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Assessment of lamb meat quality in Sydney and Melbourne

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ABSTRACT

Retail audit studies were undertaken in both Sydney and Melbourne to establish benchmarks for quality at the retail level. Midloins were obtained from ticketed carcases at 14 retail outlets in Sydney, on 3 occasions (2 x 3) during the same week in March 1994. In Melbourne, midloin samples were obtained from non-ticketed carcasses in 38 and 40 retail outlets in June 1993 and January 1994 respectively. Using an L* value of 32 and a pH value of 5.8 as criteria of acceptability it was found that similar numbers of unacceptable samples occurred in both cities. Using a Warner Bratzler (WB) shear force of 5 kg as an indicator of unacceptable toughness, 15% of samples from Sydney were unacceptable compared to 5% in Melbourne. Carcass age significantly ($P < 0.001$) influenced the WB values for Sydney samples. When WB values were adjusted to 1 or 3 day old equivalents 27% and 6% exceeded 5 kg respectively. The results indicate that management options (such as ageing), and objective measurement of carcass and meat quality can be applied to increase knowledge and improve the overall quality of the lamb and its reputation with consumers.

Keywords: Lamb; Meat; Quality; pH; Tenderness.

INTRODUCTION

In recent years a concerted effort has been under way in Australia to maintain the domestic consumption of lamb meat. This effort has been concentrated within the Meat Research Corporation Prime Lamb Program which has been running in Eastern Australia for the last four years with the overall objective of achieving the annual production of 25,000 tonne of high quality value added lamb meat (McLaughlin 1992). Within this program there has been a focus on the quality of lamb meat offered to consumers at the retail level through the trial and adoption of a quality assurance program in Melbourne (Channon *et al.,* 1993).

The initial work in Melbourne showed significant variation, particularly in tenderness, as measured by objective means and the data have been used to effectively demonstrate to the retail and wholesale sectors the benefits of practices such as the ageing of meat (Channon 1993). Based on the initial results of the Melbourne program, the concept was adapted for use in Sydney because the quality of lamb meat offered to Sydney consumers was largely unknown, and not well documented. With the advent of carcass tickets which include date and location of slaughter (Hopkins and Kajons 1993), it became possible to accurately account for the age of the meat at sampling. This paper reports on objective measures of lamb loin meat quality after sampling from Melbourne and Sydney retail outlets and discusses the results in relation to improving the consistency and overall quality of lamb meat.

MATERIALS AND METHODS

Experiment 1 - Sydney

The audit was undertaken in March 1994 and involved 14 retail butcher shops and 1 wholesaler. Each retailer was involved in the Trim Lamb Select Butcher program run by the Australian Meat and Livestock Corporation and purchased ticketed carcasses. A range of shop types from a wide area of Sydney were visited three times during the week in order to account for any day-of-sampling effect. Where possible, 2 midloins were removed from 2 different carcasses at each visit. For each carcass the date and place of slaughter, hot carcass weight and the GR in millimetres or a manual fatscore as recorded on the ticket was obtained. Cold GR was measured on the carcass using a GR knife. The longissimus thoracis et lumborum (LL) was removed from the midloin along with the overlaying subcutaneous fat and held refrigerated at approximately 1°C until freezing later on the day of sampling. Loin samples were stored at -20°C until testing.

Experiment 2 - Melbourne

Midloin samples were collected in two different seasons (June 1993 and January 1994) from up to 40 butchers covering a broad economic and ethnic strata. The samples were tested using a similar regime to that used in experiment 1, except that samples were usually processed on the day following purchase and fat colour measurements were not undertaken, nor GR measured.

General methods

Subcutaneous fat depth over the deepest part of the eye muscle (Fat C) between the 12th and 13th ribs was measured on all samples. Muscle pH was determined using a Jenco 6009 pH meter with automatic temperature compensation with the electrode inserted into the lumbar end of the LL. Meat colour was measured on the cut surface of the LL at the lumbar end after 'blooming' at ambient temperature for 30 min using a Minolta Chroma meter (CR-300) set on the L*, a*, b* system. Colour of the subcutaneous fat at the thoracic end of the loin was assessed visually based on fat colour chips used in the AUS-MEAT chiller assessment scheme for beef (Anon. 1991).

