DEVELOPMENT OF PREDICTON EQUATIONS FOR BEEF CARCASS YIELD IN COSTA RICA

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Introduction

Costa Rican beef carcass grading system is pursuing to establish a primary classification according to cattle class or gender and/or to segregate carcasses according to their quality and potential cutting -out yield (CORFOGA, 2000a).

Nowadays, beef cattle farmers and tradespeople in Costa Rica are more concerned with cutting-out yields than with beef quality. Having said this however, this Central American country does not presently have a reliable system of carcass grading based on yield (CORFOGA, 2003b). Other countries use prediction equation of carcass yield developed by multiple regression techniques to anticipate cutting-out yields and this has been proved to work on young bulls and heifers (Shackelford *y col.*, 1995).

This study, the first of its kind, investigates the possibility of arriving at a prediction equation of carcass yield tailored to Costa Rican beef cattle.

Objectives

The objectives of this study were a) To examine the magnitude and sign of correlation among several carcass characteristics with the cutting-out yield, b) To select carcass characteristics with the greatest potential to predict cutting-out yield, and c) To evaluate multiple linear regression equations of cutting out yield, and choose the best one based on simplicity, ease of measurement and predictive worth.

Methodology

292 Zebu crossed cattle were reared on pasture in different regions of Costa Rica and discriminated by sex (156 bulls, 136 heifers) at the packing plant. Cattle were slaughtered by standard procedures. Warm carcasses were evaluated according to procedures described by CORFOGA (2000b) for linear measurements, conformation profiles and degrees of exterior and intramuscular fat. The weight of the chilled carcass was measured, when possible, before the boning process. Chilled carcasses were evaluated 24h *postmortem* according to several characteristics described by Vargas (2001). The

longissimus muscle was exposed by the transversal cut following USDA (1990) procedures. Subcutaneous fat thickness over the *longissimus* was obtained by averaging three measurements taken at a quarter, half and three quarters of the distance covered by the longitudinal axis of the *longissimus*. All cold carcasses were boned out following butchering procedures described by Vargas (2001). After 24 hours of storage in refrigerated chambers, the carcasses were fabricated into subprimal cuts according to local Costa Rican style. The excess sub-cutaneous fat, where present, was removed leaving a maximum of 2 mm thickness of fat on the cut. Professional butchers carried out the boning process, following precise instructions regarding the style and maximum fat cover on the cuts The cuts were weighed to determine the individual weight and to calculate the respective proportion (percentage) of the total carcass. Cutting-out yields, absolute (YCKG) and relative (YCP), were defined using boneless value cuts trimmed to a maximum of 2 mm.

An analysis of correlation between the carcass variables measured before fabrication and the relative (percentage) and absolute (kg) yields of valued cuts was conducted. Pearson's simple correlation coefficient (r) was used for measuring closeness of linear association between continuous variables and Spearman's ranges coefficients (rs) was used when at least one of the variables was discreet. To classify r or rs values as high, moderate or low, Snedector's conventional criteria was used (high: > 0.7; moderate: from 0.5 to 0.7 and low: < 0.5). To detect multi-colinearity and to evaluate the developed equations, the Variance Inflation Factor (VIF) and Durbin-Watson statistic (DW) of the SAS REG procedure (2000) were used. A residue analysis was also undertaken as selection criteria.

A multiple, linear regression analysis was conducted to develop several prediction equations of the dependent variables (MacNeil, 1983). The data were analyzed using version 8.1 of the Statistical Analysis System (SAS, 2000) statistical package.

Results & Discussion

Table 1 shows the descriptive statistics of the studied variables and the simple linear correlation coefficients for determining correlation between traits of the beef carcasses and absolute yield (YCKG) or relative yield (YCP). The sample under study was made up of lightweight carcasses, with a poor fat cover and small loin eye area (LEA), similar to data reported in American tropical countries like Venezuela where, similar to Costa Rica, Zebu crosses are produced and fattened primarily by pasture (Atencio-Valladares, 2002). The slight variation of fat measurements of the Costa Rican sample can be accounted for by the hot fat trimming, a current practice in that country which consists of removing most of the fat layer at the end of the slaughter line just before the carcass is washed.

