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SHELF LIFE OF DIFFERENT COLOUR BREAST TURQUEY MEAT UNDER MODIFIED ATMOSPHERE PACKAGE

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Introduction

The use of CO_2 enriched atmospheres extends the shelf life of raw poultry by inhibiting the psychrotrophic gram-negative bacteria and *Pseudomonas spp.* (Blakistone, 1999). The success of MAP technology application on meat depends mainly of its initial microbiological contamination (influenced by slaughtering and deboning hygienic conditions) and of temperature control during storage and distribution, however the growth of microorganisms is also influenced by intrinsic meat factors (Lucke *et al*., 1995, Borch *et al*., 1996, Dainty *et al*., 1996).

An important part of turkey breast meat presents different characteristics of colour, pH and water holding capacity being classified as PSE-like meat (Barbut, 1996, Barbut, 1997, Santé *et al.*, 1998, Owens *et al*. 2000). Boulianne *et al*. (1998) also observed darker poultry meat with a lower **L** and a higher pH than normal meat. Fletcher *et al.* (2000) observed different colour characteristics on broiler breast meat, establishing three colour groups with different values of **L**, **a** and pH. Fraqueza *et al*. (2001) stated that 23% of the turkey breast muscles measured were evaluated as being too dark or too light. These colour categories of meat with different characteristics could be sliced and packaged under modified atmosphere with gas mixtures usually composed by CO_2 and N_2 being the products shelf life influenced by intrinsic characteristics associated with colour as the pH.

Objectives

The aim of this study was to determinate the evolution of spoilage flora in sliced turkey meat under modified atmosphere packaging $50\%CO_2/50\%N_2$ along a storage period time at 0ºC clarifying the relation between meat colour and respective shelf life.

Methodology

The sampling of breast muscles with different colour was performed on different days from turkey carcasses (BUT 9 and BIG 6) slaughtered and deboned under plant conditions. Colour (Minolta Colorimeter CR-300, Minolta, Osaka, Japan; using the L, a, b, co-ordinates, CIELab colour system), and pH 24h *post-mortem* (pH_{24h}, Sentix Sp, WTW, A991409014) were measured on the *Pectoralis major* muscles after carcasses

deboning. The breast muscles were selected according to Lightness (L) value and pH: L≥51and pH<5.8 for Lighter colour, 43<L<51 for Intermediate colour, L≤43 and pH>5.8 for Darker colour. Breast muscles of different colour categories were sliced. Less than one hour after transportation under refrigeration to the laboratory the sliced meat were individually packaged in an aerobic atmosphere (polystyrene trays wrapped in an oxygen permeable polyvinyl film) and on modified atmosphere (MAP) containing 50% N_2 and 50% CO_2 in "HBX-070" bags (a multilayer film EVOH-based) sealed with a packaging machine (EVT-7-CD, Tecnoprip, Barcelona). The aerobic atmosphere and MA packaged meat have been immediately stored (0±1ºC 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 30ºC for 2 days, total psychrotrophic aerobic counts (Plate Count Agar, Sharlau, Spain) at 7ºC for 10 days, anaerobic count at 7ºC for 10 days (Brewer Anaerobic Agar, Merck, Germany), *Enterobactereaceae* counts in Violet Red Bile agar (VRB agar, Merck, Germany) at 37ºC for 2 days, *Pseudomonas spp*. counts (CFC agar base, Oxoid, UK) after incubation at 30ºC for 2 days, lactic acid bacteria (LAB) counts on Man Rogosa Sharpe Agar (Oxoid, UK) incubated at 30ºC for 3 days and *Brochothrix thermosphacta* count in streptomycin, actidione, thallous acetate agar (STAA, Oxoid, UK) incubated for 2 days at 30ºC. Counts were expressed as log cfu/g.

Statistical analysis: Data was analysed using SPSS 11.5 for Windows. The comparison between different package condition and different colour quality meat samples, for microbial parameters, was performed by model adjustment of a one-way ANOVA for each day. If *F* test from ANOVA was significant, a LSD test post hoc multiple comparisons for observed Means has been performed. The comparison between days, considering each package and colour meat condition, was made by t-test for dependent samples.

