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Factors affecting fertility traits and milk yield of Holstein cattle with different origins raised in Trakya Region

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ABSTRACT

This study was conducted with Holstein heifers imported from the United States (US), Germany, and the Czech Republic to a private dairy farm in Kırklareli/Lüleburgaz region in Turkey to evaluate their adaptation in terms of milk production and fertility performance. The first insemination age of the herd was 490.62 days, and the first calving age was 804.24 days. The number of inseminations required per pregnancy was calculated as 3.99, gestation length as 279.72 days, and service period as 213.99 days. The rate of abortion and twin births were higher in those of US origin. Increased first calving age was observed in heifers of German origin due to delayed insemination. The mean actual lactation milk yield in the first lactation periods was 11834.75 Lt, 305 days milk yield was 8573.31 Lt, lactation length was 419.61 days, the dry period was 63.02 days. Milk yield performance of Holsteins of US origin was higher in the first lactation period. In conclusion, milk production was profitable; however, the fertility performance of the herd was poor in general. Poor fertility performance was due to poor herd management and adaptation problems. Therefore, after the calving period, more attention should be paid to oestrus monitoring and insemination activities. In Turkey, the success of live animal imports should be well investigated; in particular, problems occurring during animal selection for importation should be evaluated, and short-/long-term national strategies should be developed.

Keywords: Holstein, lactation, reproduction, origin, adaptation, import

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Introduction

The cattle population in Turkey has reached 17 million heads in 2018 with an increase of 73% compared to the beginning of the 2000s. While the presence of culture cattle breeds increased by 350% and crossbred cattle by 61%, the presence of local breeds cattle decreased by 56% (MMB, 2018).

Animal imports to Turkey have started from the beginning of the 2000s to increase the ratio of culture and crossbred cattle in the cattle population and to improve the productivity in farming. Cattle imports constitute the largest part of livestock imports. While a total of 48000 cattle were imported in 2014, this figure increased to 132000 in 2018 (MMB, 2018). Live animal and food product imports, including live cattle imports

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to Turkey, were worth 6.9 billion; 6.5 billion; 6.4 billion, 8.3 billion, 8.8 billion and 8.6 billion between the years of 2014-2019, respectively. Germany, Austria, the United States (US), and the Czech Republic are among the most preferred countries for importation of live cattle. These imports were mostly made to the Aegean, East Marmara, Mediterranean, and West Marmara regions, respectively (TURKSTAT , 2020).

The effect of livestock imports on the national economy is a controversial issue. Although it is thought that live animal imports would increase productivity, opposite views are also available, suggesting that live animal imports would not be beneficial in the long term. Imports of live cattle can only be a short-term solution to Turkey's livestock problems. Live animal imports can bring meat and milk prices under control in the short term, but this effect will not be permanent, and in the long run, imports may cause an economic damage as these imports will cause a decrease in the financial reserves of Turkey. It is reported that animal breeders in Turkey do not have enough economic power to raise high-quality breeder cattle, their technical knowledge is generally not sufficient, therefore live animal imports will have a negative impact on small family businesses. Furthermore, following imports, fluctuations in raw milk prices in Turkey will cause breeder cattle to be sent to slaughterhouses, and the import-induced economic loss may be massive (Aydın et al., 2011).

The levels of reproductive and productive traits of the herd are closely related to the adaptation abilities of the animals to the climatic and environmental conditions of the region where they are raised. If animals are brought to a newly established farm from another region, or if the animals are imported from abroad, this change in the environmental conditions (e.g., climate, geography change) may be a stress factor for the animals, suppress the immune system, increase the incidence of diseases, and finally reduce the level of productivity (Yalçın, 1981).

The improvements made in the shelter conditions, especially the improvements in the micro-environmental parameters, as well as the improvements in the herd management increase the adaptability of the animals. As a result, these improvements indirectly cause an increase in milk yield (Kant et al., 2017). Poor welfare conditions in regionally displaced dairy cattle increase stress and aggression. It has been reported that old and non-pregnant cows have higher adaptation abilities than young and pregnant cows, and they adapt more easily to new environmental conditions (Broucek et al., 2013).

The aim of this study was to determine the fertility and milk yield levels of Holstein cattle imported from the US, Germany, and the Czech Republic to a private cattle farm in the Lüleburgaz/Kırklareli region and to compare their adaptation capabilities in terms of fertility and milk yield in the first production period.

Materials and Methods

This study was carried out in a newly established private dairy cattle farm in Lüleburgaz district of Kırklareli province in Turkey. The material of this research was 581 Holstein cattle imported to the enterprise as pregnant heifers from disease-free breeding farms in three different countries. Of these heifers, 182 were imported from the Czech Republic, 119 from Germany, and 280 from the US. Cows imported from the US were transported both by sea and land, whereas cows imported from the Czech Republic and Germany were transported by land.

All animals were milked twice a day with an automatic milking machine. Cows were grouped according to their reproductive status and milk production levels and were fed with different rations. The contents of these rations are presented in Table 1.

