UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

3

THE INFLUENCE OF FAT SCORE AND FAT TRIMMING ON PRIMAL CUT COMPOSITION OF SOUTH AFRICAN LAMB

S.M. van Heerden[1], P.E. Strydom[1], H.C. Schönfeldt[2], R. Kruger[2] & M.F. Smith[1]

[1]Agricultural Research Council: Animal Production, South Africa

[2]University of Pretoria, South Africa

In this chapter the style and layout, as prescribed by the Journal in which the article will be published namely, South African Journal of Meat Science, has been followed.

Abstract

The objectives of this study were firstly to determine the physical composition of cuts of South African lamb carcasses with different fat scores, and secondly to identify certain cuts suitable for trimming. In South Africa, sheep carcasses are classified according to age and, subjectively, according to the fat cover. Certain local meat companies have already altered at least a part of their operations to boneless retail cuts that could include the fat trimming of cuts to obtain a leaner more attractive cut for the consumer. Trimming of carcasses with high fat scores could also be an option for these operations provided that the cost/profit ratio is favourable. For this study, 66 grain-fed Dorper lambs (males and females) were divided into three groups and slaughtered at 30, 36 and 42 kg. Chilled carcass sides were subdivided into seven wholesale cuts. The cuts were dissected into meat (muscle, intermuscular and intramuscular fat), bone and subcutaneous fat (SCF) in order to determine the physical composition per cut and for the whole carcass. The soft tissue of the carcass was analysed for % total fat, protein, ash and moisture.

The percentages total fat in the carcass increased with 15.5 % over the five fat classes (according to SCF), with the largest increment between fat class 1 and 2, reaching a plateau from fat classes 3 up to 5. The % SCF of the loin increased the most (26 % units) as the fat score increased from score 1 to 5, followed by the flank, shoulder and neck cuts. The % meat (lean) of the neck, thick rib and breast showed no significant change between fat score 1 to 5, although the % bone decreased significantly (> 6 % units). Meat and bone proportions decreased significantly with increase in fat score for the loin, flank, leg and shoulder. Overall, the composition of the loin cut was most affected by changes in the fat score.

Trimming reduced the boneless SCF level of the loin, leg and shoulder by 12 %, 6 % and 9 % units, respectively, when trimmed from a fat score 5 down to a fat score 3. Further trimming to fat score 1, reduced the % SCF by 18 %, 8 % and 5 % units on a boneless level for the loin, leg and shoulder cuts respectively. The SCF of neck and thick rib could be reduced significantly between 4 and 5 % units from fat score 5 to fat score 3. The neck, thick rib, breast and flank could be trimmed significantly from a fat score 3 to a fat score 1 level by 5 units. The final decision on implementing trimming procedures would be determined by weighing the cost involved against the possible extra profit gained from increased sales.

Keywords: Carcass composition, lamb, fat class, yield

Introduction

In South Africa carcasses are classified by law according to age and fat class. (National Department of Agricultural Product Standards Act, ACT No. 119 of 1990, and its regulations). Age is described according to the number of permanent incisors with age class A = 0 teeth, AB = 1-2 tooth, B = 3-6 tooth and C = more than 6 tooth. Carcasses are grouped into seven fat classes by means of visual appraisal of subcutaneous fat (SCF) (fatness classes from 0 = no fat, to 6 = excessively over fat). This classification system assists the meat traders to describe their specific requirements in simple terms when purchasing carcasses and to utilize variety in the market with the goal of optimum consumer satisfaction (SAMIC, s.a.). It provides the basis for assisting consumers in their selection of meat cuts to contribute to health and eating satisfaction. It also helps to provide a price structure and to fix selling prices of meat (SAMIC, s.a.).

According to Carpenter (1966) and Sañudo *et al.* (2000) leanness is an important characteristic for the consumer when purchasing meat. A small amount of fat is desirable to sustain palatability, increase tenderness and decrease the risk of the meat drying out, but too much fat decreases the retail cut yield. According to a consumer survey (ACNielsen, 2001) South African consumers generally find sheep meat too fat. They rated sheep meat (lamb and mutton) fourth, in preference after poultry, fish and beef for four characteristics directly or indirectly related to fatness, viz. “good for health”, “good source of protein”, ”nutritious” and “rich source of iron and other minerals”. According to Hopkins (1988), consumer perception of over-fatness leads to a downward trend in sheep meat consumption, even in South Africa. Furthermore, Garrett *et al.* (1992) reported the lack of flexibility with the traditional way of presenting mutton carcasses in Australia and the USA to retailers and ultimately to the consumer, thereby contributing to lower consumption. However, lamb has always played an important role in the diet of South Africans where it is seen as a traditional food for special occasions (ACNielsen, 2001).

As the variety and availability of food products increased in the diets of consumers in Western Countries, so did the incidence of diet-related diseases. The amount of fat and its degree of saturation play an important role in the predisposition of humans to coronary heart disease, a disease that remains one of the major causes of death world wide (Girolami *et al.,* 2003). One in four South Africans is affected by coronary heart disease (Radder & le Roux, 2005). However, according to Radder & le Roux (2005), meat is a universally valued and sought-after source for human nutrition. Since the popularity of red meat among South Africans is not expected to decrease in the near future, it is important to encourage consumers to make the right choices when purchasing meat.

