Original Article

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STUDY ON EFFECT OF VARIOUS NON-GENETIC FACTORS ON PERFORMANCE TRAITS OF MURRAH BUFFALOES

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ABSTRACT

In this study, the data was collected on production traits of Murrah buffaloes w.r.t. 1 to 4 parities for the period of 25 years maintained at Directorate Livestock Farm, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The effect of non-genetic factors *viz*; period of calving, season of calving, age at first calving and parity on daily milk yield were found to be significant and subsequently data were corrected to study the comparison of various lactation curve models to define the shape of lactation curve and to develop a suitablelactation curve model for Murrah buffaloes. The data used in the study pertained to 517293 daily milk yield records pertaining to 1524 lactations of 644 Murrah buffaloes sired by 213 bulls. The analysis was done using SAS 9.3 Least squares analysis. The period of calving showed significant (P<0.01) effect on 305 MY, complete lactation milk yield (CLMY), peak yield, lactation length and service period. The season of calving showed significant (P<0.01) effect on peak yield, lactation length and service period. The age at first calving showed significant (P<0.05) effect on peak yield. The parity showed significant (P<0.01) effect on 305 MY, complete lactation milk yield (CLMY), peak yield, lactation length and service period.

Keywords: *Bubalus bubalis*, buffaloes, Murrah, lactation curve, period, season, parity, milk yield

INTRODUCTION

India is an agricultural country with 70% of the population relying on agriculture and livestock rearing. Agriculture sector generates nearly 15.87% of gross domestic production (GDP) in India. Livestock sector being a part of agriculture sector contributes 25.6% in agricultural GDP and 4.11% in total GDP, while dairy farming by itself generates 18% in agricultural GDP in India (Livestock Census, 2019).

India is top milk producer in the world and produced 187.75 million metric tons of milk during 2018 to 2019 with per capita availability of 394 g/day. Punjab is one of the top milk producing states of India and ranks 1st in terms of per capita availability of milk (1181 g/day) as well as milk productivity of all the dairy animals. Average productivity of buffalo in Punjab is 8.44 kg/day as compared to 5.62 kg/day at the national level (BAHS 2019). Buffaloes are contributing nearly

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two-third (71%) of milk produced in Punjab. Murrah and Nili Ravi are two important breeds of buffaloes reared in Punjab.

Murrah is termed as "Black Gold" that occupies a critical place in human nutrition and employment. The origin of Murrah is from Haryana (Jhajjar, Rohtak, Bhiwani, Jind) and is considered as most desired dairy buffalo breed. Present day Murrah has gained worldwide status as improver buffalo dairy breed. Buffaloes have very high agricultural importance because of great production potential through milk and meat as well as being a good source of nourishment in the developing countries. Nowadays, animal-based protein is being considered to play a vital part in the nutritional fulfilment. Milk because of its high biological value, makes it the best source of animal-based protein with balance of all the nutrients.

Milk production is a physiological activity that occurs continuously throughout lactation, and it characterizes the rate of milk secretion as lactation progresses. Even while environmental and managerial factors are consistent, the biometrical characteristics of lactation change depending on the stage of lactation (Yadav and Sharma, 1985). The primaryfeature around which the entire animal enhancement effort is centred is milk yield. Lactation milk output is a primary performance variable taken into account in the selection criteria for the genetic improvement of dairy animals and is either directly or indirectly related to all other performance traits. It shows the true economic value of the buffalo. Over the course of lactation, the buffalo's milk production trait exhibits a curvilinear pattern. The behaviour of milk production parameters can be better understood by understanding the lactation curve of dairy animals. Both the hereditary and non-genetic factors have a significant impact on milk production. The non-genetic characteristics investigated in the present study include parity, age at first calving (AFC), season of calving (SoC), and period of calving (PoC). Breederscan increase economic qualities like milk production by studying the effect of these factorson lactation parameters. Therefore, in the current investigation, the effect of numerous non- genetic factors on the lactation daily milk yield was explored.

MATERIALS AND METHODS

The data relating to the pedigree and milk production performance of Murrah buffaloes were collected from records and history sheets from year 1991 to 2015 (25 years) maintained at Directorate of Livestock Farms, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. During the present study 517,293 daily milk yield records of 1,524 lactations of 644 Murrah buffaloes were recorded.

Classification of non-genetic factors

The data for period of calving ranged from 1991 to 2015 were divided into 5 periods of 5 years each and four seasons as per the climatic conditions of Punjab, as winter (December to February), spring (March to May), summer (June to August) and autumn (September to November). Each of the four parities were taken as separate classes of parity whereas groups for age at first calving (AFC) were divided into 3 categories on the basis of Mean AFC ± 0.5*Standard Deviation.

