Meat Science 80 (2008) 1031–1036

Contents lists available at ScienceDirect

Meat Science

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

The assessment of carcass composition of Awassi male lambs by real-time ultrasound at two different live weights

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ARTICLE INFO

Article history:
Received 17 October 2007
Received in revised form 14 April 2008
Accepted 24 April 2008

Keywords:
Awassi
Fat thickness
Longissimus dorsi muscle
Lamb
Ultrasound

ABSTRACT

The accuracy of ultrasonography to measure fat thickness (FT) and longissimus dorsi muscle (LM) traits (area, depth and width) in live Awassi male lambs and predict carcass FT and LM traits was studied. Twenty six Awassi male lambs were randomly divided into light (L) ($n = 13$) and heavy (H) ($n = 13$) finishing lambs. Slaughter weight of lambs in L and H groups were 40 and 45 kg, respectively. FT and LM traits, cross-sectional area between the 12th and 13th rib were measured using real-time ultrasound in vivo and on the carcass after slaughter. All ultrasound and carcass measurements were the same except live weight (LW) ($P < 0.001$), cold carcass weight (CCW) ($P < 0.001$) and carcass LM width ($P < 0.05$). Overall, correlation coefficients between ultrasound and carcass FT, LM depth, width and area were 0.79, 0.82 ($P < 0.001$); 0.60, 0.58 ($P < 0.05$); 0.48, −0.17 ($P > 0.05$) and 0.89, 0.87 ($P < 0.001$), respectively, for lambs in L and H groups. The introduction of ultrasound FT and ultrasound LM area as independent variables in addition to LW in the multiple regression equations further improved the variations for carcass FT (84%, 71%), carcass LM area (79%, 79%), CCW (72%, 65%) for lambs in light and heavy groups whereas no improvement was observed for carcass yield.

These results indicate that in vivo ultrasound FT and measurement of the LM area in association with LW could be used to estimate carcass FT, carcass LM area and CCW in different LW Awassi lambs.

1. Introduction

Meat quality is nowadays receiving major emphasis in sheep breeding (Gruszecki et al., 2001; Honikel, 1996). The quantity and quality of fat are important to consumers (Sendim, Albiac, Delfa, & Lahoz, 1997). In many countries, fat is an unpopular constituent of meat being considered unhealthy and consumers prefer lean meat and carcasses (Macit, 2002; Sanudo, Alfonso, Sanchez, Delfa, & Teixeira, 2000; Wood et al., 2007). Also there is a relationship between consumption of animal fat and an increased risk of cancer and heart disease (Department of Health, 1994). In addition fat is energetically expensive to produce (Macit, 2002; Romdhani & Djemali, 2006). Because of these reasons it is important to select meat animals with low amounts of fat on their carcass.

Knowing the carcass composition of live animals, the optimum age of slaughter can be identified that gives more muscle and less fat. Real-time ultrasound technology has value in predicting an animal's readiness for slaughter or for selection of sheep with superior carcass traits (Leeds, Mousel, Notter, & Lewis, 2007; Romdhani & Djemali, 2006; Stanford, Bailey, Jones, Price, & Kemp, 2001).

Ultrasound technology has been used successfully to predict live lamb carcass traits for many years. There are several studies on lamb carcass determination about non-fat-tailed lambs (Delfa, Teixeira, Gonzalez, & Blasco, 1995; Edwards et al., 1989; Fernandez, Garcia, Vergara, & Gallego, 1998; Kempster, Arnall, Alliston, & Blarker, 1982; Silva et al., 2007; Teixeira, Matos, Rodrigues, Delfa, & Cadavez, 2006) but little has been published about ultrasound use in fat-tailed lambs (Romdhani & Djemali, 2006; Sahin et al., 2007). But, approximately 87% of Turkey's sheep population (25.3 million heads) consist of fat-tailed breeds and one of the most common fat-tailed breeds is Awassi (TURKSTAT, 2007). The Awassi breed, found extensively in Southern Turkey, Iraq, Syria, Lebanon, Israel, Jordan and to a lesser extent in some other West Asian and North African countries (Gursoy, Pollott, & Kirk, 2001). According to Epstein (1985) a total of 65 million Awassi breeding ewes were two present in West Asia and North Africa. Because of these reasons, use of ultrasound on carcass traits in fat-tailed breeds might be helpful to compare the results with thin-tailed breeds.

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doi:10.1016/j.meatsci.2008.04.022

In addition, there is an increasing demand for light weight lamb carcasse and there is a need to estimate the reliability of ultrasound on light lamb carcass.

The objectives of this study were (1) to estimate the 12–13th longissimus muscle (LM) traits (depth, width and area) and fat depth in live Awassi lambs by ultrasound and (2) to estimate the relationship between carcass (muscle and fat) and ultrasound (muscle and fat) traits in two different live weight Awassi lamb groups.

2. Materials and methods

2.1. Animals

Lambs were handled according to the EU directive number 86/609/EEC concerning the protection of animals used for experimental and other scientific purposes. A total of 26 Awassi male lambs 6 months old were selected from a sheep flock of the Research and Applied Center of Uludag University Faculty of Veterinary Medicine. Two groups of 13 lambs were selected randomly. Lambs were born during February–March 2007. The lambs were reared with their dams and weaned at 60 days. All animals were kept under the same management conditions and they were fed *ad libitum* with totally mixed ration (16% crude protein and 2.78 Mcal/kg metabolizable energy) according to the NRC (1985) recommendations. All animals had free access to fresh water. Lambs were kept in a semi open sheep yard and were slaughtered randomly when they reached their previously determined slaughter weights of 40 or 45 kg live weight.

