A COMBINED EFFECT OF SHORT TIME DIETARY VITAMIN E SUPPLEMENTATION AND VITAMIN C ADDITION TO MINCED MEAT ON COLOUR AND LIPIDS STABILITY OF BEEF BURGERS

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Background

Meat appearance as well as freshness perception strongly affect product shelf life and consumers choice. Colour stability in minced meat preparations and fresh beef burgers is weak and represents a main reason of product withdrawal. The mechanical disruption of muscle tissue during processing and the presence of free metal ions, associated with other factors (such as bacterial spoilage, light intensity, oxygen pressure and storage temperature), can induce a fast pigment and lipid oxidation with product discoloration and, sometimes, "warmed" off flavours formation during cooking (Bailey, 1988). Increasing antioxidants content of tissues by dietary supplementation with high levels of vitamin E has shown benefits on colour an lipid stability (Arnold et al.,1993). Vitamin C is also well known for its antioxidant effects *in vivo* (Parker and Kagan, 1993) but it has given contradictory answers when used on meat products (Mitsumoto et al., 1991; Wheeler et al., 1996).

Objectives

The aim of this study was to evaluate, on colour and lipid stability of fresh beef burgers, the single and combined effects of dietary vit. E supplementation and addition of vit. C to minced meat during processing. Since a large proportion of beef burgers, a low price meat preparation, are normally sold as frozen products with a long shelf life, the vitamins protective effects on lipids oxidation were evaluated after 5 months of storage.

Methods

Meat of thorax-ribs muscles was obtained from 18 Charolais young bulls (about 20 months old) carcasses (average weight 427 ±23 kg): 6 of them (E1) had received, for the last 10 days before slaughtering, a diet supplemented with 5,000 IU/head/d of vitamin E (*all rac.* α-tocopheryl acetate, Rovimix 50, Istituto delle Vitamine-Roche, Milan, I), 6 a diet with 10,000 IU/head/d (E2), and 6 (control-C) no extra supplementation (about 250 IU/head/d of α-tocopherol, estimated daily intake). The content of α-tocopherol of the three vitamin E treatments was determined in minced meat (Hoffmann-La Roche, Basel, CH). Meat, including intermuscular fat, from the 3 vitamin E treatments was minced separately with a cutter (8 mm ∅) and, according to a factorial design, assigned to the 3 vitamin C treatments: control-C (no vitamin C addition), C1 and C2 added respectively with 0.5% and 1%, with vitamin C (L-ascorbic acid, sodium salt, Istituto delle Vitamine-Roche, Milan, I). A total of 9 combinations of treatments (Table 1) were obtained. Twelve burgers from each combination were placed in 6 trays, over-wrapped with a high oxygen permeable PVC plastic film and continuously displayed in a cool cabinet (6 °C, fluorescent light-1800 lux, 24 h/d). At 3 h (day 0), 1, 2 and 3 d of display colour CIE Lab (Colorimeter CR 100, Minolta Co., Osaka, J) and freshness index (scored to the nearest 0.5 on a scale ranging from 1= unacceptable-completely discoloured, to 6= attractive fresh meat colour) was assessed by 10 trained panellists. In addition 6 burgers from each combinations were individually placed in a plastic bag inside a carton box, then frozen and stored at -25 °C for 5 months. Lipids oxidation after 1 and 3 days displaying and 5 months conservation was determined as TBARs -2 thiobarbituric acid reactive substances-, and expressed as ng of MDA-malondialdeyde/g of meat (Draper et al., 1993). All data were analysed using a GLM procedure of the SAS statistical package (SAS, 1998).

