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PREDICTION OF BODY WEIGHTS FROM BODY MEASUREMENTS IN EAST ANATOLIAN RED CALVES

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ABSTRACT : In this study, relationships between liveweight and body measurements were examined for East Anatolian Red calves from Northeast of Turkey. Liveweights and body measurements (body length, height at withers, chest girth and chest depth) were recorded at birth, weaning and 6 months of age. The analyses revealed strong relationships between weight and the body measurements at each age and across all ages. Prediction at each age was most accurate using a combination of measurements, but chest girth alone accounted for a large amount of variation (R^2 of 77%, 77% and 73% at birth, weaning and six months respectively). Chest girth was also a good predictor of weight across ages using a quadratic equation. This gave an R^2 of 95% compared with an R^2 of 97% from an equation incorporating all possible terms. It is concluded that chest girth can be used as a predictor of body weight in East Anatolian Red Cattle within the range birth-six months using a quadratic prediction equation, and without having to know the exact age.

Key words: East Anatolian Red calves, body measurements, liveweights.

DOĞU ANADOLU KIRMIZISI BUZAĞILARINDA CANLI AĞIRLIĞIN VÜCUT ÖLÇÜLERİ KULLANILARAK TAHMİNİ

ÖZET : Bu çalışmada, Türkiye'nin Kuzey Doğusunda yetiştirilen Doğu Anadolu Kırmızısı (DAK) buzağılarının canlı ağırlıklarıyla vücut ölçüleri arasındaki ilişki incelenmiştir. Hayvanların canlı ağırlıkları ve vücut ölçüleri (vücut uzunluğu, cidago yüksekliği, göğüs çevresi ve göğüs derinliği) doğum, sütten kesme ve 6. ayda ayrı ayrı kaydedilmiştir. Yapılan analizler canlı ağırlık ile vücut ölçüleri arasında her yaş grubu içinde ve bütün yaşlar toplu olarak ele alındığında kuvetli bir ilişki olduğunu ortaya çıkarmıştır. Her yaş dönemindeki ağırlığın tahmini için eldeki ölçümlerin kombinasyonunu kullanmak en iyi medot olarak görülse de, bu çalışmada göğüs çevresi ölçümünün oldukça geniş bir variyasyon göstermesi tek başına kullanımı için bir güven vermiştir (doğum, sütten kesim ve 6. ay ağırlıkları için sırasıyle R^2 %77, %77 ve %73 bulunmu°tur). Bütün yaşlar toplu olarak dikkate alındığında, göğüs çevresinin ağırlık üzerine olan kuadratik regrasyonu iyi bir tahmin aracıdır. Sadece göğüs çevresi kullanılarak elde edilen R^2 (%95) en az bütün ölçümlerin kullanılmasıyla elde edilen R^2 (%97) kadar güvenlidir. Sonuç olarak göğüs çevresi DAK ırkı sığırlarda doğumdan 6. aya kadarki sürede, yaş tam olarak bilinmese bile, canlı ağırlık tahmininde rahatlıkla kullanılabilir.

Anahtar Kelimeler: Doğu Anadolu Kırmızı buzağısı, vücut ölçüleri, canlı ağırlıklar.

INTRODUCTION

Body weight of animals is an important factor associated with several management practices including selection for slaughter or breeding, determining feeding levels and administration of veterinary products. Body weight is also a good indicator of animal condition.

Methods to estimate weight can be important, especially in situations where weighing facilities are unavailable. For example, in the context of extensive range or smallholder systems, linear measurements have been used to estimate liveweight in several species, including calves, pigs and sheep. Çağlar and Şekerden (1993) reported that regression equations have to be determined separately for all cattle breeds reared in different countries and locations. Ohh and Yang (1989) investigated the relationship between body weight and body measurements on Han-Woo cattle from birth to 30 months of age. Kalra et al. (1986) reported values for correlations between various body dimensions and weight in Indian Nali sheep for predicting liveweight. Similarly, Verma and Hussain (1985), °ekerden et al. (1991) predicted liveweight from girth measurements in calves. Thys and Hardouin (1991) showed that linear regression between body weight and chest girth measurements explained 86% of the variation in body weight in rams and 88% in ewes.

