PE7.32 Consumer evaluation of chilled-never-frozen versus chilled-frozen-thawed beef and venison 330.00

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Abstract—This study tests the hypothesis that ageing of meat prior to freezing will narrow or eliminate the difference in the eating quality between chilled-never-frozen (CNF) meat and frozen accelerated conditioned and aged (AC&A) meat. Beef M. semimembranosus (SM), and beef and venison M. longissimus dorsi (LD) were each divided into four portions and assigned to four ageing times: 0 (48 h post-mortem), 1, 3 and 9 (chilled-never-frozen) weeks prior to freezing, thawing and analyses. Consumers found no significant difference in the tenderness and overall acceptability of beef SM aged for 3 weeks prior to freezing compared to one CNF. In addition, CNF beef LDL was judged to be more tender than beef LD aged 3 weeks prior to freezing but both the treatments were found to be equally acceptable overall (P > 0.05). Venison LD aged for one to three weeks prior to freezing were found to be equally acceptable to CNF venison LD, indicating that in venison unlike beef, a shorter ageing period was sufficient to eliminate quality difference between CNF and thawed meat. Result in this study proves the hypothesis that the eating quality of meat can be improved by ageing the meat before it is frozen.

Index bull beef, juiciness, overall liking, red deer venison, tenderness.

I. INTRODUCTION

Tenderness, juiciness and colour are the most important attributes affecting both the consumer decision in the purchase of meat on retail display and the acceptability of the meat once cooked and consumed [1]. Chilled-never-frozen (CNF) meat currently attracts a premium price over accelerated conditioned and aged (AC&A) meat which is fully frozen within 48 h of slaughter [2]. The price differential between CNF and frozen AC&A meat is due to CNF meat having more reliable tenderness, less drip loss and longer retail colour display life than AC&A meat. The superiority of CNF meat over AC&A meat could be due to the latter having a more intact muscle structure and higher reducing enzyme activities that cause the meat to be tougher and to have a shorter colour display life relative to CNF meat. There is no clear evidence that the eating quality of CNF meat is superior to frozen and thawed meat when the meat has been aged prior to freezing. Venison is generally more tender than beef, and for some deer species ageing of the meat is not necessary at all [3, 4]. This phenomenon has been explained by high activity of tenderising enzymes in venison [3, 5] compared with beef. In the present study beef and venison were included as examples of slow (beef) and fast (venison) tenderising meats. The experiment is part of a wider study designed to test the hypothesis that ageing of meat prior to freezing will narrow or eliminate the difference in the quality, including eating quality, between CNF meat and frozen AC&A meat.

II. MATERIALS AND METHODS

The meat samples used for consumer evaluation in this study were also evaluated for tenderness, water-holding properties and colour. These results are reported in two separate papers [6, 7]. Two different muscles/meat cuts were used in the study (M. semimembranosus (SM), and M. longissimus dorsi (LD)) which were collected according to the following protocols: A. Animals for collection of M. semimebranosus Twelve young bulls (age 2-3 years) were included in the study. The animals were slaughtered according to standard procedure at a New Zealand beef export processing plant. All carcasses at this plant are hot-boned within 1 h post mortem [8]. Both SM from each animal were collected at boning and then transported chilled to AgResearch MIRINZ, stored at 10°C until in rigor and then transferred to 2°C. At 2 days post mortem, the SMs were cut in half and the resulting four sub-samples from each animal were weighed and then randomly assigned to one of the following four treatments; 1 = chilled storage at -1.5°C for 9 weeks, 2 = frozen storage at -18°C for 9 weeks, 3 = chilled storage at -1.5°C for 1 week then frozen storage at for -18°C for 8 weeks and 4 = chilled storage at -1.5°C for 3 weeks then frozen storage at -18°C for 6 weeks. Meat quality measurements and consumer evaluations were

