

## The investigation of viability and body measurements for water buffalo calves\*

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**Abstract:** The viability and body measurements of calves raised in the Livestock Research Center of Afyon Kocatepe University between 2008 and 2011 were investigated. The research was conducted on 188 calves of buffalo cows brought from different regions of Turkey. The viability of buffalo calves at 1, 3, 6, and 12 months of age was 0.95, 0.90, 0.90, and 0.89, respectively. Live weights, height at withers, rump height, body length, chest depth, chest width, rump width, and chest and cannon-bone circumferences were 30.41 kg and 72.37, 74.21, 56.52, 26.34, 15.80, 17.00, 73.13, and 12.88 cm at birth; 118.47 kg and 97.12, 100.93, 88.78, 42.33, 25.53, 29.66, 119.27, and 15.62 cm at 6 months of age; and 179.37 kg and 106.58, 110.03, 101.70, 49.98, 30.71, 36.10, 143.83, and 17.41 cm at 12 months of age, respectively. Some environmental factors had significant effects on body measurements at different ages. Calves from different regions of Anatolia and crosses carrying Bulgarian Murrah genes have adapted adequately to the conditions of Afyonkarahisar and they have the potential to contribute to the development of new genotypes.

**Key words:** Water buffalo, viability, live weight, body measurements, environmental factors

### 1. Introduction

The presence of water buffalo in Turkey dates back to 3000 BC. These animals, known as Anatolian water buffalo, have 50 chromosomes and belong to the riverine buffalo group. This is the only breed of water buffalo in Turkey. Anatolian water buffaloes are covered with a black or gray skin and sparse hair cover. Some water buffalo might have white markings on their foreheads and the tip of their tails. The horns of Anatolian water buffalo are bow-like and arc backwards. Calves are black at birth. However, at the age of 3–6 months they become reddish-brown. At the age of 10–12 months they become black again. Anatolian water buffaloes are very resistant to sudden changes in feed as well as diseases (1). The current number of these animals is 172,181 heads and they are generally raised for meat and milk (2,3). The loss of calves is of major economic importance in Turkey, as in the world (4). Different researchers suggested that factors such as birth season, genotype, and sex may affect vitality (5–10). In some studies carried out with Murrah, Nili-Ravi, and Surti breeds, the mortality rate was reported between 5% and 49.90% (4,7,10–15).

Body measurements taken at different times were ages with rate of growth and also economic features, such as

viability (11). In the studies conducted by Izgi and Asker (16), Sekerden (17), Sekerden et al. (18), Sekerden and Tapki (19), and Sekerden (20), it was reported that some body measurements of Anatolian buffalo calves were affected by factors such as genotype, sex, year of birth, parity, and birth season.

Studies carried out for Anatolian water buffaloes and crosses revealed that birth weight was between 26.50 and 32.30 kg (21, 22). Weight at 6 months of age was from 109.40 to 112.30 kg, while weight at 12 months was 178.40–181.00 kg (20,21). Sekerden (17,20) reported that the overall means for withers height were 96.30 and 106.30 cm at 6 and 12 months of age. The same researcher showed that the overall means of body length, chest depth, chest width, chest circumference, and cannon-bone circumference for 6 and 12 months of ages were 90.50 and 99.60 cm, 41.10 and 47.70 cm, 22.50 and 26.60 cm, 113.00 and 133.30 cm, 13.50 and 12.40 cm, and 13.80 and 15.90 cm, respectively.

The objective of this study was to determine the viability and body measurements of water buffalo calves from different regions of Turkey raised under the conditions of Afyonkarahisar Province.

