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VENISON VITAMIN E LEVELS AND THE RELATIONSHIP BETWEEN VITAMIN E, IRON AND COPPER LEVELS AND DISPLAY LIFE FOR VENISON AND BEEF

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Keywords: venison, beef, colour, discolouration, colour stability, display life, anti-oxidants, vitamin E, pro-oxidants, iron, copper

Background:

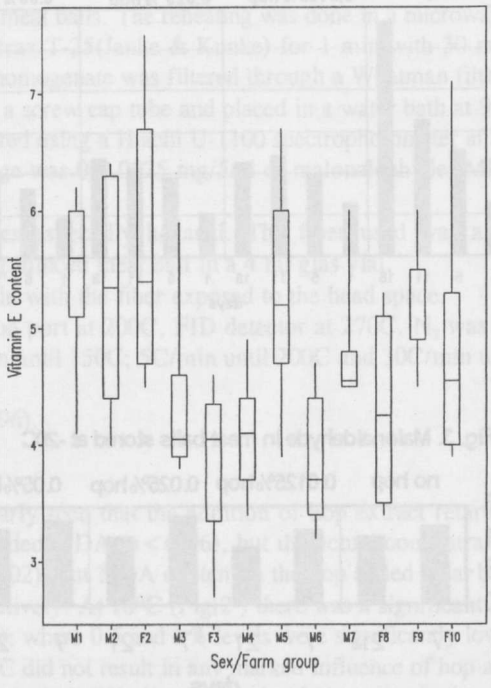
Consumers use the colour of meat as an indicator of quality and freshness, and base purchase decisions on these perceptions (West et al, 1997). Numerous papers have reported that addition of vitamin E to corn based diets for cattle delays metmyoglobin accumulation, and extends the shelf-life of fresh, chilled and frozen beef (for review, see Liu et al., 1995). For pasture-fed New Zealand beef, West et al. (1997) found that most striploins contained adequate levels of α-tocopherol for retail purposes (>3.0 mg/kg) although there were regional variations between seasons. Venison has a faster discolouration rate than lamb, beef and pork (Trout and Gutzke, 1995) and since venison is low in fat, and vitamin E is a fat soluble vitamin, it was suspected that venison may have low vitamin E levels. The objectives of this work were to measure the natural variation in vitamin E content of venison from farmed red deer stags and hinds and to determine whether age or sex of animal, or location, affects the colour stability of venison and beef.

Materials and Methods:

Experiment 1: A small portion of the striploin muscle from each of 70 red deer stags and hinds processed through a commercial deer slaughter plant was analysed for vitamin E (α-tocopherol) content by the method of Liu et al. (1996), either in duplicate or with sufficient replication so that the coefficient of variation was less than 5%. The animals constituted 12 sex within farm groups (n=6), defining the treatment structure for ANOVA.

Experiment 2: Venison and beef were sourced from commercial plants in the North and South Island of New Zealand. Striploins from six young (1-2 years of age) and old (> 3 years of age) deer were sourced from each plant in November and December 1996. Striploins from six bulls and steers were sourced from a North Island plant and striploins from six steers and heifers were sourced from a South Island plant. All striploins were vacuum packaged and stored chilled at 0°C for 1 week; then three 2.5 cm thick steaks were cut from each striploin and placed on plastic trays overwrapped with oxygen permeable film and displayed in a randomized order at 5°C ± 0.5°C for up to 14 days. Triplicate colour measurements were made on each steak 2 hours after cutting then at 12 hourly intervals using a Minolta Chromameter 200b. Display life was calculated as the time to reach an a* value of 12 for venison and 16 for beef, using linear interpolation between consecutive samples, and analysed separately for venison, fitting age, location and their interaction, and for South Island beef, fitting age. The a* and hue angle values at each time and their changes between times, were analysed by ANOVA, with steak within animal as the block structure, age/sex/location group as the treatment structure, incorporating contrasts expressing the factorial design where appropriate, and pH (mean=5.63) as a covariate. Vitamin E (as described above), selenium (Se), copper (Cu) and iron (Fe) were determined by standard procedures on a subset of samples.

Figure 1: Vitamin E content (μg α-tocopherol/g) of striploin from groups of red deer. M=male, F=female, number indicates farm source.



Results and Discussion:

Experiment 1: There were significant differences in vitamin E content between farms (P<0.001), as well as considerable variation within farms (CV=17.7%), possibly due to mixed ages (figure 1). Only one animal had less than 3 μg α-tocopherol/g muscle tissue (the level generally concluded to be the threshold for improving colour stability by supplementation).

