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Research Article

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A Research on the Determination of Lactation Length and Milk Yield of Anatolian Water Buffaloes under Different Environmental Conditions

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Abstract This study was carried out to determine the lactation length and milk yield of water buffaloes which were housed in the temperature controlled barn (Barn-I) and in the traditional farmer barn (Barn- II) by different methods and evaluate the obtained data statistically. As a result of this study, it was determined that the lactation lengths of water buffaloes were changed between 283-298 days and 278-281 days in the Barn-I and Barn-II respectively. The real lactation milk yields varied between 1071-2044 kg and 1562-1746 kg in the Barn-I and Barn-II respectively. The daily average milk yields were found as 6.47 kg and 5.82 kg in the Barn-I and Barn-II respectively. The adjusted milk yield for 305 days was found as 1965.4 kg in the Barn-I and it was found as 1757.1 kg in the Barn-II. The averages of lactation length were calculated as 290.5 and 280.5 days in Barn-I and Barn-II respectively. In the statistical analyzes, the difference between average of the data obtained from the Barn-I and Barn-II was found statistically significant ($P<0.05$).

As a result, it was observed that the lactation length and lactation milk yield of the water buffaloes housed in the controlled barn conditions without heat and cold stress were increased.

Keywords Anatolian water buffalo, barn, lactation lenght, lactation milk yield

Introduction

The bovine animal farming involves two breeding types, these are cattle and buffalo breedings. It has clearly known that the cattle breeding has been more considered than the buffalo breeding in the world and our country and scientific researches has concentrated on this field. There are not enough studies on buffalo breeding, rehabilitation and control of climatic environments in buffalo barns [1]. Buffaloes are basically divided into two groups as swamp and river buffaloes [2]. The Anatolian water buffalo which has place in the group of river buffaloes and is originated from Mediterranean water buffaloes are bred in Turkey [3].

The heat dissipation of buffaloes is limited because the buffalo's skin is thicker than the cattle skin. In addition, the density of hair in the body of buffalo is considerably lower than in the cattle. This value is 100-200 / cm^2 in the buffalo and 1000 / cm^2 in the cattle. The number of sweat glands per of the body surface in the buffalo are lower than in the cattle. This situation limits heat dissipation and evaporation by sweating. The skin and rectal temperature rapidly increase when the buffalo is exposed to sunlight for a long time. Overexposure to the sun negatively affects feed consumption, growth rate, milk production and fertility due to heat stress [4].

Animals can optimally perform their production functions and is most comfortable in the specific temperature range which is called “Comfort Zone” and this zone covers a narrow temperature range [5]. As it moves away from the comfort zone, cold stress starts at low temperatures and heat stress starts at high temperatures. Rectal temperature rises with high environmental temperature, feed and energy consumption and milk yield decrease. The thermoregulation ability of the animal is negatively affected under the conditions of high ambient temperature beyond normal limits (5-25 °C) and high relative humidity [6]. Animals can overcome heat stress with the support of some managerial arrangements such as shadowing, misting systems, showering and fan cooling. These practices prevent the animal from overturning the heat, contributing to the animal's evaporative heat removal from the body.

This study was carried out to determine the lactation length and milk yield of water buffaloes which were housed in the temperature controlled barn (Barn-I) and in the traditional farmer barn (Barn- II) by different methods and evaluate the obtained data statistically.

Material and Method

This study was carried out in a water buffalo farm which is located in Thrace Part of Istanbul Province and a member of Water Buffalo Breeder Association. The study area located at 41° 12 'northern latitude and 28° 44' east longitude and average altitude from sea level is 119 m [7].

