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The value of *in vivo* real time ultrasonography in assessing loin muscularity and carcass composition of rabbits

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ABSTRACT

Sixty nine growing rabbits were scanned over the lumbar region using a real time ultrasonography (RTU) machine to estimate loin muscularity and carcass composition. *Longissimus thoracis et lumborum* muscle (LM) depth, width and area were taken. Animals were weighed (LW), slaughtered and carcass composition was determined. Equivalent measurements to those taken by RTU *in vivo* were taken on the carcass and muscularity indices were calculated on carcass and *in vivo*. Simple correlations between the two types of measurements were determined and carcass composition was estimated by simple and multiple regressions.

The LW varied from 1200 to 3410 g. The simple correlations between carcass and *in vivo* RTU LM measurements were high ($P < 0.001$) and the LM area was the trait with the highest correlation ($r = 0.92$). Simple correlations between muscularity indices measured by RTU and in carcass were significant ($P < 0.001$).

In vivo RTU measurements explained a large amount of the variation of the carcass meat weight (MW) and bone weight (r^2 range from 0.49 to 0.77; $P < 0.001$). Using multiple regression equations to estimate carcass composition, the best fit was obtained with the LW and one or more *in vivo* RTU measurement. The LW explained 90.6% of the variation of MW in the carcass.

In vivo RTU is able to estimate loin muscularity and carcass composition of rabbits with accuracy. The usefulness of *in vivo* RTU and LW to predict carcass composition of rabbits using multiple regressions was also shown.

1. Introduction

Rabbit meat is an important product in Mediterranean countries of EU. Several studies (Hernández, Aliaga, Pla, & Blasco, 2004; Larzul, Gondret, Combes, & Rochambeau, 2005; Metzger et al., 2006) on the selection of rabbits have shown the effect of growth rate and live weight on carcass characteristics and meat quality. An effective tool for *in vivo* evaluation of carcass traits and quality is required for breeding programs. Although several non-invasive techniques using image analysis have been successfully used to evaluate carcass composition in animals (Stanford, Jones, & Price, 1998; Szabo et al., 1999) but only few studies have been conducted on rabbits (Kövér, Szendrö, Romvári, Jensen, & Milisits, 1998; Pascual, Castella, Cervera, Blas, & Fernández-Carmona, 2000; Szendrö et al., 1992). Most of these studies are related to the estimation of fat deposits (Kövér et al., 1998; Pascual et al., 2000). Pascual et al. (2000) used real time ultrasonography (RTU) for estimating the body condition of young rabbit does and concluded that this technique was an accurate method for estimating carcass perirenal fat weight ($r^2 = 0.95$; $n = 42$) and total fat weight ($r^2 = 0.93$; $n = 42$).

In most domestic species variation in carcass fatness is one of the main factors influencing carcass and meat quality. However, rabbit carcasses have a small dissectible fat content (Pascual & Pla, 2007; Pla, Hernández, & Blasco, 1996) and it is not normally used as a quality factor for carcass evaluation. Therefore, the main criteria used to define rabbit carcass quality have been meat percentage in the carcass and the muscularity defined as the ratio between meat and bone (Blasco, Estany, & Baselga, 1984; Lambertini, Bergoglio, Masoero, & Gramenzi, 1996; Lukefahr & Ozimba, 1991; Varewyck & Bouquet, 1982). Studies have shown that apparent body muscularity or cutability attributes may be improved by selection (Lukefahr, Hohenboken, Cheeke, & Patton, 1983; Lukefahr, Hohenboken, Cheeke, Patton, & Kennick, 1982). The developments of *in vivo* measures that are closely associated with measures considered most important in describing the muscularity of a rabbit carcass will be required for application in genetic improvement programs or simply in economic carcass evaluation. This subject has been investigated on other species (cattle: Purchas, Fisher, Price, & Berg, 2002; sheep: Wolf, Jones, & Owen, 2006). In rabbits, studies have also been conducted to predict

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percent of muscle and muscularity in the carcass from live body measurements (Lukefahr et al., 1982; Lukefahr & Ozimba, 1991; Michalik, Lewczuk, Wilkiewicz-Wawro, & Brzozowski, 2006). Lukefahr and Ozimba (1991) found that loin lean cut weight (measure of cutability) was accurately predicted using body weight and loin width ($r^2 = 0.797$). Since the muscularity indices based on loin measurements are related to the valuable rabbit joints (Lukefahr, Odi, & Atakora, 1996; Lukefahr & Ozimba, 1991) it seems essential, for breeding programmes, to develop reliable and accurate techniques for its measurement *in vivo*. However, there was only little information available on the use of techniques incorporating image analysis on muscularity and carcass evaluation of rabbits. Szendrö et al. (1992) pointed out that X-ray computer tomography was suitable to estimate the amount of loin muscle Longissimus dorsi ($r = 0.80$). There is no information available on the use of RTU on muscularity and carcass evaluation of rabbits. Thus the objectives of the current work were to evaluate the *in vivo* RTU measurements in assessing loin muscularity and the carcass composition of rabbits and the ability of these traits to predict carcass composition.