Analysis of non-genetic factors

The statistical analysis of the data was performed using SAS version 9.3 (Statistical Analysis System, Cary, USA). Using accepted

statistical practises, the means, standard deviations, standard error, and coefficient of variation were calculated. Using least squares analysis for non-orthogonal data, the effects of non-genetic factors such as PoC, SoC, parity, and AFC on normalised milk production traits were calculated. The model was used under the presumption that each component fitting into it was independent, linear, and additive.

Least squares analysis

In the present studies, the non-genetic factors *viz*; PoC, SoC and AFC were analysed. The data were corrected by using Least Squares Analysis (Harvey, 1990).

$$Y_{ijkl} = P_i + S_j + A_k + e_{ijkl}$$

Where, y_{ijkl} is the observation of l^{th} animal on i^{th} period of calving on j^{th} season of calving on k^{th} age at first calving, P_i is the i^{th} period of calving, S_j is the j^{th} season of calving, A_k is k^{th} age at first calving and e_{ijkl} is the residual limit of l^{th} animal on i^{th} periodof calving, j^{th} season of calving and k^{th} age at first calving.

RESULTS AND DISCUSSIONS

The overall LSMs for complete lactation (455 days) milk yield (CLMY), 305 days milk yield (MY305), lactation length (LL), peak yield (PY), days to attain peak yield (DTPY) and service period (SP) were found to be 2361.36±19.79 kg, 2150.03±13.19 kg, 345.68±1.96 days, 12.07±0.06 kg, 53.14±2.12 days and 191.43±4.02 days, respectively (Table 1).

Effect of period

It was observed that the PoC had highly significant effect (P<0.01) on all the traits except days to attain peak yield (Table 2). The highest 305 days MY was observed for (P5) 2011 to 2015 group (2607.84±49.92 kg) and lowest in (P1) 1991 to 1995 group (2143.06±46.38 kg). The overall means for complete lactation yield (455 days) was found to be 2361.36±19.79 kg. The highest complete lactation yield was observed in (P5) 2011 to 2015 group (2607.84±49.92 kg) and lowest in (P1) 1991 to 1995 group (2143.06±46.38 kg). Thismay be due to the selection of superior germplasm over the time and some part of this may bedue to better feeding and management practices over the year.

The overall means for peak yield was 12.07±0.06 kg. The highest value of peak yield was observed for (P5) 2011 to 2015 group (13.52±0.14 kg) and lowest in (P1) 1991 to 1995 group (11.70±0.13 kg).

The overall means for lactation length was 345.68±1.96 days. The highest value of lactation length was observed in (P2) 1996 to 2000 group (357.29±4.42 days) and lowest in (P4) 2006 to 2010 group (331.02±4.53 days). But no significant difference between the least squares means of lactation length of any of the 5 groups for effect of PoC was observed.

The overall means for service period was found to be 191.43±4.02 days. The highest value of service period was observed in (P1) 1991 to 1996 group (222.22±9.34 days) and lowestin (P3) 2001 to 2005 group (150.59±8.32 days). But no significant difference between the least squares means of service period of any of the 5 groups for effect of PoC was observed.

The significant effect of PoC was shown in accordance with this study by some workers in Murrah buffaloes on 1st lactation test day MYs

reported by Rana (2008) and a highly significant effect on complete lactation milk yield (CLMY), lactation length (LL), peak yield (PY) and 305-day milk yield was observed by Thiruvenkadan *et al.* (2010); Thiruvenkadan *et al.* (2014); Jakhar *et al.* (2017). Similarly, significant (P<0.05) effect on total MY and 305-day MY was shown by Verma *et al.* (2016). Dangar and Vataliya (2018) reported a significant (P<0.05) effect on full lactation MY in Jaffarabadi buffaloes, while a highly significant (P<0.01) effect for Total Lactation Yield (TLY) and Lactation Length (LL) was shown by Mire *et al.* (2019).

A significant effect on DMY and 305 MY (P<0.05) was observed by Sigdel *et al.* (2015) in Murrah buffaloes in Nepal, similarly, Dev *et al.* (2015) in Murrah buffaloes reported significant effect on first lactation MY and first lactation peak MY, while, Pander *et al.* (2017) reported significant effect only on the first service period in Hard henu cattle and Pandey *et al.* (2019) observed a significant effect on 1st lactation 305 days MY and life time MY in Sahiwal cattle.

Effect of season

SoC had highly significant effect (P<0.01) on peak yield, lactation length and service period (Table 3). The overall means for peak yield was 12.07±0.06 kg. The highest value of peak yield was observed in winter (13.14±0.11 kg) and lowest in summer (12.23±0.10 kg). This may be due to favorable meteorological and climatic conditions for the winter calvers.

