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The accuracy of prediction of body weight from body measurements in beef cattle*

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Abstract

The objective of this study was to determine the accuracy of prediction of body weight from body measurements in beef cattle. Wither height, chest girth, body length, chest depth, hip width and hip height measurements were obtained from Holstein, Brown Swiss and crossbred (n=140). Determination coefficients (R^2) of regression equation that included all body measurements were higher in Brown Swiss and crossbred than Holstein (92.2, 95.0 and 68.2 %, respectively). However, it was found that chest girth was the best parameter of all for prediction of body weight in Brown Swiss (R^2=91.1 %) and crossbred cattle (R^2=88.8 %) in comparison to Holstein (R^2=60.7 %). According to these results, the body weight estimation of Brown Swiss and crossbred cattle using the body measurements produced higher prediction accuracies than Holstein but chest girth was the best parameter to prediction of body weight among all body measurements. However, the prediction accuracy of prediction of body weight from body measurements and also chest girth was decreased when the animals frame size was increased.

Keywords: cattle, body measurements, body weight, Holstein, Brown Swiss, crossbred

Zusammenfassung

Die Genauigkeit einer Vorhersage des Körpergewichtes mittels Körpermaßen bei Schlachtrindern

Ziel vorliegender Studie war die Bestimmung der Genauigkeit der Vorhersage des Körpergewichtes von Schlachtrindern mit Hilfe von Körpermaßen. Bei 140 Schlachtrindern der Rassen Holstein und Brown Swiss sowie deren Kreuzungen wurden folgende Körpermaße erfasst: Widerristhöhe (wither height), Brustumfang (chest girth), Körperlänge (body length), Brusttiefe (chest depth), Hüftbreite (hip width) und Hüfthöhe (hip height). Die Regressionskoeffizienten lagen bei den Brown Swiss und Kreuzungstieren höher als bei Holstein Rindern. Für die Vorhersage des Körpergewichtes erwies sich der Brustumfang mit R^2=91,1 % bei Braun Swiss, bei den Kreuzungstieren mit R^2=88,8 % und bei den Holstein mit R^2=60,7 % als bester Parameter. Allerdings verringert sich bei Nutzung des Brustumfanges die Genauigkeit der Vorhersage mit zunehmender Rahmengröße der Tiere.

Schlüsselwörter: Rinder, Körpermaße, Körpergewicht, Holstein, Brown Swiss, Kreuzungstiere

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Introduction

Body weight of animals is an important factor associated with several management practices including selection for slaughter or breeding, determining feeding levels and also it is a good indicator of animal condition (ULUTAS *et al.* 2001).

The relationship between body measurements and body weight depends upon breed, age, type, size, condition and fattening level of the animals (HEINRICHS *et al.* 1992, YANAR *et al.* 1995). VAN MARLE-KÖSTER *et al.* (2000) described body measurements as selection criteria for growth in cattle.

HEINRICHS *et al.* (1992) indicated that body measurements can be used for prediction of body weight. GILBERT *et al.* (1993) reported that there is close correlation between body weight and body measurements. MSANGI *et al.* (1999), SLIPPERS *et al.* (2000), FOUIRE *et al.* (2002), WILLEKE and DÜRSCH (2002) and BOZKURT (2006) indicated that chest girth can be used to predict body weight that it is the best prediction parameter. CAGLAR and SEKERDEN (1993) declared that the regression equations must be determined for all beef breeds for different country and region.

The aim of this study was to determine the accuracy of prediction of body weight from metric body measurements in beef cattle.

Material and methods

This study were carried out in Isparta and Burdur provinces in the Mediterranean part of Turkey and 140 male animals in total were used and comprised of 56 Holstein (body weight ranging 337 to 677 kg), 30 Brown Swiss (body weight ranging 326 to 930 kg) and 54 Crossbred cattle (body weight ranging 326 to 677 kg).

Body weight of animals was determined by using a digital weighing scale prior to slaughter (Marmara 0580 MEB). The parameters such as body weight, chest girth, wither height, body length, chest depth, hip width and hip height were measured using measuring stick and tape (Hauptner, Germany) when animals were standing as described in OZKAYA and BOZKURT (2008).