Material and Methods

Data for this study consisted of eighty-two East Anatolian Red Cattle (EARC) born on the Research Farm of the East Anatolia Agricultural Research Institute, Northeast Turkey. Most of the calves were born between December and April. Body measurements, described by Tüzemen et al. (1993),

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were measured at birth, weaning (49-56 days) and six months in the period 1992-1994.

These measurements were:-

-Height at withers (HW): from base of hoof to highest point of wither.

-Body length (BL): from point of shoulder to the point of tuber ischi.

-Chest depth (CD): from sternum area immediately caudal to the forelimbs to top of the thoracic vertebra.

-Chest girth (CG): circumference of the thoracic cavity immediately behind the forelimbs.

Each animal was tagged at birth. Calves were reared from birth to slaughter or sale on the Institute's farm. Birth weight (BWT) was recorded within 24 hours of birth. Weaning weight (WWT) was recorded when calves reached the planned date of weaning, which ranged from 49-56 days. Six-month weight (SMW) was recorded at 180 days

Feeding of Animals

All animals were kept indoors from October to July for the winter period, then allowed to graze on pasture from the beginning of July to October. Hay of grass, alfalfa and sainfoin were used as roughage for winter feeding in addition to concentrates. Concentrate feeding was started when animals reached 2 weeks of age.

Statistical Analyses

Two datasets were prepared for the analyses. In Dataset 1 weight at each age were regressed against each body measurement fitting linear coefficients for the relationships. All possible combinations of body measurements were examined from single measurements and pairs of measurements to all four measurements. In Dataset 2, weights and measurements at each age were combined. The relationships between weight and the measurements were examined by fitting linear and quadratic coefficients for each body measurement. The best model (highest R^2) was identified by examining the relationship between weight and all possible combinations of body measurements (linear and quadratic terms) using the breg facility in MINITAB (1996) which examines all possible combinations of measurements. The best model was compared to the results obtained by regressing weight against single measurements, with and without linear and quadratic terms.

Results and Discussion

The number of the animals and descriptive statistics of body measurements by weighing dates are shown in Table 1.

The average values with standard errors for BWT, WWT and SMW were 17.8±0.38, 34.3±8.80 and 85.4±2.30 kg respectively. HW increased from 59.03 cm to 81.65 cm for birth to six months. The corresponding ranges for BL, CG, and CD were 50.61 to 82.83, 22.57 to 38.63 and 62.05 to 104.57 respectively.

Prediction equations for BWT, WWT and SMW calf weight are presented in Tables 2, 3, and 4 respectively. Results from the analysis of combined data are presented in Table 5.

Table 1. Descriptive statistics of body measurements by time of weighing

	Birth weight	Weaning weight	Six months weight
	$\bar{x}$ ±Se	$\bar{x}$ ±Se	$\bar{x}$ ±Se
Number of animals	86	79	72
Mean Weights (kg)	17.80±0.38	34.25±1.27	85.43±2.30
Height at withers (cm)	59.03±0.56	6[illegible].01±0.81	81.65±0.76
Body length (cm)	50.61±0.59	6[illegible].38±1.01	82.83±0.78
Chest depth (cm)	22.57±0.22	27.46±0.47	38.63±0.36
Chest girth (cm)	62.05±0.54	76.42±1.09	104.57±1.06

Se: Standard error

Birth weight

Maximum R^2 values for predicting BWT were obtained when BL was excluded from the model. These results differ from the findings of Shioya et al. (1975) and Tüzemen et al. (1993) who reported that including all body measurements took into account 77% of the variation in the birth weight of Japanese Black calves, 77.4% of the variation in BWT of female Brown Swiss calves, and 75.2% of the variation in BWT of male Brown Swiss calves. As shown in Table 2, HW and CD had little effect when included in the model. CG alone produced higher R^2 values than those obtained from many of the other combinations. CG alone accounted for 76.6% of the variation. The results suggest that using only CG could give an accurate estimate of birth weight. Similar conclusion was reported by Rathi et al. (1980), Jagtab and Kale (1987), Tüzemen et al. (1993; 1995) and Yanar et al. (1995).

Weaning weight

Prediction equations for WWT are presented in Table 3. The highest R^2 (86.1) was obtained from the equation, which contained HW and CG. BL and CD did not add much additional information to the prediction equation. Comparing the single body measurements in terms of R^2, CG gives the best prediction compared to other body measurements. It could be concluded that again chest girth was a good predictor for weaning weight.

