Indian Journal of Animal Sciences **90** (1): 99–101, January 2020/Short communication

Genetic analysis of first lactation test day traits in Sahiwal cattle

POONAM RATWAN[1], A K CHAKRAVARTY[2], MANOJ KUMAR[3], NISHA SHARMA[4] and POOJA JOSHI[5]

ICAR-National Dairy Research Institute, Karnal, Haryana 132 001 India

Received: 06 March 2019; Accepted: 10 May 2019

Key words: Fat yield, Heritability, Sahiwal, SNF yield, Test day milk yield

India is home to about 10.71% of world's livestock population and has 192.49 million (35.93%) cattle as per 20th All India Livestock Census (2019). Sahiwal cattle with a population of 4.88 million is one of the best milch breeds in India and are well-known for higher milk production, power of endurance for hot climate of sub-tropics and relatively resistant to diseases. Sahiwal cattle are found in Punjab and Rajasthan under field conditions and additionally, some organized farms are also maintaining Sahiwal cattle. Milk productivity of Sahiwal cattle maintained at different farms is not up to the mark despite its high genetic worth. Hammoud and Salem (2013) and Goshu *et al.* (2014) reported that dairy cattle selection for milk yield in most countries is based on the use of traditional 305 days lactation records. Traditional 305 days milk yield recording has many disadvantages like need of projecting data for the short lactation animals, problem of biasness on excluding incomplete lactation records (due to pre-selection). Hence, test day models can be used to analyze individual test day records of cows instead of 305 days lactation model (Mayeres *et al.* 2004).

A test day (TD) record is the daily milk yield of a cow at the time of testing milk and is the preferred method. To calculate milk production in the lactation the test interval method as described in Everett and Carter (1968) is the most common method. The observations on fat, solid not fat and protein yields can also be recorded on test day basis. Schaeffer *et al.* (2000) reported many advantages of using test day models like generation intervals can be reduced by performing genetic evaluations sooner. Expected Breeding Values (EBV) can also be calculated directly by using test day records. In India, large number of cattle is reared by small and marginal farmers. It is not feasible for these farmers to record daily milk of animals as it is time consuming and costly. Therefore, recording of data at intervals instead of daily recording is a good alternative. Various workers have done genetic evaluation of Sahiwal based on monthly test day milk yield (Ilatsia *et al.* 2007; Bilal *et al.* 2008; Debbarma *et al.* 2010 and Gupta 2013) but literature regarding genetic evaluation using monthly test day milk yield along with milk composition traits is not available in Sahiwal cattle. Monthly test day yields, like 305 days milk yield, are also affected by various non-genetic factors such as age at calving, month of calving, year of calving, days in milk, parity, management of herd etc. Therefore, the present study was undertaken to assess the effect of different genetic and non-genetic factors on test day traits in addition to their heritability estimation.

The present study was carried out on first lactation test day records pertaining to Sahiwal cattle maintained at ICAR-National Dairy Research Institute over a period of 29 years (1988–2016). Test day traits, viz. test day milk yields (TDMY), test day fat yields (TDFY) and test day solid not fat yields (TDSNFY) were recorded at monthly intervals starting from 5th day. A total of 11 test days were included up to 305 days lactation. Test day fat yields and test day solid not fat yields were calculated using following formulae:

$$\text{TDFY (g)} = \text{Test day fat\%} \times \text{TDMY} \times 10$$
$$\text{TDSNFY(g)} = \text{Test day SNF\%} \times \text{TDMY} \times 10$$

Data were subjected to editing first and abnormal records (dystocia, still birth, premature birth etc.) were excluded from the present study. Animals having lactation length less than 100 days and less than 3 kg daily milk yield were not considered. Data were then standardized using mean and standard deviation. Least-squares analysis was applied to identify the significance of important genetic and non-genetic factors in order to overcome the non-orthogonality of effects due to unequal and disproportionate sub-class frequencies as suggested by Harvey (1990). Sire was considered as random source of variation in the model. The following model was considered with assumptions that different components being fitted into the model were linear, independent and additive.

