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PREDICTION OF CARCASS WEIGHT OF HOLSTEIN AND BROWN SWISS CATTLE GROWN IN A 12-MONTHS INTENSIVE BEEF PRODUCTION SYSTEM BY USING REAL-TIME CARCASS MEASUREMENTS

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Abstract

In this study, it was aimed to evaluate the use of some morphometric carcass measurements to predict carcass weight of Holstein and Brown Swiss cattle grown in a 12-months intensive beef production system. Associations between carcass weights (CW) and some carcass measurements such as carcass heart girth (CHG), carcass length (CL) and carcass depth (CD) were examined for prediction ability, using the data with 134 observations for each traits.
The linear, quadratic and cubic regression models were performed to predict CW for both breeds and since there were no statistically significant (P >0.05) differences in carcass measurements between breeds. The data of these breeds were combined and found that CL and CHG would be the best possible traits in predicting CW (R^2=57.9 and 50.7% respectively) among the other measurements. The highest R^2 values were obtained from both the equation contained all carcass traits (R^2=65.5%) and the equation that included only CHG and CL (R^2=65.4%). All type of regressions showed that addition of quadratic and cubic terms contributed little benefit in predicting CW. Therefore, all linear terms of all carcass measurements were considered for analysis and they were significant (P <0.05) and the R^2 value for other carcass measurement CD was approximately 20.8%.
It can be concluded that in management situations where CW cannot be measured it can be predicted accurately by measuring CL and CHG alone and different models may be needed to predict CW in different feeding and environmental conditions and for other breeds.

Key words: *Prediction, Carcass weight, Carcass measurements, Brown Swiss and Holstein cattle, Feedlot.*

INTRODUCTION

Small-scale agriculture is characterized by weak resources and investments, especially in developing countries. Decisions on agricultural activities are primarily based on small farming level trials and errors. Body measurements of beef cattle are used for a variety of purposes, especially since ration preparations are based on the body weight of the animal and are important for predicting body weight, including growth rate, body condition, and conformation (Wilson et al., 1997; Fourie et al., 2002)
Especially in developing countries, often animal marketing to farmers is based on visual evaluation.
Most veterinary medicines are prescribed according to live weight criteria. However, prescriptions and drug estimations are often made with approximate estimates. The use of ration formulation, drug estimation, body condition score and live weight criteria in marketing requires expensive and realized at less suitable and less advanced facilities of many small scale farmers.
The use of live weight criteria in ration formulation, drug estimation, body condition score and marketing requires sophisticated facilities which are expensive and hardly affordable to many small-scale farmers.
A simple and logical technique should be considered in management decisions, as scientists appreciate the importance of correct estimation of the body weight of the animal. Some studies have indicated a relationship between some body measurements and body weight (Peters and Ball, 1995; Nesamvuni et al., 2000). It is important to know the weight of a cattle carcass for a variety of reasons, especially for breeding, selection, nutrition,

feeding strategies and health care (antibiotics, anthelmintics and other treatment doses).

The results of most investigators have indicated that the accuracy of predicting body weight from heart girth or other body characteristics can be influenced by the breed types, animal species, age, size and condition of the animal (Heinrichs et al., 1992) and also by different environmental conditions (Enevoldsen et al., 1997).

It was indicated by Bozkurt et al. (2007) and Bozkurt et al. (2008) that the prediction ability of digital image analysis system was very promising to predict body weight and hot carcass weight.

Therefore, the objective of this study was to gain further information about the relationship between carcass weight and some carcass measurements of different breeds such as Brown Swiss and Holstein cattle such as CHG, CL, CD, and also to determine the value of using more than one carcass measurement as a single variable entry to the model to predict carcass weight and to validate the potential of this method as a means of predicting carcass weight under small scale farming conditions.

MATERIALS AND METHODS

Animals

The animals used in this study were comprised of Brown Swiss and Holstein male cattle previously grown in a 12-month feedlot beef system. The average carcass weight was 254.4 and 262.5 kg for Brown Swiss and Holstein groups respectively. The carcass measurements of the slaughtered cattle were collected at Gulkoy slaughterhouse near Isparta province. Data were collected from December 2012 to March 2013 and a total of 134 observations were used for each trait measured. The carcasses were weighed using a mobile weighing bridge. Carcass weights were recorded to the nearest kilogram (kg). All carcass measurements were taken by the same individuals throughout the experimental period.

