

INFLUENCE OF MODIFIED ATMOSPHERE PACKAGING ON PHYSICAL-CHEMICAL PARAMETERS OF LOIN LAMB STORED UNDER REFRIGERATION.

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ABSTRACT

The technology of modified atmosphere packaging (MAP) can be an interesting option for extending the shelf life of refrigerated products. Higher concentrations of O₂ in MAP can improve meat color, but can also promote lipid oxidation. In order to find the best ratio between oxygen (O₂) and carbon dioxide (CO₂), lamb loin samples were packed in four different MAP conditions (40 % CO₂ + 60 % O₂, 55 % CO₂ + 45 % O₂, 70 % CO₂ + 30 % O₂ and Vacuum). Samples were evaluated by objective color (L*, a* and b* parameters), cooking losses, shear force and lipid oxidation analysis during 21 days of storage at 1° C. At the end of the experiment, L*, a* and b* values ranged from 47.30 to 51.60; 7.92 and 11.92; 11.28 and 13.90, respectively. The lowest weight loss was achieved by treatment containing the gas combination 40% CO₂ and 60 % O₂ (26.5%). The lowest shear force value was obtained for vacuum packed samples (2.4 Kg), as well as lower levels of TBARS (0.75 mg malonaldehyde/ kg⁻¹ of sample). Continued studies will allow finding intermediate values of gas composition that can promote improvement of all parameters.

I. INTRODUCTION

Factors such as color, texture, juiciness and tenderness of meat are taken by consumers as the most important. Once the color is the main criteria observed by consumers when buying the meat, it is essential that stability of red color is maintained throughout the distribution process, storage and marketing. One advantage of modified atmosphere packaging technology (MAP) use, instead

of vacuum packaging, is the color quality observed in the first case which is lost in the vacuum packaging because of lack of pigment contact with oxygen (1). However packaging with high oxygen concentration tends to increase lipid oxidation in meat, negatively affecting aspects such as color and flavor (2). In this research, MAP technology effect by using different combinations of gases on the physicochemical stored refrigerated loin lamb aspects was investigated.

II. MATERIALS AND METHODS

Eighty-five lamb loins (*Longissimus dorsi*) from male animals of same race and local of production, with live weight in the range of 35-40 kg, slaughtered at 5 months, were individually wrapped in polystyrene Dry-lock trays, perforated for drainage of fluid (21P LinStar, LINPAC). The trays were placed individually in high barrier plastic bags for chilled beef containing 7 layers on EVA (ethynyl-vinyl acetate), PVDC (polyvinylidene chloride) and EVOH (polyvinyl alcohol) (BB2800, CROVAC). The loins were wrapped in packages with the following concentrations of gases: 40 % CO₂ + 60 % O₂ (T1), 55% CO₂ + 45% O₂ (T2), 70% CO₂ + 30% O₂ (T3) and vacuum (T4) and evaluated during 21 days of storage at 1°C. Samples of each treatment were subjected to evaluation of color using a portable colorimeter (model MiniScan XE HunterLab mark) by L*, a*, b* scale of CIE Lab system. Readings were taken after 30 minutes exposure to atmospheric air. For analysis of cook loss and shear force, samples (entire loins) were weighed and

then baked at 180°C until the geometric center temperature reached 72 °C. After the samples reached room temperature, they were weighed to determine the percentage of losses through the formula: $CL = [(initial\ weight - final\ weight) / initial\ weight] \times 100$. After cooking, the lamb loins were cut into parallelepipeds of 2 x 1 x 1 cm and "Warner Bratzler" accessory was used for determining shear force. Vyncke (1970) (3) method was used to measure the development of thiobarbituric acid reactive substances (TBARS) and results were expressed as milligrams of malonaldehyde (MDA) per kilogram of sample ($mg \cdot kg^{-1}$).

III. RESULTS AND DISCUSSION

For L* (Figure 1) parameter, it was found that treatments with higher oxygen concentrations (60 % and 55 %) showed similar curves, and these samples showed higher values of L* at the end of the experiment (51.25 and 51.60, respectively).

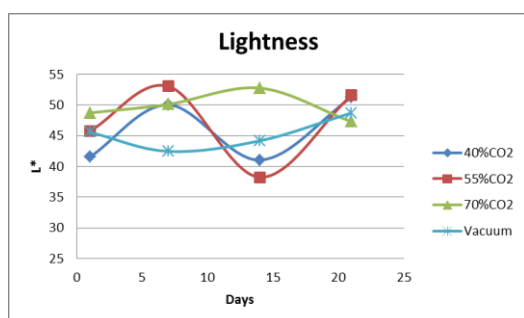


Figure 1 - Values of lightness (L*) during storage and after 30 minutes of opening the package.

Li *et al* (2012) (4) assessed the *Longissimus lumborum* loin color for 5 days. They noted that the L* value for the samples placed in Hiox -MAP (80% O₂, 20% CO₂) was greater than in vacuum.

For parameter a* (red color), it was observed that treatments with higher concentrations of oxygen (60 % and 55 %) also showed greater intensity of red color in the beginning of the experiment (14.25 and 14.26, respectively). However, at end of experiment, vacuum treatment showed higher a* values, followed by T1 (11.92 and 10.73) (Figure 2).