$$Y_{ijklm} = \mu + S_i + P_j + (Sea)_k + (AG)_l + e_{ijklm}$$

where, Y_{ijklm}, observation of m^{th} individual cows which is progeny of i^{th}sire, calved in j^{th} period, k^{th}season having

Present address: [1]Scientist (punam.ratwan@gmail.com), AGB, [3]Assistant Professor (drmanojneemwal@gmail.com), LFC, LUVAS, Hisar. [2]Principal Scientist (ak_chakravarty @yahoo.co.in), [4]PhD Scholar (nishasharma1777@gmail.com), AGB Division, ICAR-NDRI, Karnal.[5]Veterinary Officer (joshi33333puja@gmail.com), State Sheep Breeding Farm, Shamaliti, Uttarakhand.

l^{th}age group at calving; μ, overall mean; S_i, random effect of i^{th}sire; P_j, effect of j^{th}period (N=1–10); Sea_k, effect of k^{th}season of calving (N=1–4); AG_l, effect of l^{th}age group in first calving (N=1–3); e_{ijklm}, random error associated with each observation assumed to be NID (0, σ^2).

Paternal half-sib correlation method was used to estimate heritability of different test day traits (Becker, 1975) in Sahiwal cattle. Sires having three and more progenies were only included for the estimation of heritability.

Least-squares means for first lactation test day traits, viz. test day milk yields, test day fat yields and test day solid not fat yields are presented in Table 1. Almost similar milk yield was observed in second and third test day. Period of calving had significant (P<0.01) effect on TDMY11. However, Debbarma *et al.* (2010) and Gupta (2013) reported significant effect of period of calving on all test day milk yields in Sahiwal cows. Effect of season of calving was found to be significant (P<0.05) on TDMY7 and TDMY9 in the present study. Debbarma *et al.* (2010) reported

Table 1. Overall least–squares means of different test day traits in Sahiwal cattle

Test day	Overall least–squares means (Mean±S.E.)		
	Test day milk yield (kg)	Test day fat yield (g)	Test day solid not fat yield (g)
TD1	6.75±0.34	329.55±19.24	598.91±31.66
TD2	7.85±0.36	369.74±18.66	695.83±32.90
TD3	7.86±0.33	372.11±15.46	697.08±30.15
TD4	7.33±0.31	338.47±16.01	649.54±28.58
TD5	7.15±0.29	332.99±13.39	646.89±50.74
TD6	6.72±0.28	319.04±14.29	597.04±25.03
TD7	6.71±0.27	321.54±14.71	596.74±25.00
TD8	6.34±0.23	303.34±12.17	565.39±20.59
TD9	6.27±0.28	309.83±17.23	558.77±26.93
TD10	6.06±0.25	290.69±16.86	539.42±24.09
TD11	4.75±0.26	231.18±13.83	422.88±23.82

significant effect of season of calving on all the monthly test day milk yields (MTDMY) of Sahiwal cows except the first and sixth monthly test day milk yields. Gupta (2013) found significant (P<0.01) effect of season of calving on MTDMY2, MTDMY3, MTDMY9 and MTDMY10; significant (P<0.05) effect on MTDMY4, MTDMY5, MTDMY7 and MTDMY8; and non-significant effect on MTDMY1 and MTDMY6 for first lactation in Sahiwal cattle. Effect of age group at calving was found to be non-significant on all the test day milk yields in current study. Conversely, Debbarma *et al.* (2010) and Gupta (2013) reported significant effect of age at calving on some test day milk yields in Sahiwal cattle.