Garrett *et al.* (1992) suggested innovative methods where boneless fat-trimmed (even intermuscular seam fat) sub-primals are presented to retailers, was by to enable them to supply healthier, leaner retail cuts to the consumers. Hopkins *et al.* (1995) described the introduction of a “trim lamb” range of cuts where boneless, fat trimmed cuts and even muscle separation within primal cuts are performed under the Prime Lamb Program in Australia. These cuts comply with Australian National Heart Foundation guidelines, with a fat content on average of less than 10 %. South African lamb and mutton are generally sold without any trimming. However, even in lean carcasses, there is a variation in the SCF from lean (1.7 % SCF) to excess fat (± 7 % SCF). This variation in fatness level may contribute to the fact that South African consumers reject sheep meat as being too fat (ACNielson, 2001).

The past decade has been characterised by rapid changes in consumer trends (Dransfield, 2001) and meat operations have to respond to these changing trends in a competitive market. In South Africa, certain meat companies [Just Lamb (www.justlamb.co.za) and natLAM (www.lawmeat.co.za)] have altered at least part of their operations to produce boneless retail cuts, even though fatness is mostly controlled by restriction of carcass fatness during production. Adjusting these operations to trim excess fat will not only result in a more acceptable product, but will also enable processors to use carcasses of various fat classes, thereby increasing the supply. However, as trimming is costly and could potentially add to the present high cost of sheep meat, it is necessary to have an estimate of the fat yield of different cuts to make this an economical proposition (Hopkins, 1988). In addition, as different cuts accumulate fat at different rates, information on fat accumulation of cuts over different fat classes (fat levels) needs to be known, to select those cuts and carcasses that can be processed cost-effectively.

In this study, the composition of seven retail cuts with regard to subcutaneous fat, meat (including intermuscular fat) and bone of lamb carcasses of five different fat classes were compared. It was accepted that normal trimming does not necessarily involve total removal of SCF and could also include removal of seam fat, although the latter process will need separation of individual muscles and this is not common practice in South Africa for sheep meat.

Experimental design

Materials and methods - Trial lay-out

Sixty six Dorpers lambs (rams and ewes,) with a starting weight between 23 - 26 kg and were divided into three groups with equal mean total group weights (Table 1). The three groups of animals were randomly allocated to three slaughter groups viz. 30, 36 and 42 kg. The animals were grain-fed in individual pens (1.5 m x 1 m) and slaughtered when the target weight in its slaughter group was reached. Commercial slaughtering and dressing procedures were followed.

Table 1: Experimental design for evaluation of carcass and chemical composition of South African lamb

Breed type	Dorper				
Number of animals in study	66				
Starting weight (kg)	23 - 26				
Days on feed	90 – 120 days (4 - 6 months)				
Slaughter weight (kg)	30		36		42
Number of animals in slaughter group	20		24		20
Distribution of carcasses per fat class	1	2	3	4	5
	15	15	19	9	8

Carcass processing

On the day following slaughter, the chilled carcasses were sectioned down the vertebral column by band saw and the **right** sides subdivided into the following seven primal (wholesale) cuts: neck, shoulder with associated shin, breast, rib, loin, leg and shin as well as flank (Figure 1). The kidneys were removed, weighed and noted for each carcass. Each cut was dissected into meat (muscle, intermuscular and intramuscular fat), bone and subcutaneous fat in order to determine the physical composition thereof as well as that of the whole carcass. This was also done to determine the distribution of the various tissues (% muscle, % bone and % fat) in the carcass.

The total soft tissue (fat and muscle) of the deboned side was used for proximate analysis (chemical composition) to determine the percentage protein, moisture, ash and fat (AOAC, 2005). The meat and fat from the 7 cuts of a single carcass were combined and cubed, thoroughly mixed and then minced first through a 5 mm and then through a plate with 3 mm diameter holes. Samples of 300 g meat and separable fat were homogenized with an Ultra Turrax T25 homogenizer after mincing and put into aluminium trays covered with a vacuum bag prior to being freeze-dried and sent to the ARC Analytical Laboratory at Irene for proximate analysis. The analytical procedures for proximate analysis of the lamb samples were done on a double blind basis in laboratories that form part of the South African National Accreditation Services (SANAS). Subcutaneous fat, meat and bone were expressed as a percentage of the carcass side's weight (without the kidney fat) and of the relevant cut. Proximate analysis (fat, protein, ash and moisture) was expressed as a proportion of the total amount of soft tissue (boneless) of the carcass side. The composition of each cut was also presented as subcutaneous fat and meat proportional to the weight of the edible tissue (boneless) of the cut.

Statistical analyses

Data was statistically analysed using the GenStat for Windows (2000) statistical computer program. The significance of the variables measured for each sample was tested by means of a one - way analysis of variance (ANOVA) (unbalanced block design). Fat class (unbalanced, class 1 (n=15), 2 (n=15), 3 (n=19), 4 (n=9) and 5 (n=8), excluding fat class 0 and 6) was used as the main effect and tested at a significance level of 99 % ($p \leq 0.01$). If a main effect was significant, the Fisher's protected t-test Least Significant Difference (LSD) was applied to determine the direction of the differences between the mean values (Snedecor & Cochran, 1980)