2. Materials and methods

2.1. Animals and management

This experiment was conducted according to principles and guidelines of the European Communities Council Directive No. 86/609/EEC and local regulations. This trial took place in the experimental facilities of the University of Trás-os-Montes and Alto Douro.

Sixty nine rabbits (New Zealand White × Californian) were used on this trial. After weaning at five weeks of age they were fed ad libitum with a commercial pellet diet (crude protein, 16.3%; ether extract, 3.3%; neutral detergent fibre, 32.3%; acid detergent fibre, 23.3% and ash, 10.5% on dry matter basis) and had free access to water. The rabbits were housed in pens on deep litter in an air-conditioned closed building.

2.2. In vivo real time ultrasonography measurements

Prior to slaughter rabbits were restrained and ultrasound images for RTU measurements were taken over the lumbar region between 6th and 7th lumbar vertebrae. The fur at the measurement site was clipped close to the skin and shaved. A gel was used as a coupling medium. The measurement sites were identified and the images were taken using a 7.5 MHz linear probe (UST-5512 U-7.5, Tokyo, Japan) attached to an Aloka SSD 500 V real time scanner (Tokyo, Japan).

During the RTU measurements the probe was placed perpendicular to backbone over the *Longissimus thoracis et lumborum* muscle (LM). Once a satisfactory image had been obtained, it was captured on a video printer (Aloka SSZ-303E, Tokyo, Japan) for image analysis.

The printed images taken were digitized and RTU measurements were determined by image analysis using the NIH Image J software (National Institute of Health, Image J, http://rsb.info.nih.gov/ij/). The LM measurements between 6th and 7th lumbar vertebrae: LM depth (LMD), LM width (LMW) and LM area (LMA) were determined as indicated on Fig. 1a. All images were acquired and analysed by the same operator.

2.3. Live and carcass traits and measurements

Animals were slaughtered between 70 and 90 days of age and live weight (LW) was recorded prior to slaughter without prior fasting. The slaughterhouse was close to experimental facilities, so stress due to transport was minimal. After slaughter the following variables were obtained: chilled carcass weight (CCW) that represents chilled carcass weight for 24 h at 3 °C and reference carcass weight (RCW) according to Blasco and Ouhayoun (1996). The reference carcass was cut according to Blasco and Ouhayoun (1996) and all the retail joints were dissected. The following variables were determined: total meat weight (MW), total bone weight (BW); and total dissectible fat weight (DFW).

The cut-point between 6th and 7th lumbar vertebrae as described by Blasco and Ouhayoun (1996) was used to take carcass measurements equivalent to those taken *in vivo* by RTU. For this purpose, a digital camera (Nikon Coolpix 900, Tokyo, Japan) was used to capture an image of the LM plane between 6th and 7th lumbar vertebrae and after image analysis with the Image J software previously mentioned, and the LMD, LMW and LMA measurements were taken as showed on Fig. 1b.

Linear measurements of body and carcass lengths were obtained for muscularity indices determination. In both live rabbits and carcass the dorsal length (DL) was determined. This length was taken from the atlas vertebra to the 7th lumbar vertebra. The exact position of the endpoints for DL measurement *in vivo* was identified on animal by palpation on the bone anatomical basis and the measurement was taken using a flexible tape. The DL measurement on carcass was determined by image analysis. For this a digital photograph was obtained for each carcass, which

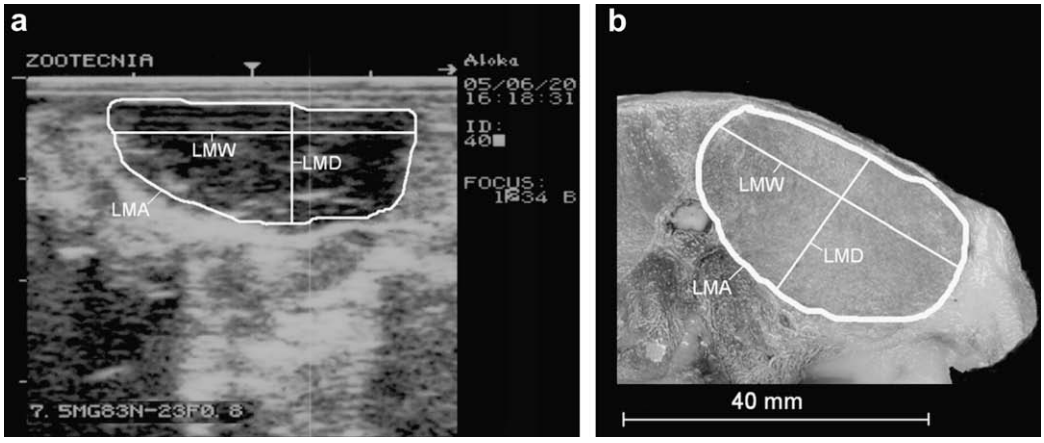

Fig. 1. Example of an ultrasound image taken *in vivo* by real time ultrasonography showing the representations of the *Longissimus thoracis et lumborum* muscle (LM) measurements (LM depth, LMD; LM width, LMW; LM area, LMA) (a) and the same measurements taken on a carcass joint (b).