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Estimation of Genetic Parameters for Milk Composition Traits in Indian Murrah Buffaloes

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Abstract | The genetic parameters of monthly test day milk composition traits are used to find out the effectiveness of selection and to assess the producing ability of buffaloes in the herd. Data of 565 Murrah buffaloes sired by 72 bulls scattered over a period of 22 years (1993 to 2014) maintained at ICAR-National Dairy Research Institute, Karnal were used in the study. Minimum monthly test day fat percentage was estimated as 9.58±0.04 % on Test day 5 (165th day) while maximum monthly test fat percentage was estimated as 9.78±0.04% on Test day 2 (62th day). Minimum monthly test day SNF percentage was estimated as 9.60±0.01% on Test day 9 (291th day) and maximum monthly test fat percentage was estimated as 9.68±0.01% on Test day 3 (97th day.) Heritability estimates of monthly test day fat percentage ranged from 0.09 ± 0.03 on Test day 9 (296th day) to 0.19 ± 0.02 Test day 2 (62th day). Heritability estimates of monthly test day SNF percentage ranged from 0.06 ± 0.002 on Test day 8 (258th day) to 0.21 ± 0.06 Test day 3 (97th day). The estimates of genetic parameters suggests that emphasis should be given to milk composition traits along with milk yield for improving overall performances and effectiveness of selection criteria in Murrah buffaloes.

Keywords | Fat percentage, SNF percentage, Heritability, Correlation, Murrah buffaloes

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INTRODUCTION

Buffaloes are considered as backbone of Indian dairy industry. Indian buffaloes contribute 17% in world milk production and 48 % milk production in Asia. About 63 % of world buffalo milk and 95 % of buffalo milk in Asia is contributed by Indian buffaloes (Anonymous, 2015). Among the various buffalo breeds in India, Murrah buffalo is essentially the cynosure for dairy type. Under Buffalo Improvement programme in India, selection criteria of elite buffaloes include Expected Producing Ability (EPA) where 305 days or less milk yield is only considered, however milk composition traits like fat, solid not fat (SNF) have received little attention. Nutritive value of milk is based on its composition and even pricing system of milk is based on its components percentage mainly fat percentage. Also, evaluation of complete lactation milk yield had decreased accuracy mainly due to following reasons viz. not giving due weightage to variation in lactation length and persistency of milk yield, consumption of more time and labour , in between sale or death of animal etc. Each test day is average of two times milk yield (morning and evening), recorded in a particular test date and expressed as in kg/day. In NDRI buffalo herd, milk recordings starts from 5th day onwards after calving. The monthly test day milk yield was considered with an interval of 30 days. Many research workers have done genetic evaluation of buffalo using monthly test day milk yield (Geeta et al., 2006; Kumar et al., 2014; Singh et al., 2016) however the concept of genetic evaluation using monthly test day milk yield along with milk composition traits is almost new in buffaloes and the literature was less. Monthly test day records helps in early genetic evaluations, thereby reducing the generation interval, economize the genetic evaluation with better accuracy and minimize cost of maintaining cows and bulls (Bilal et al., 2009).

Most of the developed countries have developed multi trait selection criteria including milk yield, milk composition traits, health and fertility for improvement of overall performance of dairy animals (Van Raden, 2004; De Vries, 2010; Cabrera, 2011). The genetic parameters viz. heritability, genetic and phenotypic correlation of milk composition traits can be used to improve the effectiveness of selection under breeding programme and to assess the producing ability of buffaloes in the herd. Heritability indicates the degree to which genes control expression of a trait, used to calculate genetic variance of a trait in the population and predicts response to selection in the herd. The genetic and environmental correlations between two traits result in phenotypic correlation with the assumption that there is no genotype and environmental interaction. Until recently, sires have been selected for high milk yields only without considering milk composition traits, which has resulted in very slow increases in fat and SNF percentages over time, as milk yield is having negative association with Fat and SNF.

The literature revealing heritability, genetic and phenotypic correlation of milk composition traits in Murrah buffaloes were very scanty. Therefore, in the present study, attempt has been made to reveal the genetic parameters of milk composition traits especially monthly test day fat and SNF percentage in Murrah buffaloes.

MATERIALS AND METHODS

Data

The present study was conducted on data pertaining to 565 Murrah buffaloes maintained at National Dairy Research Institute over a period of 22 years from January 1993 to October 2014.The normal reproduction and production records were considered. The buffaloes produced milk for at least 100 days and minimum of 500kg milk, calved and dried under normal physiological conditions were included in the present study. The number of lactations was restricted to four, since eighty percent buffaloes produced milk yield up to fourth lactation constituted 90.27% of the total milk production in the herd. After standardization and normalization of data, the number of buffaloes in first, second, third and fourth lactations were 550, 345, 214 and 130 respectively. Although, recording of milk data starts from 5^{th} day after calving, in NDRI fat and SNF are tested from 29^{th} or 30^{th} day. The average interval taken for testing fat and SNF ranged from 28-35 days and average lactation length in Murrah buffalo was 284 days. Therefore in present study, nine monthly test days of fat and SNF were considered, starting from 29^{th} day with monthly interval of 28-35 days.

