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Variation in composition and eating quality of New Zealand export beef

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ABSTRACT

Twenty four beef carcasses, all visually graded as P1, were assigned on the basis of fat depth D, to fat classes L (n = 5), P (n = 7), K (n = 8) and G (n = 4). The percent dissected lean of these samples for each class was: L, 66.9; P, 64.6; K, 63.4; G, 60.7, while total dissected fat % was: L, 14.5; P, 17.3; K, 19.0 and G, 21.8. There were no significant differences in chemical composition of individual joints across fat classes, but there were highly significant differences between joints. Percent intramuscular fat content of the lean was: topside, 5.0; chuck, 7.5; loin, 12.1 and brisket, 12.4. Overall acceptability of the cooked loin was similar for all fat classes, despite a range from 4 to 24% in intramuscular fat content. There was no significant association between intramuscular fat and eating quality, which suggests that if pre- and post- slaughter conditions are well controlled, meat of satisfactory eating quality can be obtained from lean carcasses.

Keywords Beef; composition; export fat class; eating quality; chemical composition

INTRODUCTION

Over the last ten years, consumption of red meat worldwide has declined markedly, by up to 40%, while poultry and pork have steadily increased their share of the market (eg. Fantini and MacDonald, 1987). In New Zealand, from 1975 to 1986, total red meat consumption declined by 30%, although consumption levels for beef now appear to have stabilised or marginally increased to around 37.8 kg/head/year (Cameron, 1988). Without doubt, health issues have played a role in the declining consumption of red meat. The message from consumers world wide, particularly younger people, including New Zealand, is that they prefer leanner meat. Effective education based on sound factual information may assist red meat to retain its share in the market. However, in New Zealand at least, there is little readily available information on the composition of animals, or their meat, which the trade describes as "prime" which encompasses the P, K and G classes (as opposed to Manufacturing). This preliminary work aimed to derive information to relate carcass composition to the eating quality of the end product.

MATERIALS AND METHODS

Twenty four carcasses, graded as P1 (prime export) by an experienced grader, were obtained through the Ruakura abattoir. All carcasses were aged for four days at 3-4 °C prior to being broken down into 13 primal joints. Primal joints were then separated into lean (muscle plus intramuscular fat), intermuscular fat, subcutaneous fat and bone. The chuck, brisket, topside and loin were retained. These four joints represented ~30% of total carcass weight and also produce meat perceived to be of widely different qualities. The lean from the chuck, brisket, topside and loin were minced, then chemically analysed for protein, fat, water and ash content. The loin from the opposite half-carcass was cooked to an internal temperature of 75 °C then presented to a consumer panel (n = 74) for sensory evaluation. Samples were rated (on a 1-9 scale) for aroma, texture, flavour, juiciness and overall acceptability.

Although all 24 carcasses were graded as P1, on the basis of fat depth D they spanned four fat classes. Data were therefore analysed by one-way analysis of variance, using four (L, P, K and G) fat classes.

RESULTS

TABLE 1 Carcass weight, fat depth and composition by export fat class.

	Fat class L	P	K	G	SED	Sig
n	5	7	8	4		
Hot carcass (kg)	232	204	272	266	27	*
Fat depth	2.6	5.3	10.1	15.5	0.9	***
% lean	66.9	64.6	63.4	60.7	2.3	NS
% bone	18.6	18.1	17.6	17.5	0.7	NS
% total fat	14.5	17.3	19.0	21.8	1.4	*

There were differences ($P<0.05$) between fat classes in carcass weight (Table 1). The trend for increasing carcass weight with increasing fatness (ie. , as fat class changed from L to P to K to G) was not evident in our sample. However, fat depths increased ($P<0.001$) between each grade, reflecting the grouping of carcasses based on their measured fat depth. There was a trend for lean content to decline with changing fat class, but in this limited sample, it was not significant. There was an increase in total fatness as fat class changed ($P<0.05$), with this change being dominated by a change in subcutaneous fat content (SCF) (Table 2). Intermuscular fat (IMF) content of the carcass did increase from fat class L to G, as expected, but the change was smaller than that for SCF, and not significant.

The intramuscular fat content of both raw and cooked loin also increased from fat class L to G,

TABLE 2 Carcass fat distribution and the fat content of the raw and cooked loin.

Fat component %	Fat class L	P	K	G	SED	Sig
Carcass						
subcutaneous	6.7	7.5	9.2	11.1	1.4	*
intermuscular	6.7	8.2	8.3	9.1	1.0	NS
internal	1.1	1.5	1.5	1.7	0.3	NS
Loin						
intramuscular	10.3	11.5	12.4	13.9	1.9	NS
cooked loin	5.9	7.4	7.6	12.5	2.5	NS

reflecting increasing total carcass fatness. However, because of the large variability within this small sample the changes were not significant.

A two-way analysis of variance of joint by fat class for each chemical component found no significant differences. Analysis was then restricted to joint by chemical component across all the fat classes. Table 3 shows there were differences ($P<0.001$) between joints in all components of composition. The joints, ranked for fatness, were topside leanest, followed by chuck then loin, with brisket the fattest. There was a two-fold difference in fatness between the topside and brisket. These differences were mirrored by water content, while protein content varied only slightly between joints.

TABLE 3 Chemical composition of muscle in four primal joints.

Joint	Chemical component: Water	Protein	Fat	Ash
Chuck	71.2^a	20.4^a	7.5^a	0.96^a
Brisket	67.0^b	19.6^b	12.4^b	0.93^b
Topside	71.8^a	22.1^c	5.0^c	1.11^c
Loin	66.6^b	20.4^a	12.1^b	0.30^b
SED	0.32	0.13	0.43	0.006
Significance of difference	***	***	***	***

TABLE 4 Mean minimum and maximum values for sensory evaluation scores* of the cooked loin.

