Meat Science 143 (2018) 223–229

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Predictability of lean product, bone, and fat trim in beef carcasses from Costa Rica

Nelson Huerta-Leidenz[a,1], Oscar Atencio-Valladares[a,2], Julio Rodriguez[b,3], Nancy Jerez-Timaure[a,4], Gerardo Vargas[b,5], Argenis Rodas-González[c,*]

[a] Facultad de Agronomía, Departamento de Zootecnia, Universidad del Zulia, Maracaibo Aptdo 15205, Venezuela
[b] Corporación Ganadera, San José Aptdo Postal 13528-1000, Costa Rica
[c] Department of Animal Science, Faculty of Agricultural & Food Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

ARTICLE INFO

Keywords:
Beef
Carcass cutability
Carcass traits
Prediction equation
Saleable beef cuts

ABSTRACT

Data from 292 hot fat trimmed carcasses derived from Costa Rican cattle were used to predict yield of fabricated boneless, closely-trimmed, high-valued cuts (BVS, by weight and percentage); yield of total saleable product (TSP, by weight and percentage); and percentage yields of bone and trim fat. Backfat thickness was not significantly associated with weight of BVS or TSP. Carcass weight explained 93.7% and 95.9% of the total variation in weight of BVS and TSP, respectively. Equations for predicting percentage yields of BVS and TSP showed little predictive efficacy. Conversely, the greater precision of the equations selected to predict the quantity (kg) of BVS or TSP, offers a practical alternative of using them in hot fat trimmed carcasses.

1. Introduction

Costa Rica has around 1.3 million head of cattle and its beef cattle industry has a huge impact on the economy even though there has been an 8.4% downward trend in production since 2010 (INEC, 2014). During the mid 2000s two beef chain diagnostic studies (Blandino-Herrera, 2005; Holmann et al., 2008) consistently identified a deficient marketing system for live cattle and beef produced in Costa Rica and recommended the implementation of a beef grading system to increase industry competitiveness. Several grading systems for beef carcasses have been developed or proposed to assist in the uniform marketing of beef in Latin America (Huerta-Leidenz, 2010). However, Costa Rica has never officially implemented a grading system (Murillo-Bravo et al., 2012). Previous attempts of the Livestock Corporation of Costa Rica (CORFOGA) to develop and implement quality standards faced some reticence or lack of interest on the part of some industry organizations, (J.D. Obando, personal communication). Nevertheless, according to this source, a change of attitude is very possible through adoption of a voluntary, yield grading (grid) system by the larger packers to stimulate livestock productivity. Initiatives to market beef cattle/carcasses on the basis of value are growing around the world. Value-based transactions for which premiums or discounts are applied, depending on the carcass USDA yield grade, can alter the final value of the carcass, and these commercial practices are commonly accepted in marketing of beef cattle/carcasses in the U.S. (Lawrence, 2018). A rapid, huge marketing impact of a yield standard could be expected in Costa Rica because three large meat companies have traditionally controlled 80% of the domestic slaughter and all beef exports (Holmann et al., 2008). In 2017, 21% of total beef production was exported and 41% of exports were targeted for the US market as lean beef trimmings (CORFOGA, 2017).

Only a limited characterization of the Costa Rican beef carcass population is available in the literature (Murillo-Bravo et al., 2012; Rodriguez et al., 2014) and there are few studies in tropical America aimed to develop beef yield prediction equations (Atencio-Valladares, Huerta-Leidenz, & Jerez-Timaure, 2008; da Luz Silva et al., 2012). Clearly, there is a need for: (a) analysing larger observational data aimed to better assess variation in cutting yield of the beef carcass supply in Costa Rica, and (b) development of prediction equations for estimating cutability or product weight as the first step to develop a yield grade standard. A standardized scoring appraisal of carcass fat

