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Estimation of Relationships Between Components of Carcass Quality and Quantity in Taleshi Lambs

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Abstract: This study estimated the relationship between Urea Space (US) and carcass attributes in lambs to derive coefficients for these relationships and functional equations for components of carcass qnality and quantity. Twenty-four male Taleshi lambs with an average age of 8 months were used. Lamb live weight was determined using the urea dilution method and two or three days before slaughter, the urea dilution procedure was again used to estimate the chemical composition of the carcass. Subsequently, plasma urea nitrogen was determined and the percentage of urea space to lamb live weight was calculated. After slaughter, the carcasses were butchered and the parts measured. The results showed that the average amount of urea injected was 20.09 cm^2 and the Blood Urea Nitrogen (BUN) averaged 17.16 and 27.72 mg before and after injection respectively. The average percentage of US to lamb live weight was 18.78%. Correlation coefficients between live weight, empty body weight, hot carcass weight and the weight of different parts of the carcass were high and statistically significant ($p<0.01$). The urea space was significantly related to the percentage of protein and ash in the region of the 9th, 10th and 11th ribs ($p<0.05$). Using this rib area and US, the development of functional equations between live weight and empty body weight for different parts of the carcass showed that the urea dilution test is a useful tool for predicting the chemical composition of Taleshi lamb carcasses.

Key words: Lamb, urea, carcass quality, performance, function

INTRODUCTION

Carcass quantity and qnality characteristics are amongst the most important factors affecting income in the lamb fattening industry. These characteristics are influenced by variables such as nutrition, management and season, awareness of which is critical in livestock production. Research effort has been directed at identifying methods for predicting carcass quantity and quality traits.

Studies using a variety of dilution methods such as deuterium and tritium oxides have been rejected due to the shortcomings of such treatments. However, the urea dilution technique has been widely used for cattle and other ruminants (Bartle and Preston, 1992). Wells and Preston (1998) indicated that urea appeared to be a suitable substance for estimating body water content. Urea costs much less than the hydrogen isotopes and the analytical procedures for measuring urea are relatively simple. Since Brosh *et al.* (1995) reported that Urea Space (US) was highly correlated with empty body water and fat contents in cattle, a number of investigators have demonstrated that urea dilution can be used to estimate the body components of ruminants (Gad and Preston, 1990; Velazco *et al.*,

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1997; Ngwa *et al*., 2007) and nonruminants (Mills and Litster, 2005, 2006). Conversely, some studies have shown that urea dilution methods are only capable of estimating 60-70% of the changes which take place in the body. Furthermore, various physiological factors can affect these relationships (Shiran, 1995; Khorshidi, 1996; Wells and Preston, 1998). In addition, different ruminant species transfer urea in the rumen in different ways and vary in the amount of urea purification that occurs in the kidneys (Bartle and Preston, 1986). Jones *et al*. (1982), however, did not find a significant relationship between urea dilution and carcass composition, whilst Meissner *et al*. (1980) reported large standard errors when estimating this relationship. It is possible that imprecise handling of blood samples during laboratory analysis or error involved in determining body composition or live weight could have contributed to these poor results.

Few studies have examined the suitability of the urea dilution technique and the usage of functional equations for estimating qnality and qnantity traits of lamb carcasses. This method was used in the current experiment in order to study the relationship between US and a range of carcass characteristics and to determine correlation coefficients and equation functions for qnalitative and qnantitative traits in the carcasses of Taleshi lambs, one of the most important breeds in Iran.

MATERIALS AND METHODS

This study was conducted at 2006 in Natural Resources and Agricultural Research Center of Guilan at Iran. Twenty-four male Taleshi lambs with an average age of 8 months with initial live weight of 21.7±1.32 kg were used. The animals were allowed a one month period to adjust to the new feeding and housing conditions prior to the start of the experiment. They were sheared, given an anti-parasitic drug (albendazole) and a subcutaneous vaccination against diseases known to be present in the herd (enterotoxaemia, anthrax and pox). The animals were housed in experimental pens and fed twice daily for a period of 105 days. Chemical analysis of the feeds was performed according to AOAC (1990). Subsequently, with reference to the average age and weight of the lambs and based on the standards set by the NRC, feed rations were prepared with an energy level of 2.4 Mcal ME kg^{-1} and a crude protein content of 14%. Feed composition included alfalfa (25.0%), wheat straw (2.5%), wheat bran (5.0%), cotton meal (17.88%), bagasse (5.0%), barley grain (36.32%), sorghum silage (6.0%), mineral and vitamin premix (1.0%), limestone (0.56%), calcium phosphate (0.53%) and salt (0.21%). Housing and management conditions were the same for all lambs.

