Farm factors that influence the eating qualitites of lamb meat

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ABSTRACT

If predictions for future growth of New Zealand's exports of chilled lamb meat are to be fulfilled, overall quality will have to be maintained at a consistently high level, and properties like storage life and appearance will require emphasis.

A review of scientific literature showed that a wide range of farm practices can influence meat quality. The trend to breed leaner lambs, to slaughter more ram lambs at heavier weights and older ages in winter and spring, and effects of stressful experiences before slaughter, were seen as areas of potential concern for the production of high quality meat.

However, it has not been established that these factors are of economic importance to the meat industry. It is suggested that they should be investigated as possible constraints on the future development of markets for premium quality lamb.

Keywords Lamb; meat quality; management.

INTRODUCTION

Statements by leaders in the New Zealand meat industry indicate that more attention will have to be paid to the quality of lamb exports as the proportion that is exported as frozen carcasses declines and that exported in further processed forms, particularly by chilled transport, increases.

Chilled lamb cuts are seen as a major area for market growth (Anonymous, 1985; Phillips, 1986). They require emphasis on different quality characteristics and more consistent and higher overall standards of quality than frozen carcasses, so it is appropriate to review our knowledge of factors influencing meat quality.

MEAT QUALITY

Meat quality is influenced by farm production practices, transport to slaughter, factors operating in slaughter and processing plants, transport to retail sites and at retail sites. In this review attention is confined to on-farm factors without implying that they are more important than off-farm factors.

The term *meat quality* covers many characteristics (Table 1) several of which are highly subjective. The assessment of each, and its contribution to overall meat quality is influenced by such things as the form that the meat is in, the use to which it is to be put, and the expectation of the consumer. Consumer tastes vary markedly between cultures, such as between Japan and the Middle East (Park and Thomas, 1973) and even within nations (Currie *et al.*, 1986). Thus it is often not possible to say what effect a practice will have on meat acceptability. Nevertheless it can be safely assumed that chilled lamb cuts should have a long storage life, be lean, tender and juicy. Toughness due to cold-induced shortening of muscles (Locker, 1985) is still a significant issue for frozen lamb despite routine electrical stimulation (Chrystall and Devine, 1985) of carcasses immediately after slaughter. It is less of a problem for chilled lamb because higher storage temperatures mean that cold-shortening of muscles is less likely and meat becomes more tender during storage.

An objective measurement that is widely used as an indicator of the quality of meat is its ultimate pH (Newton and Gill, 1980-81; Tarrant, 1981). Apart from the tenderising influence of protein hydration, the effects of high pH on beef quality are deleterious (Table 2). Although the situation in lamb is less well known, the fact that high pH meat has a shorter storage life alone would render it less desirable for export in chilled forms.

TABLE 1 Meat quality characterisitics and possible farm influences.

Lamb meat characteristics	Possible farm influences
Storage life	Hygiene, stress
Amount of lean	Genotype, maturity, season
marbling fat	
removable fat	
bone	
Colour of lean	Genotype, maturity, diet
fat	
Odour and flavour	Diet, stress
Tenderness	Stress, maturity
Juiciness	Stress, maturity

TABLE 2 Beef quality responses to increased ultimate pH; adapted from Purchas (1988).

Changes associated with an increase in muscle pH	Accompanying quality responses
More rapid bacterial growth	Shorter storage life
Earlier protein breakdown	Shorter storage life
Increased protein hydration	More tender
Less lactic acid etc.	Less flavour
Less oxymyoglobin	Darker colour

FARM FACTORS

Genotype

Breeds. Differences between breeds and sires in meat palatability are seldom large and by no means consistent (Woodhams *et al.*, 1966; Crouse, 1983) and may be due to associated factors such as amount of fat (Butler-Hogg *et al.*, 1987). With respect to New Zealand breeds, Petersen (1984) noted that the pH of the *m. longissimus dorsi* of Perendale lambs was 0.25 units higher than other breed groups in a slaughter plant survey (Table 3). Moore and Duganzich (1985) also recorded higher pH values in Perendale cross rams but not ewes or wethers. Additionally Purchas *et al.* (1980) noted that Cheviots had higher corticosteroid hormone levels suggesting that sheep with Cheviot genes, such as Perendales, may be more likely to exhibit stress-induced effects. However, none of the above studies can be said to offer good evidence of a genetic effect.

