CARBON DIOXIDE MASTERPACK AS A MEANS FOR EXTENDING SHELF LIFE OF CHICKEN CUTS

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BACKGROUND

Over the past tem years, the poultry processing industry in Brazil has experienced a number of radical changes in the way it processes, handles and markets raw materials and finished products. Among these changes, one of the most sweeping perhaps is the tendency to sell poultry in selected fresh cuts rather than in whole fresh units (1).
In recent years, several studies have been carried out to investigate the efficiency of modified atmosphere (MA) packaging systems in prolonging the shelf life of poultry products. A significant number of these research efforts concentrated on evaluating the effect of different combinations of gas mixtures and storage temperatures on the keeping quality of pre-packaged foods(2,3).

OBJECTIVES

Evaluate from a microbiological and sensory standpoint, the effect of gaseous atmospheres containing high levels of $C0_2$ (80% $C0_2$/20%N_2) in extending the shelf life of chicken cuts (chicken leg).

MATERIALS AND METHODS

Packaging and Storage: About 1Kg of chicken legs were arranged in a heat sealed low density polyethylene primary pack. Next, four of these 1kg- primary packs were put inside a secondary masterpack barrier bag of co-extruded nylon/low density polyethylne film. The masterpacks were filled, evacuated, injected with MA gas mixtures and heat sealed with a hand-operated vacuum machine (SELOVAC Model CA 1000). The masterpacks of the experimental lot was injected with injected with 80%$C0_2$/20%N_2.

Packaging headspace gas analyses: The 0_2, $C0_2$ and N_2 contents of the masterpack headspace were determined to evaluate the overall composition of the gaseous environment in wich the poultry samples were stored. The exact levels of 0_2, $C0_2$ and N_2 were determined in a gas chromotograph equipped with a thermal conductivity detctor and Molecular Sieve 5A and Porapack Q Columns. The final results were expressed as % volume 0_2, $C0_2$ and N_2.

Microbiological Evaluation: Initial microbiological characterization of the product samples consisted of the following tests: total aerobic mesophilic count, total aerobic psychrotrophic count, total enterobacteria count, faecal coliform count. From this point on, variations of bacterial populations during storage were monitored by means of periodical total aerobic psychrotrophic and total enterobacteria counts. All the methods employed for microbiological evaluation are recommended and described by VANDERZANT & SPLITTSTOESSER (4).

Sensory Analysis: Consisted of the evaluation of rancid, putrid and öld"odors and overall product appearance by a panel of 5 trained judgers. Both sensory quality parameters were evaluated separately and were assigned a rating on a hedonic scale of 1 to 5. Shelf life investigations were discontinued whenever a sample presented putrid odor (rating 2 on the hedonic scale).

RESULTS AND DISCUSSIONS

Headspace Gas Analyses: In the masterpacks flushed with 80% $C0_2$/20%N_2, the initial oxygen content was 0.25%. After 6 days storage, these samples contained 0.75% oxygen. After 17 days, the oxygen content had dropped back to 0.38%. On the other hand, the initial C02 of 77.54% had been reduced to 57.05% after 17 days as a result of both disolution in the product and permeation through the packaging material. The changes in the concentration of N_2, from 22.28% to 42.57%, are mainly due to the loss of $C0_2$ from the head-space.

Microbiological Evaluation: The initial microbiological profile of the chicken leg cuts tested in this study is presented as: Total aerobic mesophilic count was 5.38 log CFU/g, total aerobic psychrotrophic count was 5.72 logCFU/g, total and faecal coliforms 350 NMP/g, and Enterobacteria 3.11 logCFU/g.
The tests carried on with samples packed and stored in MA showed a relatively elevated initial psychrotrophic count of 5.72 log CFU/g which probably restrained the effect of $C0_2$ on the shelf life of the chicken legs. Even so, in the period between the 6th and the 9th day of the storage , the product under MA presented pschrotrophic counts 2 logarythmic cycles lower than the counts obtained from the control cuts under air (Figure 1). Based on the sensorial evaluation criteria outlined before, the control samples under air had already reached their shelf life limit after only 7 days storage. On the other hand, the products stored under 80%$C0_2$ presented extended shelf life of 17 days when the final psychrotrophic count attained 8 log CFU/g.
The equations that describe the growth evolution of psychrotrophic bacteria in poultry cuts stored in 80%$C0_2$/20%N_2 and corresponding control samples stored in air shown below:

80%$C0_2$/20%N_2	log CFU/g = 4.99+0.20t (R^2 = 0.88)	(1)
air	log CFU/g = 4.97+0.40t (R^2 = 0.79)	(2)

where: t= time (days)

The curve slope, which indicates the growth rate per time unit, was 2 times higher for the product packed in air (equation2) when compared to the slope produced by samples under MA with 80%$C0_2$ (equation1). The system of MA packaging significantly reduced the growth rate of psychrotrophic bacteria when compared to storage in air.

