DISPLAY LIFE OF FRESH PORK SAUSAGE: A COMPARISON BETWEEN TWO DIFFERENT PACKAGING SYSTEMS

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Introduction

Meat industries have shown growing interest in development of suitable techniques to extend shelf life and improve consumer acceptance while maintaining nutritional quality and ensuring safety. The combination of light and oxygen may cause discolouration during illuminated retail display life both in air and modified atmosphere packages. Recently, Schivazappa *et al.*, (2004) evaluated lipid oxidation and browning of fresh pork sausages packed under MA finding that the application of oxygen enriched atmospheres (60-80%) was advantageous up to 7 days. Tremonte *et al.*, (2005) reported that the application of 60% O_2 and 40% CO_2 atmosphere on fresh sausages resulted in an inhibitory effect of bacterial growth positively affecting colour and other physical attributes. The aim of this work was to evaluate shelf life of fresh pork sausage packed under an over-wrapping O_2-permeable film or a MA (65% O_2 and 35% CO_2) packaging system and stored under a refrigerated display cabinet. Changes of pH, water activity (a_w), lipid oxidation, colour and microbiological counts of pathogenic and spoilage bacteria were evaluated.

Materials and Methods

A total of 150 fresh pork sausages were purchased from a local manufacturer that also performed their packaging on trays containing 5 sausages each. The packaging treatments were: O_2Pfilm = packaging in a solid PS tray and over-wrapping with PVC O_2-permeable film; MAP= packaging in a solid PP tray coated by a PA-PP film under modified atmosphere (65% O_2 and 35% CO_2). Sausages were stored in a refrigerated display cabinet (5 ± 0.3°C), exposed for 24hr per day at a light intensity of 1000 lux for the following times after packaging: 3, 6 (commercial term) and 9 days for O_2Pfilm; 6, 12 (commercial term) and 15 days for MAP. For each packaging x storage temperature x time, 3 packages were used (one for microbiological analyses and two for the other analytical determinations). All the determinations were carried out immediately after the opening of the trays and removal of the casing. pH was measured directly on the fresh sausages with a penetration electrode 52-32 (Crison Strumenti, Carpi, I). a_w was measured on fresh sausages with a AQUALAB SERIES 3TE water activity meter (Decagon Devices, Inc. Washington USA). Lipid oxidation was evaluated by Thiobarbituric Acid Reactive Substances (TBARS, mgMDA/kg) test (Novelli *et al.*, 1998). Colour determination of a* (redness) was carried out by means of a digital imaging method developed by M. Riva (2006), scanning external surface of sausages with a flatbed scanner (Model Scanjet 8200, HP, Cupertino, USA) together with 12 standard coloured charts (Pantone® Inc. Carlstadt, USA) that covered the colour range of the sausages. The images were calibrated and quantitatively analyzed with Adobe Photoshop standard software (Version 6.0, Adobe Systems Inc., San Jose, USA). Microbiological analyses were performed on serial decimal solution prepared in Ringer's solution by 20 g of samples, after homogenization, on Plate count agar (PCA, Liofilchem) for total viable counts; de Man, Rogosa and Sharpe agar (MRS, Liofilchem) for lactic acid bacteria; Mannitol salt agar (MSA, Oxoid, Basingtoke, UK) for Micrococcaceae; Yeast Glucose Chloramphenicol agar (YGC, Merck, Darmstadt, G) for moulds and yeasts.

Results and Discussion

The pH of fresh samples was 5.70 and significantly decreased up to the commercial term to 5.30 for O_2Pfilm over-wrapped samples and to 5.23 for MAP remaining substantially unvaried extending shelf life. pH decrease was probably related to the growth of lactic acid bacteria (LAB), but it is not possible to exclude the influence of CO_2 adsorption for the explanation of the larger pH decrease observed for MAP sausages in comparison to O_2Pfilm samples. a_w of fresh samples was 0.974 and did not significantly change under all storage conditions for MAP while a slight decrease to 0.965 was observed during storage for O_2Pfilm sausages, as expected by the low gas barrier property of the film. TBARS values significantly increased in all samples during the first days of storage compared to fresh product, as shown in Figure 1, remaining substantially unvaried for O_2Pfilm sausages after 3 day storage. On the contrary, MAP samples showed a significant increase in lipid oxidation, resulting from a great light exposure influence on the rate of lipid oxidation for storage under O_2/CO_2 enriched atmosphere. MAP sausages also showed higher TBARS values than O_2Pfilm samples, as expected by higher O_2 percentage of MAP in comparison to air. a* values significantly decreased for O_2Pfilm sausages after day 3 (Figure 2). A significant decrease in a* was noticed for MAP, already after 6 days of storage, too. Schivazappa *et al.*, (2004) also noticed a discolouration of sausage surface after 7 days of storage under MAP (O_2 percentage higher than 20%) related to the metmyoglobin formation. The authors measured the change of MA composition during storage, reporting a marked O_2 percentage decrement (about 20%), starting from 7 days storage at 4