The occurence of yellow fat is of some concern to the meat industry and it (Kirton *et al.*, 1975; Kruggel *et al.*, 1982), like other fat characteristics (Ch'ang *et al.*, 1980) is influenced by breeding.

Sex. Ram lambs fed on pasture and killed over the usual range of slaughter weights and ages for New Zealand lambs have generally been assessed as having similar flavour, juiciness and tenderness as induced cryptorchid, wether and ewe lambs (Kirton and Patterson, 1972; Corbett *et al.*, 1982a). Those killed at heavier weights and older ages are often less palatable (Crouse 1983; Kirton *et al.*, 1983; Field, 1984), a tendency that needs to be kept in mind in view of the trend to grow more ram lambs to heavy weights for chilled meat markets.

Data from 2 studies (Table 3) shows that ram meat can have a higher pH than wether or ewe meat. Also meat companies report that rams cause more hygiene problems during slaughter than other sex types due to the presence of the scrotum and dirtier fleeces from riding each other.

Maturity

Age. The darkness, toughness, strength of flavour and presence of off-flavours increase with age (Asghar and Pearson, 1980; Kirton *et al.*, 1983) but over the age range (3 to 9 months) when most lambs are slaughtered in New Zealand, few differences have been detected (Woodhams *et al.*, 1966; Furnival *et al.*, 1977; Crouse, 1983). Even lambs that have been held over winter and slaughtered at around 12 months of age have not shown deleterious changes in meat quality (Butler-Hogg and Buxton, 1986; Butler-Hogg *et al.*, 1985; Hagyard, 1984). By the end of winter lambs will be leaner than expected for their weight (Jagusch and Rattray, 1979; Kirton *et al.*, 192b; Bray and Taylor 1987) and there has been industry reports of poor quality meat from very lean lambs in late winter and early spring. Older lambs may be more sensitive to stress effects (Monin and Gire, 1977, cited by Monin, 1981).

TABLE 3 Breed and sex effects on the ultimate pH of *m. longissimus dorsi* of lambs.

Breed	Sex			Source
	Ewe	Wether	Ram	
Romney cross	5.57	5.58	5.70	Moore and Duganzich (1985)
Coopworth cross	5.57	5.63	5.80	(n = 9)
Perendale cross	5.57	5.58	6.02	
Coopworth	5.66	5.74	6.12	A.R. Bray and B.B. Chrystall (unpublished) (n = 34)
Romney		5.57[1]		
Romney cross		5.58		Petersen (1984)
Mixed breed		5.56		(n = 240 - 744)
Perendale		5.76		

[1] Mixed sex

Size. Large carcasses clool slower after slaughter than small carcasses so their meat is less likely to be tough because muscles have cold shortened (Marsh *et al.*, 1968; Wenham *et al.*, 1973). Thus very lean lambs are more susceptible to toughness due to cold shortening and to freezer burn and may be less flavoursome.

On the other hand, because of larger amounts of fat in subcutaneous and intermuscular depots, untrimmed meat from large carcasses can be less attractive to consumers. Intramuscular (marbling) fat is desired by many but neither genetic nor farm management means of obtaining good levels of marbling fat at low levels of subcutaneous and intermuscular fat have been identified.

Diet

The composition of lamb diets influences the products of digestion and hence meat odour, flavour and fat characteristics. (Cramer, 1983; Field *et al.*, 1983; Ford and Park, 1980). Off flavours have been noted on some but by no means all occasions in lambs fed brassicas (Park *et al.*, 1972; Wheeler *et al.*, 1974; Jagusch *et al.*, 1977; Koch *et al.*, 1987) legume forages (Cramer *et al.*, 1967; Shorland *et al.*, 1970; Park *et al.*, 1975; Nicol and Jagusch, 1971; Nixon, 1981), cereal greenfeeds (Park *et al.*, 1972) maize silage and weeds (Park and Thomas, 1973). Terms used to describe these off-flavours have included *pungent, nauseating, sour* and *porky*.

Kruggel *et al.*, (1982) implicated diet in the occurrence of yellow fat in lambs with a reduced incidence from grain diets.

Health and Hygiene

Dirty lambs presented for slaughter represent a problem as contamination of meat is more likely. If not detected, storage life and eating quality can be reduced. In New Zealand slaughter plants many lambs have to be washed before slaughter to reduce contamination. Repeated washing can adversely affect meat quality (Petersen, 1983). The greater hygiene problem with ram lambs has already been noted.