Statistical Analysis

The data were adjusted for significant non-genetic factors for buffaloes calved in different period and season of calving, parities and age group at first calving using fixed linear models. Since the data were non-orthogonal, the least-squares technique suggested by Harvey (1990) was used to estimate the effect of non-genetic factors. The model considered was as follows:

$$Y_{ijklm} = \mu + S_i + P_j + Pa_k + AG_l + e_{ijklm}$$

Where:

Y_{ijklmn}: observation of the m^{th} buffalo born in l^{th} age group of first caving, calved in k^{th} parity, j^{th} period and i^{th} season; μ: overall mean; S_i: Fixed effect of i^{th} season of calving (winter, summer, rainy and autumn); P_j: Fixed effect of j^{th} period of calving (1 to 8); Pa_k: Fixed effect of k^{th} parity(1 to 4), AG_l: Fixed effect of l^{th} age group of first calving(1 to 3); e_{ijklm}: Random error ~ NID $(0, \sigma^2_e)$.

Paternal half-sib correlation method was used to estimate the heritability of different traits (Becker, 1975) in Murrah buffaloes. The sires with three and more than three progenies were only included for the estimation of heritability of traits. The model for estimation of heritability was as follows:

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where:

Y_{ij}: observation of the j^{th} progeny of the i^{th} sire; μ: overall mean; s_i: Effect of the i^{th} sire; e_{ij}: Random error ~NID $(0, \sigma^2_e)$.

The genetic and phenotypic correlations were estimated from the analysis of variance and covariance among sire groups.

RESULTS AND DISCUSSION

The information of 565 Murrah buffaloes sired by 72 bulls were used in the study. Overall maximum monthly test day fat percentage (MTDFP) was found to be 9.79 ± 0.03% on

Table 1: Analysis of variance (M.S. values) of monthly test day fat percentage in Murrah buffaloes

Effects	TD1 FP	TD2 FP	TD3 FP	TD4 FP	TD5 FP	TD6 FP	TD7 FP	TD8 FP	TD9 FP
Parity	0.22 (3)	1.32 (3)	1.10 (3)	0.510 (3)	2.34 (3)	0.3 (3)	0.29 (3)	1.56 (3)	0.848 (3)
Season of calving	0.41 (3)	0.58 (3)**	1.27 (3)*	0.67 (3)	1.19 (3)	4.20 (3) **	1.55 (3)**	1.97 (3)*	3.24 (3)*
Period of calving	12.88 (9)**	5.32 (9)**	3.94 (9)**	1.41 (9)**	3.94 (9)**	4.01 (9)**	3.54 (9)**	7.69 (9)**	9.08 (9)**
Age group at first calving	0.85 (6)	0.17 (6)	0.38 (6)	0.93 (6)	0.19 (6)	1.26 (6)	0.08 (6)	0.07 (6)	0.35 (6)
Error	1.06 (1217)	1.06 (1217)	1.12 (1217)	1.02 (1217)	1.02 (1217)	0.09 (1199)	1.35 (1168)	1.06 (1152)	1.11 (1134)

Figures in parentheses indicate respective degrees of freedom. *P < 0.05, **P < 0.01

Table 2: Analysis of variance (M.S. values) of monthly test day SNF percentage in Murrah buffaloes

Effects	TD1 SNFP	TD2 SNFP	TD3 SNFP	TD4 SNFP	TD5 SNFP	TD6 SNFP	TD7 SNFP	TD8 SNFP	TD9 SNFP
Parity	0.10 (3)	0.59 (3)	0.07 (3)	0.03 (3)	0.05 (3)	0.08 (3)	0.18 (3)	1.03 (3)	0.03 (3)
Season of calving	0.41 (3)	0.90 (3)**	0.34 (3)*	0.11 (3)	0.89 (3)**	0.91 (3)*	0.06 (3)**	0.08 (3)	0.13 (3)
Period of calving	0.79 (9)**	0.65 (9)**	0.71 (9)**	0.73 (9)**	0.59 (9)**	0.79 (9)**	0.61 (9)**	0.75 (9)**	0.74 (9)**
Age group at first calving	0.03 (6)	0.16 (6)	0.04 (6)	0.66 (6)	0.77 (6)	0.02 (6)	0.01 (6)	0.02 (6)	0.01 (6)
Error	0.08 (1217)	0.07 (1217)	0.08 (1217)	0.07 (1217)	0.13 (1217)	0.07 (1199)	0.07 (1168)	0.08 (1152)	0.15 (1134)

