EFFECT OF DIETARY SUPPLEMENTATION AND DIRECT ADDITION OF TEA CATECHINS AND ROSEMARY ON THE OXIDATIVE STABILITY OF BEEF.

Maher M.[1], O'Grady MN.[1], Buckley DJ.[1], Troy D.[2], Moloney AP.[3] and Kerry JP.[1]
[1]Department of Food Science, Food Technology and Nutrition, University College Cork, Ireland.
[2]Teagasc, National Food Centre, Dunsinea, Castleknock, Dublin 15, Ireland.
[3]Teagasc, Grange Research Centre, Grange, Dunsany, Co. Meath, Ireland.

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Background

The three important sensory characteristics by which consumers judge meat are appearance, texture and flavour. Appearance, specifically colour is an important quality attribute influencing the consumer's decision to purchase. Over the past number of years much research has focused on feeding beef cattle the lipid soluble antioxidant vitamin E (α-tocopherol) as a means of extending the oxidative stability of fresh beef (Faustman et al., 1989). Also, direct addition of vitamin E to beef patties has been shown to improve oxidative stability (Mitsumoto et al., 1991). Oxidative stability encompasses both colour and lipid stability and the processes of colour and lipid oxidation in beef are believed to be linked (O'Grady et al., 2001). More recently, research has shown that direct addition of tea catechin antioxidants to cooked beef and chicken significantly reduced levels of lipid oxidation (Tang et al., 2001a). Dietary supplementation of poultry diets with tea catechins also reduced lipid oxidation (Tang et al., 2001b). Rosemary contains a number of antioxidant compounds and has been shown to reduce lipid oxidation when added to pork (McCarthy et al., 2001). The possibility of dietary supplementation of beef animal diets with tea catechins and rosemary as a means of improving overall beef quality merits investigation.

Objectives

The objective of the present study was to investigate the effects of tea catechins and rosemary supplementation of beef animal diets on the oxidative stability of beef. The effect of direct addition to beef of tea catechins and rosemary on oxidative stability was also investigated.

Methods

Thirty bull animals (~16 months old) were randomly divided into 3 groups and assigned to one of three diets for 100 days prior to slaughter as follows: a control diet consisting of a barley-based concentrate (control group); the control diet containing green tea catechins (~86% purity, Kinglong Natural Plant products Industry Ltd, China) supplying 1000 mg tea catechins/animal/day (catechin group); the control diet containing rosemary extract (~30% total diterpenes, Guinness Chemical (Ireland) Ltd) supplying 1000 mg rosemary/animal/day. Following slaughter *M. longissimus dorsi* (LD) samples were vacuum packaged and stored at –20°C prior to analysis.
LD samples were thawed, cut into steaks (25.4 mm thickness) and placed in retail display trays. Portions of LD taken from each animal in the control group were also pooled and minced through a plate with 4 mm holes. Following mincing, the tea catechins and rosemary extract used to supplement the animal diets were added at a level of 1000 mg/kg muscle and subsequently the minced beef was formed into beef patties. Trays containing either beef steaks or beef patties were over-wrapped with oxygen permeable film for aerobic storage or flushed with 80% O_2 : 20% CO_2 for storage under modified atmosphere conditions. All samples were stored for up to 8 days at 4°C under simulated retail display conditions (616 lux fluorescent lighting).
Colour measurements were made at 2 day intervals using a Cr-300 Chromameter (Minolta Co. Ltd., Japan) set on the CIE colour scale and reported as the 'a' redness value.
Lipid oxidation was measured 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/kg muscle.
All analysis was performed in duplicate. Data was analysed by ANOVA using the SPSS statistical package (*version 10.0*) and differences among treatment means were calculated using the least significance difference (LSD) test at the 5% level.

Results and Discussion

Direct addition of tea catechins and rosemary extract resulted in greater colour and lipid stability, relative to controls, in LD patties stored aerobically (Figure 1A) and under modified atmosphere conditions (Figure 1B). Under both storage conditions lipid oxidation was minimal in the presence of tea catechins and rosemary whereas colour stability, as indicated by the 'a' redness value, followed the trend: catechin > rosemary > untreated LD. Antioxidant effects due to direct addition of tea catechins and rosemary have previously been reported in a variety of muscle foods (McCarthy et al., 2001; Tang et al., 2001a). Dietary supplementation with tea catechins and rosemary did not significantly improve the colour stability of LD steaks, relative to controls, stored aerobically for up to 6 days (Table 1). Similarly, no significant improvement in lipid stability was observed (Table 2). After 4 days of aerobic storage lipid oxidation followed the order catechin < rosemary < control however the results were not significant ($P > 0.05$). Dietary supplementation with tea catechins resulted in significantly ($P < 0.05$) greater colour stability, relative to controls, in LD steaks stored for 4 and up to 6 days under modified atmosphere conditions (Table 1). However, the magnitude of response to supplementation was not as great as has been previously reported for antioxidants such as vitamin E (Faustman et al., 1989). No significant differences in lipid oxidation in LD stored under modified atmosphere conditions was observed at any of the storage times (Table 2). Overall, no major antioxidant effects as a result of dietary supplementation were observed. Since effective dietary supplementation of tea catechins has been demonstrated in monogastrics (Tang et al., 2001b) it is possible that the rumen biotransforms tea catechins and indeed rosemary into unavailable forms. Further studies are underway to investigate this hypothesis.