Table 1. Different combinations of vit. E x vit. C in the 9 experimental treatments.

dietary vit. E and α-tocopherol content (mg/kg)	*processing addition of vit. C (sodium ascorbate)*		
	Control-no addition = C	0.5% of meat weight = C1	1% of meat weight = C2
Control-no supplementation= C (2.9 ±0.09)	1 CC	4 CC1	7 CC2
5,000 UI/head/d x 10 d = E1 (4.1 ±0.15)	2 E1C	5 E1C1	8 E1C2
10,000 UI/head/d x 10 d = E2 (3.9 ±0.18)	3 E2C	6 E2C1	9 E2C2

Results and discussion

Ground meat of all the 3 main preparations (C-E1-E2) was leaner (about 8% fat) than that of normal beef burgers from commercial plants. Dietary vit. E supplementation increased significantly the content of α-tocopherol as compared to the control (C-2.9[a]; E1 4.1[b]; E2 3.9[b], $P < 0.05$); no differences were found between the two supplementation levels (E1 vs E2).

The average values of the 4 assessments for panel freshness index are shown in Fig. 1. Control (CC) burgers –no vit. E supplementation or vit. C addition- had the lowest freshness values ($P < 0.05$). Vit. E dietary supplementation significantly ($P < 0.05$) improved the freshness index as compared to all the other combinations, but the two supplementation levels –E1C *vs* E2C- did not differentiate. Both the levels of vit. C addition improved the freshness index as compared to the control, however the lower level (0.5%) achieved better values. When vit. C was added to vit. E supplemented meat (C1E1, C2E1, C1E2 and C2E2) the freshness index resulted lower than with vit E treatments only. These findings are also confirmed by the objective colour measurements of redness - a*- showed in Fig. 2. If the effects of vit. E and vit. C on maintaining a longer colour stability during the 3 days displaying are compared, it can be seen that vit E supplemented burgers (E1C) showed significantly higher ($P < 0.05$) a* values than the control (CC) and vit. C samples (C1C and C2C). In addition, the combination of the two vitamins (E1C1) did not seem to offer any benefit. A significant pro-oxidant effect of vit. C addition was found in comparison with the control (CC) samples, more evident for the higher level (C2C, 1%) after 2 days displaying, with a clear reduction of surface redness (Fig. 2). In other studies, (Mitsumoto et al., 1991; Schaefer et al., 1995; Wheeler et al., 1996) vit. C (pre-post slaughter infusion, injection or addition to meat) anti-oxidant effects, such as a longer colour stability with lower metmyoglobin formation, have been reported. However, Okayama et al., (1987) described a higher metmyoglobin formation on steaks surface after a dip treatment in a 3% vit. C solution. The pro-oxidant effect of vit. C found in this experiment might be due to the fairly high levels of addition and commercial displaying conditions (light intensity and temperature).

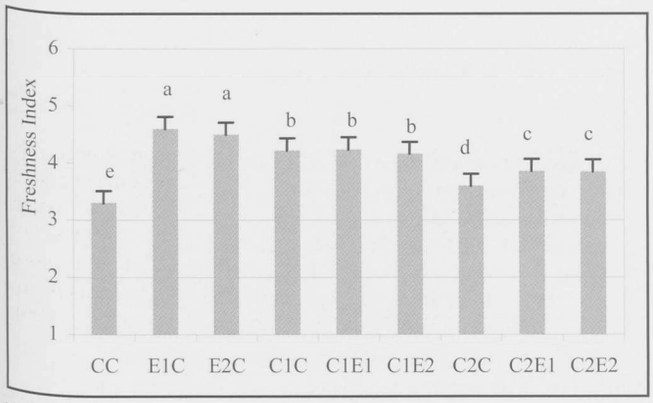

Fig. 1. Least-square means and S.E. bars for freshness index of all 9 thesis; a, b, ... means with no common letters differ significantly (P <0.05). See table 1 for treatment codes

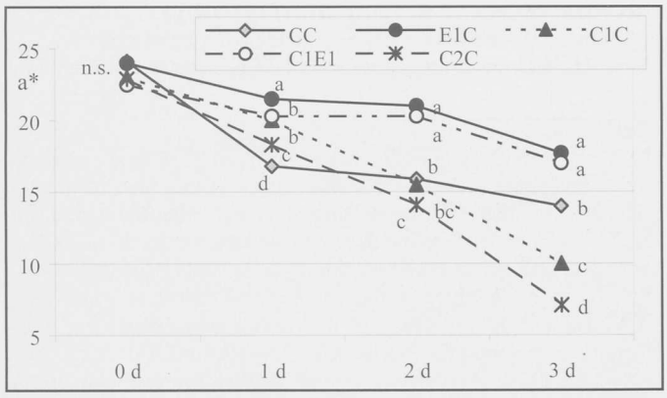

Fig. 2. Least square means of colour surface –redness, a*- of beef burgers from 5 selected treatments; a, b, ... means with no common letters differ significantly (P <0.05) within the same displaying time. See table 1 for treatment codes.

