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USE OF LIVE BODY MEASUREMENTS FOR PREDICTION OF BODY AND CARCASS CUTS WEIGHTS IN THREE EGYPTIAN BREEDS OF SHEEP

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ABSTRACT

Eight body measurements were recorded on 30 Egyptian ram lambs (10 Ossimi, 10 Barki and 10 Rahmani) at slaughter age 12 months to predict weights of live body, hot carcass and carcass cuts.

There was a positive and significant relationship between round circumference of Ossimi, Barki and Rahmani ram lambs and round weight of their carcasses. To predict live body weight of Ossimi ram lambs, paunch girth (PG) and body length (BL) must be included in the model with an accuracy of 93 %. Whereas, the equation including heart girth (HG), chest depth (CD) and paunch girth (PG) could predict hot carcass weight of Ossimi with R^2 = 97 %. Meanwhile, body length (BL) alone contributed 47 % and 59 % of the variation in body weight and hot carcass weight of Barki ram lambs, respectively. Heart girth (HG) was the best single predictor and accounted alone for 86 % and 90 % of the variation in body weight and hot carcass weight of Rahmani ram lambs. The prediction equation must include only round circumference (RC) to predict round weight of both Ossimi and Barki carcasses with accuracy 67 % and 60 %, respectively. Height at withers (HW) of Rahmani ram lambs alone explained 57 % of the variation in round weight of carcass. Chest depth (CD) was the single variable used to predict shoulder weight of Ossimi carcass (R^2 = 0.72). Whereas, body length (BL) was the single variable entered in the model to predict shoulder weight in Barki carcass (R^2 = 0.70). Two body measurements (Height at withers (HW) and chest depth (CD)) were used to predict shoulder weight of Rahmani carcass (R^2 = 0.93).

It was found that all live body measurements used in this study to predict the weights of body and carcass cuts had positive regression coefficients.

Key words: *Ossimi, Barki, Rahmani, prediction, body measurements, body weight, carcass traits.*

INTRODUCTION

Recent techniques have been developed to predict carcass composition of live lambs *in vivo*. These techniques include X-ray computer tomography (CT) **(Jones *et al.*, 2002 and Lambe *et al.*, 2003)** and ultrasonic scanning **(Edwards *et al.*, 1989; Berg *et al.*, 1996 and Bedhiaf Romdhani and Djemali, 2006)**. Accurate predictions of body composition have been obtained using these methods **(Jones *et al.*, 2002)**. **Berg *et al.* (1996)** used Real time ultrasonic measurements and bioelectrical impendence analysis for development and evaluation of prediction equations for % boneless, closely trimmed primal cuts, weight or % of dissected lean tissue and chemically derived weight or % fat-free lean. Nevertheless, these methods are expensive and need specific equipments. Furthermore, **Miguel *et al.* (2003)** found that subjective methods for the estimation of carcass degree of fatness and carcass conformation are poor predictors for tissue composition in sucking lamb carcasses. Therefore, there is a need for fast, cheap and easy method to be used by smallholder sheep breeders.

In this context, rapid, inexpensive and feasible physical measurements could be used for predicting carcass traits of lambs which are not normally easily measured under field conditions. **Yaprak *et al.* (2008)** indicated that all body measurements and growth performances can provide an accurate method to estimate important carcass traits. The objective of the present study was to determine the significance of using live body measurements of Ossimi, Barki and Rahmani ram lambs for predicting weights of body, hot carcass and prime carcass cuts. The relationship between body measurements of ram lambs and weights of body and carcass cuts was also considered.

MATERIALS AND METHODS

Thirty Ossimi, Barki and Rahmani ram lambs (10 of each), aged 12 months, fattened at the sheep farm of Cairo University were used. Management and feeding of the ram lambs were already described **(Abdel – Moneim, 2009)**. The animals were fasted for 18 h before slaughtering. Animals were weighed to the nearest 100 g and their body measurements were taken using a measuring tape to the nearest 0.5 cm just before slaughtering. The body measurements recorded were:

Body length (BL): the distance between the point of shoulder and the pinbone,
Height at withers (HW): vertical distance from the withers to the floor,
Heart girth (HG): circumference of the body just behind the fore legs,
Chest depth (CD): vertical distance from the withers to the chest bottom,
Chest width (CW): width of the body at the withers,
Round circumference (RC): circumference of the round just under the body floor,
Paunch girth (PG): circumference of the body just before the hind legs. and
Pelvis width (PW): distance between the two hocks.

