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Short communication

Effects of environmental factors on some milk production traits, persistency and calving interval of Anatolian buffaloes

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Abstract

Data on 132 lactation records pertaining to 51 Anatolian buffaloes maintained at Kocatepe Agricultural Research Institute, Afyon, Turkey were analyzed to study the effects of different non-genetic factors on day at peak yield, peak yield (maximum daily yield), 305-day yield, persistency and calving interval. The persistency of lactation was estimated by three methods: P_1, the ratio of 305-day yield to maximum daily yield; P_2, the coefficient of variation (%) among daily yields in successive days, and P_3, the average of proportions of each month's milk yield to preceding month's milk yield after the peak is attained. The overall means of day at peak yield, peak yield, 305-day yield, P_1, P_2, P_3 persistency measures, and calving interval were 55.12±3.22 days, 7.30±0.15 kg, 894.17±19.55 kg, 120.56±1.72, 34.99±1.07%, 85.22±0.92% and 441.97±7.93 days, respectively. The 305-day yield was significantly ($P<0.05$) influenced by period, parity, and age. The period and calving season had significant ($P<0.05$) effects on day at peak yield and calving interval. Age was also important for $P1$ and P_3. The regression on lactation length was found significant ($P<0.05$) for all traits. Repeatability estimates of day at peak yield, peak yield, 305-day yield, P_1, P_2, P_3 and calving interval were 0.037±0.091, 0.279±0.104, 0.437±0.099, 0.027±0.09, 0.008±0.088, 0.154±0.100 and 0.134±0.10, respectively.

Keywords: Buffalo; Milk yield; Persistency; Calving interval; Turkey

1. Introduction

The lactation milk yield, persistency of lactation and calving interval have marked effects on dairy economy (Kumar et al., 1979; Rao and Sundaresan, 1979; Sölkner and Fuchs, 1987; Kandasamy et al., 1993). The milk production follows an ascending, stabilized, and descending line with the advance of lactation. The cows having flatter lactation curve are more persistent, and produce milk with a lower cost (Khan and Johar, 1985; Sölkner and Fuchs, 1987; Gengler, 1996). Calving interval has also significant effect on the lifetime milk production and cow replacement rate in a herd (Bath et al., 1985a,b; Kandasamy et al., 1993).

Lactation yield, persistency and calving interval are influenced by various factors such as inheritance, period, season, parity, age, etc. (Kumar et al., 1979; Rao and Sundaresan, 1979, 1981; Cady et al., 1983; Khan and Johar, 1985; Hatwar and Chawla, 1988;

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Parkash et al., 1989; Kandasamy et al., 1993; Dhaka and Chaudhary, 1994; Khan and Akhtar, 1999; Tekerli et al., 2000).

The Anatolian buffaloes are classed as a river type belonging to a Mediterranean group (Cockrill, 1974). The present investigation has been undertaken to study the non-genetic factors affecting milk production traits, persistency and calving interval, and to estimate the repeatabilities and phenotypic correlations of these traits in buffaloes in the Afyon province of Turkey.

2. Materials and methods

The study was conducted by using 132 lactation records of 51 Anatolian buffaloes maintained at the Kocatepe Agricultural Research Institute, Afyon, Turkey during 1984–1998. The data were collected from the cow barn sheets, including daily milk yields of each cow, and individual cow record cards. Records <60 days lactation length, <300 or >700 days calving interval, and abortion and other pathological causes which affect the lactation yield were considered to be abnormal and hence were excluded. The lactation yields obtained in records terminated earlier to 305 days were also considered as 305-day yields. Only those animals, which had completed at least two lactations were included in the estimation of repeatability.

The persistency of lactation yield was estimated as: (1) the ratio of 305-day yield to observed maximum daily yield (peak yield); (2) the coefficient of variation (%) among successive daily yields, and (3) the average of proportions of each month's milk yield to preceding month's milk yield after the peak is attained. Higher values of P_1 and P_3 and lower values of P_2 show higher values of persistency (Madsen, 1975; Rao and Sundaresan, 1979; Bath et al., 1985a,b).

To evaluate the significant effects of calving period, season of calving, parity order, age at calving, and lactation length (defined as the interval between calving and the day in which a cow dries off by herself) on different traits, the calving years were grouped into three periods, viz. (1) 1984–1988, (2) 1989–1993, and (3) 1994–1998. Parity order (lactation order) was listed numerically one through five; the fifth parity represented five or more parities. Based on the geo-climatic conditions prevailing in Turkey, four calving seasons were established; winter (December, January and February), spring (March, April and May), summer (June, July, August), and fall (September, October and November). The age factor was divided into three groups, (1) 2–4, (2) 5–6, and (3) 7 or older. Least-squares and maximum likelihood program of Harvey (1987) was utilized to study the effects of various environmental factors on different traits by using the following model:

$$Y_{ijklm} = \mu + P_i + S_j + L_k + A_l + b(Ll) + e_{ijklm}$$

where Y_{ijklm} = the mth observation in the lth age, kth parity, jth season and ith period; μ = the overall mean; P = the effect of ith period ($i=1, \ldots, 3$); S = the effect of jth season ($j=1, \ldots, 4$); L = the effect of kth parity ($k=1, \ldots, 5$); A = the effect of lth age group ($l=1, \ldots, 3$); $b(Ll)$ = regression of lactation length; e_{ijklm} = random error component assumed to be normally distributed with mean zero and variance σ^2.

