INVESTIGATION INTO THE OCCURRENCE OF DARK CUTTING IN BEEF CARCASSES

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SUMMARY

The ultimate pH of the loin in 3 168 beef carcasses was measured to investigate factors contributing to dark cutting carcasses in 1 Victorian abattoir. Cattle from feedlots had a significantly lower ($P<0.05$) mean pH than either direct purchases from farms or purchases from the saleyard (mean pH = 5.76 vs 5.94 and 5.98 respectively). Significant differences were found between transport companies and there was a trend for mean pH to increase with an increase in distance travelled.

This investigation was able to eliminate the abattoir as being the sole cause of the dark cutting problem. By working closely with preferred suppliers and transport companies in a Quality Assurance programme it is feasible that the abattoir will be able to reduce the incidence of dark cutting beef.
Keywords: meat pH, quality assurance, glycogen

INTRODUCTION

Meat quality is an important determinant of the economic value of a beef carcass. Meat quality is determined by the characteristics of value to the consumer encompassing meat tenderness and colour (Voon 1992). Dark cutting beef poses a major meat quality problem for the beef industry in Victoria and incurs a discount of $0.50/kg carcass weight (pers. comm. 1995).

Dark cutting beef results from a low concentration of muscle glycogen at the time of slaughter. This reduces lactic acid formation post-slaughter resulting in meat with a higher ultimate pH than normal. Normal ultimate pH is classified as pH < 6.0, whereas a dark cutter would have an ultimate pH > 6.0 (Munns and Burrell 1966; Tarrant 1981; Anon. 1984).

It is well established that stress applied to the animal between mustering on the farm and the point of slaughter is responsible for using up muscle glycogen reserves (Anon. 1984; Tar-rant 1988; Grandin 1988; Purchas 1988; Baker 1988).

Consumers do not like the appearance of dark beef as it is often associated with older animals or with meat that has deteriorated due to microbial spoilage. High pH meat has a shorter shelf life and is unsuitable for vacuum packing as it is susceptible to spoilage (Anon. 1984).

The aim of this investigation was to determine the causes of dark cutting beef at 1 Victorian abattoir, particularly the effects of purchasing from farms, feedlots, or saleyards; distance travelled to the abattoir; and transport company carrying the animals.

MATERIALS AND METHODS

An audit of meat pH was conducted in a Victorian abattoir over 9 days during March, 1995. In total, 3 168 carcasses of mixed breeds were measured after a minimum of 6 hours post slaughter. Two preliminary trials conducted prior to this investigation verified that the electrical stimulation method used was effective and ultimate pH was reached by < 6 hours post slaughter.

Meat pH was measured using a Sentron pH meter (Arrow Scientific, Sydney) with 2 measurements being taken per carcass in *M. Zongissimus thoracis et lumborum* between the 1 0th/1 1 th ribs and 11 th/12th ribs. If the 2 measurements were > 0.3 pH units different, the measurements were repeated.

Carcasses were individually identified by placing numbered tickets on the inside of the carcass and correlating this carcass number back to records kept by the abattoir to identify the type of carcass (sex and category), the region from which animals were obtained, nature of the purchase (saleyard purchase or direct purchase from farm or feedlot), transport company delivering the animal and the distance travelled (1-600km).

The data set was analysed by regression analysis and REML (Residual Maximum Likelihood) and, where numbers would allow, adjusted for confounding factors such as sex, category and distance travelled.

RESULTS

The carcasses measured ranged from 150-400 kg in carcass weight and comprised a wide range in market categories (vealers to heavy steers) and sexes (heifers, steers and bulls). The cattle were obtained from 8 different regions which encompassed 3 states including Victoria, New South Wales and South Australia.

Effect of direct/saleyard purchasing

Feedlot cattle had a significantly lower mean pH ($P<0.05$), (mean pH = 5.76 ± 0.02; % pH > 6.0 =15%, n = 119) than direct purchases from farms (mean pH = 5.94 ± 0.01; % pH > 6.0 = 37%, n = 875) and saleyard cattle (mean pH = 5.98 ± 0.01; % pH > 6.0 = 42%, n = 2055). Mean ultimate pH between direct farm purchases and saleyard cattle was not significantly different.

Variation in mean pH between direct farm purchases and saleyard purchases

When direct-on farm purchases were broken up into individual lots, large variations in mean pH between lots were evident. In Figure 1 below it can be seen that animals from farms 8 (mean pH = 5.74; % pH > 6.0 = 9.1%, n = 22) and 15 (mean pH = 5.73; % pH > 6.0 = 8.57%, n = 35) have a much lower mean pH than farms 27 (mean pH = 6.29; % pH > 6.0 = 80%, n = 10) and 22 (mean pH = 6.31; % pH > 6.0 = 53%, n = 30).

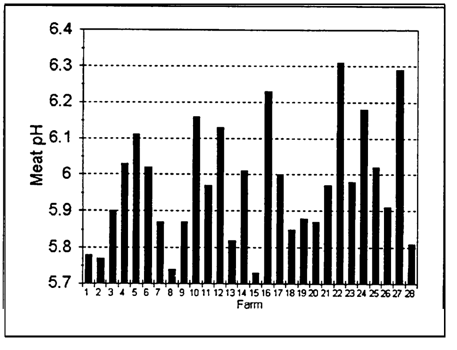

Figure 1. Variation in mean pH measurements between direct farm purchases

In contrast to these results there was less variation in mean pH values between animals from the different saleyards (Figure 2).

