Shelf life and colour stability of beef under modified atmosphere packaging on retail display conditions

M.J. Fraqueza[1*], P.L.F. Costa[2], M.H. Fernandes[1], M.J. Fernandes[1], M.C. Ferreira[1], M.C. Leal[2], C. Morgado[2] & A.S. Barreto[1]

[1]Faculdade de Medicina Veterinária, CIISA, UT Lisbon, Av. da Universidade Técnica, Pólo Universitário, Alto da Ajuda, 1300-477 Lisboa, Portugal.

[2]Carnes do Continente, SA - Quinta do Mocho - Zona Industrial de Santarém - 2005-002 - Várzea de Santarém.

*Email: mjoaofraqueza@fmv.utl.pt.

Abstract

The objective of this work was to determine the main factors that influence shelf life and colour stability of beef steaks under modified atmosphere packaging in retail display conditions. Beef shoulders under vacuum from two different suppliers were sliced according to commercial conditions in a deboning room. Steaks were packaged under a modified atmosphere (30% CO_2/70% O_2), and separated into three samples groups. Group A: transported to laboratory and stored at 0±1 ºC in the dark, along 12 days; Group B: transported to a retail store classified as having high % of meat discard, stored in an retail open display case for 12 days; Group C: transported to a retail store classified as low % of discard, stored in an retail open display case, 12 days. Storage temperature was registered and flux light of display cases was measured. Samples were evaluated concerning microbial and physico-chemical (pH, colour CIELab, total haeminic pigments and vitamin E content) parameters at 0, 4, 8 and 12th days. Higher light intensity at open retail display case and higher temperature fluctuation are pointed out as the main causes of increasing the microbial growth and meat discoloration rate and shortening the shelf life of the beef steaks (5-6 days).

Introduction

At purchase moment a desirable beef colour must be present and maintained throughout retail-display. Colour is the main critical sensory characteristic of beef as it is experienced by consumers before tenderness or flavour determining meat acceptance and selection, being used as a perceived quality and freshness indicator (Dune *et al*., 2005). Meat colour is determined by its heme pigments concentration, their oxidation-reduction state, emergent chemical reactions and light-scattering properties (Lawrie, 1998, Brewer, 2004). However, there are several factors influencing meat colour and its discoloration. After animal slaughter and during chilling storage the formation of metmyoglobin and its accumulation on meat surface is dependent on intrinsic (pH, muscle metabolic type, animal, age, breed, sex, diet, etc.) and extrinsic factors such as temperature, oxygen availability, light type, microbial growth, packaging (air, modified atmosphere) or combination of several factors (Renerre, 1999). The discolouration of beef during retail case-life is pointed out as the major cause of rejection from the retail shops to the central of process retail ready beef cut, with high economic losses.

The aim of this work was to assess the main factors that influence shelf life and colour stability of beef steaks under modified atmosphere packaging in real retail display conditions, considering corrections and implementation of preventive measure to control beef discoloration.

Material and methods

Beef shoulders under vacuum (mean shelf life of 30-45 days) from two different suppliers (A and B) were sliced according to commercial conditions in a deboning/cut room. Steaks were packaged under a modified atmosphere (30% CO_2/70% O_2) in a thermo sealing packaging machine STAR 2HS (CFS, Convenient Food Systems). For packaging were used trays C-base E, of polyethylene and polypropylene (CFS) and film TopGuard 60 polylaminated (OPP/PE/EVOH/PE) (CFS), with hight impermeability to gases (O_2=2.5 cm^3/m^2d bar, CO_2<6.5 cm^3/m^2d bar, N_2<1 cm^3/m^2d bar and to water steam <2 g/m^2d bar). Samples were separated into three groups. Group A: transported to laboratory and stored at 0±1 ºC in the dark, along 12 days; Group B: transported to a retail store classified as having high % of meat discard, stored in a retail open display case for 12 days; Group C: transported to a retail store classified as low % of discard, stored in retail open display case, 12 days. Storage temperature on retail open display case was registered in data logger (Testo, Germany) and flux light (lux units) of display cases was measured using a Luxometer model Hibok-30. Samples were evaluated concerning microbial and physico-chemical parameters at 0, 4, 8 and 12th days. Five replications in different working days were performed. Microbial determinations were carried out