Least-squares means for test day fat yields varied from 231.18±13.83 (TDFY11) to 372.11±15.46 g (TDFY3) for first lactation in Sahiwal cattle. There was no literature on average test day fat yield and effect of non-genetic factors on test day fat yield in Sahiwal cattle. However, Costa *et al.* (2009) reported average test day fat yield as 0.79±0.24 kg, 0.90±0.30 kg and 0.96±0.32 kg for first, second and third lactation, respectively in Brazilian Holstein cattle. Sire had significant effect on all the test days except TDFY1, TDFY5, TDFY8 and TDFY11 at 1% and 5% level of significance. Period of calving was found to be significant on TDFY8 (P<0.05) and TDFY11 (P<0.01) fat yield. Season of calving had non-significant effect on all the test day fat yields except TDFY2 and TDFY7. There was no significant effect of age group on the test day fat yields in this study.

The least-squares means for test day solid not fat yield varied from 422.88±23.82 g (TDSNFY11) to 697.08±30.15 g (TDSNFY3) for first lactation in Sahiwal cattle. The study revealed the effect of sire on TDSNFY2, TDSNFY3, TDSNFY4, TDSNFY6 and TDSNFY7 for first lactation in Sahiwal cattle. Period of calving had significant effect on TDSNFY11. There was no effect of season of calving on test day solid not fat yields except TDSNFY7 and TDSNFY9. Age group at calving had non-significant effect on all the test day solid not fat yields in Sahiwal cattle.

Heritability estimates of first lactation test day traits: Heritability estimates for test day milk yields varied from 0.06 (TDMY8) to 0.40 (TDMY2) [Table 2]. Heritability was more at the beginning and mid-lactation period and then it decreased for subsequent test days. Debbarma (2010) reported the heritability estimates ranging from 0.05 (6^{th} day) to 0.36 (245^{th} day) for various monthly test day yields in Sahiwal cattle. Gupta (2013) reported heritability estimates of monthly test days milk yields ranging from 0.24 (MTDMY8) to 0.46 (MTDMY10) for first lactation. These estimates were higher than the estimates obtained in the present study. Heritability of fat yield ranged from 0.09 (TDFY11) to 0.62 (TDFY10) in different test days and heritability of SNF yield varied from 0.06 (TDSNFY5) to 0.44 (TDSNFY2) in Sahiwal cattle. Heritability estimates for fat yield were within the range as observed by different workers (Jamrozik and Schaeffer,1997; Lidauer and Mantysaari, 1999 and Lidauer *et al.* 2003) in temperate climate. The wide variation in the range of heritability in different test day fat and SNF yields may be due to sampling

Table 2. Heritability estimates of different test day milk yields, fat yields and solid not fat yields in Sahiwal cattle

Test day (TD)	Heritability of test day		
	Milk yield	Fat yield	Solid Not Fat yield
1	0.12±0.22	0.28±0.20	0.18±0.20
2	0.40±0.18	0.45±0.19	0.44±0.19
3	0.38±0.18	0.23±0.16	0.38±0.18
4	0.33±0.17	0.37±0.18	0.34±0.18
5	0.26±0.17	0.19±0.16	0.06±0.10
6	0.32±0.18	0.35±0.19	0.33±0.18
7	0.26±0.19	0.40±0.20	0.29±0.20
8	0.06±0.20	0.10±0.20	0.08±0.20
9	0.16±0.20	0.35±0.20	0.22±0.20
10	0.17±0.19	0.62±0.31	0.30±0.20
11	0.07±0.20	0.09±0.20	0.08±0.20

error and high standard error of heritability in some of the test day traits may be attributed to inadequate sample size. Second test day had the highest estimates of heritability for test day milk yield and test day solid not fat yield indicating that this test day could be used as early selection criteria for these two traits.