The correlations of service period (defined as the interval between calving and conception), gestation length, and preceding dry period with different traits were calculated by using unadjusted data. The correlations between different traits and repeatability estimates were calculated with the data adjusted for significant ($P<0.05$) non-genetic effects. The repeatabilities were estimated from the variance components using intraclass correlation and repeated records of the same animal (Yalcin, 1966; Zar, 1984; Van Vleck, 1993; Vanli et al., 1993).

3. Results and discussion

The overall means (Table 1) of different traits, viz. day at peak yield, peak and 305-day yields, P_1, P_2, P_3, and calving interval were computed as 55.12 days, 7.30 kg, 894.27 kg, 120.56, 34.99%, 85.22% and 441.97 days, respectively, in Anatolian buffaloes. The average for 305-day yield was between the values reported by Elisei and Chichernea (1991), Stravaridou (1998) and Alexiev (1998) in Romanian (890.5 kg), Greek (700 to 1000 kg) and Italian (2000 kg) buffaloes, respectively, for lactation yield. The

Table 1
Least-squares constants for different traits in Anatolian buffaloes

Effect	n	Day at peak yield	Peak yield (kg)	305-day yield (kg) (kg)	P_1	P_2 (%)	P_3 (%)	Calving interval (days)
Mean (μ)±S.E.	132	55.12±3.22	7.30±0.15	894.27±19.55	120.56±1.72	34.99±1.07	85.22±0.92	441.97±7.93
Periods		*	**	**				*
1984–1988	46	25.05^{a}	−1.28^{c}	−141.19^{c}	2.49^{a}	−1.40^{a}	0.79^{a}	4.78^{a}
1989–1993	48	−3.70^{b}	−0.35^{b}	−16.12^{b}	2.21^{a}	−0.60^{a}	−0.15^{a}	27.59^{a}
1994–1998	38	−22.25^{c}	1.62^{a}	157.31^{a}	−4.70^{a}	2.00^{a}	−0.64^{a}	−32.37^{b}
Seasons		*						
Winter	28	13.96^{a}	−0.25^{a}	−16.55^{a}	2.67^{a}	−1.43^{a}	−1.66^{a}	20.40^{a}
Spring	31	−9.87^{b}	0.23^{a}	61.16^{a}	1.05^{a}	1.00^{a}	−0.33^{a}	3.63^{a}
Summer	59	−4.54^{b}	−0.03^{a}	−8.23^{a}	−0.58^{a}	2.51^{a}	−0.17^{a}	−37.46^{b}
Fall	14	0.45^{ab}	0.05^{a}	−36.38^{a}	−3.14^{a}	−2.08^{a}	2.16^{a}	13.43^{a}
Parities			**	*				
1	32	12.72^{a}	−1.64^{b}	−103.76^{c}	10.60^{a}	−6.41^{a}	2.49^{a}	31.16^{a}
2	32	−7.09^{a}	0.33^{a}	40.27^{ab}	−1.40^{a}	−1.70^{a}	1.72^{a}	−12.33^{a}
3	25	3.62^{a}	0.54^{a}	3.18^{abc}	−5.73^{a}	3.71^{a}	−2.26^{a}	9.18^{a}
4	17	−1.08^{a}	−0.12^{a}	−40.73^{bc}	−3.43^{a}	3.47^{a}	−2.58^{a}	−26.66^{a}
≥5	26	−8.17^{a}	0.89^{a}	101.04^{a}	−0.04^{a}	0.93^{a}	0.63^{a}	−1.35^{a}
Age				*	*	*		
2–4	59	−4.26^{a}	0.32^{a}	−41.86^{b}	−9.06^{b}	5.59^{a}	−2.96^{a}	6.69^{a}
5–6	37	−3.34^{a}	0.26^{a}	79.77^{a}	5.78^{a}	−4.08^{b}	2.50^{a}	2.15^{a}
≥7	36	07.60^{a}	−0.58^{a}	−37.91^{ab}	3.28^{ab}	−1.51^{ab}	0.46^{a}	−8.84^{a}
Regression on lactation length		**	**	*	**	*	**	**
		0.188	0.012	4.697	0.517	−0.038	0.066	0.592
R^2		0.43	0.58	0.78	0.81	0.17	0.22	0.37

