

EFFECT OF OZONE ON PHYSICOCHEMICAL PARAMETERS CHANGES DURING AGEING OF BEEF

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Abstract – Ozone is a gas that is naturally present in the stratosphere; it is water-soluble and has a high oxidative power. The effect of ozone on physicochemical properties of *longissimus dorsi* through the stored time was evaluated. Samples were exposure a continuous flux of ozone (2 ppm O₃/m³/h) at 4±1°C during 28 days. Color parameters (L*, a* and b* values) decreased significantly ($P<0.01$) over time showing the lowest values at the end of refrigerated period. On the other hand, lipid oxidation increased significantly ($P<0.05$) from 0.12 to 0.27 mg MDA/kg during the whole display. As expected, shear force decreased significantly ($P<0.001$) during the first 14 days, reaching a final value of 23.3 N at the end of ageing process.

Key Words – Color, texture parameters, lipid oxidation

I. INTRODUCTION

The bovine breed “Rubia Gallega” appears in the Official Catalogue of Livestock Breeds in Spain. The use of local breeds as an alternative beef production system has important advantages, as these breeds are closely related to the environment and they help to maintain biodiversity and sustainable agricultural production, especially in depressed areas [1]. On the other hand, ozone (O₃) is an allotropic form of oxygen. It is characterized by a high redox potential of -2.07 V, as compared with chloric (I) acid (-1.49 V), chlorine (-1.36 V) or oxygen (-0.40 V) [2]. Ozone is used in a wide variety of agricultural products, such as vegetables, fruits and fish with broad-spectrum antimicrobial activity and is regarded as a potential bactericidal agent [3]. Lipid oxidation is one of the primary factors that reduce the quality of meat and occurs through the presence of both endogenous and exogenous pro-oxidants. Ozone causes oxidative conditions to which the cells respond by stimulating the expression of antioxidant enzymes [4]. Thereby, several physicochemical factors related to meat organoleptic characteristics, such as pH, color, TBARS and tenderness, might be affected. These parameters are considered important as quality indicators and they have an impact on consumer acceptability [5]. Thus, the purpose of this work was to study the influence of ozone on physicochemical properties during the ageing process of beef stored at 4±1°C during 28 days.

II. MATERIALS AND METHODS

A. Experimental design and sampling

For this study, ten cows of “Rubia Gallega” breed were used. Animals were slaughtered at ranged of five to seventeen years old. The slaughter live weight was ranged between 574 and 788 kg. Animals were conventionally slaughtered at a commercial slaughterhouse and after 48 h, the *Longissimus dorsi* (LD) muscle was extracted from the left half of each carcass. The LD samples were exposure a continuous flux of ozone (2 ppm O₃/m³/h) at 4±1°C during 28 days. Two steaks of 2.5 cm of thickness were taken after 0, 14 and 28 days of display.

B. Analytical methods

To assess the meat quality the following physicochemical parameters (pH, color, lipid oxidation and shear force) were determined. The pH of samples was measured directly using a pH-meter equipped with a glass probe for penetration. Instrumental color in the CIELAB space was automatically measured on the surface of steaks by a CM-600d portable colorimeter. The TBARS index was measured according to the method of Vyncke (1975) [6]; results were expressed as milligrams of malondialdehyde (MDA) per kilogram of meat. To measure shear force, the meat was cooked in a water bath at 80 °C by immersion until the temperature reached 70 °C *in quore* according to Franco *et al.* [7]. A texture analyzer (TA.XT.plus Stable Micro Systems) was used, and all samples were cut perpendicular to the muscle fibre direction at a crosshead speed of 3.33 mm/s. The average value for each LD sample was recorded from four replicates.

C. Statistical analysis

In order to study significant differences among the groups studied, an analysis of variance (ANOVA) and posterior Duncan's test with a 0.05 level of significance was performed, using the SPSS package (SPSS 19.0).

III. RESULTS AND DISCUSSION

The effect of ozone on physico-chemical changes through the ageing process of LD from the “Rubia Gallega” breed cows is shown in Table 1. The pH values did not show significant differences over time, which were in the “normal” range of pH values in fresh meat. This result is in disagreement with data reported by Franco *et al.* [7] who found significant differences on pH in beef samples under vacuum conditions stored during 42 days.