°C, that had probably reduced the rate of oxymyoglobin formation. On the contrary, no significant differences were found by Tremonte *et al.*, (2005) for a* values of sausages stored under 60% O_2 and 40% CO_2 in comparison to air.

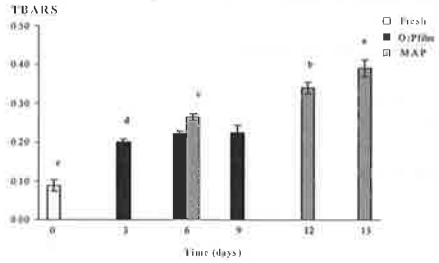

Figure 1: TBARS values during storage

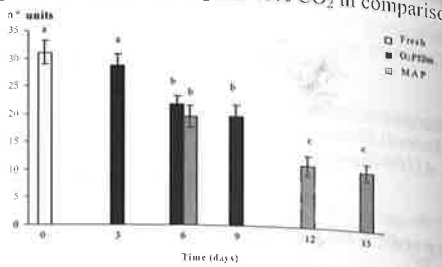

Figure 2: a* values during storage

Microbiological counts were evaluated on fresh sausages and stored samples both at the end and after the commercial term. Figures 3 and 4 show the PCA, MRS, MSA and YGC counts of O_2Pfilm and MAP, respectively.

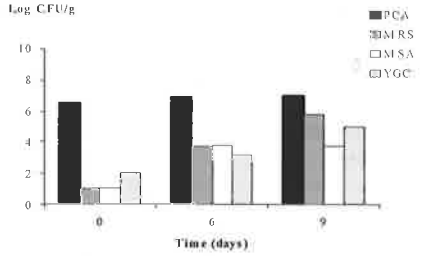

Figure 3: Microbiological counts for O_2Pfilm

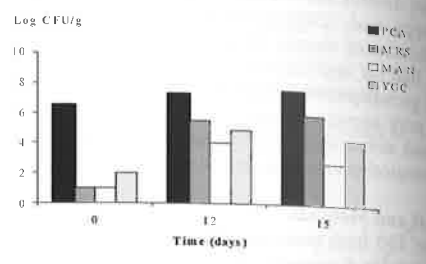

Figure 4: Microbiological counts for MAP

Total viable counts (PCA) did not significantly vary for O_2Pfilm and MAP samples during storage. Mesophilic lactic acid bacteria (MRS) increased in O_2Pfilm sausages and in MAP samples also after 12 days when a decrease in the oxygen level probably occurred in the modified atmosphere composition, showing to be tolerant to high CO_2 percentage. *Micrococcaceae* (MSA) were enabled to grow in both packaging systems until the commercial term while the subsequent count decrease of MAP samples could be related to the diminution of pH values due to LAB growth. Moulds and yeasts (YGC) showed a similar trend, increasing up to the commercial term to decrease until the end of the storage experiment probably because of the lower growing ability under diminishing oxygen only in MAP samples.

Conclusions

An extension of shelf life to 9 days could be probably applied on sausages over-wrapped by PVC film because of the substantial maintenance of the physico-chemical and microbiological properties, after the initial modification, in comparison to fresh product. Contradictory results were shown by MAP practice where a discolouration was noticeable after day 6 of storage, showing that high O_2 percentage is not able to control metmyoglobin formation for long time. In addition, TBARS values increased more under MAP, although the values were relatively lower than other literature data probably due to the presence of ascorbate in the formulation. In conclusion, MAP application on fresh pork sausage should be reconsidered paying particular attention to the advantages derived from reduction in distribution costs (*i.e.* fewer deliveries over longer distances) and the disadvantages not only derived by added costs (*i.e.* increase pack volume leading to increased retail display and transport costs) but also by the difficult maintenance of product quality for such long time.

References

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