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EFFECT OF EXOGENOUS ANTI-OXIDANT APPLICATION ON VENISON COLOUR

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Background:

Colour is one of the major factors consumers take into consideration when purchasing meat, since consumers equate colour with quality. Venison has a faster discolouration rate than lamb, beef and pork (Trout and Gutzke, 1995). Dietary supplementation with anti-oxidants, particularly vitamin E, have proved successful for improving beef quality (for review, see Liu et al., 1995). However, grass-fed deer have been found to contain similarly high levels of vitamin E to grass-fed beef (Stevenson-Barry et al., 1999) and the objectives of this work were to determine whether additional levels of anti-oxidants would provide any additional benefit.

Materials and Methods:

Experiment 1

Striploins from six young (1-2 years of age) red deer (*Cervus elaphus*) were vacuum packaged at a commercial deer slaughter plant and stored chilled at 0°C for 1 week; then 2.5 cm thick steaks were cut from each striploin. One steak from each animal was dipped for 10 s in each of the following solutions: 1) 70% ethyl alcohol (EtOH); 2) 70% EtOH containing 3% L-ascorbic acid (AsA) (3% Vit C in EtOH); 3) 70% EtOH containing 8% DL-α-tocopherol (8% Vit E in EtOH), while 4) control samples received no dip treatment (No dip). The steaks were then placed on plastic trays overwrapped with oxygen permeable film and stored at 5°C ± 0.5°C for 10 days.

Experiment 2

Striploins from six New Zealand Wapiti/Red hybrid animals (approx. 32% NZ Wapiti; *Cervus elaphus canadensis/nelsonii*) and six Red deer killed in the same week were bought from a commercial deer slaughter plant. All animals were 2-3 years of age. One striploin from each animal was vacuum packaged and stored chilled at 0°C for 1 week; then 2.5 cm thick steaks were cut from each striploin. One steak from each animal was dipped for 10 s in each of the following solutions: 1) distilled water (H_2O Dip); 2) 100 ml distilled water containing 0.01 g L-AsA (0.01% Vit C in H_2O); 3) 100 ml distilled water containing 0.1 g L-AsA (0.1% Vit C in H_2O); 4) 100 ml distilled water containing 1 g L-AsA (1% Vit C in H_2O); 5) 100 ml distilled water containing 10 g L-AsA (10% Vit C in H_2O); 6) 100 ml distilled water containing 1 g trolox (1% Trolox in H_2O; Trolox®; Aldrich Chemical Company, Milwaukee, Wisconsin, USA), while 7) control samples received no dip treatment (No dip). The steaks were then placed on plastic trays overwrapped with oxygen permeable film and stored at 5°C ± 0.5°C for 9 days.

Colour measurements

Triplicate colour measurements were made on each steak 2 hours after treatment, then twice daily for the duration of each experiment, using a Minolta Chromameter 200b as found to be appropriate for venison by Stevenson et al. (1989). Days of acceptable colour (display life) were calculated as the time taken to reach an a* value of 12 using linear interpolation between consecutive samples.

Statistical Methods

For each experiment, a* and hue angle at each time, their changes between times, and display life were analysed by ANOVA, with steak as the experimental unit, animal as the block structure and dipping treatment, together with breed and their interaction for experiment 2, as the treatment structure. In experiment 2 two animals with high pH (>6.0) and erratic colour profiles were omitted from the data as outliers. Significance levels are given relative to control.

Results and Discussion:

Experiment 1

Dipping venison steaks in either EtOH or 8% Vit E in EtOH had no significant effect on colour stability. However, dipping venison steaks in 3% Vit C in EtOH gave relatively constant high a* values ($P<0.001$) (figure 1), and none of these steaks ever recorded a* values of less than 12. These results were similar to those obtained by Okayama et al. (1987) for beef. There was an initial (2 hour) browning effect (drop in a* values) for 3% Vit C in EtOH ($P<0.01$) and the extension of display life beyond 10 days was considered far in excess of what was deemed necessary or desirable. It was concluded that investigation of lower levels of vitamin C in water may provide a moderate extension of colour stability without the initial browning. Also, since the vitamin E did not appear to be miscible with the EtOH, a water soluble analogue should be investigated.

