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Full Length Research Paper

Relationship of fat-tail and body measurements with some economic important traits in fat-tail Makoei breed of Iranian sheep

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This research seeks to predict *in vivo* carcass composition of lambs. A total of 576 Makoei fat-tailed lambs were used. Lambs were 6-7 months fold and weighed about 15.1 - 41.4 kg. Measurements included body weight, upper, middle and lower tail-depth and width, upper, middle, lower tail and neck circumference, right, middle and left tail-length, body length, whither height, abdominal and heart girth. Having slaughtered each animal, omental, mesenteric and tail fat were separated and weighed. Weight of fat-tail and sum of omental and mesenteric contents varied from 50 - 2290 g and 8.1 - 536 g, respectively. These traits showed relatively high correlation with all fat-tail and body measurements. The highest correlations were observed between fat-tail weight and lower circumference and live body weight measures (68 and 67%, respectively).

Key words: Makoei breed, fat tailed sheep, carcass composition.

INTRODUCTION

Almost all Iranian sheep breeds have large fat tails. Fat-tail and other adipose depots, negatively affect the sale of sheep by sheep industries in some country like Iran. Fat-tail is not desirable to costumers even though it appears to be affordable (the price of 1 kg of fat-tail is less than one sixth price that of red meat). Fat-tail plays an important role as a source of energy for adult ewe during periods of food shortage (Fall and specially winter).

In young lambs, carcass adiposity, particularly the fat-tail, reduces meat value. Lean lamb can be produced from manipulation of nutritional regimen, slaughter in early age, docking the fat-tail in early days after birth or by a genetic selection program. The best method is the last one because the other methods need expert individual and most people do not accept to slaughter their lambs in early age. Another reason is that those other methods have to be repeated in each generation because results obtained through them cannot be transmitted to subsequent generations. For all parts, the knowledge of lamb carcass composition and its evaluation is required. To obtain carcass composition according to the reference method, there is need for successive animal slaughtering. Such procedures are demanding and do not allow use of the same animal more than once.

Nevertheless, there are *in vivo* estimation methods based on body weight (BW) and morphological measurements that seem to be useful. The measurement of the dilution space of water tracers has been proved to be one of the most reliable methods (Robelin, 1973, 1981). This procedure has been used to develop prediction equations in lambs (Robelin, 1977). Another procedure based on the

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Abbreviations: BW, Live body weight; **NC,** neck circumference; **UW,** middle width; **MW,** upper width; **LW,** lower width; **RL,** right length of fat-tail; **LL,** left length of fat-tail; **ML,** middle length of fat-tail; **UD,** upper depth of fat-tail; **MD,** middle depth of fat-tail; **LD,** lower depth of fat-tail; **UC,** upper circumference of fat-tail; **MC,** middle circumference of fat-tail; **LC,** lower circumference of fat-tail; **BL,** body length; **WH,** wither height; **AF,** abdominal fat; **AC,** abdominal circumference.

Table 1. Body weight, *in vivo* tail and body measurements, carcass weight of lambs.

Trait	Mean	S.D.	Minimum	Maximum
Body weight (kg)	26.04	4.61	15.1	41.4
U tail –depth (cm)	2.10	6.81	0.7	3
M tail-depth (cm)	2.66	4.26	0.8	3.2
L tail-depth (cm)	2.85	5.71	0.6	4.9
U tail –circumference (cm)	37.34	6.59	22	59
M tail- circumference (cm)	39.36	8.15	4	63
L tail- circumference (cm)	35.63	7.74	13	59
U tail –width (cm)	23.76	3.71	12	35
M tail- width (cm)	25.11	3.44	15	36
L tail- width (cm)	21.72	3.47	11	32
R tail-length (cm)	19.66	3.40	10	34
M tail-length (cm)	18.82	4.75	9	34
L tail-length (cm)	19.60	3.66	8	34
Whither height (cm)	61.29	6.05	50	86
Body length (cm)	54.16	5.90	23	99
Heart girth (cm)	71.19	6.69	50	91
Abdominal circumference (cm)	79.29	7.10	28	98
Hot carcass (kg)	11.7	2.38	9	19.7
Fat-tail (gr)	1033.01	575.77	50	2290
Abdominal fat (gr)	142.58	93.77	8.1	536

U=Upper; M= middle; L= lower; R=right. S.D = Standard deviation.

adipocyte diameter may be utilized to develop prediction equations with satisfactory precision in sheep (Susmel et al., 1995). These methods are expensive and need specific equipment and products. The aim of the present study was to establish prediction equations for tail fat, abdominal fat and carcass weight in live animal using some measurements of fat-tail and body of lambs in the Makoei breed.