Two groups which have ten water buffaloes for each group was formed based on genetic similarities, same number of lactations and same birthdates in the selected farm. One of the water buffalo groups was housed in an environment where the ambient temperature could be controlled, in the fog system (Barn-I) and other buffalo group was housed under traditional farmer conditions (Barn-II). The ambient temperature is kept below 25 °C, which is threshold value for heat stress in the controlled barn conditions. The same feeding rations were applied for both buffalo groups. The daily milk yields were recorded during the lactation period of the water buffaloes which were selected as randomly. The milk yields in lactation were tried to be determined by actual and estimated lactation curves which were prepared according to the milk yield records. The statistical analysis of the study was based on descriptive statistics and DUNCAN multiple comparison test [8]. SPSS package program was used for statistical analysis [9].

Results and Discussion

The milk yields of Anatolian water buffaloes were analyzed statistically according to real values and different models. The daily milk yields were recorded for randomly selected water buffalo farms in the each group. The Anatolian water buffaloes were fed with standard rations as group feeding considering age and lactation periods. The lactation lengths and lactation milk yields of the two groups generated were subtracted from the daily milk records. These values were given in Table 1.

Table 1: The lactation lengths and lactation milk yields of Anatolian water buffaloes

Barn-I			Barn-II		
Number of ear tag	**Lactation length (day)**	**Lactation milk yield (kg)**	**Number of ear tag**	**Lactation length (day)**	**Lactation milk yield (kg)**
1(12.14)	285	1701	1(7.0)	281	1746
2(12.0)	283	1887	2(35.0)	278	1620
3(38)	295	1906	3(27.44)	280	1610
4(17.85)	298	2044	4(12.10)	280	1562
Average	290.5	1884.4	Average	280.5	1634.6

According to Table 1, the lactation times of the water buffaloes varied between 283-298 days in the Barn-I and 278-281 days in the Barn-II. Likewise, the lactation milk yields ranged from 1701 to 2044 kg in the Barn-I and ranged from 1562 to 1746 kg in the Barn-II.

With the help of the available correction factors, the dairy yields of the water buffaloes were corrected according to 305 days and corrected milk yields were found [10]. The average daily milk yields, corrected milk yields and significance test results were given in Table 2.

Table 2: The milk yield of water buffaloes and significance test results

Number of barn	**Daily milk yield (kg)**	**Milk yield (kg)**	**Milk yield of 305 days (kg)**	**Lactation length (day)**
I	6.47 ± 0.19^{A}	1884.4 ± 70.5^{A}	1965.4 ± 73.5^{A}	290.5 ± 3.80^{A}
II	5.82 ± 0.13^{B}	1634.6 ± 39.2^{B}	1757.1 ± 42.1^{B}	280.5 ± 0.64^{B}
Overall	6.14 ± 0.16	1759.5 ± 170.2	1861.2 ± 57.8	285.5 ± 2.60

Note: The statistical significant differences between the averages were indicated by different letters in the same column ($P<0.05$).

As it was given in Table 2, the highest values were seen at Barn-I. The average milk yields per day were found as 6.47 kg and 5.82 kg in the Barn-I and Barn-II respectively. The corrected milk yields of 305 days were calculated as 1965.4 kg and 1757.1 kg in the Barn-I and Barn-II respectively. Also, the means of lactation times were found 290.5 days and 280.5 days for Barn-I and Barn-II respectively.

Three different models (Exponential, Wood and Wilmink) for the parameter estimates of the lactation curve were made individually for each animal using the daily control milk yield records of the water buffaloes [11, 12].

The equations of these models were given in Table 3. The terms in these models are; Y = the milk yield at the control day, T = the day when the yield is obtained, a, b, c are the parameters included in the model; a= the point where the curve intersect with y axis, b= the coefficient refers the rising of curve at the beginning of lactation c= the coefficient refers the decline of curve after reaching top level.

The most suitable model for the lactation curve was selected by making the parameter estimations related to these models and considering the concordance criteria. In the selection of the most suitable model among the models, the concordance criteria defined as the Determination Coefficient (R^2) was used.

