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EFFECTS OF DAM MILK YIELD AND MILK COMPOSITION ON BIRTH WEIGHT AND GROWTH PERFORMANCE OF ANATOLIAN BUFFALO CALVES

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ABSTRACT

This study was conducted to determine the effects of the dam's milk yield and composition on birth weight, 6-month, and 12-month live weight (LW) of Anatolian buffalo calves born in 2017 and 2018 years in Çorum province, Türkiye. Calving age had a significant impact on daily milk yield (DMY) (P=0.031), lactation milk yield (LMY) (P=0.048) and solids-not-fat (SNF) (P=0.034). DMY (P=0.022) and fat content (P=0.005) were affacted by calving season. Suckling period and calf sex had no significant impact (P>0.05) on DMY, LMY, fat content, and solids-not-fat (SNF) (P>0.05). The dam's calving age had a significant impact on birth weight (P=0.029), except for 6-month and 12-month live weight (LW). Calving season affected 6-month (P=0.002) and 12-month LW (P=0.012) without birth weight. The suckling period and calf sex were not significantly affected on the birth weight, 6-month, and 12-month LWs (P>0.05).

The highest 6-month LW (P=0.025) was determined in the calves of high DMY buffaloes (>6.50 kg). The DMY of the dam had no effect on the birth weight and 12-month LWs (P>0.05). The calves of buffaloes with the highest LMY (>1300 kg) were observed the highest birth weight (P=0.040) and 6-month LW (P=0.046). The dam's fat and SNF content had no effect on the birth weight, 6-month, and 12-month LWs. To conclude; "higher milk yield resulted in higher birth weight" means that better dams give better calves, suggesting that buffalo keepers should feed buffalo cows sufficiently to get heavier calves at least.

Keywords: *Bubalus bubalis*, buffaloes, Anatolian buffalo, calves, milk composition, birth weight, growth traits

INTRODUCTION

Dam's milk is regarded as the best nutritional supply for calf development and preterm calfs. Its potential positive effects include a decrease in the severity and frequency of necrotizing enterocolitis and retinopathy of prematurity, also infection prevention in premature calves (Furman *et al*., 2002). Milk yield level in buffaloes is critical for growth of calf in pre-weaning period (Cortés-Lacruz *et al*., 2017). Liu *et al*. (2015) reported that milk production and its composition affected pre-weaning calf weight.

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Body weight at birth is a good indicator of fetal growth and largely influenced by the fetal environment inside the dam's uterus. The amount of food consumed by the dam during pregnancy, physical condition, and age of the dam at conception, and placenta size affect the amount of nutrients that are accessible to the developing fetus. The latter one affects fetal growth and has a late-gestational limit. By altering the maternal body size and uterine environment, one can either promote or prevent fetal growth from reaching its typical genetic potential. According to estimates, the uterine environment, along with maternal and paternal factors, accounted for around 60% of the difference in size at birth (Swali and Wathes, 2006).

The influence of fetus on dam's subsequent lactation has been demonstrated in several studies. Hypothesize that sire of fetus effect may be explained in part or even completely by potential differences in size of fetus because birth weight is heritable and is correlated positively with placental weight. A larger placental mass may increase the secretion of placental lactogen and estrogen. The role of estrogen and placental lactogen in influencing mammary gland development has been reviewed. Indeed, the higher calf birth weight has been correlated positively with more circulating estrogen. Also, the increased placental lactogen was reported in dairy cows with higher producing than lower producing cows (Chew *et al*., 1981).

There are numerous non-genetic factors affecting birth weight in buffaloes such as sex (Kul *et al*., 2018; Pramod *et al*., 2018), calving season (Ghavi *et al*., 2012; Kul *et al*., 2018) and calving age (Moaeen-ud-Din and Bilal, 2017; Yilmaz *et al*., 2017). These non-genetic factors prevent from revealing their true genetic capacity for growth. Therefore, determination of environmental factors affecting calf birth and growth characteristics is most important. Indeed, the small number of studies on Anatolian buffaloes raised in Türkiye has been seen as a major shortcoming. Although the effect of maternal milk production quality on calf growth characteristics has been demonstrated in many studies on dairy cattle and fattening cattle, the number of studies that can reveal this relationship has been limited, especially in buffaloes. In Antolian water buffaloes, the sampling of milk and the analysis of milk components could not be revealed exactly because it is more difficult than those of dairy cattle due to the small number of animals in the farms. Therefore, the conditions of Türkiye are a need for more studies on this subject. This study aimed to investigate the effects of milk yield and its composition on birth weight, 6-month, and 12-month LW by using the records of Anatolian buffaloes and their calves resulting from them and to reveal the effects of environmental factors on all these factors.

