**Effect of Environmental Factors on Lactation Milk Yield, Lactation Length and Calving Interval of Anatolian Buffalo in Istanbul**

M. İ. Soysal1\*, S. Genç2, M. Aksel3, E. Ozkan Unal1, E. K. Gürcan1

*1Namık Kemal University, Faculty of Agriculture, Department of Animal Science, 59100, Tekirdag, TURKEY*

*2Ahi Evran University, Faculty of Agriculture, Department of Agricultural Biotechnology, 40100, Kırsehir, TURKEY*

*3*Istanbul Water Buffalo Breeders Association*, Istanbul, 34100, TURKEY*

*\*Corresponding author e-mai:misoysal@gmail.com*

**Abstract** In this study, 3843 lactation yield records of Anatolian Buffaloes within “Anatolian Water Buffalo Breeding Project” and reared in Istanbul province and district were used. The aim of study was to investigate the effects of environmental factors on the lactation milk yield (LMY), lactation length (LL) and calving interval (CI) of the Anatolian buffalo. For this propose 2034 Anatolian buffalos’ pedigrees in Istanbul between 2012 to 2017 were used. The overall mean and standard error of the LMY, LL and CI were determined as 1223.9 ± 6.83 kg, 230.99 ± 0.89 kg and 417.51 ± 1.73 days respectively. The effects of the province, calving year, lactation number, season and calving age on these characteristics were determined. Also effects of the province, calving year, lactation number, season and calving age on LMY, effect of province, calving year and season on LL and calving year, lactation number and calving age on CI were statistically significant (p<0.01), Phenotypic correlation were calculated between LMY, LL and CI also.

**Keywords:** Anatolian Water Buffalo, environmental factors, milk yield, lactation period.

**Introduction** While the number of buffaloes in the world, was 173 million in 2005, it was reported that the number was increased to 200 million in 2013. The population of buffaloes has increased by 87% between 2005-2013. In Turkey, the number of buffaloes was 103000 in 2005, and it was 107000 in 2013. (Anonymous 2014a). In 2014, due to the Project of Nationwide Improvement of Buffalo Breeding in Farm Condition, the number of buffaloes in Turkey, has increased to 107435. The buffaloes being raised in Turkey, are originated from the Mediterranean buffaloes, which is a subgroup of river buffaloes, and they are named as Anatolian Water Buffaloes (Soysal 2009). In Turkey, by the year of 2014, 300 tons meat and 50000 tons milk were produced from buffaloes (Anonymous 2014b).

Anatolian water buffaloes are generally bred in Samsun and Sinop in the seashores of Northern Anatolia; in Çorum, Amasya and Tokat in Middle and Inner North Anatolia; in Afyon and Balıkesir in Inner West Anatolia; in İstanbul in Marmara; in Sivas and Muş in East Anatolia; and in Diyarbakır in Southeast Anatolia (Şekerden 2001). Moreover, in Anatolian water buffaloes, it is reported that lactation duration is ranging between 180 and 280 days and 305-day yield is ranging between 800 and 1100 kg (Anonymous 2004). Buffalo breeding in Turkey is made for milk (lüle kaymağı, yoghurt, cheese, and ice cream) and meat (sucuk, salami, and pastırma) production (Soysal 2009). However, buffalo breeding is usually practiced by family-run small-scale (83%) and medium-scale (17%) enterprises (Sarıcan 1993). Importance of the buffalo, stems from milk and meat yield, resistance to many infectious diseases, low breeding costs, and being an appropriate livestock for low-income growers. In addition to this, the studies contducted, have indicated that buffalo meat contained 40% less cholesterol, 12% less fat, 55% less calorie, and 11% more protein and mineral than beef (Sarıözkan 2011 and Borghese et al. 2010). Therefore, buffalo meat is reported to be a good choice of red meat for people with heart and circulatory system diseases (Küçükkebapçı 2005).

The aim of study was to investigate the effects of environmental factors on the lactation milk yield (LMY), lactation length (LL) and calving interval (CI) of the Anatolian buffalo. For this propose 2034 Anatolian buffalos’ pedigrees in Istanbul between 2012 to 2017 were used.

