*J. Agr. Sci. Tech. (2014) Vol. 16: 791-800*

# Accuracy of Real-time Ultrasonography in Assessing Carcass Traits in Torki-Ghashghaii Sheep

S. M. Hosseini Vardanjani[1], S. R. Miraei Ashtiani[1*], A. Pakdel[1], and H. Moradi Shahrebabak[1]

## ABSTRACT

**The possibility of *in vivo* carcass trait prediction using the ultrasound measurements obtained between 12th and 13th ribs was studied. Attention was paid to several carcass traits such as carcass backfat thickness (CBFT), carcass longissimus dorsi muscle (CLMA) and carcass weight (HCW). Also, the effects of the flock, as the fixed effects, and body weight (BW), as covariate, on these traits were considered. The study was carried out on 99 lamb of Torki-Ghashghaii breed from 4 flocks. BW had significant effects (P< 0.001) on HCW, Fat-tail, CBFT, and CLMA, but had no significant effect on carcass longissimus dorsi muscle depth (CLMD) and width (CLMW). The flock had a significant effect (P< 0.0001) on HCW and CBFT, only. The correlations between ultrasound and carcass measurements, before and after adjustment for flock effect, ranged between (0.27 to 0.80) and (0.22 to 0.78), respectively. Estimates of CBFT, CLMW, CLMD and CLMA based on the corresponding ultrasound measurements explained 49%, 29%, 59%, and 64% of their variation, respectively. BW explained 57% variation of HCW and only 12% variation of Fat-tail. The introduction of two or three ultrasound measurements by stepwise procedure in the multiple regression equations improved the explanation of variation for all traits by 0.01 up to 0.13. The results indicate that ultrasound has potential for carcass traits prediction in live Torki-Ghashghaii sheep.**

**Keywords:** Backfat, Correlation, Longissimus dorsi muscle, Regression, Ultrasound.

## INTRODUCTION

Carcass quality is an important goal of sheep meat industry, which is achieved after quantitative and qualitative carcass evaluation both *in vivo* and at slaughter house. However, carcass traits cannot be directly measured on live animals and, therefore, to estimate carcass composition of selected live lambs, use of suitable techniques to accomplish that goal is necessary. The most commonly used techniques are based on linear measurements or subjective assessments. The subjective measurements on a live animal exhibit some indications of the quality of the carcass, but these measurements are not always reliable (Swatland *et al.*, 1994) since, sometimes, there are many differences between animals. The keys to changing carcass trait to better meet consumer demand are methods of evaluating body composition *in vivo* (Stanford *et al.*, 1998). Therefore, one of the important goals in the meat industry is to have an accurate, low cost, and easy method for assessing the economically important carcass traits and determine the value of the carcass on live animals. These methods should be rapid and non-destructive, with lower risk of human error for potential industrial application (Prevolnik *et al.*, 2011).

Ultrasound machines have the potential to predict carcass composition on live animals. In recent years, real-time

[1] Department of Animal Sciences, College of Agriculture, University of Tehran, Karaj, Islamic Republic of Iran.
[*] Corresponding author; e-mail: ashtiani@ut.ac.ir

ultrasound technology has shown practical value for selection of sheep with superior carcass traits in the breeding programs (Bedhiaf Romdhani and Djemali, 2006). Ultrasound scanning of fat and muscle depth is a valuable way to predict carcass fat, carcass lean, and muscle. Some researchers have shown statistically significant correlations between ultrasound measurements and their actual measurements on carcass (Stanford *et al*., 2001; Junkuszew and Ringdorfer, 2005; Teixeira *et al*., 2006; Ripoll *et al*., 2009; Orman *et al*., 2010). This high correlation demonstrated the aptness of ultrasound measurements in the selection programs which aim to improve carcass quality (Cemal *et al*., 2007). Furthermore, those reports show that regression models which are usually developed by combining different traits of body measurements and ultrasonic measurements provide good predictions of carcass traits.

Hitherto, few researches using ultrasound to measure longissimus dorsi muscle and backfat thickness have been conducted on sheep in Iran. Torki-Ghashghaii sheep is an indigenous fat-tailed breed in Iran. Most of the 1.5 million Torki-Ghashghaii sheep are mostly distributed in the north-east, west, and south-west of the Fars province, and in Kohgilouye and Boyerahmad, Isfahan, and Boushehr provinces (Safdarian *et al*., 2008). This breed is physically large and muscular and the physical maturity weight of this breed is 60-65 kg. The fat-tail is an important component of the total body weight in this breed.