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A scale of 0 to 4 with half scores was adopted where higher scores indicate a yellower fat. The b* values of the fat were also obtained using the Chroma meter (b_2*). A sample of the muscle (80±2g) was cooked at 80°C for 1 h and then cooled in cold running water for 30 min, and stored in a refrigerator overnight at 0°C. Five samples per LL with a 1cm² cross section were removed and tested for shear force using a Warner-Bratzler (WB) Shear blade fitted to an Instron Universal Testing Machine Model 4301. Cooking loss (CL) expressed as a percentage was determined by dividing the weight of each sample pre-cooking by the post-cooking weight.

A 5 kg WB shear force was adopted as a criterion of acceptability, given that many Australian consumers consider lamb meat that exceeds this value is tough (Shorthose *et al.*, 1986). For pH, all samples below 5.80 were considered acceptable (Hopkins and Kajons 1993). An L* value of 32 was used as a criterion of acceptability based on the relationship between pH and this value (Hopkins unpublished data).

The data were analysed using both standard regression techniques within SYSTAT (Wilkinson 1990) and by the use of Restricted Maximum Likelihood (REML) techniques within GENSTAT 5.3.1 (Genstat 5 Commitee, 1993). REML analysis was used to examine the relationships between carcass weight, GR, day of collection, time between slaughter and sampling, retail outlet and abattoir and the variates, pH, L*, a*, b*, WB and cooking loss. This type of analysis was required due to the unbalanced, non-orthogonal design of the project. In the Sydney audit one midloin sample was 5 days old at sampling and another 8 days old. These were omitted from analysis.

RESULTS

Experiment 1 - Sydney

Over the week of the Sydney audit, 83 loins were obtained. The mean values and the range for each meat quality characteristic measured, is shown in Table 1.

Two of the samples tested had ultimate pH's above 5.80. No factor was found to significantly influence the pH levels of the loins. It was found that both pH and carcass weight had a significant ($P < 0.05$) effect on the L* values of the loin, pH being more important. Thus as pH or carcass weight increased L* values decreased and the meat was darker. The model describing this relationship has an $R^2 = 0.38$ and an r.s.d. = 2.21.

In an attempt to relate L* to acceptability, 50 of the samples obtained in the Sydney audit were subsequently assessed by 12 retailers and these assessments compared to values obtained using the chroma meter. Each retailer was asked to view each sample and give a score for lightness/darkness based on the following criteria; 1 = very acceptable, 2 = acceptable, 3 = mildly acceptable and 4 = unacceptable. The scores for each sample were averaged over the retailers and the relationship between the average score and L* values established. The model describing this relationship has an $R^2 = 0.54$ and an r.s.d. = 2.05. Based on the model, a sample scored as a 4 would have an L* value of 32.1 indicating that the criteria adopted, appears reasonable as a guide for assessing acceptability. Two outlets had significantly higher L* values indicating lighter meat. Overall 11 samples had darker meat with L* values less than 32. The correlation between b^2* values and the fat colour scores was 0.46.

Of the carcasses sampled in this project, the average time between slaughter and sampling was 2.3 days the range being 1 to 8 days. The majority of samples (n = 60) were taken from carcasses up to 2 days old. The major factor that significantly ($P < 0.001$) influenced WB values was the age of the sample, which explained 24% ($R^2 = 0.24$) of the variation in WB values. Based on raw WB values, 13 of the samples (15%) had a WB value greater than 5.0 kg. Using the model shown below for predicting WB values from the age of the sample it was possible to determine adjusted WB values for each sample. Thus for a sample from a carcass 2 days old (Age 2) the predicted WB value is 4.57 - 1.13 = 3.44. The standard error for each coefficient is shown in brackets.

Constant 4.57(0.24) - 1.13(0.32)Age 2 - 1.73(0.47)Age 3 - 1.85(0.40)Age 4

$R^2 = 0.24$;r.s.d = 1.19

WB values were adjusted to be one or three day old equivalents and the number exceeding 5.0 kg calculated. When samples were adjusted to an age of 1 day, 22 exceeded 5.0 kg (27%), whereas an adjustment to an age of 3 days

TABLE 1: Mean and range of carcass and meat quality characteristics for 83 samples collected in Sydney (March 94) and 84 and 85 samples collected in Melbourne (January 94 and June 93 respectively).