Sensory Evaluation: After 6 days storage, slightly "old" and rancid odors were detected in all the samples, both those under air and the ones under MA, while 100% of the samples presented 'slightly changed"overal appearance. On the 6th day, the product under air started to give off putrid odors rated as "absent" and "light", whereas "moderate" putrid odor set in on the 9th day. As the detection of "light" putrid odor is considered the limit of sensory acceptability in this study, the samples under air were rejected after 7 days storage when aerobic psychrotrophic counts had reached between 8.13 and 8.30 log CFU/g.
Betwen the 9th and the 13th day of storage, the chicken leg cuts stored under 80%$C0_2$ practically didn't undergo any perceptible sensorial changes. However, from the 14th day onwards, this moderate rancid odor gradually grew stronger until it was rated "intense" after 17 days. The occurence of "light"putrid odor, i.e. the limit for sensorial acceptability, was only detected after 17 days storage, when rancid odors had already turned quite intense. In the same period, the chicken cuts presented a "moderately" to "intensely" changed overall appearance, while microbiological assessment tests produced total aerobic psychrorophic counts between 8.13 and 8.17 CFU/g.

CONCLUSIONS

The above results allow us to conclude that the packaging system investigated 80%$C0_2$/20%N_2 masterpack provides greater shelf life extension (from 7 to 17 days), even though the poultry cuts under MA carried a higher initial microbial population.
Products packed in high $C0_2$ MA only started to develop putrid odor after high psychrotrophic counts had been attained (around 8 log CFU/g), whereas in the case of products stored under air, putrid odor delopment may be associated with comparatively lower counts (between 7.3 and 7.7 log CFU/g).

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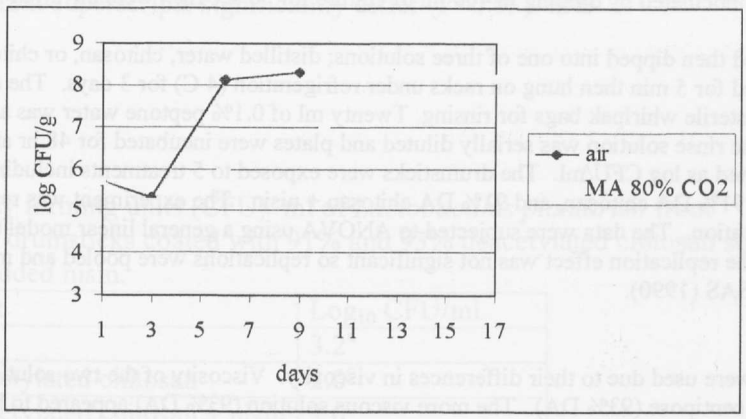

Figure 1. Evolution of psychrotrophic bacteria in chicken leg cuts stored in modified atmosphere masterpacks with 80%CO_2/20%N_2 and their corresponding control samples stored in air, during dark storage at 3+1°C.

TABLE 1. Sensory evaluation of chicken leg cuts in masterpacks with 80%CO_2/20%N_2 and a corresponding control samples packed in air, during dark storage at 3+1°C

Atribute	Storage (days)															
	Initial		3		6		9		10		13		15		17	
	AIR	MA	AIR	MA	AIR	MA	AIR	MA	AIR	MA	AIR	MA	AIR	MA	AIR	MA
"old" odor	1,0	1,0	1,0	1,3	2,1	1,9	2,0	2,2	Nd	2,3	nd	2,4	Nd	3,1	nd	2,4
Odor rancid	1,0	1,0	1,0	1,0	2,3	2,0	2,3	2,7	Nd	3,1	nd	3,4	Nd	3,5	nd	3,9
Putrid odor	1,0	1,0	1,3	1,0	1,4	1,1	3,0	1,4	Nd	1,3	nd	1,4	Nd	1.6	nd	1,9
Overall apearence	1,0	1,0	1,1	1,1	1,9	1,5	3,0	2,3	Nd	2,2	nd	2,6	Nd	2,8	nd	3,4

nd - not determined
AIR – air packed
MA – modified atmosphere masterpack