

EVOLUTION OF MICROBIOLOGICAL AND SENSORY QUALITY ALONG STORAGE OF PACKAGED "SALCHICHÓN" ENRICHED IN MUFA AND PUFA

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Introduction

Salchichon is one of the most important dry-cured sausages prepared in Spain. Nowadays, due to the recent changes in shopping and consumption habits, packaged sliced meat products are an important retail selling method. Furthermore, nutritionists have persistently recommended changes in the composition of fat associated with meat, towards a reduction of saturated acids to the advantage of mono and polyunsaturated fatty acids, for their positive effects. For this, the problem of safe preservation in the meat industry has become more complex as today's products require longer shelf life and greater assurance of protection from microbial spoilage. Therefore, industrial trends try to extend the shelf life of this type of products by storage practices such as modified atmosphere packaging (vacuum and gas mixtures packaging). The aim of this work was to evaluate the shelf life of salchichon manufactured with raw meat with different fatty acid composition, packaged under two kinds of conditions: vacuum and 20/80% CO₂/N₂ currently used by the meat industry. The assessment of the shelf life was based on the microbiological counts, pH and a_w measurements as well as on the sensory evaluation.

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 1 mm thickness and 100 g of 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% CO₂/N₂ (Carbuos Metálicos S.A., Barcelona, Spain). Then, they 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. 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 replicated twice.

Microbiological analysis: The samples were analysed for aerobic mesophilic bacteria (3M Petrifilm Aerobic Count Plate (Bioser, Barcelona, Spain) at 30°C for 48 h), psychrotrophic bacteria (Plate Count Agar (Scharlau, Spain) at 7°C for 10 days), anaerobic bacteria (Schaedler Agar (Scharlau, Spain) at 37°C for 48 h), *Enterobacteriaceae* (3M Petrifilm Enterobacteriaceae Count Plate (Bioser, Barcelona, Spain) at 37°C for 24h), *Enterococcus* (Slanetz Bartley Agar (Scharlau, Spain) at 37°C for 24 h), *Pseudomonas* (*Pseudomonas* Agar (Oxoid, Spain) supplemented with Cetrimide, Fucidine and Cephaloridine (CFC, Oxoid, Spain) at 30°C for 48 h), lactic acid bacteria (LAB) (MRS Agar (Scharlau, Spain) at 30°C 72 h), *Micrococcaceae* (MSA (Scharlau, Spain) at 37°C for 48 h), yeasts and molds (3M Petrifilm Yeast and Mold Count Plate (Bioser, Barcelona, Spain) at 25°C for 5 days).

Physicochemical analysis: Water activity (a_w) was measured by CX2 AQUA LAB equipment. The pH values were determined by blending with a pH meter equipped with a glass electrode.

Sensory evaluation: This was carried out on "salchichon" slices after each storage time by an experienced 8-member sensory panel. The sensory attributes (colour, odour, taste, hardness, juiciness and overall acceptability) were scored using 5-point scales (5 = excellent, 4 = good, 3 = acceptable, 2 = fair and 1 = unacceptable).

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 storage. Furthermore, 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

The results of the microbiological analysis showed that the lactic acid bacteria constituted the major microflora of the sausages (7.7-8.5 log cfu/g). Because of the good adaptation of lactic acid bacteria to the meat environment and their faster growth rates during fermentation and ripening of sausages, they become the dominant microflora (Drosinos *et al.*, 2005). In general, microorganisms in either vacuum or gas mixture packed salchichon, remained nearly constant for up to 210 days (data not shown). The stability in the counts during storage time, could be explained by taking into account that packaging in anoxic environments retards microbial growth and delays spoilage due to slow proliferation of

bacteria capable of tolerating anaerobic conditions (Martínez *et al.*, 2006). However, enterobacteria and pseudomonad counts were subjected to a significant inhibition when the salchichon was packaged under vacuum and with 20/80% CO₂/N₂ and values under detection limit were found after 15 days of storage, probably due to the strong competitive effect of lactic acid bacteria on the rest of the endogenous flora. Lactic acid bacteria suppress the growth of Gram-negative bacteria by producing organic acids and various antibacterial metabolic products (Holzapfel *et al.*, 1995). Regarding packaging method, no significant differences ($p > 0.05$) were found in counts for flora studied between both types of packaging for the same salchichon group. Therefore, vacuum and gas mixtures (20/80% CO₂/N₂) packaging did not show differences with respect to the shelf life of salchichon.

Storage time had a significant effect on pH values of different sausages and during storage the pH values were significantly reduced in all groups (from 5.05-5.10 to 4.77-4.99). The decrease in pH values during the refrigerated storage of vacuum and gas mixture packed samples could be attributed to the activity of lactobacilli and to the dissolution of CO₂ into meat product. The results of water activity (a_w) showed a_w remained constant during storage under modified atmospheres packaging and no differences were found between both types of packaging. Mean values obtained were 0.862, 0.877 and 0.869 for CO, HO and HL, respectively.

Storage time had significant effects ($p < 0.05$) on sensory parameters (Figure 1) considered and the sensory parameters values decreased linearly over time in vacuum and 20/80% CO₂/N₂ packed samples of sausages. In general, a loss of spice odour and taste and a higher acid taste were detected in samples by the judges. In addition, they perceived a slight increase of hardness. Taken together, these results indicate that packaging under both modified atmospheres (vacuum and 20/80% CO₂/N₂) increases the shelf life of the product, though without entirely preventing the maturational changes that occur in dry fermented sausages. These results agree with those provided by Fernández-Fernández *et al.* (2002) for Galician chorizo sausage.

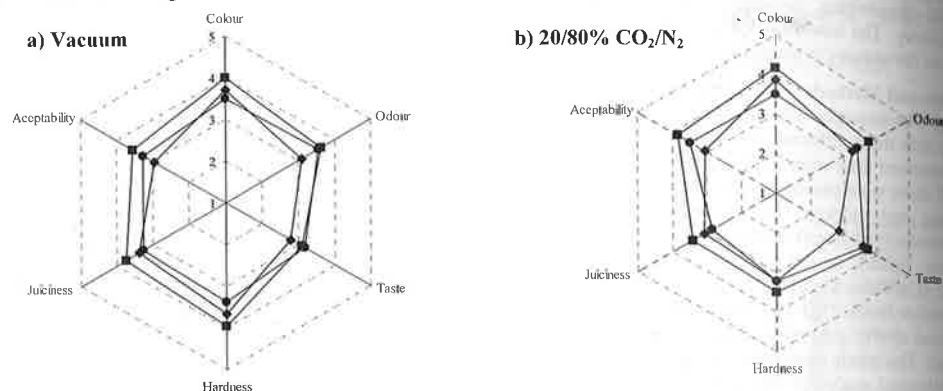


Figure 1: Sensory parameters evaluated on salchichon: (●) CO control (■) HO high oleic (◆) HL high linoleic at 210 days of storage under vacuum (a) and under 20/80% CO₂/N₂ (b).

Conclusions

The results of this study indicate that packaging under both modified atmospheres (vacuum and 20/80% CO₂/N₂) increases the shelf life of the CO, HO and HL salchichon. In terms of overall acceptability, the shelf life of HO and CO salchichon packed under vacuum and with 20/80% CO₂/N₂ were 210 days, and 150 days for HL salchichon.

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