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## 2. Materials and methods

This study was conducted under Project 08.REK.01 of the Afyon Kocatepe University Scientific Research Fund (AKÜ-BAPK) between 2008 and 2011 at the Afyon Kocatepe University Livestock Research and Application Center's Water Buffalo Unit in Turkey, situated at 38°42'09"N, 30°40'06"E. The research was carried out on 188 calves born to 25 cows from Central Anatolia, 17 cows from the Middle Black Sea region, 16 cows from Afyonkarahisar, and 17 Bulgarian Murrah × Anatolian F<sub>1</sub> cows from the Bandırma Sheep Breeding Research Institute. Their own bulls were used in Anatolian groups. F<sub>1</sub> cows were mated with Bulgarian Murrah × Anatolian B<sub>1</sub> bulls. The water buffaloes were placed into maternal pens before freshening and the delivered calves were left with dams for 1–4 days. Subsequently the calves were housed collectively in a separate unit throughout the suckling period. Ad libitum dry alfalfa and 2 kg of calf grower feed were given per calf. The calves were weaned when they were 7 months old. The weaned calves were fed with concentrate, corn silage, and barley straw mix, the same as the buffaloes. Considering the physiological status, age, and condition of the animals, 2–9 kg of concentrated feed and 6–12 kg of roughage were served. During this time, the female and male calves of the same age from all groups were divided and placed into two separate paddocks. The calves spent their days in back yards and were taken indoors on cold, snowy winter days. All buffaloes and calves were kept cool on hot days with showers installed in the paddocks (Figure).

The body measurements of the calves were taken on a monthly basis after their birth. All measurements and related information were recorded and processed with Manda Yıldızı software (23) and only accurate data obtained from calves were analyzed.

The viability of calves was determined by assigning the value of one to those alive throughout 2009 that were at



**Figure.** The buffaloes cooling down with a shower system on a hot day.

the ages of 1, 3, 6, and 12 months and assigning zero to those that died (24). The body measurements of the calves were taken monthly throughout the study as reported by Arpacık (25) and the values for 6 and 12 months were calculated by interpolation according to the method of Gurtan (26).

The following models for viability, live weight, and body measurements were used to determine the effects of environmental factors and least squares means for each subgroup. For viability of calves:  $Y_{ijkl} = \mu + O_i + BS_j + G_k + b(X - \bar{X}) + e_{ijkl}$ . For live weight and body measurements:  $Y_{ijklm} = \mu + O_i + BY_j + BS_k + G_l + b(X - \bar{X}) + e_{ijklm}$ . Here, Y is the vector of observations,  $\mu$  is the overall mean, O is the fixed effect of origin, BY is the fixed effect of birth year, BS is the fixed effect of birth season, G is the fixed effect of sex, b is the coefficient of linear regression for age of dam, and e is the random residual error  $N(0, \sigma^2)$ . PASW Statistics 18 (27) was used for statistical analysis.

## 3. Results

The viability of water buffalo at the ages of 1, 3, 6, and 12 months; live weights at birth, 6, and 12 months of age; and ANOVA results for withers height, rump height, body length, chest depth, chest width, rump width, and chest and cannon-bone circumference measurements and marginal means are presented in Tables 1–4. The findings indicated that while origin, seasons, and the dam's age were factors with no significant impact on the viability of calves at the ages of 1 month, 3 months, 6 months, and 12 months, sex had a significant impact on livability after the age of 3 months ( $P < 0.05$ ). In this research, livability was found to be high especially during the first 1-month period (0.95) up to 12 months. The origin of animals had a significant effect on withers height, rump height, body length, and cannon-bone circumference in terms of measurements at birth while the year also had a significant ( $P < 0.05$ ) impact on withers height, rump height, body length, and chest width for measurements at birth. The effect of season was significant ( $P < 0.05$ ) for body length, chest width, and cannon-bone circumference at birth and live weight, and for withers height, rump height, body length, chest width, rump width, and chest circumference at 6 months. Sex had a significant ( $P < 0.05$ ) effect on live weight, chest width, and cannon-bone circumference at birth, and on withers height, chest depth, chest width, and cannon-bone circumference at 6 months of ages. The age of the dam was significant ( $P < 0.05$ ) for withers height, rump height, body length, chest depth, rump width, and cannon-bone circumference taken at birth but only for rump height measured at the age of 6 months of age. Live weights, withers height, rump height, body length, chest depth, chest width, rump width, and chest and cannon-bone circumferences were 30.41 kg, and 72.37, 74.21,

