.92 ± 0.375^{Aab}	3.39 ± 0.098	2.99 ± 0.056	4.50 ± 0.039^{Ab}	11.61 ± 0.141	8.22 ± 0.064	5.4609 ± 0.0663^{Bb}	289,001
L. Stage	**	*	**	*	**	**	**	
1 (66)	11.14 ± 0.36^{Aa}	3.45 ± 0.094^{Aab}	2.66 ± 0.054^{Aa}	4.60 ± 0.037^{Aa}	11.53 ± 0.135^{ABa}	8.13 ± 0.061^{Aa}	5.0498 ± 0.0633^{Aa}	112,150
2 (71)	9.78 ± 0.35^{Ab}	3.17 ± 0.092^{Aa}	2.71 ± 0.053^{ABab}	4.57 ± 0.037^{ABa}	11.31 ± 0.132^{Ba}	8.13 ± 0.060^{Aab}	5.1830 ± 0.0623^{ABab}	152,405
3 (44)	7.54 ± 0.44^{Bc}	3.41 ± 0.115^{Aab}	2.93 ± 0.066^{Bb}	4.58 ± 0.046^{ABa}	11.78 ± 0.165^{ABab}	8.38 ± 0.075^{ABb}	5.2598 ± 0.0776^{ABab}	181,886
4 (41)	6.43 ± 0.46^{Bc}	3.59 ± 0.121^{Ab}	3.25 ± 0.069^{Cc}	4.42 ± 0.048^{Bb}	12.07 ± 0.173^{Ab}	8.51 ± 0.079^{Bb}	5.3889 ± 0.0815^{Bb}	244,850
Herd (X) Breed	N.S.	N.S.	*	N.S.	N.S.	*	N.S.	-
Breed (X) Season	N.S.	*	N.S.	N.S.	N.S.	N.S.	*	-
Breed (X) Parity	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	-
Breed (X) L. Stage	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	-

[1]: Values in parenthesis show the number of observations. MMY: Morning milk yield, FC: fat content (%), PC: protein content (%), LC: lactose content (%), TDMC: total dry matter content (%), NFDMC: nonfat dry matter content (%), SCC: somatic cell count. N.S.: Not significant, *: $P < 0.05$, **: $P < 0.01$. A, B, C: significance at $P < 0.01$; a, b, c: significance at $P < 0.05$.

could play an important role in this distinction (14-16). Another important factor causing the significant difference between the SCC levels of the breeds could be the milk yield. As milk yield increases, the resistance of the cows against mastitis decreases, and, as a result, cows with high milk yields have a higher risk of infection (8,21). The SCC mean found for the HF and M breeds in this study were lower than those in some other studies conducted in Turkey (2,6,7).

The statistically significant differences among parities for LMY and 305-dMY values found in this study are in agreement with those in the literature (2,3). However, the statistically significant differences found among parities for MMY and SCC in this study disagree with one similar study (2) and agree with another (7).

The statistically significant differences between seasons for FCA and milk constituents found in this study show that the performance of the cows was greatly affected by the high temperature and humidity from May to October. The heat stress on the cows caused important reductions in both reproduction and milk constituents.

The statistically significant herd (X) breed interaction effects for 305-dMY, PC, and NFDMC show that the changes in performances of the breeds were due to differing nutrition and management among the herds.

The significant breed (X) season interaction effect found for FC and SCC shows that the degree of influence of season could be different from breed to breed as a result of their different tolerance and resistance mechanisms for dealing with extreme environmental changes and diseases. One can conclude that, because of their higher milk yield, HF cows might be affected by environmental changes and diseases more than the M breed under Mediterranean climatic conditions. As a result of this, the decrease in FC and increase in SCC were higher for HF cows than M cows.

The significant breed (X) lactation stage interaction for MMY shows that MMY changed significantly in and between breeds.

With this study, some important findings about M and HF breeds were obtained with regard to reproduction, milk production, milk constituents, and the SCC in milk produced under Mediterranean climatic conditions. This study showed that farms in this region need to provide shade and cool water and operate cooling systems for the cows. In addition, changing rations and feeding times during the summer season would prevent the decrease in reproduction performance and milk constituents.

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