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REPVAS
RESEARCH & PRACTICE in VETERINARY & ANIMAL SCIENCE

Volume: 2 Issue: 1 Year: 2025 Research Article ISSN: 3023-6681

Effect of Age at First Calving and Season on First Lactation Milk Yield, Lactation Period and Calves Growth Data in Anatolian Water Buffaloes in Çorum Region

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Article Info

Article History

Received: 24.05.2024
Accepted: 11.10.2024
Online First: 04.12.2024
Published:

Keywords:
Anatolian water buffalo,
First calving,
Lactation milk yield,
Lactation period,
Correlation.

ABSTRACT

This study was carried out using the data of the National Anatolian Water Buffaloes (AWB) Breeding in Farm Project, which is being carried out in Çorum Region. Data of 292 AWB gave birth between 2019 and 2023 and their calves (n=292) raised in 30 enterprises were used. Age at First Calving (AFC), Lactation Milk Yield (LMY), Lactation Period (LP), Daily Average Milk Yield (DAMY), Calf Birth Weight (CBW), Calf Gender (CG), and Calving Season (CS) were evaluated. The highest milk yield was detected in the buffaloes that were first bred after 50 months while the lowest LMY was observed in buffaloes with AFC less than 38 months (p=0.003). According to data, an increase in milk yield can be expected as AWB get older. Furthermore, the difference between LP and AFC and calving season, sex of calves were not significant. The difference between DAMY and the effect of AFC and CS was statistically significant (p<0.05). While the LMY of the buffaloes with the highest AFC were high, there was a difference between the other two groups. The milk yield of the AFC in summer was significantly lower than in other seasons (p<0.05). AWB with high AFC had high LMY and prolonged lactation period. When AFC was in the summer months, LMY and LP decreased, so arranging calving in the spring can be recommended. In addition, although the effect of first breeding at older ages appears to be positive on CBW, the disadvantage of first breeding at older ages in terms of sustainable herd management should also be considered.

To cite this article:
Yılmaz, M.A., Sevgi, R., Ünay, E., Coşkun, M.İ., Okuroğlu, A., Yıldırır, M., Bülbül, B., Sarıkaya, Ö., Kaplan, Y., & Özdemir, A. (2025) Effect of Age at First Calving and Season on First Lactation Milk Yield, Lactation Period and Calves Growth Data in Anatolian Water Buffaloes in Çorum Region. *Research and Practice in Veterinary and Animal Science (REPVAS), 2(1), 22-33.*
https://doi.org/10.69990/REPVAS.2025.2.1.3

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INTRODUCTION

All foods of animal origin play a major importance in human nutrition (Say et al., 2021, Şenyüz et al., 2022, Uysal et al., 2024). They contain proteins, vitamins, and minerals necessary for human (Şenyüz et al., 2022; Oyan et al., 2024; Yılmaz et al., 2024). As the world population, people's need for animal protein also increasing (Yıldırır et al., 2011; Sevgi et al., 2019; Yılmaz et al., 2024). In order to meet this demand, preferences, and strategies are changing in the animal food production sector (Chaudhari, 2015; Yılmaz et al., 2024). With changing preferences, new strategies need to be developed (Moioli, 2005; Say et al., 2016). One of these strategies is the effective use of genetic supply from the past (Yıldırır et al., 2011; Satılmış et al., 2021; Şenyüz et al., 2022). These include the breeding of local cattle, small ruminant and buffalo breeds (Yıldırır et al., 2011; Say et al., 2021; Satılmış et al., 2021; Şenyüz et al., 2022; Yılmaz et al., 2024). Buffaloes are seen as the livestock of the bride in most countries due to many factors such as their resistance to most diseases, ability to utilize roughage well, and quality milk properties (Borghese, 2010; Uğurlu, 2017; Yılmaz et al., 2024). In addition, it is estimated that buffaloes will have an easy adaptation ability to the difficult conditions that will occur in a possible climate change (Nanda and Nakao, 2003; Soysal et al., 2005; Borghese, 2010; Uğurlu, 2017; Yılmaz et al., 2024). Buffaloes have a great economic value, especially in various regions of Asia (India, China, Pakistan, Indonesia, and the Philippines) as a farm animal, and they are bred for their meat, milk, and power (Moioli, 2005). Approximately 95% of the 200 million buffalos in the world are in Asia and this is constantly increasing (FAO, 2020). It is known that water buffalos in Anatolia date back to 3000 BC (Yılmaz et al., 2024). However, it turned out that domesticated water buffalos were brought to Anatolia much later. The buffalos found in the region are genetically close to the Mediterranean buffalo (Italian buffalo), a subgroup of the river buffalo. Today, there is a specific breed called AWB in Anatolia. These buffaloes are considered to be a separate or smaller subgroup of Mediterranean buffaloes (Şahin and Küçükkebapçı, 1999; Soysal, 2013; Uğurlu, 2017; Yılmaz and Kara, 2019).

