INFLUENCE OF CARBON MONOXIDE/HIGH CARBON DIOXIDE ATMOSPHERE PACKAGING ON TURKEY MEAT SHELF LIFE AND THE SUBSEQUENT DEVELOPMENT OF A PINK COLOUR AFTER COOKING

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Introduction

The use of gas mixtures oxygen free/high CO_2 gas mixtures benefits meat shelf life and promotes the inhibition of pathogens (Farber *et al.*, 1996; Jensen, 2002). However, the meat colour is unattractive to the consumer due to the myoglobin being in the deoxymyoglobin form. In spite of being forbidden in the EU, gas mixtures containing carbon monoxide (CO) are used in the USA for beef packaging to stabilise colour during storage (Sørheim, 2003; FDA, 2004). One of the problems of the adoption of CO in poultry meat, is the development of a pink colour after cooking or roasting turkey meat attributed to the presence of CO and nitric oxide (Sørheim *et al.*, 1997 and 2001). The aim of this work was to evaluate the effect of 0.5% CO in mixtures of gases containing 50 and 80% CO_2 on sliced turkey meat. The shelf life and the development of a pink colour after cooking was investigated. N_2 was used to package the sliced turkey meat.

Materials and Methods

Breast muscles from turkey carcasses were collected in a deboning room and sliced according to commercial practices. The muscles were transported under refrigeration to the laboratory in less than one hour. The sliced meat were individually packaged in an aerobic atmosphere (polystyrene trays wrapped in an oxygen permeable polyvinyl film) and in four different modified atmospheres (50% N_2 and 50% CO_2; MAP-1, 49.5% N_2, 50% CO_2, 0.5% CO; MAP-2, 19.5% N_2, 80% CO_2, 0.5% CO, MAP-3 and 100%N_2, MAP-4) in "HBX-070" bags (a multilayer film EVOH-based) sealed with a packaging machine (EVT-7-CD, Tecnoprip, Barcelona). The aerobic and modified atmosphere packaged meat have been immediately stored (0±1°C in the dark) for 12 and 25 days respectively. At least five replicates were performed for each study condition. On days 0, 5, 12, 19 and 25 the following microbiological analyses were carried out: Total mesophylic aerobic counts (Plate Count Agar, Sharlau, Spain) at 30°C for 2 days, *Pseudomonas* spp. counts (CFC agar base, Oxoid, UK) after incubation at 30°C for 2 days, lactic acid bacteria (LAB) counts [Man Rogosa Sharpe Agar (Oxoid, UK)] incubated at 30°C for 3 days and *Brochothrix thermosphacta* counts [streptomycin, actidione, thallous acetate agar (STAA, Oxoid, UK)] incubated for 2 days at 30°C. Counts were expressed as log cfu/g. Objective measurement of colour was performed over the surface of raw sliced samples which were aerobically exposed for 30 min. and on cooked samples (80°C, 15 min) with a Minolta Colorimeter CR-300 (Minolta, Osaka, Japan) using the **L**, **a**, **b** coordinates (CIELAB colour system). Statistical analysis of data was performed using SPSS 11.5 for Windows.

Results and Discussion

The evolution of total mesophylic aerobic, *Pseudomonas* spp., lactic acid bacteria and *Brochothrix thermosphacta* counts on sliced turkey meat packaged in aerobic and different modified atmospheres (MAP-1, MAP-2, MAP-3 and MAP-4) during storage at 0°C are presented on Figures 1 and 2. *Pseudomonas* spp., the main spoilage flora of turkey meat, was inhibited by 50% CO_2 in gas mixtures (Figure 1B). The increase of CO_2 concentration from 50% to 80% did not have any observable effect on mean spoilage microbial flora (Figures 1B and 2). *Brochothrix thermosphacta* was not inhibited by CO_2 but by the anoxic conditions created by MAP (Figure 2B; MAP-1 and MAP-4). The introduction of 0.5% CO in the mixtures (MAP-2 and MAP-3) did not had any effect on *Pseudomonas* spp. counts which agrees with Luno *et al.* (1998) who found that beef package with gas mixture containing 1% CO did not inhibit psychotrophic aerobic flora. However, the synergic effect of a higher concentration of CO_2 (80%) with 0.5% CO was responsible for the significantly lower total mesophylic aerobic counts ($p<0.001$). In fact, the introduction of 0.5% CO in MAP-2 and MAP-3 promoted a significant inhibition of *Brochothrix thermosphacta* (Figure 2B), which can benefit meat sensorial characteristics retarding the development of spoiled smell and taste (Jensen, 2002) and extending meat shelf life to 25 days. Sliced turkey meat under MAP-2 and MAP-3 had significantly higher a values ($p<0.001$), 13.25 and 13.73 respectively, due to

carboxymyoglobin formation (Sørheim *et al.*, 2001). However, cooked turkey meat after being exposed to CO during a storage period of 25 days had no significant differences in l, a, and b values (Figure 3). The meat exposure to 0.5% CO during long period of storage and the formation of carboxymyoglobin did not induced a subsequent pink colour defect on cooked turkey meat.