Sex condition (SEX) was moderately associated ($P<0.01$) with YCP. However, previous studies including castrated young bulls and entire bulls have shown medium r-values, indicating that over a quarter of the variation seen in YCP could be explained by its linear regression with SEX (Atencio-Valladares, 2002; Reiling, Rouse & Duello, 1992).

The degree of association of carcass weight (WEIGHT; $P<0.01$) was high with YCKG but it was unrelated ($P>0.05$) with YCP. This high association with absolute yield, in general, indicate that heavier carcasses had higher yield of cuts (Kg) which does not imply they have a better percentage yield.

The tendency observed among the fat indicators, where the internal fat percentage (IFP) is a better estimator of YCP than the covering fat (BACKFAT) is supported by Huerta and Morón (1996) whose study showed that external fat accounted for the 40% of YCP variation. In this sample LEA was a better predictor of YCP.

Prediction equations of absolute and relative yield of valued cuts

None of the equations evaluated in this study achieved sufficient power of YCP prediction. As to predicting YCKG, the equations that best estimated its variation are presented in Table 2. More than 92 percent of the variation of yield of valued cuts in kilograms can be attributed to their linear regression on the variables included in the proposed prediction equations. Particular attention should be paid to equation number 3, for this might be the one that satisfies the requirements of the Costa Rican industry in terms of predicting absolute yield.

The prediction of absolute yield would be of questionable usefulness to the butcher, seeing as when the carcass is boned out the total weight of the cuts would be greater, but the amount of trimmed fat (waste) would also be more. Seeing as the equations in this study are able to predict absolute yield in cuts, these equations must be validated. Possibly, their usefulness might be restricted to a determined weight range within the Costa Rican carcass population. This would limit its recommendation as an official method to design a yield-based grading system.

Conclusions

A large part of the YCP variation cannot be attributed to its simple linear regression with the independent variables studied, whereas these variables on their own manage to explain more than 80% of the variation in YCKG.

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Tables and Figures

Table 1. Costa Rican beef carcass characteristics and its relationship to absolute (Kg) and relative(%) cuts yield.

Variables	N	Average	ED	YCKG[c]	YCP[c]
Sex condition	292			0.674**r	0.153**r
Carcass weight, Kg	292	242.03	47.20	0.962**	0.028ns
Fattening, score[a]	292	1.52	0.63	-0.156**	-0.325**
Subcutaneous fat, cm	292	0.323	0.14	0.007ns	-0.259**
Internal fat percentage, %.	292	1.36	0.73	-0.277**	-0.383**
Loin eye area, In^2	292	9.40	1.85	0.716**	0.116*r
Carcass length, cm.	292	159.76	9.86	0.479**	-0.214**
Achiles tendon length, cm.	292	19.18	1.54	0.176**	-0.160**
Thigh perimeter, cm.	292	87.29	7.39	0.501**	0.276**
Conformation, puntos[b]	292	2.25	0.75	-0.531**	-0.224**
YGKG	292	98.20	19.89		
YCP	292	40.56	2.22		

N: number of observations; ED: Standard Deviation; [a]: 1=uniform, 3= without; [b]: 1= excelent, 4= canner; [c]: r: Pearson simple correlation coefficient; rs: Spearman simple correlation coefficient. YCKG: absolut yield in Kg; YCP: relative yield in percentage.

*:P < 0.05, **: P< 0.01, ns: non significative.

Table 2. Predictive equations selected for YCKG.

	Coefficient ß						
	Intercept	Carcass Weight	Internal Fat Percentage	Length of achiles tendon	R^{2a}	Cp^b	CME^c
1	-2.124	0.416			0.937	94.75	23.12
2	3.870	0.408	-3.092		0.949	27.29	18.88
3	18.741	0.414	-3.254	-0.835	0.953	4.00	17.36

[a]Determinación coefficient; [b]Mallows coefficient; [c]Square means error; Intercept: $ß_0$. All the variables were significant at 5%.