SUMMARY

Records on first lactation test day traits pertaining to Sahiwal cattle maintained at ICAR-National Dairy Research Institute over a period of 29 years (1988–2016) were utilized in this study. Test day traits, viz. test day milk yields (TDMY), test day fat yields (TDFY) and test day solid not fat yields (TDSNFY) were recorded at monthly intervals and a total of 11 test days were included up to 305 days lactation. Effect of different genetic and non-genetic factors on test day traits was assessed using least-squares mixed model. Random effect of sire and fixed effect of period of calving as well as season of calving had significant effect on different test day traits, however, age group at first calving had no significant effect in the present study. Paternal half-sib correlation method was used to estimate the heritability of different test day traits. Heritability estimates as observed for different test day traits varied from low to high. Heritability for test day milk yields, test day fat yields and test day SNF yields ranged from 0.06 (TDMY8) to 0.40(TDMY2), 0.09 (TDFY11) to 0.62 (TDFY10) and 0.06 (TDSNFY5) to 0.44 (TDSNFY2), respectively. Highest heritability of test day milk yield and test day solid not fat yield in second test day suggested that this test day could be used as early selection criteria for these two traits.

REFERENCES

20th Livestock Census. All India Report, DAHD&F. 2019. Ministry of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India. (*www.dahd.nic.in*).

Becker W A. 1975. *Manual of Procedure in Quantitative Genetics*. 3rd Edition. Publication of Washington. Washington State University, USA.

Bilal G, Khan M S, Bajwa I R and Shafiq M. 2008. Genetic control of test-day milk yield in Sahiwal cattle. *Pakistan Veterinary Journal* **28**(1): 21–24.

Costa C N, Carvalheira J, Cobuci J A, Freitas A F and Thompson G. 2009. Estimation of genetic parameters of test day fat and protein yields in Brazilian Holstein cattle using an autoregressive multiple lactation animal model. *South African Journal of Animal Science* **39**: 165–68.

Debbarma M, Gandhi R S, Raja T V, Singh A and Sachdeva G K. 2010. Influence of certain non-genetic factors on test day milk records in Sahiwal cattle. *Indian Journal of Dairy Science* **63**(6): 504–06.

Everett R W and Carter H W. 1968. Accuracy of test interval method of calculating dairy herd improvement association records. *Journal of Dairy Science* **51**: 1936–41.

Goshu G, Singh H, Petersson K J and Lundeheim N. 2014. Heritability and correlation among first lactation traits in Holstein Friesian cows at Holeta Bull Dam Station, Ethiopia. *International Journal of Livestock Production* **5**: 47–53.

Gupta A. 2013. 'Genetic evaluation of Sahiwal cattle using lactation curve models'. PhD. Thesis, NDRI (Deemed University), Karnal, Haryana, India.

Hammoud M H and Salem M M I. 2013. The genetic evaluation of some first lactation traits of Holstein cows in Egypt. *Alexandria Journal of Agricultural Research* **58**: 1–8.

Harvey W R. 1990. User guide for LSMLMW and MIXMDL package. Mix model least squares and maximum likelihood computer programme, PC-2 version, Mimeograph, Columbia, Ohio, USA.

Ilatsia E D, Muasya T K, Muhuyi W B and Khai A K. 2007. Genetic and phenotypic parameters for test day milk yield of Sahiwal cattle in semi-arid tropics. *Animal* **1**: 185–92.

Jamrozik J and Schaeffer L R. 1997. Estimates of genetic parameters for a test day model with random regression for yield traits of first lactation Holsteins. *Journal of Dairy Science* **80**(4): 762–70.

Lidauer M and Mantysaari E A. 1999. Multiple traits reduced rank random regression test-day model for production traits. *Interbull Bulletin* **22**: 74–80.

Lidauer M, Mantysaari E A and Stranden I. 2003. Comparison of test-day models for genetic evaluation of productions traits in dairy cattle. *Livestock Production Science* **79**: 73–86.

Mayeres P, Stoll J, Bormann J, Reents R and Gengler N. 2004. Prediction of daily milk, fat, and protein production by a random regression test-day model. *Journal of Dairy Science* **87**: 1925–93.

Schaeffer L R, Jamrozik J, Kistemaker G J and Doormaal J V. 2000. Experience with a test-day model. *Journal of Dairy Science* **83**: 1135–44.