Results & Discussion

The characteristics of pH and L from breast turkey samples selected and categorized as Lighter, Intermediate and Darker colour are presented on Table 1. Darker turkey meat is characterized by significantly ($p<0.001$) lower lightness (**L**) values and higher pH values than Intermediate and Lighter colour meat.

The microbial flora evolution during storage of sliced turkey meat under MAP (50% CO_2 and 50% N_2) and aerobic package is represented on Figures 1 to 4.

The total mesophylic and psychrotrophic aerobic counts on turkey meat under MAP after five days of storage are not significantly different from those observed initially, the gas mixture have an inhibitory effect on microbial flora which present a longer lag phase related to the presence of CO_2 (Dixon *et al*., 1989, Blakistone, 1999). The inhibitory effect of CO_2 is evident when we observe the significant reduction ($p<0.001$) obtained on microbial counts of aerobic gram-negative flora in meat under MAP conditions (Figure 1 and 2) compared to those obtained in meat under aerobic package.

After the initial storage time at 0ºC was observed on darker meat colour under MAP a significant increase ($p<0.05$) of total mesophylic counts (from 4.88 to 5.95 log $cfu.g^{-1}$) and total psychrotrophic aerobic counts (from 4.97 to 5.56 log $cfu.g^{-1}$) despite the

anaerobic conditions created and the inhibitory effect of CO_2. Between the different periods of analysis (12^{th}, 19^{th} and 25^{th} days) the growth difference of mesophylic and psychrotrophic aerobic flora (Figure 1) was of 2 log cfu.g^{-1} in Darker turkey meat and of 1 log for Lighter and Intermediate. After 25^{th} days of storage a higher total mesophylic and psychrotrophic aerobic counts ($p<0.05$) of approximately 2 log ufc.g^{-1} was registered in the darker meat compared the other colour categories of meat. After this storage time the difference of microbial population between meat colour categories could be not relevant because all are over the limits of hygienic acceptability (Figure 1) but the darker meat will have off-odors and slime sooner than the others meat colour categories.

Pseudomonas spp. and *Enterobactereaceae* growth was inhibited during meat storage time under MAP 50% CO_2 and 50% N_2 (Figure 2).

After 12 days of storage the anaerobic psychrotrophic counts increased significantly ($p<0.05$) on sliced meat under MAP 50% CO_2 and 50% N_2 (Figure 3). Their growth is more effective in dark colour meat than on the others colour meat categories however this difference was not significant between colour meat categories. There is anaerobic facultative flora that seems to be not inhibited by CO_2 (Figure 3). The lactic acid bacteria counts was higher on Intermediate and Darker colour meat than on Lighter, respectively with 4.14, 4.03 and 3.06 log ufc.g^{-1} after twelve days of storage under MAP (Figure 4). After this period of storage the LAB counts difference of 1 log disappears; the increase of counts related to storage time was not significantly different between colour meat categories ($\approx$5 log cfu.g^{-1}).

Brochotrix thermosphacta counts was similar on different colour turkey meat categories under aerobic and MAP 50% CO_2 and 50% N_2 conditions (Figure 4) and increased significantly ($p<0.05$) during storage time. There is an inhibitory effect of the anaerobic conditions of this gas mixture on the growth of *Brochotrix thermosphacta* however the sensitivity of these microaerophylic bacteria to the absence of O_2 was more pronounced on lighter and intermediate meat colour.

