

CHAPTER 9

9 INTEGRATION, CONCLUSIONS & RECOMMENDATIONS

9.1 INTEGRATION

It has been established that there is a potential to improve chevon production and marketing within South Africa, Zimbabwe and possibly other neighbouring countries in the region, such as Botswana, Mozambique and Zambia (§ 1.4 refers). Achieving this task is however, hindered by multifaceted constraints. These constraints include unorganised collection and distribution of goats from the production areas, non-strategic location of slaughter facilities and poor animal handling throughout the marketing chain (Devendra, 1994; Seleka, 2001).

Further drawbacks to chevon production are a result of no flow of information relating to meat quality within the marketing chain. This has led to a lack of synchrony between market preferences and the type of goat supplied to the market (Simela et al., 1998). On one hand, rural goat producers tend to sell bigger and hence older goats in order to maximise the income earned per animal sold. Moreover, the goats sold are predominantly culled breeding females. On the other hand, retailers prefer carcasses that keep well under refrigeration, without dehydrating and deteriorating in colour. Consumers prefer meat that has an attractive colour, looks fresh and is tender when cooked (USAID/South Africa and ARC-ANAPI, 1998a).

The net effect of the poor handling of the goats during marketing and the incongruous producer and market needs has been that chevon markets are dominated by carcasses of unacceptable quality. The present study has explicated some of the reasons for poor chevon quality.

9.1.1 Relationship between Carcass and Meat Quality

Carcass and meat evaluations in the present study indicate that chevon of acceptable colour and tenderness, and that has not suffered cold shortening during post-mortem chilling may be obtained from goat carcasses that weigh about 15kg and have about 7% total carcass fat (Tables 5.11 and 5.23). Lighter weight carcasses (12.5 to 13kg) with low fat content (~6% or less) were not suitable for the experimental conditions of chilling. They had a slow rate of glycolysis, chilled too fast, suffered cold shortening and had poor colour quality 24-hours post-mortem. The lightweight carcasses also tended to yield tough chevon 24-hours post-mortem. Though

CHAPTER 9

tenderness improved with ageing, colour differences between the light and heavier carcasses persisted to 96-hours post-mortem (Table 5.23). The lightweight carcasses would therefore not be suitable for processing under normal conditions of primary chilling in the commercial sector but are more likely to result in chevon that is perceived as ‘tough when cooked’ and ‘looks dry’ (Figure 1.2).

In the present study, measurement of carcass subcutaneous fat thickness was excluded because it was almost non-existent and difficult to measure for most of the non-conditioned goats. Moreover, it has been shown that subcutaneous fat cover is not a reliable parameter to include in goat carcass classification because it is too thin (<1mm) and in a very narrow range of values (Devendra and Owen, 1983; Simela et al, 1999).

Goats with two or more permanent incisors could achieve the ideal carcass weight and fatness of 15kg and 7%, respectively (Table 4.2). Carcasses of milk-teethed goats tended to be too small, though they could attain more than 7% carcass fatness. Carcasses of female goats also tended to be small with mean weight closer to that of carcasses that are susceptible to cold shortening compared to those of castrates and intact males (Table 4.1). Even so, female goat LT and SM did not suffer cold shortening, possibly because they were well insulated by the comparatively high carcass fat content (Table 4.8). On average, carcasses of non-conditioned goats were all too small, with a mean carcass weight that was less than 12.5kg whereas the pre-slaughter conditioned goats had mean carcass weight and fat content that were well above 15kg and 7%, respectively (Tables 4.3 and 4.18).

Pre-slaughter conditioning not only resulted in higher carcass yield (Tables 4.3) and meat yield (Table 4.17) but also improved goat carcass rate of cooling and pH decline under post-mortem chilling at about 4°C. It seems that intact males would respond better to pre-slaughter finishing off systems than females and castrates. This was reflected in the intact males’ greater DO%, lower chilling losses (Figure 4.1), greater increases in myofibre areas with pre-slaughter conditioning (Figure 5.4) and the higher lean content of the intact male goat carcasses (Table 4.8). However, only young males that have not developed secondary sexual characteristics would be suitable for finishing off systems. Older intact males are less acceptable in the meat industry and so their carcasses are downgraded (e.g. Government of Zimbabwe, 1995; SAMIC, 2004).

