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Genetic and Environmental Parameters of Milkability Traits in Holstein Friesian Cows

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Abstract: The research was performed to determine the effect of non-genetic factors on milkability characteristics and to estimate genetic parameters and relationships among Milk Flow Rate (MFR), Milking Time (MT) and milk yields of Holstein Friesian cows reared in Eastern Region of Turkey. The data used in this study consisted of 1267 observations of MT and MFR on 177 lactations of 91 Holstein Friesian cows. The least squares means for MFR, MT and Total Test Day Milk Yield (TTDMY) were 1.049 kg min^{-1}, 5.83 min and 12.31 kg, respectively. Parity, stage of lactation and calving season affected ($p<0.01$) on the MFR, MT and TTDMY. Multiparous cows had higher MT and TTDMY ($p<0.01$) than primiparous cows. Calving season affected ($p<0.01$) on MT, MFR and TTDMY. The heritability coefficients for MFR, MT and TTDMY were 0.21, 0.23 and 0.23, respectively. The positive genetic correlations of MFR with TTDMY, actual milk yield and 305 days milk yield were 0.62, 0.49 and 0.48, respectively, while genetic correlations between MT and TTDMY, actual milk yield and 305 days milk yield were 0.20, 0.28, 0.34, respectively. Phenotypic and genetic correlations between MFR and MT were -0.49 and -0.63, respectively.

Key words: Milk flow rate, milking time, milkability, genetic parameters, holstein friesian

INTRODUCTION

Milkability in dairy cattle is one of the traits which belongs to the group of functional, cost saving characteristics in addition to health, feed efficiency, fertility and calving ease (Gade *et al*., 2006). Common characteristics in the milkability trait are average Milk Flow Rate (MFR), Milking Time (MT) and maximum milk flow rate.

Milkability traits are important economic factors in dairy cattle practice. They are used for animal selection (Bruckmaier *et al*., 1995), animal breeding and monitoring of udder health (Duda, 1995; Naumann *et al*., 1998), evaluation and development of milking machines and in setting parameters for their use (Rasmussen, 1993). Milkability evaluation also helps to improve labour efficiency.

Many researchers have obtained moderate estimates of heritability for milkability characteristics (Sekerden and Kuran, 1991; Povinelli *et al*., 2003; Gade *et al*., 2006). The estimates of heritability for average MFR and MT varied from 0.17-0.49 and from 0.16-0.38, respectively. Regarding the results of the literature (Santus and Bagnato, 1998; Mijic *et al*., 2003; Cho *et al*., 2004; Juozaitiene and Japertiene, 2005), there were positive genetic and phenotypic correlations between milk yield and MFR and MT.

Average altitude of Erzurum Province located in Eastern Region of Turkey is about 1950 m. Cold season in this region is longer than rest of the country and it snows a lot. In recent years, number of Holstein Friesian cattle brought to this area considerably increased. However, there is no information about milkability characteristics of Holstein Friesian cows reared in such high altitude conditions. Therefore, the study was undertaken to investigate effects of non-genetic factors on the milkability traits and to estimate genetic parameters as well as relationships among milk yield, MFR and MT of Holstein Friesian.

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MATERIALS AND METHODS

The study was carried out in Research Farm of College of Agriculture at Ataturk University, Erzurum, Turkey. Data used in this research consisted of 1267 observations of MFR and MT on 177 lactations of 91 Holstein Friesian cows. The cows were milked in the same milking parlour in order to collect data. On each sampling day, the milking and pulsation vacuum was adjusted to 50 kPa and pulsation ratio was 60:40 at a rate of 60 cycles min^{-1}. Each, stall of the milking parlour contained a milk-o-meter. Observations were made once a month during the lactation period and data were collected for 3 years. All observations on MT and MFR were determined by the same researchers at evening control milking. The observers stationed around the milking parlour and recorded MT of each cow by using chronometers. MT was determined as the interval from the attachment of the milking unit to the udder until it was completely removed. MFR was calculated as the ratio between milk yield and MT. Amounts of milk from morning and evening milking were also measured and recorded. Total Test Day Milk Yield (TTDMY) resulted from adding up the respective milk yields from all single milking per day. Three hundred and five days milk and actual milk yields were also calculated for each cow.

