58th Annual Meeting of European Association for Animal Production, EAAP, Dublin 2007
Session 37.13: Free Communications on Cattle Production, Abstract no:1662

Digital Image Analysis for prediction of carcass weight of different breeds of slaughtering beef cattle using some carcass measurements

Y. Bozkurt * , S. Aktan and S. Ozkaya
Suleyman Demirel University, Faculty of Agriculture, Department of Animal Science, Isparta, Turkey, 32260.
**Corresponding author: Y. Bozkurt, E-mail address: ybozkurt@ziraat.sdu.edu.tr*

ABSTRACT

The objective of this study was to use digital image analysis system in order to predict carcass weight of different breeds of slaughtering beef cattle by using some carcass measurements and to develop prediction models. A total of 50 digital images and carcass measurements were taken such as carcass weight (CW), carcass area (CA), carcass length (CL) and carcass depth (CD) from different breeds of beef cattle namely, Holstein, Brown Swiss and their crosses.

For prediction of carcass weight, CA was found to be the best predictor compared to CL and CD. Linear, quadratic and cubic effects of predictors were examined and R^2 values of CA were higher than those of other measurements for all breeds and were 85.9, 72.9 and 84.1% for Holstein, Brown Swiss and crossbreds respectively. When considering correlation between CW and other measurements, correlation values of CA were greater than the rest for all breeds. The correlation coefficients between CW and CA were 0.93, 0.85 and 0.92 for Holstein, Brown Swiss and crossbreds respectively and found statistically significant ($P<0.05$).

The results indicated that digital image analysis system could be used to predict CW. However, there is still a need for further studies in order to develop better techniques to use it for prediction.
Key words: *Beef cattle, Prediction, Carcass weight, Digital Image Analysis*

INTRODUCTION

Digital image analysis has been considered to be one of the most promising methods for objective carcass evaluation. It has also been utilised for determination of colour and fat thickness, marbling scores and water retention capacity in beef (Gardner *et al*., 1995, Monin, 1998, Albrecht *et al*., 1996, Irie *et al*., 1996, Greiner *et al*., 1995).

The use of this technique has been reported to develop an objective system for carcass classification which has been used as a standard of payment to European Union beef producers based mainly on determination of confirmation and slaughtering characteristics (Borggaard et al., 1996).

In this study it was aimed to predict carcass weight of slaughtered beef cattle of different breeds by using digital image analysis system.

MATERIAL and METHODS

Selection and measurements of carcasses

A total of 50 digital images and carcass measurements were taken such as hot carcass weight (HCW), carcass area (CA), carcass lenght (CL), carcass depth (CD) from beef cattle.

The carcasses used in this study were from a group of Holstein, Brown Swiss and their crosses slaughtered at a commercial beef packing plant. HCW was taken as carcasses hanging on the rail by a weighing scale with a digital display (kg).

Digital images and Image analysis

Images were captured using a digital camera. The camera was set on a standard quality (640×512 pixel resolution). Illumination conditions, location of camera and camera settings were tried to be the same and constant for all samples. Whole carcass images were taken by placing the reference card over each carcass and obtaining two sequential but separate images without moving the camera head unit in a fixed position perpendicular to the long axis of the carcass.

Images collected by the instrument were obtained while carcasses were in a stationary position on the rail. In digital carcass images,
CA was measured from the left side as the area around the whole carcass in cm^2;
CL was the distance from the point of the shoulders to the ischium (cm);
CD was from sternum area immediately caudal to the forelimbs to the top of the thoracic vertebra (cm) as indicated by Cross and Belk (1994).

In order to calibrate the software a reference card with a known ruler (15cm) was positioned next to the object such that the same distance and focus were kept when images were captured. Digital images were downloaded from the camera to a computer file and processed using Image Pro Plus 5 software to obtain carcass measurements from the images. An image of left side of carcass with reference card and the image processed by software are shown in Figure 1.

Statistical analysis

Regression models were developed and assessed for prediction of hot carcass weight (HCW) and some carcass traits using some carcass measurements as predictors. Descriptive statistics and regression analysis of HCW on each of the variables were performed using the GLM (General Linear Model) procedure (Minitab). Pearson’s correlation coefficients were calculated between actual and predicted values obtained by image analysis. Linear, quadratic and cubic effects of independent variables on HCW were included in the following model:

$$\boldsymbol{Y_i = b_0+b_1x_i+b_2x_i^2+b_3x_i^3+e_i}$$

Where; Yi= HCW observation of an *i* th animal, b_0= intercept, b_1, b_2 and b_3= corresponding linear, quadratic and cubic regression coefficients *i*, χ_i = carcass measurements (CA, CL, CD), e_i = residual error term.

