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Effect of Slaughter Weight on Carcass Characteristics and Cutability of Imported Merino Wethers

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Abstract. Forty five imported Australian Merino wethers were equally allotted to three predetermined weight groups of 52, 58 and 65 kg. The effect of slaughter weight on carcass characteristics and cutability was determined.

The results indicated that, dressing percentage, KPH fat weight, loin eye area, body wall thickness and the various wholesale cut weights increased linearly ($p < 0.01$) as slaughter weight or cold carcass weight increased. While the loin eye area did not increase significantly between the 52 and 58 kg weight groups, it did from 58 to 65 kg. The correlations of slaughter weight and cold carcass weight with all studied carcass characteristics were positive and highly significant ($p < 0.01$), except for body fat thickness and for dressing percentage.

On the other hand, fat thickness and body wall thickness had unfavourable correlations with loin eye area and dressing percentage.

Introduction

The economic pressures have provoked sheep importers to become more aware of the importance of maximizing their processing efficiency. The ultimate goal is to import and process quality sheep at the least possible cost. Many of the overhead costs in the importation industry and in the retail stores are on a per carcass basis. As a result, heavy market sheep with high cutability would result in substantially improved efficiency of processing. This should encourage retailers to merchandise heavier carcasses if they are available. One legitimate objection to heavier carcasses is the well-known positive relationship between carcass weight and carcass fat weight [1]. In addition, several studies have reported that heavy carcasses were less tender and had less desirable yield grades than the light weight carcasses [1-3].

There is limited information concerning the carcass characteristics of imported Australian Merino wethers. Therefore, the purpose of this study was to investigate the influence of slaughter weight on qualitative and quantitative differences in Merino wether carcasses.

Materials and Methods

Forty five imported Australian Merino wethers were purchased in April 1986 from Saudi Livestock Transport and Trading Co. and trucked to the Department of Animal Production Farm, King Saud University (approx. 45 km). Upon purchase, all animals were individually identified and allotted to three prescribed slaughter weight groups of 52 ± 2, 58 ± 2 and 65 ± 2 kg, which are within the normal weights range of imported wethers on the Saudi market. Subsequently, wether were slaughtered at a commercial slaughterhouse after an 18 hr period without feed; thereafter, carcasses were returned to the meat laboratory for processing. Carcasses were allowed to chill for 24 hr at 5°C before carcass traits were measured. After chilling, the cold carcass weight of each individual was recorded and the kidney, pelvic and heart fat (KPH) were removed and weighed. Dressing percentage was calculated as: (100)(Cold carcass weight) / (slaughter weight). Carcasses were then split down the backbone, and the right side of each carcass was ribbed between the 12th and the 13th ribs. After ribbing, a tracing was made of the loin eye muscle (longissimus dorsi) on the anterior surface of the loin and a planimeter was used to determine the area in cm^2. Fat thickness over the center of the loin eye muscle at the 12th rib and the body wall thickness 11 cm lateral to the dorsal process between the 12th and the 13th ribs were also measured.

Right sides of the carcasses were then fabricated into standard wholesale leg, loin, rack, shoulder, breast and shank and flank cuts following the procedures of Romans and Ziegler [4]. The neck was removed from the shoulder by a cut made parallel to the line of the scapula. Each wholesale cut was then weighed to the nearest 10 gm. KPH fat and the neck weights were not included in the cold half carcass weight calculations.

Means, standard errors, correlations and regressions were calculated and Duncan's multiple range test was used to detect differences among individual means according to Steel and Torrie [5]. All statistical computations were accomplished by the use of a computer program entitled: Statistical Analysis System [6].

Results and Discussion

Means of various carcass characteristics and their standard errors for the three slaughter weight groups are shown in Table 1. The data revealed that as slaughter weight increased, the cold carcass weight significantly ($p < 0.01$) increased. Also, dressing percentage increased slowly but significantly ($p < 0.01$) as slaughter weight increased. This probably was a result of increased kidney, pelvic and heart (KPH) fat weight. The kidney and pelvic regions are the sites of a large amount of fat deposition as an animal increases in weight [7-8]. Therefore, when the KPH fat weight is subtracted from the carcass weight, there is no difference in the dressing percentage of the three groups. These results are consistent with the findings reported by Shelton and Carpenter [9] who concluded that dressing percentage increased with increasing carcass weight which was partially an expression of increased fat deposition.