Figures in parentheses indicate respective degrees of freedom. *P < 0.05, **P < 0.01

Table 3: Overall least-squares means and standard errors of monthly test day fat and SNF percentage in Murrah buffaloes

Monthly test days	FP (%)	SNFP (%)
TD 1 (29th day)	9.73±0.05 (1235)	9.63±0.03 (1235)
TD 2 (62th day)	9.78±0.04 (1235)	9.62±0.11 (1235)
TD 3 (97th day)	9.67±0.03 (1235)	9.60±0.01(1235)
TD 4 (132th day)	9.64±0.04 (1235)	9.64±0.01(1235)
TD 5 (164th day)	9.58±0.04 (1235)	9.65±0.02 (1235)
TD 6 (196th day)	9.68 ±0.02 (1218)	9.64±0.11(1218)
TD 7 (228th day)	9.72±0.05 (1190)	9.63±0.01(1190)
TD 8 (258th day)	9.69±0.04 (1174)	9.66±0.01(1174)
TD 9 (291th day)	9.70±0.05 (1152)	9.68±0.01 (1152)

Test day 2 (62nd day) while overall minimum monthly test day fat percentage was found to be 7.79 ± 0.03% on Test day 4 (132nd day). The coefficients of variation of monthly test day fat yield varied from 23.29% in TD 5 to 36.56% in TD 3 in Murrah buffaloes. Minimum monthly test day SNF percentage (MTDSNFP) in overall lactations was found to be 9.60 ± 0.01% on Test day 5 (165th day) while overall maximum monthly test day SNF percentage was found to be 9.75± 0.02 on Test day 1 (29th day). The coefficients of variation of monthly test day SNF percentage varied from 22.52% in TD 2 to 38.55% in TD 4 in Murrah buffaloes.

Monthly test day fat and SNF percentage were significantly influenced by period and season of calving (P<0.01) and not significantly affected by parity and age group at first calving, presented in Table 1 and 2. Milk fat and SNF percentage of buffaloes calved in winter season was significantly (P≤0.05) higher than that of the animals calved in summer season. Highest Fat and SNF percentage were obtained in 2008-2009 period.

Least- squares mean of monthly test day fat and SNF percentage is presented in Table 3. Minimum least-square monthly test day fat percentage was estimated as 9.58±0.04% on Test day 5 (165th day) while maximum was estimated as 9.78±0.04% on Test day 2 (62th day). However, minimum least-square monthly test day SNF percentage was estimated as 9.60±0.01% on Test day 9 (291th day) and maximum monthly test SNF percentage was estimated as 9.68±0.01% on Test day 3 (97th day).

The heritability estimates of most of the monthly test day fat and SNF percentage were found low, depicted in Figure 1 and 2, respectively. Heritability estimates of monthly test day fat percentage ranged from 0.09 ± 0.03 on Test day 9 (296th day) to 0.19 ± 0.02 Test day 2 (62th day). Heritability estimates of monthly test day SNF percentage ranged from 0.06 ± 0.002 on Test day 8 (258th day) to 0.21 ± 0.06 Test day 3 (97th day).

In the present study, estimates of phenotypic correlation between different monthly test day fat percentage in Murrah buffaloes ranged from -0.08±0.01 (between TD6-196th day and TD9-291th day) to 0.20 ± 0.09 (between TD5-164th day and TD8-258th day). The estimates of phenotypic correlation between different monthly test day SNF percentage in Murrah buffaloes ranged from 0.10±0.03 (between TD2-62th day and TD7-228th day) to 0.88±0.17 (between TD6-196th day and TD7-228th day).The genetic correlation estimates between most of the monthly test day fat and SNF percentage were found non-significant.

