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EFFECT OF DIFFERENT PACKAGING CONDITIONS ON SHELF-LIFE OF HAM

Abstract

Packaging is an integral and final part of each production line and its aim is to provide the final product with safer manipulation, storage and transportation to the customer, while the packaging forms an inseparable part of the product and its role is to keep the product as it is best presented to the customer. Contemporary achievements in technology enable the quality of food produced by various technological processes to be preserved in the chosen packaging using optimal packaging process. This paper presents the results of the analysis of the impact of different types of packaging (under normal atmospheric conditions and vacuum packaging) on the sustainability of products such as dry meat. No significant change in color, consistency, structure, and other sensory characteristics of the tested sample was observed in the vacuum packageing until the end of the study. In order to provide sustainability for the tested product vacuum or inert atmosphere packaging should be used.

Key words: *Packaging materials, dried pork, packaging, sustainability*

INTRODUCTION

Packaging materials and packaging are necessary companions of food products. Meat and meat products are fairly sensitive to the effects of external factors such as light, moisture, oxygen, and microorganisms. Protection against these factors, as well as the preservation of nutritive properties for the declared shelf life, is provided by properly selected packaging and application of ideal packaging conditions. By developing the science of packaging, it has become known that a better protective effect of

packaging materials can be achieved by applying different packaging conditions (Ahvenainen, 2003), such as packing under atmospheric, normal conditions, vacuum and inert gas or a mixture of inert gases packaging, or packaging in a modified atmosphere and aseptic packaging.

Depending on the quality of the packaged content, needs or the length of product sustainability, there is a wide range of packaging materials, their combinations, the specifications of the packaging application, as well as the variety of shapes and designs used for packaging (Gvozdenović, 1981, Gvozdenović et al., 1982, 2000, 2006, Gvozdenović, 1987, Gvozdenović et al., 1993, Hanlon, 1984, Varšanji, 1985).

Packaging and storage of dried meat

Due to its high sensory and nutritional quality, dried meat is highly appreciated and sought after product. It is consumed to a great extent both in our country and abroad. Color is one of the most important indicators of the overall sensory quality of meat and meat products and consumers notice it first, make an estimate, and on the basis of this assessment make a decision to purchase it. The formed color is the result of complex physical and chemical processes that take place in the product, and very often mistakes in the technological process of production can first be noticed by the lack of optimal and characteristic color of the product. Dried meat is most often packaged in polymer packaging materials. These packaging materials can be barrier or high-bubbling, with the possibility of thermal collection, different composition and properties, produced by different technologies. Packaging can be carried out under atmospheric conditions, vacuum or modified atmosphere (MAP). The increasing demands of consumers for high quality meat products, as well as the increasing demands of the producers in terms of standardization and rationalization of production, led to the use of various packaging and application procedures of various packaging materials in this branch of the food industry (Petrović et al., 2011a, 2011b). Choosing the appropriate packaging method requires knowing the basic mechanisms of product spoilage, the hygienic status of the product immediately before packaging, as well as the temperature during storage and distribution (Jeremiah, 2001).

Consequently, in order to extend the shelf life of these products, the trend is the application of new, more efficient packaging methods in anaerobic conditions. For meat products produced with the addition of nitrite, packaging should be aimed at completely disabling the contact ofthe product product with oxygen, and this is achieved by applying a vacuum or a modified atmosphere (MAP) packaging. (Møller and Skibsted, 2007). These types of packaging enable the extension of shelf life, but also provide the attractive appearance of the product in retail (Fernández-Fernández et al., 2002; Rubio et al., 2007).

No specific conditions are placed in packaging of most food industry products and they are packaged under normal atmospheric conditions. This means that a certain quantity of air is left inside the packaged product.

Vacuum packaging is a way of packaging that removes air or oxygen from the packaging before closing it. It is very difficult to keep the remaining amount of oxygen at a sufficiently low level and therefore the remaining oxygen in the package imme-

diately after closing is certainly an important parameter in preventing the discoloration of packaged dry-cured meat (Muller, 1990). Low oxygen permeability, which depends on temperature and relative humidity, is crucial for the stability of the product's color during storage.

In vacuum packaging, removal of air in oxygen-tight packaging, creates anaerobic / microaerophilic eco systems. Oxygen in the packaging passes into carbon dioxide due to respiration of meat tissue and bacterial activity. The created anaerobic conditions and the inhibiting effect of CO_2 suppress the growth of bacteria *Pseudomonas* and *Achromobacter* species and allow for the growth of optional anaerobes such as *Lactobacillus* and *Leuconostoc* species (Vereš, 2004).

The aim of this paper is to demonstrate the possibility of packaging ham and to monitor the impact of packaging on product sustainability.

MATERIALS AND METHODS

Ham preparation

This research used samples of pork ham taken from 3 different households with the same method of production, under identical microclimate conditions and of the autochthonous animal species – 12–24 months old pigs. Ham was prepared in a similar manner in all 3 households. The meat was first well rubbed with salt. Salted meat was left so that salt penetrated by diffusion into the deeper layers and evenly throughout the meat, and then an additional amount of salt was added. Diffusion of salt in hams cured with 5-6% of salt lasted for at least 4 days per one kilogram, and in hams cured with 3-4% of salt in proportionally extended period of time. After this phase, the meat was hung on rods in a well-ventilated place where it is pressed for 2–3 hours. Meat prepared in this way was then smoked by cool beech smoke to 16°C and dried in draft.

Three samples of ham from the same production year were taken, which were then coated with hot pepper extract, followed by a uniformly applied suspension of the tested molds. Ham samples were placed in polyethylene bags and vacuum-packed in a vacuum packaging machine (Intrama Accent 420). Samples were stored at ambient temperature at 25°C, with a 30-day time interval followed by a rise in fungal growth rate.