The Darker turkey meat presented higher counts of psychrothrofic aerobic flora than the Lighter samples ($p<0.05$) after 12^{th} day of storage in aerobic conditions at 0ºC. This tendency was observed on the *Pseudomonas spp.* counts. The increased development of the flora on Dark poultry meat compared with that observed in Lighter colour samples is related to differences on pH and temperature which influence the development of aerobic psychrotrophic counts particularly *Enterobactereaceae* and *Pseudomonas spp.* (Allen *et al*., 1997 and 1998, Fraqueza *et al*., 2002). When other hurdles are created as in MAP these previous referred bacterial groups are inhibited. The inhibitory effect of CO_2 is related with gram-negative bacteria particularly *Pseudomonas spp.* (Blakistone, 1999). The dissolution of CO_2 in meat water phase with carbonic acid formation change the internal pH of bacterial cells disturbing the biological systems equilibrium and inducing cell inactivation without interruption of their walls (Erkmen, 2000) also the aerobic flora without the presence of O_2 will be inhibited. Lactic acid bacteria are responsible by spoilage of turkey meat under MAP since this slower growing group is not inhibited by the anoxic conditions (Santé *et al.*, 1994). The pH associated with meat colour has no effect on their development. However other aerobic facultative psychrotrophic bacterias have grown on darker meat under MAP with 50% CO_2 and 50% N_2 when *Pseudomonas spp*. and *Enterobactereaceae* were inhibited, being responsible by meat spoilage. Their development is promoted by intrinsic conditions related to darker meat with a pH value

equal or higher than 6 and its nutrients content. According to Boulianne *et al*. (1998) the darker meat is richer in iron. This nutrient is very important for non-siderophores species and rapidly utilized without energetic loss by siderophores species (Champomier *et al*. 1996, Gram *et al*., 2002) promoting their growth.

The shelf life of sliced dark turkey meat under MAP with 50% CO_2 and 50% N_2 is shorter than the Lighter and Intermediate turkey meat. According to hygienic microbial standards (Unnamed, 1998), sliced turkey dark meat under MAP (50% CO_2 and 50% N_2) after 12 days of storage at 0ºC, will be over the limit of quality hygienic standards and not recommended to be consumed. The microbial shelf life period of MAP sliced turkey meat is increased of one more week to Intermediate and Lighter colour turkey meat under this study conditions.

Conclusions

The shelf life of sliced Darker turkey meat under MAP (50% CO_2 and 50% N_2) at 0ºC is one week shorter than the Lighter and Intermediate colour meat. This difference is attributed to intrinsic characteristics of Darker meat promoting the development of spoilage aerobic facultative psychrotrophic flora.

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Tables and Figures

Table 1: Characteristics of breast turkey samples (*Pectoralis major*) selected.

Breast samples	Lighter n=6	Intermediate n=6	Darker n=5	Sig.
pH	5.69 ± 0.07^{a}	5.85 ± 0.03^{b}	6.05 ± 0.13^{c}	***
L	51.73 ± 0.60^{c}	46.78 ± 1.47^{b}	41.33 ± 1.31^{a}	***

[abc]Means within a row with different superscript letters are significantly different; *** $p<0,001$

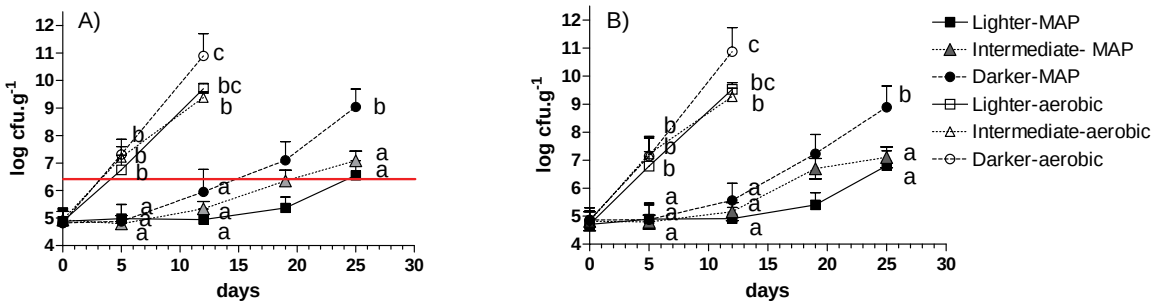

Figure 1: Total mesophylic (A) and psychrotrophic aerobic (B) counts evolution on Lighter, Intermediate and Darker colour sliced turkey meat during storage time (^{abc} different letter for the same day are significantly different).