* Corresponding author.
E-mail addresses: nelson.huerta@ttu.edu (N. Huerta-Leidenz), ogatencio@gmail.com (O. Atencio-Valladares), jurodriguez@itcr.ac.cr (J. Rodriguez), nancy.jerez@uach.cl (N. Jerez-Timaure), gerardovrgs@gmail.com (G. Vargas), Argenis.RodasGonzalez@umanitoba.ca (A. Rodas-González).
[1] Present address: Department of Animal and Food Sciences, Texas Tech University. Box 42141, Lubbock, TX 79409-2141, United States.
[2] Present address: DELIZULIA, Calle 66 No. 24A-12, Sector Santa Maria, Maracaibo-Zulia 4001, Venezuela.
[3] Present address: Tecnologico de Costa Rica, Sede Regional de San Carlos, Costa Rica.
[4] Present address: Instituto de Ciencia Animal, Facultad de Ciencias Veterinarias, Universidad Austral de Chile, Valdivia, Chile.
[5] Present address: Ganaderia Colono Real S.A., Apartado Postal 3740-1000, Pococi-Limon, Costa Rica.

https://doi.org/10.1016/j.meatsci.2018.05.012
Received 4 January 2018; Received in revised form 18 May 2018; Accepted 18 May 2018
Available online 21 May 2018
0309-1740/

covering and muscling (or conformation) along with carcass linear measurements have been evaluated as predictors of carcass lean beef weight or percentages (Amador-Gómez, Palacios-Gómez, & Maldonado-Carrillo, 1995; Atencio-Valladares et al., 2008; Bain, Mcewan, Mclean, & Johnson, 2010; Conroy, Drennan, McGee, Kenny, & Berry, 2010; da Luz Silva et al., 2012; Drennan, McGee, & Keane, 2008; Jooyoung, Seunggun, Jeongkoo, & Jongbok, 2016; Melendez, 2003).

Based on relative larger data bases it would be feasible to explore the use of some carcass traits that correlate well with cutability and (or) saleable beef weight, and develop corresponding prediction equations. To our knowledge, this investigation would be the first scientific attempt in Costa Rica for predicting commercial beef yield, and eventually, supporting the development of a carcass yield grading system. Therefore, the objective of the present study was to develop and select several multiple linear regression equations to estimate the yield and (or) weight of fabrication products and co-products (bone and fat trim), using a mixture of bulls and cull females that predominate the market.

2. Materials and methods

2.1. Animals and carcass harvest

This study was carried out in one of the three main federally-inspected abattoirs located in the north region of Costa Rica. The location and accessibility of this establishment were ideal to obtain a representative sample of the cattle slaughtered in the country. The animals slaughtered in this abattoir were selected randomly and consisted of 156 intact males (bulls) and 136 cull females (predominantly cows) of *Bos indicus* influence and unknown production history. This cattle sample was presumably grassfed because most Costa Rican beef cattle production is pasture-based (Blandino-Herrera, 2005; Chacon et al., 2015; Rodriguez, 2012). All animals were slaughtered following standard and humane handling procedures (Rodriguez, 2012). After carcass splitting, a hot fat trimming procedure was performed. Cod or udder fat, and fat in the flank regions were consistently removed whereas fat over the ribeye and loin area were rarely trimmed off. Once the carcass was trimmed, the hot carcass weight (HCW) was taken, and the kidney, pelvic and heart fat (KPH) were removed and weighted. In addition, the sex was recorded (SEX; 1 = Bull, 2 = Female) and carcasses were placed in the cold room at −3 to 2 °C.

2.2. Carcass evaluation

Individual carcass data were collected by trained personnel of CORFOGA. Once the carcasses entered the cooler, they were weighted and subjected to evaluation. Carcass muscling scores (MUSCLING; carcass thickness and muscle development of round and rump) and fat finish scores (FINISH; amount and distribution of subcutaneous fat) were assessed using picture pattern developed by CORFOGA (CORFOGA, 2002). MUSCLING was assigned as follows: 1 = Excellent muscle development, straight to convex round-and-rump profile, wide and thick quarters, full loin; 2 = Good muscle development, straight rump profile, generally, with full rib and chuck; 3 = Poor muscle development, concave rump and round profiles, narrow and thin quarters; 4 = Very poor muscle development, concave to very concave rump and round profiles, emaciated and angular. FINISH was assessed as follows: 1 = Practically devoid or with a slight to very thin fat cover; 2 = Irregularly distributed, generally < 1.0 cm-thick; 3 = Ample and regularly distributed, generally > 1.0 cm-thick. Other linear measurements were: carcass length (CLENGTH), leg perimeter (LEGPER), and Achilles tendon length (TENDONL). TENDONL was made from the distal Achilles tendon insertion on the calcaneus bone to the medial gastrocnemius myotendinous junction as described by Melendez (2003). CLENGTH and LEGPER were described by Huerta-Leidenz, Alvarado, Martínez, and Rincón (1979).