**Materials and methods** Material of this study consisted of 3843 milk yield records from buffaloes that reared in 4 different province of İstanbul in the framework of Project of Nationwide Improvement of Buffalo Breeding in Farm Condition. On the other hand milking is carried on twice daily, in the morning and evening. Milk controls of buffaloes are collected monthly with a weighing scale with a precision of 10gr/50kg. In this study, The effects of the province, calving year, lactation number, season and age on these characteristics were determined. Also effects of the province, calving year, lactation number, season and age on LMY, LL and CI. were analyzed by Variance Analysis Technique (ANOVA; Least Squares Method). Minitab version 14 was used for statistical analyses and, subsequently, factors that reveal significant effects were compared in Tukey's multiple-range test (Tukey 1953 and Sheskin 2004). The mathematical model that will be used to determine the effect of environmental factors, is given Model:

Yijklmn=µ+ai+bj+ck+dl+fm+eijklmn

Definitions of symbols are as follows:

Yijklmn : observation value of the investigated trait (lactation milk yield, lactation length and calving interval of 1. cow, that in i. province, in j. calving year, in k. lactation number, in l. season and in m. calving age)

µ : population average,

ai : i. amount of effect of province,

bj : j. amount of effect of calving year,

ck : k. amount of effect of lactation number

dl : l. amount of effect of season

fm : m. amount of effect of calving age

eijklmn : error

**Results** The overall mean and standard error of the LMY, LL and CI were determined as 1223.9 ± 6.83 kg, 230.99 ± 0.89 kg and 417.51 ± 1.73 days respectively. The effects of the province, calving year, lactation number, season and calving age on these characteristics were determined. Also effects of the province, calving year, lactation number, season and calving age on LMY, effect of province, calving year and season on LL and calving year, lactation number and calving age on CI were statistically significant (p<0.01), Phenotypic correlation were calculated between LMY, LL and CI also.

**Table 1.** Characteristics of Anatolian water buffalo that determined in Istanbul Turkey

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Yield Characteristics | n | Min | Max |  |
| Lactation Lenght, day | 3843 | 120 | 397 | 230.99 ± 0.89 |
| Lactation Milk Yield, kg | 3843 | 402 | 3155 | 1223 ± 6.83 |
| Calving Interval, day | 2239 | 300 | 700 | 417 ± 1.73 |