Statistical analysis was carried out by a least squares and maximum likelihood general program for mixed models (Harvey, 1987). A general linear model with fixed effects of parity, calving season, stage of lactation and their interactions with each other was used to identify the main sources of variation for studied traits in preliminary statistical analyses. Interactions were excluded from final statistical model, since they were not statistically significant.

The statistical model was following as:

$$Y_{ijkl} = \mu + P_i + L_j + S_k + e_{ijkl}$$

where:

- Y_{ijkl} = The measurement of a particular trait
- μ = The population mean, P_i is fixed effect of parity (i= 1, 2, 3, 4, 5, 6, 7)
- L_j = Fixed effect of stage of lactation (j = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
- S_k = Fixed effect of calving season (k= Winter, Spring, Summer, Fall)
- e_{ijkl} = Random error with a mean of zero and variance σ_e

Significant differences between the levels of the effects were tested by Duncan's multiple range test for studied traits. Heritability estimates as well as genetic and phenotypic correlations were also calculated (Harvey, 1987).

RESULTS AND DISCUSSION

Least square means with standard error for MT, MFR and TTDMY are tabulated in Table 1. The average MT of Holstein Friesian cows reared in Eastern Turkey was 5.83 min (Table 1). The finding is in accordance with results of Petersen *et al.* (1986), Arave *et al.* (1987), Povinelli *et al.* (2003) and Gade *et al.* (2006). Shorter total MT values (1.54 and 3.30 min) were obtained respectively by Tripathi *et al.* (1991) and Bhivasankar *et al.* (2003). On the other hand, the average MT reported by Pandey *et al.* (1990), Tancin *et al.* (2005) and Lee and Choudhary (2006) were higher (6.63, 7.43 and 8.23 min, respectively) than results of the present study. Major factors which affect on MT reported by other researchers could be due to differences in the milk production levels, age of cows as well as pre-milking preparations.

The average MFR for Holstein Friesian cows was 1.049 kg min^{-1}. The result is in agreement with findings of Pandey *et al.* (1990) and Kuran and Sekerden (1992). On the other hand, the mean MFR observed in the present study was lower than results of Arave *et al.* (1987) (1.61 kg min^{-1}), Mijic *et al.* (2003) (1.61-3.60 kg min^{-1}), Gade *et al.* (2006) (2.21-2.75 kg min^{-1}) and Lee and Choudhary (2006) (2.30 kg min^{-1}) for Holstein Friesian cows. However, the average MFR of crossbred and Shavial cows were 0.467 kg min^{-1} and 0.597 kg min^{-1}, respectively (Bhivasankar *et al.*, 2003). Corresponding values were 0.81 and 0.57 kg min^{-1} for crossbred and Desi cows in mid lactation (Tripathi *et al.*, 1991). Singh *et al.* (1999) also noted that average MFR of crossbred cows in the range of 0.691-0.920 kg min^{-1} and all these findings were lower than results of the present study.

Parity affected ($p<0.01$) all milkability traits (Table 1). Multiparous cows had higher MT and TTDMY than primiparous cows. Increased MT with parity corroborates previous studies (Petersen *et al.*, 1986; Aydin *et al.*, 2008). Naumann and Fahr (2000) observed that increasing parity was associated with decreasing average MFR and the result is in accordance with our finding.

