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The potential of non-invasive pre- and post-mortem carcass measurements to predict the contribution of carcass components to slaughter yield of guinea pigs

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ABSTRACT

Guinea pig meat consumption is increasing exponentially worldwide. The evaluation of the contribution of carcass components to carcass quality potentially can allow for the estimation of the value added to food animal origin and make research in guinea pigs more practicable. The aim of this study was to propose a methodology for modelling the contribution of different carcass components to the overall carcass quality of guinea pigs by using non-invasive pre- and post mortem carcass measurements. The selection of predictors was developed through correlation analysis and statistical significance; whereas the prediction models were based on Multiple Linear Regression. The prediction results showed higher accuracy in the prediction of carcass component contribution expressed in grams, compared to when expressed as a percentage of carcass quality components. The proposed prediction models can be useful for the guinea pig meat industry and research institutions by using non-invasive and time- and cost-efficient carcass component measuring techniques.

1. Introduction

The diversification of commercial meat production practices creates the opportunity for the meat of certain indigenous species to be used as valuable food sources (Hoffman & Cawthorn, 2013). For example, nutria (*Myocastor coypus*) meat consumption is common in South America, and its consumption is increasing in Europe, Russia, China and the southern states of the USA (Glogowski & Panas, 2009; Migdal et al., 2013; Tůmová et al., 2017). When the guinea pig (*Cavia porcellus*) is considered, Lammers, Carlson, Zdorkowski, and Honeyman (2009) reported an increase in consumption in Latin American countries such as Ecuador, Perú, Colombia, and Bolivia; as well in other Asiatic and African countries. The biological, ecological and economic benefits that can arise from guinea pig production warrants further attention by those working to alleviate global poverty and food insecurity (Lammers et al., 2009). Vincent, Speybroeck, Assidjo, Grongnet, and Thys (2011) reported that guinea pig producers are found on all levels of society, regardless of gender, age, religion, education level or community.

The prediction of the contribution of different carcass components to overall carcass quality will produce valuable information for ensuring the viability and sustainability of agribusinesses, and nutritional and marketing approaches, as well to optimize production systems or determine the suitability of new feeds.

A variety of internal or external carcass measurements, on live or slaughtered animals, have been used in the prediction of carcass composition as a simple method to assess the edible product quality without involving carcass damage. In an experiment based on pigs, Doeschl-Wilson et al. (2005) showed the relationship between the body size and shape measurements with regard to the carcass component composition. Diverse results have been observed in the prediction of the contribution of carcass components to lamb carcass quality. Thereby, Wolf, Jones, and Owen (2006), Carrasco, Ripoll, Panea, Álvarez-Rodríguez, and Joy (2009) and Lambe et al. (2009) demonstrated the primary importance of live weight and external carcass measurements as predictors of tissue weights and proportions in lambs. More related to guinea pig, studies on carcass components prediction of rabbits were performed by Blasco et al. (1984) and Hernandez et al. (1996). In both works, they analyzed the prediction ability of live weight and some external measurements in a model by simple regression on carcass component composition of rabbits.

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Studies on carcass and meat quality of guinea pig characteristics are limited. To the best of our knowledge no studies have been conducted on the models to estimate carcass quality from carcass components based on standard methods and procedures proposed by Sánchez-Macías, Castro, Rivero, Argüello, and Morales-de la Nuez (2016). Anye, Manjeli, and Ebangi (2010) implemented linear models with different combinations of body metric traits to predict live weights during the growing period of local guinea pigs in Cameroon, useful when lack weighing machines. Hong, Ediger, Raetz, and Djurickovic (1977), developed by the method of least squares two equations in which the guinea pig weight (W2/3 × 8.054, as the general formula for guinea pig) or weight and length of the body (W0.425 × L0.725 × 3.545) were used to calculate the body surface area (BSA), with not significant differences due to sex or age. However, the ability of measured carcass components to predict carcass quality can depend on the experimental conditions. For instance, Liu (1988) concluded that it is necessary to include in the general formula the K-value (a shape constant for a given species), but it should be different for calculating BSA of guinea pig for various ages and body weights. In another guinea pig study (Liu, 1989), K-value also varied as a function of time after viral infection, suggesting that it may be inappropriate to use the BSA formula without another suitable predictor. The body conformation of guinea pigs is relatively uniform, which discard the problems associated with a large conformations variety found in another species. Zelenák, Körmendy, and Vada-Kovács (2004), working with pigs, found significant and considerable differences between prediction equations for individual subgroups representing different crossbreeds and/or different fattening systems; although the overall equation obtained still provided sufficient bias in comparing with the separate sub-group equations.

The objective of this study was thus to use non-invasive carcass component measurement of fattened and discarded reproductive guinea pigs in vivo, at slaughter and after slaughter to predict the contribution of each carcass component to carcass quality.

2. Materials and methods

2.1. Animals and carcass measurements

2.1.1. Animals selection and slaughter procedure

The project was approved by the Universidad Nacional de Chimborazo, which included a statement that the approval by a bioethical committee was not required, since no other procedures were applied than the normal slaughters procedures.