**Table 2.** Descriptive statistics and significance test results for values of lactation milk yield (LMY), lactation length (LL) and calving interval (CI) according to the province, calving year, lactation number, season and calving age.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | LMY |  |  | LL |  |  | CI |  |
| Province | n |  |  | n |  |  | n |  |  |
| Arnavutköy | 1207 | 1193.3b | 12.3 | 1207 | 236.42 | 1.51a | 661 | 421.77 | 3.39 |
| Çatalca | 1481 | 1194.2b | 10.9 | 1481 | 227.79 | 1.45b | 987 | 403.87 | 2.34 |
| Eyüp | 781 | 1321.5a | 13.7 | 781 | 234.05 | 1.96b | 409 | 431.32 | 4.04 |
| Silivri | 374 | 1236.8ab | 24.2 | 374 | 219.69 | 3.04c | 182 | 444.48 | 6.79 |
| p |  | \*\* |  |  | \*\* |  |  | ns |  |
| Calving year |  |  |  |  |  |  |  |  |  |
| 2012 | 420 | 1125.9b | 12.6 | 420 | 213.72c | 1.59 | 308 | 407.37a | 4.24 |
| 2013 | 542 | 1277.2a | 17.7 | 542 | 244.49ab | 2.42 | 351 | 414.32ab | 4.29 |
| 2014 | 591 | 1279.1ab | 16.3 | 591 | 235.64b | 2.12 | 341 | 419.14c | 4.33 |
| 2015 | 631 | 1227.0ab | 16.8 | 631 | 232.60b | 2.30 | 358 | 422.75c | 3.93 |
| 2016 | 980 | 1281.3a | 15.3 | 980 | 244.19a | 1.85 | 522 | 428.08bc | 4.01 |
| 2017 | 679 | 1108.3c | 16.1 | 679 | 206.28c | 1.94 | 359 | 406.94c | 4.28 |
| p |  | \*\* |  |  | \*\* |  |  | \*\* |  |
| Lactation number |  |  |  |  |  |  |  |  |  |
| 1th | 1516 | 1155.9b | 9.89 | 1516 | 229.27 | 1.42 | 1107 | 388.78b | 2.14 |
| 2nd | 1029 | 1270.3a | 13.1 | 1029 | 234.20 | 1.75 | 636 | 421.81a | 2.96 |
| 3rd | 625 | 1258.1a | 17.7 | 625 | 233.13 | 2.12 | 325 | 454.71ab | 4.06 |
| 4th | 422 | 1287.8a | 22.4 | 422 | 232.91 | 2.65 | 137 | 504.95a | 6.49 |
| 5th | 251 | 1251.8a | 30.9 | 251 | 219.59 | 3.52 | 34 | 562.1ab | 13.4 |
| p |  | \*\* |  |  | ns |  |  | \*\* |  |
| Season |  |  |  |  |  |  |  |  |  |
| Winter | 1332 | 1316.7a | 11.4 | 1332 | 244.82b | 1.34 | 775 | 414.58 | 2.83 |
| Spring | 1587 | 1163.0b | 10.0 | 1587 | 220.65c | 1.32 | 921 | 422.89 | 2.74 |
| Summer | 589 | 1128.9c | 17.3 | 589 | 215.80d | 2.44 | 336 | 418.96 | 4.60 |
| Autumn | 335 | 1310.6a | 25.9 | 335 | 251.65a | 3.53 | 207 | 401.78 | 5.63 |
| p |  | \*\* |  |  | \*\* |  |  | ns |  |
| Calving age |  |  |  |  |  |  |  |  |  |
| 4 | 827 | 1115.2c | 13.4 | 827 | 231.60 | 1.98 | 827 | 350.15e | 0.588 |
| 5 | 426 | 1210.1bc | 18.7 | 426 | 236.21 | 2.65 | 426 | 387.04d | 0.401 |
| 6 | 465 | 1230.1ab | 18.1 | 465 | 232.01 | 2.51 | 465 | 426.15c | 0.734 |
| 7 | 405 | 1257.3ab | 22.6 | 405 | 228.77 | 2.63 | 405 | 511.75b | 2.10 |
| 8 | 407 | 1234.8bc | 20.1 | 407 | 228.68 | 2.65 | 116 | 645.21a | 2.53 |
| 9 | 348 | 1252.7ab | 24.4 | 348 | 230.81 | 3.01 |  |  |  |
| 10 | 276 | 1309.8ab | 27.5 | 276 | 225.65 | 3.27 |  |  |  |
| 11 | 204 | 1357.1a | 31.7 | 204 | 231.69 | 3.90 |  |  |  |
| 12 | 485 | 1252.9ab | 20.1 | 485 | 231.00 | 2.55 |  |  |  |
| p |  | \*\* |  |  | ns |  |  | \*\* |  |

a-e : The difference between the averages indicated by different letters in the same column are statistically significant. \*\*: P<0.01, ns: non-significant

It is determined that the effects of the province, calving year, lactation number, season and calving age on LMY (1223 kg) were significant (p≤0.01). This value is less than the lactation milk yield reported by other studies (Caddy et al., 1983; Babar et al., 1996; Vasconcellos and Tonhati, 1998; Rosati and Van Vleck, 2002; Malhado et al., 2013) for Nili-Ravi (1702-2064 kg), Brazil Murrah (1493.3-1631.5 kg) and Italian buffaloes (2286.8 kg). This result can be attributed to the differences in breed, feeding and management conditions. In addition, the lactation milk yield obtained in this study is higher than the values reported by some other studies (Tekerli et al., 2001; Tekerli et al., 2016; Uğurlu et al., 2016) for Anatolian buffalo (894.3, 925.4 and 1000.7 kg respectively) in Afyonkarahisar and Giresun provinces of Turkey. This may be due to advances in feeding and management conditions and the effect of selection in the National Anatolian Water Buffalo Improvement Program.