**Table 1.** ANOVA results and marginal means related to viability<sup>†</sup> in buffalo calves.

Viability of buffalo calves					
Age (months)					
Factors	n	One	Three	Six	Twelve
μ	66	0.95	0.90	0.90	0.89
Origin					
Afyon	16	1.00	1.00	1.00	0.97
Bandırma	12	0.96	0.83	0.83	0.84
Çorum	15	0.84	0.84	0.84	0.84
Diyarbakır	23	1.00	0.89	0.89	0.89
Birth year					
2009		-	-	-	-
2010		-	-	-	-
Birth season					
Winter	7	0.93	0.886	0.886	0.903
Spring	16	1.00	0.853	0.853	0.795
Summer	17	0.96	0.941	0.941	0.931
Autumn	26	0.92	0.901	0.901	0.906
Sex			*	*	**
Male	36	0.91	0.80 <sup>b</sup>	0.80 <sup>b</sup>	0.80 <sup>b</sup>
Female	30	0.99	0.99 <sup>a</sup>	0.99 <sup>a</sup>	0.99 <sup>a</sup>
Regression for					
age of dam		0.007	0.012	0.012	0.011

<sup>†</sup>: Viability was determined only for those born in 2009 in the direction of research possibilities.

\*\* P < 0.01, \* P < 0.05.

<sup>ab</sup>: Different superscript letters mark significant differences in each subgroup in the same column.

56.52, 26.34, 15.80, 17.00, 73.13, and 12.88 cm at birth; 118.47 kg and 97.12, 100.93, 88.78, 42.33, 25.53, 29.66, 119.27, and 15.62 cm at 6 months of age; and 179.37 kg and 106.58, 110.03, 101.70, 49.98, 30.71, 36.10, 143.83, and 17.41 cm at 12 months of age, respectively.

#### 4. Discussion

Kumar et al. (6), Kamboj et al. (8), and Shivakumar et al. (9) reported that the impact of seasons on calf mortality rates was significant (P < 0.05). Balakrishnan et al. (5), Thamilsanan et al. (7), and Sreedar et al. (9) indicated that both the calving season and sex, corresponding to the findings of this study, were important (P < 0.05). Marginal means indicated that the viability of females was higher than that of males. According to Singh et al. (28) this could be attributed to the fact that immunoglobulins are absorbed less by males than females. The viability rates for 1 month,

3 months, 6 month, and 12 months of age among calves were 95.40%, 89.50%, 89.50%, and 88.70%, respectively. When these values were indicated as mortality rates, they corresponded respectively to values of 4.60%, 10.50%, 10.50%, and 11.30%. These values were less than the limits of 4.10% to 37.10% reported by different researchers under the conditions of India, Pakistan, and Bangladesh (7,11–14). These differences in research results may be due to breed, management and nutrition requirements, and changes in healthcare programs. The age of dam was significant (P < 0.05) for withers height, rump height, body length, chest depth, rump width, and cannon-bone circumference measurements taken at birth and had an impact only on rump height measured at the age of 6 months. Similarly to the results of this study, Izgi and Asker (16) reported that the impact of season was insignificant in terms of birth weight while the differences between sexes