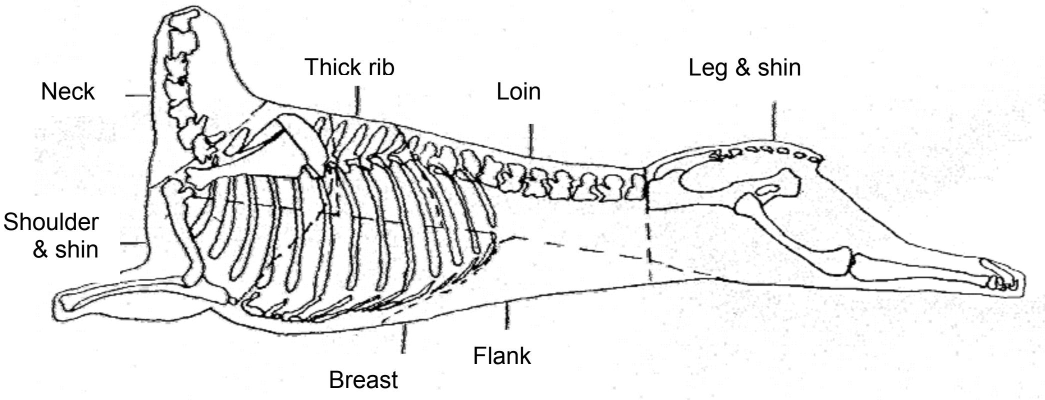

Figure 1 Dissection diagramme (Casey, 1982)

.According to the fatness classification of sheep, (National Department of Agriculture, 1990:9-14, in SAMIC s.a), the seven fat classes are described as follows:

Fatness class	Guideline for the determination of the thickness of the subcutaneous fat layer (mm)	Guideline for the percentage subcutaneous fat
0	Zero	Less than 1.0
1	Less than one	Not more than 5.6
2	At least 1 but not more than 4	> 5.6, but not more than 8.6
3	More than 4 but not more than 7	> 8.6, but not more than 11.6
4	More than 7 but not more than 9	> 11.6, but not more than 14.6
5	More than 9 but not more than 11	> 14.6, but not more than 17.6
6	More than 11	> 17.6

In this study, animals were selected from the A age class and fat class one to five of seven. No animals from the zero and six fat class were included.

Results

It is well known that muscle to bone ratio increases during initial growth (increase in weight of the animal). During the fattening period of growth, fatty tissue grows at a greater rate followed by muscle (meat) and then bone, so that the proportions of both tissues decrease in a regular manner as fat increases (Callow, 1948 and Berg & Butterfield, 1978).

Carcass weights (Table 2) ranged between 11.4 and 21.9 kg, and increased with an increase in fat class, but tended to taper off over fat class 3, 4 and 5. Carcasses from fat class 2 were significantly $p < 0.001$ heavier than those from fat class 1, and fat classes 3 to 5 were heavier than fat classes 1 and 2 ($p < 0.001$), but did not differ significantly ($p < 0.001$) from each other.

The percentage total fat in the soft tissue of the carcass increased with 15.5 % units (28.45-12.93) over the five fat classes with a concomitant decrease in percentage moisture (11.8 % units), ash (0.2 % units) and protein (2.6 % units), which agrees with the earlier findings of Callow (1948); Kemp *et al.* (1970, 1976) and Solomon *et al.* (1980). The % subcutaneous fat (% SCF) increased significantly by 13.0 % units over the five fat classes, with a decrease in the total % meat (6.1 % units) and bone (6.9 % units) between fat class 1 and 5. The largest variation between the classes in the present study both increases and decreases) was between fat class 1 and 2 for fat, protein and moisture, which is typical for the onset of the carcass fattening phase (Berg & Butterfield, 1978).

Table 2 Means (± SEM) for physical and chemical composition of the carcass per fat class (n=66)

Attribute	Unit	p-value	Fat Class				
			1 n = 15	**2** n = 15	**3** n = 19	**4** n = 9	**5** n = 8
Slaughter weight	kg	< 0.001	25.80^{a} ±1.29	34.63^{b} ±1.25	39.32^{b} ±1.11	39.86^{b} ±1.61	40.33^{b} ±1.71
Carcass weight (cold)	kg	< 0.001	11.40^{a} ±0.654	16.16^{b} ±0.632	19.09^{c} ±0.562	20.62^{c} ±0.816	21.89^{c} ±0.866
Fat thickness	mm	< 0.001	0.650 ±0.426	2.193 ±0.411	4.353 ±0.365	5.178 ±0.531	7.550 ±0.563
Chemical composition of soft tissue							
Total fat	%	< 0.001	12.93^{a} ±0.849	19.27^{b} ±0.820	22.98^{cd} ±0.729	26.11^{de} ±1.059	28.45^{e} ±1.123
Moisture	%	< 0.001	67.85^{d} ±0.66	62.91^{c} ±0.639	60.24^{bc} ±0.568	57.91^{ab} ±0.825	56.01^{a} ±0.875
Ash	%	< 0.001	1.00^{c} ±0.018	0.90^{b} ±0.017	0.83^{ab} ±0.015	0.80^{a} ±0.022	0.79^{a} ±0.023
Protein	%	< 0.001	18.40^{b} ±0.315	16.62^{a} ±0.304	15.91^{a} ±0.271	15.38^{a} ±0.393	15.76^{a} ±0.417
Carcass composition (% of carcass weight less the kidney plus fat)							
Subcutaneous fat	%	< 0.001	3.04^{a} ±0.243	7.45^{b} ±0.235	10.27^{c} ±0.209	13.21^{d} ±0.303	16.03^{e} ±0.321
Meat (lean)	%	< 0.001	77.12^{a} ±0.339	76.58^{a} ±0.327	74.63^{b} ±0.291	73.02^{b} ±0.422	71.05^{b} ±0.448
Bone	%	< 0.001	19.83^{d} ±0.394	15.97^{c} ±0.380	15.10^{bc} ±0.338	13.79^{ab} ±0.491	12.94^{a} ±0.521
Total meat (SCF + lean)	%	< 0.001	80.18^{a} ±0.394	84.02^{b} ±0.381	84.90^{b} ±0.338	86.21^{bc} ±0.492	87.06^{c} ±0.521
Kidney + fat	%	< 0.001	2.28^{a} ±0.261	3.30^{ab} ±0.252	3.75^{b} ±0.224	5.21^{c} ±0.325	5.18^{c} ±0.345