From another hand it is reported that, mean lactation period of Anatolian water buffaloes was 232 days (112-449 days) and depending on various factors as race, care-nutrition, age, lactation, and length of the dry period, lactation milk yield reported to be 925 kg (Soysal 2009). Similarly to the results of this study, it was reported (Vasconcellos and Tonhati, 1998; Hussain et al., 2006; Marai et al., 2009) that the year, season and age have significant effects on the lactation length. The mean of the lactation length determined in this study is shorter than those reported in other studies (Babar et al.,1996; Rosati and Van Vleck, 2002; Malhado et al., 2013) involving Nili-Ravi (327.9 days), Murrah (269.4 days), and Italian water buffaloes (270 days) but longer than those reported by some other studies (Tekerli et al., 2016; Uğurlu et al., 2016) for Anatolian buffaloes (229.4 days and 231.9 days).

Generally, in buffaloes, it is stated that the highest milk yield can be seen between the ages of 6 and 7, namely during the 3rd lactation (İzgi and Asker 1988 and Metin 1999). Özenç et al. (2008) have determined that lactation milk yield was changing in the range of 350-1580 kg and that the mean lactation milk yield was 943.2. It is reported that the 1st lactation milk yields of buffaloes reared in Buffalos Research Institute of Afyon, were ranging between 227 and 1443 kg with an average milk yield of 813 kg (İzgi and Asker 1988). It was noted by Kreul and Sarıcan (1993) that lactation milk yield of buffaloes range from 600 to 800 kg in Turkey, although this value was determined as 1200 kg in Europe. The LL average, which is closely related to lactation milk yield, was determined to be 220 days for indigenous water buffaloes, and 225 days for hybrid buffaloes, in Buffalos Research Institute of Afyon. İlaslan et al. (1983) have defined the mean lactation length as 224 days. In a study conducted in Tokat, according to Vogel method, the highest milk yield was 761.4±16.4 kg; according to Trapez method, the lowest milk yield was 657.7±13.7 kg. In the same study, LL and dMY were 146.55±1.79 days and 5.21±0.096 kg, respectively (Şahin ve Ulutaş 2013). In a study on Anatolian water buffaloes that carried out in Afyon Kocatepe Agricultural Research Institute, average values of 305dMY and LL were determined to be 1070.5±279,9 kg, and 221±44.19 days, respectively (Şekerden 1999). Garcia et al. (2013) have used 2575 lactation records which belong to 1377 buffaloes, to estimate genetic parameters for the milk yield and LL of buffaloes. Accordingly, they noted the 244-day average milk yield and lactation length as 864 kg and 240 days, respectively. It is reported that Nili Ravi buffaloes that reared in Pakistan, had a mean lactation period of 317 days and a mean lactation milk yield of 2219 kg.

In the study, during winter and autumn, LMY was highest in comparison to values from summer and spring, on the other hand, during summer, LMY was lower in comparison to spring, summer and autumn. In this case, being at the onset of lactation and good condition of pastures in this season, might have been effective. The lowest milk yield was attained during winter (December to February). Accordingly, this case can be explained by the end of the lactation of animals and pasture effect (Şekerden et al. 1999). It is seen from results that buffaloes which calve in winter and autumn had a higher milk yield than buffaloes which calve in summer and spring. In order to explain that how buffaloes which calve in winter had higher milk yields in comparison to other seasons, it is possible to think that influence of critical temperatures resulting from seasons, feeding inside, and longer milking durations. So, for the buffaloes consistently grown under intensive conditions in the winter, attention is paid to care and nutrition. In addition to this, longer lactation lengths were seen in buffaloes which calve in winter and autumn than those which calve in summer and spring, respectively. This has been effective in the high milk yield in winter and autumn seasons (Şekerden et al. 1999).