However, the objectives of the present work were to: (1) evaluate the effect of flock and body weight on some carcass trait, (2) investigate the relationship between ultrasound measurements on live animal with their actual measurements on carcass, and (3) establish regression models to predict carcass composition by using ultrasound measurements in Torki-Ghashghaii sheep.

## MATERIALS AND METHODS

### Animals

The experimental group consisted of ninety-nine male sheep from Torki-Ghashghaii fat tailed breed. These animals are selected from the four traditional flocks in Shiraz city after fattening period. The lambs were weaned during May of 2011 and reached their target weights by mid-November, 2011. Feeding was based on dry alfalfa and commercial lamb concentrate feed fed ad libitum. Fresh water was supplied ad libitum.

### Measurements of Live Animals and Their Carcass

To minimize measurement errors due to the filled rumen, prior to body weight measurements and subsequent ultrasound measurements, lambs were not fed 12 hours before slaughter but water was provided. Just before slaughter, animals were scanned for backfat thickness (UBFT), longissimus dorsi muscle depth (ULMD), width (ULMW) and area (ULMA) with a Pie Medical Falco 100, B mode real-time ultrasound machine (RTU) with an 8 MHz linear probe and a 6.8 cm length (Pie Medical, The Netherlands). In order to do the ultrasound measurements, wool was removed from the measurement site by shearing at the $12^{th}$ and $13^{th}$ rib position on the right side. To obtain the RTU images, the sheep were immobilized and a gel was applied to allow a better contact between the probe and the skin of the sheep. The animals were held manually while the operator scanned this region. The probe was placed between the $12^{th}$ and $13^{th}$ ribs lateral to the vertebral column and parallel to the rib. At this site, RTU images were taken for measurements of backfat thickness, longissimus dorsi muscle depth, width and area. After RTU measurements, the body weight (BW) of all animals was recorded.





[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]

Then, the lambs were slaughtered by conventional method within the abattoir. The fore and the limbs were then separated at the radio-carpal and tarso-metatarsal articulations, respectively, and the pelt, head, and all internal organs were removed, non-carcass fat depots (omental, mesenteric, kidney and pelvic fat) were removed and, finally, carcass was weighted and recorded as Hot carcass weight (HCW). All the carcasses were transferred to cool room at 4°C for 24 hours. After this term, the fat tail was separated and weighed. The carcasses were split into two equal carcass parts, i.e. right and left. The right carcasses were ribbed at the $12^{th}$ and $13^{th}$ ribs and then the subcutaneous fat depth, width and the depth of longissimus dorsi muscles in this region were measured by using the caliper. To measure the area of the longissimus dorsi muscle, a picture of this area was drawn by using a semi-transparent tracing paper used in drawing and design (Calc paper).

## Image Analysis

The measurements related to the backfat thickness and longissimus dorsi muscle were obtained by using Image tools software (UTHSCSA, Image tool, Version 2.00, 1996). The ultrasound images of backfat and longissimus dorsi muscle were introduced to a software to calculate the dimensions.

## Statistical Calculations

Collected data were analyzed using SAS (Statistical Analysis Systems Institute, Version 9.1) software. HCW and other carcass measurements were analyzed using GLM procedure, according to the following linear model:

$$Y= \mu+Flock_i+b(BW_{ij} -BW)+e_{ijk}$$

Where, $Y$= Trait measurements, $\mu$= Overall means of the trait, $Flock_i$ = Fixed effect of Flock (i= 1, 2, 3 and 4), $b$= Regression coefficient of body weight, $BW_{ij}$ = Body weight, $B$W= Mean body weight, and $e_{ijk}$ is random error with the assumption of N $(0, \sigma^2)$.

The correlation coefficients between the ultrasound and carcass measurement were estimated by “Proc Corr”. Moreover, the univariate regression and multivariate regression were estimated by “Proc Reg”, by using body weight as the independent variable and the other carcass traits as dependent variables. In addition to body weight, multiple regression equations were performed by including another ultrasound measurement as independent variable. Finally, the best regression equations were obtained by using a stepwise procedure. The best models were evaluated by the value of Coefficient of Determination ($R^2$) and by the residual standard deviation (RSD) as criteria.

## RESULTS AND DISCUSSION

Basic mean values, SE, Min, Max and CV for carcass and RTU measurements are presented in Table 1.

