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Use of ultrasound technology in selecting meat quality in fat-tailed sheep

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Abstract

Real time ultrasound technology offers a possibility to estimate carcass characteristics in live animals and it represents a potential method for use in selection of breeding stocks. The objective of this work was to estimate genetic parameters of rib muscle and fat depth measured on live lambs by ultrasound. A total of 745 lambs born during 2001-2003 in two flocks was used in this study. Lambs came from 559 ewes and 97 rams of a fat tailed breed known as the "Barbarine" in North Africa. Ultrasound measurements of external fat thickness (UFD) and muscle (UMD) taken at the 12-13th rib and palpation of body conditions (loin and tail scores) were made from 150 d till 520 days of lamb ages. Variance components estimation of fat and muscle depth at 180 d, 200 d, 240d and 520 days of age were computed based on REML method using an additive model including Flock-year-month of lambing, sex of lamb, age of dam, genetic groups of sires and sires within groups. Main results showed that after 200 days of age UMD, UFD, loin and tail scores increased as live weights increase. The highest muscle depth for males was reached at 180 d and the lowest fat depth was recorded between 180 and 200 days. Average loin scores became greater for males than females from 240 days of age. Male lambs had greater tail scores at all ages. Regression equations estimating carcass traits (UMD, UFD) at 180 d and 240 d were computed. Phenotypic correlations were relatively small between fat depth, muscle depth and body scores (loin and tail) at 180 d and 240 d of age, respectively. Values varied from -.09 between fat depth and muscle depth at 180 d to .48 between loin and tail scores at 240 d. However, higher genetic correlations were obtained between ultrasound measured muscle and fat depths and muscle and fat depths measured on carcass. Heritabilities were higher for fat and muscle depths at 240 d of age but relatively low in other ages. Genetic correlations were relatively low between fat and muscle depths with a negative sign.

Key-words : sheep, meat, ultrasound, muscle, fat, genetic.

Introduction

The use of non-invasive imaging techniques such as ultrasound, X-ray tomography (CT) and magnetic resonance imaging (MRI), widely used in human medicine today, can have a great potential in animal science and production. Real-time ultrasound technology has been used to predict carcass characteristics in live animals. It has been used extensively in beef cattle (Stouffer et al., 1989; Herring et al., 1998) and on a limited basis in sheep (Edwards et al.,

1989; Hopkins, 1990). Tissue boundaries can be mapped and used to predict body composition (Simm, 1983 and 1992). The advantage of this method is its use on live animals, its high heritability and its relatively low costs (Olesen and Husab, 1994, Stanford et al., 1998). Bedhiaf and Djemali (2006) reported a description of carcass traits measured by ultrasound and identified the age where Barbarine animals have more muscle and less fat.

The objectives of this study were 1) to evaluate muscle and fat thickness by ultrasound techniques and 2) to estimate genetic parameters of carcass traits of Barbarine lambs.

Material and methods

Animals

A total of 745 lambs born during the period 2001-2003 in two flocks was used in this study. Lambs came from 559 ewes and 57 rams of a fat tailed breed known as the "Barbarine" breed in North Africa. Lambs were born during the period of September- November. At birth, lambs were ear tagged and weighed at seven different intervals of 20 days until weaning at 3 months of age. The first weighing occurred 20 days after the birth of the first lamb in the flock. The system of rearing is based mainly on natural pasture. However, concentrate are used as supplement during breeding and late gestation periods.

After weaning, *in vivo* ultrasound measurements of external fat thickness (UFD) and muscle depth (UMD) were taken at the 12-13th rib by using a real-time ultrasound (Bedhiaf et Djemali, 2006). Palpation of body conditions (loin and tail scores) were made using the technique of Russel and al., (1969) which employs a 1 to 5 score range and intervals of 0.25 units.

Variance components were estimated by REML based on the mixed model (2) and heritabilities and genetic correlations of carcass traits were computed. The model applied included, fixed effects of the i^{th} flock- year-month of lambing (FYM); the j^{th} sex of lamb (1: male, 2: female); the k^{th} age of dam (2, 3, 4, 5, 6, 7, $\geq$8), the l^{th} genetic groups; the m^{th} sires within n^{th} groups and the random residual error (e_{jklmno}).

$$Y_{ijkl} = \mu + FYM_i + Sex_j + Agd_k + G_l + S_m(G_n) + e_{jklmno}$$

where μ is the population mean.

Results and discussion

Trends of lamb carcass traits from 150 d to 520 days of age

Trends of live weights (W), ultrasound muscle (UMD) and fat (UFD) thickness and loin scores (LS) are shown in figure (1). Ultrasound muscle depth and fat depth followed the same trend 150 days to 520 days of age and may be later since this study did not go beyond this age.

