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Estimates of Genetic and Phenotypic Parameters for Birth Weight in Holstein Friesian Cattle

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Abstract: The purpose of this study was to estimate genetic and phenotypic parameters for birth weight in Holstein calves raised at 4 different state farms. The least squares mean of birth weight was 38.09±0.07 kg. Effects of birth year, birth type, parity, farm (P<0.01) and season (P<0.05) on birth weight was significant; however, the effect of sex on birth weight was not significant. Repeatability and heritability estimates for birth weight were 0.34±0.02 (P<0.05) and 0.13±0.02 (P<0.01). Based on these results it can be suggested that the effects of environmental factors should be eliminated in the selection which will be mediated based on birth weight.

Key words: Holstein, birth weight, heritability, repeatability

INTRODUCTION

One of the important breed characteristics in cattle breeding is calf birth weight. Since birth weight is considered as an initial reference point with regard to subsequent development of individual as well as other characteristics, this trait is of critical importance to cattle industry. It is demonstrated that calves having too small live weight at birth may lack vigor and tolerance to external conditions, whereas various degrees of dystocia may occur in calves that are too large at birth. Besides these extremes, heifers having high birth weight grow fast and produce more beef. These heifers also can reach mature weight to produce offspring at an earlier age and subsequently, milk production[1]. High correlations between birth weight and first calving age have been reported[2,3].

In general, factors affecting birth weight may be grouped into genetic and environmental factors[4]. Breed, sex and genetic anomalies are considered as genetic factors; and dam age, birth weight at calving, mothering ability, nutritional conditions of dam, litter size, gestation length, calving year, season, geographical region and altitude are considered as environmental factors[5-8]. In the present study the effects of some environmental factors on birth weight of Holstein Friesian calves raised in various state farms in Turkey and estimation of some genetic parameters were studied.

MATERIALS AND METHODS

Birth weight data of 2583 Holstein Friesian calves reared in four different farms (Ceylanpınar, Tahirova, Reyhanlı and Ankara Sugar Factory) between 1982 and 1999 were evaluated. Birth weights were taken within 24 h after calving. Effects of environmental factors on birth weight were studied. Birth weights of calves were analyzed by using the following statistical model,

$$Y_{ijklmno} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + e_{ijklmno}$$

where, μ= the population mean, a_i = the effect of calving year, b_j = the effect of farm, c_k = the effect of season, d_l = the effect of sex, f_m = the effect of birth type, g_n = the effect of parity, $e_{ijklmno}$ = error. LSMLMW program was used for statistical analysis[9]. S_p and h_p which describe the effects of sire and dam, respectively, were included in the model for estimation of heritability and repeatability.

Half sib-correlation was used for estimation of heritability of birth weight. Maternal half sib correlation (within group-correlation coefficient between dams) was used for estimation of repeatability of birth weight. Duncan test was utilized in comparisons of sub-groups' means[10].

RESULTS

Mean calf birth weight, repeatability and heritability estimates of birth weight were 38.09±0.07 kg, 0.34±0.02 (P<0.05) and 0.13±0.02 (P<0.01), respectively. Effects of birth year, birth type, parity, farm (P<0.01) and season (P<0.05) on birth weight was significant. However, the effect of sex on birth weight was not significant. Birth weight varied among the years. While birth weights obtained in years 1983, 84, 86 and 89 were heavier than

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overall mean, they were lower than this value in years 1982, 1997, 98 and 99 (P<0.01).

When farm was taken into consideration, the calves born in Reyhanlı State Farm had the highest birth weight (40 kg) and those born in Sugar Factory Farm had the lowest (34 kg) birth weight (P<0.01). Male and single calves had 1.80 and 3.93 kg higher mean birth weight than female and twin calves, respectively. Although differences among means were marginal, the effect of parity on birth weight was highly significant. While the lowest birth weight was observed in the first parturition (35.4 kg) the highest value was observed in the eighth parturition (38.0 kg). Winter born calves were higher in birth weight than calves born in other seasons (Table 1).

DISCUSSION

Expected (Adjusted) means: Least squares mean for birth weight was 38.09±0.07 kg. Several researchers report comparable[11-13], lower[14,15] or higher[16] values obtained in different farms in Turkey. Roy[17] reported 45-46 kg male and 41-42 kg female birth weights of Holstein Friesian calves raised in USA. It could be said that Holstein Friesian are in a good condition in terms of birth weight in Turkey.

Effects of environmental conditions: The effect of year on birth weight was highly significant (P<0.01). The ratio of year in total variability of birth weight was 6.2%. As observed in the present study, the significant effect of year on birth weight was reported by various researchers[8,12,13,15,18-20]. Because of changes occur in climate and pasture conditions from year to year, differences in calf birth weights among years are expected.