Carcass Measurements

Carcass measurements were taken while carcasses were strap in a bascule before weighing. A plastic tape marked in centimetres (cm) was used for the measurement of most carcass traits except carcass depth, which was measured by measuring stick (Hauptner, Germany).

Carcass weight was measured in kilograms and the carcass measurements in centimetres.

Statistical Analysis

The best prediction equations for carcass weight from other traits as independent variables, including CHG, CL and CD were determined. Descriptive statistics and regression analysis of CW on each of the independent variables was performed using the General Linear Models procedure of Minitab, 16 Inc. (Minitab, 2016).

Correlation coefficients were also obtained between carcass traits. Polynomial regression analysis of carcass weight on CHG, CL and CD were performed.

Linear, quadratic and cubic effects of independent variables on CW were included in the following model:

$$\mathbf{y_i = b_0+b_1X_i+b_2X_i^2+b_3X_i^3+e_i}$$

Where

y_i= CW observation of an i' th carcass,

b_0= intercept, b_1, b_2, b_3= corresponding linear, quadratic and cubic regression coefficients I,

X_i = Carcass measurement (CHG, CL, CD) and

e_i = residual error term

Several different regression analyses were conducted;

1- All three carcass measurements, expressed as linear functions, were combined in CW prediction equation

2- Each carcass measurement was included separately in regression analysis as linear, quadratic and cubic expressions to predict CW; and

3- The linear regression of each other carcass measurement was then also added to the model as described previously.

RESULTS AND DISCUSSIONS

There were no statistically significant differences in carcass measurements between breeds ($P > 0.05$).

Therefore, data of these breeds were combined for all statistical analysis.

Descriptive statistics of carcass weight and carcass traits on basis are shown in Table 1.

Table 1. Descriptive statistics of carcass weight and carcass traits by weight means

Weight	CW (kg)	CHG (cm)	CL (cm)	CD (cm)
Means [SE]	258.46 [3.38]	179.85 [0.99]	170.18 [1.37]	66.29 [0.613]

CW: Carcass Weights, CHG: Carcass Heart Girth, CL: Carcass Length, CD: Carcass Depth, SE: Standard Error

The average values for CW 258.5 kg. The corresponding ranges for CHG, CL, and CD were 179.85 cm, 170.18 cm and 66.29 cm respectively.

Regressions models of animal carcass weight on various carcass measurements using individual observations are shown in Table 2.

Table 2. Prediction equations of carcass weight and the linear effects of other carcass traits

Models With Three Variable	R^2 %
CW= -185+1.20CHG+1.27CL+0.191CD	65.5
Models With Two Variable	
CW = -184+1.26CHG+1.28CL	65.4
CW = -180+2.29CHG+0.408CD	51
CW = -90.7+1.72CL+0.861CD	59.8
Models With One Variable	
CW = - 179 + 2.43 CHG	50.7
CW = - 62 + 1.88 CL	57.9
CW = 91.6 + 2.52 CD	20.8

As Table 2 shows models with one variable together with determination coefficients it was found that CL and CHG would be the best possible traits in predicting CW (R^2=57.9% and 50.7% respectively) among the other carcass measurement. In other words, the R^2 values in the models with one predictor shows the proportion of variation in the dependent variable that is predictable from the independent variable. Therefore, in this study 57.9% of the variation in CW can be explained by CL.

It was observed that in every steps of regression analysis, inclusion of CL and CHG in the equation increased R^2 greatly. It was also found that when all variables were included in the regression CD was not significant while the rest gave significant slope values. The table containing the equations with all combinations of all carcass traits were cumbersome therefore it was not shown in the paper. However, the highest R^2 values were obtained from the equation contained all carcass traits (R^2=65.5%) and the equation that only CHG and CL (R^2=65.4%) and those equations that included CL and CD (R^2=59.8 %), CHG and CD (R^2 =51 %). These results were in line with the findings of Tuzemen et al. (1993), Ulutas et al. (2001), Bozkurt et al. (2007), Bozkurt et al. (2008).