The average of carcass backfat depth in these lambs was 9.47 mm in average 65.2 kg of body weight. Other authors reported carcass and ultrasound backfat thickness values of 6.2 and 8.5 mm in a total of 96 purebred Suffolk (SU; n= 44) and Dorset (DP; n= 52) lambs, respectively, but the range of empty BW in implicit research was 36 to 55.8 kg (Thériault *et al*., 2009), which is different than the BW in the present research. Also, the mean subcutaneous fat depth as measured on carcass of 4 sheep breeds (Poll Dorset, Suffolk, Wiltshire Horn and Coop Worth) was 4.9±2.65 mm and covered a range of 14 mm (Hopkins, 1990), which seems lower than backfat depth for Torki-Ghashghaii sheep.

The average values for carcass longissimus dorsi muscle area, depth, and width were 18.69 $cm^2$, 38.54, and 63.39 mm, respectively. This result is in agreement with Fernández *et al*. (1998) who reported that the mean value of longissimus dorsi muscle depth and width were 33.86 and 61.14 mm,





[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]

**Table 1.** Basic statistics for carcass and ultrasound measurements.

| Trait | Mean±SE | Minimum | Maximum | CV (%) [l] |
|---|---|---|---|---|
| BW (kg) [a] | 65.23±0.61 | 52.00 | 81.00 | 9.36 |
| HCW (kg) [b] | 29.10±0.27 | 22.5 | 36.9 | 9.34 |
| Fat-tail (kg) | 7.03±0.14 | 3.70 | 12.00 | 20.80 |
| CBFT (mm) [c] | 9.47±0.24 | 4.80 | 15.00 | 25.35 |
| CLMA ($cm^2$) [d] | 18.69±0.19 | 13.91 | 24.08 | 10.36 |
| CLMW (mm) [e] | 63.39±0.83 | 42.00 | 85.00 | 13.12 |
| CLMD (mm) [f] | 38.54±0.65 | 26.00 | 55.00 | 16.95 |
| UBFT (mm) [g] | 5.55±0.17 | 2.01 | 11.20 | 31.36 |
| ULMA ($cm^2$) [h] | 15.85±0.13 | 12.93 | 18.4 | 8.44 |
| ULMW (mm) [i] | 42.50±0.68 | 31.00 | 58.00 | 16.03 |
| ULMD (mm) [k] | 31.91±0.61 | 16.00 | 51.00 | 19.06 |

[a] Body Weight; [b] Hot Carcass Weight; [c] Carcass Backfat Thickness; [d] Carcass Longissimus dorsi Muscle Area; [e] Carcass Longissimus dorsi Muscle Width; [f] Carcass Longissimus dorsi Muscle Depth; [g] Ultrasound Backfat Thickness; [h] Ultrasound Longissimus dorsi Muscle Area; [i] Ultrasound Longissimus dorsi Muscle Width; [k] Ultrasound Longissimus dorsi Muscle Depth, [l] Coefficient of Variation

respectively, in Manchego lambs. However, in comparison with the other breeds such as Awassi male lambs at 45 kg of body weight, the average values for carcass longissimus dorsi muscle depth and width were 25.15 and 58.15 mm, respectively (Orman *et al*., 2008). The longissimus dorsi muscle area and depth for Akkaraman lambs were found to be 12.25 $cm^2$ and 22.05 mm at average 41.58 kg of slaughter weight (Sahin *et al*., 2008). In comparison with 96 lambs (Suffolk 44 and Dorset 52) the CLMA was 16.28 $cm^2$ (Thériault *et al*., 2009). That is almost similar to the present study.

The results of analysis of variance for the examined traits according to different flocks as fixed effect and body weight as covariate are presented in Table 2.

The body weight had a significant effect on HCW (P< 0.0001), Fat-tail (P< 0.001), CBFT (P< 0.0004), and CLMA (P< 0.0001). These results are in agreement with research on Awassi ram lambs that was reported by Abdullah and Qudsieh (2008) that HCW, fat depth and longissimus dorsi muscle area increased with increasing slaughter weight. Again, this result is in agreement with Fernández *et al*. (1998) who have reported that the CBFT and CLMA increased with increasing slaughter weight from 25 to 35 kg in Manchego lambs.

Also, flock just had a significant effect on carcass backfat thickness and hot carcass weight (P< 0.0001). It is reported that the flock has a significant effect on backfat in Kivircik lambs and no significant effect on CLMD (Cemal *et al*., 2007). The present study obtained the same result. However, these results suggest that genetic potential and environmental factors differ between herds. Therefore, these items should be considered in breeding programs for Torki-Ghashghaii breed.