Table 1. Means and standard errors for carcass characteristics from Merino wethers at three slaughter weights[a]

Character	Slaughter weight, kg		
	52	58	65
Slaughter weight, kg	$52.73 \pm .34^{d}$	58.37 ± 0.55^{c}	65.98 ± 0.60^{b}
Cold carcass weight, kg	$25.33 \pm .50^{d}$	28.39 ± 0.69^{c}	32.47 ± 0.72^{b}
Dressing %	$48.04 \pm .79^{c}$	48.64 ± 1.28^{bc}	49.22 ± 1.02^{b}
Loin eye area, cm^2	$13.46 \pm .50^{c}$	14.42 ± 0.32^{c}	16.34 ± 0.51^{b}
Fat thickness, mm	$5.90 \pm .05^{c}$	6.70 ± 0.09^{b}	6.88 ± 0.06^{b}
Body wall thickness, cm	$2.15 \pm .07^{c}$	2.60 ± 0.19^{b}	2.79 ± 0.11^{b}
KPH fat weight, kg	$0.84 \pm .06^{d}$	1.17 ± 0.12^{c}	1.51 ± 0.14^{b}
KPH fat weight, %[e]	$3.34 \pm .23^{c}$	4.06 ± 0.37^{bc}	4.49 ± 0.40^{b}

[a] 15 animals per slaughter weight group.

[b,c,d] Means in the same row with no common superscripts differ ($p < 0.01$).

[e] Kidney, pelvic and heart fat; calculated on the basis of cold carcass weight.

The loin eye area increased nonsignificantly as the slaughter weight increased from 52 to 58 kg and significantly ($p < 0.01$) from 58 to 65 kg. However, the corresponding increased in loin area per kg of live body weight were .26, .25 and .25 cm^2, respectively. These rates of increase are similar to that reported by Kemp *et al.* [10] and Sents *et al.* [1], but somewhat higher than those reported by Lambuth *et al.* [7] and Shelton and Carpenter [9].

Several fat measurements, including fat thickness, body wall thickness and KPH have proved to be good indicators for total body fat [7]. Fat measurements increased with increased slaughter weight. These results are in agreement with those reported by Lloyd *et al.* [8] and Meyer and Kirton [11]. Although, the fat thickness and body wall thickness were thicker ($p < 0.01$) for the heavy slaughter weight group (65 kg) than those wethers of lighter weights, the differences between the three studied weight groups became smaller ($p < 0.01$) as slaughter weight increased.

The regression coefficients for each studied carcass characteristic regressed on slaughter weight or cold carcass weight and the associated standard errors are presented in Table 2. Because nonlinear responses were not statistically significant, except for loin eye area, linear responses are presented for all characters. The carcass characteristics increased linearly ($p < 0.01$) as the live body weight increased except for dressing percentage and body fat thickness. The analysis of a quadratic effect for loin eye area rate of increase indicated that, the loin area increased at a faster rate ($p < 0.01$) as live body weight increased. The calculated quadratic equation is, Loin area, $cm^2 = 74.52 + (-2.22 \pm 1.09)(S.wt) + (.02 \pm .01)(S.wt)^2$ where S.wt is slaughter weight in kilograms.

Table 2. Regression coefficients[a] and standard errors for carcass characteristics regressed on slaughter weight or cold carcass weight, kg

Character (Y)	Slaughter weight (X)			Cold carcass weight (X)		
	b_o	b_i	R^2	b_o	b_i	R^2
Cold carcass weight	−1.52	.51±.07**	.59			
Dressing %	45.70	.05±.11	.05	27.27	.74±.12**	.48
Loin eye area, cm^2	3.11	.19±.05**	.28	6.94	.26±.08**	.21
Fat thickness, mm	−1.94	.14±.01	.08	1.40	.16±.01	.05
Body wall thickness, cm	−1.08	.06±.02**	.27	.32	.07±.03**	.20
KPH fat weight, kg	−1.45	.04±.01**	.24	−1.42	.09±.02**	.47

[a] Linear model $Y_i = b_o + b_i X_i$ where b_o is the intercept and b_i is the slope.
** $p < 0.01$.

Further, all carcass characteristics increased in a linear manner ($p < 0.01$) as cold carcass weight increased except for body fat thickness. These findings are not in agreement with the results by Shelton and Carpenter [9] and Sents *et al.* [1] who showed a linear relationship between fat thickness and carcass weight. However, linear relationships for loin eye area and body wall thickness with carcass weight [1] and between kidney fat weight with carcass weight [11] have been reported for ram lambs of various breeds.