Animals were slaughtered according to the Islamic procedeure in an experimental abattoir at the sheep farm. Each carcass was deskinned and decapitated. External and internal offals were separated from the dressed carcass. Carcasses were weighed hot (about 1h after slaughtering). Dressing percentage, based on pre-slaughter body weight, was calculated. Fat tail of carcass was removed and weighed. Dressed carcass was then longitudinally split into approximately two equal halves. The left side of carcass was cooled at 4 °C for 24h. The chilled half of each carcass was divided into six cuts according to **Atti and Ben Hamouda (2004).** These carcass cuts were round, loin, shoulder, thoracic region (ribs and brisket), neck and flank.

Statistical analysis was conducted using SAS package program **(SAS, 1998).** Simple correlation coefficients between body measurements and weights of body and carcass cuts, within each breed, were calculated and tested for significance. To predict weights of live body, hot carcass and prime cuts (round, shoulder and thoracic region) from body measurements of ram lambs, the stepwise procedure was used to select the variables for the prediction equations. This procedure did not include variables with a $P > 0.05$ as suggested by **Diaz *et al.* (2004) and Marshall *et al.* (2005).** The coefficient of determination (R^2) assessed the accuracy of the equations.

RESULTS AND DISCUSSION

Table 1 shows means, standard deviations, minimum and maximum values and coefficients of variation of different body measurements of Ossimi, Barki, and Rahmani ram lambs. The coefficients of variation of different body measurements were generally small (less than 10 %), except that of the round circumference of Ossimi ram lamb (C.V. = 11.2 %) (Table1). Variability estimates among individuals in this study were lower than those recorded on Australian Merino by **Nigm *et al.* (1995)**. The authors showed that the coefficients of variation of different body dimensions ranged from 9 - 12 % with the exception of pelvis width (C.V. = 18.7 %) and round circumference (C.V. = 14 %).

1. The relationship between body measurements and body weight and carcass traits:

It was noticed (Table 2) that body weight of Ossimi ram lambs was positively and significantly correlated with BL ($P < 0.05$), HG ($P < 0.01$), CD ($P < 0.01$), RC ($P < 0.05$) and PG ($P < 0.01$). However, only body length of Barki ram lambs was positively and significantly ($P < 0.05$) correlated with body weight (Table 3). Meanwhile, positive and significant correlation coefficients were found between body weight of Rahmani ram lambs and each of BL ($P < 0.05$), HW ($P < 0.01$), HG ($P < 0.01$), CD ($P < 0.05$), PG ($P < 0.01$) and PW ($P < 0.01$) (Table 4). Such positive relationships were reported by **Nigm *et al.* (1995) and Shaker and Hammam (2008). Nigm *et al.* (1995)** showed that heart girth and chest depth had the highest correlations with body weight.

Table 1: Means, standard deviation (S.D.), minimum (Min.) and maximum (Max.) values and coefficient of variation (C.V.) of live body measurements of Ossimi, Barki and Rahmani ram lambs at slaughtering.

Variable	Mean	S.D.	Min.	Max.	C.V.
a : Ossimi ram lambs:					
1- Body length (cm)	71.5	2.84	67.0	75.0	4.0
2- Height at withers (cm)	73.0	3.40	69.0	80.0	4.7
3- Heart girth (cm)	86.1	3.87	80.0	92.0	4.5
4- Chest depth (cm)	36.7	2.36	33.0	40.0	6.4
5- Chest width (cm)	22.6	1.35	21.0	25.0	6.0
6- Round circumference (cm)	42.2	4.73	35.0	51.0	11.2
7- Paunch girth (cm)	90.5	4.17	84.0	98.0	4.6
8- Pelvis width (cm)	22.2	1.32	20.0	24.0	5.9
b : Barki ram lambs:					
1- Body length (cm)	72.7	2.58	70.0	77.0	3.5
2- Height at withers (cm)	74.1	2.38	70.0	78.0	3.2
3- Heart girth (cm)	96.6	4.72	90.0	107.0	4.9
4- Chest depth (cm)	39.8	1.75	37.0	42.0	4.4
5- Chest width (cm)	23.7	1.49	22.0	27.0	6.3
6- Round circumference (cm)	42.1	2.13	40.0	46.0	5.1
7- Paunch girth (cm)	100.8	3.68	96.0	107.0	3.7
8- Pelvis width (cm)	21.6	1.07	20.0	23.0	5.0
c : Rahmani ram lambs:					
1- Body length (cm)	72.3	5.62	63.0	80.0	7.8
2- Height at withers (cm)	72.6	2.95	68.0	77.0	4.1
3- Heart girth (cm)	86.8	5.51	80.0	98.0	6.3
4- Chest depth (cm)	38.9	1.60	37.0	42.0	4.1
5- Chest width (cm)	20.7	1.50	19.0	23.0	7.2
6- Round circumference (cm)	43.5	4.22	37.0	50.0	9.7
7- Paunch girth (cm)	91.1	6.47	80.0	97.0	7.1
8- Pelvis width (cm)	20.8	1.32	18.0	22.0	6.3