**Table 2.** ANOVA results and marginal means related to live weight, wither height, and rump height in buffalo calves.

Factors	Live weight (kg)						Withers height (cm)						Rump height (cm)					
	n	Birth	n	Six months	n	Twelve months	n	Birth	n	Six months	n	Twelve months	n	Birth	n	Six months	n	Twelve months
	μ	140	30.41	100	118.46	63	179.37	117	72.37	100	97.12	35	106.58	109	74.21	99	100.93	35
Origin								*						*				
Afyon	32	30.09	23	125.19	15	181.67	23	72.61 <sup>ab</sup>	23	96.19	13	107.29	23	75.25 <sup>a</sup>	23	100.68	13	110.99
Bandırma	30	33.	14	117.53	11	178.95	26	74.52 <sup>a</sup>	14	97.91	4	102.28	23	75.97 <sup>a</sup>	14	102.01	4	107.29
Çorum	29	29.06	25	118.41	14	173.50	23	71.08 <sup>b</sup>	25	97.16	8	107.38	22	72.60 <sup>b</sup>	25	100.37	8	109.91
Diyarbakır	49	29.44	38	112.72	23	183.34	45	71.26 <sup>b</sup>	38	97.23	10	109.35	41	73.00 <sup>b</sup>	37	100.67	10	111.95
Birth year		**						**						**				
2009	62	30.31 <sup>b</sup>	60	113.97	58	190.42	42	73.31 <sup>a</sup>	60	96.82	31	107.82	34	74.25 <sup>b</sup>	59	100.36	31	111.43
2010	62	32.32 <sup>a</sup>	40	122.95	5	168.32	60	73.92 <sup>a</sup>	40	97.42	4	105.38	60	76.28 <sup>a</sup>	40	101.51	4	108.64
2011	16	28.60 <sup>b</sup>	-	-	-	-	15	69.88 <sup>b</sup>	-	-	-	-	15	72.09 <sup>c</sup>	-	-	-	-
Birth season				**				**								*		
Winter	25	29.99	9	113.72 <sup>ab</sup>	9	179.12	20	72.69 <sup>ab</sup>	9	97.40	9	106.40	20	74.61	8	99.90 <sup>ab</sup>	9	109.52
Spring	33	31.22	26	105.07 <sup>b</sup>	17	180.17	17	74.44 <sup>a</sup>	26	95.07	8	103.93	16	75.40	26	99.03 <sup>b</sup>	8	107.38
Summer	26	30.25	26	126.35 <sup>a</sup>	14	184.87	25	71.43 <sup>b</sup>	26	97.63	6	109.31	18	73.29	26	101.88 <sup>a</sup>	6	113.33
Autumn	56	30.17	39	128.70 <sup>a</sup>	23	173.30	55	70.92 <sup>b</sup>	39	98.38	12	106.67	55	73.52	39	102.93 <sup>a</sup>	12	109.92
Sex		**								*								
Male	70	31.50 <sup>a</sup>	51	121.91	32	182.24	61	72.85	51	98.21 <sup>a</sup>	18	106.07	55	74.65	51	101.71	18	109.64
Female	70	29.31 <sup>b</sup>	49	115.02	31	176.49	56	71.89	49	96.04 <sup>b</sup>	17	107.09	54	73.76	48	101.16	17	110.44
Regression for age of dam								*						*		*		
		0.28		0.79		-0.39		0.30		0.36		0.09		0.31		0.41		0.18

\*\* P < 0.01, \* P < 0.05.

abc; Different superscript letters mark significant differences in each subgroup in the same column.

**Table 3.** ANOVA results and marginal means related to body length, chest depth, and chest width in buffalo calves.

Factors	Body length (cm)				Chest depth (cm)				Chest width (cm)										
	n	Birth	n	Six months	n	Twelve months	n	Six months	n	Twelve months	n	Birth	n	Six months	n	Twelve months			
μ	116	56.52	100	88.78	35	101.70	117	26.34	100	42.33	35	49.98	110	15.80	98	25.53	35	30.71	
Origin		*																	
Afyon	23	57.37 <sup>ab</sup>	23	89.37	13	105.30	23	26.44	23	42.38	13	50.20	23	15.74	22	26.19	13	31.68	
Bandırma	26	59.01 <sup>a</sup>	14	87.99	4	94.00	26	27.21	14	41.61	4	46.19	23	16.02	14	25.34	4	28.74	
Çorum	23	54.18 <sup>c</sup>	25	89.00	8	103.15	23	25.99	25	42.82	8	51.98	22	15.46	25	25.40	8	30.80	
Diyarbakır	44	55.52 <sup>bc</sup>	38	88.77	10	104.33	45	25.78	38	42.49	10	51.55	42	15.97	37	25.19	10	31.61	
Birth year		**					*							**					
2009	41	58.56 <sup>a</sup>	60	87.92	31	102.86	42	26.61 <sup>a</sup>	60	42.69	31	50.92	35	15.97 <sup>a</sup>	59	25.23	31	30.30	
2010	60	57.44 <sup>a</sup>	40	89.64	4	100.53	60	26.87 <sup>a</sup>	40	41.97	4	49.04	60	16.28 <sup>a</sup>	39	25.84	4	31.11	
2011	15	53.56 <sup>b</sup>	-	-	-	-	15	25.58 <sup>b</sup>	-	-	-	-	15	15.15 <sup>b</sup>	-	-	-	-	
Birth season		*		**										**		**			
Winter	20	55.91 <sup>b</sup>	9	88.87 <sup>ab</sup>	9	101.00	20	26.97	9	42.07	9	49.28	20	16.05 <sup>a</sup>	8	24.82 <sup>b</sup>	9	30.44	
Spring	17	58.87 <sup>a</sup>	26	85.10 <sup>b</sup>	8	97.03	17	26.64	26	41.69	8	47.85	17	16.53 <sup>a</sup>	26	24.41 <sup>b</sup>	8	29.37	
Summer	24	56.02 <sup>ab</sup>	26	90.64 <sup>a</sup>	6	108.26	25	25.80	26	42.67	6	52.29	18	15.13 <sup>b</sup>	26	26.70 <sup>a</sup>	6	31.48	
Autumn	55	55.29 <sup>b</sup>	39	90.53 <sup>a</sup>	12	100.50	55	26.02	39	42.87	12	50.51	55	15.48 <sup>b</sup>	38	26.20 <sup>a</sup>	12	31.53	
Sex										*				**		*			
Male	60	56.23	51	89.70	18	101.75	61	26.52	51	42.91 <sup>a</sup>	18	49.59	56	16.21 <sup>a</sup>	50	25.98 <sup>a</sup>	18	31.02	
Female	56	56.81	49	87.87	17	101.65	56	26.19	49	41.74 <sup>b</sup>	17	50.38	54	15.38 <sup>b</sup>	48	25.08 <sup>b</sup>	17	30.39	
Regression for age of dam		*					*												
		0.34		0.02		-0.23		0.15		0.10		-0.06		0.06		0.09		-0.05	