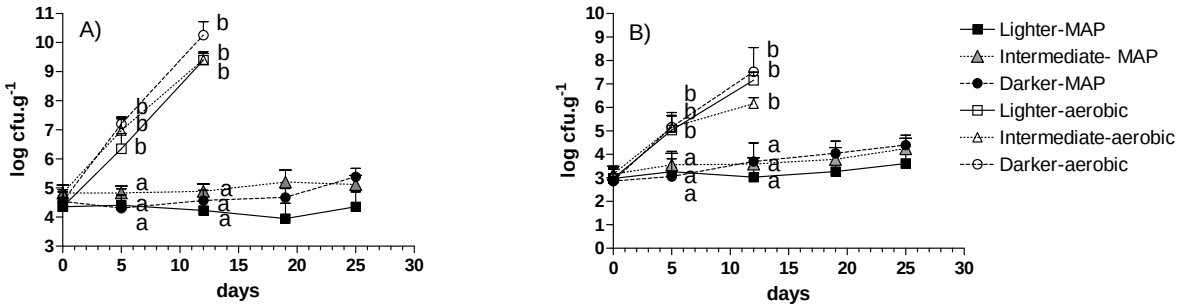

Figure 2: *Pseudomonas spp*. (A) and *Enterobactereaceae* (B) evolution on Lighter, Intermediate and Darker colour sliced turkey meat during storage time (^{ab} different letter for the same day are significantly different).

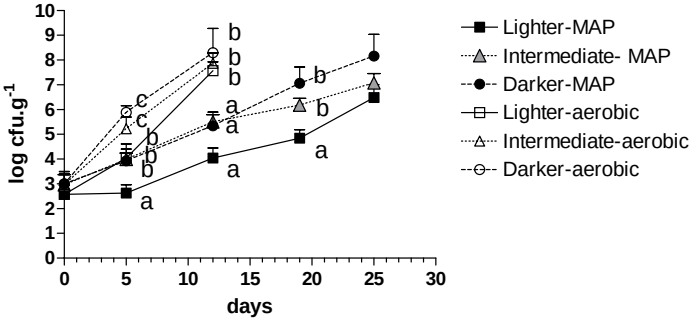

Figure 3: Total anaerobic flora evolution on Lighter, Intermediate and Darker colour sliced turkey meat during storage time (^{abc} different letter for the same day are significantly different).

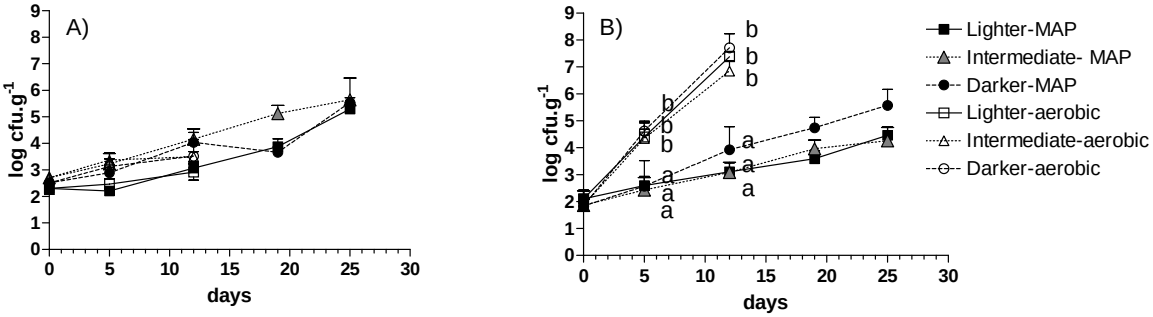

Figure 4: Lactic acid bacteria (A) and *Brochotrix thermosphacta* (B) evolution on Lighter, Intermediate and Darker colour sliced turkey meat during storage time (^{ab} different letter for the same day are significantly different).