It is apparent from Table 2 that hot carcass weight of Ossimi ram lambs was positively and significantly associated with BL ($P < 0.05$), HG ($P < 0.01$), CD ($P < 0.01$), RC ($P < 0.05$) and PG ($P < 0.01$). Meanwhile, the correlation coefficients of BL ($P < 0.01$) and RC ($P < 0.05$) were positive with hot carcass weight of Barki (Table 3). Moreover, all body measurements of Rahmani ram lambs, except CW, were positively and significantly correlated with hot carcass weight (Table 4). These results conform

Table 2: Correlation coefficients between body measurements and body weight and carcass traits of Ossimi ram lambs.

Body weight and carcass traits	Body measurements							
	BL	HW	HG	CD	CW	RC	PG	PW
1- BW	0.73*	0.49	0.86**	0.85**	0.40	0.67*	0.88**	0.29
2- Crwt	0.68*	0.53	0.89**	0.87**	0.32	0.67*	0.86**	0.29
3- Dressing %	-0.32	0.04	-0.06	-0.08	-0.36	-0.14	-0.23	-0.11
4- Rwt	0.66*	0.20	0.67*	0.66*	0.62	0.82**	0.66*	0.54
5- Lwt	0.47	0.25	0.77**	0.69*	0.55	0.54	0.67*	0.49
6- Thwt	0.82**	0.45	0.93**	0.82**	0.46	0.70*	0.64*	0.22
7- Swt	0.67*	0.44	0.84**	0.85**	0.48	0.52	0.61	0.41
8- Nwt	0.34	0.59	0.49	0.59	0.05	0.09	0.36	0.32
9- Fwt	0.48	-0.07	0.72*	0.50	0.48	0.44	0.61	0.16
10- Tailwt	0.01	0.47	0.03	0.23	-0.16	0.18	0.65*	0.13

BL: body length, HW: height at withers, HG: heart girth, CD: chest depth, CW: chest width, RC: round circumference, PG: paunch girth, PW: pelvis width, BW: fasted body weight, Crwt: hot carcass weight, Rwt: round weight, Lwt: loin weight, Thwt: thoracic region weight, Swt: shoulder weight, Nwt: neck weight, Fwt: flank weight, Tailwt: tail weight. * $P < 0.05$ ** $P < 0.01$

Table 3: Correlation coefficients between body measurements and body weight and carcass traits of Barki ram lambs.

Body weight and carcass traits	Body measurements							
	BL	HW	HG	CD	CW	RC	PG	PW
1- BW	0.68*	0.27	0.42	0.40	0.23	0.60	-0.21	0.40
2- Crwt	0.77**	0.25	0.34	0.37	0.01	0.71*	-0.34	0.29
3- Dressing %	0.55	0.04	-0.06	0.07	-0.55	0.55	-0.50	-0.17
4- Rwt	0.55	0.07	0.35	0.51	-0.29	0.78**	-0.24	0.26
5- Lwt	0.60	0.30	0.32	0.31	0.38	0.45	-0.06	0.41
6- Thwt	0.63*	0.05	0.01	0.33	-0.11	0.39	-0.38	0.16
7- Swt	0.84**	0.41	0.54	0.51	0.15	0.64*	-0.32	0.51
8- Nwt	0.41	0.11	-0.09	0.43	-0.09	0.67*	0.09	0.36
9- Fwt	0.38	0.10	0.37	0.34	-0.11	0.69*	0.04	-0.09
10- Tailwt	0.14	-0.05	0.42	-0.15	-0.09	-0.09	-0.11	-0.38

BL: body length, HW: height at withers, HG: heart girth, CD: chest depth, CW: chest width, RC: round circumference, PG: paunch girth, PW: pelvis width, BW: fasted body weight, Crwt: hot carcass weight, Rwt: round weight, Lwt: loin weight, Thwt: thoracic region weight, Swt: shoulder weight, Nwt: neck weight, Fwt: flank weight, Tailwt: tail weight. * $P < 0.05$ ** $P < 0.01$

Table 4: Correlation coefficients between body measurements and body weight and carcass traits of Rahmani ram lambs.