The best prediction equations for body weight from other traits (chest girth, body length, wither height, chest depth, hip width and hip height) as independent variables were determined. Descriptive statistics and regression analysis of body weight on each of the independent variables were performed using the MINITAB, 13 Inc (2001). Comparisons between means were determined by Tukey test.

Correlation coefficients were also obtained from parameters. Linear, quadratic and cubic effects of independent variables on body weight were included in the following model:

$$Y_i = b_0 + b_1 x_i + b_2 x_i^2 + b_3 x_i^3 + e_i \quad (1)$$

where is Y_i the body weight observation of an *i*-th animal, b_0 the intercept, b_1, b_2, b_3 the corresponding linear, quadratic and cubic regression coefficients, x_i the body measurement (chest girth, body length, wither height, chest depth, hip width and hip height) and e_i the residual error term.

Results and discussion

Descriptive statistics of body weight and body traits are shown in Table 1. The parameters of Holstein were higher and statistically significant ($P<0.05$) than Brown Swiss and crossbreds. All parameters were found no significant between Brown Swiss and crossbred cattle but only wither height values were found statistically significant in all breeds ($P<0.05$).

Table 1
Descriptive statistics for body weight and body measurements
Beschreibende Statistik für Körpergewicht und Körpermaße

Variables	Breeds	*n*	Mean ± SE
Body weight, kg	Holstein	30	513.4^{a} ± 11.6
	Brown Swiss	56	440.7^{b} ± 25.7
	Crossbred	54	460.9^{b} ± 13.6
Body length, cm	Holstein	30	146.37^{a} ± 0.95
	Brown Swiss	56	136.88^{b} ± 1.97
	Crossbred	54	140.15^{b} ± 1.26
Wither height, cm	Holstein	30	132.60^{a} ± 0.66
	Brown Swiss	56	123.45^{b} ± 1.40
	Crossbred	54	127.95^{c} ± 1.14
Hip height, cm	Brown Swiss	30	137.20^{a} ± 0.68
	Holstein	56	128.87^{b} ± 1.46
	Crossbred	54	132.16^{b} ± 1.12
Hip width, cm	Holstein	30	46.152^{a} ± 0.58
	Brown Swiss	56	43.283^{b} ± 0.87
	Crossbred	54	43.222^{b} ± 0.56
Chest depth, cm	Holstein	30	68.488^{b} ± 0.75
	Brown Swiss	56	64.78^{b} ± 1.12
	Crossbred	54	65.074^{b} ± 0.68
Chest girth, cm	Holstein	30	189.36^{a} ± 1.73
	Brown Swiss	56	180.25^{b} ± 3.38
	Crossbred	54	181.59^{b} ± 1.66

^{a,b,c} means in a column bearing different superscript are significantly ($P<0.05$) different

The best regression equations of body weight on various body measurements are shown in Table 2. Results of regressions of body weight on the linear, quadratic and cubic effects of each body measurements are presented in Table 3.

Chest girth was statistically significant for all breeds (Table 2). The R^2 value for Holstein was obtained from the equation contained body length, wither height, chest depth and chest girth was found 66.1 %. This result was lower than findings of TUZEMEN *et al.* (1995) who reported R^2=90.7 %. The R^2 value obtained from the equation contained body length, wither height and chest girth was found 66.1 % and this result was lower than findings of SEKERDEN *et al.* (1991) (R^2=97.7 %). R^2 value was obtained from the equation contained only chest girth (R^2=60.7 %) was lower than those findings of SEKERDEN *et al.* (1991) (R^2=97.3 %) and TUZEMEN *et al.* (1995) (R^2=86.7 %).

The highest R^2 value for Brown Swiss were obtained from the equation contained all body measurements (R^2=92.2 %) (Table 2). R^2 value was determined as 91.8 % which contained body length, wither height, chest depth and chest girth. This result was in line with findings of TUZEMEN *et al.* (1993) (R^2=90.7%) and BOZKURT (2006) (R^2=93.6%). R^2 value was obtained from the equation contained only chest girth was higher than those findings of TUZEMEN *et al.* (1993) and BOZKURT (2006) (R^2=91.1, 86.9 and 89.9%, respectively).