**Conclusion** It was concluded that the factors affecting milk production and reproduction must be considered in a selection program. Also, after corrections according to factors deemed significant in terms of milk yield and composition, buffaloes could be selected based on the first lactation milk yield.

**References**

Anonim (2004). Yerli Hayvan Irk ve Hatlarının Tescili Hakkında Tebliğ. 25668 Sayılı Resmi Gazete ve 2004/39 nolu tebliğ. Ek4 ve Ek6. (http://www.regabasbakanlik.gov.tr)

Anonim (2014a). TÜİK-Türkiye İstatistik Kurumu, Hayvancılık İstatistikleri. http://www.tuik.gov.tr/PreTabloArama.do, (20.09.2014).

Anonim (2014b). FAO-Food and Agriculture Organization of The United Nations. http://faostat3.fao.org/faostat-gateway/go/to/download/Q/QA/E, (20.09.2014).

Duncan WR (1955). Multiple Range And Multiple F Test. Biometrics, 11, 1-42.

Garcia Y, Fraga LM, Tonhati H, Abreud D, Aspilcueta R, Hernandez A, Padron E, Guzman G, Mora M and Quinonez D (2013). Genetic Parameter Estimates fot Milk Yield and Lactation Length in Buffalo. The 10th World Buffalo Congress and the 7th Asian Buffalo Congress May 6-8, 2013. Hilton Phuket Arcadia Resort and Spa, Phuket, Thailand.

İlaslan M, Karabulut A, Aşkın Y, İzgi AN (1983). Yerli mandalarda vücut yapısı, döl ve süt verimi üzerine araştırmalar. Afyon Zirai Araştırma İstasyonu, Yayın No: 14, Afyon.

Babar, M. E., M. Yaqub and T. Ahmad (1996). Repeatability estimates of some performance characteristics in Nili-Ravi buffaloes. Pak. Agri Sci. Vol. 85-87.

[Cady, R. A., S. K. Shah,](http://www.sciencedirect.com/science/article/pii/S0022030283818281#!)  E. C. [Schermerhorn](http://www.sciencedirect.com/science/article/pii/S0022030283818281#!) and R. E. [McDowell](http://www.sciencedirect.com/science/article/pii/S0022030283818281#!) (1983). Factors affecting performance of Nili-Ravi buffaloes in Pakistan. [Journal of Dairy Science](http://www.sciencedirect.com/science/journal/00220302) 66(3): 578-586.

Hussain, Z., K. Javed, S. M. I. Hussain and G. S. Kiyani (2006). Some environmental effects on productive performance of Nili-Ravi buffaloes in Azad Kashmir. J. Anim. Pl. Sci. 16(3-4):66-69.

İzgi AN, Asker R (1988). Mandalarda doğum mevsimi ve ilkine doğurma yaşının laktasyon süresi ve süt verimi üzerine etkileri. Mandacılık Araştırma Enstitüsü, Yayın No: 19, Afyon.

İzgi AN, Asker R, Karabulut A, Sabaz S, Kozandağı M (1989). Yerli ırk mandaların melezleme ile ıslah olanakları üzerinde bir araştırma. Mandacılık Araştırma Enstitüsü, Yayın No: 20, Afyon.

Kreul W, Sarıcan C (1993). Türkiye’de manda yetiştiriciliği. Hasad Dergisi, 95: 8, 1993.

Malhado, C. H. M., A. C. M. Malhado, A. D. A. Ramos, P. L. S. Carneiro, J. C. D. Souza, and A. Pala (2013). Genetic parameters for milk yield, lactation length and calving intervals of Murrah buffaloes from Brazil. R. Bras. Zootec. 42(8): 565-569.

Marai, I. F. M., A. H. Daader, A. M. Soliman and S. M. S. El-Menshawy (2009). Non-genetic factors affecting growth and reproduction traits of buffaloes under dry management housing (in sub-tropical environment) in Egypt. Livestock Research for Rural Development 21 (3): Available at: http://www.lrrd.org/lrrd21/3/mara21030.htm, Accessed on: june 10, 2017.