MATERIALS AND METHODS

A total of 576 lambs of Makoei breed were used in this study. The lambs were reared in Ardebil province located on the East Azerbaijan in Iran. Lambs were 6 - 7 months of age and weighed about 15.1 - 41.4 kg. Body weight (BW) of lambs, fat-tail and body measurement were recorded before slaughtering. These measurements were heart girth, upper, middle and lower tail-depth, upper, middle and lower tail-width, upper, middle and lower tail circumference, right, middle and left tail-length, body length, whither height, abdominal and heart girth. Upper measurement was made at the base while tail-length measurement included only fat part and not the thin part of the tail. Circumference and length were measured with flexible tape and calipers were used for depth.

Immediately after slaughtering, omental and mesenteric fat were removed and weighted collectively. Hot carcass was weighed, and then fat-tail was separated and weighed. Linear correlation among live BW, hot carcass weight, fat tail, abdominal fat and body and tail measurements were estimated using Proc Reg. of SAS (SAS Institute, 2006).

The relationships were further estimated among tail fat, hot carcass on BW and fat-tail and body measurements on the basis of linear and non-linear regressions (quadratic: $y = ax^2 + bx + c$, where y: fat tail, abdominal fat, BW, or hot carcass weight, and x: any measurements on body and fat tail).

RESULTS AND DISCUSSION

Descriptive statistics of body weight (BW), tail and body measurements are shown in Table 1. Mean of BW varied from 15.1 - 41.4 kg (± 4.61), which represent commercial age-weight slaughter range.

Fat tail average was shown to be 1.03 kg (Table 1). Furthermore, tail fat as a proportion of carcass also varied widely. This could be as a biological diversity criterion in this breed, and could be used for selecting lambs with smaller fat-tail. The fat-tail of Makoei breed was relatively light compared to Turkish Awassi sheep where mean tail fat weight averaged 3 kg and represented 15% of the carcass weight (Ozcan et al., 1994), compared to Lori breed (Farahani et al., 2002, unpublished) or Mehraban and Ghezel breeds of Iran (Zamiri and Izadifard, 1997). Some of carcass characteristics are shown in Table 1.

The highest correlation coefficients were observed between lower circumference measurement and fat tail ($r > 0.68$) in tail measurements. However, abdominal fat was relatively high correlation with fat tail. Correlation between fat tail, M tail-depth (cm) and L tail-depth (cm) were negative and small (Table 2).

The significant linear regressions of fat tail, body and fat tail measurements were established: In the first regression

Table 2. Correlation coefficient of body components, fat tail and body measurement.

Hot carcass (kg)	Abdominal fat (kg)	Fat-tail (g)	Trait
87/0	39/0	67/0	Body weight (kg)
37/0	13/0	22/0	Whither height (cm)
58/0	39/0	38/0	Heart girth (cm)
19/0	06/0	11/0	Body length (cm)
57/0	26/0	35/0	Abdominal circumference (cm)
28/0	31/0	18/0	U tail-width (cm)
35/0	25/0	27/0	M tail- width (cm)
47/0	27/0	43/0	L tail- width (cm)
49/0	30/0	37/0	R tail-length (cm)
33/0	25/0	25/0	M tail-length (cm)
49/0	29/0	37/0	L tail-length (cm)
14/0	08/0	11/0	U tail-depth (cm)
01/0	02/0	06/0-	M tail-depth (cm)
005/0-	02/0	05/0-	L tail-depth (cm)
53/0	37/0	61/0	U tail-circumference (cm)
48/0	31/0	63/0	M tail-circumference (cm)
59/0	36/0	68/0	L tail-circumference (cm)
66/0	43/0	00/1	Fat-tail (gr)
43/0	00/1	43/0	Abdominal fat (gr)

model, prediction of fat tail weight was done based on linear form of measurements and animal live weight. In the second model, quadratic regression with the same data was used. In the third model, in addition to measurements and animal live body weight data, abdominal fat weights also were used. In the last model, only all measurements were used as linear regression. The accuracy of prediction of these regression models are 63, 69, 63 and 50%, respectively. The fat tail prediction equation was in agreement with Mehraban rams (R^2 = 0.69) in Iran (Zamiri and Izadifard, 1997) but less accurate than established fat tail prediction equation with Mehraban rams (R^2 = 0.83) and fat-tailed Barbarian sheep (R^2 = 0.81). The reasons for this discrepancy are first, age of experimental sheep, second, may be fat tail morphological shape variation in Makoei is more than Mehraban rams and Barbarian fat-tail sheep. The third reason could be sample size and sampling method; a small number of animals from the same flock was used in their work. However, our work utilized more animals from different flocks, hence the observed variation in results.

The following equations may be specific for utilized flocks:

(1) Fat tail (g) = -550.161 + 50.101BW - 37.967NC - 30.150MW + 29.754LW - 29.494RL + 16.030ML - 42.448UD + 40.809MD - 46.633LD + 25.669UC + 26.4MC R^2= 0.63.