Table 2
The best prediction equations of body weight
Beste Vorhersagegleichungen des Körpergewichtes

Breeds	Regression equations	R^2, %
Holstein	*Y*=−784+3.56 BL*+7.48 WL−6.79 HH−0.77 HW−0.45 CD+4.14 CG*	68.2
	Y=−872+2.91 BL+2.19 WH −0.22 BD+3.62 CG*	66.1
	Y=867+2.87 BL+2.11 WH+3.59 CG*	66.1
	Y=−473+5.21 CG*	60.7
	Y=−715+8.39 BL*	47.7
	Y=−1006+11.5 WH*	43.2
Brown Swiss	*Y*=−868+2.28 BL−0.10C WH−0.94 HH+4.03 HW−4.35 CD+6.87 CG*	92.2
	Y=−883+2.53 BL−0.69 WH−5.30 BD+7.81 CG*	91.8
	Y=−866+1.36 BL−1.00 WH+6.91 CG*	91.3
	Y=−869+7.27 CG*	91.1
	Y=−1156+11.7 BL*	79.2
	Y=−1466+15.4 WH*	70.8
Crossbred	*Y*=−1065+1.76BL−1.27 WH+3.48 HH*+2.63 HW+0.81 CD+4.49 CG*	95.0
	Y=−1068+2.80 BL*+1.76 WH+5.02 CG*	93.9
	Y=−935+7.69 CG*	88.8
	Y=−912+9.80 BL*	82.2
	Y=−836+10.1 WH*	71.8

BW body weight, BL body length, WH wither height, HH hip height, HW hip width, CD chest depth, CG chest girth, *statistically significant (P<0.05)

The highest R^2 value for crossbred was obtained from equation contained all body measurements (R^2=95.0%). In addition, R^2 value was found 88.8% which included only CG (Table 2).

The highest R^2 value was obtained from chest girth for all breeds (Table 3). For Holstein, R^2 was found 61.5% and this result was lower than those findings of HEINRICHS *et al.* (1992) and WILSON *et al.* (1997) (R^2=95 and 97%, respectively). In the present study, results showed that when the body weight increased to 500 kg, the prediction accuracy of body weight from chest girth was decreased for Holstein (R^2=39.4%).

Linear, quadratic and cubic coefficients of chest girth for Brown Swiss were found 91.1, 94.3 and 94.4%, respectively (Table 3). These results were higher than findings of BOZKURT (2006) (89.9, 60.1 and 90.2%, respectively).

The highest R^2 value was found in body length and chest girth for crossbreds (Table 3) (R^2=82.2 and 88.8%, respectively). The cubic term was statistically significant for body length and chest girth (P<0.05).

The correlation coefficients of traits are shown in Table 4.

The highest correlation was obtained between body weight and chest girth. The correlation coefficient (r=0.78) between body weight and chest girth for Holstein was lower than those findings of SEKERDEN *et al.* (1991) and TUZEMEN *et al.* (1995) (r= 0.99 and 0.83, respectively). For Brown Swiss, correlation coefficient between body weight and

Table 3
Regressions of body weight on linear, quadratic and cubic effects of each body measurements
Effekte linearer, quadratischer und kubischer Regressionsmodelle bei einzelnen Körpermaßen zum Körpergewicht