Table 1. Effect of ozone on physicochemical changes during ageing of *Longissimus dorsi* from “Rubia Gallega” breed cows

Parameters	Storage time (days)			Significance
	0	14	28	
pH	5.74 ± 0.09	5.71 ± 0.07	5.76 ± 0.14	n.s.
<i>Color parameters</i>				
L*	33.52 ± 2.98 ^b	30.64 ± 4.30 ^b	27.33 ± 2.99 ^a	**
a*	14.72 ± 1.62 ^c	6.63 ± 3.69 ^b	3.53 ± 2.09 ^a	***
b*	11.24 ± 1.40 ^c	6.86 ± 3.78 ^b	3.98 ± 2.38 ^a	***
<i>Lipid oxidation</i>				
TBARs (mg MDA/kg)	0.12 ± 0.05	0.22 ± 0.16	0.27 ± 0.11	*
<i>Textural parameters</i>				
Shear force (N)	52.6 ± 20.5 ^b	23.8 ± 7.50 ^a	23.3 ± 5.90 ^a	***

Significance: *** (P<0.001), ** (P<0.01), n.s. (not significant); ^{a-b} Means in the same row not followed by a common superscript number differ significantly (P<0.05)

On the other hand, color parameters presented significant ($P<0.01$) differences throughout the ageing process. In this regard, the L*, a* and b* values decreased from an initial average value of 33.52, 14.72 and 11.24 to 27.33, 3.53 and 3.98 at the end of process, respectively. Regarding lipid oxidation, the TBARS values also showed significant ($P<0.05$) differences during the whole display, reaching the highest TBARS values at the end of period (0.27 mg MDA/kg). Finally, ageing process had a significant ($P<0.001$) effect on shear force values, reaching the lowest shear force values at the end of process (23.3 N). A similar trend was observed by Franco *et al.* [7] who noticed the lowest shear force values in beef samples under vacuum conditions stored after 42 days.

IV. CONCLUSION

The results obtained in terms of meat quality confirm that ageing of *Longissimus dorsi* with ozone affected to color, lipid oxidation and texture parameters, fact that could affect to the product acceptability by consumers.

ACKNOWLEDGEMENTS

Authors are grateful to Xunta de Galicia (grant number FEADER 2015/27) for the financial support.

REFERENCES

1. Franco, D., Fernández, M., Justo, J.R., Lorenzo, J.M., González, L., Rivero, C.J., Lama, J., García-Fontán, M.C., Bispo, E., Carracedo, S., Moreno, T. (2010). Meat characterization of four endangered Galician cattle breeds. 56th Int Cong of Meat Sci and Technol, Jeju (Korea), August 15-20, p: 115.
2. Kim, J.G., Yousef, A.E., Dave, S. (2009). Application of ozone for enhancing the microbiological safety and quality of foods: A review. Journal Food Protect 62: 1071–1087.
3. Greene, A. K., Guzel-Seydim, Z. B., and Seydim, A. C. (2012). Chemical and physical properties of ozone. In: Ozone in food processing. O'Donnell, C., Tiwari, B. K., Cullen, P. J., and Rice, R. G. (ed) Wiley-Blackwell Publishing Co., Ames, IA, pp. 19-32.
4. Lee, Y. K., Kim, S. M., and Han, S. (2003). Ozone-induced inactivation of antioxidant enzymes. Biochimie. 85: 947-952.
5. Dunne P.G., Monahan F.J., O'Mara F.P., Moloney A.P. (2009). Colour of bovine subcutaneous adipose tissue: a review of contributory factors, associations with carcass and meat quality and its potential utility in authentication of dietary history. Meat Science 81: 28-45.
6. Vyncke, W. (1975). Evaluation of the direct thiobarbituric acid extraction method for determining oxidative rancidity in mackerel (*Scomber scombrus* L). Fette Seifen Anstichm 77: 239-240.
7. Franco, D., Bispo, E., González, L., Vázquez, J.A. & Moreno, T. (2009). Effect of finishing and ageing time on quality attributes of loin from the meat of Holstein-Friesian cull cows. Meat Science 83: 484-491.