Presented in Table 3 are the estimates of correlation coefficients among carcass characteristics in Merino wethers. The correlation of slaughter weight with each carcass characteristic tends to be positive and highly significant ($p < 0.01$) except with dressing percentage and body fat thickness. Also, cold carcass weight was positively correlated with all carcass characteristics but not with fat thickness. The correlation coefficients among the various fat measures were positive and highly significant ($p < 0.01$). Fat measures had nonsignificant correlations with loin eye area and dressing percentage, the exception was KPH fat weight with dressing percentage.

Table 3. Coefficients of correlation among carcass characteristics of Merino wethers

Character	CCW	DP	LEA	FT	BWT	KPH[a]
Slaughter weight	.765**	.068	.528**	.278	.521**	.493**
	(41)[b]	(41)	(42)	(43)	(27)	(42)
Cold carcass weight (CCW)		.692**	.458**	.215	.449*	.685**
		(41)	(38)	(40)	(24)	(41)
Dressing % (DP)			.094	−.019	.149	.518**
			(38)	(40)	(24)	(41)
Loin eye area (LEA)				.190	.060	.265
				(40)	(25)	(39)
Fat thickness (FT)					.736**	.502**
					(27)	(41)
Body wall thickness (BWT)						.704**
						(25)

[a] Kidney, pelvic and heart fat weight.
[b] Values in parentheses are number of observations.
* $p < 0.05$; ** $p < 0.01$.

Means, standard errors and percentages for various wholesale cut weights in cold half carcasses from Merino wethers at three slaughter weights are shown in Table (4). The total weight of prime cuts, including wholesale leg, shoulder, loin and rack, increased significantly ($p < 0.01$) in weight as slaughter weight increased from 52 to 58 kg and from 58 to 65 kg, or .198 kg and .210 kg per each kg increase in cold half carcass weight, respectively. However, the overall rate of increase in prime cut weights was estimated to be 0.205 kg/kg increase in cold half carcass weight. This rate of increase is similar to that found by Sents *et al.* [1]. Conversely, there were no observable differences in percent prime cut weights between the three studied slaughter weight groups. This finding confirms the previous results of Craddock *et al.* [12] who indicated that less variation is accounted for by an analysis of percentages than on of actual weights. Therefore, no analyses was conducted on the percentage values from this study, but they are presented for comparative and discussion purposes.

Table 4. Means, standard errors and percentages for wholesale cuts in cold half carcasses from Merino wethers at three slaughter weights[a]

Wholesale cut	Slaughter weight, kg					
	52		58		65	
	weight, kg	%	weight, kg	%	weight, kg	%
Prime cuts:	8.85 ± .13[d]	76.7	10.04 ± .14[c]	75.4	11.51 ± .15[b]	75.9
Leg	3.92 ± .12[d]	33.9	4.41 ± .13[c]	33.1	4.76 ± .09[b]	31.2
Shoulder	2.86 ± .08[d]	24.8	3.22 ± .12[c]	24.2	3.79 ± .09[d]	24.9
Loin	1.12 ± .05[c]	9.7	1.23 ± .16[c]	9.2	1.69 ± .08[b]	11.4
Rack	.95 ± .03[c]	8.3	1.18 ± .08[b]	8.9	1.27 ± .06[b]	8.4
Rough cuts:	2.69 ± .11[d]	23.3	3.27 ± .07[c]	24.6	3.65 ± .10[b]	24.1
Breast & shank	2.16 ± .08[d]	18.7	2.55 ± .06[c]	19.2	2.87 ± .11[b]	18.9
Flank	.53 ± .03[c]	4.6	.72 ± .05[b]	5.4	.78 ± .04[b]	5.2

[a] 15 animals per slaughter weight group.
[b,c,d] Weights in the same row with no common superscripts differ ($p < 0.01$).

The weights of wholesale leg and shoulder cuts increased significantly ($p < 0.01$) as slaughter weight increased. These results reveal much the same trend as those reported by Lambuth *et al.* [7] and Kemp *et al.* [10]. The weight of loin cut increased nonsignificantly from 52 to 58 kg and significantly ($p < 0.01$) from 58 to 65 kg, whereas wholesale rack cut increased significantly ($p < 0.01$) from 52 to 58 kg and nonsigificantly from 58 to 65 kg. Generally, the weight of loin cut changed the most, increasing 50.8% between 52 and 65 kg, while the corresponding weight of leg cut changed the least, increasing only by 21.4%. However, as slaughter weight increased, percentage leg cut in cold half carcass decreased while percentages shoulder, loin and rack cuts changed variably. These changes are similar to those reported by Kemp *et al.* [10], with the exception for shoulder cut which decreased in percentage as slaughter weight increased. These changes, however, probably reflect the different rates of maturation among the carcass parts previously reported by Palsson and Verges [13], Sents *et al.* [1], Abouheif *et al.* [14], in which the leg region matures relatively early, while the loin is a late- maturing part.

