Estimation of some genetic parameters (heritability and repeatability) for milk yield in the Anatolian population of Holstein cows

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SUMMARY

In this study, between 1993 and 2006, lactation records were obtained from Polatlı State Farm, Ankara in Turkey, belonging to the Ministry of Agriculture. Lactation milk yield was calculated by taking results of monthly test day milk yield tests in the farm by using Holland method. Lactations with less than 7 tests were not used in calculation. Milk yields were standardized to mature age and 305 days by using adjustment factors estimated for this herd, and were adjusted for year and season whose effects were significant, and then repeatability and heritability of first, second and all lactation milk yields was estimated on 2004, 936, 543 and 2653 standardized lactation records with minimum of 2 lactations/cow, 5 daughters/bull, 5 daughters/bull and 10 daughters per bull, respectively.

Heritability of all lactation milk yields was estimated by paternal half sib method from 2653 lactations of cows sired by 71 bulls which had at least 10 daughters. Heritability of milk yield for first, second and all lactations were estimated as 0.47 ± 0.12, 0.38 ± 0.04 and 0.30 ± 0.06, respectively.

From a total of 2004 lactation records of cows which had at least two lactations, repeatability of milk yield was estimated as 0.51 ± 0.02. By using successive two, three, four, five and total lactation data from records adjusted, the repeatability were estimated as 0.60 ± 0.02, 0.49 ± 0.03, 0.37 ± 0.05, 0.37 ± 0.08, 0.51 ± 0.02 for milk yield, respectively.

As repeatability was high, cows may be evaluated according to first milk yield records in culling. Heritability of milk yield for first lactations was at high level. So, both individual and relatives yield in this farm ought to be taken into consideration to select cows for milk yield. Selection of heifer for milk yield should be conducted in first lactation.

Keywords: cattle, milk yield, genetic parameters, repeatability, heritability

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INTRODUCTION

In animal breeding, selection and culling are the important ways to raise yield for each animal. While female are being culled, real breeding value of the animals in the herd must be determined then culling must be done according to this determination. While real breeding value of any animal is being determined, repeatability should be known. Repeatability appears how possible that high yield with animals in first performance year is continued in the following years (Ariturk and Yalcin 1966). Repeatability of milk yield were estimated as 0.424 ± 0.043 for Brown Swiss by Vurgun (1994); 0.42 ± 0.05 for Brown Swiss, 0.14 ± 0.08 for Holstein by Aydin (1996); 0.71 for Brown Swiss, 0.59 for Holstein, 0.69 for Simmental by Klopcic et al. (1997); 0.73 for Jersey by Toit et al. (1999); 0.35 ± 0.07 for Holstein by Tuzemen et al. (1999), 0.44 ± 0.028 for Simmental by Cilek and Tekin 2006a), 0.52 ± 0.02 for Brown Swiss by Cilek and Tekin (2006b).

While bulls or cows are being selected for breeding, in addition to their high yield capability, their transfer ability of high yield to their progeny is considered by the breeders. Heritability is the value of how much parents transfer their high yield capability to their progeny. While selection is being done, heritability of trait must be known. Heritability helps to determine which selection method is suitable for the improvement of yield. Heritability of milk yield for all lactations was estimated for Brown Swiss as 0.364 ± 0.127 by Vurgun (1994); 0.39 ± 0.22 by Aydin (1996); 0.65 by Klopcic et al. (1997); for Holstein as 0.27 ± 0.34 by Aydin (1996); 0.263 ± 0.120 by Erdem (1997); 0.20 by Klopcic et al. (1997); 0.25 ± 0.16 by Tuzemen et al. (1999).

Heritability of first lactation milk yield was estimated respectively as 0.166 and 0.167 with Restricted Maximum Likelihood (REML) and Henderson's method for Holstein by Kaps and Posavi (1992); 0.32, 0.31, 0.31 with Maximum Likelihood (ML), REML, Minimum Norm Quadratic Unbiased Estimation (MINQUE) methods for Brown Swiss by Akbulut (1995); 0.342 Derivative Free Maximum likelihood (DFREML) method for Ayrshire by Hallowell et al. (1999). Heritability of second lactation milk yield was estimated as 0.25 by Dong and Van Vleck (1989), 0.29 by Toit (1998), 0.12 by Albuquerque (1999) and as 0.22 by Strabel and Misztal (1999). In this study, it was aimed to determine heritability and repeatability of the standardized milk yield for the Holstein cattle reared in Polatlı State Farm.