^{a,b,c,d,e} Row means with common superscripts, do not differ (p<0.001)
± Standard Error of Mean (SEM)
Meat = Muscle and intermuscular fat between muscle (IMF)

As animals grow older, weight increases until mature size is reached (growth phase) and the body composition and shape changes (developing phase). According to Hammond *et al*. (1971) as well as Berg & Butterfield (1978) the maximum relative growth ("growth curve") starts at the head and spreads down to the trunk. Secondly, growth curves start at the extremities of the limbs and move upwards. All these curves meet at the junction of the loin and last rib, this being the last region to develop. In this regard the growth gradient pattern of fat deposition is similar to that of muscle, according to the earlier report of Hammond (1932) and supported by later reports of Berg & Butterfield (1978) and Kempster *et al.* (1976b) i.e. growth gradients from the distal limbs converging in the abdominal/lumbar region.

In the present study, these patterns were confirmed where certain cuts were more influenced with regard to variation in tissue composition over fat classes than other cuts. These results are reported in Tables 3, 4 and 5 as well as visually presented in a bar graph (Figure 2) for comparison and interpretation. While Bruwer & Naudé (1987) reported on the total carcass composition for the different fat classes of the classification system, no data exist for the individual cut composition in South Africa and this is what was recorded in this present study.

Table 3 Means (± SEM) for the percentage subcutaneous fat for different lamb cuts of five fat classes (n=66)

Cut	p-value	Fat Class				
		1	2	3	4	5
Neck	< 0.001	3.48[a] ±0.610	7.73[b] ±0.589	8.31[b] ±0.524	10.87[bc] ±0.761	12.93[c] ±0.807
Shoulder with shin	< 0.001	2.03[a] ±0.531	3.69[a] ±0.513	5.98[b] ±0.455	9.49[c] ±0.662	13.26[d] ±0.702
Thick Rib	< 0.001	1.75[a] ±0.326	4.49[b] ±0.315	5.77[bc] ±0.279	6.98[c] ±0.406	9.29[d] ±0.431
Breast	< 0.001	4.97[a] ±0.523	7.08[ab] ±0.505	9.07[bc] ±0.449	11.64[cd] ±0.652	12.24[d] ±0.692
Leg with shin	< 0.001	2.91[a] ±0.419	6.99[b] ±0.404	9.90[c] ±0.359	13.03[d] ±0.522	14.94[d] ±0.554
Flank	< 0.001	6.50[a] ±0.943	13.46[b] ±0.911	18.20[c] ±0.809	19.74[c] ±1.176	19.50[c] ±1.247
Loin	< 0.001	1.84[a] ±0.907	12.58[b] ±0.876	17.85[c] ±0.779	21.70[c] ±1.131	28.98[d] ±1.200

[a,b,c,d,e] Row means with common superscripts, do not differ (p<0.001)
± Standard Error of Mean (SEM)

The percentage SCF increased significantly (p<0.001) in all seven cuts as fat class (Table 3) increased. In certain cuts, SCF was deposited in higher increments over fat classes than in others, especially between fat class 1 and 2, e.g. neck, thick rib, leg and flank and loin, where, in some cases, the fat content was more than double. In the last two fat classes (fat class 4 and 5) the fat increase was less especially for the neck, leg, breast and flank cuts. According to Kempster (1980/81) relative growth of subcutaneous fat in the loin, breast and neck was higher than in the total carcass, while that of the shoulder and leg was lower. For the loin, leg and shoulder cuts this was in agreement with the present study, however, Kempster (1980-81) did not report on the flank.

Percentage lean (meat) decreased significantly between fat class 1 and 5 in the shoulder with shin, leg with shin, flank and loin but not for the neck, thick rib and breast cuts (Table 4). The proportional yield of bone decreased significantly between fat class 1 and 5 for all the cuts with an increase in fat class (Table 5), and this was expected, as bone is an earlier-developing tissue than muscle and fat (Berg & Butterfield, 1978). In cuts such as the neck, thick rib and breast where the lean (meat) yield did not vary significantly over the five fat classes, the increase in fat was inversely related to the decrease in bone. For the remaining cuts (shoulder, leg, flank and loin), both the % bone and lean (meat) decreased as the proportion of SCF increased across the fat classes. Diaz *et al*. (2005) reported that in suckling lambs, the lean (meat) yield of the leg were unaffected by weight or fat gain, while the bone decreased as fat proportions increased.

In general, the proportional lean (meat) yield decreased within each cut as fat score increased (Table 4). Of all the cuts, the loin decreased the most in yield over the fat classes with as much as 18 % units. In contrast, the proportional lean (meat) yield of the neck, thick rib and breast were the least affected by an increase in fat class.

