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MICROBIAL CONDITION OF LACTIC ACID TREATED AND MODIFIED ATMOSPHERE RETAIL-PACKAGED BEEF

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Background:
Microbial contamination of beef carcasses surface is an inevitable consequence inherent to its processing. Several factors affect meat stability, however, bacterial growth is one of the most important factors in shelf life and overall quality of both fresh and aged beef. Marketability of fresh beef is strongly affected by its perishability, particularly in countries such as Argentina where meat is usually marketed fresh (Rodríguez et al., 1993). Due to increasing changes related to consumer demands in the meat industry, a need for efficient packaging technologies has been observed. In this sense, modified atmosphere packaging (MAP) is one of the methods which has received widespread acceptance (Taylor et al., 1990). Use of organic acids have been reported to be effective in controlling spoilage microorganism in carcasses; while, had little or no effect on the microbial quality of meat cuts after fabrication (Ouattara et al., 1997). Overall quality of retail beef could further be improved by combining MAP and application of organic acids, such as lactic acid (LA). There is not much information, however, on the combined use of LA sprays and MAP on the microbial quality of retail-beef cuts.

Objective:
The objective of the current study was to evaluate the overall condition and microbial quality of fresh and aged whole sale beef, as bone-in and sliced boneless cuts, respectively, treated with lactic acid and master-packaged under MAP as retail cuts.

Material and Methods:
Beef used consisted of fore shank bone-in cuts (n=80), and sliced boneless beef (n=42) produced and packaged at a commercial centralized distribution center. Treated samples were sprayed with 1.5% (vol/vol) LA solution before MAP. Bone-in retail samples were obtained from carcasses chilled at 2-3 °C for 24 (n=40) and 72 h (n=40). For each production date (24/72 h carcass chilling), four master packs were prepared (trial 1). Whereas, sliced beef samples that had been previously vacuum packaged during 7 (n=30) and 15 (n=12) days storage at 1±0.5 °C, were used (trial 2). Samples were prepared as follow: each bone-in cut was placed in a polystyrene tray, while sliced beef samples were placed, in groups of five in the try. Both kind of samples were then overwrapped with a polyethylene film and distributed in groups (six or ten) into a master pack (barrier film, GRACE, Arg). Each master pack were then evacuated, filled with a mixture of O_2 80% y CO_2 20% and kept at 1 ± 0.5° C until they were opened. For trial 1, four master packs (two of each production date) were opened after 1 day of storage under MAP; the other four were opened after 3 days under the same conditions. For trial 2, samples of the two storage times under vacuum, 7 and 15 days, were analyzed after 1, 3 and 5 days under MAP. For both trials, half of the samples belonging to each master pack were immediately analyzed; while the other half, was assessed after 48 hours to simulate retail display storage.

Sensory evaluations: Organoleptic characteristics, color, odor and general appearance were evaluated subjectively.

Determination of gas composition: Previous to master pack aperture, a 10cm^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).

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), and *Pseudomonaceae* count, were performed (Rodríguez et al., 1993).

Determination of pH: Determination of pH was done in a slurry using a Metrohm 691 pHmeter (Metrohm, Switzerland) using a combined pH electrode (Metrohm 6.0218.010).