Table 3: The used models to determine biometry of lactation curve

Model	Function
Wood Model	$Y= a.T^b.e^{(- cT)}$
Exponential Model	$Y= a .e^{(- cT)}$
Wilmink Model	$Y= a + b T + c_. e^{-0,05.T}$

Statistica package program has been used in model analysis and parameter estimation [13]. The lactation curves can be classified as typical and atypical by evaluation of the parameters signs of the models. According to the Wilmink model, b (-) and c (-) are typical, while others are called atypical. In the Wood model, it is called the atypical lactation curve when the b and c parameters are negative. In this study, the water buffaloes in two barns had the standard type of lactation curve. Atypical or non-standard lactation curves were not seen.

According to the Wood model, the lactation order, lactation persistence level (S), daily maximum milking yield (Y_{max}) and the day when obtained maximum milk yield (T_{max}) were calculated [14].

$S= -(b+1).\ln c$

$T_{max}= b/c$

$Y_{max}= a(b/c)^b.\ e^{-b}$

In this study, various descriptive statistics and importance tests were performed for the parameters in the models according to the number of barn. The relationships between the parameters were investigated using the Pearson Moments Correlation Coefficient (r) [8]. SPSS package program was used for these analyzes [9].

In the study, biometric of lactation curves were investigated with three different models of lactation (Wood, Exponential and Wilmink) and the results of this study were presented respectively. The averages of the parameters of the Wood model which is one of the models used in the study and the concordance criteria of the model were presented in Table 4 for each barn.

Table 4: Descriptive statistics and importance test results of the parameters based on number of the barn in the Wood model

Number of barn	a	b	c	R^2
I	3.31 ± 1.12^a	0.37 ± 0.12^a	0.007 ± 0.001^a	0.93 ± 0.01^a
II	2.07 ± 0.26^a	0.43 ± 0.01^a	0.007 ± 0.0005^a	0.71 ± 0.16^a
Overall	2.60 ± 0.51	0.40 ± 0.04	0.007 ± 0.0007	0.80 ± 0.09

Note: The statistical significant differences between the averages were indicated by different letters in the same column ($P<0.05$).

A parameter in the model which expresses the milk yield at the beginning of the lactation was found as 3.31 ± 1.12 in the Barn-I. The determination coefficient (R^2) was highest in Barn-I with 93%. According to the significance test, Wood model parameters are not important for each barn. The average of $Y_{max,}$ T_{max} and S values for barn types which were calculated based on Wood Model were given in Table 5.

Table 5: The average of Y_{max}, T_{max} and S values for barn types which were calculated based on Wood Model

Number of barn	T_{max} (day)	Y_{max} (kg)	S
I	52.85	9.91	6.79
II	61.42	7.90	7.09
Overall	57.13	8.90	6.94

The average of these values for the barns based on Wood Model were calculated as 57.13 days, 8.90 kg and 6.94, respectively. The highest of Y_{max} value was found at Barn-I with 9.91 kg.

The averages of the parameters in the exponential model and the concordance criteria of the model used were presented in Table 6 for each barn.

Table 6: Descriptive statistics and importance test results of the parameters based on number of the barn in the Exponential model

Number of barn	a	c	R^2
I	9.54 ± 0.41[a]	0.0026 ± 0.0002[a]	0.61 ± 0.05[a]
II	8.15 ± 0.67[a]	0.0024 ± 0.0006[a]	0.43 ± 0.18[a]
Overall	8.94 ± 0.44	0.0025 ± 0.0002	0.53 ± 0.08

Note: The statistical significant differences between the averages were indicated by different letters in the same column (P<0.05).

A parameter was found as 9.54 ± 0.41 and 8.15 ± 0.67 for Barn-I and Barn-II respectively. The average of a parameter values for barns was 8.94 ± 0.44 in the Exponential model. As a result of the significance test of this parameter, no significant difference was found in terms of the number of barns (P>0.05).

The averages of the parameters in the Wilmink model and the concordance criteria of the model used were presented in Table 6 for each barn.

