EVALUATION OF THE QUALITY CHARACTERISTICS OF BEEF PATTIES CONTAINING ROSEMARY, BORAGE, CAYENNE OR SWEET PEPPER PACKAGED IN MODIFIED ATMOSPHERE

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BACKGROUND AND OBJECTIVE. Lipid oxidation in foods leads to flavour deterioration, possible formation of toxic products, discolouration of pigments, and loss of nutritional value, arising from the destruction of fat-soluble vitamins and essential fatty acids (Shahidi *et al.*, 1995). The use of antioxidants to increase the storage life of foods has made possible the marketing of many new products. Today antioxidants are widely used in processed foods and there is a tendency for the consumers to reject synthetic antioxidants while accepting the natural ones (Chang *et al.*, 1977). Natural antioxidants can be added directly to the meat or the meat products during processing (Mielche and Bertelsen, 1994). The incorporation of antioxidants protects lipids from oxidation and may indirectly stabilise oxymyoglobin from oxidation (O'Grady *et al.*, 1996). Meat colour is a major factor affecting acceptability at retail points of purchase. Oxidation of oxymyoglobin and deoxymyoglobin accounts for beef deterioration during retail display (Hood, 1980). 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 objective of this study was to investigate the antioxidant effectiveness of rosemary, borage seed meal, sweet pepper, cayenne pepper, and ascorbic acid on the extension of quality characteristics of fresh beef patties packaged in modified atmosphere.

MATERIALS AND METHODS

Samples and atmospheres. *Semimembranosus* muscles were obtained from 3 beef carcasses 48 hr *post mortem*, and ground using a conventional mincer through a plate with 4 mm holes. Portions of uniform weight of the minced muscle (about 85 g) were formed, placed on polypropylene trays in gas impermeable bags (polyethilene and poliamide), and sealed after flushing with the gas mixture. Gas mixture consisted of 70% O_2 + 20% CO_2 + 10% N_2. Eight different formulations were prepared, including 1) 1000 ppm rosemary powder, 2) 500 ppm ascorbic acid, 3) 2% cayenne pepper, 4) 2% sweet pepper, 5) 1000 ppm rosemary powder + 500 ppm ascorbic acid, 6) 1% borage meal, 7) 2% borage meal and 8) control (no antioxidant). All of the antioxidants were mixed with salt and then added to the mixtures. Borage meal was obtained from seeds (defatted with hexane and air dried). The patties were stored for 24 days at 2 ± 1°C in the dark. The entire experiment was replicated twice and all of the evaluations were done on the days 0, 3, 7, 10, 14, 18 and 24 of the display period. **Lipid oxidation.** Lipid oxidation was measured by the 2-thiobarbituric acid method of Pfalzgraf *et al.* (1995). TBA values were expressed as mg malonaldehyde/kg sample. **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). **Microbial analysis**. Counts of aerobic psychrotrophic flora were determined in Plate Count Agar (Merck; Darmstadt, Germany) after incubation at 10°C for 7 days (Elliott *et al.*, 1983). Counts were expressed as log cfu/g. **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). **Statistical analysis.** Data were analysed according to SPSS for Windows (1989-1997).

RESULTS AND DISCUSSION

Lipid Oxidation. Figure 1 shows the changes in TBA value. Lipid oxidation increased rapidly with increasing time ($p<0.01$) in control and ascorbic acid samples. On the contrary, TBA values were kept to a minimum in samples containing rosemary, alone or with ascorbic acid, borage (1 and 2%), paprika and cayenne. These results agree with the results of Wettasinghe and Shahidi (1999), who found that borage meal possesses concentration-dependent antioxidant properties; and those of Yildiz Turp and Serdaroglu (1998) and McCarthy *et al.* (1998), regarding rosemary. With respect to cayenne and sweet pepper, both peppers exerted an outstanding antioxidant effect, although cayenne pepper inhibited almost totally the oxidative reactions. Antioxidant properties of peppers are related, according to Lee *et al.* (1995), to the presence of a variety of tocopherols, flavonoids and carotenoids, while those of cayenne pepper must be due to the additional presence of capsaicin (Ito *et al.*, 1986; Semwal *et al.*, 1999).

Metmyoglobin formation. Figure 2 shows the changes in metmyoglobin percentage. The amount of metmyoglobin was lower ($p<0.01$) in samples with borage (1 and 2%) than in the control, although they were maintained below 40% only for 10 days. Beef patties with rosemary, rosemary+ascorbic acid and sweet peppers did not reach 40% even after 24 days of storage. Green *et al.*. (1971) reported that 40% metmyoglobin caused meat rejection by consumers. Cayenne pepper inhibited totally metmyoglobin formation. No references have been found thus far for this dramatic activity. Ascorbic acid alone exerted a slight inhibitory effect on myoglobin oxidation. The efficiency of ascorbic acid to retard oxidation of meat pigments was reported by Mitsumoto *et al.* (1991). Sánchez-Escalante *et al.* (2001) found that rosemary, alone or with ascorbic acid, was a very effective antioxidant (lipid and myoglobin).

Microbial Analysis. The results of counts of psychrotrophic aerobes are summarised in Figure 3. The counts reached about 10^6 cfu/g after 15 days of storage in MAP. No differences were found among treatments, with the exception of samples containing cayenne and sweet peppers, which presented a reduction in bacterial counts of about 1 log cfu/g ($p<0.01$).