Simple correlation coefficients between

**Table 2**. Test of significance (F) for carcass measurement of Torki-Ghashghaii sheep.

| Factor | DF [a] | HCW [b] | Fat-tail | CBFT [c] | CLMA [d] | CLMW [e] | CLMD [f] |
|---|---|---|---|---|---|---|---|
| Flock | 3 | < 0.0001 | 0.099 | < 0.0001 | 0.86 | 0.16 | 0.57 |
| Body weight | 1 | < 0.0001 | 0.001 | 0.0004 | < 0.0001 | 0.86 | 0.18 |
| Residual DF | | 94 | 94 | 94 | 94 | 94 | 94 |
| $R^2$ | | 0.66 | 0.18 | 0.51 | 0.34 | 0.06 | 0.04 |

[a] Degrees of Freedom; [b] Hot Carcass Weight; [c] Carcass Backfat Thickness, [d] Carcass Longissimus dorsi Muscle Area; [e] Carcass Longissimus dorsi Muscle Width; [f] Carcass Longissimus dorsi Muscle Depth.





[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]

ultrasound and carcass measurements, as shown in Table 3, indicate that ultrasound and actual measurement were highly correlated.

All results in Table 3 indicate that ultrasound methods can be used to accurately predict CBFT, CLMA, CLMD, and CLMW in sheep. However, the highest correlation *r*= 0.80, (P< 0.0001), was observed between ultrasound longissimus muscle area (ULMA) and carcass longissimus muscle area (CLMA). Correlation between CLMA and ULMA was 0.78 after adjusting for flocks effects (Table 4). This parameter is 0.75 (P< 0.01) in lambs that were produced as part of a terminal sire breed after adjusting for breed of sire effects (Leeds *et al*., 2008). Also, Sahin *et al.*, (2008) reported the highest correlation between ULMA and CLMA (r = 0.82; P < 0.01) in fat-tailed Akkaraman lambs which is similar to the present study (Sahin *et al*., 2008).

Moreover, high and significant correlation coefficient was found *r*= 0.70, (P< 0.0001), between UBFT and CBFT values in the Torki-Ghashghaii sheep. The correlation coefficient found in Akkaraman lambs by Sahin *et al*. (2008) was slightly higher (0.77) than that observed in the present study. It is reported that the correlation between CBFT and UBFT at the 2 cm and 4cm from spinal column with their corresponding carcass measurements were 0.54 and 0.90 (Fernández *et al*., 1998). In contrast, in fat-tailed Barbarine sheep, this parameter was reported 0.43, which is lower than the value found in the present study (Bedhiaf Romdhani and Djemali, 2006).

There were high correlation coefficients between ULMD and CLMD *r*= 0.77, (P< 0.0001). The coefficient found in the present study were greater than that found previously: r = 0.60, (P< 0.01), in Akkaraman lambs (Sahin *et al*., 2008). Also, reported correlation coefficients between ULMD and CLMD was 0.53 in the fat-tailed Barbarine sheep (Bedhiaf Romdhani and Djemali, 2006), whereas the correlation coefficients between ULMD and CLMD was 0.83 for Manchego lambs (Fernández *et al*., 1998).

In Torki-Ghashghaii sheep, the correlation coefficient between ULMW and CLMW was *r*= 0.54, (P< 0.0001), too. The same correlation coefficients reported in male and female of Awassi lambs were 0.57 and 0.58, respectively (Orman *et al*., 2010). Correlations among ULMW and CLMW were marginally lower than the estimates of the phenotypic correlations reported for purebred Manchego lambs (Fernández *et al*., 1998).

Phenotypic correlations between ultrasound and carcass measurements after adjustment for flock effects are shown in Table 4.

Adjustment for variation in flock had little effect on the size of the correlations between most ultrasound and carcass measurements included in Table 3. All residual correlations, after adjusting for flock effects, were positive (0.22≤ r≤ 0.78) and different from 0 (P< 0.02), except two cases (ULMD with CBFT and CLMW). Generally, values of the greatest changes were about 0.14 less

**Table 3**. Correlations between ultrasound and carcass measurements of fat and longissimus dorsi muscle.

| Trait | UBFT [e] | ULMW [f] | ULMD [g] | ULMA [h] |
|---|---|---|---|---|
| CBFT [a] | 0.70 (<0.0001) | 0.45 (<0.0001) | 0.09 (N.S) | 0.32 (0.001) |
| CLMW [b] | | 0.54 (<0.0001) | 0.04 (N.S) | 0.31 (0.001) |
| CLMD [c] | | | 0.77 (<0.0001) | 0.27 (0.006) |
| CLMA [d] | | | | 0.80 (<0.0001) |

[a] Carcass Backfat Thickness, [b] Carcass Longissimus dorsi Muscle Width; [c] Carcass Longissimus dorsi Muscle Depth; [d] Carcass Longissimus dorsi Muscle Area; [e] Ultrasound Backfat Thickness; [f] Ultrasound Longissimus dorsi Muscle Width; [g] Ultrasound Longissimus dorsi Muscle Depth; [h] Ultrasound Longissimus dorsi Muscle Area.