Buffaloes can efficiently utilize roughages and by-products of many agricultural crops. They are also highly resistant to diseases (Nanda and Nakao, 2003; Yılmaz et al., 2024). In both cattle (Eastham et al., 2015) and buffaloes (Hossein-Zadeh, 2016; Sathwara et al., 2020), the first lactation yield traits are interrelated as they affect subsequent lactation performance. Age at First Calving (AFC) is the major reproductive trait that influences herd productivity and profitability due to its impact on both breeding cost and future yield performance of the animal (Soliman and Sadek 2004; Krpalkova et al., 2014; Eastham et al., 2018). Buffaloes have been accepted as the best breeding animal for poor farmers from past to present due to their unique animal products (meat, milk, cream, etc.), utilization of their power, and high utilization of poor-quality roughages. Feeding and administrative costs are low in buffaloes compared to cattle (Şahin and Küçükkebapçı, 1999; Atasever and Erdem, 2008; Chaudhari, 2015; FAO, 2020; Yılmaz et al., 2024).

Various factors are effective on Lactation Milk Yield (LMY) and Lactation Period (LP) in buffaloes (Cady et al., 1983; Khan and Chaudhry, 2000; Afzal et al., 2007; Patbandha et al., 2015; Verma et al., 2018). One of these is the AFC and it is usually expressed in months (Alim and Ahmed, 1954; Chaudhry and Ahmed, 1978; Sreedharan and Nagarcenkar, 1987). Early AFC has positive contributions to fertility in both cattle (Krpalkova et al., 2014; Mokhtari et al., 2015) and buffaloes (Thiruvenkadan et al., 2015). In addition, it is known that AFC has a relationship with reproductive parameters and yield values throughout the life of the individual (Khan and Chaudhry, 2000; Afzal et al., 2007; Tamboli et al., 2022). There are also studies reporting that the potential benefits of earlier calving in buffaloes but these are few (Ali et al., 1999; Borghese et al., 2005). In buffaloes with low AFC, the profitability of the auxiliary dairy enterprise increased by reducing the cost of production (Lopez-Paredes et al., 2018). However, as in domestic animals, it is necessary to understand the production and reproductive potentials as well as the relationships between them to determine strategies in breeding programs in buffaloes (Malhado et al., 2013; Hossein-Zadeh, 2016). Many studies have been conducted to estimate the heritability, genetic and phenotypic correlations of yield traits in buffalo breeding (Catillo et al., 2002; Breda et al., 2010; Hossein-Zadeh, 2016; Sathwara et al., 2020; Tamboli et al., 2022).

This study was carried out to analyze the effect and relationship of various factors on milk production in AWB reared semi-extensively in farms located in the north of Anatolia. For this purpose, correlations and interactions between LMY, LP, DAMY, AFC, Calf Birth Weight (CBW), Calf Gender (CG), and Calving Season (CS) data were evaluated. With the help of these data, it was tried to determine the ideal AFC and birth season for higher milk yield in the specified region.

MATERIAL and METHOD

Study Material

This study was conducted within the scope of the sub-project of the National Anatolian Water Buffaloes Breeding in Farm Project carried out in Çorum Region. They were fed *ad-libitum* in farms. The lactating all buffaloes grazed outside between the months of late March to early December, while beingkept and fed indoors through the winter.

Method and Data Collection

In this study, data of 292 AWB gave birth for the first time between 2019 and 2023 and their calves (n=292) raised in 30 farms were used. All data were collected by the same technical personnel and recorded in the Manda Yıldızı program (Tekerli, 2022) as soon as they were received. LMY, LP, Daily Average Milk Yield (DAMY), AFC, CBW, CG, and CS data were used in the study. In the farms where the project was carried out, the weights of the calves born were taken on the first day and the milk yields of the buffaloes were taken monthly. The interpolation method was used to calculate lactation milk yields; ie, data from at least 4 or 5 months of milk control during the lactation period were used (Tekerli, 2022).

Statistical Analysis

Data of LMY, LP, and DMY were analyzed using the general linear model. The fixed effects considered the first age of birth in three classes (25-37 months, 38-49 months, and 50+ months), gender of the calf in 2 classes (male and female), and the season of birth in 4 classes (spring, summer, autumn, and winter). All analyses were performed by R statistical software. The differences between the means of the sub-groups were tested by the Tukey test (Petrie and Watson, 2013; Selvi, 2024) ($p<0.05$).