After 24 hour postmortem, the carcasses were ribbed between 12th–13th rib interface, and ribeye area (REA) and backfat thickness (BACKFAT) were evaluated according to USDA system (USDA, 1997). The REA was measured with a plastic grid in square inches, and then converted to square centimetres. Also, BACKFAT (non-adjusted, but subjected to influence by hot fat trimming) was measured with a caliper perpendicular to the skin three-fourths of the way out over the loin muscle. It is worth noting that the lack of well-trained evaluators led to KPH being calculated by its weight and was not visually estimated as it is usually done by USDA graders. Likewise, it was not possible to adjust back-fat thickness due to inequalities of fat cover on all carcass surfaces.

2.3. Carcass fabrication

After evaluation of chilled carcasses, professional butchers conducted the fabrication process, following precise instructions on style and maximum fat cover. The two sides of the carcasses were reduced to boneless saleable cuts, removing subcutaneous fat in excess to 2 mm. Weights of fabrication products derived from the two sides, were averaged and computed as a percentage of the chilled carcass weight. Likewise, the proportions of clean bone (BONE%), and trimmed fat (FAT%) were computed. The anatomical (myology) descriptions of individual Costa Rican beef cuts (Rodriguez, 2012) with their nomenclature equivalence to US counterparts (Huerta-Leidenz, 2013; NAMP, 2007) are depicted in Table 1. For the purposes of this study, the individual saleable products were combined in two composite groups as follows: (1) Boneless, closely trimmed, valuable (account for 74% of the carcass value) cuts (**BVS**): tenderloin, strip loin, ribeye, center cut sirloin, knuckle, tri-tip, inside round, outside round, top sirloin cap, eye of round, ribeye lip, shoulder clod, top blade, chuck tender, short ribs, flap, shoulder tender, brisket; and (2) Total bone-in and boneless saleable product (**TSP**): **BVS** plus, heel of round, fore shank, hind shank, hump, flank steak, outside skirt, inside skirt, rib plate, chuck roll, and oxtail.

2.4. Statistical analysis

The procedure PROC UNIVARIATE of SAS software (SAS, 2012) was followed to evaluate normal distribution of the dependent variables (BVSK, BVS%, TSPK, TSP%, BONE% and FAT%). The independent carcass variables used for development of the prediction equations were SEX, HCW, KPH, FINISH, MUSCLING, CLENGTH, LEGPER, TENDONL, REA, and BACKFAT.

The central tendency was measured by the arithmetic mean. The coefficient of variation (CV), the standard deviation (STD) and the range values were used as dispersion statistics. For the correlation analysis, the Pearson simple coefficient (r) was used for continuous variables and the Spearman rank coefficient (rs) for discrete variables. The standard Snedecor criterion (high: ≥0.7, moderate: 0.5 to 0.7, and low: ≤0.5) was used to classify r or rs values.

A multiple linear regression analysis was performed with the easy-to-measure variables that presented lesser multicollinearity (lower FV value), and those that were most associated with the dependent variables, in order to choose the best prediction equations (MacNeill, 1983) through the RSQUARE and STEPWISE options of REG procedure (SAS, 2012). Based on the criteria of MacNeill (1983), the regression that best expresses the variation of a dependent variable is the one that shows the highest coefficient of determination (R^2) value, the best coefficient of Mallows (Cp) and the smallest mean square of the error. Another selection criterion recommended by MacNeill (1983) is to select the predictive formula that has the least number of variables. From a practical standpoint, an equation with fewer variables is easier to apply by the industry. Complementary diagnostics were conducted. To detect multicollinearity and to evaluate the developed equations, the variance inflation factors (VIF), Durbin Watson coefficients (DW) and collinearity diagnostics (COLLINOINT) option REG procedure of SAS (2012) were used. A residual analysis was also performed, through the option