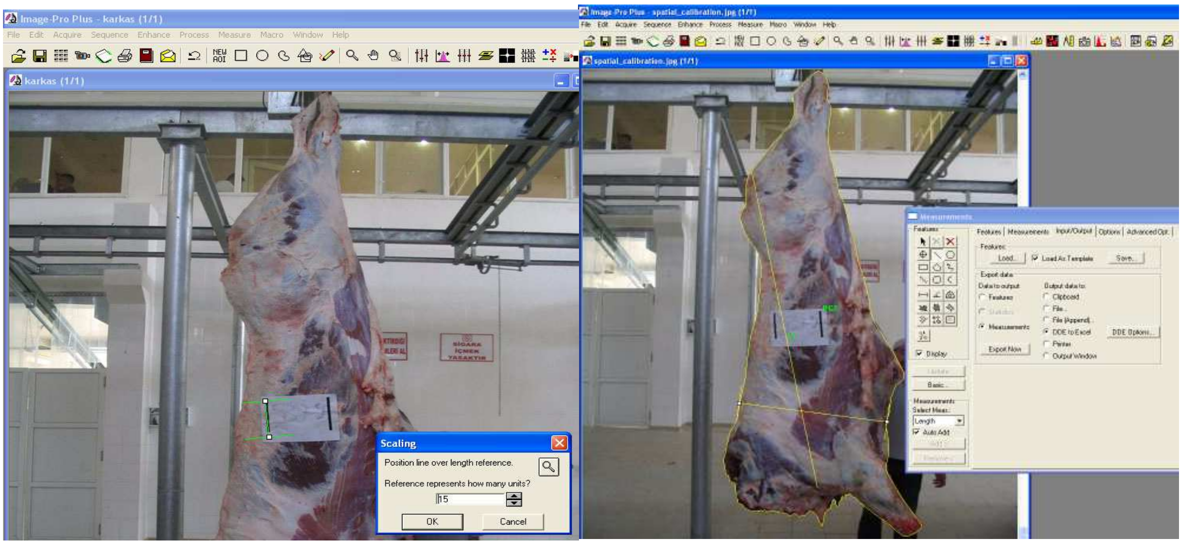

Figure 1. An image of left side of carcass with reference card and the image processed by software

RESULTS and DISCUSSION

The results of multiple regression analysis of hot carcass weight on digital measurements of CA, CL and CD used as predictors for prediction of HCW are shown in Table 1, together with coefficient of determination (R^2%). Since the effect of quadratic and cubic terms of variables on HCW was found non-significant they are not presented in the table.

Table 1. Multiple linear regression equations to predict HCW using CA, CL and CD

Prediction equations	Constant	CA	CL	CD	R^2%
$Y=a+b_1x_1+b_2x_2+b_3x_3$					
Holstein	-197	0.023	0.304^{ns}	1.65^{ns}	88.0
Brown Swiss	48	0.02	0.22	-0.65	73.5
Crosses	-103	0.032	-0.229^{ns}	0.01^{ns}	84.2
$Y=a+b_1x_1+b_2x_2$					
Holstein	-175	0.025	0.770^{ns}	-	87.0
Brown Swiss	30	0.01	0.13	-	73.0
Crosses	-103	0.032	-0.226^{ns}	-	84.2
$Y=a+b_1x_1+b_3x_3$					
Holstein	-172	0.024	-	1.95^{ns}	87.9
Brown Swiss	68,9	0.02	-	-0.54	73.3
Crosses	-114	0.032	-	-0.28^{ns}	84.2
$Y=a+b_2x_2+b_3x_3$					
Holstein	-425	-	1.88^{ns}	4.89^{ns}	56.7
Brown Swiss	-124	-	1.31	1.80	44.2
Crosses	-242	-	1.41^{ns}	3.31^{ns}	57.0

ns: statistically non-significant ($P>0.05$).
[#] Only non significant regression coefficients had superscripts (ns), the rest were significant at $P<0.05$.

The highest R^2 values (Table 1) were obtained from the multiple regression equation that contained all carcass traits for each breeds (R^2=88, 73.5 and 84.2% for Holstein, Brown Swiss and Crosses respectively). Similar results were obtained for all breeds from both the equation containing CA and CL as predictors except CD (R^2=87, 72 and 84.2% respectively) and the equation that included CA and CD, excluding CL as predictors (R^2=87.9, 73.3 and 84.2%

respectively), but the equation that included CL and CD gave very low R^2 values for all breeds (56.7, 44.2 and 57% respectively). Multiple regression results showed that inclusion of CA as a predictor in the equations increased R^2 values remarkably. Similar trend was also reported by Bozkurt *et al.* (2006)

The results of linear regression analysis of hot carcass weight on variables CA, CL and CD used as individual predictors for prediction of HCW are shown in Table 2, together with coefficient of determination (R^2%).