carried out after the 9 week storage period was completed. B. Animals for collection of M. longissimus dorsi Eight young bulls (age 2-3 years) and eight red deer (Cervus elaphus) stags (< 2 years) were included in the study. The bulls were slaughtered according to standard procedure at a New Zealand beef export processing plant. All carcasses at this plant are hot-boned within 1 h post mortem [8]. The deer were slaughtered according to standard procedure at a New Zealand specialised deer slaughter facility approved for export. The deer carcasses were kept at 10°C for approximately 6 hrs post mortem and then chilled down to 1°C according to normal practices at the plant. Carcasses were boned out 1 day post mortem. The beef samples (left side LD) were collected at hot-boning and transported chilled to AgResearch MIRINZ, stored at 10°C until in rigor and then transferred to 2°C. Deer samples (left side LD) were collected at boning 1 day post mortem and transported chilled to AgResearch MIRINZ. At 2 days post mortem, all LDs (beef and deer) were cut into four pieces and the resulting sub-samples from each animal were weighed and then randomly assigned to one of four treatments; 1 = chilled storage at -1.5°C for 9 weeks, 2 = frozen storage at -18°C for 9 weeks, 3 = chilled storage at -1.5°C for 1 week then frozen storage at -18°C for 8 weeks and 4 = chilled storage at -1.5°C for 3 weeks then frozen storage at for -18°C for 6 weeks. Meat quality measurements and consumer evaluations were carried out after the 9 week storage period was completed. C. Consumer evaluation Three consumer evaluations, carried out on three separate days were included in the study; one using the beef SM, one using the beef LD and one using the deer LD. At each of the three evaluations 48 consumers assessed the meat samples. Every consumer assessed all four treatments of the meat (Treatments 1, 2, 3 and 4 described above). The group of consumers could be regarded as an in-house consumer panel at AgResearch MIRINZ, Ruakura Research Centre, recruited through the campus by e-mail. The meat samples were roasted in a conventional oven at 175°C to an end temperature of 72°C (measured with thermocouples). The preparation of the meat samples took place on the day of the individual evaluation immediately prior to the sensory sessions which were carried out in a sensory laboratory with separate booths and under normal white light. At each of the sensory sessions the consumers were presented with four warm meat samples placed in plastic cups with lids, and coded with a random three-digit number. Together with the meat samples, a questionnaire was presented. The consumers were asked to evaluate the samples for three different attributes; tenderness, juiciness and overall liking using an unstructured continuous line scale from 0 (low intensity) to 15 (high intensity). The consumers were also asked to record any other comments they had about the samples. D. Statistical analysis For the study carried out on beef SM, the sensory data was analysed using the REML directive of GenStat [9]. In the comparison of beef and venison LD one animal (beef) was excluded from the analysis due to high pH. Sensory data was analysed using the REML directive of GenStat [9] with both species included in the same analysis.

III. RESULTS AND DISCUSSION

A. Beef SM The consumer scores for sensory attributes in beef SM are presented in Figure 1. Significant effects of treatment were found for consumer scores for tenderness ($p = 0.024$) and overall liking ($p = 0.015$). For tenderness, CNF meat and SM samples aged for three weeks before freezing were given the highest (average SED = 0.64) consumer scores (5.8 and 5.9, respectively), SM samples frozen at 48 h post mortem had the lowest scores (4.0) and the SM samples aged for 1 week before freezing were given intermediate values (consumer score average 4.8). Overall liking was evaluated in a similar way to tenderness by the consumers so that CNF meat and SM samples aged for three weeks before freezing were given the highest (average SED = 0.59) consumer scores (7.1 and 7.3, respectively), SM samples frozen at 48 h post mortem the lowest scores (5.4) and the SM samples aged for 1 week before freezing given intermediate values (consumer score average 6.2). No significant effect of the different treatments was found on juiciness ($p = 0.257$) (Fig. 1).

B. Beef LD Figures 2, 3 and 4 shows the consumer scores for the three sensory attributes of beef LD. Ageing prior to freezing significantly affected consumer scores for tenderness ($p = 0.004$), juiciness ($p = 0.014$) and overall liking ($p = 0.005$). For tenderness, the significant effect of treatment was mainly related to the CNF meat receiving the highest (average SED = 0.65) consumer scores (6.1) relative to the other treatments that did not differ (Fig. 2). Scores for juiciness reflected that of tenderness with CNF meat receiving the highest (average SED = 0.59) consumer scores (7.8) while all the other LD samples had lower and similar consumer scores (Fig. 3). CNF and LD aged for 3 week before freezing did not differ significantly (average SED = 0.57) in consumer scores (7.8 and 7.1, respectively)

for overall acceptability. LD samples frozen at 48 h post mortem and the ones aged for one week before freezing had the lowest scores (6.0 and 5.9, respectively) (Fig. 4). The treatments applied to two different beef cuts in the present study affected the eating quality of the meat in a similar way, although the positive effect of ageing before freezing on consumer scores observed for tenderness in beef SM was not as evident for beef LD. However, for the attribute overall liking the positive effect of ageing before freezing on consumer scores were the same in LD as in SM. There was also a similar trend in both beef cuts showing that juiciness of the LD samples was not significantly affected by treatment.

C. Deer LD Consumer scores for venison LD are presented in Figures 2, 3 and 4. Venison LD samples frozen at 48 h post mortem had the lowest (average SED = 0.65) consumer scores (7.8) for tenderness relative to the other LD samples (Fig. 2). For juiciness (average SED = 0.59) and overall liking (average SED = 0.57) the consumer scores were similar for all treatments (Figs. 3 and 4). As previously stated in the M & M section, the statistical analysis for beef and venison LD was carried out with both species included in the same analysis, which made it possible to make a comparison of the consumer scores for the different LD samples. For all the sensory attributes assessed, there were highly significant (p  0.001 for all three attributes) differences between beef and venison LD samples. Venison LD samples given the highest consumer scores (Figs. 2, 3 and 4). This difference was most obvious in the consumer scores for tenderness where the average scores ranged between 7.8 – 9.9 for venison LD samples and between 4.2 – 6.6 for beef LD samples (Fig. 2).