Body weight and carcass traits	Body measurements							
	BL	HW	HG	CD	CW	RC	PG	PW
1- BW	0.66*	0.89**	0.93**	0.71*	0.47	0.58	0.85**	0.78**
2- Crwt	0.64*	0.95**	0.92**	0.72*	0.39	0.68*	0.78**	0.71*
3- Dressing %	0.40	0.81**	0.57	0.50	0.06	0.72*	0.33	0.27
4- Rwt	0.56	0.75*	0.71*	0.56	0.10	0.65*	0.36	0.25
5- Lwt	0.36	0.51	0.40	0.30	0.19	0.20	0.48	0.21
6- Thwt	0.60	089**	0.95**	0.83**	0.47	0.52	0.78**	0.64*
7- Swt	0.68*	0.92**	0.91**	0.79**	0.43	0.67*	0.67*	0.64*
8- Nwt	0.71*	0.86**	0.83**	0.74*	0.36	0.46	0.72*	0.76*
9- Fwt	0.74*	0.57	0.82**	0.77**	0.55	0.18	0.57	0.49
10- Tailwt	0.28	0.84**	0.68*	0.48	0.07	0.68*	0.75*	0.71*

BL: body length, HW: height at withers, HG: heart girth, CD: chest depth, CW: chest width, RC: round circumference, PG: paunch girth, PW: pelvis width, BW: fasted body weight, Crwt: hot carcass weight, Rwt: round weight, Lwt: loin weight, Thwt: thoracic region weight, Swt: shoulder weight, Nwt: neck weight, Fwt: flank weight, Tailwt: tail weight. * P < 0.05 ** P < 0.01

with **Nigm *et al.* (1995), Shaker and Hammam (2008) and Yaprak *et al.* (2008). Shaker and Hammam (2008)** found that hot carcass weight of Barki lambs was positively and significantly correlated with chest circumference and abdominal circumference. In the meantime, **Yaprak *et al.* (2008)** found positive and significant correlations for body length and heart girth circumference with cold carcass weight of Red Karaman lambs.

On the other hand, no significant correlations were observed between body measurements of Ossimi and Barki ram lambs with dressing percentage of their carcasses (Tables 2 and 3). This finding is in agreement with that of **Yaprak *et al.* (2008)** who reported that height at wither, body length and heart girth circumference of Red Karaman lambs were not significantly correlated with dressing %. Nevertheless, dressing percentage of Rahmani was positively and significantly correlated with HW ($P < 0.01$) and RC ($P < 0.05$) (Table 4).

It was found that round weight of carcass was positively and significantly associated with round circumference in the three breeds studied (Tables 2, 3 and 4). The attained result casts light on the close relationship between round circumference of live lamb and its weight after slaughtering.

While loin weight of both Barki and Rahmani carcasses (Tables 3 and 4) were not significantly correlated with any of body measurements, loin weight of Ossimi carcass was positively and significantly associated with HG ($P < 0.01$), CD ($P < 0.05$)

and PG (P < 0.05) (Table 2). In this context, **Cunningham *et al.* (1967)** found that simple correlation of live measurements with percentage retail loin were low.

It is clear (Table 2) that thoracic region weight of Ossimi carcass was positively and significantly correlated with BL (P < 0.01), HG (P < 0.01), CD (P < 0.01), RC (P < 0.05) and PG (P < 0.05). Moreover, results in Table 4 showed positive association of each of HW (P < 0.01), HG (P < 0.01), CD (P < 0.01), PG (P < 0.01) and PW (P < 0.05) with thoracic region weight in Rahmani carcass. Nevertheless, only body length of Barki ram lambs was positively and significantly (P < 0.05) correlated with thoracic weight in carcass (Table 3).