Metin M (1999) Süt Teknolojisi, Sütün Bileşimi ve İşlenmesi. I. Bölüm, Genişletilmiş Üçüncü Baskı, Ege Üniv. Mühendislik Fak. Yay., No: 33, Ege Üniv. Basımevi, İzmir.

Özenç E, Vural MR, Şeker E, Uçar M (2008). An evaluation of subclinical mastitis during lactation in Anatolian buffaloes. Turk J Vet Anim Sci, 32 (5): 359-368.

Rosati, A. and L. D. Van Vleck (2002). Estimation of genetic parameters for milk, fat, protein and mozzarella cheese production for theItalian river buffalo Bubalus bubalis population. Livestock Production Science, 74 :185–190.

Sheskin DJ (2004). Hand Book of Parametric and Nonparametric Statistical Procedures 3rd ed. Chapman and Hall/CRC, Boca Raton, FL 1193p.

Soysal Mİ (2009). Manda ve Ürünleri Üretimi. Namık Kemal Üniversitesi Ziraat Fakültesi Zootekni Bölümü, Ders Notları. ISBN NO: 978-9944-5405-3-7, 237s, Tekirdağ.

Soysal, M.İ. (2012). Biyometrinin Prensipleri. Namık Kemal Üniversitesi Ziraat Fakültesi Yayın No:10 Ders Notu:3.

Şahin A, Ulutaş Z (2014). Anadolu Mandalarının Değişik Metotlara Göre Tahmin Edilen Süt Verimleri Üzerine Bazı Çevresel Faktörlerin Etkilerinin Belirlenmesi Kafkas Univ Vet Fak Derg 20 (1): 79-85.

Şekerden Ö (1999). Afyon Kocatepe Tarımsal Araştırma Enstitüsü Anadolu Mandalarında Süt Verim Ve Bileşiminin Laktasyon Dönemlerine Göre Değişimi, Süt Ve Bazı Döl Verim Özellikleri Atatürk Üniv. Ziraat Fak. Derg. 30 (2), 151-159.

Şekerden Ö (2001) Büyükbaş Hayvan Yetiştirme (Manda Yetiştiriciliği). Temiz Yürek Ofset Matbaacılık, Antakya-Hatay.

Şekerden Ö, Tapkı İ, Kaya Ş (1999). Anadolu mandalarında Hatay ili köy şartlarında süt verim ve bileşiminin laktasyon dönemi ve verim mevsimine göre değişimi. Atatürk Üniv Zir Fak Derg, 30 (2): 161-168.

Tukey JW (1953). The Problem of Multiple Comparisions. Departmen of Statistics. Princeton University, Princeton, NJ. Unpublished paper.

Tekerli, M., M. Küçükkebabçı, N. H. Akalın and S. Koçak (2001). Effects of environmental factors on some milk production traits, persistency and calving interval of Anatolian buffaloes. Livestock Production Science 68: 275–281.

Tekerli, M., A. Altuntaş, F. Birdane, O. Sarımehmetoğlu, İ. Doğan, Z. Bozkurt, M. Erdoğan, H. A. Çelik, S. Koçak, Z. Gürler, T. Bülbül, M. Kabu and K. Çelikeloğlu (2016). Farklı bölge orijinli Anadolu Mandalarından oluşturulan bir sürüde verim özellikleri, beden ölçüleri ve biyokimyasal polimorfizm yönünden islah olanaklarının karşılaştırmalı belirlenmesi: Laktasyon özellikleri ve genetik polimorfizm. Lalahan Hay. Araşt. Enst. Derg. 56 (1) 7-12.

Uğurlu, M., İ. Kaya and M. Saray (2016). Effects of some environmental factors on calf birth weight and milk yield of Anatolian Water Buffalo (Bubalus Bubalis). Bulgarian Journal of Agricultural Science, 22 ( 6): 995–998.

Vasconcellos, B. F. and H. Tonhati (1998). Inbreeding and its effects on some productive and reproductive traits in a Murrah buffalo herd. J. Anim. Breed. Genet. 115: 299-306.