The effect of farm on birth weight was highly significant (P<0.01). The highest and lowest birth weights have been found as 40.31±0.46 kg and 34.21±0.45 kg in Reyhanlı and Sugar Factory Farm, respectively. The difference in birth weight between these farms was 6.1 kg. The ratio of farm in total variability of birth weight was 14.5%. The differences between farms could be attributed to feeding, climate and maintenance conditions and farming practices.

The effect of birth type (single vs. twin) on birth weight was significant (P<0.01). The mean birth weight of single calves was 3.93 kg (11.2%) higher than that of twin calves. The ratio of birth type in total variability of birth weight was 29.8%.

The effect of sex on birth weight was not significant, nevertheless, birth weight of male calves were 0.21 kg (0.6%) heavier than female ones. In the studies investigating the factors affecting birth weight of calves

Table 1: General and least square means of birth weight and significance and multiple comparison test results

Factors	N	X±S$_X$	%Variation
Overall mean	2583	38.09±0.07	
Year		**	6.2
1982	12	33.13±1.03[a]	
1983	13	40.29±1.09[c]	
1984	16	39.90±1.00[c]	
1985	28	37.81±0.83[b]	
1986	33	38.38±0.79[c]	
1987	56	37.31±0.69[b]	
1988	52	36.73±0.70[b]	
1989	63	39.16±0.67[c]	
1990	93	36.91±0.57[b]	
1991	82	37.17±0.54[b]	
1992	144	37.45±0.46[b]	
1993	232	38.06±0.44[b]	
1994	361	37.00±0.41[b]	
1995	457	37.46±0.41[b]	
1996	457	37.61±0.41[b]	
1997	169	34.82±0.46[a]	
1998	175	34.27±0.43[a]	
1999	140	32.66±0.46[a]	
Farm		**	14. 5
Ceylanpınar Farm	1021	36.14±0.46[a]	
Tahirova Farm	709	37.39±0.43[b]	
Reyhanlı Farm	461	40.30±0.46[c]	
Ankara Sugar Factory Farm	392	34.20±0.45[d]	
Season		*	0.2
Winter	701	37.34±0.40[a]	
Spring	607	36.88±0.40[b]	
Summer	603	36.87±0.40[b]	
Autumn	672	36.94±0.39[b]	
Sex		NS	0.1
Male	1341	37.93±0.39	
Female	1242	36.13±0.39	
Birth type		**	29.8
Single	2554	38.97±0.23[a]	
Twin	29	35.04±0.67[b]	
Parity		**	2.4
1	885	35.40±0.37[a]	
2	599	36.46±0.38[b]	
3	498	37.15±0.38[c]	
4	300	37.12±0.40[c]	
5	152	37.24±0.44[c]	
6	79	37.14±0.52[c]	
7	34	37.17±0.70[c]	
8	23	37.98±0.81[c]	
9	13	37.42±1.03[c]	
Heritability		0.131±0.022**	
Repeatability		0.341±0.017*	

*P<0.05   **P<0.01,   NS: Non significant
a, b, c, d: means with different letter(s) differ significantly (P<0.01, P<0.05) from each other

Holland and Odde[4] and Kaygısız et al.[13] reported that birth weight of male calves were 5–8% heavier than female calves. This was attributed this to longer gestation period of male calves[21], or high androgen concentrations in male fetuses[5]. The findings of present study were consistent with results of Kaygısız[22], Bakır and Söğüt[12], Uğur and Yanar[23], Akbulut et al.[15,20] who found that the effect of the sex on birth weight was significant. The ratio of sex in total variability of birth weight was 0.1%.

The effect of parity on birth weight has been found to be highly significant (P<0.01). The ratio of parity in

total variability of birth weight was 2.4%. The lowest birth weights have been observed in 1st parturitions. However, the mean birth weights appeared to be similar between 3rd and 9th parturitions. Kaygısız et al.[13], Bakır and Söğüt[12], Kaygısız[22] reported that effect of parity on birth weight was highly significant. However, Freitas et al.[18] found that parity had no significant effect on birth weight. It was reported that birth weight was lowest in calves born by 2 years of age dams, increased rapidly at 3 years of age. This increase happened gradually until dams reached 5-6 years of age and then birth weight decreased until 9-11 years of age[5,6,8].

One of the factors affecting birth weight was calving season. In the present study the effect of the season on birth weight was significant (P<0.05). The ratio of the season in total variability of birth weight was 0.2%. The highest birth weight (37.35 kg) obtained in winter and the average birth weights for other three seasons were comparable. As observed in this study, the effect of the season on birth weight was significant in other studies carried out by Shibata and Kumazaki[24], Sang and Kim[8], Ulusan[25], Souza et al.[26], Kaygısız et al.[13] and Başpınar et al.[16]. However, not significant in those of done by Ornelas and Ponce[27], Akbulut et al.[20,28].