Table 1. Content of rations according to yield and pregnancy status of cows

	High Yield (kg/day)	**Moderate Yield** (kg/day)	**Low Yield** (kg/day)	**Pregnant Heifers** (kg/day)	**Close-up Dry Pregnancy** (kg/day)	**Far-off Dry Pregnancy** (kg/day)
Milch Factory Feed	15	11.5	10.5	-	-	-
Silage	24.8	19	19	10	12	12
Clover	3.5	3.75	2.5	1	1	1
Meadow Grass	1.8	2	2.5	2	-	-
Sodium bicarbonate	0.2	0.2	0.2	-	-	-
Straw	0.2	0	1	3	1	3.4
Canola Pellets	1	-	-	-	-	-
Dry Period Feed	-	-	-	3	-	4.5
Trans Feed	-	-	-	-	5.75	-
By-Pass Fat	0.4	0.2	-	-	0.1	-

Table 2. Some reproduction parameters and significance control in Holstein cows of different origins in the first production year (%).

Characteristics	CZ		DE		US		Overall		Significance
	n	%	n	%	n	%	n	%	
Cows pregnant at 1st insemination	43	23.6	24	20.2	79	28.2	146	25.1	NS
Cows pregnant at 2nd insemination	27	14.8	21	17.6	61	21.8	109	18.8	NS
Cows pregnant at 3rd insemination	29	15.9	18	15.1	44	15.7	91	15.7	NS
Cows pregnant at 4th + inseminations	83	45.6[a]	56	47.1[a]	96	34.3[b]	235	40.4	*
Total	182	100.0	119	100.0	280	100.0	581	100.0	-
Cows with stillbirth	4	2.2	3	2.5	8	2.9	15	2.6	NS
Cows with abort	3	1.6	1	0.8	15	5.4	19	3.3	NS
Cows with twin birth	0	0.0	0	0.0	4	1.4	4	0.7	-
Cows with single birth	175	96.2	115	96.6	253	90.4	543	93.5	NS
Total	182	100.0	119	100.0	280	100.0	581	100.0	-

CZ: Czech Republic; DE: Germany; US: United States
a, b: Differences between means marked with different letters in the same column are significant
NS: Not Significant (P>0.05); *: P<0.05

Investigated reproductive traits included age at first insemination, age at first calving, insemination number, first insemination interval, service period, gestation length, calving interval, and yearly fertility parameters expressed in proportion. Milk yield was evaluated with the following parameters: actual milk yield, 305-day milk yield, lactation period, dry period, and persistence of lactation. The effect of origin (the Czech Republic, Germany, or the US), birth/calving month at first production year, and their interactions on these parameters were determined.

Age at first insemination and age at first calving were categorized into subgroups according to the origin and the cow's month of birth, while other reproductive parameters and milk yield traits were categorized into subgroups according to the origin and calving month.

The difference between the groups was analyzed by ANOVA using the general linear model (GLM) procedure. The statistical model used was as follows:

$$Y_{ijk} = \mu + a_i + b_j + ab_{ij} + e_{ijk}$$

where Yijk was the individual observation, μ was the overall mean, ai was the effect of origin (i = Czech Republic, Germany or the US), bj was the effect of month of calving/birth (j = January, February, …), abij was the effect of origin and month of calving/birth interaction, and eijk was random error. The differences between subgroup means were determined with Duncan's test. In order to determine the persistence, individual daily milk levels were grouped for every fifteen days and differences between origins were analyzed. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0, Armonk, NY.

Results

Fertility: The insemination, pregnancy, and calving status of Holstein cattle of different origins in the first production period including fertility parameters expressed in proportion are presented in Table 2. In the first production period, 93.5% of the cows gave single birth, 2.6% stillbirth, and 3.3% aborted. Twin births were only observed in Holstein heifers of US origin. No statistical difference was detected between different-origin Holsteins in terms of a single birth, stillbirth, or abort rates. While the rate of conception was similar for all groups in cows that got pregnant after 1st, 2nd, or 3rd inseminations, in the group of cows that became pregnant after four or more inseminations, Holsteins of Czech and German origin had a higher rate of pregnancy than those of US origin (P<0.05). When all the cows were evaluated together, the pregnancy rate in the first insemination was determined as 25.1%.

