An evaluation of the lamb and mutton carcase grading system in the Republic of South Africa. 3. Fatness score, conformation score and carcase mass as predictors of carcase composition

G.G. Bruwer* and R.T. Naudé
Animal and Dairy Science Research Institute, Private Bag X2, Irene, 1675 Republic of South Africa
W.A. Vosloo
University of Stellenbosch, Stellenbosch, 7600 Republic of South Africa

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The influence of fatness, conformation and carcase mass as individual predictors of carcase composition, was determined in 104 carcases which were fully dissected and of which carcase composition was determined. Chemical analysis was done on each carcase and the total fat percentage of each carcase was determined. The official graders evaluated carcase fatness and conformation on an 18- and 15-point scale respectively. Cold carcase mass was recorded. Visual evaluation of fatness showed higher relationships with carcase tissues than did conformation or carcase mass. The contribution of fatness score to explain the variation in lean percentage in lamb carcases was 68,38%, whilst conformation and carcase mass contributed 3,06% and 0,68% respectively. Similar results were obtained when carcases of all the age groups were combined. Of the variation that occurred in total fat percentage for lamb carcases 80,83% was explained by fatness score whilst conformation and carcase mass contributed 0,75% and 0,44% respectively. The contribution of conformation as a predictor of carcase composition was negligible. The relationships of carcase mass with subcutaneous fat percentage and total fat percentage were very low.

Die invloed van vetheid, bouvorm en karkasmassa as individuele beramers van karkassamestelling is bepaal op 104 karkasse wat volledig gedissekteer is en waarvan die karkassamestelling bepaal is. Die chemiese samestelling van elke karkas is bepaal en die totale vetpersentasie in die karkas is bereken. Die amptelike gradeerders het elke karkas vir vetheid en bouvorm onderskeidelik volgens 'n 18-punt- en 15-puntskaal beoordeel. Koue karkasmassa is aangeteken. Visuele evaluering van vetheid het hoër verwantskappe met al die karkasweefsels getoon as bouvorm en karkasmassa. Vetheid se bydrae tot die verklaarbare variasie in vleis was 68,38% teenoor onderskeidelik 3,06% en 0,68% vir bouvorm en karkasmassa by lamkarkasse. Ooreenstemmende resultate is gevind toe karkasse van al die ouderdomsgroepe saamgegroepeer is. Van die verklaarbare variasie in totale vetpersentasie, is 80,83% by lamkarkasse deur vetheid verklaar, terwyl bouvorm en karkasmassa onderskeidelik 0,75 en 0,44% bygedra het. Bouvorm se bydrae as beramer van karkassamestelling is weglaatbaar klein. Die verwantskappe van karkasmassa met onderhuidse vet- en totale vetpersentasie was opmerklik laag.

Keywords: Lamb, mutton, carcase, classification, fatness, conformation, carcase mass.

* To whom correspondence should be addressed

Introduction

Classification of products comprises the systematic grouping of similar products into uniform classes. The objective of carcase classification is to describe carcases on the basis of measurable and definable criteria (Moxham & Brownlie, 1976), using a common language which is understood by everyone trading in the market (Kempster, Cuthbertson & Harrington, 1982). According to Klingbiel (1984) the advantage of a classification system is firstly that the classification of fat and age together with carcase mass as quantitative indicators are valuable parameters which can be easily measured and this could ensure greater consistency in the nature of the product over the years. Secondly production targets may be formulated regarding carcase mass, fatness, age and sex for each breed in different systems. Currently carcases are classified according to fatness, conformation, age, sex and kidney fat, while carcase mass is merely recorded.

Internationally the trade believes that carcase conformation traits such as short in the leg, plumpness and blockiness indicate more meat, less bone and a higher proportion of the higher priced cuts, than flatter carcases that are longer in the leg (Kirton & Pickering, 1967). This perception has changed drastically in South Africa since the introduction of the 'new' grading system in which conformation is of lesser importance. Research results on sheep have shown that longer carcases are leaner and contain a higher proportion of muscle and bone and less fat than the blockier ones when compared at similar mass (Fourie, Kirton & Jury, 1970; Jackson & Mansour, 1974). It seems therefore that carcase conformation would be a poor predictor of carcase composition. Carcase fatness on the other hand has important influences on the retail value of the carcase (Smith-Pilling & Barton, 1954; Naudé, 1985). The fatter the carcase the lower the saleable meat yield.

Currently the fatness of the carcase is evaluated visually in the classification scheme on a six-point scale in South Africa. Kempster, *et al.* (1982) were of the opinion that the visual evaluation of carcase fatness is a most reliable predictor of carcase composition, but that there are distinct advantages in applying objective methods for predicting carcase composition especially for more accurate classification of borderline carcases thus preventing dispute about these.