Lambs in light live weight group (L) were slaughtered at 39.73 ± 1.68 kg and those in the heavy group (H) were slaughtered at 45.08 ± 2.03 kg live weight. There is a fluctuation in lamb carcass weight in different years in Turkey which was 16.5 kg in 1994 and increased to 19.3 kg in 2002 but then decreased to 17.8 kg in 2005 (TURKSTAT, 2007). This change of lamb carcass weight in consecutive years was taken into account to estimate the reliability of the use of ultrasound on lambs of different live weight.

2.2. Ultrasound equipment

The ultrasound measurements were performed using a portable real-time ultrasound (Dynamic Imaging – MCV Concept model) which is a version of B-mode producing images almost instantaneously using a 7.5 MHz and 6 cm linear transducer. The resolution of the scanner calipers was 0.01 cm. Scanner maximum penetration depth was 8 cm with a 7.5 MHz probe.

2.3. Ultrasound measurements

Before measurement, wool was removed from the measurement areas by a clipper. To obtain the measurements, the animals were immobilized and acoustic gel was used to allow better contact between the probe and the skin of the animal. Lambs were scanned just before slaughter. Real-time ultrasound was used to measure the subcutaneous fat thickness (FT), over the longissimus dorsi muscle (LM) depth, width and area between the 12th and 13th ribs. The transducer was placed between the 12th and 13th ribs lateral to the vertebral column and parallel to the rib following physical palpation and preparation. All measurements were taken from the right side and 4 cm from the vertebral column of the lambs. After capturing the scan image the depth (ULMD), width (ULMW) and area of the longissimus dorsi muscle (ULMA) and the thickness of back fat (UFT) at the same point was measured using the electronic calipers of the scanner. LM area was measured on live lambs on the same image after the borders of the muscle had been drawn.

2.4. Carcass measurements

All lambs were slaughtered at a commercial slaughterhouse using a standard slaughtering procedure. The fore and the rear limbs (feet) were then separated at the radio-carpal and tarso metatarsal articulations, respectively. The pelt, head and all internal organs were removed. After being stored at +4 °C for 24 h in a conventional chill cooler. Carcasses were weighed without separating the tail and carcass yields were determined according to these weights. Then carcasses were split down the vertebral column with a band saw into two halves (right and left). The right half of each carcass was ribbed at the 12th and 13th ribs (on a slice cut through the side parallel to the back bone and passing through the probe sites) at the same anatomical point where measurements were taken on the live animal using ultrasonics. Cross-sectional area of LM and fat tissue were imaged over tatransparent film. Carcass LM area was calculated using a X-PLAN 380 dIII Digital Planimeter, Ushikata (Japan). FT, LM depth and width were measured on the transparent film surface by a Mitutoyo Absolute Digimatic & Vernier Caliper Series 551, Model CDN-20C and caliper have 0.01 mm resolution (Mitutoyo Corp., Japan).

2.5. Statistical analysis

All data were analyzed by analysis of variance using the ANOVA procedure to evaluate the source of variation, means comparison (paired *t*-test), Pearson correlations and regressions used the Minitab (Minitab 13, 2001) statistical program. Pearson correlation coefficients were determined between ultrasonic and carcass measures. Regression analysis was used to determine the equations to predict carcass composition. All data for subcutaneous fat, LM depth, width and area were estimated by multiple regression equations using live weight and ultrasound measurements. All regression analyses were performed to determine which independent variables best predicted carcass composition. The best regression equations were obtained using a stepwise procedure. The multiple regression equations were evaluated with the determination coefficient (R^2) and the residual standard deviation (RSD).

3. Results and discussion

Analysis of variance and mean comparisons between the two different live weight (LW) for the 26 lambs are presented in Table 1. There is no research yet on Awassi lambs using ultrasound measurements, therefore objective comparison was not possible.

As expected, ultrasound and carcass measures from lambs in the two groups were similar with the exception of live weight, cold carcass weight (CCW) and carcass longissimus dorsi muscle width (CLMW). These findings are in agreement with Macit (2002) who reported that CCW increased with increasing slaughter weight from 40 to 45 kg in Morkaraman ram lambs.

Different results have been reported for carcass fat thickness (CFT) by several researchers. According to Abdullah and Qudsieh (2008), CFT was increased with the increase of live weight of Awassi lambs (from 30 to 40 kg). On the other hand, CFT was not changed with the increase of live weight of fat-tailed Morkaraman lambs (from 40 to 45 kg) which was consistent with the findings of our results. According to our results it can be concluded that the increase in slaughter weight causes a significant increase of CFT.

Carcass yield (CY) did not change with increasing slaughter weight and previous studies supported our results (Macit, 2002; Macit, Esenbuga, & Karaoglu, 2002; Momani Shaker et al., 2002). Several researchers have reported different results regarding carcass longissimus muscle depth (CLMD). For instance, Abdullah