The findings regarding the first insemination and first calving ages of Holstein heifers of different origins are presented in Table 3. The mean age at first insemination of Holstein heifers was 490.62 days. Holstein heifers of Czech Republic origin reached the first insemination age at an earlier age, heifers of German origin at a later age, and a statistically significant difference was found between the first

Table 3. Some reproduction parameters and significance control according to the origin and calving month in Holstein cows of different origins

Factors		Insemination number		Gestation length		First insemination Interval		Service period		Calving interval		Age at first insemination [f]		Age at first calving [f]	
	n	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$
Origin															
CZ	182	4.18	0.283	278.6^{b}	0.622	96.6	5.450	229.21^{a}	12.169	507.9^{a}	12.300	471.2^{c}	6.989	776.8^{b}	8.512
DE	119	4.34	0.348	279.5^{a,b}	0.761	103.7	11.877	222.3^{a,b}	14.892	501.7^{a,b}	15.053	517.4^{a}	7.367	842.3^{a}	8.972
US	280	3.44	0.178	280.9^{a}	0.388	89.3	3.091	190.4^{b}	7.596	471.4^{b}	7.677	491.7^{b}	3.179	796.6^{a}	3.872
Calving month															
January	70	3.77	0.367	280.9	0.805	84.8	5.992	208.1	15.754	489.1	15.923	469.4^{c,d,e}	6.330	762.2^{c,d}	7.709
February	60	3.68	0.390	281.4	0.856	96.3	7.383	218.1	16.766	499.6	16.946	449.9^{e}	17.205	821.6^{d}	20.953
March	66	4.32	0.348	280.1	0.764	97.1	5.864	229.9	14.953	510.1	15.114	452.6^{d,e}	12.819	803.5^{d}	15.612
April	20	5.23	0.612	278.9	1.342	99.1	13.053	243.1	26.279	521.9	26.562	470.8^{c,d,e}	12.508	797.3^{b,c,d}	15.233
May	15	5.04	0.721	280.5	1.582	72.1	11.807	283.2	30.973	563.7	31.307	512.8^{a,b}	13.885	785.5^{a,b,c}	16.910
June	24	3.75	0.599	276.4	1.314	76.1	9.848	192.4	25.731	468.9	26.009	513.2^{a,b}	13.682	846.9^{a,b,c}	16.663
July	34	4.92	0.528	279.1	1.142	83.1	8.221	232.5	22.360	511.7	22.601	500.8^{a,b,c}	17.484	828.1^{a,b,c}	21.293
August	28	3.01	0.591	280.6	1.297	90.6	17.440	156.5	25.392	437.1	25.666	508.8^{a,b}	11.086	822.9^{a,b}	13.501
September	11	3.28	0.854	279.8	1.874	114.4	24.767	187.1	36.687	466.8	37.082	525.7^{a}	8.280	828.1^{a}	10.084
October	50	3.46	0.435	279.6	0.932	115.3	7.213	219.6	18.242	499.2	18.438	515.7^{a,b}	6.294	810.8^{a,b}	7.665
November	77	3.73	0.342	279.1	0.750	90.2	7.013	203.3	14.679	482.3	14.837	487.8^{b,c,d}	5.710	771.4^{b,c,d}	6.955
December	126	3.63	0.248	279.8	0.544	91.1	4.295	193.8	10.658	473.6	10.773	488.7^{b,c}	9.432	758.1^{b,c,d}	11.487
Overall	581	3.99	0.174	279.7	0.382	92.9	3.172	213.9	7.482	493.7	7.562	490.6	3.506	804.2	4.270
Significance															
Origin		NS		*		NS		*		*		***		*	
Calving Month		NS		NS		NS		NS		NS		***		*	
Origin x Calving Month		NS		NS		*		NS		NS		***		*	

$\bar{x}$: Mean; $\sigma_{\bar{x}}$: Standard error. CZ: Czech Republic; DE: Germany; US: United States. a, b, c, d, e: Differences between means marked with different letters in the same column are significant (P<0.05). f: The first insemination and calving ages were compared according to the month of birth. NS: Not Significant (P>0.05); *: P<0.05; ***: P<0.001

significant difference was found between the first insemination ages for all origins (P<0.001). The lowest mean age at first insemination was observed in heifers born in February. The mean age at the first calving of heifers of all three origins was 804.24 days. The mean age of the first calving of Holstein cows from Germany and the Czech Republic was older than those of US origin (P<0.001). The mean age of the first calving of heifers born in January was 762.2 days, and this duration was significantly shorter than those born in August, September, and October (P<0.001). The interaction between origin and month of birth was statistically significant in terms of both first insemination age and first calving age (P<0.001).

Insemination number, gestation length, first insemination interval, service period, and calving interval of Holstein heifers of different origins are presented in Table 3. The overall inseminations number of Holstein heifers in the first production period was 3.99, gestation length was 279.72 days, first insemination interval was 92.92 days, service period was 213.99 days, and calving interval was 493.71 days. The effect of origin and calving month on the number of inseminations was not statistically significant (P>0.05). A statistically significant difference was found only between Holstein cows originating from the Czech Republic and the US in terms of gestation length, and it was determined that the mean gestation length of cows originating from the US was approximately 2 days longer (P<0.05). The effect of calving month and origin × calving month interaction on the length of gestation was not significant (P>0.05). The effect of origin and calving month on the first insemination interval was not significant as well. The mean service periods of Holstein cows originating from the Czech Republic, Germany, and the US were calculated as 229.2 days, 222.3 days, and 190.5 days, respectively. A significant difference was found between Holstein cows originating from the

Czech Republic, Germany, and the US were calculated as 229.2 days, 222.3 days, and 190.5 days, respectively. A significant difference was found between Holstein cows originating from the Czech Republic and the US, and it was observed that the mean service period of cows originating from the US was shorter than the others (P<0.05). Calving month did not have an effect on the service period (P>0.05). The mean first calving intervals of Holstein cows originating from the Czech Republic, Germany, and the US were calculated as 507.9 days, 501.8 days, and 471.4 days, respectively. The mean first calving interval was shorter in Holstein cows from the US than in cows from the Czech Republic (P<0.05).