Table 7: Descriptive statistics and importance test results of the parameters based on number of the barn in the Wilmink model

Number of barn	a	b	c	R^2
I	11.34 ± 0.83[a]	-0.029 ± 0.004[a]	-7.18 ± 1.60[a]	0.91± 0.01[a]
II	9.68 ± 0.51[a]	-0.023 ± 0.003[a]	-6.84 ± 0.05[a]	0.72 ± 0.16[a]
Overall	10.51 ± 0.55	-0.026 ± 0.002	-7.01 ± 0.74	0.81 ± 0.08

Note: The statistical significant differences between the averages were indicated by different letters in the same column (P<0.05).

It was shown that a parameter was found as 11.34 ± 0.83 and 9.68 ± 0.51 for Barn-I and Barn-II respectively in the Table 7. The average of a parameter values for barns was 8.94 ± 0.44 in the Wilmink model. As a result of the significance test of this parameter, no significant difference was found in terms of the number of barns (P>0.05).

The R^2 values were calculated as 80%, 53% and 81% for the Wood model, Exponential model and Wilmink model respectively. According to these values, the best fit was obtained in Wilmink and Wood models.

The actual and estimated daily milk yields of water buffaloes for Barn-I and Barn-II were calculated by using the monthly control days for the three different models were given in Table 8 and Table 9. Also, the lactation curves produced from the actual and estimated yields were graphically shown in Figure 1 and Figure 2. The lactation curves produced from actual yields for Barn-I and Barn-II were shown in Figure 3.

Table 8: The actual and estimated daily milk yields based on models for Barn-I

Days	Models actual	Wood model estimated	Exponential model estimated	Wilmink model estimated
1	5.87	5.48	8.60	5.64
30	7.75	9.21	8.05	8.90
60	10.0	8.95	7.52	9.02
90	8.37	8.21	7.03	8.37
120	7.50	7.36	6.56	7.56
150	6.75	6.52	6.13	6.71
180	6.00	5.72	5.73	5.85
210	5.12	4.99	5.35	4.99
240	4.12	4.34	5.00	4.12
270	3.00	3.76	4.67	3.26

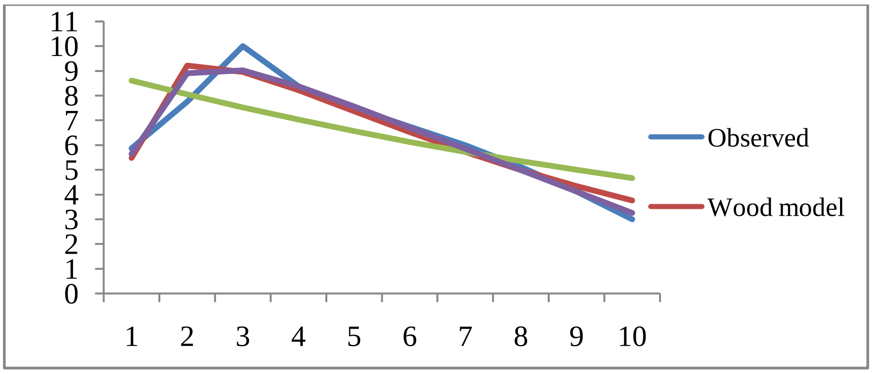

Figure 1: The lactation curves produced from the actual and estimated yields for Barn-I

Table 9: The actual and estimated daily milk yields based on models for Barn-II

Days	Models actual	Wood model estimated	Exponential model estimated	Wilmink model estimated
1	4.50	4.02	7.18	4.23
30	6.37	7.82	6.79	7.64
60	8.50	7.80	6.41	7.89
90	7.75	7.25	6.05	7.37
120	6.75	6.55	5.71	6.67
150	6.12	5.83	5.39	5.94
180	5.25	5.14	5.09	5.20
210	4.50	4.49	4.81	4.46
240	4.25	3.91	4.54	3.72
270	2.37	3.39	4.28	2.98