Table 2. Linear regression equations to predict HCW using CA, CL and CD as individual predictors*

Prediction equations	Constant	CA	CL	CD	R^2%
$Y=a+b_1x_1$					
Holstein	-72.2	0.027	-	-	85.9
Brown Swiss	45.5	0.01	-	-	72.9
Crosses	-123	0.031	-	-	84.1
$Y=a+b_2x_2$					
Holstein	-401	-	3.81	-	46.3
Brown Swiss	-99	-	1.90	-	38.8
Crosses	-264	-	2.97	-	52.9
$Y=a+b_3x_3$					
Holstein	-283	-	-	7.44	51.4
Brown Swiss	-21	-	-	3.43	33.3
Crosses	-176	-	-	5.65	54.4

* All corresponding constants of variables were statistically significant (P<0.05).

Among the equations that included only one predictor individually; CA gave the higher coefficient of determination values for all breeds than CL and CD respectively. R^2 values of CA were 85.9, 72.9 and 84.1% for Holstein, Brown Swiss and Crossbreds respectively.
The lowest R^2 values were obtained by CL for all breeds (Table 2). Moreover, regression coefficients of all variables in all equations were found significant (P<0.05) but still CL and CD variables produced very low R^2 values for all breeds (Table 2). These results were in agreement with those reported by Bozkurt *et al.* (2006).

Correlation coefficients of variables between HCW and other carcass measurements in breeds are shown in Table 3.

Table 3. Correlation coefficients of variables between HCW and other carcass measurements in breeds

		HCW	
Varaibles	**Holstein (n=16)**	**Brown Swiss (n=8)**	**Melez (n=26)**
CA	0.93	0.85	0.92
CL	0.68	0.62^{ns}	0.73
CD	0.72	0.58^{ns}	0.74

ns: statistically non-significant (P>0.05).

When considering correlation between HCW and other measurements, correlation values of CA were greater than the rest for all breeds. The correlation coefficients between CW and CA were 0.93, 0.85 and 0.92 for Holstein, Brown Swiss and Crossbreds respectively and found statistically significant (P<0.05).

CONCLUSION

It can be concluded that CA obtained by digital image analysis as only one parameter can provide a considerably reliable prediction of hot carcass weight. It is unavoidable that some images may not be clear enough for processing due to the lighting conditions inside the plant and improper position of reference cards placed on carcasses can make it difficult to measure correctly especially carcass areas on digital images. Prediction ability of the equations may also be affected by the variation of the slaughtered animal's breed type and size.

Therefore, HCWs can be predicted by the digital image analysis system with confidence and flexibility because the acceptable agreement and the close relationship between predicted CA and HCW gives general support to provide predictions of hot carcass weights of the slaughtered animals.. However, there is still a need for further investigations under better controlled experimental conditions.

REFERENCES

Albrecht, E., Wegner, J., Ender, K., (1996). A new Technique for Objective Evaluation of Marbling in Beef, Fleischwirtschaft, v.4, pp.11-16.

Borggaard, C., Madsen, N.T., Thodberg, H.H., (1996). In Line Image Analysis in the Slaughter Industry, Illustrated by Beef Carcass Classification, Meat Science, v.43, pp. 151-163.

Bozkurt, Y., Aktan, S., Ozkaya, S. (2006). Prediction of Carcass Weight and Some Carcass Characteristics of Beef Cattle using Digital Image Analysis. International Conference on Information Systems in Sustainable Agriculture, Agroenvironment and Food Technology, 20-23 September, Volos, Greece, 1035-1041, 2006

Cross, H.R., Belk, K.E., 1994. Objective Measurements of Carcass and Meat Quality, Meat Science, v.36, pp. 191–202.

Gardner, T. L., Dolezal, H. G., Allen, D. M., (1995). Utilization of Video Image Analysis in Predicting Beef Carcass Lean Product Yields. 1995 Animal Science Research Report–Oklahoma State. Pp. 61–67.

Greiner, S. P., Rouse, G. H., Wilson, D. E., Cundiff, L. V., Wheeler, T. L., (2003). The Relationship between Ultrasound Measurements and Carcass Fat Thickness and *Longissimus* Muscle Area in Beef Cattle. J. Anim. Sci. 81: 676–682.

Irie, M., Izumo, A., Mohri, S., (1996). Rapid Method of Determining Water Holding Capacity in Meat Using Video Image Analysis and Simple Formulae, Meat Science, v.42, pp.95–102.

MINITAB., (2001). Statistical Package, Vol. 13. Minitab Inc. USA.

Monin, G., (1998). Recent Methods for Predicting Quality of Whole Meat, Meat Science, v.49, pp.231–243.