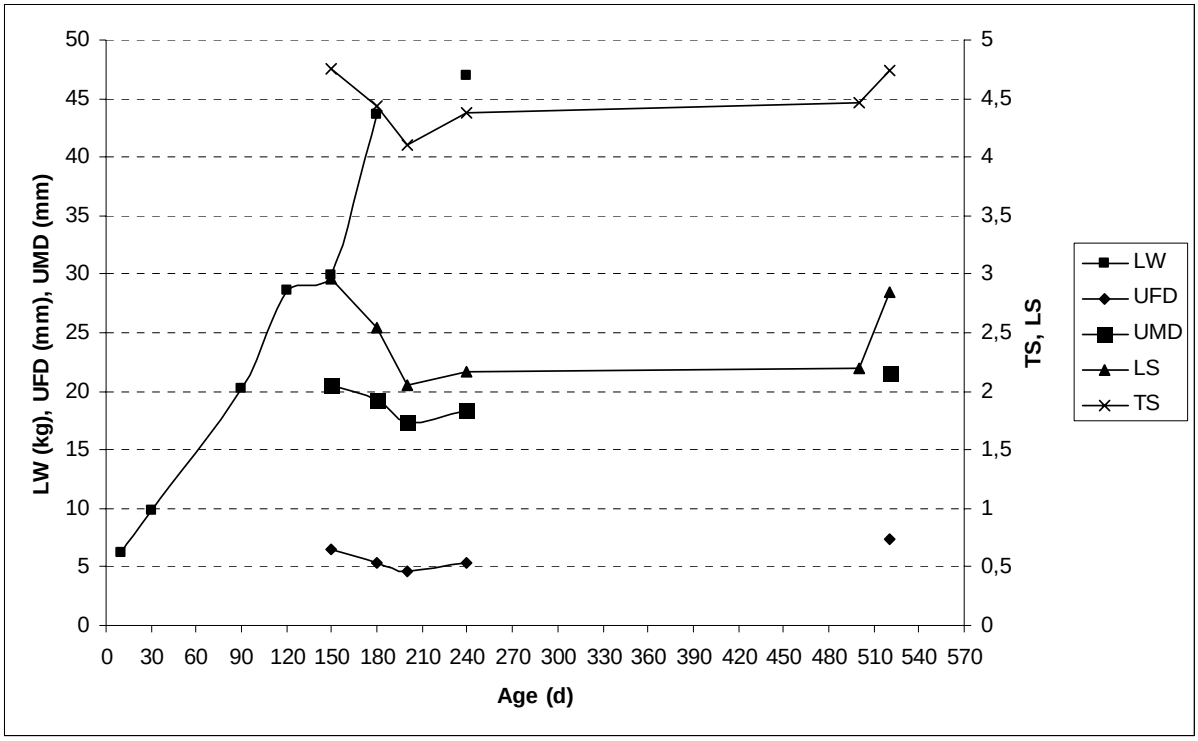

Figure 1. Trends of live weights, muscle and fat thickness and loin and tail scores

Both muscle and fat depths decreased from 150 d until 200 d and then increased. Loin scores showed a similar trend as muscle and fat.

In the case of Barbarine lambs, loin scores are a translation of fat depth and not muscle depth as seen in figures 2, 3 and 4 and described by Bedhiaf and Djemali (2006).
All these measured carcass traits (UMD, UFD and LS) showed that between 180d and 200d of age, Barbarine lambs reached more muscle depth and have the lowest fat depth. This age could be chosen as an optimum slaughter age for Barbarine lambs raised in low input production systems.