	Sydney - Mar' 94		Melb - Jan' 94		Melb - Jun' 93	
	Mean	Range	Mean	Range	Mean	Range
Carcass weight (kg)	19.3	15.4 - 23.90	19.7	16.0 - 23.0	20.5	17.0 - 26.0
Cold GR[1] (mm)	11.8	6.0 - 24.0				
Fat C (mm)	2.3	0.5 - 5.5	5.6	1.0 - 14.0	4.8	2.0 - 14.0
pH	5.46	5.33 - 5.99	5.53	5.32 - 5.93	5.50	5.30 - 6.00
L*	35.3	28.4 - 42.5	34.8	29.7 - 40.6	34.5	30.8 - 40.6
a*	17.0	12.9 - 21.3	15.7	13.4 - 18.7	16.3	12.7 - 20.7
b*	8.1	4.8 - 11.8	5.4	3.2 - 7.9	7.0	4.3 - 12.1
WB (kg)	3.57	1.70 - 8.24	2.48	1.48 - 4.47	2.70	1.40 - 6.70
Cooking loss (%)	36.8	30.6 - 40.1	33.2	28.8 - 37.5	34.4	31.4 - 37.0
Fat colour score	2.5	1.5 - 4.0				
b_2*	9.1	4.1 - 14.3				

[1] GR for 2 carcasses could not be measured.

reduced the number to 5 (6%). The least squares means for WB according to age of sample were; Age 1 4.57; Age 2 3.45; Age 3 2.84; and Age 4 2.72 with a s.e.d. of 0.42.

Experiment 2 - Melbourne

Results from the Melbourne audit are presented in Table 1. One sample in January and 4 samples in June had pH values >5.80 while 8 and 9 samples in January and June respectively had L* values <32. Four samples had elevated (>5.0 kg) WB values in June while no elevated WB values were found in January. In a survey of butchers in 1992, 47% of butchers did not age carcasses while 34% aged carcasses for ≤ 2 days.

DISCUSSION

The level of carcasses with a high pH was lower than expected for both cities based on previous observations (Hopkins and Kajons 1993), but since there is a general lack of robust comparative data, exhaustive comparisons are not possible. If the data in this study is indicative of lamb meat available at the retail level, high pH in Australian lamb does not appear to be a significant problem. In contrast, our criteria for colour acceptability indicates that there is a need to investigate ways of improving this characteristic of our lamb meat since colour has a significant impact on initial consumer purchasing decisions (Kropf 1993). Given that only a small number of samples had a high pH, this can not be blamed for the higher number of dark samples, suggesting that either the holding temperatures may have been less than optimal leading to lower levels of oxygen uptake inhibiting formation of oxymyoglobin, or that differences in myoglobin concentration existed leading to a darker colour. Furthermore, because of biological variation and imperfect relationships between pH and colour, pH can not be used as a sole criteria for deciding whether meat has acceptable colour (Purchas 1989). There is clearly a need to further develop relationships between visual acceptability and objective measurements like those available from the chroma meter.

The Melbourne audit results confirm industry's view of the importance of seasonality of lamb production and its potential to affect the quality of meat reaching consumers. Samples from the 'winter slaughter' had a greater incidence of elevated pH and WB values demonstrating the potential to lower consumer satisfaction by presenting lamb of variable quality.

It is evident that some of the lamb offered to Sydney and Melbourne consumers does not meet satisfactory levels of acceptability in terms of tenderness. Since ten (71%) of the Sydney retailers and 47% of the Melbourne retailers indicated that they hung carcasses for only 1 day before preparing them for sale, there is a lot of scope to promote the concept of ageing given that most abattoirs processing lamb in Australia do not use electrical stimulation. The lower levels of toughness found for the Melbourne samples may result from one of two things. Firstly, because carcasses were not ticketed, there is no confidence about carcass age and given that the samples were held for 24 hours before testing, the age of the samples may have been older than estimated. It is also noted that the level of tough samples has continued to fall during the Melbourne program which began in 1992 (Channon *et al.*, 1993) possibly indicating that retailers were adopting practices, like ageing, to improve the tenderness of the meat they sold.

CONCLUSIONS

Audits such as described here are needed on a regular basis to ensure that the quality of lamb is improved, firstly by identifying causes of problems and addressing these and secondly, by providing practical benchmarks of meat quality for retailers. While further refinement of some parameters is required, ticketing and auditing promote a climate supporting objective assessment of lamb carcass and meat quality. The indications are that Australian lamb, processed under a variety of conditions, can be a high quality product, but that particular care is needed to ensure uniformity in relation to tenderness, and to a lesser degree, colour.

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