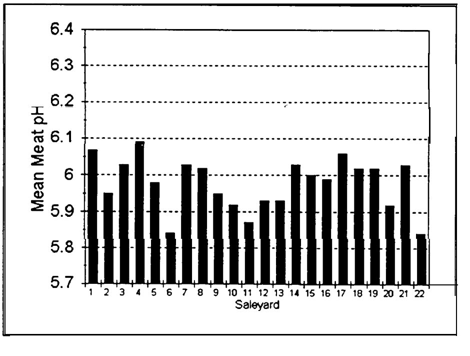

Figure 2. Variation in mean pH measurements between saleyard purchases

Effect of transport company

There were significant differences in mean ultimate pH values, for heavy steer, heifer and vealer categories between animals transported by different transport companies (Table 1). For example, in the vealer category, animals transported by company 6 had the lowest mean pH and those transported by companies 11 and 12 had the highest.

Table 1. Mean ultimate pH for animals transported by various transport companies, adjusted for distance travelled

Transport company	Heavy steer	Heifer	Vealer
12			6.04^{cA}
11	6.05^{b}		6.04^{c}
7	5.96^{bc}	5.90^{ac}	5.97^{c}
13		5.95^{bcd}	5.96^{c}
6		6.08^{d}	5.69^{a}
9			5.96^{c}
8			5.77^{ab}
10			5.81^{b}
5	5.84^{ac}	5.79^{a}	
14	5.74^{a}		

[A] Means within categories with similar superscripts are not significantly different (P>0.05).

Effect of distance

For animals travelling > 300km to the abattoir, mean meat pH increased as distance travelled increased. For example, the mean pH of animals travelling 201- 300 km to the abattoir (mean pH = 5.9; % pH > 6.0 = 32%, n = 361) is lower than animals travelling 501-600 km to the abattoir (mean pH = 6.02; % pH > 6.0 = 48%, n = 284).

DISCUSSION

This investigation found the level of high ultimate pH carcasses (pH > 6.0) to be very high by comparison with past research results. Of the 3168 carcasses measured, 39.8% were found to have an ultimate pH > 6.0, whereas Warner *et al.* (1988) found the incidence of high ultimate pH meat to be only 9.6% throughout abattoirs in Victoria. Not all of the high pH carcasses measured incurred the heavy 50c/kg carcass weight discount. The abattoir involved determined a dark cutting carcass by conducting a visual assessment of meat colour during load out. A possible explanation for the high prevalence of high pH carcasses found in this investigation is that the audit was conducted during the peak season for high pH meat in Victoria. In 2 preliminary trials it was verified that the electrical stimulation was effective and ultimate meat pH was being reached by <6 hours post-slaughter. During this investigation carcasses were measured from 6-15 hours post slaughter with the vast majority of carcasses being measured a minimum of 10 hours post-slaughter.

Cattle purchased from feedlots had a much lower mean pH than both direct purchases from farms and cattle purchased in the saleyard. The lower incidence of dark cutting amongst feedlot cattle found in this study agrees with previous studies conducted by Warner *et al.* (1988). There was greater variation in mean pH between lots purchased direct from farms compared to saleyard lots despite there being no significant difference between the mean pH of each group. Large variation in the mean ultimate pH was also found between groups of similar animals transported by individual transport companies. This suggests there is scope to work with the direct suppliers and transporters in a Quality Assurance programme to try to reduce the incidence of dark cutting beef from some properties and transport companies.

Saleyard cattle had the same mean pH as direct consignment farm cattle. This was surprising as saleyard cattle are generally subjected to an increased time from leaving the farm to slaughter and may experience mixing of lots, additional handling and noise stress compared with cattle going direct to the abattoir. Warner *et al.* (1988) also reported little difference between the sources and this suggests on-farm nutrition and mixing of mobs may be more important than method of consignment.

A trend is evident which shows once the distance travelled to the abattoir is greater than 300km, mean pH will increase with distance.

CONCLUSION

It is inevitable that animals will undergo stress right along the marketing chain. Each process in this chain should aim to minimise this stress which can reduce glycogen reserves and cause dark cutting beef. This investigation has eliminated the abattoir as being the sole contributor to the dark cutting problem for this particular company.

A full year's audit should be recorded to gain an accurate account of the dark cutting problem at the co-operating abattoir.

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REFERENCES

ANON. (1984). Meat Research Newsletter, CSIRO Division of Food Research, No. 84/1.

BAKER, S. K. (1988). Proceedings of an Australian Workshop on Dark Cutting in Cattle and Sheep, AMLRDC, pp. 75-6.

GRANDIN, T. (1988). Proceedings of an Australian Workshop on Dark Cutting in Cattle and Sheep, AMLRDC, pp.38-41.

MUNNS, W. 0. and BURREL, D. E. (1966). *Food Tech.* 20: 1601-3.

PURCHAS, R. W. (1988). Proceedings of an Australian Workshop on Dark Cutting in Cattle and Sheep, AMLRDC, pp. 42-5 1.

TARRANT, P. V. (1981). *In* "The Problem of Dark Cutting Beef', (Eds D. E. Hood and P. V. Tarrant), p. 3-34 (Martinus Nijhoff Publishers: Netherlands).

TARRANT, P. V. (1988). Proceedings of an Australian Workshop on Dark Cutting in Cattle and Sheep, AMLRDC, pp. 8- 18.

VOON, T. J. (1992). *Irish J. of Agric. and Food Res.* **31: 63-9.**

WARNER, R. D., TRUSCOTT, T. G., ELDRIDGE, G. A. and FRANZ, P. R. (1988). Proc. 34th Inter. Cong. Meat Sci. and Tech., Brisbane, pp. 150-1.