It is worthy to note that positive and significant correlation coefficients were found between shoulder weight of Ossimi carcass and each of BL (P < 0.05), HG (P < 0.01), CD (P < 0.01) (Table 2). Whereas, shoulder weight of Barki carcass (Table 3) was positively and significantly correlated with BL (P < 0.01) and RC (P < 0.05). Meanwhile, all body measurements recorded on Rahmani ram lambs, except CW, were positively and significantly associated with shoulder weight (Table 4). A positive but insignificant correlation coefficient between CW of Rahmani ram lambs and shoulder weight was observed (Table 4). This result contradicts with the finding of **Cunningham *et al.* (1967)** who found non significant correlations among live measurements of sheep and shoulder weight.

The results in Table 2 show that neck weight of Ossimi carcass was not significantly correlated with any of body measurements studied. Additionally, only round circumference (RC) of Barki ram lambs was positively and significantly (P < 0.05) associated with neck weight (Table 3). Nevertheless, positive and significant correlation coefficients between neck weight in Rahmani carcass and each of BL (P < 0.05), HW (P < 0.01), HG (P < 0.01), CD (P < 0.05), PG (P < 0.05) and PW (P < 0.05) were found (Table 4).

It is clear that flank weight of carcass was positively and significantly (P < 0.05) associated with HG of Ossimi ram lambs (Table 2) and RC of Barki ones (Table 3). Meanwhile, positive and significant correlation coefficients between flank weight of Rahmani carcass and each of BL (P < 0.05), HG (P < 0.01), and CD (P < 0.01) were obtained (Table 4).

On the other hand, the correlation coefficient between tail weight of Ossimi carcass and PG was positive and significant (P < 0.05) (Table 2). Nevertheless, no significant correlations were obtained between tail weight and body measurements of Barki ram lambs (Table 3). **Yaprak *et al.* (2008)** found that height at wither of Red Karaman lambs was positively and significantly (P < 0.05) correlated with tail weight. Whereas, body length and heart girth circumference had no significant correlations with fat tail weight. Meanwhile, tail weight of Rahmani carcass was positively and significantly correlated with each of HW (P < 0.01), HG (P < 0.05), RC (P < 0.05), PG (P < 0.05) and PW (P < 0.05) (Table 4). In this context, **Vatankhah and Talebi (2008)** showed that all phenotypic correlations among body weight of lamb and fat-tail measurements were generally positive.

2. Prediction equations of body weight from live body measurements:

Table 5 presents prediction equations of body weight of Ossimi, Barki and Rahmani ram lambs from body measurements. In Ossimi ram lambs, two body measurements (PG and BL) were included in the model. This equation represented 93 % of the variation in body weight of Ossimi ram lambs (Table 5). In the meantime, BL alone contributed 47 % of the variation in body weight of Barki ram lambs (Table 5). Whereas, the best equation for predicting live body weight of Rahmani ram lambs was when HG entered the equation with coefficient of determination (R^2) being 86 % (Table 5). This finding agrees with that of **Nigm *et al.* (1995)** who found that heart girth was the best single predictor and accounted alone, for 77 % of the variation in body weight of Merino males.

Table 5: Prediction equations for calculating body weight (*Y*) from body measurements (independent variables) of Egyptian ram lambs.

Breed	Steps	Variables	Sig.	R^2	S.E.
Ossimi :	1	PG	**	0.78	0.14
	2	BL	**	0.93	0.20
Equation = -91.51 + 0.89 PG (cm) + 0.81 BL (cm)					
Barki :	1	BL	*	0.47	0.42
Equation = -33.36 + 1.12 BL (cm)					
Rahmani :	1	HG	**	0.86	0.17
Equation = -60.46 + 1.22 HG (cm)					
All breeds:	1	BL	**	0.44	0.18
	2	PG	**	0.64	0.10
Equation = -47.84 + 0.81 BL (cm) + 0.38 PG (cm)					

PG: paunch girth, BL: body length, HG: heart girth, R^2: determination coefficient, Sig.: significance, * $P < 0.05$, ** $P < 0.01$, S.E.: standard error.

Regardless of breed, the equation including BL and PG could predict body weight of Egyptian ram lambs with an accuracy of 64 % (Table 5). It is worthy to note that all measurements used to predict body weight of ram lambs had positive regression coefficients indicating that body weight of ram lambs increased as those measurements increased.

