PE1.52 Survey of current pH status in New Zealand bull beef 317.00

Eva Wiklund (1) eva.wiklund@agresearch.co.nz, Mustafa Farouk(1), Adam Stuart (1), Pete Dobbie (1) Dominic Lomiwes (1) Debbie Frost (1)
(1)AgResearch MIRINZ

Abstract — The present survey was set up to obtain a representative picture of the current pH status - with focus on the intermediate pH group - of New Zealand bull beef. Four cattle slaughter plants in the North Island of New Zealand were chosen to be representative as "typical" processing plants for beef. The survey was carried out during a two-year period and included measurements at three different seasons; autumn, winter and spring, i.e. samplings at each plant three times per year. All cattle surveyed were part of the normal production at the four processing plants, incorporating a total of 1759 cattle (1336 bulls, 269 steers and 154 cows). Since the last comprehensive survey of pH in New Zealand beef was carried out 15 years ago, it appears that particularly the overall pH status of bull beef has improved. This was clearly demonstrated as an increasing proportion of normal pH bull beef in the present survey; 47% versus only 29% in the earlier study. However, with 53% of all bull beef in the intermediate and high pH ranges there is still a substantial amount of bulls with elevated pH values that contribute to a variable and suboptimal quality of the bull beef produced.

Index: bull beef, intermediate pH, pH distribution, seasonality.

I. INTRODUCTION

In pastoral production systems of cattle psychological and physiological factors combine to generate a range of meat pH values. Taking pH 5.8 as the upper level for the quality of M. longissimus dorsi beef, a New Zealand survey in the early 1990s showed that about 70% of bulls and 12% of steers exceeded this value [1]. A similar profile probably occurs in other pastoral production systems. Beef from carcasses with an ultimate pH between 5.8 and 6.2 are termed "intermediate pH". Intermediate pH meat can age normally and reach acceptable levels of tenderness [2], or it can be tough initially with improving tenderness with storage, although the ageing rate of intermediate pH meat is slower than that of normal pH meat [3]. The mechanism causing this variation in tenderness specifically related to intermediate pH meat is unknown. New measurement methods developed at AgResearch allow the ultimate pH of carcasses to be predicted early post mortem, which enables sorting into acceptable and unacceptable classes [4]. However, this results in downgrading of all intermediate pH beef when approximately half will be acceptable. Evidence found in recent studies at AgResearch MIRINZ has shown that small heat shock proteins (sHSP), found in abundance in bovine muscles, are cleaved by μ-calpain and hence sHSP may shield myofibrillar proteins from the activities of calpains and their presence may result in toughness in intermediate pH beef [5, 6]. The present survey was set up to obtain a good picture of the current pH status - with focus on the intermediate pH group - for New Zealand bull beef. The survey is an essential part of a wider program aimed at improving the performance, quality and consistency of intermediate pH bulls to provide New Zealand beef processors with the tools to transform frozen commodity beef into value added chilled cuts.

II. MATERIALS AND METHODS

Four cattle slaughter plants in the North Island of New Zealand were chosen to be representative of "typical" processing plants for beef. The survey was carried out during a two-year period and included measurements at three different seasons; autumn, winter and spring, i.e. samplings at each plant three times per year. All cattle surveyed were part of the normal production at the four processing plants, incorporating a total of 1759 cattle (1336 bulls, 269 steers and 154 cows). The processing plants included in the survey practiced hot boning for all beef carcasses [7]. Meat samples (2.5 cm thick slices of M. longissimus at the 12th rib, quartering cut site) were collected at boning, labeled, packed in plastic bags and transported back to AgResearch MIRINZ, Hamilton. Samples were chilled (1-2°C) for 48 hrs and ultimate pH was then measured using a portable pH meter (Mettler Toledo, MP 125, Switzerland) equipped with a Mettler Toledo combination electrode (InLab®427)

and with automatic temperature compensation. The pH meter was calibrated at pH 7.0 and 4.0 using buffers (LabServ, Biolab, Australia) stored at room temperature (20°C). The measured pH values were classified in three groups; normal (pH < 5.8), intermediate (5.8  pH  6.2) and high pH (pH > 6.2).

