THE EFFECTS ON SOME PROPERTIES OF BEEF OF RESTING AND FEEDING CATTLE AFTER A LONG JOURNEY TO SLAUGHTER

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Summary

Steers rested and fed for 4 days rather than 2 days after a long journey to slaughter had a lower pH in the M. longissimus dorsi (LD) and flexor profundus 24 h postmortem and a lower ultimate pH in the M. vastus lateralis (VL). The extra holding period did not significantly affect the mechanical properties of the VL or LD, whether they were aged or cooked at either 65 or 90°C for 90 min.

I. INTRODUCTION

In Australia cattle are often transported long distances to slaughter, and then held at meatworks, prior to killing, for varying lengths of time, l-7 days. They are not usually fed during this period unless they arrive in an exhausted condition. The degree of exhaustion of animals at slaughter could be expected to influence some properties of the meat.

There is some evidence that long periods of uninterrupted transport may increase the pH of beef muscles, taken 24 h postmortem, (van der Heever et al. 1967). However, Howard and Lawrie (1956) found that it was difficult to deplete muscle glycogen of cattle by transportation. The pH of meat affects its colour, keeping quality, water-holding capacity and tenderness (Howard and Lawrie 1956).

An experiment was designed to determine if resting and feeding cattle at a meatworks after a long rail journey influenced meat properties, particularly pH and tenderness. As ageing of meat cuts in evacuated, gas-impermeable, plastic bags is being increasingly practised in Australia to improve the tenderness of beef, the effects on this tenderising process of resting and feeding the cattle were also studied.

II. MATERIALS AND METHODS

(a) Experimental animals and treatments

A group of 400 Shorthorn steers was transported 322 km by road to a railhead. The animals were rested for 16 h, with water available, and then railed 966 km to the meatworks, a journey which took a further 42 h. The cattle had been without feed for approximately 4 days. Three hours after arrival, three groups of 20 animals, Groups 2, 3 and 4 were split from the 400 and put into a bare resting paddock. The remaining 340 animals were held, together, in another bare

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resting paddock. A group of 20, Group 1, was selected, en bloc, at random from this 340, immediately prior to slaughter, as a control group.

Group 1 had access to water and Group 2 to feed and water for one day after arrival and both groups were killed 2 days after arrival. Groups 3 and 4 were killed 4 days after arrival. Group 3 had access to feed for 2 days and water for 3 days prior to slaughter and Group 4 had access to both feed and water for 3 days.

Native hay with molasses poured on it was offered in hay racks. Approximate feed consumption was determined by weighing the amount of hay required to replenish the racks. Water containing 1.5 g of 65 per cent phosphoric acid/1 was always available in the resting paddock, but was withdrawn approximately 18 h prior to slaughter when the animals were moved to holding yards. Apparent water consumption was determined by measuring the amount of water required to refill the trough. During transport and the holding period daily maximum temperatures varied from 25-28°C and daily minimum temperatures from 12-17°C.

(b) Slaughter procedure and post-slaughter determinations

The animals were stunned with a pneumatic stunner and the spinal chord cut before hoisting and bleeding. The hot carcase weight, less 3 per cent, was recorded as estimated cold carcase weight. Grading was subjective and done by an experienced meatworks employee, but downgrading due to blemishes was disregarded.

The pH of a shin muscle, M. flexor profundus (FP), was determined 70 min and 24 h postmortem and of the M. longissimus dorsi (LD), at the last rib at a point 4 cm from the midline and 2-3 cm deep, at 24 h postmortem on all carcases. The pH values were determined using an IL 175 pH meter† and a probe combined electrode. The pH of some beef muscles of normally chilled carcases is not always minimal 24 h postmortem and values measured at this time cannot be considered ultimate values. The pH taken immediately before cooking was taken as the ultimate pH.

(c) Ageing and preservation procedures

Two cuts, the striploin (LD) and the knuckle (containing the M. vastus lateralis, VL) were boned from 10 of the carcases in each group 24 h postmortem; every second carcase was sampled. One knuckle and one striploin from each of the selected carcases were wrapped in polyethylene film, placed in a standard cardboard carton, frozen in a blast freezer, and stored at -20°C. The other knuckle and striploin were put into gas-impermeable plastic bags, which were evacuated and heat shrunk within 15 min of removal of the cuts from the carcase and the cuts aged at 1-2°C for 3 weeks. After this 3-week ageing period the aged cuts were blast frozen and stored at -20°C.

(d) Cooking procedures and determination of mechanical properties

Both aged and unaged LD and VL muscles from half of the 10 available carcases in each treatment group were cooked. Five carcases were selected at random from the 10 carcases of Group 1, and the corresponding 5 carcases, in

†Instrumentation Laboratory Inc., Boston, Mass.
terms of order of slaughter within a group, selected from each of the other 3 groups.