Genetic parameter estimations

Heritability: A moderate (0.13±0.02) and highly significant (P<0.01) heritability of birth weight was estimated. Heritability estimate reported by Kaygısız[22] for Simmental was lower (0.078) than this value but the similar (0.084) for Brown Swiss. Heritability estimate found in the present study was lower than the estimates reported by Guaragna et al.[19], Bakır and Söğüt[12], Akbulut et al.[15] 0.34, 0.104, 0.34, respectively, in the same breed. Also, this value was lower than values 0.40, 0.25, 0.54, 0.75, 0.76 and 0.102 and reported for Sahiwal, Charolois, Nelore, Jersey, Brown Swiss, respectively[13,22,26,29-31]. On the other hand, heritability estimates for birth weight was reported as 0.17 for Holstein, 36 and 0.28, 0.35 for Brown Swiss and Brahman crosses and 0.50 for Nelore breed[32].

Repeatability: A significant (P<0.05) repeatability of birth weight of calves (0.34±0.02) was estimated. Repeatability estimate found in the present study was very similar to 0.30, 0.35 and 0.38 for Brown Swiss[25], Nelore[32] and Nelore[33], respectively. This value is higher than 0.17, 0.011, 0.158, 0.19 and 0.22 for Holstein, Brown Swiss, Nelore[8,12,26,34] and lower than 0.57, 0.65, 0.67 and 0.67 for Shorthorn, Brown Swiss, Angus and Hereford[34].

Since birth weight is related to growth, development and various yield traits during the early ages this trait can be used as an indirect selection criterion in farm animals.

Birth weight means determined in the present study was similar to findings in literature. This indicated that cows in the farms were treated well during gestation when intrauterine growth of the fetus was rapid. Effects of environmental factors such as year, farm, birth type, parity and season on birth weight have been found to be significant. Therefore, the effects of environmental factors should be eliminated in the selection which will be mediated based on birth weight.

REFERENCES

1. Ilaslan, M., Y. Aşkın, C. Geliyi and I. Alataş, 1978. Body condition, milk and reproductive traits in Brown Swiss and Simmental cattle raised in Kars Testing Station. Kars Deneme Istasyonu, Yay. No: 5. 1-36.

2. Schmidt, G.H. and L.D. Van Vleck, 1974. Principles of dairy science. W.H. Freeman Company, San Francisco, pp: 558.

3. Akbulut, Ö., N. Tüzemen, M. Yanar and R. Aydın, 1998. The relationships between live weight and body measurements with first lactation milk yield in Brown Swiss cattle. Atatürk Üniv. Zir. Fak. Derg., 29: 250-258.

4. Holland, M.D. and K.G. Odde, 1992. Factors affecting calf birth weight. A review. Theriogenology, 38: 769-798.

5. Kim, C.K., S.C.C. Yen and K. Benirschke, 1972. Serum testosterone in fetal cattle. Gen. Comp. Endocrinal., 18: 404-407.

6. Bourdon, R.M. and J.S. Brinks, 1982. Genetic, environmental and phenotypic relationships among gestation length, birth weight, growth traits and age at first calving in beef cattle. J. Anim. Sci., 55: 543-553.

7. Sakhare, P.G. and U.M. Ingle, 1983. Genetic and non-genetic factors affecting birth weight in Holstein Sahiwal crossbred calves. Indian J. Dairy Sci., 36: 184-186.

8. Sang, B.C. and C.K. Kim, 1986. Repeatability estimates of gestation length and birth weight and the environmental effects on these traits in dairy cattle. Korean J. Anim. Sci., 28: 184-187.

9. Harvey, W.R., 1986. Least Squares Analysis of Data with Unequal Subclass. A.R.S. USDA, pp: 20-28.

10. Duncan, W.R., 1955. Multiple Range and Multiple F Tests. Biometrics, 11: 1-42.

11. Cengiz, F., 1982. Comparison of Holstein and Brown Swiss cattle raised in Malya and Koçaş State Farms for various traits. Milk and reproductive traits. Ph.D. Thesis, Ankara Üniv. Zir. Fak. Ankara, Turkey.

12. Bakır, G. and B. Söğüt, 1998. Genetic and phenotipypic parameter estimates for birth in Holstein calves raised the Ceylanpınar State. Doğu Anadolu Tarım Kongresi. Erzurum, 810-816.

13. Kaygısız, A., I. Yılmaz and I. Akyol, 1995. Genetic and phenotipypic parameter estimates for birth weigth in Brown Swiss calves raised at Regional School in Van. Hay. Araş. Derg., 5: 71-73.

14. Akbulut, Ö., N. Tüzemen and R. Aydın, 1993. The performance of Holstein cattle in Erzurum, eastern Turkey, conditions. 2. Birth weigth, growth and survival characteristics. Doğa Tr. J. Vet. Anim. Sci., 17: 193-200.