Stage of lactation had significant effect on MT, MFR and TTDMY (Table 1). Peak milk yield was attained at the first month of the lactation and later, milk production declined gradually. Similar results were also reported by Sekerden and Erdem (1996) and Aydin *et al.* (2008). The values of MT corresponded TTDMY changes during the lactation. As a result of that fact, MT was the greatest at the beginning of the lactation and diminished as long as

Table 1: Least squares means with standard errors for milk flow rate, milking time and total test day milk yield

	n	Milking time (min) X±Sx	Milk flow rate (kg min^{-1}) X±Sx	Total test day milk yield (kg) X±Sx
Overall mean	1267	5.83±0.07	1.049±0.019	12.31±0.12
Parity		**	**	**
1	413	4.49±0.08^{a}	1.007±0.022^{ab}	9.68±0.14^{a}
2	239	4.80±0.11^{a}	1.147±0.029^{c}	10.51±0.19^{a}
3	187	5.64±0.13^{b}	1.138±0.032^{bc}	13.00±0.21^{bc}
4	169	5.99±0.13^{b}	1.168±0.034^{c}	14.04±0.23^{c}
5	147	6.04±0.14^{b}	1.109±0.036^{bc}	13.43±0.24^{bc}
6	93	6.87±0.18^{c}	0.932±0.046^{a}	13.40±0.30^{bc}
7	19	7.00±0.40^{c}	0.839±0.101^{a}	12.09±0.67^{b}
Stage of lactation		**	**	**
1	121	6.27±0.16^{b}	1.284±0.042^{f}	15.75±0.28^{g}
2	150	6.22±0.15^{b}	1.195±0.039^{ef}	14.84±0.26^{fg}
3	133	6.00±0.16^{ab}	1.185±0.041^{ef}	14.08±0.27^{ef}
4	126	6.07±0.16^{ab}	1.117±0.041^{de}	13.49±0.28^{e}
5	128	5.70±0.16^{a}	1.111±0.041^{def}	12.55±0.28^{d}
6	148	5.65±0.15^{a}	1.009±0.039^{cd}	11.49±0.26^{c}
7	129	5.61±0.16^{a}	1.015±0.041^{cd}	11.22±0.27^{c}
8	123	5.65±0.16^{a}	0.933±0.042^{bc}	10.81±0.28^{c}
9	112	5.58±0.17^{a}	0.868±0.044^{ab}	9.86±0.29^{b}
10	97	5.57±0.18^{a}	0.768±0.047^{a}	8.99±0.31^{a}
Calving season		**	**	**
Winter	262	6.11±0.12^{c}	0.933±0.030^{a}	11.29±0.20^{a}
Spring	362	5.42±0.11^{a}	1.411±0.027^{b}	14.72±0.18^{c}
Summer	355	5.71±0.11^{b}	0.937±0.028^{a}	11.24±0.18^{a}
Fall	288	6.08±0.12^{c}	0.914±0.029^{a}	11.99±0.19^{b}

**$p<0.01$

Table 2: Heritabilities on diagonal, genetic correlations below diagonal and phenotypic correlations above diagonal of milking and milk yield traits

	MY-am[1]	MY-pm[2]	MFR[3]	MT[4]	TTDMY[5]	AMY[6]	305 DMY[7]
MY-am	0.20 (0.06)[8]	0.82**	0.46**	0.28**	0.96**	0.45**	0.50**
MY-pm	0.98**	0.21 (0.06)	0.66**	0.21**	0.95**	0.41**	0.46**
MFR	0.56**	0.67**	0.21 (0.06)	-0.49**	0.58**	0.15**	0.16**
MT	0.27	0.12	-0.63**	0.23 (0.06)	0.26**	0.25**	0.28**
TTDMY	0.99**	0.99**	0.62**	0.20	0.23 (0.06)	0.45**	0.50**
AMY	0.96**	0.93**	0.49*	0.28	0.95**	0.30 (0.07)	0.93**
305 DMY	0.99**	0.96**	0.48*	0.34	0.98**	0.97**	0.38 (0.08)