In the current study, the Urea Dilution (UD) procedure was used two to three days before slaughter to estimate the body's chemical composition. Feed was withheld for 16 h before infusion and a blood sample was collected from the jugular veins. All blood samples were stored on ice in a sterile Vacutainer that contained EDTA as an anti-coagulant. Following this, 0.65 mL of 20% urea solution kg^{-1} body weight was injected and blood was extracted between 9 and 12 min post-injection. In the laboratory, the blood samples were centrifuged at 3,000 x g for 20 min. Plasma urea nitrogen was estimated and the percentage of urea with respect to live lamb weight was determined (Searle, 1984):

Percentage of live body weight composed of urea = [The amount of nitrogen in urea injected (mg)]/[Change in BUN (mg mL^{-1})×live body weight (kg)×10]

Percentage of empty body weight composed of urea = [The amount of nitrogen in urea injected (mg)]/[Change in BUN (mg mL^{-1})×empty body weight (kg)×10]

All of the lambs were slaughtered at the end of the test period and the weight of the edible and inedible parts of the carcass were determined. The carcasses were divided into different parts and each part was separately recorded using the method of Nik-Khah and Assadi-Moghaddam (1977). The area

of the 9th, 10th and 11th ribs together with the adjoined section of spinal column was used to estimate the amount of bone-free meat, fat and bone in the carcass. The meat, fat and bones were weighed after separation and the bone-free meat component was used for the chemical analysis. Data were statistically analyzed using the General Linear Model procedures of SAS (1996) using individual sheep as the experimental unit. We used functioual equations for estimating the relationship between US and carcass quality and quantity traits such as

$$y = a+bx$$

Where:

A = Intercept
b = A coefficient function

The coefficient represents the amount of change required in the dependent variable in order to cause one unit of change in the independent variable. R^2 is the portion of the total variance (y) which relates to (x) changes.

RESULTS AND DISCUSSION

The results showed that the average amount of urea injected was 20.09 cc and that the average Blood Urea Nitrogen (BUN) level before and after injection was 17.16 and 27.72 mg in 100 mL respectively. The average percentage of US to lamb live weight was 18.78%.

There was a high and significant correlation between live weight, empty body weight, hot carcass weight and the weight of different parts of the carcass ($p<0.01$; Table 3). In addition, the US percentage was significantly correlated with the percentage of protein and ash in area of the 9th, 10th and 11th ribs ($p<0.05$; Table 1).

The equations between US and different characteristics of the 9th, 10th and 11th rib area (Table 1) and those between different parts of the carcass (Table 2) were significant. Furthermore, the functioual equations between different characteristics of the selected rib area and lamb live weight, empty body weight and the different portions of the carcass were also significant ($p<0.05$; Table 3).

The study found a significant association between the urea dilution method and carcass characteristics. Significant negative relationships between US and the carcass protein and ash percentages were apparent which conforms to the findings of other studies using different breeds of sheep. Previously, Alrahim *et al*. (1992) showed that the correlation coefficient between the percentage of mutton in the carcass together with US and live body weight was 0.49 whilst that between US and

Table 1: Function equations between different traits in the 9th, 10th and 11th rib area and US (Urea Space) in Taleshi lambs