Table 4 Means (± SEM.) for the percentage lean (meat) for different lamb cuts of five fat classes (n=66)

Cut	p-value	Fat Class				
		1	2	3	4	5
Neck	0.252	78.37 ±0.866	78.03 ±0.837	79.06 ±0.743	76.67 ±1.080	76.46 ±1.146
Shoulder with shin	< 0.001	73.63^{ab} ±0.543	75.40^{a} ±0.524	73.68^{ab} ±0.466	71.14^{bc} ±0.677	68.19^{c} ±0.718
Thick Rib	0.187	74.38 ±0.683	76.26 ±0.660	76.47 ±0.586	76.22 ±0.852	75.55 ±0.904
Breast	0.271	73.66 ±0.607	75.00 ±0.586	73.84 ±0.521	72.95 ±0.757	74.19 ±0.803
Leg with shin	< 0.001	77.67^{a} ±0.524	76.47^{ab} ±0.506	74.68^{bc} ±0.450	72.63^{cd} ±0.654	71.31^{d} ±0.693
Flank	< 0.001	90.90^{a} ±0.963	84.82^{b} ±0.930	80.22^{c} ±0.826	78.85^{c} ±1.201	79.24^{c} ±1.273
Loin	< 0.001	78.00^{a} ±0.915	74.18^{a} ±0.884	68.10^{b} ±0.786	67.60^{b} ±1.141	59.77^{c} ±1.211

^{a,b,c,d,e} Row means with common superscripts, do not differ (p<0.001)
± Standard Error of Mean (SEM)

Table 5 Means (± SEM) for the percentage bone in lamb cuts for five fat classes (n=66)

Cut	p-value	Fat Class				
		1	2	3	4	5
Neck	< 0.001	18.15^{a} ±0.581	14.25^{b} ±0.561	12.63^{b} ±0.499	12.46^{bc} ±0.725	10.61^{c} ±0.769
Shoulder with shin	< 0.001	24.34^{a} ±0.464	20.92^{b} ±0.448	20.34^{b} ±0.398	19.37^{b} ±0.578	18.55^{b} ±0.613
Thick Rib	< 0.001	23.87^{a} ±0.655	19.25^{b} ±0.632	17.77^{bc} ±0.562	16.81^{bc} ±0.816	15.17^{c} ±0.866
Breast	< 0.001	21.37^{a} ±0.502	17.92^{b} ±0.485	17.09^{b} ±0.431	15.40^{bc} ±0.626	13.57^{c} ±0.664
Leg with shin	< 0.001	19.42^{a} ±0.420	16.54^{b} ±0.046	15.43^{bc} ±0.361	14.35^{bc} ±0.524	13.76^{c} ±0.556
Flank	0.032	2.60 ±0.294	1.72 ±0.284	1.58 ±0.253	1.41 ±0.367	1.25 ±0.389
Loin	< 0.001	20.16^{a} ±0.852	13.25^{b} ±0.823	13.95^{b} ±0.731	10.70^{b} ±1.063	11.26^{b} ±1.127

^{a,b,c,d,e}Row means with common superscripts, do not differ (p<0.001)
± Standard Error of Mean (SEM)

Discussion

Sañudo *et al*. (2000) reported that too much fat on meat discourages the consumer and is often removed either before cooking or during the meal, especially by young people. Garrett *et al*. (1992) and Hopkins (1988) demonstrated the advantage of trimming and deboning certain cuts of the lamb carcass before retail sales, in order to present more acceptable and attractive cuts to the consumer and to have a larger supply basis (over fat carcasses) of lamb cuts suitable for the consumer. Carpenter (1966) stated that little information is available regarding the minimum fat covering needed on a lamb carcass in order to assure the desired product (cut) and that a fat covering of at least 5 mm is needed to prevent product dehydration and to produce an attractive retail cut. Five millimetres is equal to the fat class 3 score in the SA classification system but preferences will vary between consumer groups. Furthermore, the value is a mean value mostly measured on the loin, and other cuts may have more or less fat cover and also differ in their appeal to consumers.

The results of the present trial show that within a fat class (read vertically in tables 2-4) the different cuts contain different levels of SCF and that among the fat levels, the rates of SCF deposition differ between the cuts. Considering the major cuts most likely to be trimmed, viz. the shoulder with shin, leg with shin and loin, trimming from a fat score 5 to a fat score 3, will reduce the boneless SCF level by 9 % units for the shoulder, almost 6 % units for the leg and 12 % units for the loin. Further trimming to fat score 1, will reduce the % SCF with a further 5 %, 8 % and 18 % units on a boneless level for these three cuts. Due to the variation among cuts in the amount of fat deposition over fat scores, trimming certain cuts of fat score 5 carcasses down to fat score 3 will not have a significant impact on the SCF level, e.g. the breast and flank (Table 6). Apart from the shoulder, leg and loin discussed earlier, the SCF level of the neck and thick rib cuts could be reduced significantly between 4 and 5 % units from fat score 5 to fat score 3. All five these cuts could be trimmed significantly from a fat score 3 to a fat score 1 by at least 5 units (the flank = 12 % units).

Although Garrett *et al*. (1992) emphasized that seaming of the muscles i.e. separating the muscles, and removing all excess fat was necessary to obtain an acceptable final fat level in the cuts, they worked with USDA yield grades 2, 3 and 4, representing fat thickness levels in excess (9 mm, 14 and 20 mm, respectively) of the SA system (Zero to > 11 mm) and the carcasses of the present trial. Furthermore, Hopkins (1988) stated that the seaming of muscles required heavy lean carcasses (22-25 kg) to make it an economical and aesthetic proposition and these carcasses are not common in the local industry (Australia). Hopkins (1988) worked with bone-in cuts that were trimmed of excess SCF and the intermuscular fat (seam fat) left intact and concluded that trimming of SCF alone could remove most of the differences in composition of lamb cuts from carcasses of different fatness. He did, however, admit that the amount of untrimmed fat (mostly seam fat), increased with increase in fat score. Regarding the practical implication of separating muscles, Garret *et al*. (1992), pointed out that certain cuts like the shoulder and rack (loin) poses a problem to remove the seam fat as this fat depot makes up the larger portion of fat in these cuts and is therefore not an aesthetic or economical proposition.