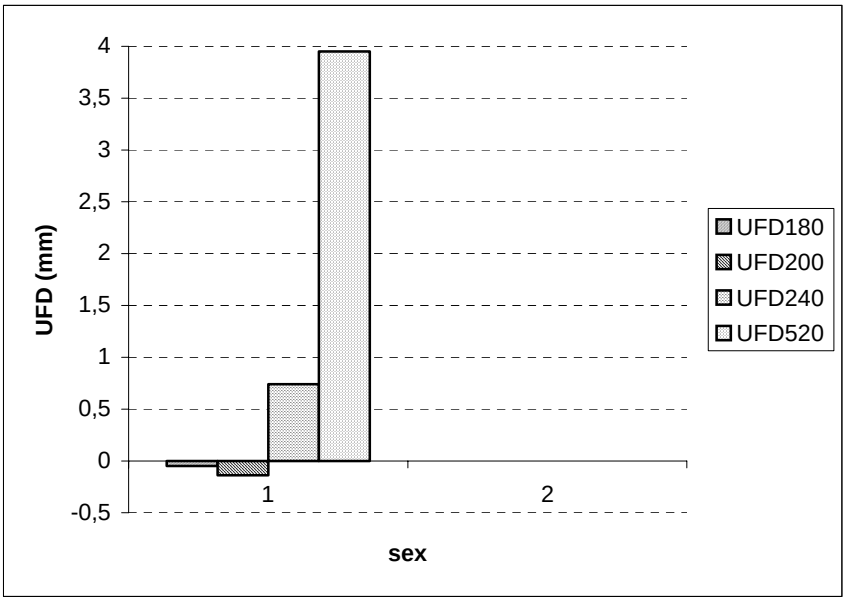

Figure 2. Effect of sex (1: male, 2: female) of lamb on fat depth

Figure 3. Effect of sex of lamb on muscle depth

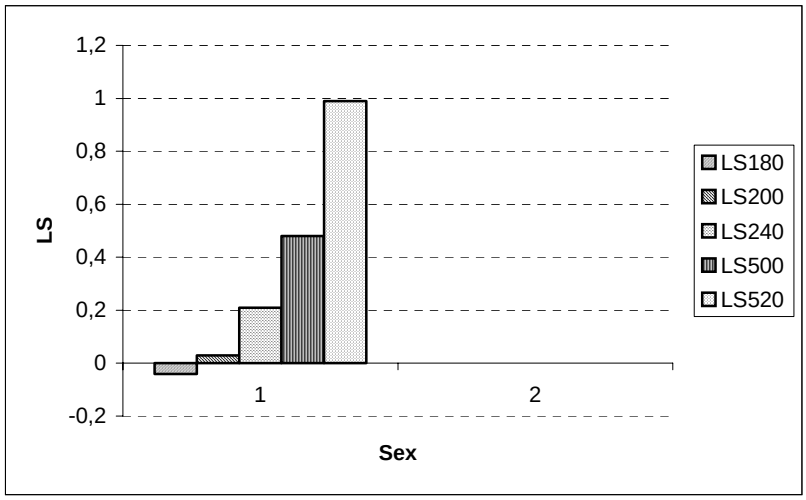

Figure 4. Effect of sex of lamb on loin score

Heritability of carcass traits

Heritability estimates of UMD and UFD at different ages 180d, 200d, 240d and 520 days are reported in table (1). All heritability values were low varying from .013 to .099, exception made for both traits measured at 240 d. Heritability estimates at 240 days were .20 and .27 for UFD and UMD, respectively.

Table 1. Heritability estimates of UMD and UFD of Barbarine lambs.

Trait	Age	N	Heritability	s.e
UMD	180	341	.09	.09
	200	185	.06	.09
	240	319	.20	.14
	520	166	.10	.09
UFD	180	341	.01	.03
	200	185	.02	.06
	240	319	.27	.16
	520	166	.10	.13

Phenotypic correlations

Phenotypic correlations among muscle depth, fat depth, loin scores and live weights measured at 180 d of age are in table (2). Most correlation values were low (from .06 to .39). A negative correlation was found between muscle depth and fat depth.

Table 2. Phenotypic correlations between live weight, muscle, fat and loin scores at 180 days

Traits	UMD180	UFD180	LS180
W180	.12	.06	0.21
UMD180		-0.09	0.39
UFD180			0.21

At 240 days of age, all correlation values become greater than the ones computed at 180 days but without reaching 50% (table 3).

Table 3. Correlations between muscle, fat traits and body scores at 240 days of age

Traits	UMD240	UFD240	LS240
W240	0.42	0.40	0.32
UMD240		0.20	0.40
UFD240			0.28

Direct measurement of muscle and fat at 240 d of age allowed computing phenotypic correlations between these two traits and their measurements by ultrasound techniques (table 4). Phenotypic correlations were .66 and .36 between direct muscle depth and UMD and direct fat depth and UFD, respectively.

Table 4. Phenotypic correlation between direct measurement of muscle and fat thickness and ultrasound measurement

Traits	AMD	AFD
UMD	0.66	0.38
UFD	0.31	0.36

Genetic correlation

Regression

Regression equations were established between direct measurement of muscle and fat thickness and their ultrasound measurements (table 6).

Table 6. Linear equations of carcass traits

Dependent trait	Independent trait	Regression coefficient	Intercept	R^2
AFD	UFD	.47	1.39	.18
AMD	UMD	.34	11.26	.28

Ultrasound muscle and fat thickness were estimated based on live weights at 180 d and 240 d of age. Linear equations parameters are shown in table 7.

Table 7. Linear equations between ultrasound measurements of muscle and fat and live weights at 180 d and 240 d of age.

Dependent trait	Independent trait	Regression coefficient	R^2
UMD180	W180	.54	.98
UFD180	W180	.15	.94
UMD240	W240	.44	.99
UFD240	W240	.14	.96

Conclusion

Ultrasound technology allowed monitoring muscle and fat thickness of live Barbarine lambs at different ages. It has been identified that the age between 180-200 days was as an optimum slaughter age leading to more muscle and less fat in the carcass. This result has its market implication on consumers who become very resistant to fat in the carcass even in developing countries where energy is often lacking to their diet. Real-time ultrasound measurements have practical values for the producer to predict animals' readiness for slaughter or for use in selecting animals with superior carcass traits.

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