to: total mesophilic aerobic counts; *Pseudomonas* spp. counts (cephaloridene, fucidin and cetrimide agar base; Oxoid, UK), lactic acid bacteria (LAB) counts in Man Rogosa Sharpe Agar (Oxoid) and *Brochothrix thermosphacta* count in streptomycin, actidione, thallous acetate agar (Oxoid). Physical-chemical analysis: pH was determined with a portable pH meter (HI9023) equipped with a pH electrode (FC 230B, Hanna Instruments, Italy); Colour was measured on the surface of sliced beef, approximately 30 min. after opening the package, with a Minolta colorimeter CR-300 using the L^*, a^*, b^* coordinates. Each value resulted from the arithmetic mean of twelve determinations at four point of measure. Total haeminic pigments were performed according to Hornsey (1956). α-tocoferol content was determined according to Prates *et al*. (2006) and expressed in µg of α-Tocoferol (Vit. E)/g of meat. Statistical analysis was undertaken using SPSS 11.5 for Windows.

Results and discussion

On Figure 1 was observed that sliced beef packaged under MAP during storage condition B were submitted to higher temperature fluctuation. Group B samples were exposed to a significant higher light intensity (335 lux) than those under condition C (153 lux), but there was no observed significant variation of light intensity at open retail display cases during time storage.

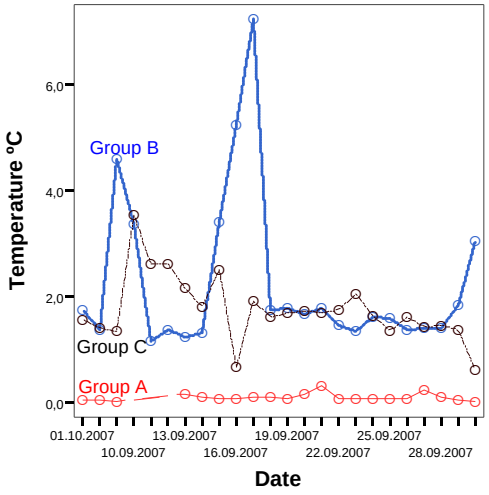

Figure 1. Temperature (ºC) during storage condition of group A, B and C sliced beef packaged under MAP.

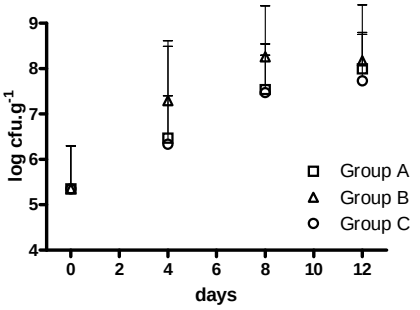

Figure 2. Total mesophilic aerobic counts evolution on sliced beef packaged under MAP during storage time in A, B and C conditions.

The microbiota evolution on sliced beef packaged under MAP (70% O_2 and 30% CO_2) during storage time in A, B and C conditions are presented on Figures 2 and 3.

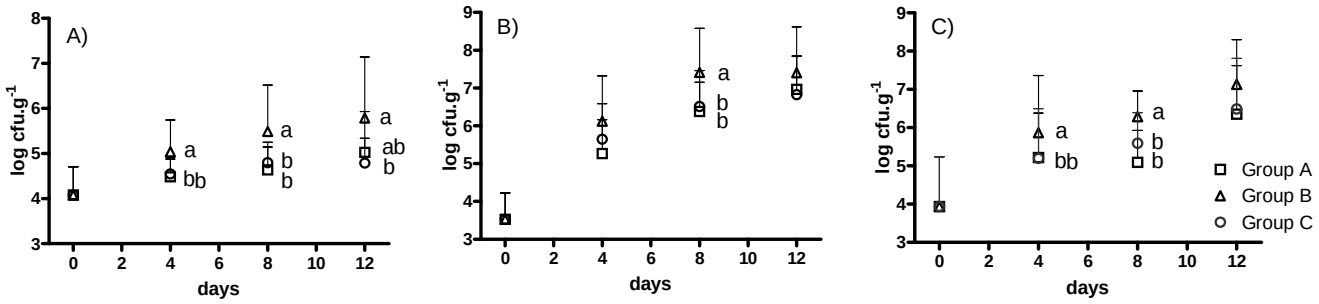

Figure 3. *Pseudomonas* spp. (A), *Brochothrix thermosphacta* (B) and lactic acid bacteria (C) counts evolution on sliced beef packaged under MAP during storage time in A, B and C conditions (^{ab} different letter for the same day are significantly different, $p<0.05$).