Milk Yield: The actual milk yield and 305-day milk yield parameters of Holstein Friesian cows from the Czech Republic, Germany and US are presented in Table 4. In the first lactation period, the highest mean actual milk yield was calculated as 12206 lt in Holstein cows of US origin, followed by Czech origin (12033 lt) and German origin (10664 lt). However, a significant difference was not found in terms of origin in actual milk yield values (P>0.05). When the 305-day milk yield in the first lactation was evaluated, it was found that Holstein cows of US origin (8919 lt) produced significantly more milk than cows of German (8073 lt) and Czech (8357 lt) origin (P<0.05). In cows of different origins, it was observed that calving month did not have a significant effect on actual milk yield or 305-day milk yield (P>0.05).

The mean overall lactation period of Holstein cows was 419.61 days, and the mean dry period was 63.02 days (Table 4). It was found that the effect of origin and calving month on the lactation length of cows of

Table 4. Some lactation parameters and significance control according to the origin and calving month in Holstein heifers of different origins

Factors	Actual milk yield (litres)			305 Days milk yield (litres)		Lactation period (days)		Dry period (days)	
Origin	**n**	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$	$\bar{x}$	$\sigma_{\bar{x}}$
CZ	182	12033.1	856.14	8357.2^{b}	288.47	443.4	23.71	63.3^{b}	2.71
DE	119	10664.5	1008.86	8073.4^{b}	339.93	396.3	27.94	97.7^{a}	5.92
US	280	12206.6	263.78	8919.6^{a}	88.88	415.4	7.31	48.38	1.38
Calving month									
January	70	12572.9	492.57	8822.2	165.97	433.1	13.64	56.9	2.81
February	60	11933.3	694.91	8630.2	234.14	422.9	19.25	56.9	2.91
March	66	13300.1	523.81	9064.3	176.49	445.4	14.51	56.3	2.87
April	20	11582.2	2058.14	9438.8	693.47	376.1	57.01	55.5	6.35
May	15	13858.5	1035.91	9266.6	349.04	456.8	28.69	47.4	5.89
June	24	11494.2	818.96	8585.8	275.94	413.9	22.68	49.7	4.45
July	34	13328.4	688.06	8703.2	231.84	461.7	19.06	48.2	3.87
August	28	9367.1	1472.02	7599.8	495.98	365.8	40.77	86.9	8.63
September	11	10638.7	2103.93	8295.4	708.90	389.0	58.28	53.2	12.27
October	50	12081.7	1393.65	7989.0	469.58	471.8	38.60	74.2	3.20
November	77	11813.8	591.17	8619.4	199.19	413.2	16.37	67.5	3.39
December	126	11625.6	368.25	8606.6	124.08	405.8	10.20	73.6	2.09
OVERALL	581	11834.7	352.03	8579.3	118.61	419.6	9.75	63.1	1.63
Significance									
Origin		NS		*		NS		*	
Calving Month		NS		NS		NS		NS	
Origin x Calving Month		NS		*		NS		NS	

x: Mean; σx̄: Standard error. CZ: Czech Republic; DE: Germany; US: United States. a, b, c: Differences between means marked with different letters in the same column are significant (P<0.05). NS: Not Significant (P>0.05); *: P<0.05

Table 5. Milk yield in 15-day periods and comparisons according to origin in the first lactation in Holstein cows of different origins

		DAYS																			
	N	**15**	**30**	**45**	**60**	**75**	**90**	**105**	**120**	**135**	**150**	**165**	**180**	**195**	**210**	**225**	**240**	**255**	**270**	**285**	**305**
CZ	182	20.6	25.9	28.4	30.2	31.2	31.2	31.4	31.4	31.1	30.4	29.6	29.3	28.8^{b}	27.9^{b}	27.7^{b}	27.5	27.2	26.8$^{a, b}$	27.1	26.8
DE	119	20.8	26.9	29.2	30.7	30.9	31.5	31.4	30.5	30.7	30.6	30.6	30.4	30.6^{a}	29.7^{a}	29.4^{a}	28.7	27.2	26.1^{b}	25.5	25.3
US	280	21.1	26.2	29.4	31.1	31.9	32.2	31.7	31.4	31.1	30.8	30.5	30.2	29.8$^{a, b}$	29.3^{a}	29.1^{a}	28.7	28.2	27.8^{a}	26.9	26.3
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	*	*	NS	NS	*	NS	NS	

CZ: Czech Republic; DE: Germany; US: United States; NS: Not significant; *:P<0.05.

different origins was not statistically significant (P>0.05). The effect of the origin on the dry period was found to be significant. In the first lactation period, the shortest mean dry period was detected in Holstein cows of US origin, followed by cows of the Czech Republic and Germany origins, respectively (P<0.001). The effect of calving month on the dry period was found to be nonsignificant (P>0.05).