III. RESULTS AND DISCUSSION

The distribution of ultimate pH values combined for all animal categories, the four different processing plants and three different seasons is shown in Figure 1. It was very clearly demonstrated that the bulls had an overall high mean pH (5.99) compared with steers (5.61) and cows (5.53). This meant an indication towards a higher overall mean pH for all cattle (5.89) compared to the overall mean value of 5.79 from the New Zealand survey published in the early 1990s [1]. The present results demonstrated that 47 % of all bull beef had normal ultimate pH, which is a considerably higher percentage than in the previous survey [1], where only 29% of the bull beef had an ultimate pH below 5.8. In the present study, beef from steers and cows showed very high proportions of normal pH values, 84 and 95% respectively. Comparing these new results with the earlier survey, the proportion of normal pH values has increased considerably in meat from both bulls and cows, and decreased in steers. Despite the significant increase in the proportion of normal pH bull beef the present study demonstrated that a substantial part of the bull beef (18%) was still classified as intermediate pH (Fig. 1). Also the steer category produced relatively high frequencies of intermediate and high pH values; 7 and 9%, respectively (Fig. 1). The seasonal effects on the distribution of pH values in beef from bulls, steers and cows are presented in Figures 2 - 4. For bull beef, the distribution across the pH ranges was quite similar in autumn and spring (Fig. 2). The winter season showed a higher frequency of normal pH values and a lower frequency of high pH values for bulls (Fig. 2). This seasonal effect was also seen in the average pH values for bulls with autumn and spring being similar (pH 6.01 and 6.02, respectively) and with a lower mean pH value for the bulls slaughtered during winter (5.88). The proportion of intermediate pH bull beef during the seasons was still considerable and varied between 14% and 20% (Fig. 2). In the other two categories (steers and cows) the most notable seasonal pattern was a very high frequency of normal pH in beef from steers slaughtered in spring (Fig. 3) and the opposite trend in beef from cows with lower proportions of normal pH and higher proportions of intermediate and high pH values for animals slaughtered in spring (Fig. 4). The frequencies of intermediate pH values in beef from these two categories were lower than for bulls, but still relatively high and ranged between 3 – 12% for steers and 1 - 8% for cows (Figs. 3 and 4).

IV. CONCLUSION

Since the last comprehensive survey of pH in New Zealand beef was carried out 15 years ago, it appears that particularly the overall pH status of bull beef has improved. This was clearly demonstrated by the increase in the proportion of normal pH bull beef in the present survey. However, with 53% of all bull beef in the intermediate and high pH ranges there is still a substantial amount of bulls with elevated pH values that contribute to a variable and suboptimal quality of the bull beef produced. Using the information collected in the present survey, additional work within the wider research program will address the high proportions of intermediate and high pH values in bull beef. The work will include investigations of new and improved pre-slaughter handling techniques for bulls adapted to New Zealand production systems and aims to increase the degree of tameness and thereby reduce the levels of stress on the bulls. In addition, further investigations will determine the role of small heat shock proteins in meat toughness/tenderness for intermediate pH bull beef. Collectively this work will develop knowledge and technologies that can transform intermediate pH bull beef into acceptably tender products; thereby allowing beef to be exported to higher value markets.

ACKNOWLEDGEMENT

The authors would like to thank the meat processing plants involved in the survey for their support and assistance in connection with collection of the samples. Funding for this project was provided by the New Zealand Foundation for Research, Science and Technology (contract number C10X0708).

REFERENCES

[1] Graafhuis, A.E. & Devine, C.E. 1994. Incidence of high pH beef and lamb: II: Results of an ultimate pH survey of beef and sheep plants in New Zealand. In: Proceedings 28th

Meat Industry Research Conference, pp133-141, MIRINZ, New Zealand.

[2] Silva, J. A., Patarata, L. & Martins, C. 1999. Influence of ultimate pH on bovine meat tenderness during ageing. Meat Science 52, 453-459.

[3] Purchas, R. W., Yan, X. & Hartley, D. G. 1999.The influence of a period of ageing on the relationship between ultimate pH and shear values of beef M. longissimus thoracis. Meat Science 51, 135-141.

[4] Young, O. A., West, J., Hart, A. L. & van Otterdijk, F. F. H. 2004. A method for early determination of meat ultimate pH. Meat Science 66, 493-498.

[5] Pulford, D. J., Fraga Vazques, S., Frost, D. A., Fraser-Smith, E., Dobbie, P. & Rosenvold, K. 2008. The intracellular distribution of small heat shock proteins in post-mortem beef is determined by ultimate pH Meat Science 79, 623-630.