Although intramuscular fat was not determined in the present study, the work of Kempster *et al.* (1957) could shed some light on the effect of SCF trimming on remaining fat in fat carcasses, such as the fat class 3 carcasses in the present trail. They reported that IMF and SCF increased at a higher rate in the loin than in the shoulder and at a higher rate in the shoulder than in the leg and chump. For the loin the rate of fat growth was higher than for the whole carcass, (1.3); for the shoulder slightly less (0.9) and for the leg less (0.7 – 0.9) than for the carcass. In addition, the rates of both depots were the same for the loin and shoulder but the growth coefficient for IMF of the shoulder was less than the SCF of the shoulder.

Extrapolating from these results in the present study the high increase of SCF in the loin over increasing fat classes would have been paralleled by similar increases in IMF. As a result trimming of fat class may produce loins with less fat cover (SCF) but still a relatively high total fat content due to IMF. As the rate of fat gain in the shoulder is less than in the loin (and whole carcass), but similar for SCF and IMF, the same applies as for the loin. In addition, as pointed out by Garret *et al*. (1992), the IMF makes out a large portion of the total fat of this cut. Therefore trimming of most of the SCF will still leave a large portion of IMF intact. Trimming of the SCF of the leg of fat carcasses has a slightly higher advantage due to the slower increase of IMF compared to SCF in this case, as total fat increases.

Table 6 Means (± SEM) for the percentage subcutaneous fat for the edible portion (boneless) of different lambs cuts and fat classes (n=66)

Cut	p-value	Fat Class				
		1	2	3	4	5
Carcass	< 0.001	3.80[a] ±0.270	8.86[b] ±0.261	12.08[c] ±0.232	15.32[d] ±0.337	18.39[e] ±0.358
Neck	< 0.001	4.25[a] ±0.707	9.04[b] ±0.683	9.52[b] ±0.607	12.45[c] ±0.881	14.43[c] ±0.935
Shoulder with shin	< 0.001	2.66[a] ±0.652	4.64[b] ±0.630	7.47[c] ±0.560	11.77[d] ±0.814	16.28[e] ±0.863
Thick Rib	< 0.001	2.29[a] ±0.394	5.55[b] ±0.380	7.01[b] ±0.338	8.39[b] ±0.491	10.94[c] ±0.521
Breast	< 0.001	6.31[a] ±0.615	8.63[a] ±0.594	10.92[b] ±0.528	13.76[b] ±0.767	14.16[b] ±0.813
Leg with shin	< 0.001	3.62[a] ±0.482	8.37[b] ±0.466	11.69[c] ±0.414	15.20[d] ±0.601	17.32[d] ±0.638
Flank	< 0.001	6.66[a] ±0.959	13.70[b] ±0.926	18.50[c] ±0.823	20.02[c] ±1.20	19.76[c] ±1.168
Loin	< 0.001	2.21[a] ±1.000	14.44[b] ±0.966	20.69[c] ±0.859	24.30[c] ±1.247	32.64[d] ±1.323

[a,b,c,d,e] Row means with common superscripts, do not differ (p<0.001)
± Standard Error of Mean (SEM)

As discussed earlier, trimming cuts to fat score 1 may not be appealing to all consumers or be optimal for cooking according to Carpenter (1966), but will have different effects on different cuts with regard to the final amount of fat removed. Depending on the consumer it may enable the process to supply cuts from broader supply basis.

Although the option of trimming as discussed above, refers to both over fat carcasses in general and over fat cuts within the same (lower) fat score, finally, the costs involved need to be weighed against the possible extra profit. In general, it is more expensive to gain fat compared to muscle. On the other hand over fat carcasses obtain lower prices. Therefore, the reason for trimming over fat carcasses will be to gain from lower prices of normally limited numbers of these carcasses in order to increase available product. Furthermore, the cost of trimming (labour and value of trimmed fat) should be measured against the lower value of the carcass (Bruwer *et al*., 1987) and the higher price (compared to the carcass) the consumer is willing to pay for the trimmed product. Hopkins *et al*. (1995) and Hopkins (1988) showed that both weight and fatness of the carcass influenced the processing time (cost). According to Hopkins *et al*. (1995), consumers responded positively to "Trim Lamb" an Australian Meat and Livestock promotion. This response within the South African context will probably depend on the quality of the final product in terms of final fat content and consumers in general. Refer to Figure 2 for a summery of cut composition data presented in this study.