However, in this study, the individual equations with one predictor CD had the lowest R^2 values as 20.8% (Table 2).

Results of regression analysis of carcass weight on the linear, quadratic and cubic effects of each carcass measurement are presented in Table 3.

Table 3. Regressions of carcass weight on the linear, quadratic and cubic effects of each carcass measurement#

Carcass Measurements	Model	Intercept	b_1	b_2	b_3	R^2 %
Carcass Heart Girth (CHG)	Linear	-178.6	2.43	-	-	50.7
	Quadratic	-6037	68.35	-0.185	-	72.5
	Cubic	-33750	539.9	-2.857	0.005039^{ns}	73.3
Carcass Length (CL)	Linear	-62.02	1.88	-	-	57.9
	Quadratic	-1403	18.12	-0.049	-	71.6
	Cubic	2483	-53.38	0.387	-0.000881^{ns}	72.3
Carcass Depth (CD)	Linear	91.6	2.51	-	-	20.8
	Quadratic	-2422	79	-0.58	-	46.9
	Cubic	-19355	861.3	-12.59	0.0613	55.5

#Only non-significant regression coefficients had superscripts (ns), the rest were significant at P<0.05

It was observed in this study that a 1 cm change in CD resulted in almost 2.51 kg change in carcass weight. Similarly, a 1 cm change in CHG, CL and resulted in 2.43 and 1.88 kg change in carcass weight respectively (Table 3).

Higher order polynomial equations were examined. The R^2 values from the regression models indicate that carcass length and carcass heart girth to be the most highly related to carcass weight considering all linear, quadratic and cubic coefficient terms. For all carcass traits, addition of the cubic term increased the R^2 slightly. In this study, CL and CHG contributed 57.9% and 50.7% of variation respectively.

However, while all linear, quadratic terms of CL, CHG and CD were significant (P <0.05); only the cubic terms of CHG and CL were not significant (P >0.05). However, Heinrichs et al.

(1992) reported that none-significant cubic term for heart girth and significant term for wither height. In contrast Heinrichs et al. (1992) found that quadratic term of body length was significant. The results in this study also showed that linear, quadratic and cubic expressions of both CL and CHG are the most useful predictors, and support the findings of Wilson et al. (1997), Bozkurt (2006), Bozkurt et al. (2007) and Bozkurt et al. (2008). All linear terms of all body measurements were significant ($P < 0.05$). These results were in line with Heinrichs et al. (1992), Wilson et al. (1997), Ulutas et al. (2001), Bozkurt (2006), Bozkurt et al. (2007) and Bozkurt et al. (2008).

It can be noted that, in the correctness of the carcass weight estimates, the additional carcass measurements of the equations provide a slight increase except CL alone.

Correlation coefficients of the traits are shown in Table 4.

Table 4. Pearson correlations between carcass traits in both breed cattle

Variables	CW	CHG	CL
CHG	0.71		
CL	0.76	0.67	
CD	0.46	0.57	0.43

All correlation values were found to be statistically significant ($P< 0.05$). Amongst all the carcass measurements, the highest correlation was found between CL and CW (r=0.76). The second highest correlation was between CHG and CW (r=0.71). In addition the correlation value between CL and CHG (r=0.67) was higher than the correlation between the rest of the traits. It was expected that CL would give higher correlation coefficient value than the other carcass measurements since the R^2 value between CW and CL was also high.

CONCLUSIONS

As most of the previous studies have shown, this study also showed that carcass length and carcass heart girth can be used accurately to predict carcass weight of Brown Swiss and Holstein cattle grown in small-scale farming conditions. The carcass length (CL) showed the highest correlation with the carcass weight of the other carcass properties examined. When using any of the other three carcass measurements in the models that contained linear, quadratic and cubic terms, CL usually provided the most important contribution compared with other carcass dimensions. CHG can be considered the second best predictor.

For this reason, the use of carcass length and carcass heart girth provides a simple way of estimating carcass weight. This is the general purpose of applying the technique to practice. However, there is always a need for further research in this work and for other breeds, as well as for identifying different model parameters and developing different models to predict carcass weight in different management and environmental conditions. It is also important to be very careful when measuring carcass dimensions to reduce experimental errors.

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