Variables	Function equations	Determination coefficient (R^2)	p-value
X = US, Y = Rib weight (kg)	Y = 645.467+3.02X	0.1410	0.0078
X = US, Y = Weight of mutton, 9th, 10th and 11th rib area (kg)	Y = 257.44+1.94X	0.3940	0.0069
X = US, Y = Weight of fat, 9th, 10th and 11th rib area (kg)	Y = 213.38+1.742X	0.1159	0.0024
X = US, Y = Weight of ribs, 9th, 10th and 11th rib area (kg)	Y = 174.63-0.66X	0.0297	0.0006
X = US, Y = Mutton percentage of the 9th, 10th and 11th rib area (%)	Y = 40.91+0.071X	0.0703	0.0031
X = US, Y = Fat percentage of the 9th, 10th and 11th rib area (%)	Y = 32.937+0.089	0.0436	0.0008
X = US, Y = Bone percentage of the 9th, 10th and 11th rib area (%)	Y = 26.145-0.16X	0.1427	0.0032
X = US, Y = Moisture percentage of mutton (%)	Y = 57.671+0.188X	0.0028	0.0004
X = US, Y = Protein percentage of mutton (%)	Y = 16.0007-0.043X	0.1837	0.0049
X = US, Y = Fat percentage of mutton (%)	Y = 25.481-0.030X	0.0054	0.0019
X = US, Y = Ash percentage of mutton (%)	Y = 0.842-0.0059X	0.4364	0.0086

Table 2: Function equations between different components of Taleshi lambs

Variables	Function equations	Determination coefficient (R^2)	p-value
X = Fat percentage of mutton, Y = Moisture percentage of mutton (%)	Y = 79.59-0.827X	0.9492	0.0011
X = Protein percentage of mutton, Y = Moisture percentage of mutton (%)	Y = 31.452+1.751X	0.2530	0.0097
X = Fat percentage of mutton, Y = Protein percentage of mutton (%)	Y = 19.52-0.166X	0.4684	0.0059
X = Ash percentage of mutton, Y = Protein percentage of mutton (%)	Y = 9.941+7.161X	0.3919	0.0071
X = Carcass weight, Y = Tail fat weight (kg)	Y = 0.091+0.132X	0.4755	0.0068
X = Carcass weight, Y = Leg weight (kg)	Y = -369.32+30.01X	0.0940	0.0017
X = Carcass weight, Y = Weight of fat around heart (kg)	Y = -0.125+0.0134X	0.1540	0.0029
X = Carcass weight, Y = Weight of fat around rumen (kg)	Y = -0.424+0.0426X	0.6195	0.0082
X = Carcass weight, Y = Cold carcass weight (kg)	Y = 1.704+0.837X	0.8629	0.0008
X = Carcass weight, Y = Breast weight (kg)	Y = 0.336+0.130X	0.3780	0.0067
X = Carcass weight, Y = Shoulder weight (kg)	Y = 1.0756+0.084X	0.2920	0.0083

Table 3: Function equations between live weight, empty body weight and different components of the carcass in Taleshi lambs

Variables	Function equations	Determination coefficient (R^2)	p-value
X = Live body weight (kg), Y = Carcass weight (kg)	Y = 8.029+0.2X	0.1090	0.0031
X = Live body weight (kg), Y = Carcass weight (kg)	Y = 5.618+0.251X	0.1969	0.0066
X = Live body weight (kg), Y = Fat percentage of mutton (%)	Y = -13.267+1.272X	0.2980	0.0049
X = Live body weight (kg), Y = Weight of the 9th, 10th and 11th rib area (kg)	Y = 0.0644+0.0204X	0.2181	0.0062
X = Live body weight (kg), Y = Fat thickness (mL)	Y = 1.738+0.053X	0.1214	0.0008
X = Live body weight (kg), Y = Ribeye area-REA (cm^2)	Y = 29.514-0.136X	0.0167	0.0009
X = Live body weight (kg), Y = Cold carcass weight (kg)	Y = 7.400+0.178X	0.1220	0.0021
X = Live body weight (kg), Y = Diaphragm weight (kg)	Y = -0.0211+0.0038X	0.1727	0.0036
X = Live body weight (kg), Y = Weight of fat around heart (kg)	Y = 0.0161+0.00127X	0.0043	0.0003
X = Live body weight (kg), Y = Weight of fat around rumen (kg)	Y = 3.994+0.0221X	0.0075	0.0001
X = Live body weight (kg), Y = Spleen weight (kg)	Y = -0.0272+0.0015X	0.2140	0.0062
X = Live body weight (kg), Y = Weight of empty intestine (kg)	Y = 0.863-0.0032X	0.0011	0.0007
X = Live body weight (kg), Y = Lung weight (kg)	Y = 0.0987+0.0095X	0.3414	0.0064

empty body weight was 0.48. Additionally, the correlation coefficients between empty body weight and fat percentage and between empty body weight and US were both 0.31. However, Shiran (1995) in Lori and Bakhtiyari lambs, Khorshidi (1996) in Kurdi lambs and Davarnia (1996) in Varamini lambs failed to find a significant relationship between urea dilution and carcass composition. These discrepancies may have resulted from the use of different sheep breeds.

