EFFECTS OF α-TOCOPHEROL CONCENTRATION ON LIPID PEROXIDATION AND VOLATILES IN RAW VENISON DURING STORAGE

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BACKGROUND

Reduction in the number of rapidly increasing feral Japanese Shika deer (*Cervus nippon centralis*) is becoming necessary as it has been shown that they are damaging to farm crops in some areas of the countryside. Many feral deer are slaughtered every year, and used as venison, which is for its high protein and low fat content, but there are few studies on venison quality and deteriorative changes during storage.

OBJECTIVES

We have shown that optimal ageing of venison takes seven days when stored at 3 ℃. However, the ageing is accompanied by off-flavours that develop in aerobically packaged venison at the end of this ageing period, and the off-flavour appears to be produced by the lipid peroxidation. One of the suggested practical methods for reducing this off-flavour is the feeding of anti-oxidant such as vitamin E before slaughter. The objectives of the present study are to clarify the effects of dietary α-tocopheryl acetate (α-toc. acetate) supplementation on the development of lipid peroxidation and production of volatiles in raw venison during storage, and to determine the effective α-tocopherol (α-toc.) concentration in muscle.

METHODS

Animals and treatments

Fourteen Japanese shika deer were fed alfalfa meal and beet pulp as basal diets, which were also supplemented with different amounts of α-toc. acetate ranging from 0 to 3.0g of dl-α-toc. acetate per animal daily for 21 to 37 days prior to slaughter. The shika deer were stunned and slaughtered, and *M.longissimus thoracium et lumborum* (LD) was excised from each carcass. These muscles were placed in a chiller at 2 ℃, and 24 hours later, they were divided into three portions for analyses of α-toc. concentration, lipid peroxidation state and headspace volatiles.

Analytical procedures

The concentration of α-toc. at one day after slaughter was determined by HPLC (Ueda & Igarashi, 1987). Studies on lipid peroxidation were made on 10 mm thickness samples stored aerobically for 1, 3, 5, 7, 9, 11 days in the dark at 2 ℃. Lipid peroxidation in each sample was assessed as thiobarbituric acid reacting substance (TBARS) numbers and expressed as mg TBARS / kg tissue (Kosugi *et al.*, 1992). Headspace volatiles were obtained from two 1 cm cubes placed in 25ml glass bottle that were sealed by teflon inner and aluminium outer caps, and these bottles were stored under the same conditions as for lipid peroxidation test. The volatiles in headspace were trapped with Tenax-GC, and measured using GC or GC-MS (Yano *et al.*, 1995).

RESULTS AND DISCUSSIONS

A range of α-toc. concentrations (4.2 - 15.9 mg / kg tissue) was produced in the LD-muscle from the various supplementing treatments. The effects of α-toc. concentration on TBARS numbers at day 1 and day 11 are shown in Figure 1-(a) and 1-(b), respectively. Irrespective of α-toc. concentration, the TBARS numbers at day 1 were ranged from 0.1 to 6.0 mg / kg tissue. At day 11, there was a tendency for a decrease of TBARS numbers with increasing of α-toc. concentrations, and the relationship was represented by the equation of $y=5.64+262\exp(-0.72x)$, $R^2=0.82$. From this result, ca. 9 mg α-toc./ kg tissue would appear to be a minimum concentration for the effective control of lipid peroxidation in venison.

Figure 2-(a) and 2-(b) show typical GC-profiles of headspace volatiles of venison with high (9.2 mg / kg tissue) and low (4.2 mg / kg tissue) α-toc. concentration, respectively. On the whole, both peak height and number were apparently lower in figure 2-(a) than in figure 2-(b). Nine peaks in the chromatogram were identified by comparing retention time with the mass spectra analyses, and five of them, acetone, hexanal, 1-penten-3-ol, 1-pentanol and 1-hexanol, were obviously lower in figure 2-(a).

Figure 3-(a) and 3-(b) show the effects of α-toc. on hexanal evolution, which has been suggested as the primary marker in warmed over flavour development. The equation of $y=190556\exp(-0.33x)$, $R^2=0.73$ obtained from the relation in figure 3-(b), shows that ca.9 mg α-toc./ kg tissue was required for depressing the hexanal evolution.

This α-toc. level required for venison was much higher than the level required for beef reported by Mitsumoto *et al.*(1991). It is widely known that lipid peroxidation starts in phospholipid containing unsaturated fatty acids (Morrissey *et al.*, 1994). High concentration of phospholipid has been reported in venison compared with beef (Williams *et al.*, 1983), and the concentration of long chain polyunsaturated fatty acids in phospholipid fraction has been reported to be much higher in venison. Further, venison has a higher content of myoglobin than beef, in which ferric hem ion acts as a catalyst of lipid peroxidation. These facts would be the main reasons for requirement of higher concentrations of α-toc. in venison than in beef.

CONCLUSIONS

The addition of α-toc. acetate to the diet of Japanese shika deer made it possible to control the TBARS numbers during storage, reducing the production of hexanal. For effective control of lipid peroxidation and development of volatiles, a minimum of ca. 9 mg α-toc./ kg tissue was required, but the exact relationship between feeding level and α-toc. concentration in muscle is not known.

PERTINENT LITERATURE

Kosugi,H., Kojima,T., Yamaki,S. & Kikugawa,K. Anal. Biochem., **202**; 249-255. 1992.

Mitsumoto,M., Cassens,R.G., Schaefer,D.M., Arnold,RN. & Scheller,K.K. J. Food Sci., **56**; 1489-1492. 1991.

Morrissey,P.A., Buckley,D.J. & Sheehy,P.J.A. Proc. Nutr. Soc., **53**; 289-295. 1994.