These authors also stated that carcase mass should be included as the first dependent variable when different predictors of carcase compostion are being compared because it is always available. Kirton & Johnson (1979) and Thompson & Atkins (1980) also supported this approach.

The purpose of the present investigation was to study the visual assessment of fatness and conformation as well as the carcase mass as predictors of carcase composition and the use of these parameters in a classification and grading system.

Procedure

The same carcases and methods were used for the purpose of this study as was described by Bruwer, Naudé, Vosloo, Du Toit & Cloete (1987). The visual assessment of carcase fatness and conformation was performed on an 18-point and 15-point scale respectively by different graders. Cold carcase mass was recorded.

The average carcase composition and standard deviation of carcases of each fat and conformation class was calculated. Simple regression analyses and residual standard deviations (*RSD*) were calculated for fatness, conformation and carcase mass as predictors of carcase composition. The model of Kempthorne (1969) was used to determine the proportional contribution of carcase fatness, carcase conformation and carcase mass to the variation that occurred in the different carcase tissues. This model states that in a multiple regression analysis where

$$y = b_0 + b_1x_1 + \ldots b_ix_i,$$

the factor $b_i' = b_iV_i/V_y$ is calculated, where b_i = multiple regression coefficient between x_i and y, V_i = standard deviation of x_i and V_y = standard deviation of y.

The variation which can be attributed to each dependent factor X_i, is $(b_i')^2$ and to each combination of $X1_i\ X2_i$ is $2(b1_i\ b2_i)\ r1_i2_i$. The portion $2(b1_i\ b2_i)\ r1_i\ 2_i$ will be described by the word 'interactions' in Table 4.

The sum of the variation is the variation which can be attributed to each X_i plus the variation which can be attributed to each combination of $X1_i\ X2_i$ and this should be equal to the coefficient of determination (R^2).

Results and Discussion

In Tables 1 and 2 the average carcase composition of the different fat and conformation classes is shown. Table 1 illustrates that with an increase in carcase fatness, i.e. from fat class 1 - 6, the total fat percentage increased from 14,30% to 29,93% and the lean percentage decreased from 76,00% to 72,02%. The same pattern was found for the different conformation classes (Table 2).

As conformation classes increased from 2 to 5 the total fat percentage increased from 17,01% to 28,65% and lean percentage decreased from 75,11% to 72,59%. The increase in conformation score is partially the result of what was described by Kirton & Pickering (1967) and Cuthbertson & Harrington (1976) as the accumulation of subcutaneous fat over the carcase giving it a more blockier appearance and thus a higher conformation score. Fat has the effect of filling in the indentations between muscles giving the carcase a rounded appearance (Kempster, *et al.*, 1982). Because the experimental carcases were originally selected according to the fatness class the number of the carcases for each conformation class within a fat class was not constant.

Carcase fatness, carcase conformation and carcase mass as predictors of carcase composition

Lambs slaughtered comprise 70% of the market and sheep 30% and therefore emphasis will be placed on the prediction of carcase composition of lamb carcases as a group and then also for all age groups combined.

Table 1 Means and standard deviations (*SD*) of the carcase composition of lamb and mutton carcases in the different fat classes

Fat class	*n*	Subcutaneous fat (%)	Lean (%)	Bone (%)	Kidney knob (%)	Total fat (%)	V3 (mm)
1	4	3,46	76,00	18,26	2,28	14,30	2,17
		(1,39)	(1,55)	(1,73)	(1,07)	(3,88)	(1,47)
2	36	5,16	77,08	15,20	2,55	17,26	3,71
		(3,21)	(2,33)	(1,44)	(0,79)	(3,07)	(1,50)
3	18	8,01	74,69	13,85	3,45	23,31	7,79
		(1,52)	(1,79)	(1,08)	(1,75)	(2,80)	(2,81)
4	18	9,79	72,76	12,61	4,84	26,35	9,74
		(2,13)	(2,76)	(1,28)	(1,94)	(4,27)	(2,48)
5	14	11,16	72,37	12,11	4,36	29,32	12,02
		(1,77)	(2,71)	(1,37)	(1,87)	(3,45)	(2,16)
6	14	11,96	72,02	11,46	4,55	29,93	11,93
		(2,42)	(2,61)	(1,63)	(2,00)	(4,53)	(2,73)

Table 2 Means and standard deviations of the carcase composition of lamb and sheep carcases in the different conformation classes