Urea appeared to achieve equilibrium with body water approximately 15 min after infusion. However, equilibration times differed from one sheep to another with a range of approximately 9 to 21 min. Asmare *et al*. (2007) also reported similar findings in sheep and goat respectively. Plasma urea concentrations decreased continuously, but more gradually, after reaching an apparent equilibrium, probably due to reual clearance and (or) transfer of urea into the gastrointestinal tract (Bartle and Preston, 1986; Agnew *et al*., 2005). A high correlation between urea dilution estimates is partially attributable to the fact that animals fatten as they become heavier and live weight is used to determine the amount of urea to infuse, is used in the calculation of the percentage of urea space and is a variable in the equation used to calculate the urea dilution estimates of the fat content of the empty body (Campeneere *et al*., 2000; Nonaka *et al*., 2006). Urea dilution estimates for different traits of the 9th, 10th and 11th rib area were correlated with the live weight estimated by urea dilution. Correlations between the various periods were made to determine whether reasonable estimates could be made for sorting sheep during the feeding trial. Furthermore, significant positive correlations were found between live weight characteristics and carcass weight which may have resulted from the simultaneous growth of these traits. These results are in agreement with the results of Shiran (1995), Khorshidi (1996) and Davarnia (1996).

The effect of sex on empty body water content on a fat-free basis has been reported by Garrett *et al.* (1971) for cattle (73.5 vs 73.0% for steers and heifers, respectively). Additionally, as Ferrell and Cornelius (1984) have indicated, the accuracy of estimating body composition using any water dilution technique can be no better than that obtained from using the actual amount of empty body water. Shields *et al.* (1983) reported that empty Body Weight (BW) can be predicted accurately from live BW ($R^2 = 0.99$) in pigs. The results of the current experiment with sheep confirm that if the empty body water volume can be estimated precisely, then the empty body protein and fat components can be predicted accurately. The lower coefficients of determination obtained in the present experiment probably were caused by the narrow range of BW studied and the use of diets with diverse compositions. The determination of live animal carcass composition has become of economic importance because of the emphasis placed on the production of lean carcasses, the reduced support available to researchers and the desire to avoid slaughtering animals purely for these measurements. The urea dilution procedure (Hammond *et al.*, 1990; Wells and Preston, 1998; Wuliji *et al.*, 2003) holds much promise as a practical tool that can be easily implemented for research and on farm applications. Hammond *et al.* (1990) concluded that slight differences in prediction equations may be needed for various breed types when using UD, whilst Wappler and Staufenbiel (1999) indicated that the UD procedure was more accurate when applied to groups of homogeneous animals. In contrast, UD estimates of empty body fat, when using fat thickness as a basis of comparison, have been found to be more accurate when data from several breeds are pooled than when breeds are considered independently. In the present experiment, measurements from the urea dilution procedure correlated significantly with characteristics of the carcass. Moreover, the association between the amount of urea and the percentage of protein and ash in the carcass was significant and negative, in agreement with the findings of Karim *et al.* (2001), Silva *et al.* (2003) and Yurtman and Coskuntuna (2006).

In conclusion, the urea dilution technique for live animal carcass composition determination is a valid and useful procedure that can be applied to a wide range of body condition and breed types. A draw-back to this procedure is the time required for sampling and plasma urea nitrogen analysis and consequently, the technique is more suited to research than on-farm applications. However, geneticists and performance test stations could use this procedure as part of a sheep selection index. The value of the approach would result from being able to avoid sacrificing animals and multiple progeny in order to predict body composition from chemical analyses. Thus, the rate of genetic gain could be faster, which, in turn, would help the sheep industry meet the demands of the consumer for leaner meat.

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