Whole or part carcasses visibly affected by disease are rejected for human consumption but other less obvious disorders that influence digestive and metabolic processes may well affect production of flavour compounds. For instance, Kirton *et al.* (1976, 1979) reported that meat from lambs badly affected by facial eczema was less palatable.

Also to be considered is the perceived healthiness of the product in light of the world-wide trend away from consumption of fatty meats and growing markets for natural products without residues of unwanted chemicals. A recent survey (Chrystall and Winger, 1986) has shown that some consumer opinions are illfounded and that New Zealand lamb products have a number of positive health attributes relative to alternative foods.

Stress

Stress before slaughter can affect meat quality by increasing muscle pH.

Underfeeding. Short-term starvation or prolonged underfeeding with limited weight loss has been found to have little influence on meat quality (George *et al.*, 1966; Kirton *et al.*, 1968; 1981; Jacobs *et al.*, 1973; Shorthose, 1978; Riley *et al.*, 1981; Devine *et al.*, 1983; Warriss *et al.*, 1987). However when underfeeding resulted in loss of up to 18% of carcass weight in 6 weeks, meat pH increased with weight loss. The increase was greater when weight loss was more rapid (Fig. 1). Lambs that lost 34% of carcass weight in 6 weeks had tougher meat than growing lambs though juiciness and flavour were not affected (Asghar and Yeates, 1979 a, b).

Shearing. Shearing had no effect on the meat pH of growing lambs (Sumner, 1984) but in lambs that lost weight shearing increased pH with the effect still present 6 weeks after shearing (Table 4). In the survey conducted by Petersen (1984) an inverse correlation existed between meat pH and wool weight.

Other stressors. Climate, exercise, prolonged transport and holding period before slaughter, washing before slaughter and administration of exogenous adrenal hormones have all been shown in increase meat pH or reduce meat quality (Bramblett

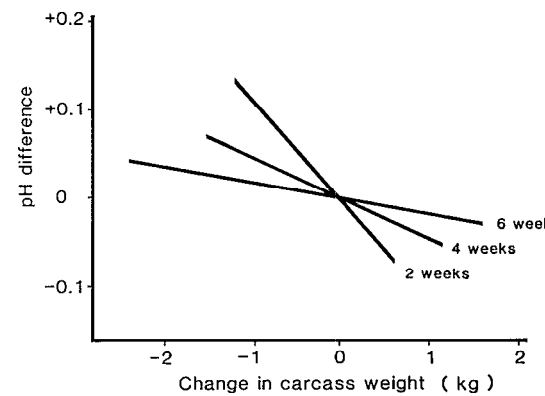

FIG. 1 Influence of carcass weight change over 2, 4 or 6 weeks on the ultimate pH of *m. longissimus dorsi*, relative to lambs that maintained weight (A.R. Bray and B.B. Chrystall, unpublished).

TABLE 4 Effect of shearing on ultimate pH of *m. longissimus dorsi* of lambs fed low pasture allowances (A.R. Bray, *et al.* unpublished).

Experiment	Shearing treatment	Duration of undernutrition (weeks) 2	3	4	6	Overall	Significance
1	Woolly	5.72	-	5.67	5.72	5.70	*
(n = 30)	Shorn	5.80	-	5.69	5.82	5.77	
2	Woolly		5.86				†
(n = 25)	Shorn		5.95				

Furnival *et al.*, 1977; Shorthose, 1977; 1978; Chrystall *et al.*, 1981; 1982; Petersen, 1983; 1984).

The results of a recent experiment (A.R. Bray and A.E. Graafhuis, unpublished) showed that the response to a stressor was greater in lambs exposed to other stressors. This finding suggests that the responses to single stressors measured in experiments will likely underestimate their impact under commercial conditions where lambs can be exposed to multiple stressors.

CONCLUSION

It is apparent from experimental studies that a wide range of farm practices may influence the quality of lamb meat. However, their importance to the New Zealand meat industry is not known. It is necessary to correct this situation if the industry is to consistently supply meat of high quality and maintain the rapid growth of markets for premium products such as chilled cuts.

It is suggested that early attention should be focused on the impact, if any, on lamb meat quality of breeding for leanness, increasing number of ram lambs killed at heavier weights and older ages, often after supplementary feeding and stressful farm practices, particularly in light of the cumulative effect of stressors.

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