

# STORAGE OF PACKAGED SLICED "SALCHICHÓN" ENRICHED IN MUFA OR PUFA: EFFECT ON COLOUR AND OXIDATION STABILITY

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## Introduction

From the nutritional point of view, fermented sausages are an important source of proteins of high biological value (Berain *et al.*, 2000); however, these traditional meat products show some negative aspects as a consequence of their high animal fat content. Nowadays, the meat industry tries to offer the consumer healthy products obtained by different strategies, improving the nutritional quality of food by modification of the lipid fraction: increasing the monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA). Moreover, a high percentage of MUFA and PUFA makes these products highly sensitive to oxidation. In this sense, packaging methods in modified atmospheres (vacuum and gas packaging) allow a longer product shelf life as well as variety in presentation method. The aim of this work was to investigate the effect of different storage conditions (vacuum and gas mixture packaging) on oxidation and colour stability of sliced salchichon, manufactured with raw meat enriched in MUFA and PUFA, and stored for a long period time (210 days) at 6 °C.

## Materials and Methods

**Samples.** The sausages were manufactured according to a traditional formulation with lean and backfat obtained from pigs fed with three different diets: 1) control (CO), 2) enriched in monounsaturated fatty acids (HO) and 3) enriched in polyunsaturated fatty acids (HL). Two sausages, randomly selected for each batch, were sliced at 1mm thickness and 100g slices were placed in polystyrene trays.

**Packaging and storage.** The trays were packed under: (a) **Vacuum:** trays were introduced in plastic bags (polyamide/polyethylene) which were subjected to vacuum and sealed using a packer (mod. EVT-7-TD Tecnotrip, Barcelona, Spain), or (b) **Gas mixture:** trays were evacuated and flushed with the selected gas mixture, 20/80% CO<sub>2</sub>/N<sub>2</sub>, (Carburros Metálicos S.A., Barcelona, Spain). Then, were closed with a high barrier film by heat-sealing with a packer (mod. TSB-100 Tecnotrip, Barcelona, Spain). Packages had a headspace volume ratio of 1:1. The gas content of each pack and the residual O<sub>2</sub> was controlled using a gas analyzer 1450 B3 Servomex (Aries, Madrid, Spain).

All samples were stored at 6°C until their analysis. Samples for all treatments were analysed at 0, 15, 30, 60, 90, 150 and 210 days of storage. The whole experiment was replicate twice.

**Determination of fatty acids.** Fatty acids were determined in the lipid extracted from ripened sausages for each packaging method and after each storage time. The Bligh and Dyer (1959) method was used for the lipid extraction. Fatty acids composition was determined by gas chromatography. Boron trifluoride/methanol was used for the preparation of fatty acid methyl esters (Morrison and Smith, 1964). Fatty acids methyl esters were identified by comparison with standards run previously alone or together with samples and were quantified as percentage of total methyl ester percentage.

**TBA (2-Thiobarbituric acid) analysis.** TBA measurements were made using the Maraschiello *et al.* (1999) method. The TBA values are expressed as micrograms of malonaldehyde per gram of sausage.

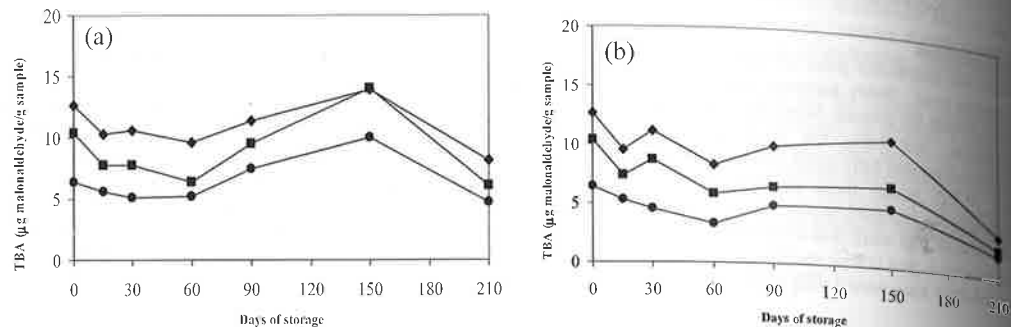
**Instrumental colour measurement.** Objective measurement of colour was performed at the surface of the salchichon using a reflectance spectrophotometer (Minolta CM-2002; Osaka, Japan). Colour coordinates were determined in the CIE-LAB system and the results were expressed as lightness (L\*), redness (a\*) and yellowness (b\*).