Accurately weighed samples of the VL (approx. 140 g) and the LD (approx. 120 g) from these carcasses, five per treatment group, were cooked in polyethylene bags in water baths at 65 or 90°C for 90 min (see Bouton, Harris and Shorthose, 1971). The cooked samples were blotted dry and reweighed to determine loss of weight during cooking. Strips 0.66 x 1.5 cm in rectangular cross-section were cut from the cooked samples so that muscle fibres would be sheared at right angles to their long axes by the blade of a Warner-Bratzler shear device. Six to 10 shear measurements were made on each sample and the mean of these used in the analyses.

An Instron Universal Testing Machine† was used to determine the ‘hardness’ and ‘chewiness’ of the meat samples using procedures detailed by Bouton et al. (1971).

III. RESULTS

(a) Apparent feed and water consumption

In the first 23.5 h in the holding paddock the apparent water consumption by the 60 steers in Groups 2, 3 and 4 was 25.9 l/head; 20 l/head was consumed in the first 5.5 h. From 23.5 to 50.5 h consumption by the 40 cattle of Groups 3 and 4 was 11.4 l/head and increased, for Group 4, to 12.7 l/head in the period 50.5-73.5 h after entering the holding paddock.

On the first day the apparent consumption of molassed hay was 0.66 kg/head, Groups 2, 3 and 4. This increased to 0.86 kg/head on the second day, Groups 3 and 4, and 0.92 kg/head on the third day, Group 4.

(b) Carcase weight, and grade

The mean carcase weights of Groups 1, 2, 3 and 4 were 229 ± 6, 233 ± 5, 226 ± 4, and 223 ± 4 kg (± SE) and the mean grades 2.3, 1.7, 2.0, and 2.3 respectively.

(c) pH values of the FP, LD, and VL muscles

The mean pH values of the muscles at various times postmortem are shown in Table 1. The pH of the FP 70 min postmortem was significantly greater in Groups 1 and 2 than in Groups 3 and 4, whereas the 24 h pH of this muscle was significantly greater in Groups 3 and 4 than in the other 2 groups. In Group 2 the 24 h pH of the LD was significantly greater than in Groups 3 and 4, but there was no significant difference in the ultimate pH of the LD. However, the ultimate pH of the VL from Groups 1 and 2 combined was significantly greater than from Groups 3 and 4 combined. The percentages of animals with a 24 h pH of the LD below 5.8 were 60 per cent, 50 per cent, 90 per cent and 95 per cent in Groups 1, 2, 3 and 4 respectively. There were significantly more animals with 24 h pH values of the LD above 5.8 in the groups rested for 2 days than in the groups rested for 4 days.

The significance of the effects of preslaughter holding treatments on the mechanical properties of the cooked meat were determined by analysis of variance; differences between the four groups and between 2 (Groups 1 + 2) and 4 (Groups 3 + 4) days of preslaughter holding were tested. There were no significant differences between the treatment groups or the two periods of holding in any of the mechanical measurements, Warner-Bratzler shear, ‘hardness’, or ‘chewiness’, whether the samples were aged or not, or cooked at either 65 or 90°C. All three measurements of mechanical properties gave similar results. The Warner-Bratzler shear value of the LD (27) was significantly less than that of the VL (45). Ageing decreased the shear values of the LD from 33 to 21, and of the VL from 50 to 39.

The Warner-Bratzler and ‘hardness’ values of the VL were significantly correlated with ultimate pH; the relationships were curvilinear with peak values at a pH of approximately 6. The percentage cooking losses differed significantly between the two muscles and the cooking temperatures, but not between treatment groups.

IV. DISCUSSION AND CONCLUSIONS

Differences between treatment groups were considered to be largely due to differences in holding time and handling procedures because of the small amounts of feed consumed by the animals with access to feed. Group 1 was a control group of animals in a mob of 340 handled as they would have been in practice. It was considered possible that handling animals in this way might produce different results from handling animals in groups of 20, but this was not borne out by comparisons between Groups 1 and 2.

Holding animals for 2 days longer than the normal 2 day period decreased the 24 h pH of the LD and FP, and the ultimate pH of the VL but not the LD. It was possible that muscular activity during the journey depleted the glycogen concentration of the leg muscle (VL) more than in the LD. As the pH of meat
increases the meat becomes darker in appearance. It was of commercial interest that the extra holding period reduced the proportion of animals with a 24 h pH in the LD above 5.8. Meat with a pH above 6.0 is considered unsuitable for ageing in evacuated gas-impermeable packs as at, and above, this pH bacterial production of H₂S may occur and result in the formation of green sulphmyoglobin (Nicol, Shaw, and Ledward 1970).

Holding animals for 4 days rather than 2 days had no significant effect on the mechanical properties of the cooked meat or the percentage loss of weight during cooking. Ageing of the LD decreased the Warner-Bratzler shear force to a degree that the aged meat would be rated ‘tender-slightly tough’ by a taste panel, whereas the aged VL would still have been rated ‘tough’.

The extent of any effects on meat properties from increased holding periods after a journey to slaughter should depend upon the condition of the animals prior to transportation, how exhausting the journey is, feed consumption during the holding period and how restful the holding conditions are. The results of this present experiment are only applicable to similar types of animals handled in the way described.

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VI. REFERENCES