RESULTS

In the study, the first calving age were divided into three groups as 25-37 months, 38-49 months, and 50+ months and the number of sire buffaloes in AFC groups were 99, 94, and 99, respectively. The average LMY was 900.8 kg, 986.9 kg, and 1010.3 kg, and LP was 226 days, 233 days, and 227 days in AFC groups, respectively. In terms of general averages, means of LMY, LP, and DAMY were 956.0±17.41 kg, 228.5±2.58 days, and 4.2±0.07 kg, respectively (Table 1). DAMY was 3.9 kg, 4.3 kg, and 4.5 kg in AFC groups, respectively (Table 1). According to the age at first calving of the buffaloes, the highest milk yield was in buffaloes calving for the first time after 50 months ($p= 0.003$). The lowest LMY was in buffaloes whose age at first calving was less than 37 months. An increase in milk yield can be expected with increasing age. However, although the milk yield of the buffaloes that were first milked between the ages of 38-49 months was not statistically different, it was 86 kg higher than the buffaloes that were not first milked. The effects of AFC and season were significant (p<0.05). While DAMY was the highest in the buffaloes with the highest AFC there was no difference between the other two groups. The milk yield of buffaloes mulched in summer was significantly lower than in the other seasons. According to the season of calving (CS), the number of first calving buffaloes was 164 (56%), 78 (27%), 14 (5%), and 36 (12%) in spring, summer, autumn, and winter seasons, respectively. According to the seasons, LMY was 968.7 kg, 903.5 kg, 993.2 kg, and 998.5 kg, and LP average was 224 days, 224 days, 232 days, and 234 days, respectively. DAMY was 4.3 kg, 4.1 kg, 4.3 kg, and 4.3 kg according to the seasons, respectively (Table 1).

The number of male and female calves born were 134 and 158, respectively. The average, LMY was 954.0 kg and 977.9 kg in male and female calving in AWB, respectively, and the average LP was 228.5 days and 228.5 days, respectively. CBW according to the calves gender was close to each other (4.2 kg and 4.3 kg, respectively). There was no significant difference between the calf genders in terms of LMY and LP (Table 1).

Table 1. Means of lactation characteristics of Anatolian Water Buffalo **(**±SEM.).

Factor	**n**	**Lactation milk yield (kg)**	**Lactation period (d)**	**Daily milk yield (kg)**
Age (month)				
25-37	99	900.8 ± 40.39^{b}	225.9±5.98	3.9 ± 0.17^{b}
38-49	94	986.9 ± 21.54^{b}	232.6±3.19	4.3 ± 0.09^{b}
50+	99	1010.3 ± 21.07^{a}	227.0±3.12	4.5 ± 0.09^{a}
p		**0.003**	**0.183**	**0.004**
Calving Season				
Spring	164	968.7 ± 11.46^{a}	223.8±1.70	4.3 ± 0.05^{a}
Summer	78	903.5 ± 17.68^{b}	223.9±2.62	4.1 ± 0.08^{b}
Autumn	14	993.2 ± 60.77^{a}	232.4±9.00	4.3 ± 0.26^{ab}
Winter	36	998.5 ± 26.32^{a}	233.8±3.90	4.3 ± 0.11^{ab}
p		**0.010**	**0.315**	**0.029**
Gender				
Male	134	954.0±25.24	228.5±3.74	4.2±0.11
Female	158	977.9±18.42	228.5±2.73	4.3±0.08
p		**0.138**	**0.522**	**0.199**
General	**292**	**956.0±17.41**	**228.5±2.58**	**4.2±0.07**

[a, b]: Means of the same parameter in the same column with different superscripts differ significantly (P<0.05).

Calves' birth weights averaged as 27.4, 28.7, and 30.2 kg in AFC groups, respectively (Table 2); The calves' birth weights were 29.7, 29.3, 26.8, and 29.2 kg according to season, respectively; The number of male and female calves were 134 and 158, respectively, and their birth weights averaged 28.9 and 28.5 kg, respectively (Table 2). Although there was no statistical difference according to season and gender of the calves, there was a tendency being significant for the differences according to age at birth (p=0.087) (Table 2).

Phenotypic correlations and interactions between the investigated traits showed that there were positive correlations between AFC and CS, MA, LMY, LP, and DAMY, between CS and LP, between CBW and LMY, LP and DAMY, between LMY and LP and DAMY, negative correlations between DM and CBW, LMY and DAMY, and between LP and DAMY (Table 3).