[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]

**Table 4**. Residual correlations, after adjusted for flock effect, between ultrasound and carcass measurements.

| Trait | UBFT [e] | ULMW [f] | ULMD [g] | ULMA [h] |
|---|---|---|---|---|
| CBFT [a] | 0.58 (<0.0001) | 0.31 (0.002) | 0.07 (N.S) | 0.22 (0.02) |
| CLMW [b] | | 0.56 (<0.0001) | 0.04 (N.S) | 0.30 (0.002) |
| CLMD [c] | | | 0.77 (<0.0001) | 0.26 (0.008) |
| CLMA [d] | | | | 0.78 (<0.0001) |

[a] Carcass Backfat Thickness, [b] Carcass Longissimus dorsi Muscle Width; [c] Carcass Longissimus dorsi Muscle Depth; [d] Carcass Longissimus dorsi Muscle Area; [e] Ultrasound Backfat Thickness; [f] Ultrasound Longissimus dorsi Muscle Width; [g] Ultrasound Longissimus dorsi Muscle Depth; [h] Ultrasound Longissimus dorsi Muscle Area.

than the unadjusted phenotypic correlations.

The highest changes in the correlation coefficients were for the correlation between UBFT and CBFT and between CBFT and ULMW, which decreased from 0.70 to 0.58 and from 0.45 to 0.31, respectively, indicating that the flock had very significant effect on CBFT. A high correlation $r$= 0.80 between ultrasound backfat and carcass backfat adjusted for breed-of-sire effects has been reported by Leeds *et al*. (2008).

BW or ultrasound carcass measurements were used as independent variables to estimate HCW and other carcass traits, as dependent variables. The results are shown in Table 5. Coefficient of determination of the simple regression equations ranged from 0.12 to 0.64. The potential of BW and ultrasound measurements *in vivo* as predictors of measurements made in carcass was high, especially for muscle area measurements, HCW, and fat depth.

Carcass weight is an important trait in the grading system together with fat content, sex, age, and the commercial cut percentage in the categorization of lamb carcasses into commercial types (Abdullah and Qudsieh, 2008). However, according to the results of the current study, the regression coefficient for estimation of HCW based on BW was 0.335, indicating that for each unit change in body weight, hot carcass weight would change 33.5%. The coefficient of determination for this equation was ($R^2$= 0.57 and RSD= 1.79), indicating body weight as a better predictor to estimate carcass weight. But, BW explained only, 12% of the variation of Fat-tail. Also, it is reported that BW explained 64% of variation of cold carcass weight in Awassi male lambs (Orman *et al*., 2008) and 36% of

**Table 5**. Simple regression equations to predict carcass traits by using BW or ultrasound measurements.

| Dependent variable | | | Independent variable | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BW [f] | UBFT [g] | ULMA [h] | ULMW [i] | ULMD [k] | $R^2$ | *RSD* [l] | *Pr> F* [m] |
| HCW [a] | 0.335 | - | - | - | - | 0.57 | 1.79 | <0.0001 |
| Fat-tail | 0.084 | - | - | - | - | 0.12 | 1.37 | 0.0003 |
| CBFT [b] | - | 0.970 | - | - | - | 0.49 | 1.7 | <0.0001 |
| CLMA [c] | - | - | 1.154 | - | - | 0.64 | 1.1 | <0.0001 |
| CLMW [d] | - | - | - | 0.660 | - | 0.29 | 7.04 | <0.0001 |
| CLMD [e] | - | - | - | - | 0.828 | 0.59 | 4.17 | <0.0001 |

[a] Hot Carcass Weight; [b] Carcass Backfat Thickness; [c] Carcass Longissimus dorsi Muscle Area; [d] Carcass Longissimus dorsi Muscle Width; [e] Carcass Longissimus dorsi Muscle Depth; [f] Body Weight; [g] Ultrasound Backfat Thickness; [h] Ultrasound Longissimus dorsi Muscle Area; [i] Ultrasound Longissimus dorsi Muscle Width; [k] Ultrasound Longissimus dorsi Muscle Depth; $R^2$: Determination coefficient, [l] Residual standard deviation, [m] p-value





[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]

variation of Fat-tail in Akkaraman lambs (Sahin *et al*., 2008).