**Statistical analysis.** Data were statistically analysed using one-way analysis of variance (ANOVA) in order to determine the effect of storage time for each batch and for each type of packaging. In addition, a two-way ANOVA test was carried out in order to determine significant differences among sausages depending on the type of formulations and type of storage. Means were separated by Tukey honest significant difference test at 5% level. Data analyses were conducted using the statistical package STATISTICA 7.0.

## Results and Discussion

Regarding fatty acids composition, significant differences were observed between the group CO and those with modified fat composition. An increase (2.67%) of oleic acid was observed for the HO group compared to CO group and a greater increase in linoleic and linolenic acids (48.08 and 57.27% respectively) was obtained for the HL group compared to the CO group. With these fatty acids profiles, modified products (HO and HL) showed better ratios than control products (CO) from a nutritional point of view. Higher MUFA+PUFA/SFA (1.63 and 1.51) and PUFA/SFA (0.40 and 0.47) in HO and HL products were found than in control ones (1.36 and 0.32 respectively), which is considered beneficial in relation to blood lipids. In Figure 1, the evolution of TBA values can be observed for vacuum

packaged salchichon (Figure 1a) and for 20/80% CO<sub>2</sub>/N<sub>2</sub> packaged salchichon (Figure 1b). Higher values were observed in the HL salchichon, followed by HO and CO samples. This may be due to the fact that SFA and MUFA fatty acids are less susceptible to oxidation than PUFA. With respect to the lipid oxidation evolution, for all treatments, TBA values increased ( $p < 0.05$ ) at 150 days of vacuum storage and then began to decrease ( $p < 0.05$ ). For the samples stored under 20/80% CO<sub>2</sub>/N<sub>2</sub> no changes ( $p > 0.05$ ) were observed up to 150 days and then, TBA values decreased ( $p < 0.05$ ) at the end of storage period. Janero (1990) pointed out that a decrease in TBA values during storage could be attributed to reaction of MDA with amino acids, sugars and nitrite in complex formulations. With respect to storage conditions, gas packaged samples showed lower TBA values ( $p < 0.05$ ) than those found in vacuum packaged samples after 90 days of storage.



**Figure 1:** Evolution of TBA values on ripened salchichion with three formulations: (○) CO control (■) HO high oleic (▲) HL high linoleic along 210 days of storage under vacuum (a) and under 20/80% CO<sub>2</sub>/N<sub>2</sub> (b).

Regarding colour parameters of salchichon packaged under vacuum and with 20/80% CO<sub>2</sub>/N<sub>2</sub>, no differences were found for L\* values along storage, and no differences ( $p > 0.05$ ) were obtained for this parameter between packaging methods at each storage time. Besides, no differences ( $p > 0.05$ ) were found in L\* values between salchichon types, except at day 0 of storage, where significant differences were found between CO salchichon (49.21) and HO group (42.96). With regard to redness value (a\*), which is used as an indicator of colour stability in meat and meat products, did not show differences ( $p > 0.05$ ) during the storage period, and values at the end of storage were similar to those at the packaging moment (7.23-11.93). As expected, a\* values remained constant throughout all storage period because nitrite was added, which acts as a colour stabiliser (Harms *et al.*, 2003). The b\* value is a colour parameter concerning with lipid oxidation. In this work, storage time did not determine changes ( $p > 0.05$ ) on parameter b\* in vacuum and gas mixtures packaged samples, and no differences ( $p > 0.05$ ) were obtained for this parameter between packaging methods at each storage time. However, statistical differences ( $p < 0.05$ ) were observed for this parameter between sausages with different fat composition when sausages were packed under 20/80% CO<sub>2</sub>/N<sub>2</sub>, although these differences did not follow a clear trend.

### Conclusions

On the basis of the results obtained in this work, it can be concluded that it is possible to store sliced dry fermented sausages enriched in MUFA or PUFA, (desirable from a nutritional point of view) for a long time period without a significant increase on the colour parameters and on oxidation if a suitable packaging method is used.

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