[a,b,c]Constants superscripted by different letters differ significantly ($P<0.05$) among themselves.
R^2 = proportion of variance explained by least-squares model.
*$P<0.05$; **$P<0.01$.

higher findings ranging from 1841 to 1954 kg for 305-day yield were also found by Cady et al. (1983), Iype and Nagarcenkar (1992), Dhara and Chakravarty (1996) in Nili-Ravi and Murrah buffaloes. The overall mean for calving interval was in the range of 416–548 days reported by Dutt and Yadav (1988), Parkash et al. (1989), Danev (1991), Kandasamy et al. (1993), and Khan and Akhtar (1999) in Bulgarian, Murrah and Nili-Ravi buffaloes.

Periods had highly significant ($P<0.01$) effects on all traits except persistency. Similar results were reported by Cady et al. (1983), and Chhikara et al. (1995) for 305-day yield and calving interval. In the present study, this may be explained by the fact that the milking system was changed to machine milking after 1988, and advances in feeding and other administrative conditions throughout the periods. Opposite to these results, Kandasamy et al. (1993) observed non-significant effect of period on calving interval making evident that there was no appreciable variation in management during considered years.

The effect of calving season on day at peak yield and calving interval was found to be significant ($P<0.05$ and $P<0.01$, respectively). This was in accordance with the findings of Cady et al. (1983) and Chhikara et al. (1995), and contrary to that reported by Dutt and Yadav (1988), Parkash et al. (1989) and Kandasamy et al. (1993) for calving interval. The winter calvers were observed to reach the day at peak yield in a longer period than the others. This may result from the lower ambient temperatures in winter, availability of green fodder when the buffaloes are on pasture during spring and summer, and feeding of first-cut silage in fall. As for the calving interval, it was found to be shorter in summer calvers. This may be caused by the tendency towards seasonality. These results are in tune with those of Cady et al. (1983), Singh (1988), Danev (1991) and Zicarelli (1997) for calving interval and service period. This may be considered to be more inherently associated with physiological functions. Beg and Totey (1999) reported that the higher temperature and longer day length were found to depress cyclicity and to lead to inactivation of ovaries, and if the animals were subjected to superior management, involving cooling by sprinkling water, provision of shade and better nutrition, the number of oestrus period and the intensity and duration of oestrus were increased. The opportunity of cooling by wallowing exists for these buffaloes during the summer when they are grazing in the pasture. In addition, the duration of daylight is starting to shorten after 21 June in Turkey and the buffaloes are fed with a prescribed feeding program throughout the year. These factors may also result in a shorter calving interval in summer calvers.

The parity was not observed to affect all the traits except peak and 305-day yields. This was consonant with the findings of Cady et al. (1983) for 305-day yield and Parkash et al. (1989) for calving interval. In this investigation, both the peak and 305-day yields were lower in the first lactations. The parity was reported to be a significant source of variation by Kumar et al. (1979) and Dhaka and Chaudhary (1994) for persistency, and by Kandasamy et al. (1993) and Chhikara et al. (1995) for calving interval. The differences between the findings of various workers and this study were likely due to persistency measures used. In addition, variations caused by the parity in both persistency and calving interval may be too small to detect in these data. However, the perusal of least-squares constants (Table 1) showed that the persistency and calving interval were higher in the first lactations. The higher persistency may be caused by the relatively lower peak yield resulting in a flatter lactation curve in the primiparous cows. These cows are additionally tend to have more negative energy balance postpartum than do multiparous cows and may fail to show oestrus until the energy balance is more favorable as in cattle. (Schmidt and Van Vleck, 1974; Reksen et al., 1999). The longer calving interval of first-lactation buffalo heifers may also be explained by this phenomenon.

The age at calving was found to have significant ($P<0.05$) effect on 305-day yield, P_1 and P_2. This supported the result of Cady et al. (1983) for 305-day yield. The least-squares constants indicated that there is a decreasing tendency for 305-day yield and persistency of cows aged seven or more, implying the buffaloes start to lose their abilities of persistency and productivity, and move towards the senility after the ages of 5–6.

The least-squares analysis of variance revealed that the regressions of all traits on lactation length were significant ($P<0.05$). This was in unison with the finding of Cady et al. (1983) for 305-day yield. The regression constants showed a trend of increase in all traits with the increase in lactation length. Similar results were also reported by Rao and Sundaresan (1979, 1981).