Phenotypic correlations and interactions between AFC, BM, BW, LMY, LP and DAMY traits were calculated in statistical analyses (Table 3).

Table 2. Means of birth weights of Anatolian Water Buffalo calves according to age at calving (month), season and calf gender **(**±SEM.).

Factor	n	Birth weight (kg)
Age (month)		
25-37	99	27.4±1.13
38-49	94	28.7±0.61
50+	99	30.2±0.59
p		**0.087**
Calving Season		
Spring	164	29.7±0.32
Summer	78	29.3±0.49
Autumn	14	26.8±1.70
Winter	36	29.2±.0.74
p		**0.644**
Gender		
Male	134	28.9±0.71
Female	158	28.5±0.52
p		**0.272**
General	**292**	**27.7±0.49**

Table 3. Phenotypic correlations among traits.

	BM	BW	LMY	LP	DAMY
AFC	0.127*	0.217**	0.233**	0.085	0.189**
BM		- 0.024	- 0.088	0.013	- 0.094
BW			0.202**	0.072	0.156**
LMY				0.412**	0.781**
LP					- 0.234**

* Correlation is significant at P<0.05. ** Correlation is significant at P<0.01. AFC; age at first calving, BM; birth month, BW; birth weight, LMY; lactation milk yield, LP; lactation period, DAMY; daily avarage milk yield.

DISCUSSION

AFC was reported as 37.64 ± 3.19 months in Italian Buffaloes that live in Anatolia (Özbaşer et al., 2022), 37.4- 39.4 months in Egyptian Buffaloes (Alim and Ahmed, 1954), 47.06 months in Nili Ravi Buffaloes (Chaudhry and Ahmed, 1978) and 41 months in Murrah Buffaloes (Sreedharan and Nagarcenkar, 1987; Tamboli et al., 2022). The effect of AFC on LMY, LP, and CBW has been reported by many researchers (Alim and Ahmed, 1954; Sreedharan and Nagarcenkar, 1987; Chaudhary and Ahmed, 1978; Özbaşer et al., 2022).

In livestock, especially in extensive systems with high dependence on nature, it is expected that the birth season will be intensified in the spring season when feed resources are high. In the semi-extensive AWB breeding system in Çorum conditions, it was observed that the births were concentrated in spring. On the other hand, it was determined that the buffaloes AFC in the spring period, which had the highest birth rate, had approximately 65 kg more LMY compared to the buffaloes AFC in the summer period (P = 0.010). Afzal et al. (2007) found significant effect of the first calving season on LMY and LP. They also reported that milk yield was higher in spring than in summer in the first calving season (Aflaz et al., 2007).

In the present study, the highest LMY in terms of AFC was observed in buffaloes that were AFC of 50+ months (p= 0.003). The lowest LMY was observed in buffaloes whose AFC was less than 37 months. An increase in milk yield can be expected with increasing age. The effects of AFC and season were found to be statistically significant ($p<0.05$). While DAMY was found to be the highest in the buffaloes with the highest AFC there was no difference between the other two groups. The milk yield of the buffaloes that were calving in summer was found to be significantly lower than in the other seasons. These data are close to some previous studies in Indian local buffaloes (Verma et al., 2018), Italian buffaloes (Catillo et al., 2002), Nili Ravi buffaloes (Cady et al., 1983; Chaudhry, 1992; Khan and Chaudhry, 2000; Afzal et al., 2007), in Murrah buffaloes (Pandey et al., 2015; Tamboli et al., 2022) and Jaffrabadi buffaloes (Patbandha et al., 2015). It has been reported by many researchers that breeding, management and nutrition conditions in different regions have also affect on these parameters (Cady et al., 1983; Khan and Chaudhry, 2000; Afzal et al., 2007, Pandey et al., 2015; Patbandha et al., 2015; Verma et al., 2018).

In the present study, the effects of AFC, season, and CG on LP were not significant while the effects of AFC and season on DAMY were significant ($p<0.05$). The buffaloes with the highest age at first calving (50≤ months) had the highest DAMY, but there was no statistical difference between the other two groups. Verma et al. (2018) classified the buffaloes as two groups with an average calving age of 36 or 48 months, and determined the LP as 309.35±15.13 and 344.80±13.36 days in the first lactation period, respectively. The AWB data were close to the data of Verma et al. (2018) in Indian buffaloes and Afzal et al. (2007), Cady et al. (1983) and Khan and Chaudhry (2000) in Nili Ravi buffaloes. In addition, the data of our study are lower than that obtained by the studies conducted on Nili Ravi buffaloes (Chaudhry, 1992), Murrah buffaloes (Pandey et al., 2015), Italian buffaloes (Catillo et al., 2002) and Jaffrabadi buffaloes (Patbandha et al., 2015). Along with the regional, maintenance and feeding differences, breed is also a major factor which is responsible for the differences of the data among the studies (Cady et al., 1983; Chaudhry, 1992; Afzal et al., 2007; Krpalkova et al., 2014; Verma et al., 2018, Tamboli et al., 2022).