Forty Andean breed guinea pigs (10 male and 10 female of 3 month-old fattened animals, and 10 male and 10 female of 12 month-old reproductive animals) were randomly selected from the experimental flock maintained at the Universidad Nacional de Chimborazo. The animals were fasted for a period of 12–14 h overnight (Vicent Kouakou et al., 2013), and then were slaughtered according to the procedures described by Sánchez-Macías et al. (2016). Live weight (LWS) of all animals was recorded just before slaughter. Empty body weight (EBW) was calculated as the LWS minus the sum of urine in the bladder and tract gastrointestinal content.

The carcasses were weighted approximately 15 min after slaughter in order to obtain the hot carcass weight (HCW) and weighted again after chilling at 4 °C for 24 h to obtain the cold carcass weight (CCW). Hot carcass yield (HCY) and dressing percentage (DCY) were calculated as HCW or CCW divided by LWS (×100), respectively. Also, net (after chilling) carcass yield (NCY) was calculated as CCW divided by EBW (×100).

2.1.2. Linear carcass conformation measurements

Carcass dimensions were measured according to the procedures detailed in the study of Sánchez-Macías et al. (2016). The following measurements were recorded for carcasses suspended in a gamble with a constant width:

- Internal carcass length (L): a straight line from the cranial edge of the manubrium of the sternum to the cranial edge of the pubic bone, measured internally in the left carcass.
- External Carcass Length (ECL): distance from the atlas vertebra to the distal part of os ischia.
- External hind limb length (F1): Distance from the tarsal-metatarsal joint surface to cranial edge of the pubic bone, measured externally in the left carcass.
- Internal hind limb length (F2): Distance from the tarsal-metatarsal joint surface to cranial edge of the pubic bone, measured internally in the left carcass.
- Width of the buttocks (G): Maximal length between both greater trochanters of the femur.
- Width of the thorax (ThW): The greatest width of the chest of the carcass at the level of the caudal edge of the scapula.
- Lumbar circumference (LC): Carcass circumference around the buttocks at the level of the maximum width of the greater trochanters.
- Thorax circumference (ThC): The circumference measured between the spinous process of the eighth thoracic vertebra and the xiphoid cartilage of sternum, just behind the elbow.

2.1.3. Carcass tissue dissection and composition

After the above mentioned linear measurements were recorded, carcasses were halved through the center of the vertebral column, and peri-renal fat (PF) was dissected free and weighed using a precision balance (PS 2100.R2, Radwag, Poland). Both carcass halves were divided into four cuts according to Sánchez-Macías et al. (2016) (Fig. 1), and each cut was weighed, packed in polyethylene bags and frozen at −20 °C for subsequent dissection.

Carcass cuts were thawed overnight at 4 °C, and thawing losses were calculated. After each cut was completely thawed, the respective tissue types were dissected free and grouped into muscle (M), subcutaneous fat (SF), inter-muscular fat (IF), bone (B), skin (Sk) and remainders (Rm, major blood vessels, ligaments, tendons, and thick connective tissue sheets associated with muscles). Total fat (TF) was calculated as the sum of subcutaneous and intermuscular fat deposits. No valuable or edible tissue was calculated as the sum of bone and remainders weights (B + Rm). Also, muscle and muscles + thawing losses weight (M + L, as the sum of M and thawing loss) was calculated. Tissue weights were summed across all individual carcass cuts to obtain the total weight of

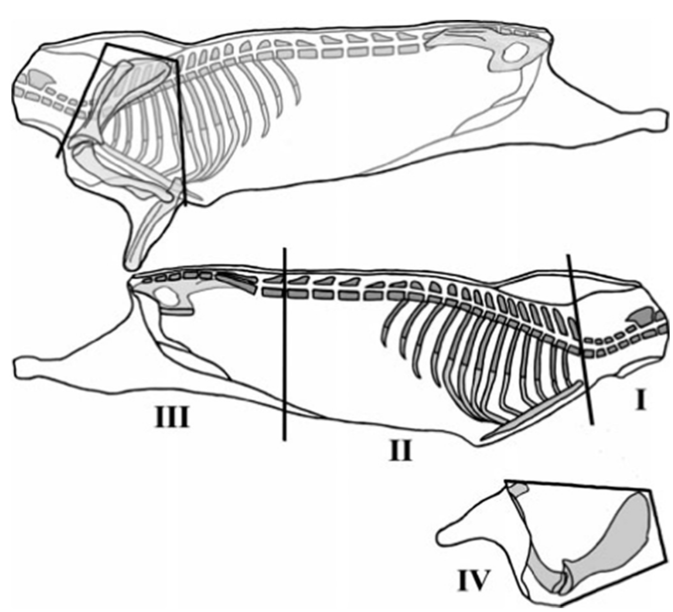

Fig. 1. Scheme for jointing the left half guinea pig carcass into 4 anatomical regions: I, Neck; II, Ribs; III, Long leg; and IV, Shoulder (Sánchez-Macías et al., 2016).