MATERIALS AND METHODS

Material

This study was conducted to reveal the effects of the dam's milk yield and its composition (fat and SNF) on the birth weight, 6-month, and 12-month LWs of a total of 98 calves born in 2017 and 2018 on small-scale family in Çorum province of Türkiye.

Method

The birth weight was measured by digital scales within 24 h after birth. Milk records were obtained from individual buffalo farms. The DMY and milk samples were taken from the morning milking five times in the first 150 DIM (±15 days) as monthly intervals. After cleaning the teats with tepid water, the first stream of foremilk was discarded, and a 50 mL milk sample was taken into sterile tubes. Raw milk samples were stored at 4°C in an ice-cooled box and analyzed within 5 to 6 h of collection.

Fat and SNF contents were determined using ultrasonic milk analyzer (Master Classic LM2).

Statistical analyses

The data were recorded in Buffalo Star Program developed by Tekerli (2015 to 2018). Data were subjected analysis in this program. In the study, 6-month and 12-month LWs were calculated by linear interpolation in this program. Also, LMY was calculated within Buffalo Star Program.

To determine the effect of calving age, calving season, suckling period and calf sex on DMY, LMY, fat content and SNF, birth, 6-month and 12-month LWs, the following model was performed;

$$Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$$

Y_{ijklm} : is the observation value

μ : Overall mean

a_i : Effect of i[th] calving age (i: ≤5, >5 year)

b_j : Effect of j[th] calving season (j: winter, spring, summer)

c_k : Effect of k[th] suckling period (k: ≤3, >3 mo)

d_l : Effect of l[th] calf sex (l: male, female)

e_{ijklm} : Random error

DMY was divided into three groups: low (<5.50), moderate (5.50 to 6.50), and high (>6.50 kg). LMY was divided into three groups as low (<1100 kg), moderate (1100 to 1300 kg), and high (>1300 kg). Fat content was formed as three groups: low (<7.50%), moderate (7.50 to 8.50%), and high (>8.50%). SNF was divided into three groups: low (<9.35%), moderate (9.35 to 9.65%), and high (>9.65%).

To examine the influence of DMY, LMY, fat content and SNF levels of dam on birth, 6-month and 12-month weight, the following linear model was used;

$$Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$$

Y_{ijklm} : is the observation value

μ : Overall mean

a_i : Effect of i[th] DMY (i: <5.50, 5.50-6.00, >6.50 kg)

b_j : Effect of j[th] LMY (j: <1100, 1100-1300, >1300 kg)

c_k : Effect of k[th] fat content (k: <7.50, 7.50-8.50, >8.50%)

d_l : Effect of l[th] SNF (l: <9.35, 9.35-9.65, >9.65%)

e_{ijklm} : Random error

The statistical analysis was performed using SPSS 17.0 for Windows. The differences among the groups were analyzed by Duncan's Multiple Range Test. Also, phenotypic correlations between parameters were calculated.

RESULTS AND DISCUSSIONS

In this study, the highest birth weight was determined in calves of buffaloes calving more than 5 age (P=0.029). However, the effect of calving age on 6-month and 12-month LWs were insignificant (P>0.05). Results of current study showed that the birth weight increased with increasing maternal age; this is consistent with previous findings

(Moaeen-ud-Din and Bilal, 2017; Kul *et al*., 2018). Contrary to the present findings, some studies (Erdem *et al*., 2015; Uğurlu *et al*., 2016) showed the effect of dam age on birth weight was not important. Unlike the results of this study, Thiruvenkadan *et al*. (2009); Erdem *et al*. (2015) found that the statically significant influences of calving age on 6-month and 12-month LWs were significant. Erdem *et al*. (2015) stressed that the 6-month LW would be the most appropriate selection time.The highest 6-month LW (P=0.002) was determined in calf born in winter, but the lowest LW was recorded in summer. The highest 12-month LW (P=0.012) was observed in calves born in winter and spring compared with summer (Table 2). In this study, it is thought that the obtained highest 6-month and 12-month LWs of calves born in winter were due to the presence of good quality feed during late winter and spring period (Ahmad *et al*., 2002). Also, the lowest 6-month and 12-month LWs were determined in calves born in summer due to poor quality feeds and pasture in late summer and early autumn.

The results showed that birth, 6-month and 12-month LWs were not affected by suckling period (P>0.05) (Table 2). These results showed that suckling period less than three months or longer had no effect on 6-month and 12-month LWs of calves. This was consistent with the findings from Koçyiğit *et al*. (2015), who determined that the weaning age of the Brown x Eastern Anatolian Red F1 crossed calves was not effective on LW gain after weaning and during the whole trial period. The findings of the current study differed with those of Abbas *et al*. (2017), who found that early weaned calves with low milk content had the lowest body weight while late weaned calves with high milk content had the highest.