Table 2. Prediction equations for BWT

Prediction equations	Constant	HW(cm)	BL(cm)	CD(cm)	CG(cm)	R^2(%)
$Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4$	-34.5	0.118	-0.010	0.163	0.679	76.3
$Y=a+b_1x_1+b_2x_2+b_3x_3$	-17.1	0.309	0.218	0.252	-	35.5
$Y=a+b_1x_1+b_2x_2+b_4x_4$	-33.1	0.137	0.006	-	0.685	77.6
$Y=a+b_1x_1+b_3x_3+b_4x_4$	-34.5	0.117	-	0.157	0.676	78.1
$Y=a+b_2x_2+b_3x_3+b_4x_4$	-33.0	-	0.019	0.236	0.717	77.8
$Y=a+b_1x_1+b_2x_2$	-14.9	0.342	0.249	-	-	38.0
$Y=a+b_1x_1+b_3x_3$	-14.3	0.385	-	0.421	-	34.1
$Y=a+b_1x_1+b_4x_4$	-33.0	0.139	-	-	0.688	77.6
$Y=a+b_2x_2+b_3x_3$	-10.4	-	0.337	0.495	-	32.7
$Y=a+b_2x_2+b_4x_4$	-30.3	-	0.051	-	0.734	76.9
$Y=a+b_3x_3+b_4x_4$	-33.0	-	-	0.251	0.727	77.8
$Y=a+b_1x_1$	-9.63	0.467	-	-	-	30.9
$Y=a+b_2x_2$	-3.82	-	0.428	-	-	28.5
$Y=a+b_3x_3$	-2.97	-	-	0.922	-	19.2
$Y=a+b_4x_4$	-29.6	-	-	-	0.764	76.6

Y: Predicted Birth Weight in Kg, a: Constant, HW: Height at Withers, BL: Body length, CD: Chest Depth, CG: Chest Girth. b1, b2 ,b3 and b4 are linear coefficients for HW, BL, CD and CG respectively.

Table 3. Prediction equations for WWT

Prediction equations	Constant	HW(cm)	BL(cm)	CD(cm)	CG(cm)	R^2(%)
$Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4$	-76.8	0.585	0.159	-0.023	0.807	85.3
$Y=a+b_1x_1+b_2x_2+b_3x_3$	-68.1	0.899	0.581	0.205	-	76.3
$Y=a+b_1x_1+b_2x_2+b_4x_4$	-76.8	0.585	0.169	-	0.788	85.4
$Y=a+b_1x_1+b_3x_3+b_4x_4$	-79.4	0.671	-	-0.003	0.889	86.0
$Y=a+b_2x_2+b_3x_3+b_4x_4$	-61.1	-	0.367	0.192	0.852	79.4
$Y=a+b_1x_1+b_2x_2$	-67.0	0.948	0.605	-	-	75.9
$Y=a+b_1x_1+b_3x_3$	-68.8	1.370	-	0.418	-	71.5
$Y=a+b_1x_1+b_4x_4$	-79.1	0.681	-	-	0.874	86.1
$Y=a+b_2x_2+b_3x_3$	-44.5	-	1.010	0.513	-	66.2
$Y=a+b_2x_2+b_4x_4$	-59.3	-	0.378	-	0.887	79.4
$Y=a+b_3x_3+b_4x_4$	-63.4	-	-	0.340	1.130	77.9
$Y=a+b_1x_1$	-66.6	1.51	-	-	-	70.3
$Y=a+b_2x_2$	-38.3	-	1.140	-	-	64.1
$Y=a+b_3x_3$	-17.4	-	-	1.790	-	33.4
$Y=a+b_4x_4$	-60.1	-	-	-	1.200	77.3

Y: Predicted Weaning Weight in Kg, a: Constant, HW: Height at Withers, BL: Body length, CD: chest Depth, CG: Chest Girth. b1, b2 ,b3 and b4 are linear coefficients for HW, BL, CD and CG respectively.

Six months weight

Table 4 shows regression equations for estimated six months weights of calves. The highest R^2 was obtained from the equation, which contained all body measurements. These results are in agreement with the findings of Tüzemen et al. (1993) who also reported a high R^2 from a model, which contained all body measurement. In another study, Rao and Nagarcenkar (1979) reported that the contribution of CG alone was higher than that of other body measurements. In this study chest girth contributed 73 % of variation. As suggested by Jagtab and Kale (1987), Tüzemen et al. (1993;1995) and Yanar at al. (1995) CG alone can give reasonable prediction of six months weight.