MATERIAL AND METHODS

In this study, between 1993 and 2006, lactation records were obtained from Polatlı State Farm, Ankara in Turkey (Middle Anatolia), belonging to the Ministry of Agriculture. Lactation milk yield and was calculated by taking results of monthly milk yield tests in the farm by using Holland method (Eker et al. 1982, Cilek 2002). Lactations that tested less than 7 were not used in calculation. After lactation records were standardized to mature age and 305-

days by using adjustment factors reported by Çilek (2008) for Holstein cows reared in this farm, records were standardized for year and season whose effects were important, and then repeatability and heritability of milk yield was estimated.

In calculation of repeatability for milk yield, 2004 lactation records of cattle which had at least two lactations were used. In calculation, standardized milk yields were used and repeatability was estimated by intra class correlation method (Ariturk and Yalcin 1966).

Heritability of milk yield for all lactations were estimated from 2653 standardized lactation records of daughter of 71 bulls which had at least 10 daughters. Heritability of first lactation milk yield was estimated from 936 first lactations of daughter of 52 bulls which have at least 5 daughters. Heritability of first lactation milk yield was estimated from 543 first lactations of daughter of 43 bulls which have at least 5 daughters. Heritability of milk yield for both all lactations and first lactations were estimated by paternal half sib method (Ariturk and Yalcin 1966, Çilek 2002).

RESULTS AND DISCUSSION

Variance analyze of heritability of milk yield for all lactations was presented in Table 1. Average lactation record number for each bull (no) was found as 37.076. Total phenotypic variance ($\sigma^2_f = 2075366$) and between groups variance ($\sigma^2_a = 157472.1$) were calculated by using mean squares within groups and between groups in Table 1, then correlation coefficient within bulls ($t = 0.075$) was calculated by dividing $t = \sigma^2_a / \sigma^2_f$. As heritability was 4t, heritability was found as 0.30. Standard deviation of correlation coefficient within groups ($S_t = 0.015$) was estimated. This was multiplied by four and standard deviation of heritability for all lactation milk yields ($S_h^2 = 4\ S_t = 0.06$) was found.

Heritability of all lactation milk yields was estimated as 0.30 ± 0.06. This level is medium heritability. Ariturk and Yalcin (1966) reported that heritability to be reliable, standard deviation of it should be smaller than half of it. Results in this study are accordance with this rule. So in these results, large data set was used and lactations were standardized to environmental factors. Otherwise, to make calculations by paternal half sib correlation method reliable, all necessary conditions (selection of bulls by change, breeding in the same environmental factors, coefficient of relationship) were performed apart from relationship in herd (Duzgunes, 1987).

In this study, heritability of milk yield for first, and second were estimated at medium level as 0.47 ± 0.12 and 0.38 ± 0.04, respectively. The reason of lower of heritability of all lactation milk yields than heritability of first and second lactation may be culling and selection in this farm. Because, that on average level of herd and lower level animals were sold the breeders for many years in this farm was determined. Phenotypic variance of herd in first lactation was higher than second and following lactations.

To calculate heritability of milk yield in first lactation, variance analyze was defined in Table 2. In calculation for heritability of first lactation milk yield, daughter number for each bull was found as 17.82. Total phenotypic variance (σ^2_f = 1730081) and between groups variance (σ^2_a = 201742,6) were calculated by using mean squares within groups and between groups in Table 2, then correlation coefficient within bulls (t = 0.1166) was calculated by dividing $t = \sigma^2_a / \sigma^2_f$. As heritability was 4t, heritability was found as 0.47. Standard deviation of heritability for first lactation milk yield (S_h^2) was found as 0.12.

Variance analyze of heritability of milk yield for second lactations was presented in Table 3. Daughter number for each bull (no) was found as 12.55. Total phenotypic variance (σ^2_f = 2276383) and between groups variance (σ^2_a = 215512.8) were calculated, then heritability was found as 0.38. Standard deviation of heritability for first lactation milk yield (S_h^2) was found as 0.04.