Experiment 2

The 10% Vit C in H_2O treatment produced a more prolonged (31 hours) initial browning than experiment 1 (figure 2) and for some samples for this treatment a* fell below 12 within the duration of the experiment. However, 1% Vit C in H_2O gave no initial browning ($P>0.05$) and an extension of colour stability of over 4 days (6.1 days acceptable colour vs 1.8 days in the non-dipped and water-dipped controls; $P<0.001$). Lower levels of vitamin C solutions provided no benefit compared to controls ($P>0.05$). The 1% trolox (water-soluble analogue of vitamin E) solution provided some benefit compared to controls, leading to 4.5 days acceptable colour ($P<0.001$). It was concluded that both vitamin C and vitamin E can improve colour stability. Further, if these compounds can be incorporated into muscle tissue via feeding then this would be the most desirable route since direct application to steaks is considered adulteration in many countries.

However, the steaks in this experiment ranged in pH and the higher the pH, the lower the initial a* value and higher the initial hue angle. Although the vitamin treatments had similar colour stabilising effects on the high pH muscles, these treatments were not able to improve the colour of high pH venison enough to bring it up to acceptable levels (a* above 12). Meat that has high pH should not be used for retail purposes and production processes should aim to avoid or reduce the incidence of high pH.

Conclusions

1. Dipping venison steaks in a 70% ethyl alcohol + 3% vitamin C solution significantly and dramatically improved venison colour stability. However, there was a slight initial browning effect which may be avoided by lower concentrations of vitamin C. Dipping venison steaks in a 70% ethyl alcohol + 8% vitamin E solution had no effect, possibly because the vitamin E was not miscible with the 70% ethyl alcohol.
2. Dipping venison steaks in a 1% vitamin C solution caused no initial browning and an extension of colour stability from 1.8 days in the non-dipped and water-dipped controls to 6.1 days. Solutions of 0.1% and 0.01% vitamin C provided no benefit compared to controls. The 1% trolox (water-soluble analogue of vitamin E) solution provided some benefit compared to controls, leading to a mean of 4.5 days good colour. It was concluded that there was evidence that both vitamin C and vitamin E could improve colour stability; this would be best achieved by incorporating these compounds into muscle tissue via feeding. However, these treatments were not able to significantly improve the colour of high pH venison enough to bring it up to acceptable levels (a* above 12). Meat which has high pH should not be used for retail purposes and production processes should aim to avoid or reduce the incidence of high pH.

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Figure 1: Mean Minolta (a) a* and (b) hue angle for dipping treatments from Experiment 1 over 10 days display at 5° C

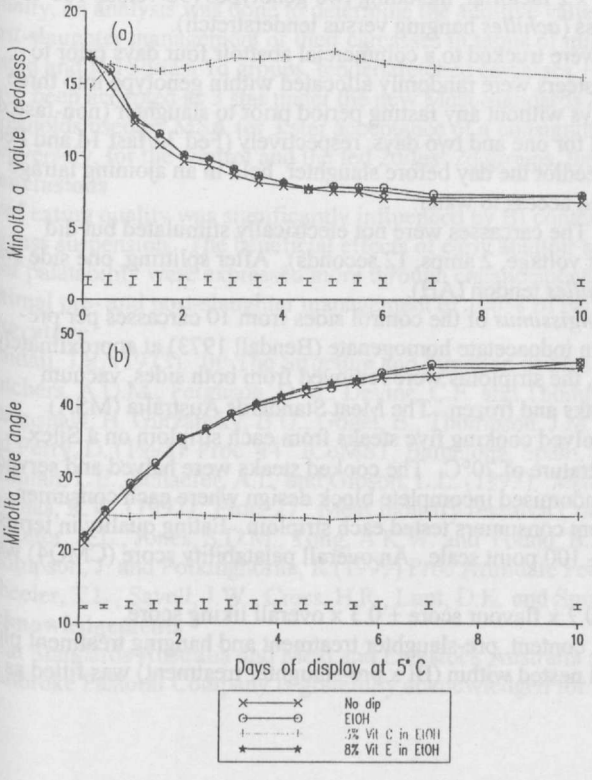

Figure 2: Mean Minolta (a) a* and (b) hue angle for dipping treatments from Experiment 2 over 9 days display at 5° C