As slaughter weight increased the weight of rough cuts increased significantly ($p < 0.01$) in weight, the weights of breast and shank cuts increased significantly ($p <$

0.01), while flank weight increased only significantly ($p < 0.01$) from 52 to 58 kg and nonsignificantly from 58 to 65 kg. However, percentages of breast and shank weight and flank weight changed in a variable manner with increasing slaughter weight. These results were in disagreement with the previous findings by Kemp *et al.* [10] who indicated that as slaughter weight increased, percentage breast and flank cut increased, while percentage shank cut decreased. These conflicting results can be explained in part by the fact that the former workers considered shank as a separate cut, while in this work breast and shank were included in one wholesale cut.

The regression coefficients for each wholesale cut weight regressed on slaughter or cold carcass weight and the associated standard errors are presented in Table 5. A linear relationship ($p < 0.01$) for each cut weight with slaughter weight or cold carcass weight was found. Sents *et al.* [1] reported similar trends for leg, loin, rack and shoulder cuts regressed on live body weight. However, the magnitude of those linear relationships with slaughter weight were relatively smaller than those found with cold carcass weight.

Table 5. Regression coefficients[a] and standard errors for wholesale cuts regressed on slaughter weight or cold carcass weight

Wholesale cut (Y)[b]	Slaughter weight (X)			Cold carcass weight (X)		
	b_0	b_i	R^2	b_0	b_i	R^2
Leg	1.12	.06 ± .01**	.32	.98	.12 ± .01**	.68
Shoulder	− .57	.07 ± .01**	.49	.16	.11 ± .01**	.68
Loin	−1.15	.04 ± .01**	.47	−.55	.07 ± .01**	.60
Rack	.01	.02 ± .01**	.19	.04	.04 ± .01**	.31
Breast and shank	−.41	.05 ± .01**	.41	.31	.08 ± .01**	.53
Flank	−.33	.02 ± .01**	.25	−.14	.03 ± .01**	.32

[a] Linear model $Y_i = b_o + b_i X_i$ where b_o is the intercept and b_i is the slope.
[b] All weights in kg.
** $p < 0.01$.

Imported sheep in Saudi Arabia are sold without grading and animals of various weights or conditions usually fetch the same price per head. Therefore, it seems reasonable to suggest that retailers should process more heavy carcasses because they would benefit from the increased weight of salable cuts per unit cost when compared to the lighter carcasses. Since carcass weight will be of increasing concern if importation becomes directed toward marketing and processing heavier wethers, new carcass indicators including fatness and palatability, to satisfy the local demands would be useful.

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تأثير وزن الذبح على صفات ذبائح وقطعيات أغنام المرينو المستوردة

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ملخص البحث. استخدم في هذه التجربة ٤٥ رأسًا من ذكور أغنام المرينو المخصية المستوردة من استراليا والتي وزعت على ٣ مجاميع على أساس متوسط وزن الجسم كالتالي ٥٢ ، ٥٨ ، ٦٥كجم بغرض دراسة تأثير وزن الذبح على خواص الذبيحة. وقد أثبتت النتائج أن نسبة التصافي ووزن دهن الكلية والحوض والقلب ومساحة العضلة العينية وسمك جدار الجسم وكذلك وزن القطعيات القياسية المختلفة تزداد بصورة خطية كلما زاد وزن الجسم أو الوزن المبرد للذبيحة، وقد لوحظ أن مساحة العضلة العينية تتسع بمعدل متزايد مع زيادة وزن الجسم الحي لهذه الأغنام.

وقد أوضحت الدراسة وجود علاقات ارتباط موجبة ومعنوية إحصائيًا بين كل من وزن الجسم أو الوزن المبرد للذبيحة مع مختلف صفاتها ماعدا الارتباط بين سمك طبقة الدهن أو نسبة التصافي مع وزن الجسم الحي. وبصورة عامة فإن كلا من سمك طبقة الدهن أو سمك جدار الجسم لم يكن بينها وبين مساحة العضلة العينية أو نسبة التصافي أي علاقات ارتباط إحصائية.