*$p<0.05$; **$p<0.01$; MY-am: Milk Yield from Morning Milking; [2]MY-pm: Milk Yield from Evening Milking; [3]MFR: Milk Flow Rate; [4]MT: Milking Time; [5]TTDMY: Total Test Day Milk Yield; [6]AMY: Actual Milk Yield; [7]305 DMY: 305 Days Milk Yield; [8]Standard Error of Heritability Estimates

lactation advanced. The result is in agreement with findings of Povinelli *et al*. (2003) and Tancin *et al*. (2006). MFR decreased gradually with increasing stages of lactation. Similarly, Tancin *et al*. (2005) and Gade *et al*. (2006) reported that MFR of the dairy cows gradually reduced during the lactation.

The effect of calving season on all studied parameters were statistically significant ($p<0.01$) (Table 1). MT was the longest during winter and fall milking while the greatest MFR and TTDMY were measured from cows calved in spring. Significant influence of calving season on MFR was also observed by Jomeh and Pakdel (2000), Cho *et al*. (2004). Significant effect of the calving season on the TTDMY of cows was also supported by findings of Kurt *et al*. (2005) and Nagawade *et al*. (2008).

Heritability estimates for MFR and MT are presented in Table 2 and the values for MFR and MT were at moderate level with 0.21 and 0.23 respectively. Similar results were calculated by Sekerden and Kuran (1991) who estimated heritability coefficients for MFR, MT and TTDMY as 0.172, 0.204 and 0.221, respectively. However, the findings of the present study were lower than results of Gade *et al*. (2006).

Genetic and phenotypic correlations among milkability and milk yield traits are given in Table 2. Significant positive correlations of MFR with TDMY, actual and 305 day milk yield were obtained. The results are in agreement with findings of Sekerden and Erdem (1996), Mijic *et al*. (2003), Cho *et al*. (2004), Lee and Choudhary (2006). MT had also positive genetic and phenotypic correlations with TDMY, actual and 305 day milk yield, but they were not significant. The higher milk yield traits were associated with higher MFR. The results indicate that further selection for higher milk yield could cause in deterioration of udder health since higher MFR was associated with increased udder health problems (Lacky-Hulbert and Hillerton, 1995; Boettcher *et al*., 1998; Zwald *et al*., 2005). Therefore, Holstein cows with extremely low or high MFR should be tried to exclude from breeding due to the interrelation to labour efficiency and udder health and to avoid a worsening of the udder health and to attain more uniform milking duration among cows simultaneously.

CONCLUSION

The results of this study demonstrated that non-genetic factors such as parity, stage of lactation and calving season had significant ($p<0.01$) effect on the MFR, MT and TTDMY. Moderate heritability coefficients for MFR and MT and significant genetic and phenotypic correlations among MFR, MT and milk yield traits were also obtained.

REFERENCES

Arave, C.W., K.L. Macmillan and R. Kilgour, 1987. Milking characteristics of Friesian, Jersey and Friesian-Jersey crossbreds in eleven New Zealand dairy herds. New Zealand J. Exp. Agric., 15: 33-37.

Aydin, R., M. Yanar, O. Guler, S. Yuksel, F. Ugur and L. Turgut, 2008. Study on milkability traits in Brown Swiss cows reared in eastern region of Turkey. J. Anim. Vet. Adv., 7: 1218-1222. http://www.medwelljournals.com/fulltext/java/2008/1218-1222.pdf.

Bhivasankar, A.K., J.M. Chahande and S.Z. Ali, 2003. Studies on milkability traits in Sahiwal and crossbred cows. Ind. Vet. J., 80: 76-77. http://direct.bl.uk/bld/PlaceOrder.do?UIN=126178670&ETOC=RN&from=searchengine.

Bruckmaier, R.M., E. Rothenanger and J.W. Blum, 1995. Milking characteristics in dairy cows of different breeds from different farms and during the course of lactation. J. Anim. Breed. Genet., 12: 293-302. http://jds.fass.org/cgi/reprint/88/1/137.pdf.

