ESTIMATING BEEF CARCASS COMPOSITION USING 3D IMAGE MODELS

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I. INTRODUCTION

Image-based systems for automatic carcass classification are increasingly being studied and proposed in the literature with the aim of increasing accuracy and avoiding human subjectivity [1]. A 3D beef carcass model can be analyzed using innovative technologies such as video image analysis (VIA) and machine learning algorithms to predict live weight, carcass characteristics, and meat yield accurately [2]. To achieve the yield of the cuts and their composition, it is necessary to apply an exhaustive deboning method. This method is usually carried out manually, making it a slow process that requires hours of work, being costly and subject to notable biases associated with the dexterity of butchers. Therefore, it is important to develop a simple, fast, and accurate method to replace traditional approaches in the business environment [3]. It is estimated that through a computer vision system based on three-dimensional digital image analysis we can improve the quality of the beef industry by automating and standardizing the process of evaluating carcass quality and tissue composition. Therefore, the objective of this research was to evaluate the relationship between the volumetric measurement of digital images with total carcass weight and the yield of commercial cuts of the bovine carcass.

II. MATERIALS AND METHODS

Data were collected from 36 young Nellore males (18 bulls and 18 steers), receiving maintenance (n = 8), high (n = 14), or low (n = 14) concentrate diets. The treatments were selected to maximize the range in hot carcass weight and fat score. The animals were slaughtered at the Slaughterhouse of the Universidade Federal de Viçosa (UFV), following the brazilian standards of the Technical Regulation for Pre-Slaughter Management and Humane Slaughter. After harvest, the half-carcasses were weighed to obtain the hot carcass weight (HCW). Subsequently, cold carcass weight (CCW) was obtained after chilling period of 24h at 4ºC. The left half-carcasses were scanned before being stored in the cold chamber and after chilling, obtaining 3D models of hot and cold carcasses. The 3D scanner used was the Artec Leo, configured with a 3D reconstruction rate of 30 FPS (frames per second) and a 3D resolution of 0.2mm, with an accuracy of 0.1mm. The 3D images processing was performed using the Artec Studio 17 software, obtaining measurements of the biometric parameters of volume and area. After 3D scanning, the carcasses were sectioned into anatomical regions that constitute commercial meat sections. The commercial cuts were obtained and weighed according to the routine deboning adopted by the UFV slaughterhouse. The evaluation of the 3D model for estimating carcass weight and cuts yield in comparison with the traditional deboning was by means of linear regression testing the slope and intercept parameters. Precision was assessed by the coefficient of determination (R^2) and accuracy by mean absolute error (MAE). Statistical analyses were performed in SAS (Institute Inc., Cary, NC, USA).

III. RESULTS AND DISCUSSION

Figures 1 and 2 show the equations for predicting the carcass composition using 3D imaging models. It can be observed in both graphs that the coefficient of determination was high, establishing a high correlation for both the weight of the hot carcass and the yield of cuts in relation to the volume extracted from the 3D image models generated from the scanning of the hot carcasses. The P values for the slope coefficients in both regression equations were statistically significant ($p<.0001$).

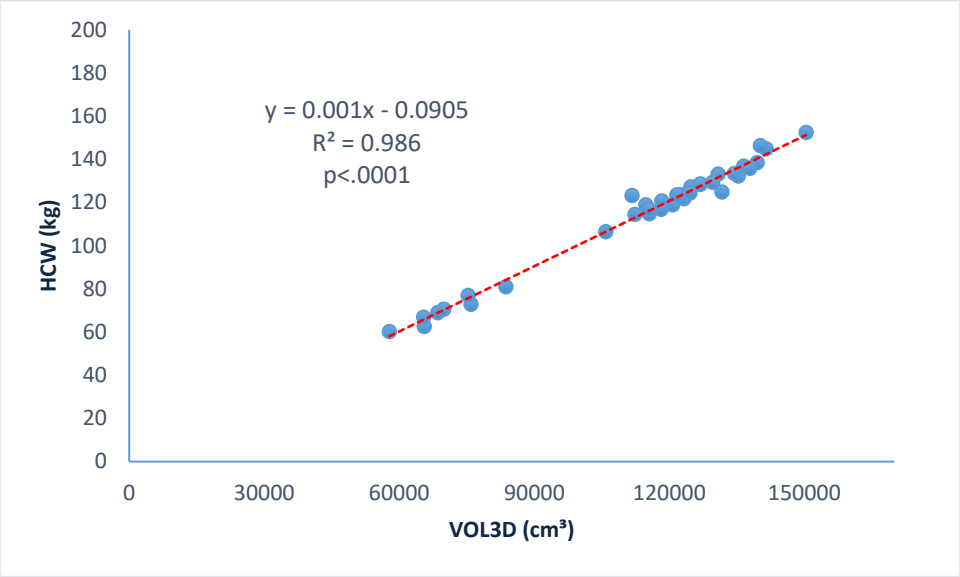

Figure 1. Correlation between hot carcass weight and volume obtained from the 3D model.

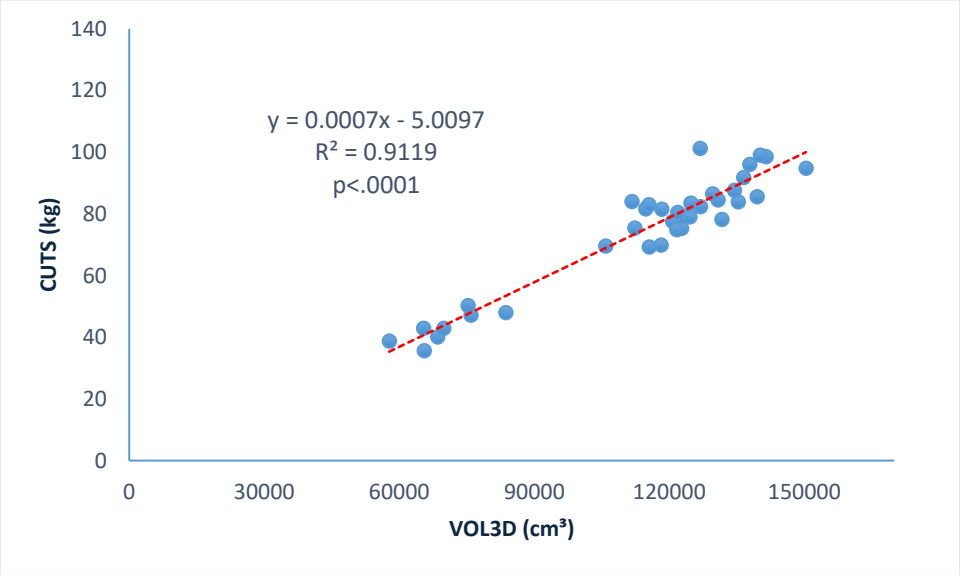

Figure 2. Correlation between commercial cuts yield obtained from the carcass and volume obtained from the 3D model.

IV. CONCLUSION

The 3D images can be used to predict total weight and carcass commercial cut yields. However, more studies are necessary since our equations are based on Nellore bulls and steers and low sample size. This technology can be makes the carcass evaluation process more automated, allowing many potential improvements in the meat industry, offering new perspectives for the evaluation of the superior quality beef carcasses.

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