DIETARY SUPPLEMENTATION AND ADDITION OF TEA CATHECHINS: ASSESSMENT OF THE EFFECTS OF CATECHIN LEVEL AND PH ON ANTIOXIDANT ACTIVITY IN FRESH BEEF

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Introduction

Colour and lipid oxidation are important factors influencing the quality of fresh beef. The muscle pigment myoglobin is responsible for the colour of fresh beef. The principal catechins found in green tea (*Camellia sinensis*) are (-)-epicatechin (-EC), (-)-epigallocatechin (-EGC), (-)-epicatechin gallate (-ECG), and (-)-epigallocatechin gallate (-EGCG). Addition of tea catechins (TC) to poultry diets (up to 300 mg/kg feed for 42 days pre-slaughter) significantly reduced lipid oxidation in poultry meat (Tang et al., 2001). In contrast, supplementation of beef cattle diets with TC (1000 mg TC/animal/day for 100 days pre-slaughter) did not significantly improve beef quality in terms of colour and lipid stability (O'Grady *et al.*, 2006). It was concluded that the lack of an effect of dietary TC may be attributed to the level of TC included in the diet, pH sensitivity of TC isomers (Zhu *et al.*, 1997) to alkaline conditions present in the bovine rumen and intestine, or simply to excretion of TC in the urine. The aim of this study was to assess the effect of increasing levels of TC (1000, 4000 and 10,000 mg TC/animal/day) on fresh beef quality. The pH sensitivity of the TC supplement, employed in the dietary trial, was also assessed in minced beef.

Materials and Methods

Twenty eight continental cross bred heifers were randomly assigned to one of four diets for 90 days pre-slaughter. The control group were offered a diet consisting of a barley-based concentrate and the three remaining groups were fed the control diet plus incremental amounts of TC, 1000 (+ TC 1000), 4000 (+ TC 4000) and 10,000 (+TC 10,000mg/animal/day). The TC supplement (81.43%) extracted from green tea (*Camellia sinensis* L. variety *assamica*) was supplied by Kinglong Natural Plant Products Industry Ltd., China. *M. longissimus dorsi* (LD) samples were vacuum packaged and stored at 0°C (~ 1 week) prior to analysis. Muscle TC levels and composition of the dietary TC supplement were determined by HPLC following the extraction procedure of Tsuchiya *et al.* (1998), with modifications. The TC supplement contained 10.29% -EGC, 8.23% -EC, 44.15% -EGCG and 17.65% -ECG. LD samples were cut into steaks (~ 25mm thickness), placed in retail display trays and flushed with 80% O_2 : 20% CO_2 for storage in modified atmosphere packs (MAP) for up to 8 days at 4°C under simulated retail display conditions (616 lux fluorescent lighting).

Portions of LD samples from animals fed the control diet were pooled and minced through a plate with 4 mm holes. Following mincing, pH adjusted TC (5.5 – 8.0) dissolved in 60 mM sodium phosphate buffers (Na_2HPO_4) (pH 5.5, 6.0, 6.5, 7.0, 7.5 and 8.0) were added to minced LD samples (10 mg TC/kg beef) which were subsequently formed into meat patties. Meat patties were stored in MAP (80% O_2 : 20% CO_2) for up to 10 days at 4°C (616 lux). Colour measurements were made at 2 day intervals using a Cr-300 Chromameter (Minolta Co. Ltd., Japan) and reported as CIE 'a' redness values. Lipid oxidation was measured at 2 day intervals by the distillation method of Tarladgis et al. (1960), as modified by Ke *et al.* (1977), and results were expressed as 2-thiobarbituric acid reactive substances (TBARS) in mg malondialdehyde (MDA)/kg muscle. Data was analysed by repeated measures ANOVA using the SPSS 11.0 for Windows software package.

Results and Discussion

Dietary supplementation with increasing concentrations of TC (1000, 4000 and 10,000 mg TC/animal/day) did not significantly improve the colour or lipid stability of LD steaks, relative to controls (Table 1). Similarly, TC isomers were not detected in LD samples (chromatograms not shown). Zhu et al. (1997) reported that stability of TC was pH dependent with -EGC and -EGCG demonstrating least stability in alkaline conditions. Both -EGC and -EGCG represent >50% of the total TC concentration of the dietary supplement used in the present study. Therefore lack of a dietary effect of TC on fresh beef quality may have been due to degradation of TC in the alkaline conditions of the bovine rumen and intestine. In meat patties containing pH adjusted TC, surface colour was unaffected by TC pH (Figure 1A). An upward trend in lipid oxidation was observed from day 4 to day 10 at pH 7.0 and higher (Figure 1B) which indicated lower antioxidant activity of TC above pH 7.0.

Conclusions

Supplementation of beef cattle diets with TC at levels up to 10,000 mg/animal/day did not affect beef quality. This may be attributed to pH sensitivity of certain TC isomers to alkaline pH conditions.

Table 1: Effect of dietary TC (0, 1000, 4000 and 10,000 mg TC/animal/day) on surface redness ('a' value) and lipid oxidation (TBARS) in *M. longissimus dorsi* (LD) steaks stored in modified atmosphere packs (MAP) (80% O_2 : 20% CO_2).

Treatment	Storage time at 4°C, d									
	Surface redness, 'a' value					TBARS, mg MDA/kg muscle				
	0	2	4	6	8	0	2	4	6	8
Control	20.86[a]	18.03	17.17	15.31	12.68	0.07[a]	0.43	0.43	1.26	1.80
+ TC 1000	21.41	18.08	16.82	13.77	12.26	0.07	0.43	0.74	1.10	2.16
+ TC 4000	21.59	18.23	16.16	15.56	11.60	0.07	0.33	0.52	1.17	2.07
+ TC 10,000	21.67	18.07	15.96	14.44	12.09	0.07	0.35	0.65	1.35	2.14

[a]Within each day, no significant effects were observed for dietary treatment, $P > 0.05$.

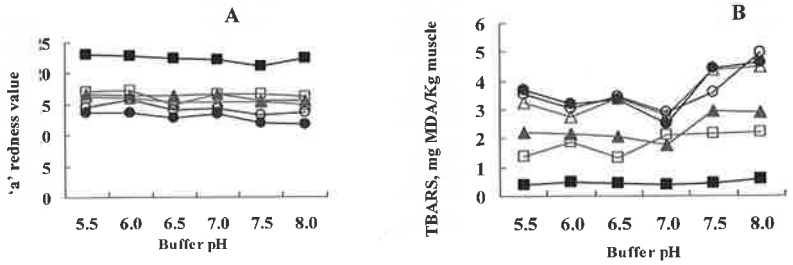

Figure 1: Effect of pH adjusted TC (5.5 – 8.0) (10 mg TC/kg beef) on surface redness ('a' value) (A) and lipid oxidation (TBARS) (B) in minced meat patties stored in MAP (80% O_2 : 20% CO_2) for 10 days at 4°C.
■, day 0; □, day 2; ▲, day 4; △, day 6; ○, day 8; ●, day 10.

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