(2) Fat tail (g) = 7/2693- + 0/68BW - 0.071WH^2 - 0.489NC^2 + 49.608AC - 0.357AC^2 - 263.777UW + 5.047UW^2 + 138.854MW - 3.301MW2 + 30.521LW - 33.794RL + 0.7ML^2 + 139.813LL - 3.253LL^2 - 1.652UD^2 + 77.721UC - 0.819UC^2 - 49.764MC + 0.992MC^2 R2= 0.69.

(3) Fat tail (gr) = 580.947 + 65.961BW - 24.279HG - 21.541NC - 23.834MW + 23.676ML - 26.907LL + 13.489UC + 16.792MC + 16.614LC + 0.980AF R^2=0.63.

(4) Fat tail (g) =-1196.899 - 15.567NC + 7.783AC - 17.247UW - 23.003MW + 33.369LW + 9.696ML + 27.208UC + 31.056MC R^2=0.50.

The regression model useful for predicting abdominal fat is showed to be as followed:

Abdominal fat (g) = -330.380 + 3.807BW + 6.246HG - 2.385AC

) + 6.280UW - 4.372MW - 4.371UD +

4.597MD - 4.876LD + 2.625UC R^2=0.40.

Accuracy of prediction of abdominal fat by this model is not high. One probable reason of low accuracy of the model may be other unknown factors affecting this trait. This result showed that the relationship among body, fat tail measurements and body weight is low and it is useful for designing breeding schemes to reduce size of fat-tail in Iranian sheep.

Two regression models were fitted for prediction of hot carcass. The first model is linear, while the second one is a nonlinear (quadratic) regression model. The comparison of prediction accuracy showed that nonlinear regression model improves the accuracy of prediction by 6%.

(1) Hot carcass (kg) = -6.722 + 0.327BW + 0.101HG + 0.066NC + 0.034AC - 0.039UW + 0.051LW - 0.036ML + 0.091RL - 0.188UD + 0.130MD - 0.127LD + 0.036UC + 0.0009LC R^2=0.88.

(2) Hot carcass (kg) = -15.568 + 0.404BW - 0.082WH + 0.0009WH^2 + 0.041HG - 0.0005NC^2 + 0.292AC - 0.001AC^2 - 0.246UW + 0.004UW^2 + 0.585MW - 0.011MW^2 - 0.562RL + 0.014RL^2 + 0.773LL - 0.017LL^2 - 0.009UD^2 + 0.0017MD^2 - 0.0019LD^{2-} - 0.147MC + 0.002MC^2 + 0.0018LC R^2=0.94.

A regression model for the prediction of hot carcass weight without fat-tail was fitted. The accuracy of prediction by this model was high. The results show that we can use this regression model for estimating hot carcass weight without fat tail, with high accuracy on live animal and use this record in breeding program.

Hot carcass without fat-tail (kg) = -0.276 + 0.407BW + 0.023NC

+ 0.012AC - 0.049ML + 0.094LL +

0.070MD - 0.064LD - 0.015UC - 0.033MC R^2=0.96.

Linear and nonlinear regression models for the prediction of live body weight. These models are as follows:

(1) BW (kg) = -19.507 + 0.041WH + 0.137HG + 0.205NC + 0.053BL + 0.164AC - 0.103UW + 0.175LW + 0.129RL - 0.104ML + 0.162UC + 0.092LC R^2=0.65.

(2) BW (kg) = 75.128 + 0.0005WH^2 - 0.385HG + 0.004HG^2 + 0.003NC^2 - 0.242BL + 0.001BL^2 - 1.026AC + 0.0068AC^2 - 0.0037MW^2 + 0.007LW^2 + 1.466RL - 0.040RL^2 - 0.116ML - 2.009LL + 0.056LL^2 + 0.435UD - 0.151LD + 0.004LD^2 - 0.353MC + 0.0068MC^2 - 0.000001LC^2 R2=0.96.

Considering the coefficient of correlation (R^2) of the two models, it can be seen that the second model, nonlinear regression model, has higher accuracy of prediction. Therefore, it can be recommended to use this model. Using quadratic nonlinear regression model improves the accuracy of prediction significantly.

In conclusion, it was shown that abdominal fat, fat-tail, live body weight and carcass weight are so variable. Fat tail was found to be significantly correlated with *in vivo* measurements especially with lower fat-tail- circumference (cm) and live body weight (68 and 67%, respectively). These measurements in live animal could be used to predict fat-tail, and live body weight (whole and without fat tail carcass) with high accuracy and to predict abdominal fat weight with approximately low accuracy without slaughter. Furthermore, *in vivo* measurements help us with potential use for selection of animal to reduce meat adiposity and increase parts of muscle carcass in lambs of Makoei sheep breed.

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