According to Kim *et al* (2010) (2) various studies have concluded that Hiox -MAP system creates a desirable red color in meat at start of the storage period, but the discoloration rate is faster when compared to systems with low O₂ content or vacuum.

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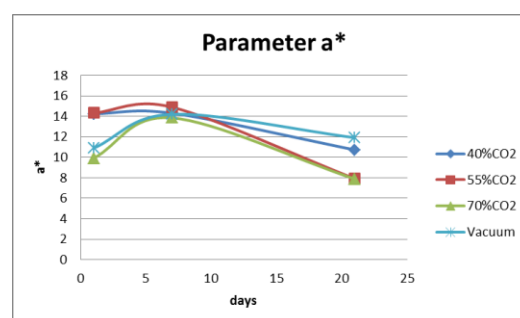


Figure 2 - Values of the parameter red color (a*) during storage and after 30 minutes of opening the package.

The values of b* parameter (Figure 3) were also higher for samples packaged in systems with higher O₂ content in the first test days (12.72 and 15.10). There was an increase along storage period in b* value for samples subjected to vacuum.

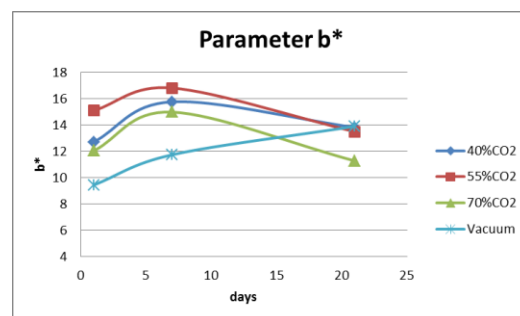


Figure 3 - Graph parameter values of the yellow color (b*) during storage at 1 ° C and 30 minutes after opening the package.

Results of cooking losses, shear force and TBARS are showed at table 1. The greatest loss was obtained by the sample under 55 % CO₂ / 45 % O₂ and lowest for the sample under 40 % CO₂ / 60 % O₂ in the last week of analysis. Hill *et al* (2012) (5) reported that preparation of lamb meat for consumption caused cooking losses of

35.20 %, which is higher than the highest value found in this study. This study did not reveal any tendency of weight loss

according to the different treatments to which the samples were subjected.

Tabela 1 - Analysis results of cooking loss, shear force and TBARS in lamb loins stored under different conditions of atmosphere and under refrigeration.

VARIABLE/ PERIOD	40% CO2 + 60% O2	55% CO2 + 45% O2	70% CO2 + 30% O2	Vacuum
<i>COOKING LOSS (g)^a</i>	Mean	Mean	Mean	Mean
Zero	28.98	21.40	19.60	26.69
7 days	18.86	25.17	22.80	23.90
14 days	25.61	15.92	24.45	22.38
21 days	26.52	33.71	27.59	30.04
<i>SHEAR FORCE (Kg)^b</i>	Mean ± SE ^d	Mean ± SE	Mean ± SE	Mean ± SE
Zero	3.17 ± 0.59	3.07 ± 0.19	3.33 ± 0.31	3.03 ± 0.36
7 days	3.18 ± 0.34	3.40 ± 0.08	3.23 ± 0.37	3.35 ± 0.14
14 days	2.72 ± 0.33	2.40 ± 0.28	4.10 ± 0.33	2.30 ± 0.26
21 days	3.43 ± 0.12	3.68 ± 0.10	2.83 ± 0.33	2.38 ± 0.08
<i>TBARS^c</i>				
Zero	0.61 ± 0.05	0.6 ± 0.1	0.98 ± 0.06	1.4 ± 0.4
7 days	0.77 ± 0.06	1.4 ± 0.1	1.0 ± 0.3	1.40 ± 0.09
14 days	0.31 ± 0.09	0.39 ± 0.09	0.6 ± 0.2	0.18 ± 0.01
21 days	0.88 ± 0.07	1.6 ± 0.2	0.90 ± 0.03	0.7 ± 0.1

^aFor each treatment, entire loins was used as a sample (results expressed in grams, g); ^bFor each treatment, 10 pieces of 2x 1x 1cm was used as sample, the result showed is a mean of these values. (results expressed in kilograms, Kg); ^cMean of four readings (Mg of MDA/Kg of sample), ^d SE = Standard deviation.

High oxygen levels can lead to formation of proteins cross-links by means of various reactions that render the protein less susceptible to enzymatic proteolysis reducing meat tenderness (Lund et al, 2007) (6). Thus, it can be seen that samples vacuum packed showed lower shear force.

The results of analyzes for thiobarbituric acid reactive substances (TBARS) showed that the highest value obtained at end of

experiment was achieved by treating 55 % CO2 + 45 % O2 (1.65 mg of MDA/ Kg of sample), and the vacuum treatment with the lowest (0.75 mg / kg sample).

Kim et al (2010) (2) also found higher values of lipid oxidation in samples subjected to Hiox-MAP, confirming that high levels of O2 tend to accelerate meat oxidation.

IV. CONCLUSION

This study demonstrated that treatments with higher concentrations of oxygen provided better color to the samples, which can be observed by high values of the parameters L *, a * and b *. However, high amount of oxygen negatively affected other physical-chemical aspects such as oxidation of lipids and texture. Continued studies will

help to identify an intermediate value of gas composition that can promote all the mentioned parameters.

V. REFERENCES

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