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SHELF LIFE OF REFRIGERATED MODIFIED ATMOSPHERE RETAIL-PACKAGED AGED BEEF

Lelis H. Meichtri, M. Susana Neira, H. Ricardo Rodríguez, Gabriela Grigioni and Jorge A. Lasta
Instituto Tecnología de Alimentos, ITA, CIA-CNIA, INTA, C.C. 77, 1708 Morón, Buenos Aires, ARGENTINA
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Background:
Several factors affect shelf life of fresh beef; spoilage flora and chemical reactions, which occur under normal oxygen atmosphere, progressively decrease the acceptability of fresh meat by producing unfavorable organoleptic changes (Bell, 1995). In this sense, modified atmosphere packaging (MAP), as a part of centralized packing operation, increase shelf life with respect to both hygienic and sensorial properties of fresh retail meat cuts (Coventry et al., 1998). Good Manufacturing Practices, adequate refrigeration storage and efficient packaging system are requirements for centralized preparation of fresh retail beef cuts. MAP technique uses mixtures of oxygen and carbon dioxide to achieve a bright red meat color and to restrict growth of spoilage microorganisms. Usually read meats are packed under MAP mixtures of approximately 75% oxygen and 25% carbon dioxide (Taylor et al., 1990). MAP can be maintained within individual retail packs, or a number of retail packs can be sealed into a master pack that contains the modified atmosphere. Master-packaged retail beef maintain an adequate appearance when it is displayed under commercial conditions (Gill et al., 1994). Most reports on MAP technology deal with fresh beef; there is not much information, however, on aged whole sale beef and MAP packaged retail cuts fabricated under centralized commercial conditions.

Objective:
The objective of this study was to evaluate the overall condition and keeping quality of aged whole sale beef master-packaged under modified atmosphere as retail-beef cuts.

Material and Methods:
The study was designed to simulate fabrication, master packaging under MAP, and storage of retail beef under commercial conditions. Retail samples of chuck eye coming from a commercial centralized distribution center, were obtained from 25 days old vacuum packaged primals stored at 1± 0.5ºC prior to MAP. A total of 90 samples were used. Each cut was placed in a polystyrene tray containing a soak pad; each tray was overwrapped with a polyethylene film. Trays were distributed in groups of nine into the appropriate master pack (barrier film, GRACE, Arg.). The master packs were then evacuated, filled with a mixture of 80% O_2 and 20% CO_2 and kept at 1± 0.5ºC until they were opened. To simulate display conditions, groups of three samples for each master pack were stored at 1, 4 and 7ºC. One tray from each storage temperature was analyzed at 24, 48 and 72 hours of storage, respectively.
Sensory evaluations: Organoleptic characteristics, color, odor and general appearance were evaluated subjectively and objectively (color).
Determination of gas composition: Previous to master pack aperture, a 10 cm^3 sample of headspace was drawn from the master pack with a syringe through a septum glued onto the surface. Sample was analyzed for O_2, CO_2 and balance composition, using a atmosphere analyzer unit (MAP Test 4000, Hitech, England).
Determination of color: Color of the lean beef portion was measured in the tray through the film. Color was measured on a colorimeter (ByK Gardner Color View 900) with a large view area port. Data were transformed to Hunter L, a, b values from which saturation (s) was calculated.
Microbiological analysis: A surface area of 14.73cm^2 and 3 mm depth was aseptically removed for analysis and stomached with 50 ml of 0.1% peptone water. From these homogenates, suitable decimal dilutions in 0.1% peptone water were prepared. Total Viable Count (TVC), *Pseudomonaceae* and *Enterobacteriaceae* counts were performed (Rodríguez et al., 1993).
Determination of pH: Determination of pH from surface and depth were done in a slurry using a Metrohm 691 pHmeter (Metrohm, Switzerland) using a combined pH electrode (Metrohm 6.0218.010).
Statistical analysis: Analysis of variance was carried out using the GLM procedure of SAS (SAS, 1998).

Results and Discussion:
Gas composition of master packs varied in the range of 58.2 - 74.2% for O_2 and 17 - 19.3% for CO_2 over a ten days period. Chuck eye samples remained bright red for 5 days under MAP conditions, while samples which had been displayed became brownish; this effect was more intense after 72 h display at 7°C. Changes in saturation (s) after removal from master packs were observed. Means of (s) values were 16.6 ± 2.5; 12.8± 2.0 and 15.1± 2.9 for samples held under MAP for 8, 9 and 10 days, respectively. The $\log_{10}$ CFU/cm^2 of TVC for master-packaged samples, after 24, 48 and 72 hours storage period simulating display conditions at 1, 4 and 7 °C, are showed in Figures 1, 2 and 3. For each storage temperature, no difference ($P>0.05$) was found between mean TVC values considering the three storage times. Only three samples over ninety (3.33%) showed TVC counts over 10^7 CFU/cm^2, these values corresponded to samples held at 7 °C. Regarding to total storage period (vacuum packaging, MAP and retail display) of about 38 days, TVC counts were lower than 10^7 CFU/cm^2, which is the cut off value generally used to indicate the end of shelf life. *Pseudomonaceae* counts obtained from cuts belonging to the master packs opened at days one and ten, are showed in Table 1. Considering both storage times, values were between 10^2 CFU/cm^2 and 10^4 CFU/cm^2, taking into account all display conditions. For the three display temperatures, a significant difference ($P>0.05$) was found between 24, 48 and 72 storage time. Little or no growth of *Enterobacteriaceae* (mean log 0.62 CFU/cm^2) was detected on samples regardless storage time or temperature. These results are similar to those reported by Taylor et al. (1990) for MAP-VSP packaged beef sirloins and pork loin steaks; they could indicate a high hygienic standard during fabrication and an ecological microflora selection due to the combination of MAP with previous vacuum-packaging storage. Chuck eye samples showed a constant pH values (5.24-6.03). In a grain-fed beef study, Coventry et al. (1998) found that samples of steaks reached a shelf life period of 2 weeks under MAP-VSP at –1°C, with subsequent retail display at 4°C (up 2 days). Based on the results of the current study, considering both sensory and microbiological parameters, use of vacuum packaging, MAP (80% O_2 and 20% CO_2) and display mentioned conditions, provided acceptable chuck eye retail cuts for up to 30 days; even for those samples kept at 7°C during retail display.

Conclusion:

Vacuum packaged beef primals aged for 25 days at 1 ± 0.5 °C can be fabricated as retail cuts and master packaged under MAP conditions achieving an acceptable shelf life under commercial refrigeration.

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TABLE 1: *Pseudomonaceae* values (mean $\log_{10}$ CFU/cm^2) of beef chuck eye at different storage times and temperatures considering storage under MAP and under regular display conditions

Storage time under display conditions (h)	Temperature under display conditions (°C)	$\log_{10}$ CFU/cm^2	
		Master pack 1	Master pack 10
24	1	3.81	1.93
	4	1.93	4.11
	7	1.93	2.83
48	1	5.06	3.23
	4	4.51	3.13
	7	2.83	4.51
72	1	3.89	3.13
	4	4.20	4.23
	7	5.78	5.77