The effects of vitamin treatments on protecting lipids from oxidation -TBARs values- during displaying or frozen conservation are shown in Fig. 3 and 4. Both the vitamins showed a significant (P <0.05) positive effect on reducing TBARs values in comparison to the control (Fig. 3). The combination of the two vitamins did not improve lipid stability (Fig. 3), as compared to the single treatment, suggesting that the positive reactions between the α-tocopheroxyl radical and ascorbic acid in regenerating α-tocopherol, which are reported by Parker and Kagan (1993), specifically predominate *in vivo*. Indeed, in the meat system the ascorbic acid sequestration activity of free metal ions, such as iron and copper, seems to promote lipid oxidation (Morrissey et al., 1998). However, despite the possible free or catalytic iron increase after processing and during storage, in our study vit. C addition protected lipids from oxidation significantly (P <0.05) more during the frozen conservation than under displaying conditions of fresh burgers (Fig. 4).

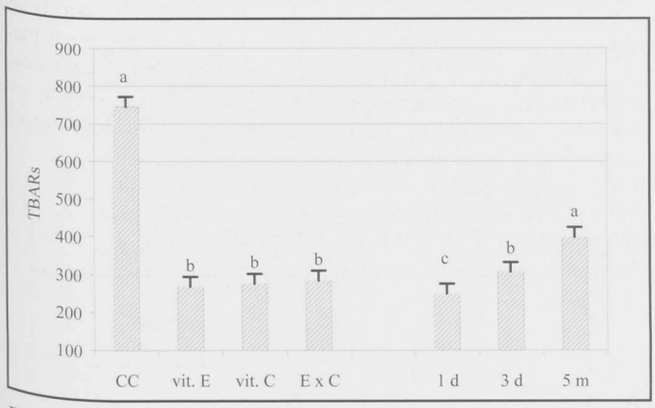

Fig. 3. Least square means and S.E. bars for TBARs of the main effects and interaction in the ANOVA model.

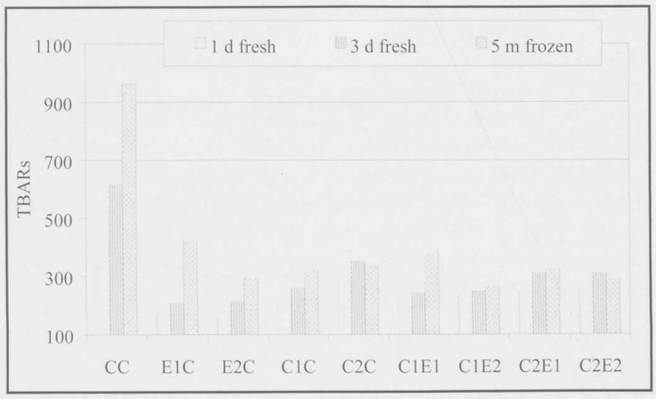

Fig. 4. Mean values of TBARs during fresh burgers display and after frozen conservation of all 9 tratments. See table 1 for treatment codes.

Conclusions

Short time high levels of dietary vit. E supplementation in finishing young bulls are effective in improving colour and lipid stability of beef burgers during short time display as well as during long time frozen conservation. Vit. C addition to ground meat showed contrasting results as it had a pigment pro-oxidant effect in fresh displayed burgers, but protected lipids from oxidation, especially during frozen conservation. Vit. C optimal levels might be different for long storage frozen product as compared to fresh preparations. More studies are needed to find out the interactions between the two vitamins in the meat system.

Pertinent literature

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