The overall means for lactation length was 345.68±1.96 days. The highest value of lactation length was observed in winter calvers (352.59±3.95 days) and lowest in summer calvers (334.58±3.78 days). But no significant difference between the least squares means of lactation length for any of the 4 seasons was observed.

The overall means for service period was 191.43±4.02 days. The highest value of service period was observed in winter season (212.40±8.11 days) and lowest in autumnseason (170.53±7.52 days). But no significant difference between the least squares means of service period for any of the 4 groups for effect of SoC was observed.

The significant effect of the SoC was shown in accordance with this study by some workers such as according to Kamble *et al.* (2014), buffaloes that calved during the winter showed greater lactation length, while those that calved during the summer displayed shorter lactation length., Pander *et al.* (2017) reported significant effect only on the first SP in Hard henu cattle. Hassan *et al.* (2017) revealed that the statistical analysis showed that the SoC had a highly significant (P<0.01) effect on lactation length in Egyptian buffaloes. In Jaffarabadi buffaloes, a non-significant effect (P>0.05) on complete lactation MY was revealed by Dangar and Vataliya (2018) and Pandey *et al.* (2019) observed the effect of the SoC was non-significant on first lactation 305 days MY and lifetime MY.

Effect of age at first calving

AFC had (P<0.05) significant effect only on peak yield (Table 4). The overall means for peak yield was found to be 12.07±0.06 kg. The highest peak yield was observed for group 3 (12.89±0.11 kg) and lowest in Group 1 (12.52±0.10 kg). But no significant difference between the least squares means of peak yield of any of the 3 groups for effect of AFC was observed.

The significant effect of AFC was shown in accordance with this study by some workers in dairy animals. Singh (2014) reported a non-

significant effect of AFC on TD-6, TD-8 and TD-10 in Murrah buffaloes, Penchev *et al.* (2011) reported that the effect of AFC was non-significant on daily milk yield (DMY) in Bulgarian Murrah buffaloes, similarly a non-significant (P>0.05) effect on full lactation MY was shown by Dangar and Vataliya (2018) in Jaffarabadi buffaloes. Pandey *et al.* (2019) reported a non-significant effect on first lactation 305 days MY.

Effect of parity

It was found that parity had (P<0.01) highly significant effect on all parameters except days to attain peak yield (Table 5). The overall means for 305-day MY was 2150.03±13.19 kg. The highest 305-day milk yield was observed for Parity 4 (2330.66±36.84 kg) and lowest in Parity 1 (1993.28±18.82 kg). But no significant difference between the LSMs of 305-day MY of 2nd, 3rd and 4th parity was observed.

The overall means for complete lactation MY (455 days) was 2361.36±19.79 kg. The highest complete lactation MY (455 days) was observed for Parity 3 (2505.67±45.43 kg) and lowest in Parity 1 (2252.74±30.08 kg). But no significant difference between the LSMs of complete lactation MY of 2nd, 3rd and 4th parity was observed.

The overall means for peak yield was 12.07±0.06 kg. The highest peak yield was observed for parity 4 (13.70±0.16 kg) and lowest in Parity 1 (10.72±0.08 kg). But no significant difference between the LSMs of complete lactation MY of 3rd and 4th parity was observed.

The overall means for lactation length was 345.68±1.96 days. The highest lactation length was observed for Parity 1 (356.18±3.01 days) and lowest in Parity 3 (335.58±4.55 days). But no significant difference between the LSMs of lactation length of 2nd, 3rd and 4th parity was observed.

The overall means for service period was 191.43±4.02 days. The highest service period was observed for Parity 1 (223.31±6.08 days) and lowest in Parity 2 (173.09±7.39 days). But no significant difference between the LSMs of lactation length of 2nd, 3rd and 4th parity was observed.

The significant effect of parity was shown in accordance with this study by some workers as Chaudhary *et al.* (2000) observed that the peak yield was 9.8±0.55 kg for first parity buffaloes, increased till 4th parity and declined thereafter. A highly significant (P<0.01) was also reported for the effect of parity on CLMY, 305 MY, Peak Yield and lactation length in Murrah buffaloes. Similarly, in Murrah buffaloes it was reported that the parity had a significant (P<0.01) effect on 305 MY as shown by Jamuna *et al.* (2015), Verma *et al*. (2016); Jakhar *et al.* (2016). According to Thiruvenkadan *et al*. (2014), buffalo's daily milk production increased from the first to the fourth parities. According to Hassan *et al*. (2017), parity has a significant effect on DMY. He also came to the conclusion that lactation length and CLMY are significantly influenced by parity (P>0.01), with the highest CLMY found in the fourth parity and a subsequent decline in CLMY in purebred Egyptian buffaloes.