Boettcher, P.J., J.C.M. Dekkers and B.W. Kolstad, 1998. Development of udder health index for sire selection based on somatic cell score, udder conformation and milking speed. J. Dairy Sci., 81: 1157-1168. PMID: 9594405. http://jds.fass.org/cgi/reprint/81/4/1157.

Cho, Y.M., B.H. Park and B.S. Ahn, 2004. A study on estimation of factors affecting duration of milk flow and milk flow rate and their relationships with milk yields of dairy cattle. J. Anim. Sci. Technol., 46: 517-524. http://www.cababstractsplus.org/google/abstract.asp?AcNo=20043155498.

Duda, J., 1995. Associations between milkability and susceptibility to mastitis. Zuchtungskunde, 67: 467-476. http://www.fao.org/agris/search/display.do? f=./1996/v2225/DE96A4599.xml;DE96A4599.

Gade, S., E. Stamer, W. Junge and E. Kalm, 2006. Estimates of genetic parameters for milkability from automatic milking. Livest. Sci., 104: 135-146. http://dx.doi.org/10.1016/j.livsci.2006.04.003. http://www.sciencedirect com/science?_ob=MImg&_imagekey=B7XNX-4K1X8CG-1-C&_cdi=29710&_user=610102&_orig=search&_coverDate=10%2F31%2F2006&_sk=998959998&view=c&wchp=dGLbVlz-zSkWA&md5=a3af1f1d329b2814f913d53a52460b3e&ie=/sdarticle.pdf.

Harvey, W., 1987. User's Quide for LSMLMNN., PC-1 Version. The Ohio State University, Columbus, OH., USA.

Jomeh, N.E. and A. Pakdel, 2000. Study of milking speed in Holstein dairy cattle. Agric. Sci. Technol., 14: 13-20.

Juozaitiene, V. and R. Japertiene, 2005. Phenotypic evaluation of correlation between milkability, milk yield, milk composition and milk quality in cows. Veterinarija ýr Zootechnika, 32: 54. http://www.lva.lt/vetzoo/data/vols/2005/32/en/juozaitiene.pdf.

Kuran, M. and O. Sekerden, 1992. The relationships between the rate of milk flow with milk yield and milking time for jersey cows milked by machines. J. Univ. Agric. Fac., 7: 41-49.

Kurt, S., F. Ugur, T. Savas and M. Saglam, 2005. Milk production characteristics of Holstein Friesian cattle reared in Tahirova State Farm located in Western Anatolia. Ind. J. Dairy Sci., 58: 62-64. http://cat.inist.fr/?aModele=afficheN&cpsidt=16911256.

Lacky-Hulbert, S.J. and J.E. Hillerton, 1995. Physical characteristics of the bovine teat canal and their influence on susceptibility to streptococcal infection. J. Dairy Res., 62 (3): 395-404. PMID: 7593826.

Lee, D.H. and V. Choudhary, 2006. Study on milkability traits in Holstein cows. Asian Austral. J. Anim., 19: 309-314. http://cat.inist.fr/?aModele=afficheN&cpsidt=17613073.

Mijic, P., I. Knezevic, M. Baban, M. Domacinovic and D. Rimac, 2003. Investigation of correlations and milking parameter distribution on cattle farms in eastern Croatia. Acta Agron. Hung., 51: 191-198. http://www.akademiai.com/content/k6758q08v1561r82/fulltext.pdf.

Naumann, I., R.D. Fahr and G. Lengerken, 1998. Relationship between somatic cell count of milk and special parameters of milk flow curves of cows. Arch. Tierz. Dummerstorf, 41:237-250. http://cat.inist.fr/?aModele=afficheN&cpsidt=10447516.

Naumann, I. and R.D. Fahr. 2000. Investigation of milk flow from udder quarters. Arch. Tierz. Dummerstorf, 43: 431-440. http://www.fao.org/agris/search/display.do?f=./2002/v2803/DE2000A14258.xml;DE2000A14258.