The averages of preceding dry period, service period, gestation length and lactation length were computed as 231.16 ± 11.45 ($n=92$), 112.71 ± 9.80 ($n=85$), 320.05 ± 1.05 ($n=85$), and 221.62 ± 5.47 ($n=132$) days, respectively. The coefficients of variation for these traits were also found to be 0.48, 0.80, 0.03 and 0.28. Correlation coefficients (Table 2) indicated an increase in day at peak yield, persistency and calving interval with the increase in service period. The correlations of dry period with the other traits showed that the dry period in this herd can be successfully reduced without adversely affecting the milk production, persistency and calving interval. Significant negative correlations of gestation length with peak yield and P_2 suggested that buffaloes with longer gestation length tend to have lower peak yield and higher persistency.

The repeatabilities (Table 2) were low for day at peak yield, persistency and calving interval (0.08–0.15), but medium and high for peak and 305-day yields (0.28, 0.44). The repeatability of 305-day yield was higher than the estimates reported by Cady et al. (1983) (0.23) in Nili-Ravi, and Hatwar and Chawla (1988) (0.39) and Dass and Sadana (1999) (0.41) in Murrah buffaloes. The repeatability estimate for calving interval was in the range of -0.05–0.19 found in literature (Hatwar and Chawla, 1988;

Table 2
Phenotypic correlations and repeatability estimates[a] for different traits

Trait	Preceding dry period (92)[b]	Gestation length (85)	Service period (85)	Day at peak yield (132)	Peak yield (132)	305-day yield (132)	P_1 (132)	P_2 (132)	P_3 (132)	Calving interval (132)
Day at peak yield	0.118	−0.005	0.360**	0.037±0.09	−0.134	−0.041	0.244**	−0.234**	−0.069	0.132
Peak yield	−0.163	−0.252*	−0.088	–	0.279±0.10	0.709**	−0.161	0.135	−0.158	−0.097
305 day yield	−0.151	−0.18	0.177	–	–	0.437±0.10	0.368**	−0.034	−0.022	−0.178*
P_1	−0.043	−0.017	0.429**	–	–	–	0.027±0.09	−0.576**	0.311**	0.006
P_2	−0.215*	−0.224*	−0.362**	–	–	–	–	0.008±0.09	−0.619**	−0.095
P_3	0.099	0.120	0.279*	–	–	–	–	–	0.154±0.10	0.006
Calving interval	0.357**	0.073	0.994**	–	–	–	–	–	–	0.134±0.10

[a] Diagonals on the right-hand of the vertical line are repeatabilities and their standard errors estimated from 116 lactations of 35 cows.
[b] Note: Figures within parenthesis indicate number of observations.
*Significant ($P<0.05$); ** ($P<0.01$).

Parkash et al., 1989; Kandasamy et al., 1993; Dass and Sadana, 1999) on Murrah buffaloes. The differences in repeatability values announced by various workers could be due to inherent breed and herd differences. In this study, the repeatability figure of 305-day yield indicated that buffaloes can be selected for improvement on the basis of their early performance without waiting for more lactation records. Due to low repeatabilities of persistency and calving interval, temporary environmental factors seemed to have a greater effect on these traits. This suggested that the performance of persistency and calving interval cannot be estimated based on previous record. Therefore, the improvements in these traits are only possible by selection as well as better feeding and management practices.

Day at peak yield was significantly ($P<0.01$) correlated with P_1 and P_2, indicating that a later day at peak yield would result in increased persistency. The significant correlation of 305-day yield with P_1 showed that these traits are dependent on each other, whereas P_2 and P_3 are independent from 305-day yield. Correlations between different measures of persistency were highly significant ($P<0.01$) and in desirable direction. The magnitude of negative phenotypic association between 305-day yield and calving interval was low but significant ($P<0.05$). This appears in conflict with the positive finding of Olds et al. (1979) in Holsteins. This may be due to the sample studied has been under selection for regular fertility and higher milk yield for several generations. The correlations between persistency and calving interval were observed to be non-significant, in undesirable direction, and low in magnitude. Similar but statistically significant results for P_1 were also reported by Dhaka et al. (1994b).

4. Conclusions

The results of this study, in general, indicated that the factors affecting milk yield, lactation persistency and calving interval in buffaloes are similar to those in cattle. Use of the data adjusted for the effects of significant environmental factors would give results that are more reliable in genetic evaluation. Moreover, because the Buffaloes calving in summer had shorter calving interval, it will be useful to investigate the seasonal variation in the reproductive functions of Anatolian buffaloes. The repeatability estimate (0.44) of 305-day yield indicated that the herd has a potential for improvement of total milk yield. The phenotypic correlations showed that the association between the 305-day yield and persistency was heavily dependent on the measure of persistency used. Among the persistency measures worked in this study, P_1 may be preferred by the buffalo breeders because of its higher correlation with 305-day yield and computational ease. The correlations between persistency and calving interval suggested that the selection for one of these traits would not produce useful results for the other trait on the basis of collateral response.

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