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Table 1. Estimation of Least Square Means (LSMs) of lactation traits in Murrah buffalo.

Trait	N	Least squares mean	Coefficient of variation
CLMY (kg)	1523	2361.36±19.79	32.72215
MY305 (kg)	1524	2150.03±13.19	23.95922
LL (days)	1524	345.6811±1.96	22.18669
PY (kg)	1524	12.07552±0.06	21.71196
DRPY (days)	1521	53.14596±2.12	155.5717
SP (days)	1165	191.4352±4.02	71.78023

Table 2. Least squares mean (LSMs) for effect of PoC affecting production performance in Murrah buffalo.

PoC	N	MY305 (kg)	CLMY (kg)	PY (kg)	LL (days)	SP (days)
1991-1995	313	1972.97±29.02^{d}	2143.06±46.38^{c}	11.70±0.13^{d}	344.01±4.65^{ab}	222.22±9.34^{a}
1996-2000	329	2157.47±27.59^{c}	2380.54±44.09^{b}	12.16±0.12^{c}	357.29±4.42^{a}	204.04±8.83^{a}
2001-2005	336	2315.80±26.12^{ab}	2543.86±41.93^{a}	13.10±0.12^{ab}	335.88±4.20^{b}	150.59±8.32^{b}
2006-2010	298	2275.97±28.26^{b}	2447.06±45.17^{ab}	12.88±0.12^{b}	331.02±4.53^{b}	168.83±8.91^{b}
2011-2015	248	2402.00±31.23^{a}	2607.84±49.92^{a}	13.52±0.14^{a}	348.05±5.00^{ab}	195.85±10.44^{ab}
Overall means	1524	2150.03±13.19	2361.36±19.79	12.07±0.06	345.68±1.96	191.43±4.02

Values with different superscript within column differ significantly (P≤0.01).

Table 3. Least squares mean (LSMs) for effect of SoC affecting production performance in Murrah buffalo.

SoC	N	PY (kg)	LL (days)	SP (days)
Winter	389	13.14±0.11^{a}	352.59±3.95^{a}	212.40±8.11^{a}
Spring	243	12.71±0.14^{ab}	350.69±5.05^{a}	197.89±10.10^{ab}
Summer	433	12.23±0.10^{c}	334.58±3.78^{b}	172.40±7.27^{b}
Autumn	459	12.62±0.10^{b}	335.13±3.63^{b}	170.53±7.52^{b}
Overall mean	1524	12.07±0.06	345.68±1.96	191.43±4.02

Values with different superscript within column differ significantly (P≤0.01).

Table 4. Least squares means (LSMs) for effect of AFC affecting production performance in Murrah buffalo.

AFC (in months)	N	PY (kg)
1 (<40.25)	551	12.52±0.10[b]
2 (40.25-47.6)	543	12.62±0.09[ab]
3 (>47.6)	430	12.89±0.11[a]
Overall mean	1524	12.07±0.06

Values with different superscript within column differ significantly (P≤0.01).

Table 5. Least squares mean for effect of parity affecting production performance in Murrah buffalo.

Parity	N	MY305 (kg)	CLMY (kg)	PY (kg)	LL (days)	SP (days)
1	644	1993.28±18.82[b]	2252.74±30.08[b]	10.72±0.08[c]	356.18±3.01[a]	223.31±6.08[a]
2	430	2256.00±23.01[a]	2442.22±36.82[a]	12.78±0.10[b]	341.32±3.68[b]	173.09±7.39[b]
3	282	2319.42±28.42[a]	2505.67±45.43[a]	13.49±0.13[a]	335.58±4.55[b]	176.12±9.11[b]
4	167	2330.66±36.84[a]	2497.26±58.88[a]	13.70±0.16[a]	336.91±5.90[b]	180.71±11.9[b]
Overall mean	1524	2150.03±13.19	2361.36±19.79	12.07±0.06	345.68±1.96	191.43±4.02

Values with different superscript within column differ significantly (P≤0.01).

CONCLUSION

Murrah buffalo is considered as a precious bubaline breed of the Asian continent which has been imported to other continents. The future breeding strategy to improve the lactation MY and lifetime MY is the prime challenge of buffalo breeders. This study demonstrates that scientific breeding and improved managemental practices can further improve the productivity of Murrah buffaloes in coming years. Though the progeny testing programme utilizes the first lactation 305-day milk yield, it is recommended that all available production performances of the animals must be utilized to further improve the accuracy of selection following progeny testing.

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