In ruminant animals, in general, male birth weight is higher than females and this is generally an expected result in field and academic studies. However, in this study, which is different from this generalization, there was no statistical difference between males and females in terms of both birth weight and 6-month and 12-month LWs, and males and females showed similar values (Table 2). This conclusion was supported by the findings of Yadav *et al*. (2001); Hamad and El-Moghazy (2015). This result was differed than those of the previous studies (Kul *et al*., 2018; Pramod *et al*., 2018). Different breed, feeding and herd management could be the main reasons for the obtained different results.

The dam's DMY had a major impact on the calf's birth weight (Table 3). However, 6-month LW of calf was affected by DMY of dam (P=0.025). The calves of buffaloes with high milk yields (DMY>6.50 kg) had the highest 6-month LW values, while those with low milk yields (DMY 5.50 kg) had the lowest 6-month LW values (Table 3). In other words, the 6-month LW of the calves was increased when their dam' DMY increased. The 12-month LW of calf was not affected by the DMY of dam (P>0.05).

A statistically significant relationship existed between LMY of buffaloes and birth weight (P=0.040) and 6-month LW of their offsprings (P=0.046). However, the 12-month LW of calf was not affected by the LMY level of dam (P>0.05). There was a 16 kg weight difference between the lowest and highest values of the 12-month LW, but this difference was not statistically important. Abbas *et al*. (2017) found that low milk intake in Nili-Ravi calf caused lower growth rate and weight, as similar to our current study. Researches stressed that the dam's milk yield level was more effective on the 90th day weight than the 150th day weight of calf. The present findings were consistent with those of Chew *et al*. (1981), who found that calf birth weight was affected by the dam's milk. It can be hypothesized that the mechanism of action is probably through changes in concentrations of hormone receptors in the target tissue and through hormonal changes, as hormones play an essential role in regulation of lactogenesis (Chew *et al*., 1981).

The birth and 6-month LW of the offspring were greatly influenced by the dam's milk production, which is closely correlated with the placenta weight of the dam. Chew *et al.* (1981) stressed that larger placental mass may increase secretion of placental lactogen and estrogen. The role of estrogen and placental lactogen in influencing mammary gland development has been reviewed. Indeed, higher calf birth weight is correlated positively with more circulating estrogen. In this study, concentrate consumption of calves may not sufficient to alter their suckling behavior; therefore, 12-month LW was not affected by dam's milk yield (Cortés-Lacruz *et al*., 2017).

The effect of fat and SNF in milk of dam on birth weight, 6-month and 12-month LWs of calf was not statistically significant (P>0.05). However, the results of this study are different than those of Chew *et al.* (1981) who stated that dams producing milk with higher fat and SNF contents gave calves having heavier birth weight. According to Brown and Brown (2002), the main factors on these parameters were breed and management. They also determined the impact of dam's milk yield and its components on calf weight.

There was positive and moderate correlation (r = 0.331) between birth weight and LMY. Buffalo's cows producing higher milk yield had higher birth weight. There was a positive correlation (r = 0.230) between birth weight and DMY. Similar to our study, Cortés-Lacruz *et al.* (2017) found the positive correlations between dam's milk yield and 90th (r = 0.59) and 150th day weights (r = 0.48) of calves. The weak correlation between birth weight and milk fat content was negative (r = -0.015), while birth weight and SNF was positive (r = 0.094).

In this study, the moderate positive correlations were found between 6-month LW and DMY (r = 0.339) and LMY (r = 0.267). High milk yield resulted high 6-month LW. However, the weak correlations between 6-month LW and milk fat content (r = 0.077) and SNF (r = 0.086) were positive.

Correlations between 12-month LW and DMY (r = 0.200) and LMY (r = 0.201) were positive and weak. The 12-month LW was correlated with fat content (r = -0.194) and positively with SNF (r = 0.089). Despite the low correlations determined, it may be said that the calves whose dam's having higher milk yield their may tended to be higher LW at 12-month old possibly (Table 4). In this regard, the selection of high-yielding buffaloes or breeding studies to increase their milk yields will also make it possible to obtain heavier and more viable calves being the future of the herd. Although the effect of dam's milk production and quality on calf growth characteristics has been demonstrated in many studies on dairy cattle and beef cattle, the number of studies that can reveal this relationship in buffaloes has been limited. In particular, the collection of milk and analysis of milk components could not have been fully demonstrated due to their native behavioral charactheristics in buffaloes, needing more labor force and difficulty in collecting milk samples compared to dairy cattle. Therefore, more studies are needed to reveal these relationships in the buffaloes.

Table 1. Effects of calving age, calving season, suckling period and calf sex on milk yield and milk composition (Mean ± SE).