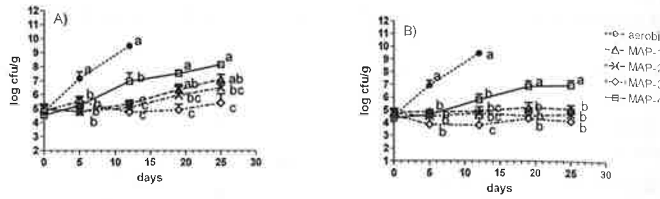

Figure 1: Total mesophylic aerobic (A) and *Pseudomonas* spp. (B) counts evolution on sliced turkey meat packaged in aerobic and MAP during storage at 0ºC ([abc] means with different letters for the same day are significantly different).

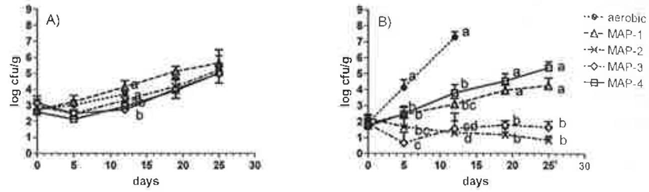

Figure 2: Lactic acid bacteria (A) and *Brochothrix thermosphacta* (B) counts evolution on sliced turkey meat packaged in aerobic and MAP during storage at 0ºC ([abc] means with different letters for the same day are significantly different).

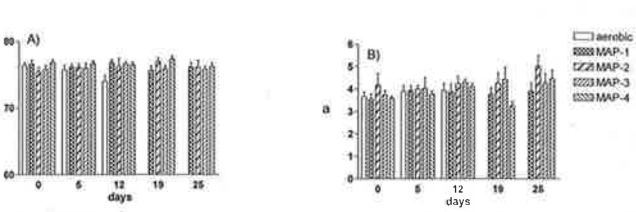

Figure 3: **L** (A) and **a** (B) values on sliced turkey meat cooked after being storage under aerobic and MAP packages.

Conclusions

The introduction of 0.5% CO in gas mixtures with higher CO_2 concentration promoted a significant inhibition of *Brochothrix thermosphacta* which can benefit meat sensorial characteristics, extending meat shelf life to 25 days. The meat exposure to 0.5% CO during long period of storage and the formation of carboxymyoglobin did not induced a subsequent pink colour defect on cooked turkey meat.

References

Farber, J.M., Cai, Y., Ross, W.H. (1996). Predictive modeling of the growth of *Listeria monocytogenes* in CO_2 environments. Int. J. Food Microbiology, 32, 133-144.

FDA, 2004. Agency Response Letter GRAS Notice No. GRN 000143. Center of Food Safety and Applied Nutrition, Office of Food Additive Safety, July 29. http://www.cfsan.fda.gov/~rdb/opa-g143.html

Jensen, J.S. (2002). Critical packaging parameters in MAP of meat products and their optimisation. Nordic Foodpack Seminar, 4-6 September. 6p.

Luño, M., Beltrán, J.A., Roncalés, P. (1998). Shelf-life extension and colour stabilization of beef packaged in a low O_2 atmosphere containing CO: Loin Steaks and ground meat. Meat Science, 48, 75-84.

Sørheim, O. 2003. Request for an amendment inserting CO as a packaging gas in annex 1 of Directive 95/2 EC. 2p.

Sørheim, O., Erlandsen, T., Nissen, P., Lea, P., Høyem, T. (1997). Effects of modified atmosphere storage on colour and microbiological shelf life of normal and pale, soft and exudative pork. Meat Science, 47, 147-155.

Sørheim, O., Lea, P., Nissen, H., Nesbakken, T. (2001). Effects of high CO_2/low CO atmosphere on colour and yield of cooked ground beef patties. Proceedings of 47[th] International Congress of Meat Science and Technology, ICoMST, Kraków, Poland. pp. 74-75.