# THE EFFECTS OF NATURAL ANTIOXIDANTS ON THE QUALITY CHARACTERISTICS OF BEEF PATTIES PACKAGED IN MODIFIED ATMOSPHERE

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**BACKGROUND AND OBJECTIVE.** The colour of fresh meat is the most important quality attribute influencing the consumer's decision to purchase (Faustman and Cassens, 1990). Oxymyoglobin, the oxigenated form of the muscle pigment myoglobin, is primarily responsible for the desirable colour of freshly cut red meats. With prolonged storage oxymyoglobin oxidises to metmyoglobin and gives meat an unattractive brown colour. A common approach to extending the colour shelf-life of fresh red meats is the use of modified atmosphere packaging (MAP) (Okayama, 1987). The atmospheres used combine oxygen ($O_2$), carbon dioxide ($CO_2$) and eventually nitrogen ($N_2$) to maintain the quality of fresh red meat, both from a microbiological and an organoleptic point of view. The incorporation of antioxidants protects lipids from oxidation and may indirectly stabilise oxymyoglobin from oxidation (O'Grady *et al.*, 1996). Various antioxidants (natural and synthetic ones) can be used. Also concern about safety and renewed interest in natural products resulted in increased research on natural antioxidants. Natural antioxidants can be added directly to the meat or the meat products during processing (Mielche and Bertelsen, 1994). The aim of the present research was to investigate the effect of various natural antioxidants (rosemary, ascorbic acid, taurine, carnosine, oregano and lycopen-rich tomato pulp (LRTP) on the extension of quality characteristics of fresh beef patties packaged in modified atmosphere.

## MATERIALS AND METHODS

**Samples and atmospheres**. *Semimembranosus* samples were obtained from 3 beef carcasses 48 hr *post mortem*, and ground using a conventional mincer through a plate witn 4 mm holes. Portions of uniform weigh of the minced muscle (about 85 g) were formed, placed on styrofoam trays in gas impermeable bags (polyethilene and poliamide), and sealed after flushing with the gas mixture. Gas mixtures consisted of 70% $O_2$ + 20% $CO_2$ + 10% $N_2$. Eight different formulations, incluing 1) 1000 ppm rosemary powder, 2) 500 ppm ascorbic acid, 3) 50 mM carnosine, 4) 50 mM taurine, 5) 1000 ppm rosemary powder + 500 ppm ascorbic acid, 6) 200 ppm oregano powder, 7) 1.5% LRTP and 8) control (no antioxidant), were prepared. All of the antioxidants were mixed with salt and then added to the mixtures. The patties were stored for 20 days at $2 \pm 1$°C in the dark. The entire experiment was replicated twice and all of the evaluations were done on the 0, 4, 8, 12, 16 and 20 days of the display period. **Colour measurement**. Objective measurement of colour (CIE L*, a*, b*) was performed at the surface of meat samples using a reflectance spectrophotometer (Minolta CM 2002, Japan). **Metmyoglobin**. Metmyoglobin percentage was estimated spectrophotometrically by measuring the reflectance at 525 and 572 nm according to Stewart *et al.* (1965). The maximum value of the quotient between $K/S_{572}$ and $K/S_{525}$ at the beginning of the experiment was fixed as 0% MetMb, while 100% MetMb was obtained after oxidising a sample in a 1% (w/v) solution of potassium ferricyanide (Ledward, 1970). **Lipid oxidation.** Lipid oxidation was measured by the 2-thiobarbituric acid method of Witte *et al.* (1970). TBA values were expressed as mg TBARS/kg sample. **Sensory analysis.** Samples of beef patties were evaluated by a six-member trained panel. The attribute Fresh Meat Odour was evaluated using a 5-point scale. Data were analysed according to SPSS for Windows (1989-1997).

## RESULTS AND DISCUSSION

**Colour Instrumental Measurement**. Figure 1 shows that samples with ascorbic acid + rosemary had significantly ($p<0.01$) higher a* values, than those of control and samples with the other antioxidants, even after 20 days of storage. Ascorbic acid, carnosine, oregano and rosemary alone also gave significantly ($p<0.01$) higher a* values than control during the first 12 days of storage. LRTP was very effective in maintaining red colour for the first 8 days, while it failed to prevent discoloration. Yildiz Turp and Serdaroglu (1998) did not find any difference by effect of rosemary during the first days of storage of chicken patties.

**Metmyoglobin formation**. Figure 2 shows the changes in metmyoglobin percentage. The amount of metmyoglobin was lower ($p<0.01$) in samples with ascorbic acid + rosemary, which maintained a highly acceptable level (below 40%) after 20 days of storage. Green *et al.*. (1971) reported that 40% metmyoglobin caused meat rejection by consumers. Ascorbic acid, taurine, oregano and rosemary alone exerted also a significant ($p<0.01$) inhibitory effect of myoglobin oxidation; this effect was less durable for LRTP. The efficiency of ascorbic acid to retard oxidation of meat pigments was reported by Mitsumoto *et al.* (1991).

**Lipid Oxidation**. Figure 3 shows the changes in TBA value. Lipid oxidation increased rapidly with increasing time in control samples and in those with ascorbic acid and taurine. However, TBA values were kept to a minimum in samples containing rosemary, either alone or with ascorbic acid, and oregano. Treatment with carnosine and LRTP exerted an intermediate antioxidant effect. These results agree with the results of Decker and Faraji (1990), regarding carnosine; and those of Yildiz Turp and Serdaroglu (1998) and McCarthy *et al.* (1998), regarding rosemary.