Ueda,T & Igarashi,O. J.Micronutr. Anal., **3**; 185-198. 1987.

Williams J.C., Field R.A., Miller G.J. & Welke R.A. J. Food Sci., **48**; 1776-1782. 1983.

Yano,Y., Maeda,T. & Hirata,T. Anim. Sci. Technol. (Jpn)., **66**; 684-692. 1995.

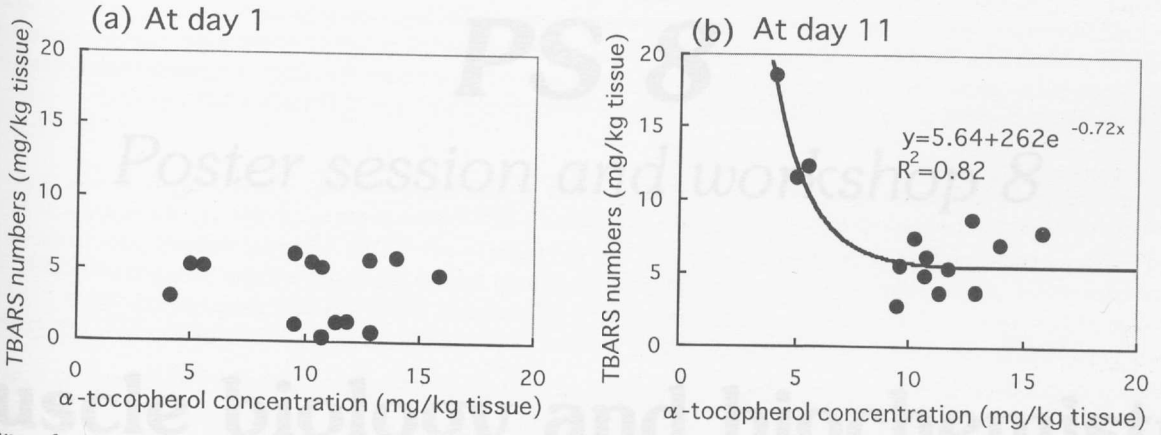

Figure 1 Effects of α-tocopherol concentration on TBARS number of raw venison

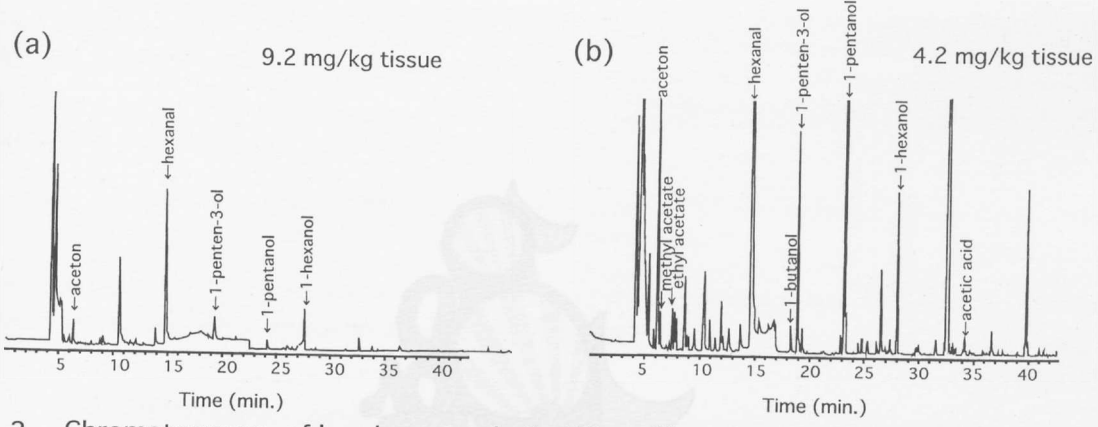

Figure 2 Chromatograms of headspace volatile GC-prpfiles of raw venison at day 9 with (a); high and (b); low concentration of α-tocopherol

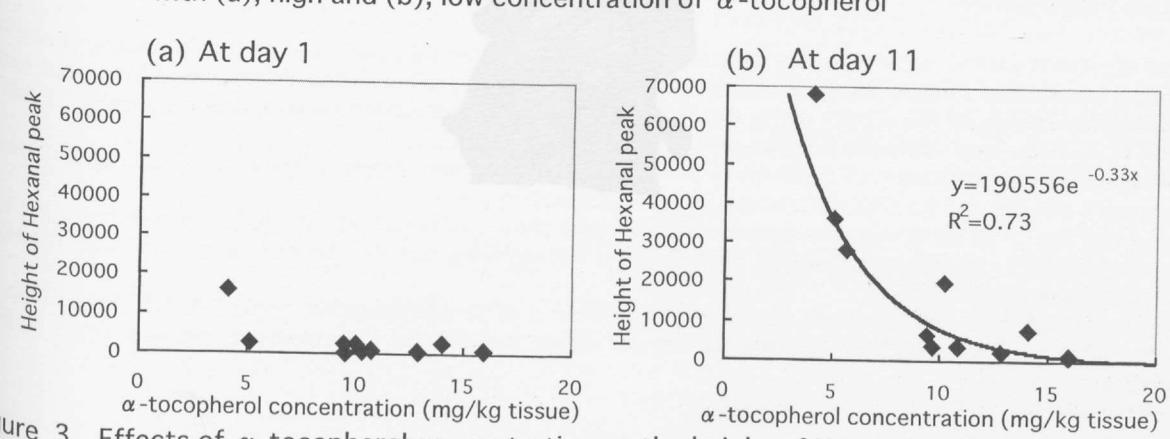

Figure 3 Effects of α-tocopherol concentration on the height of Hexanal peak of raw venison

NOTES