Combined weight

Table 5 shows the R^2 and coefficients obtained by regressing body weight (at several ages) against body measurements. The most comprehensive model, containing linear and quadratic terms for the four body measurements, gave an R^2 of 97.4%. Some other equations, omitting one term, also gave a comparable high R^2. The highest R^2 using only one term was obtained from an equation based on CG (R^2 of 95% based on equation with quadratic term).

Table 4. Prediction equations for six months weight

Prediction equations	Constant	HW(cm)	BL(cm)	CD(cm)	CG(cm)	R^2(%)
$Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4$	-155	0.630	0.746	1.250	0.749	84.3
$Y=a+b_1x_1+b_2x_2+b_3x_3$	-155	0.660	1.020	2.630	-	81.1
$Y=a+b_1x_1+b_2x_2+b_4x_4$	-150	0.779	0.823	-	0.990	83.3
$Y=a+b_1x_1+b_3x_3+b_4x_4$	-147	0.916	-	1.620	0.920	82.3
$Y=a+b_2x_2+b_3x_3+b_4x_4$	-148	-	0.993	1.810	0.767	82.5
$Y=a+b_1x_1+b_2x_2$	-140	1.190	1.155	-	-	75.2
$Y=a+b_1x_1+b_3x_3$	-143	1.100	-	3.600	-	77.2
$Y=a+b_1x_1+b_4x_4$	-142	1.170	-	-	1.260	80.2
$Y=a+b_2x_2+b_3x_3$	-148	-	1.290	3.260	-	79.4
$Y=a+b_2x_2+b_4x_4$	-137	-	1.210	-	1.160	80.6
$Y=a+b_3x_3+b_4x_4$	-131	-	-	2.770	1.050	78.5
$Y=a+b_1x_1$	-110	2.390	-	-	-	63.5
$Y=a+b_2x_2$	-115	-	2.420	-	-	68.3
$Y=a+b_3x_3$	-122	-	-	5.370	-	71.6
$Y=a+b_4x_4$	-109	-	-	-	1.850	73.1

Y: Predicted Six month Weight in Kg, a: Constant, HW: Height at Withers, BL: Body length, CD: chest Depth, CG: Chest Girth. b1, b2 ,b3 and b4 are linear coefficients for HW, BL, CD and CG respectively.

Table 5. Prediction equations of combined weights across weighing dates.

Prediction equations	R^2	b	c	P^1	P^2	a
Height at withers						
Linear	89.4	2.74	*	<0.001	*	-142
Quadratic	90.2	*	0.019	*	<0.001	-77.9
Linear and Quadratic	90.2	-0.85	0.025	0.372	<0.001	-85.6
Body length						
Linear	90.7	2.07	*	<0.001	*	-89.1
Quadratic	92.9	*	0.015	*	<0.001	-22.8
Linear and Quadratic	95.1	-2.24	0.031	<0.001	<0.001	50.1
Chest depth						
Linear	90.8	4.17	*	<0.001	*	-77.9
Quadratic	92.6	*	0.067	*	<0.001	-16.9
Linear and Quadratic	93.2	-3.78	0.127	<0.001	<0.001	39.3
Chest girth						
Linear	93.8	1.62	*	<0.001	*	-85.6
Quadratic	95.1	*	0.009	*	<0.001	-20.1
Linear and Quadratic	95.1	-0.47	0.012	0.133	<0.001	-0.8

*Best equation: Weight = 35.4 - 0.369 HW - 1.54 BL - 1.97 CD + 0.728 CG + 0.00601 HW*HW + 0.0145 BL*BL + 0.0443 CD*CD - 0.00002 CG*CG, R^2=97.4. P^1, for Linear term and P^2, for Quadratic term, a= constant b= Coefficient for linear term, c= Coefficient for Quadratic term

Conclusion

The results of the research suggest that CG or BL can be used as a good predictor for body weight at any age within the range birth-six months, but with better prediction if weight is predicted using quadratic terms in the prediction equation. It should be noted that BL also gave good prediction (R^2=95.1) using linear and quadratic terms.

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