The daily mean milk yield of Holstein cows of the Czech Republic, Germany, and US origin during the first lactation period are presented in Table 5 and Figure 1 as 15-day periods. In the first lactation period, Holstein cows of German and US origin reached the peak level in the period between 76-90th days with a mean milk yield of 31.5 and 32.2 lt, respectively, while the Holstein cows of Czech origin reached the peak level in the period between 101-105th days with a mean milk yield of 31.4 lt. In the first lactation, the mean milk yield was higher in Holstein cows of German origin than in cows of other origins on 195, 210, and 225th days, while the yield decreased below the mean milk yield level of other origins on the 270th day (P<0.05). Cows of US origin showed a more stable lactation persistency during the onset of lactation, peak period, and dry period.

Discussion

Fertility: For all origins, the conception rates were found to be similar in the first, second, and third insemination, while the rate of conception of Holstein cows of Czech and German origin was found to be higher than those of US origin in the cows that became pregnant after four or more inseminations. In industrial dairy cattle farms, the aim of the conception rate for the first insemination is below 50%. In this present study, pregnancy rates of cows with different origins varied between 20.2% and 28.2% in the first insemination and these results are far behind compared to the industrial target. The stillbirth rate (2.6%) determined in the present study was found to be lower than that reported by Bayram et al. (2015). The stillbirth rate determined in the present study was found to be higher than the first production period and lower than the second production period in the reports of Deliömeroğlu (1993) and Özcan (1994). The abort rate (3.3%) determined in this study was higher than that reported by Deliömeroğlu (1993). The abort rate calculated in this study was higher than the abort rate calculated in the first production period and lower than the second production period in the report of Özcan (1994). The twin birth rate obtained in this present study (0.7%) was found to be higher than the first production period and lower than the second production period in the report of Özcan (1994). Although the fertility parameters expressed in proportion remain below the recommended ideal level to make an efficient breeding, it can be accepted that they are similar to the literature reported for Holstein cows in Turkey in general.

The mean age at first insemination of young heifers grown in industrial dairy cattle farms and to be included in production for the first time is ideally expected to be between 15–16 months (450–480 days) (Oğan et al. 2011). In this study, the mean age of first insemination of Holstein cows of Czech Republic, Germany, and US origin was calculated as 471.3 days, 517.5 days, and 491.8 days, respectively. Considering the ideal age at first insemination of the Holstein heifers and the mean age at first insemination calculated in this study, it can be said that the age at first insemination of the heifers of US and Czech Republic origin were within the normal limits, but the heifers of German origin were inseminated in a period later than the ideal insemination age. When the mean age at first insemination calculated for the Holstein cows of German origin (517.5 days, approximately 17.3 months) was compared with the information reported in the literature, it was seen that the data obtained in this study was higher than the data reported by Orman (2003), Akbaş and Şahin (2008), and less than the data reported by Özcan (1994), Duru and Tuncel (2002), Aslan and Altınel (1992), and Özçelik and Arpacık (1996). In this study, the lowest mean age of first

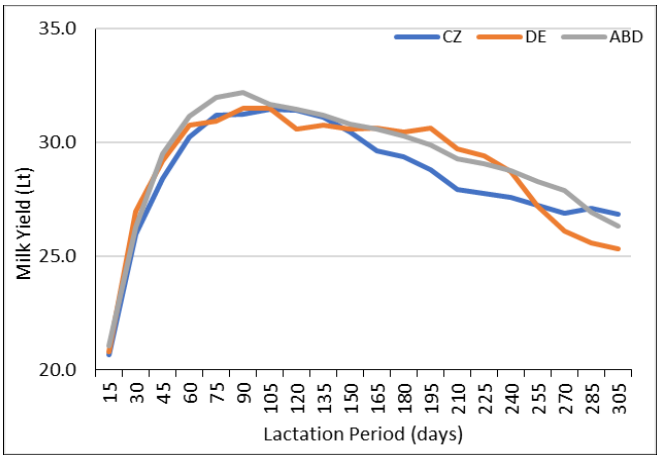

Figure 1. Milk yield in 15-day periods in the first lactation in Holstein cows of different origins
CZ: Czech Republic; DE: Germany; US: United States.

insemination was observed in Holstein heifers born in February. It was observed that the Holstein heifers born in February reached the age at first insemination significantly earlier than the heifers born in May, June, July, August, September, October, November, and December with an average of 449.96 days. Contrary to the result obtained in this study, Özcan (1994) found that the effect of the year and season on the age at first insemination in Holstein heifers was nonsignificant. Koçak et al. (2007) similarly found the effect of the season on the age at first insemination to be nonsignificant in Holstein cows. The reason for these differences may be due to the differences in the geographical conditions, climate or breeding techniques in which the studies were conducted.