Experiment 2: The venison steaks deteriorated in colour much more rapidly than the beef steaks (figures 2, 3). The North Island bull and steer steaks with normal pH all had display life of at least 10 days, with a* above 16 for all observations for 5 animals out of 8. The South Island steer and heifer beef deteriorated more rapidly than the North Island beef, with a mean display life of 6.3 (standard deviation (sd) 1.9) days. This may be because the South Island beef was sealed in bags with a metal clip (not a complete seal), as opposed to a heat-sealed plastic bag as for the North Island beef. Venison steaks on the other hand turned brown in an average of 1.3 (sd 0.83) days, with no evidence (P>0.05) of difference with age or location. The beef steaks all exhibited a rise in a* value from 2 to 12 h, possibly because they had not fully bloomed at 2 h due to the deoxygenation of vacuum packaging.

Overall there was no significant difference in venison a* between young and old stags (figure 2), while hue angle was higher for young than old stags after 7 days (P>0.01). There was no significant difference between steers and heifers or steers and bulls in

either a* or hue angle. The covariate adjustment for pH made a major contribution for a*, but not for hue angle. High pH meat (pH 5.8 and above) showed a different pattern of colour change from normal pH meat, with darker initial colour, which tended to increase in a* value with time or have a much slower decrease in a* value with time than normal pH meat.

There was also considerable variation in display life in one group, the South Island old stags. They ranged in display life from 0 to 4.5 days. Steaks from these animals, as well as the South Island heifers, were analysed for vitamin E content, Cu, Se and Fe. The vitamin E contents ranged from 3.48-5.75 mg/kg for both the beef and the venison samples and there was no correlation ($P>0.05$) between vitamin E content and display life. Both Fe ($r=-0.91$) and Cu ($r=-0.65$) were highly correlated with display life and showed major ($P<0.001$) differences with species (Fe: 445 µmol/kg for heifers, 898 µmol/kg for old stags, SED 72; Cu: 11.3 µmol/kg for heifers, 19.9 µmol/kg for stags, SED 1.50). The mean Se concentration was 393 nmol/kg for heifers compared to 542 nmol/kg for old stags (SED 64, $P<0.05$). The Fe and Cu contents were similar to those reported by Drew & Seman (1987) but the Se contents were much higher, presumably a reflection of selenium therapy during normal farm management.

Conclusions:

1. Venison has similar vitamin E levels as grass-fed or vitamin E supplemented grain-fed beef but has faster oxidation rates, possibly due to its high copper and iron levels (pro-oxidants).
2. There was no difference in the display life of venison from the North and South Island or between old and young stags, indicating that neither age of animal nor geographical location (and possibly diet or nutrition) had an effect on display life. There was no difference in the display life of beef from steers and heifers or steers and bulls with normal pH, indicating that sex of animal does not affect display life. The one factor that does appear to have the most affect on display life is meat pH.

Literature cited:

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Figure 2: Mean Minolta a* values for venison and beef from the North and South Islands over up to 12 days display at 5° C

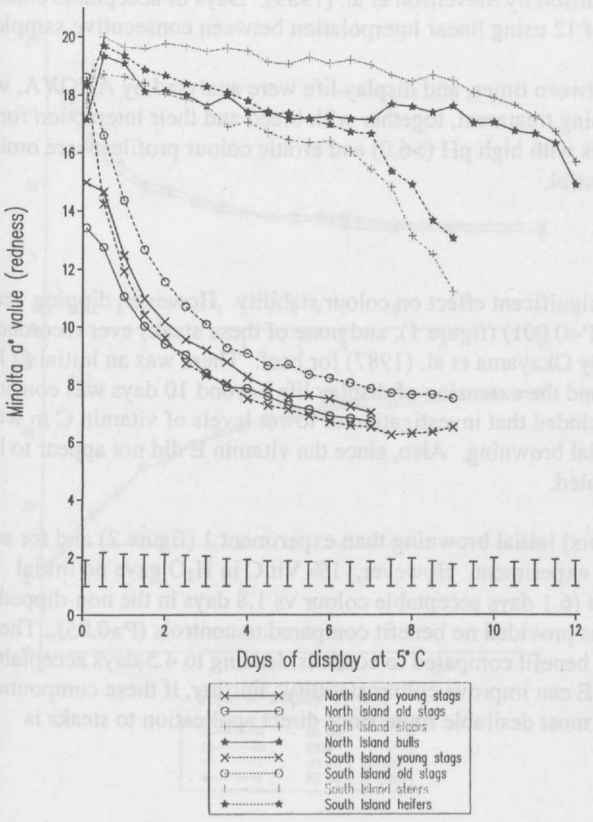

Figure 3: Mean Minolta hue angle for venison and beef from the North and South Islands over up to 12 days display at 5° C