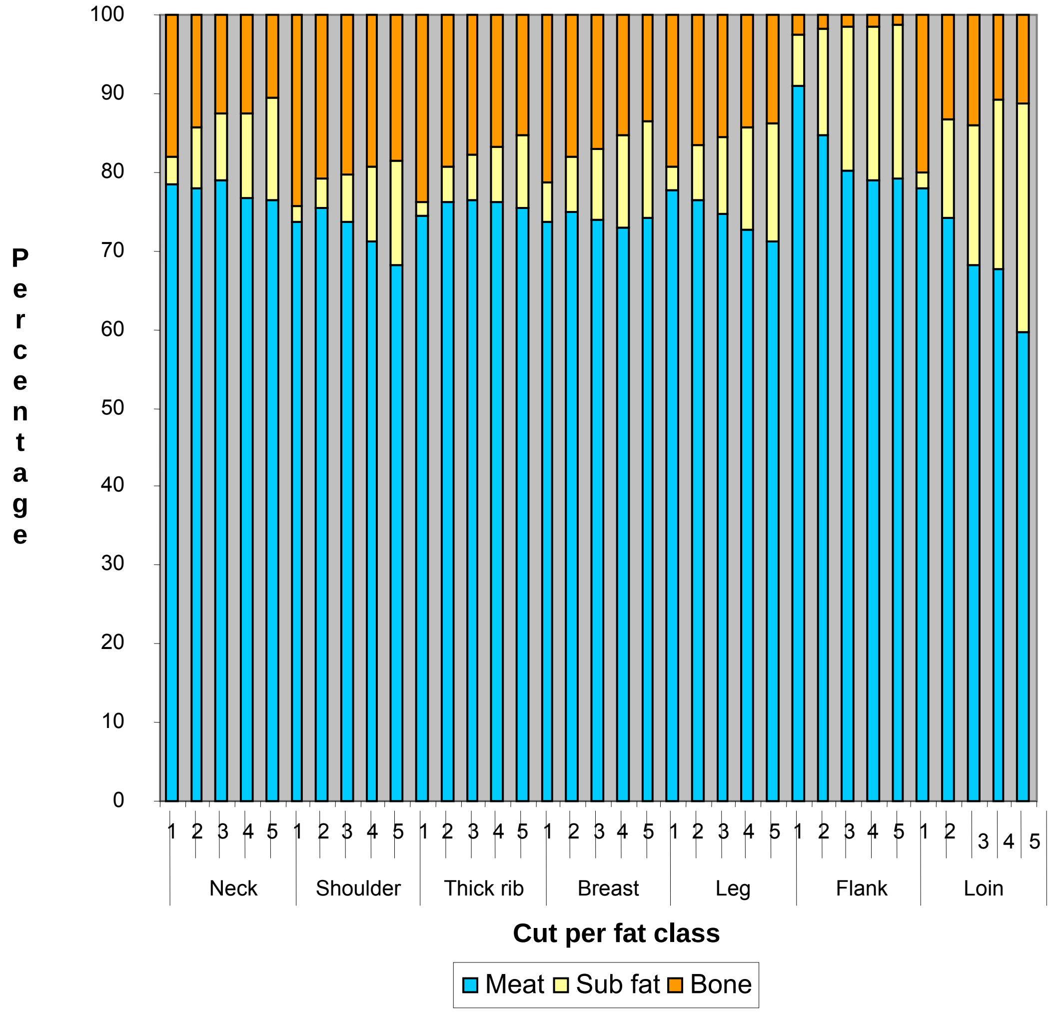

Figure 2 Percentage meat, fat and bone per fat class for each cut

Using the data of Table 2 and Table 3, a robust calculation of cost of trimming could be made using the average cost of trimming could be made by using the average core weights of 19 and 22 kg for fat class 3 and 5, respectively and the difference in subcutaneous fat % between fat class 3 and 5. It was calculated that about 1 kg of fat is trimmed off the class 5 carcasses. It was assumed that the fat class 3 carcasses is not trimmed and that processing time of fat carcasses double the processing time of a fat carcass as was reported by Hopkins (1989). If a conservative labour cost of R 5 / hour was used, the extra processing time (10 min vs. 20 min) and the trim loss of 1 kg resolved in a cost different of R 2 / kg. In other words fat carcasses need to be purchased at R 2 / kg less to be trimmed to medium fatness (fat code 3) while also considering that the final product is not exactly the same in terms of tissue composition and may therefore achieve a lower selling price.

Conclusions

With increasing consumer demand for lean meat, the relationship between fatness and eating quality as well as healthy lean meat portions has become the focus point for the meat industry lately. The cutting data in this study provides retailers with an insight into the variation in SCF of the different cuts of the carcass at different fat levels (fat scores). If the data is combined with efficient trimming skills of innovative retail operations, carcasses over a broad spectrum of fat levels could be processed into higher-value cuts that are more acceptable and attractive to fat consumers sensitive to dietary fat. In some instances, depending on the price of the carcass and the cost of trimming (labour and value of trimmed fat), further processing of over fat carcasses, can provide more affordable cuts to the consumer. On the other hand a certain sector of the consumer corps may be willing to pay premium prices if the final product is perceived as being healthier and this could perhaps justify the trimming of any cut to consumer standards. No information was gained on the intermuscular fat and previous work has showed that excessive fat may still remain in certain cuts of over fat carcasses trimmed of SCF. Therefore, further investigation into the remaining excessive fat of different cuts at different fat levels after trimming could be valuable, when decisions on trimming for specific markets are made. Consumer perceptions on the trimmed product vs. the price should also be investigated.

Acknowledgements

Sincere word of thanks is expressed to the personnel of the Analytical Services as well as the abattoir team of the ARC-LBD: Animal Production, Irene, for their contribution and technical assistance that is greatly appreciated.

References

ACNielson. 2001. South African National Meat Consumption Survey. Business needs assessment for South African Feedlot Association. Confidential report.

Association of Official Analytical Chemists International. (AOAC). 2005. Official methods of analysis of AOAC International. 18th ed. Maryland, USA.

Berg, R.T. & Butterfield, R.M. 1978. New concepts of cattle growth. 2nd ed. Sydney University Press, Sydney.