Conclusion

Direct addition of tea catechins (1000 mg/kg muscle) and rosemary (1000 mg/kg muscle) to minced LD greatly improved colour and lipid stability relative to untreated LD. Dietary supplementation of beef animal diets with tea catechins (1000 mg/animal/day) and rosemary (1000 mg/animal/day) resulted in no overall improvement in the oxidative stability of beef at the levels of inclusion used in the present study. Further research is needed to ascertain whether feeding tea catechins and rosemary at higher levels or perhaps in different forms has potential for enhancing the quality of fresh beef.

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Table 1. Effect of dietary supplementation with tea catechins and rosemary on the surface redness ('a' value ± standard deviation) of beef stored aerobically and in modified atmosphere packs (80% O_2 : 20% CO_2) at 4°C.

Group	Packaging group	Storage time, days				
		0	2	4	6	8
Control	Aerobic	20.51 ± 2.04[ab]	14.81 ± 1.18[a]	11.69 ± 1.65[a]	11.26 ± 2.05[a]	-
Catechin		19.87 ± 2.29[a]	15.76 ± 1.30[a]	12.82 ± 2.32[a]	10.20 ± 2.71[a]	-
Rosemary		21.93 ± 1.54[b]	15.65 ± 1.54[a]	12.02 ± 2.91[a]	10.61 ± 2.31[a]	-
Control	MAP	20.48 ± 1.69[a]	18.09 ± 1.43[a]	16.88 ± 1.98[a]	11.32 ± 2.91[a]	8.22 ± 1.95[a]
Catechin		20.10 ± 1.67[a]	19.30 ± 1.37[a]	18.82 ± 2.13[b]	14.94 ± 3.63[b]	8.70 ± 3.12[a]
Rosemary		21.27 ± 1.44[a]	18.98 ± 1.69[a]	18.33 ± 1.54[ab]	13.66 ± 3.51[ab]	7.71 ± 2.92[a]

[ab]Mean values in the same column with a packaging group bearing different superscripts are significantly different, $P < 0.05$.

Table 2. Effect of dietary supplementation with tea catechins and rosemary on lipid oxidation (TBARS ± standard deviation) in beef stored aerobically and in modified atmosphere packs (80% O_2 : 20% CO_2) at 4°C.

Group	Packaging group	Storage time, days				
		0	2	4	6	8
Control	Aerobic	0.086 ± 0.031[a]	0.769 ± 0.417	2.078 ± 0.690	2.203 ± 0.488	-
Catechin		0.102 ± 0.047	0.555 ± 0.268	1.478 ± 0.667	2.336 ± 0.926	-
Rosemary		0.098 ± 0.043	0.722 ± 0.154	1.670 ± 0.548	2.275 ± 0.691	-
Control	MAP	0.100 ± 0.056[a]	0.906 ± 0.414	2.561 ± 0.908	3.993 ± 1.466	5.731 ± 1.627
Catechin		0.096 ± 0.032	0.701 ± 0.382	2.100 ± 0.966	3.888 ± 2.404	5.783 ± 1.619
Rosemary		0.103 ± 0.034	0.856 ± 0.325	2.421 ± 0.898	4.430 ± 1.164	4.961 ± 0.811

[a]No significance, $P > 0.05$.

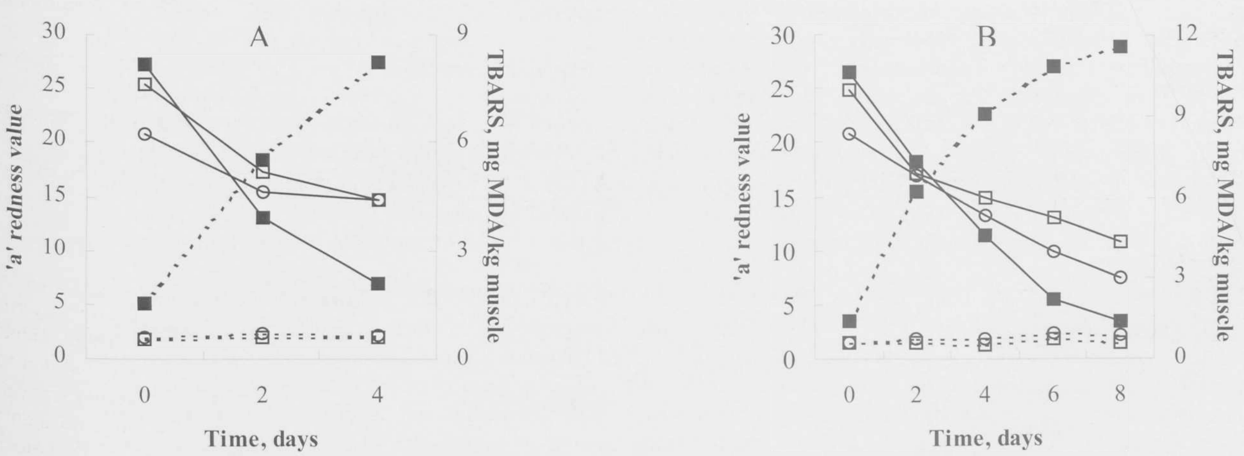

Figure 1. Surface redness 'a' values (full lines) and lipid oxidation (dashed lines) in minced beef patties stored under aerobic (A) or modified atmosphere (B) 80% O_2 : 20% CO_2 conditions at 4°C. (■), untreated LD; (□) LD + 1000 mg tea catechin/kg muscle; (○) LD + 1000 mg rosemary extract/kg muscle.

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