The UBFT in this study explained 49% of the variation of CBFT, while other researchers have reported that ultrasound measurements of fat depth over the 13th thoracic vertebra and at the third sternebra of the breast bone explains 83.5 and 53.9% of the variation of the corresponding measurements on carcass (Silva *et al*., 2006). The latter values are higher than coefficients observed in this study. It should be noted that those authors used a 5 MHz probe, which might have influenced the results. The ULMD and ULMA at the simple regression equation explained 59 and 64% of variation of the corresponding measurements of the carcass and accuracy of prediction showed very little increase by adding ULMW (for estimation of CLMD) and ULMD (for estimation of CLMA) to models (Table 6).

Estimates of carcass composition based on BW and ultrasound measurements or several ultrasound measurements were investigated and the results are summarized in Table 6.

The highest improvement was achieved in the model for prediction of CLMW, including BW and ULMA. In addition, ULMW improved the accuracy of the prediction model by 13% and led to a decrease in *RSD* of 0.63. The introduction of ULMA and UBFT as independent variables in addition to BW in multiple regression equation improved the explanation of the variation by 3% (57–60%) for the hot carcass weight and decreased *RSD* by 5%.

Estimation of CBFT based on live weight and the UBFT explained 71% of variation (Orman *et al*., 2008, which is clearly higher than the coefficient of determination in the present study. Aso, in their research, 79% of variation in CLMA could be explained by live weight and ULMA ).

The flock effect was included in the prediction of hot carcass weight and carcass backfat thickness. The results are shown in Table 7.

When flock effect was fitted in the models, the accuracy of predication was improved by

**Table 6**. Multiple regression equation to predict carcass traits by using BW and ultrasound measurement.

| Dependent variable | | | Independent variable | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BW [f] | UBFT [g] | ULMA [h] | ULMW [i] | ULMD [k] | $R^2$ | RSD [l] | C(p) [m] | Pr>F [n] |
| HCW [a] | 0.242 | 0.257 | 0.339 | - | - | 0.60 | 1.74 | 4.00 | <0.0001 |
| Fat-tail | 0.102 | -0.192 | - | 0.036 | - | 0.18 | 1.34 | 3.01 | 0.0003 |
| CBFT [b] | 0.057 | 0.757 | - | 0.080 | - | 0.57 | 1.6 | 3.00 | <0.0001 |
| CLMA [c] | - | - | 1.066 | - | 0.041 | 0.65 | 1.15 | 1.82 | <0.0001 |
| CLMW [d] | -0.617 | - | 3.049 | 0.695 | - | 0.42 | 6.41 | 2.89 | <0.0001 |
| CLMD [e] | - | - | - | -0.102 | 0.828 | 0.61 | 4.14 | 2.31 | <0.0001 |

[a] Hot Carcass Weight, [b] Carcass Backfat Thickness, [c] Carcass Longissimus dorsi Muscle Area, [d] Carcass Longissimus dorsi Muscle Width, [e] Carcass Longissimus dorsi Muscle Depth, [f] Body Weight, [g] Ultrasound Backfat Thickness, [h] Ultrasound Longissimus dorsi Muscle Area, [i] Ultrasound Longissimus dorsi Muscle Width, [k] Ultrasound Longissimus dorsi Muscle Depth, $R^2$: Determination coefficient, [l] Residual standard deviation, [m] mallows statistic, [n] p-value.

**Table 7**. Residual standard deviations and coefficients of determination for the prediction HCW and CBFT.

| Trait | Equations | $R^2$ | RSD [g] |
|---|---|---|---|
| HCW [a] | Flock + BW [c] + UBFT [d] + ULMA [e] | 0.70 | 1.53 |
| CBFT [b] | Flock + UBFT + BW + ULMW [f] | 0.65 | 1.47 |

[a] Hot Carcass Weight, [b] Carcass Backfat Thickness, [c] Body Weight, [d] Ultrasound Backfat Thickness, [e] Ultrasound Longissimus dorsi Muscle Area, [f] Ultrasound Longissimus dorsi Muscle Width, $R^2$: Determination coefficient, [a] Residual standard deviation.

10 and 8% for HCW and CBFT, respectively. Also, *RSD* was decreased in two models. This result indicates that fitting equations should be based on each individual breeding system and their effects. Thus, prediction equations should be determined for each breed according to the production system and, therefore, a general guideline cannot be applied (Teixeira *et al*., 2008). Nevertheless the equations of the present study are suitable to be used by researchers in similar conditions.