Traits	N	DMY (kg)	LMY (kg)	Fat (%)	SNF (%)
Calving age					
≤5	44	5.58±0.22[b]	1143.82±49.35[b]	7.74±0.20	9.56±0.05[a]
>5	54	6.23±0.19[a]	1252.96 ± 28.72[a]	8.24±0.17	9.43±0.04[b]
P-value		0.031	0.048	NS	0.034
Calving season					
Winter	17	6.50±0.32[a]	1225.35±62.96	8.72±0.30[a]	9.52±0.10
Spring	61	5.62±0.15[b]	1187.39±33.88	7.70±0.17[b]	9.45±0.04
Summer	20	6.44±0.47[ab]	1236.30±71.34	8.38±0.20[ab]	9.54±0.07
P-value		0.022	NS	0.005	NS
Suckling period					
≤3	49	6.23±0.21	1244.71±37.86	8.02±0.18	9.50±0.05
>3	49	5.64±0.20	1163.20±39.79	8.01±0.19	9.47±0.04
P-value		NS	NS	NS	NS
Calf sex					
Male	51	5.78±0.18	1207.75±37.41	8.00±0.18	9.45±0.04
Female	47	6.11±0.24	1199.85±41.30	8.04±0.19	9.52±0.04
P-value		NS	NS	NS	NS

[a,b]: Differences between different superscript in the same column is significant (P<0.05).

NS: Not significant (P>0.05).

DMY: Daily milk yield; LMY: Lactation milk yield; SNF: Solids-not-fat.

Table 2. Effects of calving age, calving season, suckling period and calf sex on birth, 6-month and 12-month LW (Mean ± SE).

Traits	**n**	**Birth weight (kg)**	**6-month weight (kg)**	**12-month weight (kg)**
Calving age				
≤5	44	29.12±0.78[b]	119.72±3.66	178.31±5.56
>5	54	31.15±0.53[a]	115.97±2.81	172.10±4.75
P-value		0.029	NS	NS
Calving season				
Winter	17	29.24±0.99	130.91±3.48[a]	183.91±6.98[a]
Spring	61	29.97±0.63	117.91±3.02[b]	179.64±4.93[a]
Summer	20	31.90±0.80	105.62±3.90[c]	155.08±5.11[b]
P-value		NS	0.002	0.012
Suckling period				
≤3	49	29.83±0.51	120.03±2.89	177.58±4.37
>3	49	30.64±0.77	115.28±3.45	172.60±5.58
P-value		NS	NS	NS
Calf sex				
Male	51	30.40±0.64	121.32±2.97	179.1±5.11
Female	47	30.06±0.68	113.68±3.35	170.6±5.08
P-value		NS	NS	NS

[a,b,c]: Differences between different superscript in the same column is significant (P<0.05).

NS: Not significant (P>0.05).

Table 3. Effects of DMY, LMY, fat and SNF of dam on birth, 6-month and 12-month LW of calves (Mean ± SE).

Traits	n	Birth weight (kg)	6-month weight (kg)	12-month weight (kg)
DMY (kg)				
<5.50	36	29.44±0.86	110.28±4.26[b]	168.82±6.15
5.50-6.50	29	29.90±0.83	118.85±4.29[ab]	176.12±6.71
>6.50	33	31.40±0.66	124.65±2.54[a]	180.93±5.87
P-values		NS	0.025	NS
LMY (kg)				
<1100	32	28.71±0.76[b]	114.18±4.58[b]	166.93±6.19
1100-1300	31	30.92±0.83[ab]	113.29±3.98[ab]	174.71±6.02
>1300	35	31.03±0.77[a]	124.71±2.89[a]	182.54±6.42
P-values		0.040	0.046	NS
Fat (%)				
<7.50	34	29.84±1.00	114.67±4.41	177.78±6.86
7.50-8.50	28	30.58±0.74	118.62±3.51	175.19±6.29
>8.50	36	30.34±0.63	119.73±3.64	171.77±5.65
P-values		NS	NS	NS
SNF (%)				
<9.35	30	29.10±0.84	113.56±3.75	170.95±5.09
9.35-9.65	36	31.24±0.79	118.98±3.80	173.71±6.30
>9.65	32	30.10±0.76	119.84±4.12	180.10±7.13
P-values		NS	NS	NS

[a,b]: Differences between different superscript in the same column is significant (P<0.05).

NS: Not significant (P>0.05).

DMY: Daily milk yield; LMY: Lactation milk yield; SNF: Solids-not-fat.

Table 4. Correlations among the investigated parameters.

Traits	Milk yield tratits (kg)		Milk components (%)	
	DMY	LMY	Fat	SNF
Birth weight	0.230	0.331	-0.015	0.094
6-month LW	0.339	0.267	0.077	0.086
12-month LW	0.200	0.201	-0.194	0.089

DMY: Daily milk yield; LMY: Lactation milk yield.

SNF: Solids-not-fat; LW: Live weight.

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