Results and Discussion:
Considering the entire period of study, gas composition varied in the range of 66.3-85.3% for O_2 and 13.7-19.5% CO_2 for master packs of trial 1; while for master packs containing portioned beef, the range of variation was 71.1-84.1 for O_2 and 16.7-18.9% CO_2. Samples of bone-in cuts remained bright red under MAP conditions, whereas sliced samples became brownish after 5 days under MAP. The $\log_{10}$ CFU/cm^2 of TVC of fore shank bone-in retail cuts, obtained after 1 and 3 days of MAP storage and after 48 h of display condition are showed in Table 1. Generally, little differences were observed between treated and control samples, though control samples longer aged (72h carcass chilling) had higher counts. For both carcasses chilling storage times, TVC values for samples assessed after 1 day under MAP, and at the moment of master pack aperture were around 10^3 CFU/cm^2, whereas after 48 h without MAP, count reached 10^5 CFU/cm^2. Storage in MAP for 3 days resulted in TVC approximately 1.0 log higher compared with results obtained after 1 day under MAP. Regarding to total storage period (chilling, MAP, and retail display) of 8 days RTV was 2.0 log below the cut off value (10^7 CFU/cm^2). *Pseudomonaceae* counts for trial 1 samples are showed in Table 2. For treated samples, mean counts were $\log_{10}$ 3.53 and 4.43 CFU/cm$_2$ for samples analyzed after master pack aperture and after 48 h without MAP, respectively. The $\log_{10}$ CFU/cm^2 of TVC of sliced retail cuts, obtained after 1,3 and 5 days of MAP storage and after 48 h of display condition are showed in Table 2. Taking into account retail treated samples aged for 7 days under vacuum, mean TVC value at the end of the display storage (12 days) was $\log_{10}$ 6.10. Only those samples which had been vacuum packaged for 15 days, master packaged for 5 days and held for 48 h under display conditions, mean TVC count overpass the cut off value (10^7 CFU/cm$_2$). Prasai et al. (1998) found that TVC of 97 % of beef strip loins stored for up to 186 days under vacuum and sprayed with 1.5% LA, was lower (0.7 to 2.5 log) compared to control samples. In the current study, at the end of the storage period, *Pseudomonaceae* mean counts were $\log_{10}$ 5.68 and 6.62 CFU/cm$_2$ for samples vacuum packaged for 7 and 15 days, respectively. Fore shank retail samples showed a constant surface pH value (5.73-5.77). Sliced retail samples showed pH values in the range of 5.50-5.75. Based on the results of the

current study, combined use of LA, and MAP provided an acceptable bone-in retail cuts kept during 48 h under retail display conditions. Benefits were much lower, though, in 72 h aged as well as in sliced samples.

Conclusions:

Combined use of MAP and LA treatment, could improve overall acceptability of both fresh and vacuum packaged-sliced beef fabricated as retail cuts. Aging and sliced showed adversely effect on beef shelf life under commercial refrigeration.

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TABLE 1: TVC (mean $\log_{10}$ CFU/cm^2) of fore shank bone-in cuts fabricated from chilled carcasses. Values obtained after 1 and 3 days under MAP and under regular display conditions.

		$\log_{10}$ CFU/cm^2			
Carcasses chilling storage (h)		24		72	
Storage under MAP (h)		24	72	24	72
0[a]	C[c]	3.70	4.08	3.15	5.17
	T[d]	3.99	4.23	3.37	4.60
48[b]	C	5.10	6.23	4.81	5.38
	T	5.41	5.17	4.62	5.00

[a] samples analyzed immediately after master pack aperture
[b] samples analyzed after 48 h under display conditions
[c] control samples
[d] samples treated with LA 1.5%

TABLE 2: *Pseudomonaceae* values (mean $\log_{10}$ CFU/cm^2) of fore shank bone-in cuts fabricated from chilled carcasses. Values obtained after 1 and 3 days under MAP and under regular display conditions.

		$\log_{10}$ CFU/cm^2			
Carcasses chilling storage (h)		24		72	
Storage under MAP (h)		24	72	24	72
0[a]	C[c]	3.50	3.71	1.93	4.34
	T[d]	3.70[e]	4.01	2.50	3.90
48[b]	C	4.23	5.51	4.71	4.57
	T	5.20	4.50	4.35	3.65

[a] samples analyzed immediately after master pack aperture
[b] samples analyzed after 48 h under display conditions
[c] control samples
[d] samples treated with LA 1.5%

TABLE 3: TVC (mean $\log_{10}$ CFU/cm^2) of sliced beef samples after 1, 3 and 5 days under MAP and under regular display conditions.

		$\log_{10}$ CFU/cm^2				
Previous storage under vacuum (days)		7		15		
Master pack #		II1	II2	I1	I2	I3
0[a]	C[c]	3.74	4.19	4.35	6.39	6.81
	T[d]	3.39	3.84	4.67	6.23	6.74
48[b]	C	5.13	6.19	6.08	7.40	7.20
	T	5.00	6.10	5.75	6.99	7.19

[a] samples analyzed immediately after master pack aperture
[b] samples analyzed after 48 h under display conditions
[c] control samples