## CONCLUSIONS

Several authors have previously used the real-time ultrasound devices to predict carcass measurements. The significant relationship between ultrasound and carcass measurement of the present study confirms the usefulness of ultrasound to estimate backfat depth and especially muscle measurement in Torki-Ghashghaii breed. This result can support the ultrasound technology as an accurate tool for selecting animals in breeding stock and a good marketing tool to estimate carcass traits of sheep. Actually, the ability to measure backfat depth and longissimus dorsi muscle in the live Torki-Ghashghaii breed will allow identification of superior breeding animals and the use of backfat depth and longissimus dorsi muscle in single-or multiple-trait selection programs. Also, it could be concluded that the combination of BW with some ultrasound measurements generally accounted for the majority of the variation of carcass traits. However, further investigation is necessary to develop and validate specific models for prediction of carcass trait in the future. In addition, more research is needed to investigate the potentials of the ultrasound technique for predicting carcass traits in other breeds and with updated technology.

## REFERENCES

1. Abdullah, A. Y. and Qudsieh, R. I. 2008. Carcass Characteristics of Awassi Ram Lambs Slaughtered at Different Weights. *Livest Sci.,* **117:** 165-175.
2. Bedhiaf Romdhani, S. and Djemali, M. 2006. Estimation of Sheep Carcass Traits by Ultrasound Technology. *Livest Sci.*, **101:** 294-299.
3. Cemal, I., Karaca, O., Altin, T., Gokdal, O., Yilmaz, M. and Yilmaz, O. 2007. Ultrasound Measurements of Eye Muscle Properties and Backfat Thickness in Kivircik Lambs. *J. Biol. Sci.,* **7:** 89-94.
4. Fernández, C., García, A., Vergara, H. and Gallego, L. 1998. Using Ultrasound to Determine Fat Thickness and Longissimus Dorsi Area on Manchego Lambs of Different Live Weight. *Small Rumin. Res.,* **27:** 159-165.
5. Hopkins, D. 1990. The Use of Ultrasound to Predict Fatness in Lambs. *Meat Sci.,* **27:** 275-281.
6. Junkuszew, A. and Ringdorfer, F. 2005. Computer Tomography and Ultrasound Measurement as Methods for the Prediction of the Body Composition of Lambs. *Small Rumin. Res*., **56:** 121-125.
7. Leeds, T., Mousel, M., Notter, D., Zerby, H., Moffet, C. and Lewis, G. 2008. B-mode, Real-time Ultrasound for Estimating Carcass Measures in Live Sheep: Accuracy of Ultrasound Measures and Their Relationships with Carcass Yield and Value. *J. Anim. Sci.,* **86:** 3203-3214.
8. Orman, A., Caliskan, G. and Dikmen, S. 2010. The Assessment of Carcass Traits of Awassi Lambs by Real-time Ultrasound at Different Body Weights and Sexes. *J. Anim. Sci.*, **88**: 3428-3438.
9. Orman, A., ÇalIskan, G.Ü., Dikmen, S., Üstüner, H., Ogan, M. M. and ÇalIskan, Ç. 2008. The Assessment of Carcass Composition of Awassi Male Lambs by Real-time Ultrasound at Two Different Live Weights. *Meat Sci.*, **80:** 1031-1036.
10. Prevolnik, M., Škorjanc, D., Čandek-Potokar, M., Novič, M., 2011. Application of Artificial Neural Networks in Meat Production and Technology. Computer and Information Science,11, 223-240, ISBN: 978-953-307-220-3.
11. Ripoll, G., Joy, M., Alvarez-Rodriguez, J., Sanz, A. and Teixeira, A. 2009. Estimation of Light Lamb Carcass Composition by *In vivo* Real-time Ultrasonography at Four Anatomical Locations. *J. Anim. Sci.*, **87:** 1455-1463.
12. Safdarian, M., Zamiri, M., Hashemi, M. and Noorolahi, H. 2008. Relationships of Fat-tail