Colour Instrumental Measurement. Figure 4 shows that samples with cayenne and sweet peppers had higher a* values ($p<0.01$) than those of control and samples with the other antioxidants. Red colour of this samples was very intense, due to presence of high amounts of carotenoids (De

(alone and with ascorbic acid). These latter maintained significantly ($p<0.01$) higher a* values than the control during the 24 days of storage. Borage was effective in maintaining red colour for the first 10-12 days. Sánchez-Escalante *et al.* (2001) found that rosemary with ascorbic acid, had significantly higher a* values than those of the control and samples with other antioxidants. Yildiz Turp and Serdaroglu (1998) did not find any difference by effect of rosemary during the first days of storage of chicken patties.

CONCLUSION. Rosemary, either alone or with ascorbic acid, and sweet and cayenne peppers were most effective in inhibiting oxidation of both lipid and myoglobin. In fact, cayenne pepper inhibited totally any oxidative process. Borage was very effective in preventing lipid oxidation, while it inhibited only partially metmyoglobin formation. All effects contributed to extending the shelf life of beef patties. The addition of both sweet and cayenne peppers resulted in a significant antimicrobial activity.

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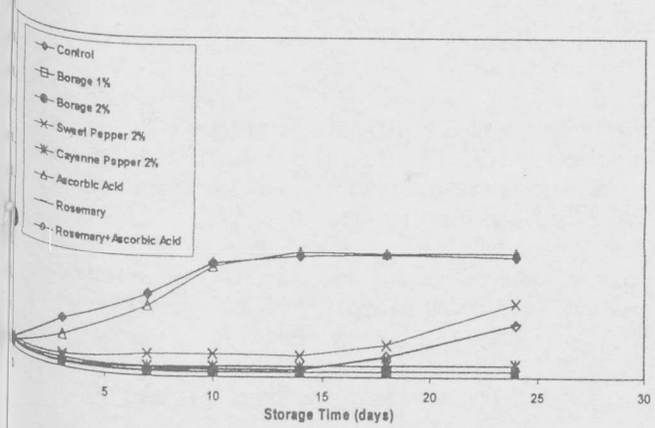

Fig. 1 Values of TBA in beef patties.

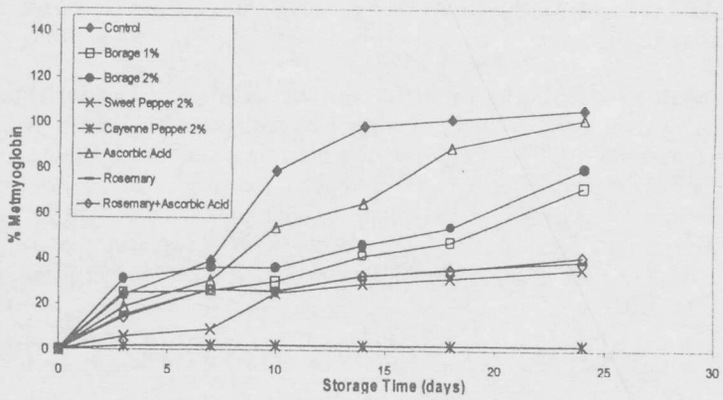

Fig. 2 Metmyoblobin (%) formation in beef patties.

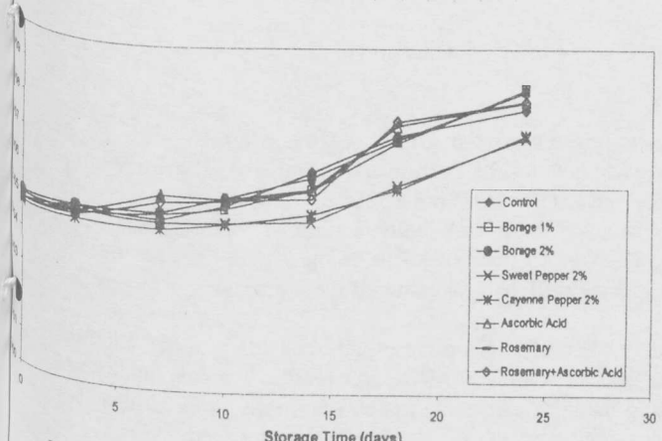

Fig. 3 Counts of psychrotrophic aerobes in beef patties.

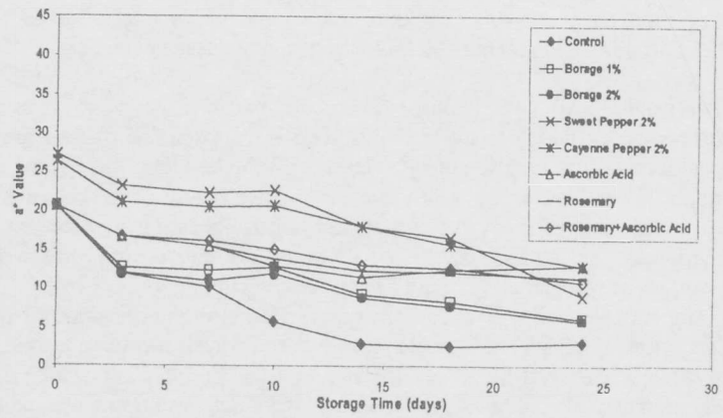

Fig. 4 Values of a* in beef patties.