**Sensory Analysis**. The results of sensory odour scoring are summarised in Table 1. They showed that odour intensity increased during storage in modified atmosphere, but not with the same intensity. Control samples had the highest value, whereas treatments with rosemary, and to a lesser extent, with oregano and LRTP, extended the odour shelf-life of fresh meat. These results agree with those obtained by Barbut *et al.* (1985), who found that rosemary inhibited undesirable odour appearance.

**CONCLUSION.** Rosemary, either alone or with ascorbic acid, was most effective in inhibiting oxidation of both lipid and myoglobin, as revealed by TBA and % of metmyoglobin results. Both effects contributed to extending the shelf-life of fresh beef patties. Oregano showed a good antioxidant effect, too. Ascorbic acid showed an inhibitory effect of myoglobin oxidation, while carnosine was effective in inhibiting lipid oxidation. LRTP was effective to a limited extent, only evident in the first phases of display.

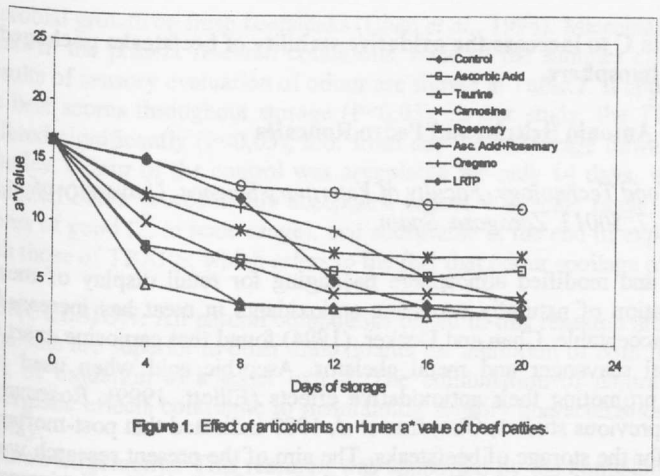


Figure 1. Effect of antioxidants on Hunter a* value of beef patties.

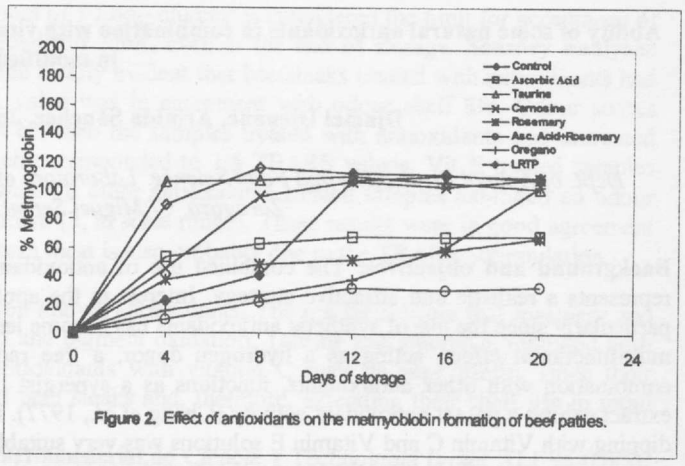


Figure 2. Effect of antioxidants on the metmyoblobin formation of beef patties.

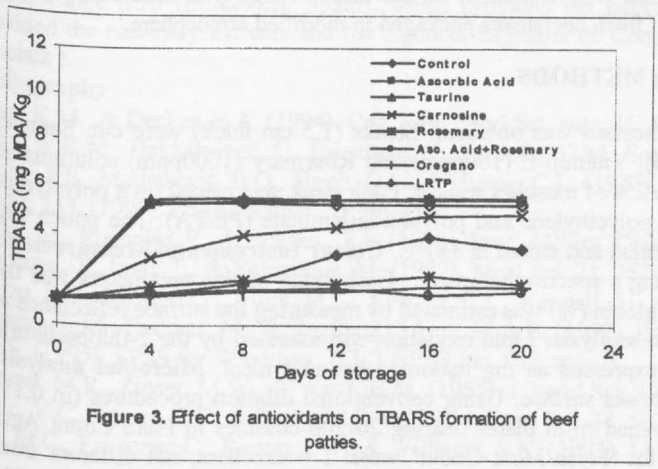


Figure 3. Effect of antioxidants on TBARS formation of beef patties.

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**Table 1. Effect of natural antioxidants on odor sensory scores** of beef patties.**

| Treatment | Days of storage | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 4 | 8 | 12 | 16 | 20 |
| Control | 1 | 2 | 3 | 5 | 5 | 5 |
| Ascorbic Acid | 1 | 2 | 3 | 4 | 5 | 5 |
| Taurine | 1 | 2 | 3 | 4 | 4 | 5 |
| Carnosine | 1 | 1 | 2 | 3 | 4 | 5 |
| Rosemary | 1 | 1 | 2 | 3 | 3 | 3 |
| Asc. Acid+Rosemary | 1 | 1 | 2 | 2 | 3 | 3 |
| Oregano | 1 | 1 | 1 | 2 | 3 | 5 |
| LRTP | 1 | 1 | 2 | 4 | 5 | 5 |

** 1=Excellent (not different from fresh meat), 2=Good, but slightly poorer than fresh meat, 3=Acceptable, 4=Hardly acceptable as fresh meat, 5=Non acceptable.

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