[6] Pulford, D. J., Dobbie, P., Fraga Vazques, S. Fraser-Smith, E., Frost, D. A. & Morris, C. A. 2009. Variation in bull beef quality due to ultimate muscle pH is correlated to endopeptidase and small heat shock levels. Meat Science, In Press, Corrected Proof.

[7] Farouk, M. M. & Swan, J. E. 1998. Effect of rigor temperature and frozen storage on functional properties of hot-boned manufacturing beef. Meat Science 49, 233-247.

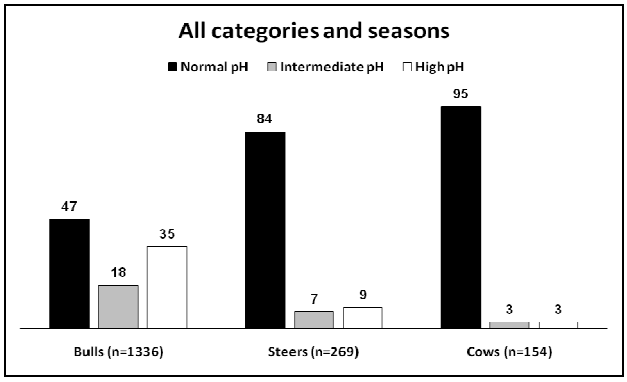

Figure 1. The overall distribution (percentage values) of ultimate pH for the three animal categories (bulls, steers and cows) included in the study.

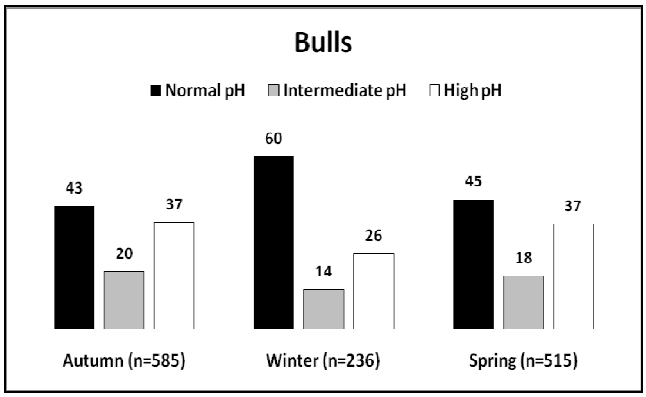

Figure 2. Seasonal distribution of ultimate pH values (percentages) for bulls included in the study and slaughtered at three different seasons; autumn, winter and spring.

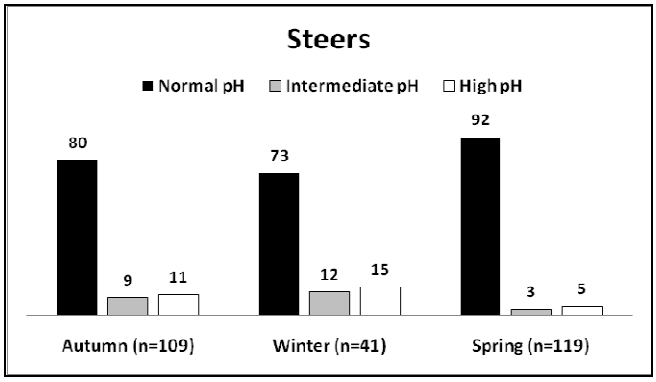

Figure 3. Seasonal distribution of ultimate pH values (percentages) for steers included in the study and slaughtered at three different seasons; autumn, winter and spring.

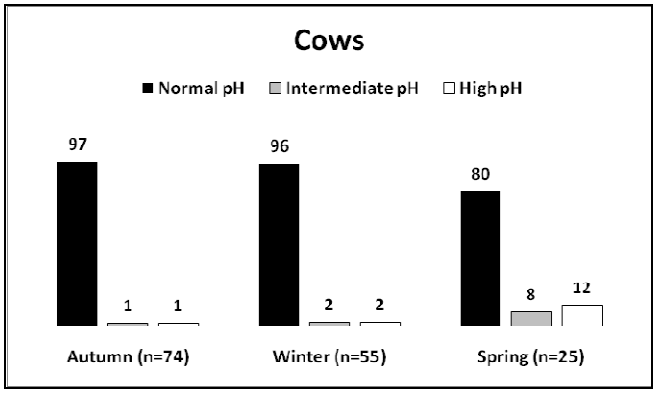

Figure 4. Seasonal distribution of ultimate pH values (percentages) for cows included in the study and slaughtered at three different seasons; autumn, winter and spring.