Table 1. Variance analyze of all lactation milk yield

Source	DF	Means of Squares (MS)	F
Between bulls	70	7756273	$\Sigma^2_i + k\sigma^2_a$
Within bulls	2582	1917894	σ^2_i
Total	2652		
No	37.076		

Table 2. Variance analyze of first lactation milk yield

Source	DF	Means of Squares (MS)	F
Between bulls	51	5123587	$\Sigma^2_i + k\sigma^2_a$
Within bulls	884	1528338	σ^2_i
Total	935		
No	17.82		

Table 3. Variance analyze of second lactation milk yield

Source	DF	Means of Squares (MS)	F
Between bulls	42	4766318	$\Sigma^2_i + k\sigma^2_a$
Within bulls	500	2060870	σ^2_i
Total	542		
No	12.55		

In calculation of repeatability, variance analyze results were defined in Table 1. In this study average record number was found (no = 37.076). Total variance (σ^2_{total} = 3427683) and between groups variance (σ^2_a=1747408) were calculated by using mean squares within groups and between groups in Table 1, then repeatability or intra class correlation was calculated as r = 0.51 ± 0.02 by dividing $r = \sigma^2_a / \sigma^2_{total}$. Standard deviation of repeatability (S_r = 0.02) was estimated.

As repeatability was found high, cows may be evaluated according to first milk yield records in culling. Heritabilities of milk yield were at medium level

and heritability for first lactations was higher level than heritability for second and all lactations. Selection for milk yield might be conducted according to first lactation records. As a result, both the repeatability and the heritability were at expected levels and these results can be used for selecting and culling of the cattle in this farm. So, to select cows for milk yield in this farm ought to be taken into consideration both individual yield and relationship yield.

In estimation of repeatability by successive using two, three, four, and five lactation data from records adjusted, variance analyze results were defined in Table 5–8, the repeatability were estimated as 0.60 ± 0.02, 0.49 ± 0.03, 0.37 ± 0.05, and 0.37 ± 0.08 for milk yield, respectively.

By using successive two, three, four, and five lactation data from records adjusted, the repeatability were estimated as 0.60 ± 0.02, 0.49 ± 0.03, 0.37 ± 0.05, 0.37 ± 0.08, 0.51 ± 0.02 for milk yield, respectively. Similar estimates have been obtained by Okan (1998). If number of successive lactations increases, repeatability decreases. Phenotypic variance and variance between cows decrease, as number of total lactation records in calculation decrease with increase of number of successive lactations.

Repeatability of milk yield was estimated as 0.51 ± 0.02 and at high level. In literatures, in different breeds and herds, repeatability of milk yield is between 0.14-0.73. Estimation of repeatability in this study was to the near higher limit of literature (Vurgun 1994; Aydın 1996; Klopcic et al. 1997; Toit et al. 1999; Tüzemen et al.1999, Çilek and Tekin 2006a,b).

Table 4. Variance analyze for repeatability of cows which had at least two lactations.

Source	DF	Means of Squares (MS)	F
Between cows	747	6354857	$\sigma^2_i + k\sigma^2_a$
Within cows	1256	1680275	σ^2_i
Total	2003		
No	2.68		

Table 5. Variance analyze for repeatability by using successive two lactations.

Source	DF	Means of Squares (MS)	F
Between cows	746	5753127	$\sigma^2_i + k\sigma^2_a$
Within cows	747	1431158	σ^2_i
Total	1493		
No	2		

Table 6. Variance analyze for repeatability by using successive three lactations

Source	DF	Means of Squares (MS)	F
Between cows	337	6706211	$\sigma^2_i + k\sigma^2_a$
Within cows	676	1742074	σ^2_i
Total	1013		
No	3		

Table 7. Variance analyze for repeatability by using successive four lactations

Source	DF	Means of Squares (MS)	F
Between cows	121	6208212	$\sigma^2_i + k\sigma^2_a$
Within cows	366	1854492	σ^2_i
Total	487		
No	4		

Table 8. Variance analyze for repeatability by using successive five lactations

Source	DF	Means of Squares (MS)	F
Between cows	37	7155283	$\sigma^2_i + k\sigma^2_a$
Within cows	152	1800300	σ^2_i
Total	189		
No	5		

Repeatability was estimated higher than heritability as pointed out in literature (Erdem 1997, Çilek 2002) and as it was expected. Repeatability, which is done the first time in this farm, as it was taken from large data set (2004 lactations), it can be the route for breeding. In other saying; culling in herd may be done according to the first lactation records. After first lactation milk yield was standardized according to environmental effects, selection for milk yield in dairy cattle may be accurately selection measurement.

CONCLUSIONS

Repeatability, which is done the first time in this farm, as it was taken from large data set (2004 lactations), it can be the route for breeding. In other saying; culling in herd may be done according to the first lactation records. After first lactation milk yield was standardized according to environmental effects, selection for milk yield in dairy cattle may be accurately selection measurement.

As repeatability was high, cows may be evaluated according to first milk yield records in culling. Heritability of milk yield for all lactations and first lactations were at medium level. Therefore, both individual and relative yield at this farm ought to be taken into consideration when selecting cows for milk yield.

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