Attribute	Mean	Minimum	Maximum
Aroma	5.6	5.4	5.7
Texture	5.6	5.0	6.2
Flavour	5.5	5.3	5.7
Juiciness	5.1	4.5	5.9
Overall acceptability	5.3	4.9	5.9

* based on 960 observations, using 0-9 point scale 1 = dislike intensely, 9 = like extremely

Results of the sensory evaluation showed very big between-animal differences in all attributes.

TABLE 5 Correlations between measures of carcass and meat fatness, and taste panel attributes. (Require r=0.36 for $P = 0.1$)

	Fat depth D	% Subcutaneous fat	% Intramuscular fat	% Fat in cooked meat
Flavour	-0.29	0.07	0.05	-0.16
Juiciness	-0.01	0.08	-0.04	-0.17
Overall acceptability	-0.29	-0.01	-0.04	-0.21

Regression analysis indicated no significant effects of either fat class or intramuscular fat content on any aspect of acceptability. Mean acceptability values for attributes showed that the cooked loin rated as acceptable in all aspects, although values were slightly on the low side, with preferences rating as neither like nor dislike to like slightly (Table 4). The range in values was quite low, from dislike slightly to like slightly.

There were no significant correlations between any measure of fatness, and flavour, juiciness or overall acceptability (Table 5).

DISCUSSION

Carcass Composition and Fatness

The P1 grade carcasses used for this study contained carcasses that would have ranged from L to G grade if an objective system of grading had been used. As expected from previous studies (Woods *et al.*, 1986) as the Export fat class increases in fatness, from L to G, the lean content declined and fat content increases. The differences between fat classes in yield of saleable meat are less than those found in a previous study where carcasses were classed subjectively ie. not on measured fat cover. This is a reflection of the very small sample size, and its deviation from the expected pattern of increasing carcass weight with increasing fatness (eg. McBee and Wiles, 1967). The difference of 1.2% units in lean content between the new fat classes P and K is in line with the differences of 1% predicted from the studies of Butler-Hogg *et al.* (1988), and supports the decision to split the "old" P1 grade to improve the precision of classification.

Bone content changed little with changing fat class, for these reclassified carcasses, reinforcing earlier observations that the major influence on yield is changing fatness. As shown in Table 2, the major fat depot influencing this change was subcutaneous fat. As total carcass fatness increases, so a greater proportion of this fat is deposited subcutaneously (eg. Butler-Hogg and Wood, 1982).

The intramuscular fat content of the loin also tended to increase with increasing total fatness, as found by McBee and Wiles (1987). The same pattern across fat classes was evident for the cooked loin, but the variability between individual animals also increased markedly, hence the non-significant differences between fat classes. With increasing intramuscular fat content the relative proportion of triglyceride (as opposed to phospholipid) will increase. Sinclair and O'Dea (1987) concluded that the leanner the cut of meat the lower the saturated fat level. From a health point of view it is reasonable to suggest that carcasses from the L and P classes may be more desirable.

Chemical Composition of Different Joints

Although fat classes did not, in this reclassified sample, influence the fat content of any joint significantly, there were large differences in composition between joints, in agreement with other studies (eg., Sinclair and O'Dea, 1987). Thus, in describing the nutritional value of meat, it will be important to clearly describe the cut, or joint in question. Protein content (and its amino acid composition) are relatively stable. In this study, the protein content ranged from 19.6 to 22.1%, while Hutchinson *et al.* (1987); and Chrystall and West, (1987), found a slightly narrower range from 21.0-21.6%. However, their sample was both larger, and lower in fat than this study. The major influence on joint composition is the moisture and fat content, with these two components varying inversely, as also found by Hutchinson *et al.* (1987).

Although the chuck is considered less desirable than the topside, on the basis of location and potential toughness, it has only slightly more fat. The loin, while highly valued, has nearly twice the fat content of these two joints, and will therefore contain relatively more saturated fatty acids. Chrystall and West (1987) determined fatty acid profiles for 5 steers which would have been classified as fat class P on their fat depth. They found that poly and mono-unsaturated fatty acids made up 56% of total fatty acids in the loin, 60% in the brisket, 56% in the chuck and 59% in the topside.

Eating Quality and Export Fat Class

Eating quality of the loin was not influenced by fat class, in agreement with some other studies relating a grade (or fat class) to consumer perceptions of accept ability (eg., Crouse *et al.*, 1978; Kingston *et al.*, 1987). Other studies suggest eating quality is influenced by marbling or intramuscular fat (eg. McBee and Wiles, 1967), although the observation was made that between animal variability within a fat class was very large. Even in studies which have considered a wide range of marbling levels, the correlations between measures of fatness and eating quality are low (Tatum *et al.*, 1982), and account only for 8-10% of variation (eg. Kingston *et al.*, 1987). In this study, values for sensory evaluation ranged from "neither like nor dislike", to "like slightly". While this appears lower than expected (Hagyard, personal communication), the normal range in values is rarely above 7 or below 4 ie. "like moderately" to "dislike slightly". The range in intramuscular fat content of the cooked samples was from 4 to 25%, and yet there was no significant association between fat and eating quality attributes. These results suggest that while there may be some minimum level of intramuscular fat required to maintain adequate eating quality, it does not appear to be related to export fat class. The current perception that fatter equals better eating quality is not well founded but is more a reflection of the insulating effect of fat reducing the chances of cold shortening and increasing the aging rate. Kingston *et al.* (1987) in Australia concluded that the most desirable loin steak had a fat cover of 2-3 mm at the 13th rib but that the fat class did not affect palatability. If post-slaughter handling is appropriate to ensure no cold shortening, and some aging, it would appear that carcass fatness levels could be reduced while still maintaining adequate quality of the end product.

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