Breeds	Variables	Intercept	Linear	Quadratic	Cubic	R^2, %
Holstein	body length	−714.76	8.39	–	–	47.7
		−1 680.75	21.43	−0.04^{ns}	–	47.9
		−32 530.30	642.95	−4.21^{ns}	0.009^{ns}	48.4
	wither height	−1 006.16	11.46	–	–	43.2
		−3 922.73	55.72	−0.16^{ns}	–	43.6
		7 538.90	−205.39	1.81^{ns}	−0.005^{ns}	43.6
	hip height	−938.10	10.58	–	–	39.2
		−5 661.64	79.62	−0.25^{ns}	–	39.9
		−178 552.00	3 857.90	−27.76^{ns}	0.07^{ns}	41.6
	hip width	132.56	8.25	–	–	17.3
		−1 906.51	88.66	−0.78	–	41.5
		−5 475.86	301.64	−4.93	0.026^{ns}	42.4
	chest depth	−63.85	8.43	–	–	30.2
		1 662.49	−43.98	0.39	–	39.2
		4 587.18	−184.99	2.62	−0.012^{ns}	40.0
	chest girth	−473.22	5.21	–	–	60.7
		740.12	−7.84	0.03^{ns}	–	61.5
		−701.95	15.33	−0.09^{ns}	0.0002^{ns}	61.5
Brown Swiss	body length	−1 155.63	11.66	–	–	79.7
		−463.51	−10.74	0.07^{ns}	–	80.2
		16 948.20	−358.35	2.51^{ns}	−0.005^{ns}	80.5
	wither height	−1 465.84	15.44	–	–	70.8
		−10 831.20	−179.34	0.77	–	85.2
		−17 734.20	508.19	−4.73	−0.015^{ns}	85.7
	hip height	−1 506.26	15.11	–	–	73.9
		5812.70	−94.95	0.41	–	78.1
		48 390.60	−1 061.28	7.70^{ns}	−0.018^{ns}	78.5
	hip width	−683.35	25.97	–	–	77.9
		1 743.80	−80.51	1.15	–	83.5
		10 125.40	−620.78	12.64	−0.081^{ns}	84.3
	chest depth	−859.55	20.07	–	–	76.2
		1 800.59	−57.70	0.56^{ns}	–	79.3
		1 415.76	−40.69	0.31^{ns}	0.001^{ns}	79.3
	chest girth	−868.79	7.26	–	–	91.1
		1 733.22	−19.84	0.07	–	94.3
		−2 235.27	41.80	−0.25	0.000^{ns}	94.4
Crossbreds	body length	−912.40	9.79	–	–	82.2
		1 325.80	−22.07	0.11^{ns}	–	83.3
		55 551.10	−1 180.85	8.34^{ns}	−0.019	86.6
	wither height	−835.90	10.14	–	–	71.8
		−1 012.60	12.86	−0.011^{ns}	–	71.8
		30 886.90	−724.36	5.653^{ns}	−0.014^{ns}	72.5
	hip height	−934.20	10.57	–	–	75.2
		−426.60	2.91	0.029^{ns}	–	75.3
		55 569.50	−1 255.93	9.436^{ns}	−0.023	77.7
	hip width	−428.90	20.59	–	–	72.9
		2 073.50	−97.67	1.38	–	79.9
		1 916.40	−86.20	1.10	0.002^{ns}	79.9
	chest depth	−582.10	16.03	–	–	63.7
		1 550.10	−49.30	0.50^{ns}	–	66.0
		22 920.30	−1 042.37	15.81^{ns}	−0.078^{ns}	67.9
	chest girth	−935.10	7.69	–	–	88.8
		1 131.20	−14.96	0.06^{ns}	–	89.5
		13 901.30	−226.40	1.22^{ns}	−0.002^{ns}	89.8

ns statistically non significant (P>0.05) chest girth was found 0.95. These result was in line with findings of BOZKURT (2006) but was higher than YANAR *et al.* (1995) (*r*=0.86). For crossbreds, the correlation coefficient between body weight and chest girth was similar with Brown Swiss but higher than Holstein (Table 4).

In conclusion, this study showed that prediction accuracy of body weight using metric body measurements in Brown Swiss and crossbred was higher than Holstein. However, the prediction accuracy of chest girth was higher than other traits for prediction of body weight. However, prediction accuracy of body weight using metric body measurements was decreased in big size animals.

Table 4
Correlation coefficients between body weight and body measurements
Korrelationskoeffizienten zwischen Körpergewicht und Körpermaßen

Variables	Breeds		
	Holstein	Brown Swiss	Crossbred
Body length	0.69	0.89	0.91
Wither height	0.66	0.84	0.85
Hip height	0.63	0.86	0.87
Hip width	0.61	0.88	0.85
Chest depth	0.64	0.87	0.80
Chest girth	0.78	0.95	0.94

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