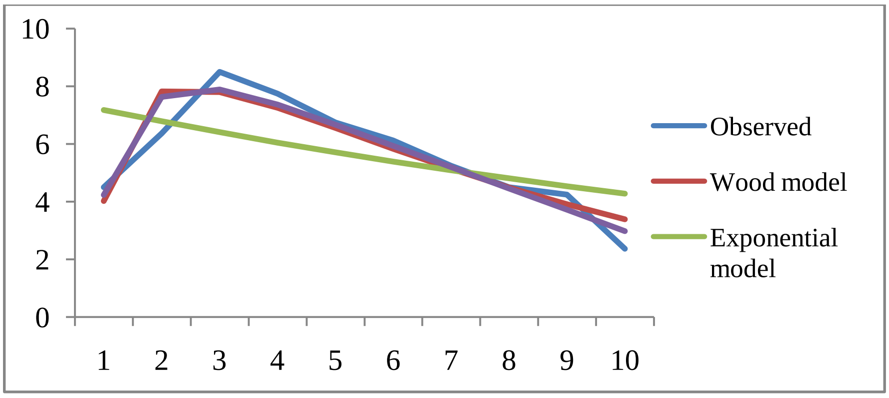

Figure 2: The lactation curves produced from the actual and estimated yields for Barn-II

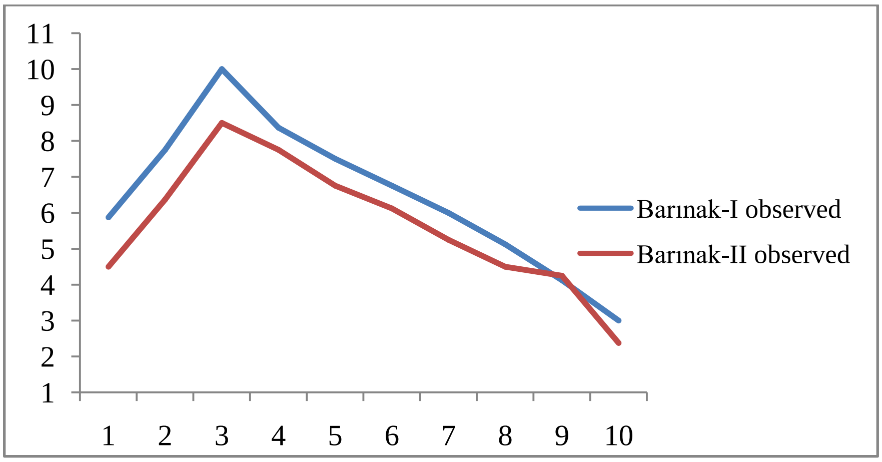

Figure 3: The lactation curves produced from actual yields for Barn-I and Barn-II

The correlation coefficients (r) between the parameters of the study model were shown in Table 10. According to this, the highest correlation coefficient was calculated as -0.931** for Wood model, -0.949** for Wilmink model between a-b. Also, the highest value of R was found as 0.723* in the Exponential model between a-c

Table 10: The correlation coefficient and importance test results of parameters for each model

Model	a-b	a-c	b-c
Wood	-0.931**	-0.677	0.860**
Wilmink	-0.949**	-0.754*	0.754*
Exponential	----	0.723*	-----

Note: **P < 0.01 and *P < 0.05

Result

When the physiological and genetic characteristics of Anatolian water buffaloes are taken into consideration, there is a great effect of air temperature on milk yield. The extreme high and low temperature conditions affect milk yield negatively. For this reason, the temperature inside the barn during the winter season should be kept at the comfort zone. In summer season, some measurements such as water buffaloes are freely located on the water's edge, installation of misting or sprinkler systems in the paddock area and barns with the aim of conversion of sensible heat to latent heat. With this type of application, it is possible to increase the milk yield, lactation times can be extended by reducing the possible temperature stress in the water buffaloes.

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