There is general agreement that body measurements may be used for predicting body weight of sheep (**Nigm *et al.*, 1995; Seker and Kul, 2001; Sarti *et al.*, 2003 and Shaker and Hammam, 2008**). **Sarti *et al.* (2003)** used heart girth to predict body weight of Italian Appenninica and Merinizzata meat sheep breeds with high determination coefficient (R^2 = 0.99). **Shaker and Hammam (2008)** reported that the optimum equation for predicting live body weight of Barki male sheep was attained when thick tail circumference and body length were entered in the equation (R^2 = 68.62 %).

3. Prediction equations of hot carcass weight from live body measurements:

Results in Table 6 show that three variables were included to predict hot carcass weight of Ossimi ram lambs. The first of these was HG, it explained 79 % of the variation in hot carcass weight. The remaining variables were CD and PG. When these two body measurements were included in the model, the accuracy increased 18 % (Table 6). Similar result was found by **Nigm *et al.* (1995)** who reported that heart girth was the most significant variable for prediction of hot carcass weight of Merino males, R^2 was 72.8 %. Entry of chest depth increased R^2 to 79.7 %.

Table 6: Prediction equations for calculating hot carcass weight (*Y*) from body measurements (independent variables) of Egyptian ram lambs.

Breed	Steps	Variables	Sig.	R^2	S.E.
Ossimi :	1	HG	**	0.79	0.09
	2	CD	*	0.91	0.12
	3	PG	*	0.97	0.07
Equation = -33.62 + 0.24 HG (cm) + 0.48 CD (cm) + 0.23 PG (cm)					
Barki :	1	BL	**	0.59	0.23
Equation = -32.47 + 0.80 BL (cm)					
Rahmani :	1	HW	**	0.90	0.18
Equation = -87.62 + 1.54 HW (cm)					
All breeds:	1	BL	**	0.41	0.14
	2	HW	*	0.53	0.19
Equation = -38.59 + 0.38 BL (cm) + 0.50 HW (cm)					

HG: heart girth, CD: chest depth, PG: paunch girth, BL: body length, HW: height at withers, R^2: determination coefficient, Sig.: significance, * P < 0.05, ** P < 0.01, S.E.: standard error.

In the prediction of hot carcass weight of Barki ram lambs, only BL was included in the model (Table 6). Coefficient of determination (R^2) was only 59 % (Table 6). Whereas, HW was the only significant (P < 0.01) variable contributed to the variation in hot carcass weight of Rahmani ram lambs with high coefficient of determination (R^2 = 0.90) (Table 6).

As a general recommendation, it may be suggested to use two body measurements (BL and HW) to predict hot carcass weight of the Egyptian ram lambs

(Table 6). BL was the most significant (P < 0.01) variable scoring alone R^2 of 41 % for estimating hot carcass weight. R^2 improved to 53 % by incorporating HW into the prediction equation (Table 6).

It is of interest that carcass weight was highly correlated with total muscle in the carcass **(Diaz *et al.*, 2004)**. The authors indicated that cold carcass weight was a good predictor of the weight of carcass tissues in suckling lambs.

The obtained results in this study are in harmony with those reported by **Seker and Kul (2001), Marshall *et al.* (2005), Alsheikh *et al.* (2007) and Shaker and Hammam (2008). Seker and Kul (2001)** showed that height at withers, height at rump, body length, chest width and rump width of Awassi yearling ram lambs may be used for predicting the warm carcass weight. **Marshall *et al.* (2005)** used live weight, rump height and thorax depth to predict weight of the half of the carcass of Pelibuey sheep with R^2 = 0.93. **Alsheikh *et al.* (2007)** found that the regression coefficient of carcass weight on principle components of body size of fattened Barki lambs were positive and significant (P < 0.05). Furthermore, **Shaker and Hammam (2008)** reported that the best equation for predicting carcass weight of Barki lambs was attained when live body weight, body height and thick tail circumference were incorporated (R^2 = 90.46 %).

4. Prediction equations of round weight from live body measurements:

It is clear (Table 7) that the prediction equation must include only RC to predict round weight for both Ossimi and Barki carcasses with accuracy of 67 % and 60 %, respectively. Similarly, one variable could be included to predict round weight of Rahmani carcass (Table 7). This variable is HW, where it explained 57 % of the variation in round weight (Table7).