The age at first calving in dairy cattle enterprises is ideally expected to be between 24-25 months (720-750 days) (Oğan et al. 2011). However, some researchers report that prolongation of this period up to 30 months should be considered normal (Kumlu and Akman, 1999). In this present study, the mean age at first calving for the whole herd was 804 days (26.8 months). The lowest mean age at first calving was determined in Holstein heifers of Czech origin as 777 days (25.9 months), followed by Holstein heifers of US origin as 797 days (26.6 months) and those of German origin as 842 days (28.1 months). It was determined that the mean age at first calving of Holstein heifers of Czech origin was shorter than those of German and US origin. Considering that the mean age at first insemination of heifers imported from Germany is also higher, this difference may be related to the insemination strategies applied in various regions/ territories/enterprises. For the heifers of German origin, calving at later ages may be due to the late insemination of pregnant heifers in the farm where they were imported from. When the studies conducted with Holstein cattle bred in Turkey were reviewed, it was observed that the mean age at first calving varied between 26.1 months (Orman, 2003) and 36.9 months (Akbulut et al., 1992). In this study, the mean age at first calving for Holstein cows of Czech Republic origin was younger than the mean age at first calving in all examined reports. The same parameter for Holstein heifers of German origin was only longer than those reported by Orman (2003) but shorter than those reported by Duru and Tuncel (2002), Karakaş (1996), Koçak et al. (2008), Özcan (1994), Alpan et al. (1976), and Akbulut et al. (1992). The mean age at first calving of the Holstein heifers of US origin was longer than those reported by Orman (2003), Duru and Tuncel (2002) and Karakaş (1996), and shorter than those reported by Koçak et al. (2008), Özcan (1994), Alpan et al. (1976), and Akbulut et al. (1992). Studies conducted with Holstein cattle outside of Turkey indicate that the youngest mean age at first calving was reported in Finland with 25.6 months (Mantysaari et al., 2002), and the oldest was reported in Ghana with 36 months (Osei et al., 1991).

Both the age at first insemination and first calving determined in this study were evaluated as far from the ideally accepted targets. This suggests an inadequate selection of heifers imported to the enterprise in the farms that they are imported from. Failure to carefully examine the pedigree information during the selection of pregnant heifers, and failure to apply scientific body condition scoring and breeding value criteria may have led to these results.

Insemination number below 1.5 is considered to be good, between 1.5-2.0 is considered fair, and above 2.0 is considered to be problematic reproductive performance (Alpan and Aksoy, 2012). Oğan et al. (2011) reported that the insemination number that can be considered ideal for dairy cattle should be less than 2. In the present study, the mean insemination number of Holstein cows of Czech Republic, Germany, and US origin were 4.2, 4.3, and 3.4, respectively. When the mean insemination number was compared with the relevant literature reports, the findings in this study were higher than all reported mean insemination number for Holstein cows. In the reviewed literature, the lowest mean insemination number (1.3) was reported by Duru and Tuncel (2002), and the highest mean insemination number (2.4) was reported by Özcan (1994). Similar to the results found in this study, many studies are reporting that the effect of the year and season on the mean insemination number in Holstein cows is insignificant (Özçelik and Arpacık, 1996; Orman, 2003).

Pregnancy is expected to last for an average of 279±5 days in Holstein cows (Yalçın, 1981; Alpan, 2012). In the present study, it was observed that the gestation length was 279.7 days in the first production period. It was found that the mean gestation length in Holstein cows of Czech origin was about 2 days shorter than those of US origin. This difference may be regarded as reasonable. For Holstein cows of different origins, it can be said that the pregnancy durations observed in the present study are consistent with those reported determined in similar scientific studies. The shortest gestation length was determined in heifers calving in June in the first production period, The longest gestation length was observed in heifers calving in February. However, the effect of calving months on gestation length was insignificant. Even if the effect of the calving month was statistically insignificant, the shortest gestation length observed in Holstein cows calving in warm months indicates that pregnancies in warm months can end earlier. Similarly, longer pregnancies have been reported in Holstein cows calving in winter compared to those calving in summer (Özçelik and Arpacık, 1996). Similar to the results obtained in this study, many researchers reported that the effect of environmental factors on pregnancy duration was insignificant (Özcan, 1994; Balcı, 1999; Orman, 2003).

In order to perform a profitable breeding in dairy cattle production, it should be aimed to inseminate the cow in the first oestrus period and 60 days after calving (Alpan and Aksoy, 2012). These values are recommended to be between 45-80 days for ideal breeding (Oğan et al. 2011). Although no statistically significant difference was found between the origins, the shortest first insemination interval was observed in cows of US origin in the first lactation period. For all three origins, the first insemination intervals of Holstein cows in the first production period were found to be above the recommended values. In the present study conducted with Holstein cows of different origins, the value of the mean first insemination interval obtained in the first production period was found to be higher than the reports of Pelister et al. (2000), Özcan (1994), and Aydın and Deveci (2001), and lower than the report of Orman (2003).