\*\* P < 0.01, \* P < 0.05.

abc; Different superscript letters mark significant differences in each subgroup in the same column.

**Table 4.** ANOVA results and marginal means related to rump width, chest circumference, and cannon-bone circumference in buffalo calves.

Factors	Rump width (cm)			Chest circumference (cm)			Cannon-bone circumference (cm)												
	n	Birth	n	Six months	n	Birth	n	Six months	n	Birth	n	Six months	n	Twelve months					
μ	117	17.00	100	29.66	35	36.10	116	73.13	100	119.27	35	143.83	117	12.88	99	15.62	35	17.41	
Origin																			
Afyon	23	17.01	23	30.08	13	36.89	23	73.12	23	120.53	13	146.45	23	13.28 <sup>a</sup>	22	15.99	13	17.71	
Bandırma	26	17.51	14	29.48	4	33.48	26	74.75	14	118.43	4	134.08	26	13.24 <sup>a</sup>	14	15.66	4	16.63	
Çorum	23	16.44	25	29.24	8	36.39	23	72.32	25	120.44	8	145.38	23	12.57 <sup>b</sup>	25	15.58	8	17.71	
Diyarbakır	45	17.04	38	29.87	10	37.63	44	72.32	38	117.63	10	149.42	45	12.45 <sup>b</sup>	38	15.25	10	17.60	
Birth year							**							**		*			
2009	42	17.09	60	29.45	31	36.34	41	71.90 <sup>b</sup>	60	118.65	31	144.67	42	12.86 <sup>b</sup>	60	15.36 <sup>b</sup>	31	17.46	
2010	60	17.29	40	29.88	4	35.85	60	75.20 <sup>a</sup>	40	119.90	4	142.99	60	13.22 <sup>a</sup>	39	15.88 <sup>a</sup>	4	17.36	
2011	15	16.62	-	-	-	-	15	72.27 <sup>b</sup>	-	-	-	-	15	12.57 <sup>b</sup>	-	-	-	-	
Birth season				**						**				*					
Winter	20	17.27	9	29.67 <sup>a</sup>	9	36.82	20	73.85	9	117.23 <sup>bc</sup>	9	141.72	20	13.10 <sup>a</sup>	9	15.31	9	18.26	
Spring	17	17.18	26	28.04 <sup>b</sup>	8	34.44	17	73.40	26	113.73 <sup>c</sup>	8	141.07	17	13.19 <sup>a</sup>	26	15.53	8	16.64	
Summer	25	16.94	26	30.06 <sup>a</sup>	6	37.03	24	72.60	26	121.70 <sup>ab</sup>	6	148.94	25	12.51 <sup>b</sup>	26	15.84	6	17.40	
Autumn	55	16.60	39	30.89 <sup>a</sup>	12	36.11	55	72.65	39	124.42 <sup>a</sup>	12	143.61	55	12.74 <sup>b</sup>	38	15.81	12	17.34	
Sex														**		*			
Male	61	17.17	51	29.98	18	36.05	60	73.72	51	120.55	18	144.24	61	13.08 <sup>a</sup>	50	15.90 <sup>a</sup>	18	17.59	
Female	56	16.83	49	29.35	17	36.14	56	72.53	49	117.99	17	143.43	56	12.69 <sup>b</sup>	49	15.34 <sup>b</sup>	17	17.23	
Regression for age of dam		*												**					
		0.13		0.13		0.03		0.25		0.32		-0.10		0.10		0.05		0.002	