On the other hand, irrespective of breed, HG contributed 42 % of the total variation in round weight of Egyptian ram lambs. Whereas, RC came next and scored a partial determination of 21 % increasing the model's R^2 to 63 % (Table7). In this context, **Anous and El-Sayed (2004)** indicated that conformation, expressed by hind leg length, with the weight of the carcass were found to be good predictors for muscle contents of the hind leg and its degree of muscling (R^2 = 0.59 - 0.86).

5. Prediction equations of shoulder weight from live body measurements:

It is apparent from Table 8 that CD was the single independent variable used to predict shoulder weight of Ossimi carcass. It accounted for 72 % of the variation in shoulder weight (Table 8) .Whereas, BL was the single significant (P < 0.01) variable entered in the model to predict shoulder weight in Barki carcass with an accuracy of 70 % (Table 8). Furthermore, the prediction equation included HW and CD as the independent variables could be applied to predict shoulder weight of Rahmani carcass with high coefficients of determination (R^2 = 0.85 and 0.93, respectively) (Table 8).

Table 7: Prediction equations for calculating round weight (*Y*) from body measurements (independent variables) of Egyptian ram lambs.

Breed	Steps	Variables	Sig.	R^2	S.E.
Ossimi :	1	RC	**	0.67	0.02
Equation = 0.35 + 0.06 RC (cm)					
Barki :	1	RC	**	0.60	0.02
Equation = 0.12 + 0.08 RC (cm)					
Rahmani :	1	HW	*	0.57	0.05
Equation = -7.68 + 0.15 HW (cm)					
All breeds:	1	HG	**	0.42	0.01
	2	RC	**	0.63	0.01
Equation = -2.19 + 0.03 HG (cm) + 0.05 RC (cm)					

RC: round circumference, HW: height at withers, HG: heart girth, R^2: determination coefficient, Sig.: significance, * P < 0.05, ** P < 0.01, S.E.: standard error.

Irrespective of the effect of breed, three variables were included to predict shoulder weight of Egyptian ram lambs (Table 8).The first variable was HG, it explained 54 % of the variation in shoulder weight (Table 8). The remaining variables were BL and RC with accuracy of 67 % and 72 %, respectively (Table 8). Similar trend was observed by **Marshall *et al.* (2005)** in Pelibuey sheep. The authors indicated that slaughter weight and length of the rump can be used to predict shoulder weight with an accuracy of 84 %.

6. Prediction equations of thoracic region weight from live body measurements:

Table 9 reveals that two body measurements (HG and BL) were included in the model to predict thoracic region weight of Ossimi carcass. This equation explained 98 % of the variation in thoracic weight (Table 9). Whereas, BL was used as a single predictor to predict weight of thoracic region in Barki carcass with an accuracy of 40 % (Table 9). However, HG alone was responsible for most variation in thoracic weight of Rahmani carcass. HG accounted for 89 % of the variation in thoracic weight of the same breed (Table 9). In this context, **Nigm *et al.* (1995)** concluded that heart girth was the best single measurement for predicting different carcass traits of Merino males.

Table 8: Prediction equations for calculating shoulder weight (*Y*) from body measurements (independent variables) of Egyptian ram lambs.

Breed	Steps	Variables	Sig.	R^2	S.E.
Ossimi :	1	CD	**	0.72	0.02
Equation = -1.31 + 0.09 CD (cm)					
Barki :	1	BL	**	0.70	0.02
Equation = -3.21 + 0.08 BL (cm)					
Rahmani :	1	HW	**	0.85	0.02
	2	CD	*	0.93	0.03
Equation = -7.27 + 0.09 HW (cm) + 0.08 CD (cm)					
All breeds:	1	HG	**	0.54	0.01
	2	BL	**	0.67	0.01
	3	RC	*	0.72	0.01
Equation = -2.42 + 0.02 HG (cm) + 0.02 BL (cm) + 0.02 RC (cm)					

CD: chest depth, BL: body length, HW: height at withers, HG: heart girth, RC: round circumference, R^2: determination coefficient, Sig.: significance, * $P < 0.05$, ** $P < 0.01$, S.E.: standard error.

Table 9: Prediction equations for calculating thoracic region weight (*Y*) from body measurements (independent variables) of Egyptian ram lambs.