IV. CONCLUSION

CNF beef (SM) chilled at -1.5°C for 9 weeks and beef SM chilled for 3 weeks and then frozen were similar in consumer acceptability for tenderness, juiciness and overall liking. These results demonstrate a positive effect of ageing before freezing on eating quality. In conclusion, these results support the hypothesis that ageing of meat prior to freezing will narrow or eliminate the difference in the eating quality between CNF and AC&A frozen meat. The significant difference observed between beef and venison in the sensory attributes measured in this study strongly suggest species-specific tailoring of process inputs is required for beef and venison by the meat processors if the eating quality of these meats is to be optimised.

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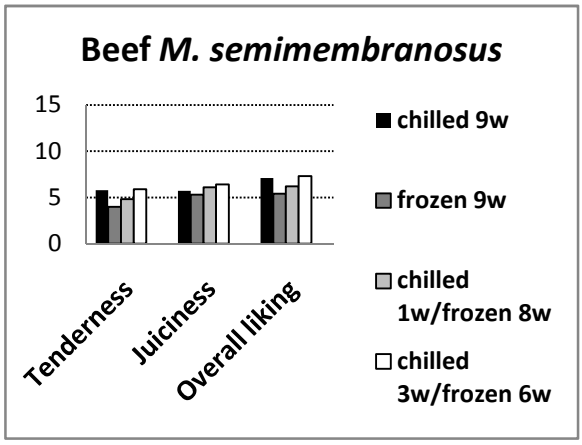

Figure 1. Consumer scores for tenderness, juiciness and overall liking for oven roasted beef SM (*M. semimembranosus*) exposed to different chilling and freezing treatments.

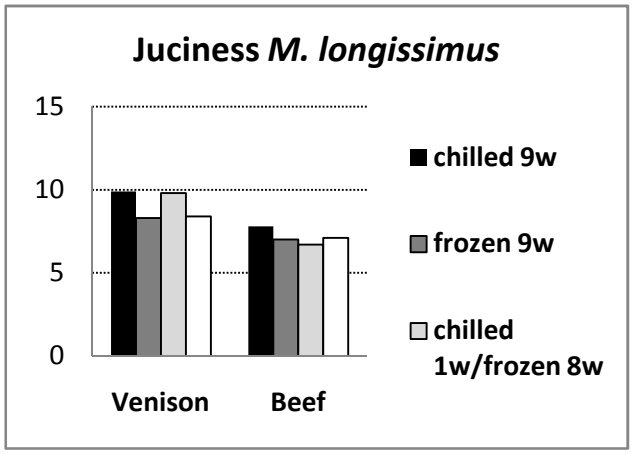

Figure 3. Consumer scores for juiciness in oven roasted beef and venison LD (*M. longissimus*) exposed to different chilling and freezing treatments.

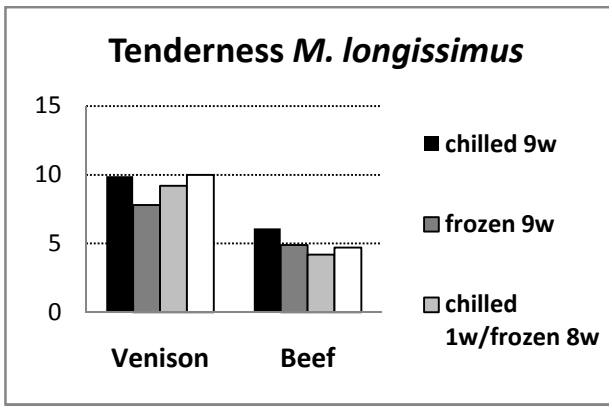

Figure 2. Consumer scores for tenderness in oven roasted beef and venison LD (*M. longissimus*) exposed to different chilling and freezing treatments.

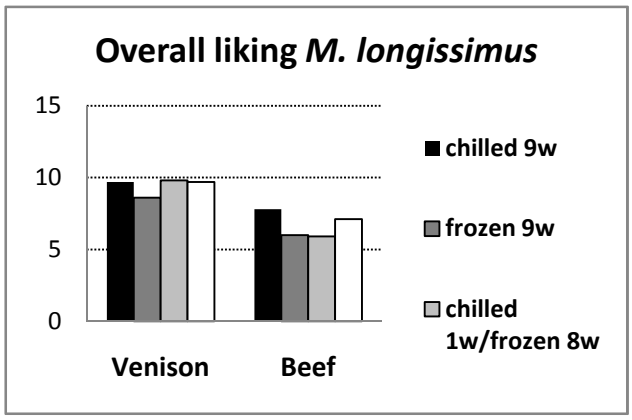

Figure 4. Consumer scores for overall liking in oven roasted beef and venison LD (*M. longissimus*) exposed to different chilling and freezing treatments.