\*\* P < 0.01, \* P < 0.05.

abc; Different superscript letters mark significant differences in each subgroup in the same column.

were found significant ( $P < 0.05$ ). Sekerden (17) reported that birth season had a significant ( $P < 0.01$ ) effect on the cannon-bone circumference at the age of 6 months. The differences between the studies in terms of the effects of environmental factors on body measurements could be attributed to the structure of data and the diversity of the applied models. The live weights of 6- and 12-month-old Italian  $\times$  Anatolian  $F_1$  crosses reported by Sekerden (20) were 112.80 and 181.00 kg, respectively, which are close to the findings of the current study. The withers height value at birth for males was 72.85 cm and it was 71.89 cm for females, while the overall average for withers height at birth in this study was 72.37 cm. The results of Nigm (29) and Sekerden (17) were between 78.30 and 71.20 cm for males and between 77.00 cm and 69.00 cm for females, respectively. The overall mean is higher than the value of 96.30 cm determined by Sekerden (20) for Italian  $\times$  Anatolian  $F_1$  crosses. Findings for withers height were in the ranges of 93.30–106.00 cm for males and 91.90–105.60 cm for females as determined by different researchers (17,19,29). The body length value at birth for males was 56.22 cm and it was 56.81 cm for females, while the average for body length at birth in this study was 56.52 cm. The results of Nigm (29) and Sekerden (17) were between 60.60 and 55.00 cm for males and between 60.30 and 55.50 cm for females, respectively. The overall body length at the age of 6 months was 88.78 cm while the value for males was 89.69 cm and the value for females was 87.87 cm. The overall mean is less than the value of 90.50 cm determined by Sekerden (20). The overall mean determined for chest depth at birth in the study was 26.34 cm, while this value was 26.52 cm for males and 26.19 cm for females. These results are similar to the values of 26.70 cm for males and 26.00 cm for females determined by Sekerden (17).

The overall mean for chest depth at 6 months was slightly higher than the value of 41.10 cm determined

by Sekerden (20). The overall mean determined for chest width at birth in the study was 15.80 cm while this value was 16.21 cm for males and 15.38 cm for females. The overall mean for chest width is higher than the value of 22.50 cm determined by Sekerden (20).

The overall mean determined for chest circumference at birth in the study was 73.12 cm while this value was 73.72 cm for males and 72.53 cm for females. These results are slightly less than the values reported by Nigm (29) and Sekerden (17) for males of 83.40 and 75.10 cm and for females of 82.10 and 75.00 cm, respectively. The overall mean for chest circumference at the age of 6 months is higher than the value of 113.00 cm determined by Sekerden (20). The findings for sex reported by different researchers (17,19,29) are at the limits of 110.30 and 133.00 cm for males and 110.10 and 131.00 cm for females, respectively.

The overall mean determined for the cannon-bone circumference at birth in the study was 12.88 cm while this value was 13.07 cm for males and 12.69 cm for females. These results are similar to the findings of Sekerden (17) for males of 13.50 cm and for females of 12.40 cm. The overall mean for the cannon-bone circumference at the age of 6 months is higher than the value of 13.80 cm determined by Sekerden (20).

With respect to viability and growth, the Anatolian buffalo calves from different regions and crosses carrying Murrah genes were adapted adequately to the conditions of Afyonkarahisar Province of Turkey. The utilization of these animals would be useful to develop robust genotypes.

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