CHAPTER 9

The present study reaffirmed earlier findings that indigenous goat breeds may attain marketable weights from as early as one year old, when they have two permanent incisors (Simela et al., 1999). Moreover, goats at that age yield carcasses that can process well under commercial conditions of primary chilling in the abattoir. Therefore, keeping the goats for too long beyond the 2-teeth stage may not be of economic benefit to the farmers (Simela et al., 1999) but may increase the risk of losing the animals to thieves, predation and diseases (Figure 1.1; Scoones, 1992; Sibanda, 1992; Simela, 1993; Láforte, 1999). The results also reaffirm the advantages of improved nutrition on carcass yield (Hatendi, 1993) and demonstrate that these extend to improved meat tenderness and colour as has been reported for beef (Keane and Allen, 1998). Intact males would probably be ideal for pre-slaughter conditioning because of their greater response to it than castrates and females.

9.1.2 Chevon Quality

The present study demonstrated that goats are particularly prone stress caused by pre-slaughter handling. Consequently most goat carcasses had very low glycolytic potential at slaughter and attained high pHu (≥ 5.8) regardless of age, sex and pre-slaughter conditioning. The present results further showed that high pHu and related quality traits are not intrinsic chevon characteristics but are a consequence of mishandling throughout the marketing chain, which results in high pH meat. This is deciphered from the fact that some carcasses did attain low pHu (< 5.8) and these ones had a higher glycolytic potential and yielded meat that was more tender and had a better colour than that from carcasses with pHu ≥ 5.8 .

Full-mouthed does (the 8-teeth group) tended to have higher pHu values (~ 6.0) than the younger goats. This adversely affected the colour of chevon from the does, resulting in low a^* values (~ 12 or less) that are typical of DFD meat, and generally very tough meat (shear force $> 75\text{N}$) that did not tenderise with ageing (Table 5.18; Figure 5.15). However, pre-slaughter conditioning (Figure 5.12) and electrical stimulation (Table 6.9) resulted in appreciably more tender chevon from the 8-teeth does. In the sensory evaluations, flavour and aroma of chevon from old does was the least acceptable and least preferred (Figures 8.4 and 8.6). The low acceptance may have been because of the DFD condition. In essence, the high proportion of carcasses with pHu > 6 and the high proportion of culled females in slaughtered stock support anecdotal evidence that chevon is 'dark', 'tough', 'has a bland taste', 'looks dry' and 'goes off quickly' (Figure 1.2). All

CHAPTER 9

these characteristics are typical of DFD meat, which seems to be more prevalent from old does. Therefore, the highly stressful highly stressful handling of goats from smallholder producers to the markets, in conjunction with the high proportion of old does amongst goats marketed for commercial slaughter could be the major contributors to the perception of chevon as poor quality meat (Figure 1.2; Simela, 2000).

Pre-slaughter conditioning, electrical stimulation and ageing were highly effective in improving the chevon quality despite its high pHu. Pre-slaughter conditioning effectively prevented cold shortening, resulted in low shear force values and better colour quality both at 24- and 96-hours post mortem (Table 5.19). Evidently, efforts to improve the condition of goats prior to slaughter would be futile if the animals are subsequently subjected to stressful handling. Pre-slaughter stress may have led to the low *M. longissimus* glycogen levels observed in the present study even for goats that were conditioned prior to slaughter. Continual change of environment and the long periods spent in transit under real market situations are therefore likely to have a more severe impact on glycolytic potential, pHu and related chevon quality characteristics than was observed herein (Warner et al., 1998; Kannan, et al, 2002b). Therefore finishing off systems for goats destined for slaughter should be coupled with minimum-stress pre-slaughter handling procedures in order to increase the likelihood of obtaining good quality chevon from the goats.

Ageing improved tenderness and colour of chevon from either NES or ES carcasses (Table 5.27; Figure 6.3). Electrical stimulation was highly effective in improving tenderness. At 24 hours post-mortem, mean shear force of ES carcasses was 35% lower than that of NES carcasses and decreased further by 19% during ageing to 96 hours. In contrast, tenderness of NES carcasses of castrated and female goats did not improve with ageing up to 96 hours (Figure 6.3). Electrical stimulation has been widely recommended for employment in the meat industry. The advantages of using ES in the goat meat industry would also include a reduction in the ageing time required for the meat to attain acceptable tenderness, and hence a reduction in carcass weight losses during storage, chances of surface spoilage, cost of refrigeration.