In this study, the mean service period of Holstein cows for the whole herd was 214 days. The length of the service period detected in the first production period remained above normal. When the results of the studies conducted with Holstein cows in Turkey are examined, it is seen that the mean service period varies between 93 days (Duru and Tuncel, 2002) and 218 days (Halıcıoğlu, 1989). The mean service period of the herd in this study was similar to the longest service period reported in Turkey. This result suggests that the first production period in this farm was far from an economic breeding in terms of the service period. In this study, it was determined that the effect of calving month on the service period in Holstein cows was insignificant. However, contrary to the result obtained in this study, Özcan (1994), Pelister et al. (2000), Orman (2003), and Özçelik and Arpacık (1996) found that the year or season had a significant effect on the service period.

In heifers calving for the first time and in high-yielding cows, prolongation of calving interval up to 400 days is considered normal (Noakes, 1997). Oğan et al. reported the target calving interval for dairy cows as 365-405 days (Oğan et al., 2011). Among the reviewed literature reports, the shortest mean calving interval was 369 days (Duru and Tuncel, 2002) and the longest calving interval was 438 days (Koçak et al., 2008) in the studies conducted with Holstein cows in Turkey. The shortest mean calving interval calculated in the present study was found in Holstein cows of US origin (471 days), but even this period is longer than the longest reported calving interval in Turkey. This shows that an economic breeding could not be performed in the first period in terms of calving interval in the enterprise where cows of different origins were bred. The technical failure in oestrus monitoring and insemination in the enterprise caused the service period and calving interval periods to be prolonged. Since this situation was observed in all cows of different origins in the first period, it would be more reasonable to explain it not with genetics and adaptation problems of the cows to the region, but with the management of the herd in the enterprise, the qualification of the personnel dealing with the cows, and the technical inadequacies in the insemination. In this study, it was concluded that the calving month did not have an effect on the calving intervals of Holstein cows. However, there are also studies reporting that factors such as year and season have a significant effect on the average calving interval in Holstein cows. While Pelister et al. (2000) reported that the effect of the year was significant in Holstein cows, Özçelik and Arpacık (1996) reported that the year and season, and Özcan (1994) reported that the season had an effect on the calving interval.

Milk Yield: The actual milk yield of cows of different origins, which were maintained and fed under similar conditions, was 11,835 lt in the first lactation period for the overall herd. A significant difference was observed between the origins in the first lactation period. In terms of mean 305-day milk yields, Holstein cows of US origin produced significantly more milk than other origins. The actual milk yield was reported as 3934 lt by Karakçı (1990), 4556.4 lt by Pelister (2000), 5350.7 lt by

Özcan (1994), 7473.5 lt by Şahin and Ulutaş (2010), and 8379.9 lt by Kaya and Bardakçıoğlu (2016) conducted with Holstein cows of different origins raised in different regions in Turkey. Alkoyak (2018) reported that the mean actual milk yields were 9034 lt in Holstein cows of Estonian origin and 8383 lt in those of US origin. It is seen that the mean actual milk yields for the Holstein cows bred in Turkey vary between 3934 and 9034 lt. In the present study, the actual milk yields calculated for the US, Czech, and German-origin Holstein cows are higher than the average values reported in Turkey for all three origins. It can be said that this situation is associated with the delay of the second pregnancy of the cows in the enterprise. The delay in the next pregnancy of cows prolongs the length of lactation, and naturally, the actual milk yields also show a relative increase. Although this situation prolongs the lactation period in enterprises and increases the actual milk yields, which is an uncorrected lactation parameter, it should be kept in mind that it may negatively affect the duration of the cows' stay in the herd and their lifetime productivity.

For the overall herd, the 305-day milk yield for cows of different origins was calculated as 8579 lt in the first lactation period. It was observed that the cows of US origin produced more milk than those of the Czech Republic and German origin, and this difference was statistically significant. The 305-day milk yields of Holstein breed cows raised in Turkey were reported by Halıcıoğlu (1989) as 3171 lt, 2771 lt, and 3500 lt for the Holstein cows of US, Netherlands, and Karacabey origin, respectively; by Karakçı (1990) as 5119 lt for those of Israeli origin, 4394 lt for German origin, and 4382 lt for US origin; by Pelister (2000) as 4455 lt for German origin; by Özcan (1994) as 4711 lt; by Şahin and Ulutaş (2010) as 6976 lt; by Alkoyak and Çetin (2018) as 7450 lt and 6738 lt for Holstein cows of the US and Estonian origin, respectively, and by Kaya and Bardakçıoğlu (2016) as 7909 lt. Our literature search indicates that the 305-day milk yields of Holstein cows grown in Turkey vary between 2771 and 7909 lt. In the present study, the 305-day mean milk yield values obtained with Holstein cows were higher for all three origins than those reported in the studies conducted in Turkey. This gives the impression that all imported Holstein cows have high genetic capacities in terms of milk yield capability. Similar to the results obtained in this study, Van Dorp et al. (1998) reported a mean milk yield of 8519 lt for 305 days in their study in Canada. In a study conducted with cows of US origin in Poland, 305-day milk yields were reported to be lower than the results obtained in this study. In the study conducted in Poland, the mean milk yield of the cows of US origin in the first three lactation periods was 3955, 4011, and 4014 lt, respectively (Zarnecki, 1991). However, there are also studies in the US conducted with Holstein cows reporting a higher 305-day mean milk yield (109,78 lt) than our study (Gröhn, 1999).