Breed	Steps	Variables	Sig.	R^2	S.E.
Ossimi :	1	HG	**	0.86	0.01
	2	BL	**	0.98	0.01
Equation = -8.99 + 0.08 HG (cm) + 0.07 BL (cm)					
Barki :	1	BL	*	0.40	0.04
Equation = -3.15 + 0.09 BL (cm)					
Rahmani :	1	HG	**	0.89	0.02
Equation = -9.31 + 0.14 HG (cm)					
All breeds:	1	BL	**	0.41	0.02
	2	PG	*	0.51	0.01
Equation = -5.50 + 0.08 BL (cm) + 0.03 PG (cm)					

HG: heart girth, BL: body length, PG: paunch girth, R^2: determination coefficient, Sig.: significance, * $P < 0.05$, ** $P < 0.01$, S.E.: standard error.

Irrespective of breed effect, entry of BL followed by PG into prediction equation of thoracic weight in Egyptian ram lambs increased R^2 to 51 %. **Marshall *et al.* (2005)** used different independent variables (slaughter weight, thoracic perimeter and length of the rump) to predict weight of ribs with accuracy of 80 %.

CONCLUSION

Weights of live body, hot carcass and carcass cuts in Egyptian ram lambs could be predicted by measuring some live body measurements such as body length , heart girth, height at withers, chest depth, chest width, round circumference, paunch girth and pelvis width. In this context, round circumference of Ossimi and Barki ram lambs was the significant variable for predicting round weight in their carcasses. Additionally, it was noticed that all body measurements used to predict the weights of body and carcass cuts had positive and significant regression coefficients.

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استخدام مقاييس الجسم للتنبؤ بوزن الجسم وأوزان قطعيات الذبيحة لثلاث سلالات من الأغنام المصرية

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استخدمت 8 مقاييس للجسم لعدد 30 حولى من الأغنام المصرية (10 حوالى من الأوسيمي، والبرقي والرحماني) عند عمر الذبح (12 شهر) وذلك للتنبؤ بوزن الجسم الحي ووزن الذبيحة الساخن وأوزان قطعيات الذبيحة المختلفة.

وجد معامل ارتباط موجب ومعنوي بين محيط الفخد لحوالى الأوسيمي والبرقي والرحماني ووزن الفخد في ذبائحهم. للتنبؤ بوزن الجسم في حوالى الأوسيمي، يجب ان تشتمل معادله الإنحدار علي محيط البطن وطول الجسم بدقة تنبؤ 93 %. في حين اشتملت معادلة الإنحدار علي محيط الصدر وعمق الصدر ومحيط البطن للتنبؤ بوزن الذبيحة الساخن لحوالى الأوسيمي، حيث بلغت قيمة معامل التحديد (R^2) 97 %. وفي غضون ذلك، ساهم طول الجسم بمفرده بنسبة 47 % و 59 % في الاختلاف في وزن الجسم ووزن الذبيحة الساخن علي التوالي لحوالى البرقى. كان محيط الصدر هو أفضل مقياس فردي للتنبؤ بوزن الجسم ووزن الذبيحة الساخن لحوالى الرحماني حيث كان مسئولاً بمفرده عن 86 % و 90% من الاختلافات في هذه الاوزان علي التوالي.

يجب ان تحتوي معادلة الإنحدار علي محيط الفخذ للتنبؤ بوزن الفخذ في كل من ذبائح الأوسيمي والبرقي مع دقة تنبؤ 67 % و 60% علي التوالي. كان ارتفاع الجسم في حوالى الرحماني مسئولاً عن 57 % من الاختلاف في وزن الفخذ في الذبيحة. كان عمق الصدر هو المتغير الفردي المستخدم في التنبؤ بوزن الكتف في ذبائح الأوسيمي ($R^2 = 0.72$)، في حين كان طول الجسم هو المتغير الفردي الذي اشتملت علية معادلة الإنحدار للتنبؤ بوزن الكتف في ذبائح حوالى البرقي ($R^2 = 0.70$). تم استخدام مقياسين للجسم (أرتفاع الجسم وعمق الصدر) للتنبؤ بوزن الكتف في ذبائح الرحماني بدقة تنبؤ 93،%.

من الجدير بالذكر، ان جميع مقاييس الجسم المستخدمة في هذه الدراسة للتنبؤ بوزن الجسم ووزن قطعيات الذبيحة كان لها معاملات إنحدار موجبة.