Conformation class	*n*	Subcutaneous fat (%)	Lean (%)	Bone (%)	Kidney knob (%)	Total fat (%)	V3 (mm)
1							
2	14	5,26	75,11	16,62	3,01	17,01	3,64
		(3,23)	(2,53)	(1,94)	(1,03)	(5,41)	(2,51)
3	59	9,41	73,49	12,82	4,29	23,67	7,92
		(3,58)	(3,44)	(1,82)	(1,70)	(6,07)	(4,07)
4	30	9,11	73,93	12,98	3,99	24,61	8,76
		(2,93)	(2,87)	(1,77)	(2,11)	(5,88)	(3,84)
5	1	9,25	72,59	10,60	7,56	28,65	12,90
		–	–	–	–	–	–

Residual standard deviations (*RSD*) for the prediction of subcutaneous fat percentage using visual fat score (1 – 18), conformation score (1 – 15) and carcase mass (kg) for lamb carcases were 1,83; 3,46 and 3,86 respectively (Table 3). For all the age groups combined, the corresponding results were 1,85; 3,21 and 3,51. *RSD*'s for the prediction of the percentage lean in the carcase using fat score, conformation score and carcase mass for lamb carcases were respectively 2,14; 3,17 and 3,10. For all the age groups combined the corresponding results were 2,46; 3,18 and 3,13. Kempster, Avis, Cuthbertson & Harrington (1976) found that the *RSD*'s for the predictions of lean percentage using fat- and conformation score were 3,17 and 3,57 respectively. The *RSD* of fat score and conformation score was higher than found in this study. The lower RSD values found in this study is possibly due to the fact that fat score was used on a 18-point scale, instead of the six-point scale found in practice. This evidently gave a more accurate prediction of carcase composition. Fat score was also a more accurate predictor of the percentage bone in the carcase than conformation or carcase mass (*RSD* = 1,15 for lamb carcases; 1,42 for all age groups). Kempster & Cuthbertson (1977) also found that fat score has a higher relationship with percentage bone in the carcase (r = 0,64) than conformation score (r = 0,54). Jackson & Mansour (1974) indicated that conformation as measured by subjective appraisal of the external appearance of the carcase is largely influenced by fatness and therefore not a useful predictor of composition. The results of this study supported this statement.

The simple correlations between total fat percentage and fat- and conformation scores as well as carcase mass for lamb carcases were 0,85; 0,35 and 0,31. The low predicting ability of carcase mass was quite obvious during this study.

The visual assessment of carcase fatness is a much better predictor of carcase composition than either the visual assessment of conformation or carcase mass. There is also a considerable amount of error involved when predicting carcase composition using conformation score or carcase mass as predictors. This is reflected in

Table 3 Simple regression equations, correlations and residual standard deviations (*RSD*) of carcase fatness, carcase conformation and carcase mass with carcase composition

	Fat score			Conformation score			Carcase mass		
	$y = a \pm bX$	r	*RSD*	$y = a \pm bX$	r	*RSD*	$y = a \pm bX$	r	*RSD*
Lamb carcases (n = 40)									
Subcutaneous fat (%)	2,9409 + 0,6054X	0,86	1,83	5,3065 + 0,3803X	0,24	3,46	4,8403 + 0,2383X	0,26	3,86
Lean (%)	78,2682 – 0,4660X	–0,74	2,14	74,6759 + 0,0825X	–0,06	3,17	75,2419 – 0,0749X	–0,11	3,10
Bone (%)	17,6669 – 0,3879X	–0,86	1,15	18,8235 – 0,5609X	–0,55	1,89	18,3797 – 0,2447X	–0,47	1,99
Total fat (%)	13,1493 + 1,4011X	0,85	3,31	14,6476 + 0,9925X	0,35	5,91	15,1385 + 0,4498X	0,31	5,99
All age groups (n = 104)									
Subcutaneous fat (%)	2,5166 + 0,6036X	0,83	1,85	4,5884 + 0,4155X	0,26	3,21	6,5592 + 0,0821X	0,13	3,51
Lean (%)	78,6522 – 0,4392X	–0,63	2,46	75,3035 – 0,0851X	–0,06	3,18	73,0380 – 0,0717X	–0,12	3,13
Bone (%)	17,0399 – 0,35843X	–0,76	1,42	18,0302 – 0,5084X	–0,48	1,90	17,4046 + 0,1734X	–0,45	1,93
Total fat (%)	12,8040 + 1,0992X	0,79	3,88	14,1388 + 1,0561X	0,34	6,00	16,4489 + 0,3126X	0,28	6,14