15. Akbulut, Ö., B. Bayram, M. Yanar and N. Tüzemen, 2001. Genetic and phenotipypic parameter estimates of Holstein Friesian calves for birth weigth and body measurements obtained at birth. GAP II. Tarım Kongresi. Şanlıurfa, 1201-1208.

16. Başpınar, H., M. Oğan, E.S. Batmaz, F. Balcı and C. Baklacı, 1998. The effects of some environmental factors on growth and survival of Brown and Holstein calves. Lalahan Hay. Araş. Enst. Derg., 38: 19-31.

17. Roy, J.H.B., 1980. The Calf. Butterworth. 4th Edn., pp: 442.

18. Freitas, R., R. Vaccaro and R. de Freitas, 1988. Factors affecting birth weight and gestation length in dairy cattle. Anim. Breed. Abst., 56: 2525.

19. Guaragna, G.P., G.G. Cameiro, J.R. Torres and L.B. Gambini, 1990. Effect of environmental and genetic factors on birth weight of Holstein cattle. Bulletin de Industries Animal, 47: 19-30.

20. Akbulut, Ö., B. Bayram, N. Tüzemen and R. Aydın, 2002. Phenotypic and genetic parameter estimations of body measurements at birth in Brown Swiss bull calves. Atatürk Üniv. Zir. Fak. Derg., 33: 59-64.

21. Spencer, E., 1982. On the gestation of cows. J. Royal Agri. Soc., 1: 165-169.

22. Kaygısız, A., 1998. Estimates of genetic and phenotypic parameter for birth weigth in Brown and Simmental calves raised at Altındere State Farm. Tr. J. Vet. Anim. Sci., 22: 527-535.

23. Uğur, F. and M. Yanar, 1998. Effects of the different weaning ages on the growth and feed conversion efficiencies in Holstein Friesian calves. Indian J. Anim. Sci., 68:1248-1286.

24. Shibata, T. and K. Kumazaki, 1984. Studies on the development of improved stains of Japanese beef cattle. 2. Genetic and environmental effects on reweaving growth of Japanese brown calves. Anim Breed. Abst., 52: 7116.

25. Ulusan, H.O.K., 1992. The change of calf growth accordoring to birth season and repeatibility of birth weight in Brown Swiss cattle raised in Elazığ Sugar Factory Farm. Uludağ Üniv. Vet. Fak. Derg., 11:57-67.

26. Souza, J.C.C., A.O. Brule, P.B. Ferraz, J.A. Oliveira, M.M., Alencar, P. Bahiense Ferraz, J. A.L. Jr. Oliveira and M. M. de Alencar, 1994. Repeatability of body weight and gain from birth to weaning in Nelore cattle. Revista da Sociedade Brasilia de Zootecnia, 23: 133-139.

27. Ornelas, G.T. and H.R. Ponce, 1984. Some environmental effects on birth of Holstein Friesian and Brown Swiss calves in the tropics. Anim. Breed. Abst., 52: 6315

28. Akbulut, Ö., B. Bayram and M. Yanar, 2001. Estimates of phenotypic and genetic parameters on birth weigth of Brown Swiss and Holstein Friesian calves raised in semi entansif conditions. Lalahan Hay. Araş. Enst. Derg., 41: 11-20.

29. Wakhungu, J.W., J.E.O. Rege and S. Itulya, 1991. Genetic and phenotypic parameters and trends in production and reproductive performance of the Kenya Sahiwal cattle. Bul. Anim. Health Prod. Africa, 39: 365-372.

30. Johnston, D.J., L.L. Benyshek, J.K. Bertrand, M.H. Johnson and G.M. Weiss, 1992. Estimates of genetic parameters for growth and carcass traits in Charolais cattle. Canadian J. Anim. Sci., 72: 493-499.

31. Khan, R.N. and S. Akhtar, 1995. Estimates of genetic parameters of some growth traits in Jersey cattle. Asian-Australasian J. Anim. Sci., 8: 567-570.

32. Euclides F., K., P.R.C. Nobre and A.N. Rosa, 1991. Age of cow and its interaction with herd, sire and sex of calf. Revista da Sociedade Brasileira de Zootecnia, 20: 40-46.

33. Najera, A.J.M., J.C.C. Pereira and H.N. Oliveira, 1991. Genetic and non-genetic effects on body weight traits in two Nelore herds. Arguivo Brasilia de Medicine Veterinarian Zootechnia, 43: 81-91.

34. Togashi, K., K. Yokouchi, S. Anyoshi, H. Kugita, M. Kawai, H. Kimura, T. Ogawa, T. Fujioka, M. Kumagai and H. Nishiura, 1985. The effect of breed characristics of growth and reproductive performance in beef cows on pastured range. Research Bulletin of the Hokkaido National Agricultural Experiment Station, 142: 123-143.