In the present study, phenotypic correlations and interactions were evaluated between AFC, BM, BW, MY, LP and DAMY. Verma et al. (2018) reported that high AFC had a weak correlation between (- 0.374 and 0.238) and (0.024 and -0.133) interactions for lactation length. The phenotypic correlation data of this study were close to the data of Verma et al. (2018) in Indian buffaloes and Afzal et al. (2007) in Nili Ravi buffaloes. Afzal et al. (2007) reported a high correlation between CS, LMY and LP. In addition, the same researchers found a high correlation between both LMY and LP in buffaloes calved first in spring and in summer. Although the interaction and correlation data of this study were similar with the results of Afzal et al., 2007 (Indian buffaloes), Cady et al., (1983) and Khan and Chaudhry (2000) (Nili Ravi buffaloes), there were difference with the studies conducted by Catillo et al., (2002) (Italian buffaloes), Chaudhry (1992) (Nili Ravi buffaloe), Pandey et al., (2015), Tamboli et al., (2022) (Murrah buffaloes) and Patbandha et al., (2015) (Jaffrabadi buffaloes). It has been reported by many researchers that these correlations may be due to genetic parameters, maintenance and feeding conditions (Cady et al., 1983; Khan and Chaudhry, 2000; Catillo et al., 2002; Afzal et al., 2007; Krpalkova et al., 2014; Pandey et al., 2015; Verma et al., 2018; Patbandha et al., 2015; Tamboli et al., 2022).

CONCLUSION

AWB with high AFC have high daily milk yield and their lactation period is increased. LMY of the buffaloes which first calved in summer is lower than those in other seasons. Therefore, it may be recommended to calve in spring. In the present study, positive correlations between AFC and CS, CBW, LMY, LP, DAMY; between CS and LP; between CBW and LMY, LP, and DAMY, and negative correlations between LMY and LP, DAMY; between DM and CBW, LMY, DAMY; between LP and DAMY were found. The characteristics showed that AFC between 38-49 months was ideal in AWB and CS in spring was effective on milk yield and LP. In addition, although the effect of AFC 50+ months of age on CBW seems to be positive, the disadvantage of AFC at older ages in terms of sustainable erd management should also be considered.

Acknowledgements

The authors are thankful to the Ministry of Agriculture and Forestry, General Directorate of Agricultural Researches and Policies, which is the coordinator of the Anatolian Water Buffalo Breeding in Farms Project; International Center for Livestock Research and Training technical personnels who is working in project; Çorum Provincial Directorate of Agriculture and Forestry, which carried out the official controls of the project; and Çorum Province Water Buffalo Breeders Association, which provided the logistically their contributions to this study.

Ethic Approval

Ethics Committee permission was granted to the study with the decision of International Livestock Research and Training Centre, Animal Experiments Local Ethics Committee (approval no: 26.02.2021/187).

Author Contributions

Research Design (CRediT 1) Author 1 (%50) – Author 2 (%10)- Author 3 (%10)- Author 4 (%10)- Author 8 (%10)- Author 9 (%10).

Data Collection (CRediT 2) Author 1 (%50) – Author 2 (%20)- Author 3 (%10)- Author 4 (%10)- Author 5 (%10).

Research - Data analysis - Validation (CRediT 3-4-6-11) Author 1 (%20) – Author 6 (%20)- Author 7 (%20)- Author 8 (%10)- Author 9 (%10) Author 10 (%10).

Writing the Article (CRediT 12-13) Author 1 (%50) – Author 2 (%10)- Author 3 (%10)- Author 4 (%10)- Author 8 (%10)- Author 9 (%10).

Revision and Improvement of the Text (CRediT 14) Author 1 (%50) – Author 2 (%10)- Author 6 (%10)- Author 7 (%10)- Author 8 (%10)- Author 9 (%10)

Funding

This study was conducted within the scope of the sub-project of the National Anatolian Water Buffaloes Breeding in Farm Project in Çorum Province. Project Number: TAGEM/19MANDA/2012-01.

Conflict of Interest

The authors declare that they have no conflict of interest.

Sustainable Development Goals (SDG)

2 Zero Hunger
3 Good Health and Well-Being
12 Responsible Consumption and Production

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