Table 4 The proportional contribution of fat score, conformation score and carcase mass to explain the variation that occurred in the different carcase tissues

	% Variation explained by					
	Fat score (1 – 18)	Conformation score (1 – 15)	Carcase mass (kg)	Interactions	*CD*	*RSD*
Lamb carcases (n = 40)						
Subcutaneous fat (%)	81,47	0,06	2,15	–8,60	75,08	1,83
Lean (%)	68,38	3,06	0,68	–13,03	59,10	2,05
Bone (%)	57,39	7,85	0,06	16,66	81,96	0,99
Total fat (%)	80,83	0,75	0,44	0,31	82,33	2,73
Carcases of all age groups (n = 104)						
Subcutaneous fat (%)	75,71	0,05	2,03	–6,99	70,80	1,81
Lean (%)	58,10	0,34	12,24	–18,52	52,16	2,20
Bone (%)	40,54	3,96	2,65	18,07	65,22	1,29
Total fat (%)	63,14	0,57	0,01	3,44	67,16	3,70

the *RSD* values in Table 3. The fact that fat score is a more precise predictor than conformation score is supported by Kempster, *et al.* (1982). The fact that carcase mass is a poor predictor of carcase composition, as found in this study, will be discussed later.

The proportional contribution of fat score, conformation score and carcase mass in the variation of the different carcase tissues

By using the method of Kempthorne (1969) as described earlier, the contribution of each factor in the variation that occurred in the different carcase tissues was calculated. The results are given in Table 4. The visual assessment of carcase fatness, by means of the fat score, explained 81,47% of the variation that occurred in subcutaneous fat percentage in lamb carcases while conformation score and carcase mass contributed only 0,06% and 2,15% respectively. The corresponding results for all the age groups were 75,71%, 0,05% and 2,03%. These results are however not surprising, as visual assessment of carcase fatness specifically takes into account the subcutaneous fat cover of the intact carcase. Consequently the official graders seem to be quite capable of evaluating subcutaneous fat of a carcase with a high degree of accuracy.

The objective of conformation assessment of a carcase is to determine the percentage lean in the carcase. As stated earlier it is thought that 'blockier' carcases contained a higher proportion lean than carcases longer in the leg (Kirton & Pickering, 1967). Conformation was therefore regarded as an important factor when predicting the percentage lean. From Table 4 it is evident that conformation score explained only 3,06% of the variation that occurred in percentage lean for lamb carcases and 0,34% of the variation for all the age groups combined. On the other hand fat score explained 68,38% (lamb carcases) and 58,10% (all age groups) of the variation that occurred in percentage lean and is therefore a more reliable predictor for percentage lean in the carcase. Kempster, *et al.* (1976), also found that subcutaneous fat score gave the most precise prediction of the percentage lean in the carcase.

Subcutaneous fat score also explained respectively 57,39% and 40,54% of the variation that occurred in the bone percentage of lamb carcases and carcases of all age groups combined. The contribution of conformation score and carcase mass when predicting bone content were respectively 7,85% and 0,06% for lamb carcases and 3,96% and 2,65% for all age groups.

Kirton & Johnson (1979) found that carcase mass alone could account for just over 50% of the variation in carcase fatness. The results of Table 3 indicate that carcase mass alone accounted for only 7,66% of the variation in carcase fatness when carcases were selected in fat score classes. These results were substantiated with those given in Table 4. When used in combination with subcutaneous fat score and conformation score, carcase mass explained respectively 0,31% and 3,44% of the variation that occurred in total fat percentage for lamb carcases and carcases of all age groups. The latter results do not support the statement of Kempster, *et al.* (1982), that carcase mass should be included as the first independent variable when different predictors are being compared. However, this statement was based on the fact that carcase mass will be measured in all classification schemes, effectively at no cost. Predictors are included in classification schemes because they are cost effective, i.e. precision in relation to cost. If cost is nil or negligible the measurement will be very cost-effective.

Conclusion

Subcutaneous fat score was found to be a more reliable predictor of the different carcase tissues than conformation score or carcase mass. Carcase fatness (fat score) should be included in the classification system as it is a reliable predictor of the lean yield of carcases. Carcase conformation was found to be an unreliable predictor of carcase composition in this study as well as in many other studies (Kempster, *et al.*, 1982), and there is little reason for it to be included in a carcase classification system. The only reason why conformation is still included in the classification system is to distinguish between the extreme types of carcases which could be of economic importance at the carcase auctions.

Carcase mass was also found to be a poor predictor of carcase composition in this study. This could be due to the fact that a wide range of carcases were selected on the market, irrespective of their breed (early — or late maturing breeds).

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