Nagawade, P.P., D.Z. Jagtap and S.S. Kamble, 2008. Effect of non-genetic factors on colostrum and production traits of Phule Triveni (triple crossbred) cattle. Indian J. Anim. Sci., 78: 215-217. http://direct.bl.uk/bld/PlaceOrder.do?UIN=227423054&ETOC=RN&from=searchengine.

Pandey, H.S., M.M. Saxena, D.N. Jana, H.N. Pandey and L.P. Nautial, 1990. Milkability in crosbred and Holstein-Friesian cows under hand and machine milking. Ind. J. Anim. Sci., 60: 732-734.

Petersen, M.L., L.B. Hansen, C.W. Young and K.P. Miller, 1986. Rates of milk flow and milking times resulting from selection for milk yield. J. Dairy Sci., 69: 556-563. http://jds.fass.org/cgi/reprint/69/2/556.

Povinelli, M., C. Romani, L. Degano, M. Cassandro, R. Dal Zotto and G. Bittante. 2003. Sources of variation and heritability estimates for milking speed in Italian Brown cows. Ital. J. Anim. Sci., 2: (Suppl. 1) 70-72. http://www.aspajournal.it/archivio/pdf_2003/Atti_ASPA2003/AttiASPA2003_session01.pdf.

Rasmussen, M.D., 1993. Influence of switch level of automatic cluster removers on milking performance and udder health. J. Dairy Res., 60 (3): 287-297. PMID: 8376630. http://www.ncbi.nlm.nih.gov/pubmed/8376630.

Santus, E. and A. Bagnato, 1998. Genetic parameters estimation for milkability traits recorded with flowmeters in Italian Brown Swiss. Proceedings of the 6th World Congress on Genetics Applied to Livestock Production, Armidale, NSW, Australia, pp: 19-22. http://elib.tiho-hannover.de/publications/6wcgalp/papers/25019.pdf.

Sekerden, O. and M. Kuran, 1991. Estimation of heritabilities of the speed of milk flow milking time and milk yield in Jersey cows of Karakoy State Farm Truk. J. Vet. Anim. Sci., 16: 86-92.

Sekerden, O. and H. Erdem, 1996. Relationship between the rate of milk flow and milk yield Simmental cattle of Kazova State Farm. Truk. J. Vet. Anim. Sci., 20: 69-72. http://journals.tubitak.gov.tr/veterinary/issues/vet-96-20-1/vet-20-1-12-94093.pdf.

Singh, S.K., H.P.S. Arya and H.S. Pandey, 1999. Type of udder and teat shape in cros-bred cows and their association with milkability. Ind. J. Anim. Res., 33: 70-72.

Tancin, V., B. Ipema and P. Hogewerf, 2005. The quarter milk flow parameters influenced by stage of lactation and milkability in multiparous dairy cows. ICAR Technical Series, No: 10, Rome, Italy. http://www.icar.org/Documents/technical_series/tec_series_10_nitra.pdf.

Tancin, V., B. Ipema, P. Hogewerf and J. Macuhova, 2006. Sources of variation in milk flow characteristics at udder and quarter levels. J. Dairy Sci., 89: 978-988. http://jds.fass.org/cgi/reprint/89/3/978.pdf.

Tripathi, S., S. Pan and S.K. Halder, 1991. Performance of deshi cattle as dairy animal. Milkability and dairy temperament. Ind. J. Anim. Prod. Man., 7: 225-229.

Zwald, N.R., K.A. Weigel, Y.M. Chang, R.D. Welper and J.S. Clay, 2005. Genetic evaluation of dairy sires for milking duration using electronically recorded milking times of their daughters. J. Dairy Sci., 88: 1192-1198. PMID: 15738252. http://jds.fass.org/cgi/reprint/88/3/1192.pdf.