Dimensions with Fat-tail Weight and Carcass Characteristics at Different Slaughter Weights of Torki-Ghashghaii Sheep. *Meat Sci.,* **80:** 686-689.
13. Sahin, E., Yardimci, M., Cetingul, I., Bayram, I. and Sengor, E. 2008. The Use of Ultrasound to Predict the Carcass Composition of Live Akkaraman Lambs. *Meat Sci.,* **79:** 716-721.
14. Silva, S., Afonso, J., Santos, V., Monteiro, A., Guedes, C., Azevedo, J. and Dias-da-Silva, A. 2006. *In vivo* Estimation of Sheep Carcass Composition Using Real-time Ultrasound with Two Probes of 5 and 7.5 MHz and Image Analysis. *J. Anim. Sci.,* **84:** 3433-3439.
15. Stanford, K., Bailey, D., Jones, S., Price, M. and Kemp, R. 2001. Ultrasound Measurement of Longissimus Dimensions and Backfat in Growing Lambs: Effects of Age, Weight and Sex. *Small Rumin. Res.,* **42:** 189-195.
16. Stanford, K., Jones, S. and Price, M. 1998. Methods of Predicting Lamb Carcass Composition: A Review. *Small Rumin. Res.,* **29:** 241-254.
17. Swatland, H., Ananthanarayanan, S. and Goldenberg, A. 1994. A Review of Probes and Robots: Implementing New Technologies in Meat Evaluation. *J. Anim. Sci.*, **72:** 1475-1486.
18. Teixeira, A., Joy, M. and Delfa, R. 2008. *In vivo* Estimation of Goat Carcass Composition and Body Fat Partition by Real-time Ultrasonography. *J. Anim. Sci.,* **86:** 2369-2376.
19. Teixeira, A., Matos, S., Rodrigues, S., Delfa, R. and Cadavez, V. 2006. *In vivo* Estimation of Lamb Carcass Composition by Real-time Ultrasonography. *Meat Sci.,* **74:** 289-295.
20. Thériault, M., Pomar, C. and Castonguay, F. 2009. Accuracy of Real-time Ultrasound Measurements of Total Tissue, Fat, and Muscle Depths at Different Measuring Sites in Lamb. *J. Anim. Sci.,* **87:** 1801-1813.

# دقت ریل تایم اولتراسونوگرافی در ارزیابی صفات لاشه در گوسفند ترکی- قشقایی

س. م. حسینی وردنجانی، س. ر. میرایی آشتیانی، ع. پاکدل، و ح. مرادی شهر بابک

## چکیده

امکان پیش بینی صفات لاشه به صورت in vivo با استفاده از اندازه گیری های بدست آمده با اولتراسوند در ناحیه بین دنده های ۱۲ و ۱۳ مطالعه شد. توجه بیشتر به چند صفت لاشه مانند اندازه گیری ضخامت چربی پشتی، عضله راسته و وزن لاشه شد. همچنین اثر گله به عنوان یک اثر ثابت و وزن بدن به عنوان اثر همبسته بر این صفات در نظر گرفته شد. مطالعه با تعداد ۹۹ راس گوسفند ترکی- قشقایی متعلق به ۴ گله انجام گرفت. وزن بدن دارای اثر معنی دار (P<۰/۰۰۱) بر روی وزن لاشه گرم، وزن دنبه، ضخامت چربی زیر پوستی و مساحت عضله راسته بود ولی بر روی طول و عمق مساحت عضله راسته اثر معنی دار نداشت. گله تنها دارای اثر معنی دار (P<۰/۰۰۰۱) بر روی لاشه گرم و ضخامت چربی زیر پوستی بود. ضرایب همبستگی بین اندازه-گیری¬های اولتراسوندی و اندازه¬گیری¬های مستقیم روی لاشه، قبل و بعد از تصحیح اثر گله به ترتیب در دامنه¬ی (۰/۲۷ تا ۰/۸۰) و (۰/۲۲ تا ۰/۷۸) بود. تخمین ضخامت چربی زیر پوستی، عمق، طول و مساحت عضله راسته در لاشه براساس اندازه¬گیری متناظر آنها با استفاده از سونوگرافی قسمت بزرگی از تغییرات این صفات را به ترتیب





[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]

۰/۴۹، ۰/۲۹، ۰/۵۹ و ۰/۶۴ توضیح داد. وزن بدن ۵۷٪ تغییرات وزن لاشه گرم و تنها ۱۲٪ تغییرات وزن دنبه را توضیح داد. معرفی دو یا سه متغیر اندازه گرفته شده با اولتراسوند در قالب رگرسیون چندگانه با روش گام به گام صحت پیش بینی همه صفات را از ۰/۰۱ تا ۰/۱۳ بهبود بخشید. نتایج حاصل از این تحقیق نشان داد که اولتراسوند پتانسیل پیش بینی ترکیبات لاشه در گوسفند زنده ترکی- قشقایی را دارد.



[ DOR: 20.1001.1.16807073.2014.16.4.3.3 ]