The hygiene quality of samples from suppliers A and B were similar. The initial value of mesophilic aerobic counts in beef was 5.5 log cfu/g, and for *Pseudomonas* spp. counts was 4.2 log cfu/g. There was a significant increase of total mesophilic, *Pseudomonas* spp., *Brochothrix thermosphacta* and LAB counts in beef under MAP during different storage conditions. The inhibition effect of CO_2 was observed in *Pseudomonas* spp. counts from beef under MAP storage conditions A and C; after 12 days of storage the counts were not superior to 10^5 cfu/g. This effect was reduced when samples were at conditions B with a

mean temperature of 4.8ºC±3.1ºC. Samples under condition B had a significant increase of all microbial counts, with 7.3 log cfu/g for mesophilic counts after 4 storage days, and 8.2 log cfu/g after 8 days.

Beef from suppliers A and B had similar values of vit. E, total pigments and pH. A slight decrease of vit. E content in beef under MAP at 0ºC from 0 d to 4th days was observed, but without any significant variation during the rest of storage time (Figure 4). Total pigments values were not different in sliced beef under MAP at different storage conditions. However after 12 days of storage, samples in condition B had values significantly lower than those in other storage conditions (Figure 5). There were no differences of samples pH at different storage conditions and time.

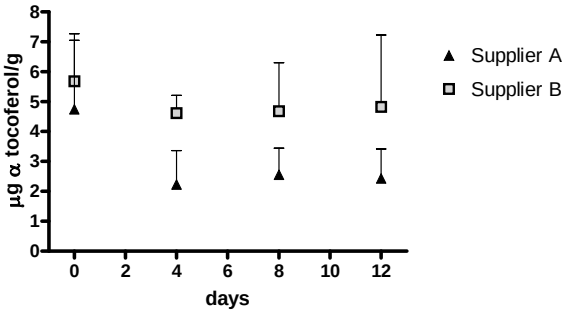

Figure 4. α-Tocoferol content evolution on sliced beef packaged under MAP during storage time (12 days at 0±1 ºC).

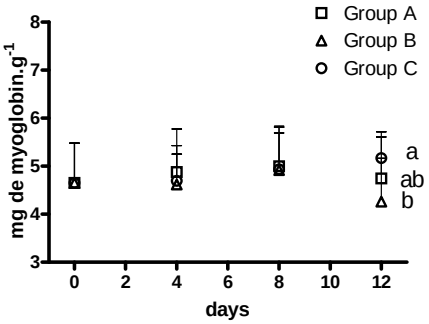

Figure 5. Total haeminic pigments evolution on sliced beef packaged under MAP during storage time in A, B and C conditions.

Storage time had no effect on colour parameters L*, a*, b* (Figure 6) in meat samples under conditions A and C but induced a significant reduction of a*, after 4 storage days, when they were under retail condition B.

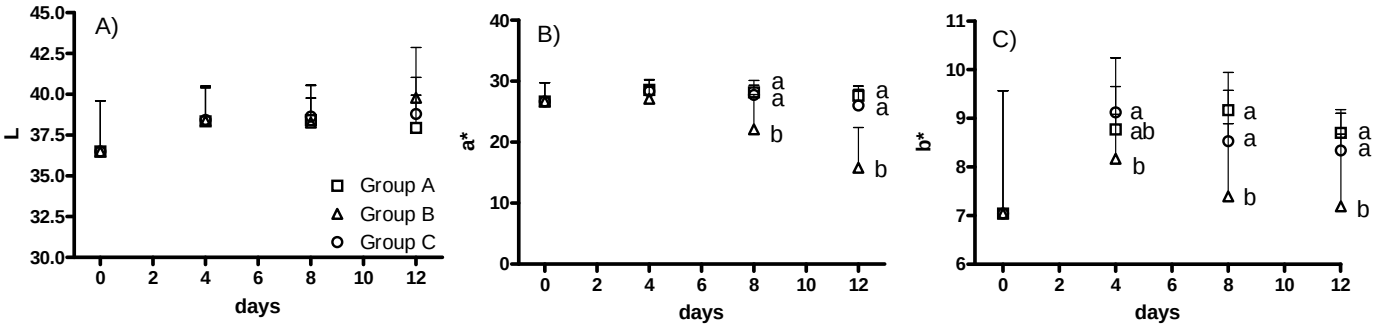

Figure 6. L*(A), a* (B) and b* (C) evolution on sliced beef packaged under MAP during storage time in A, B and C conditions (^{ab} different letter for the same day are significantly different, $p<0.05$).

Conclusions

Higher light intensity at open retail display case and higher temperature fluctuation are pointed out as the main causes of increasing the microbial growth (particularly *Pseudomonas* spp.) and meat discoloration rate, shortening the shelf life of the beef steaks (5-6 days).

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