Bruwer, G.G., Naudé, R.T. & Vosloo, W.A. 1987. An evaluation of the lamb and mutton carcase grading system in the Republic of South Africa, 1. A survey of carcase characteristics of the different grades. S. Afr. J. Anim. Sci. 17:2, 97-84.

Bruwer, G.G. & Naudé, R.T. 1987. An evaluation of the lamb and mutton carcase grading system in the Republic of South Africa. 3. Fatness score, conformation score and carcase mass predictors of carcase composition. S. Afr. J. Anim. Sci. 17:2, 90-94.

Callow, E.H. 1948. The changes in the carcass during growth and fattening, and their relation to the chemical composition of the fatty and muscle tissues. J. Agr. Sci. 38, 174–199.

Carpenter, Z.L. 1966. What is consumer-preferred lamb? S. Afr. J. Anim. Sci. 25, 1232-1235.

Casey, N.H. 1982. Carcass and growth characteristics of four South African sheep breeds and the boer goat. D.Sc. (Agric) Thesis, University of Pretoria.

Diaz, M.T., da la Fuente, J., Lauzurica, S., Pérez, C., Velasco, S., Álvarez, I., Ruiz de Huidobro, F., Onega, E., Blázquez, B. & Cañeque, V. 2005. Use of carcass weight to classify Manchego sucking lambs and its relation to carcass and meat quality. Anim. Sci. 80, 61-69.

Dransfield, E. 2001. Consumer issues and acceptance of meat. Proceedings of the 14th International Congress of Meat Science and Technology (pp.72-79), August 2001, Kraków, Poland.

Garrett, R.P., Savell, J.W., Cross, H.R. & Johnson, H.K. 1992. Yield, grade and carcass weight effects on the cutability of lamb carcasses fabricated into innovative style subprimals. J. Anim. Sci. 70, 1829-39.

GenStat for Windows. 2000. Release 4.2. 5th. ed. VSN International Ltd., Oxford, UK.

Girolami, A., Marsico, I., D'Andrea, G., Braghieri, A., Napolitano, F. & Cifuni, G.F. 2003. Fatty acid profile, cholesterol content and tenderness of ostrich meat as influenced by age at slaughter and muscle type. Meat Sci. 64, 309-315.

Hammond, J. 1932. Growth and the development of mutton qualities in the sheep. A survey of the problems involved in meat production. Edinburgh: Oliver and Boyd.

Hammond, J.Jr., Mason, I.L. & Robinson, T.J. 1971. Hammond's farm animals. 4th ed. London: Edward Arnold.

Hopkins, D.L. 1988. Composition of trimmed retail lamb cuts. In Proceedings of the 34th International Congress of Meat Science and Technology, Part A. pp.78-79.

Hopkins, D.L., Watton, J.S.A., Gamble, D.J., Atkinson, W.R., Slack-Smith, T.S. & Hall, D.G. 1995. Lamb carcass characteristics. 1. The influence of carcass weight, fatness, and sex on the weight of "trim" and traditional retail cuts. Aust. J. Exp. Agr. 35, 33-40.

Just Lamb. 2004. Unique by nature. [Online]. Available from: (http://www.justlamb.co.za). [Accessed: 12/06/2006].

Kemp, J.D. Crouse, J.D., Deweese, W. & Moody, W.G. 1970. Effect of slaughter weight and castration on carcass characteristics of lamb. J. Anim. Sci. 30, 348-354.

Kemp, J.D., Johnson, A.E., Stewart, D.F., Ely, D.G. & Fox, J.D. 1976. Effect of dietary protein, slaughter weight and sex on carcass composition, organoleptic properties and cooking losses of lamb. J. Anim. Sci. 42:3, 575-583.

Kempster, A.J., Avis, P.R.D.A. & Smith, R.J. 1976b. Fat distribution in steer carcasses of different breeds and crosses -2. Distribution between joints. Anim. Prod. 23, 223-232.

Kempster, A.J. 1980/81. Fat partition and distribution in the carcasses of cattle, sheep and pigs: a review. Meat Sci. 5, 83-98.

National Department of Agriculture. 1996. Regulations regarding the classification and marketing of meat. Agricultural Product Standards act, ACT No 119 of 1990.

natLAM. s.a. Certified Natural. [Online]. Available from: www.lawmeat.co.za [Accessed: 12/06/2006].

Radder, L. & le Roux, R. 2005. Factors effecting food choice in relation to venison: A South African example. Meat Sci. 71, 583-589.

SAMIC (South African Meat Industry Company). S.a. Classification of Red Meat – A key to more effective marketing. Pretoria. [Online]. Available from: www.samic.co.za. [Accessed: 12/06/2006].

Sañudo, C., Enser, M.E., Campo, M.M., Nute, G.R., Maria, G., Sierra, I. & Wood, J.D. 2000. Fatty acid composition and sensory characteristics of lamb carcasses from Britain and Spain. Meat Sci. 54, 339-345.

Snedecor, G.W. & Cochran, W.G. 1980. Statistical methods. 7th ed. Iowa State University Press. ISBN 0-8138-1560-6.

Solomon, M.B., Kemp, J.D., Moody, W.G., Ely, D.G. & Fox, J.D. 1980. Effect of breed and slaughter weight on physical chemical and organoleptic properties of lamb carcasses. J. of Anim. Sci. 51:5, 1103-1107.

The South African Heart Mark. S.a. Product category guidelines for acceptability. [Online]. Available from: http://www.heartfoundation.co.za/docs/hm guidelines.pdf). [Accessed: 01/24/2006].