It has been reported that the ideal lactation period for a profitable management in dairy cattle breeding is between 300-320 days (Oğan et al., 2011). In this study, the mean lactation length for the first lactation period was 420 days for the overall herd, and 443 days, 396 days, and 415 days for cows of Czech Republic, Germany, and US origin, respectively. The effect of origin and month of calving was insignificant on the lactation period. However, the mean lactation period of this study was above the ideal lactation period limits. This shows that cows had problems during the conception process. The main fertility parameters and lactation periods reveal that pregnancies are delayed in the enterprise and this situation prolongs the lactation periods. This can be explained by herd management problems rather than the genetic predisposition and adaptability of cows. The mean lactation periods in the studies conducted with Holstein cows raised in various regions in Turkey were reported by Duru and Tuncel (2002) as 304.4 days, Kaya and Bardakçıoğlu (2016) as 319.5 days, Şahin and Ulutaş (2010) as 326.5 days, Özcan (1994) as 355.7 days, and Alkoyak (2018) as 352 days for the overall herd, 296 days for cows of US origin, and 370 days for those of Estonian origin. In the present study conducted with Holstein cows of different origins, the mean lactation periods were longer than the lactation periods reported in the literature.

It is reported that milk production should be stopped at least two months before calving and the optimal dry period should be between 42-75 days in order to achieve the expected milk yield in the next lactation period and to prepare the cow for the calving (Oğan et al., 2011; Dinç, 2016). In the present study, the mean dry periods were within the ideal limits reported in the literature. The mean dry period of the Holstein cows of German origin was longer than recommended ideal dry period however, the optimal dry period was reached in the cows of Czech origin. Cows of US origin were found to have a short dry period. Since the milk yield capabilities of cows of US origin were at a higher level than cows of German and Czech origin, the short duration of the dry period can be interpreted as not having a suppressive effect. Cows of US origin that reach the ideal level of dry period, may achieve a higher milk yield performance than determined in the present study and may reflect their complete genetic potential. In the studies conducted with Holstein cows raised in different regions in Turkey, the mean dry period was reported by Çetinkaya (2006) as 62 days, by Kaya and Bardakçıoğlu (2016) as 62.7 days, by Özcan (1994) as 67.8 days, and by Şahin and Ulutaş (2010) as 82.2 days. From these reports, it is understood that the mean dry period of the cows in Turkey varies between 62 days and 82 days. The mean dry period of the overall herd observed in the present study was longer than those reported by Çetinkaya, (2006) and Kaya and Bardakçıoğlu, (2016), and shorter than those reported by Özcan (1994), Şahin and Ulutaş (2010).

In terms of persistency, no difference was observed between origins in general. The highest milk yields were observed in the 90-105 day periods. The lactation persistency values calculated for all three origins examined in the present study were generally consistent with the reports of Kaya and Kaya (2003), Küçük Baykan and Özcan (2017), Cummins et al. (2012), and Hagiya et al. (2014). In the present study, although the data obtained with Holstein cows of different origins were similar to the study of Küçük Baykan and Özcan (2017) on Brown and Simmental breed cows in terms of the time to reach the highest milk yield in the first lactation period, it was observed that the highest milk yield amounts observed in the present study were higher than those reported by Küçük Baykan and Özcan (2017).

Conclusions

In conclusion, generally, the milk yield performances of cows of Czech, German, and US origin were evaluated as good, while their reproductive performances were evaluated as problematic in the private enterprise, which started production by importing the first animal material from three different countries for intensive dairy cattle breeding in Kırklareli province. Providing appropriate breeding and feeding may help the cows to reflect their genetic potential so they can maintain their milk yield performance and even reach higher production levels. Utmost care should be taken in the oestrus monitoring and insemination activity of all cows of the three origins with regard to reproduction, since the failures detected in this study, are due to the adaptation difficulties of imported cows as well as the inadequacies in herd management. Therefore, fertility parameters should be meticulously monitored, appropriate insemination techniques should be applied, monitoring for diseases that may affect fertility and milk yield should be performed, and the animals should be fed with adequate rations and thus possible negative effects on adaptation should be minimized. In addition, the success of animal imports in Turkey should be investigated with large scale and well-designed studies on a country, region, province, and enterprise basis; in particular, the problems experienced in the first animal selection and its consequences should be examined, and new short and long-term strategies should be developed on a national basis in a way that will ultimately constitute an alternative to livestock import policies.

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