A major set back with ES is that it is considered expensive to install and maintain and therefore is unlikely to be readily adopted by the small-scale abattoirs, which are the major slaughterers of goats. In such situations, less expensive alternatives such as high temperature conditioning may

CHAPTER 9

be considered. McKeith et al. (1979) found that this practice also improved tenderness and the eating quality of chevon. Use of high temperature conditioning should however be within the temperature boundaries recommended for good hygienic practices in order to produce chevon that is safe for human consumption. Other possibilities than need to be investigated are skin-on chilling or use of alternative carcass suspension methods.

The present study dispels the notion that chevon is unpalatable but shows that the meat is highly acceptable to South African consumers of diverse backgrounds, especially if it is from goats that are one to two years old (Figures 8.3 to 8.6). Based on fatty and amino acid profiles, chevon is healthful and nutritious regardless of the age and sex of the goats. The fatty acid profile is in accordance with recommendations for healthful eating while the amino acids would meet consumers' daily requirement for essential amino acids. These attributes of chevon are concordant with present day consumer demands for leaner and nutritious meat. To meet these demands, livestock farming is generally shifting towards the production of leaner carcasses of other species. Chevon may readily meet the required criteria without major adjustments to goat production systems, and hence its consumption should be promoted on this basis.

9.2 CONCLUSIONS

The objectives set out for this study were accomplished. Sex, age, and pre-slaughter condition all affected carcass characteristics of goats. However, sex had little effect on meat quality characteristics while age and pre-slaughter conditioning affected some of the chevon characteristics. Post-mortem ageing and electrical stimulation were both effective in improving meat quality, specifically tenderness and colour. Chevon is nutritionally well-balanced for human consumption in terms of fatty acid and amino acid composition. Chevon from goats of different/age sex groups is acceptable to South African consumers. The following conclusions are therefore drawn from the study:

- South African indigenous goats belong to the large breeds of Southern Africa that have a high potential for meat production.

CHAPTER 9

- South African indigenous goats may be slaughtered under commercial conditions, chilled at about 4°C and yield meat of acceptable quality if the carcasses are big (~15kg) and have a high fat content (~7% or more).
- Carcasses that are suitable for producing chevon under commercial conditions of primary chilling may be obtained from pre-slaughter conditioned goats, goats that have at least two permanent incisors and more likely from intact males and castrates than from females.
- Old does tend to yield chevon with DFD characteristics and therefore a poor colour, a tendency to be tough, and hence lower eating quality compared to younger animals.
- A fast rate of glycolysis ($pH_3 < 6.1$) and a slow rate of carcass chilling resulted in tender chevon with a more acceptable colour (higher a^* value). Pre-slaughter conditioning, electrical stimulation and high carcass weight and fat content were highly effective in improving chevon tenderness and colour despite the high pHu of the meat.
- Post-mortem ageing also resulted in improved the colour and tenderness of chevon despite the high pHu.
- High pHu is not an intrinsic characteristic of chevon but is a result of pre-slaughter stress. As is the case with other species, goat carcasses with a low pHu yield chevon of acceptable quality while high pHu carcasses yield meat that is tough and has DFD characteristics.
- Chevon has healthful fatty acid and amino acid profiles regardless of age and sex of goats.
- Chevon is highly acceptable to South African consumers of diverse backgrounds, especially if the meat is from goats that are one to two years old.

9.3 IMPLICATION OF FINDINGS AND RECOMMENDATIONS

Based on the findings reported in the present study, it is recommended that the meat industry sets minimum standards for the production of chevon of acceptable quality. The criteria should be

CHAPTER 9

based on carcass weight and fatness, chilling rate and ultimate pH attained. Strategies to attain these standards would have to be designed and implemented. They should include simple selection for goats of body condition, weight and age that are conducive to producing an acceptable carcass. More complex criteria could include minimum handling conditions for goats from the point of sale to slaughter in order to minimise stress to the animals and hence the occurrence of high pH chevon. Any goats that do not meet the set criteria should not be accepted for chevon production but the meat could be given another name. The broad implication is that an integrated farm-to-fork approach is required in order to ensure chevon of acceptable quality in the meat market.

Areas that are suggested for further research are:

- The biochemical pathways that lead to the high pH_u of chevon and the minimum conditions under which goats may be transported without the risk of high pH meat.
- Factors affecting temporal changes in proteolytic enzymes and the effects of these on meat tenderness.
- The balance of anti-oxidants, oxidation substrates and pro-oxidants in chevon, particularly in view of the high PUFA content of the meat.
- Improving ways of on-farm assessment of live goats in order to ensure that they best suited for chevon production. These could include combinations of body condition scores, live weight and age.