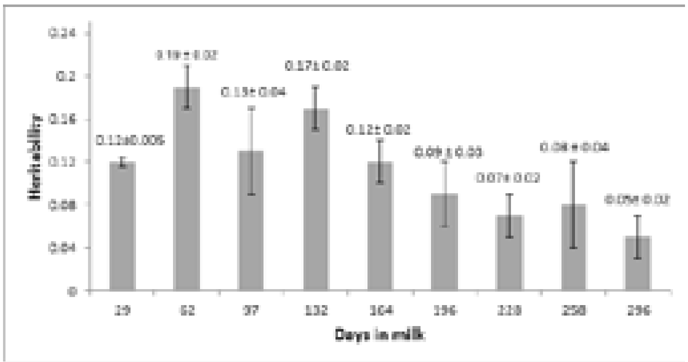

Figure 1: Heritability of monthly test day fat percentage in Murrah buffaloes

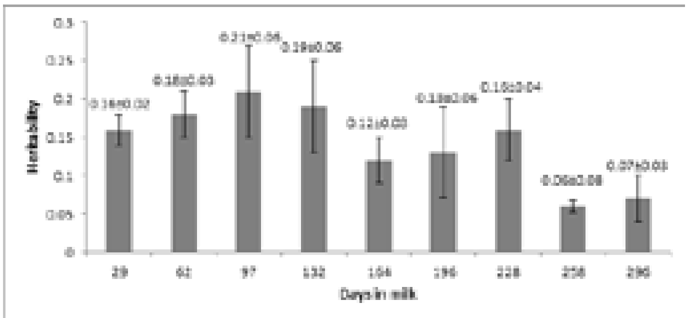

Figure 2: Heritability of monthly test day SNF percentage in Murrah buffaloes

Fat and SNF are the important constituents of milk. The application of monthly test day genetic evaluation helps to reduce variability in lactation records and increases accuracy in estimation of genetic parameters (Tohanti et al., 2008). Kumar (2015) reported the highest monthly test day fat percentage 8.33% in TD11 (305th day) and minimum 7.85% on TD3 (60th day) in overall lactations of Murrah buffaloes. No literatures were available on monthly test day SNF percentage in Murrah buffaloes.

Milk fat and SNF percentage of buffaloes calved in summer season was significantly lower than winter season, maybe due to less availability of good quality fodders in summer season. The difference in performance of the buffaloes among different periods might be attributed to differences in management practices, sires used for breeding, environmental conditions and variations in feed and fodder availability. Chitra (2015) reported significant effect of period of calving on lactation fat and SNF percentage, while Sarkar (2002) and Verma (2012) reported non-significant effect of period of calving on lactation fat and SNF percentage in Murrah buffaloes. (Kumar et al., 2016) reported significant effects of period and season of calving on most of monthly test day fat percentage (Kumar et al., 2016) reported highest least-square monthly test day fat percentage as 7.06% in TD3 (65th day) and lowest monthly test day percentage as 3.33% in TD11 (305th day). No reports were available on monthly test day SNF percentage.

Estimation of heritability of a trait is very important as it is a measure of genetic variability, measure of how much parental superiority transmitted to next generation, indication of type of gene action and helps in formulation of suitable breeding plans for genetic improvement. The heritability estimates of Fat and SNF were found low to medium. Kumar (2015) reported similar heritability estimates of monthly test day fat percentage in Murrah buffaloes. However, no reports were available on monthly test day SNF percentage in Murrah buffaloes. Verma (2012) reported heritability of lactation fat percentage of Murrah buffaloes as 0.11 ± 0.10. Chitra (2015) reported heritability estimate of lactation fat and SNF percentage of Murrah buffaloes as 0.29 ± 0.08 and 0.30 ± 0.18, respectively. Ibrahim et al. (2012) and Tohanti et al. (2008) reported heritability estimates of lactation fat percentage as 0.19 and 0.21 in Egyptian buffaloes, respectively. No literatures were available on the heritability estimates of monthly test day SNF percentage in Murrah buffaloes. The genetic correlation estimates between most of the monthly test day fat and SNF percentage were found non-significant may be due to small size of buffalo population for genetic correlation estimation. No literatures were available on estimates of genetic and phenotypic correlations among different monthly test day fat and SNF percentage in Murrah buffaloes.

CONCLUSION

In the present study, Fat and SNF percentage were significantly influenced by season and period of calving. Heritability estimates of monthly test day fat percentage ranged from 0.09 ± 0.03 on Test day 9 (296th day) to 0.19 ± 0.02 Test day 2 (62th day). Heritability estimates of monthly test day SNF percentage ranged from 0.06 ± 0.002 on Test day 8 (258th day) to 0.21 ± 0.06 Test day 3 (97th day). The estimation of genetic parameters of trait helps in improving accuracy of evaluation of animals and formulation of suitable breeding plans. The present study indicated importance of milk composition traits in Murrah buffaloes and emphasis should given to fat and SNF percentage along with milk yield in the selection strategy.

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AUTHORS CONTRIBUTION

Research work was done by Jamuna Valsalan. The experi¬ment was designed and supervised by Ashok Kumar Gupta. Mohsin Ayoub Mir assisted Jamuna Valsalan in data recording, literature collec¬tion and data analysis. Atish Kumar Chakravarty provided valuable suggestion regarding design of experiment and data analysis. All authors read and approved the final manuscript.

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