Extract of hot pepper Leskovački džinka, *Capsicum annuum* L. species, used in the research process was obtained by Soxhlet extraction with 96% *v/v* ethanol as a solvent (Virijević, 2017).

Fungal strains

As test microorganisms, fungal strains isolated from the ham were used. Isolation of molds from the surface of ham was conducted using Dichloran 18% glycerol agar (DG18 agar) (Merck, Darmstadt). First, ham sample was placed against DG18 agar surface and kept for 30 seconds in order to transmit fungal spores from the sheep ham to the surface of the substrate. Then the substrate was left to incubate at 25°C for 5 days. Secondly, the colonies which were assumed to belong to genera *Penicillium* spp.

based on the macromorphological properties were subcultured onto the Czapek Yeast Extract Agar (CYA) (Merck, Darmstadt). Obtained pure cultures of molds were identified using predetermined characteristics (colony diameter, color and texture, microscopic characteristics – hyphae and conidiophore appearance, size and shape of vesicles, metulae, phialides, and conidia). Isolated and identified fungal cultures were kept on Sabouraud Maltose Agar (SMA) (Torlak, Beograd, Serbia) at 4C in the Laboratory for Food Microbiology at the Faculty of Technology, University of Novi Sad, Serbia. The seven-day fungal cultures grown on PDA were used to prepare the fungal spore suspension tests (initial spore count of 6 log cfu/ml).

Microbiological analysis

Microbiological analysis of contaminated ham samples was done in accordance with the standard method for the preparation of samples SRPS EN ISO 6887-1:2008 . Analyses were performed on three samples from each batch in duplicate. Results were expressed as the number of colony forming units per gram (cfu/g).

Statistical Analysis

Statistical analysis of the results among the investigated groups was performed using an analysis of variance (ANOVA) using SPSS package (SPSS 19.0, Chicago, IL, USA). Duncan's t-test was used to investigate the significance of the difference between the median values of the two investigated groups. All statistical tests were performed for a significance level $p < 0.05$.

RESULTS AND DISCUSSION

The occurrence of first colonies on ham samples packed in polyethylene bags under normal atmospheric conditions was recorded on the third day of research. The total number of fungal colonies increased from the initial level of 6.0 ± .0.02 log cfu / g to 39.5 ± 0.04 log cfu/g for 3–30 days in samples that were packaged in polyethylene bags. An increase in the number of colonies of tested molds was statistically significant after the seventh day for polyethylene bags packaging. After the tenth day of the study, the number of colonies on the product was increased, so the product was covered with molds. Contamination of samples was conducted in this research, so the appearance of colonies in the increased number compared to the published works was also expected. The total number of colonies in the vacuum packaging of contaminated ham samples was in the range of 6.4 ± 0.2 log cfu/g, remained approximately at that level by the seventh day when it began to fall to a value of 3.35 ± 1 log cfu/g at the end of the study, after 30 days. Statistically significant differences were observed in the number of molds in samples packaged in polyethylene bags and samples in vacuum packaging. Skandamis and Nychas (2002) emphasize that storage of fresh meat at increasing CO_2 concentrations caused increasing inhibition of psychrotrophic aerobes and an extension of the shelf-life.

Özpolat et al., 2014 in their work indicate the appearance of mold colonies in samples packaged under normal conditions on the first day of research, whereas in the case of vacuum packing, colonies were detected on the 56th day of the research.

Ozturk et al., (2010) have reached the result that the total microbial population of beef meat packed in different packaging material remained unchanged at around 6.3 logCFU/g in vacuum and 100% CO_2 packages after 7 days, and slightly increased afterwards.

Sachindra et al., 2005 present the results of the study on buffalo sausage where yeasts and mold counts increased from 14th day in air conditions samples, and on 56th day in vacuum packed samples. Vacuum packing has shown substantially inhibitory effects on the growth of molds during storage.

Sensory results indicate that samples of traditional fermented ham packed under normal atmospheric conditions and in polyethylene bags were hygienically unacceptable for human use after the 7th day of storage. Particularly noticeable were pronounced changes on the surface of the ham and the growth of mold colonies which was uneven, creating grayish-white layers in the form of seals of different sizes. The aroma was bad, bitter, with a mildly rancid causing the shelf life of the ham to reduce and a complete change in the organoleptic properties of the product occurred (Sl. list SFRJ br. 53/91, 24/94, 28/9626).

Organoleptic characteristics of ham samples were more or less preserved in the vacuum packaging until the end of the study, with no significant change in color, consistency, structure, and other sensory characteristics (Picture 2). The extract of Leskovačka džinka hot pepper, *Capsicum annuum* L., used in the research process did not significantly affect the growth of molds in both cases. Sachindra et al., (2005) point out that vacuum packaged sausages made from bison meat had a shelf life of 32 days, while sausages packaged in polyethylene bags had a 16-day shelf life at refrigeration temperature.

Picture 2. *Sensory analysis of ham samples packed in vacuum packaging*

Martınez et al., (2006) concluded that packaging of fresh pork sausages in the absence of oxygen, either under vacuum or in an oxygen-free modified atmosphere with an oxygen scavenger, led to the extension of shelf-life in terms of both color and odor stability as a consequence of low oxidation rates.

The results of Kim et al., (2014) strongly suggested that VP preserved the quality of dry-cured pork neck products better than the MAP, especially with regard to discoloration, lipid oxidation, pH and tenderness.

CONCLUSION

Packaging materials for food products, in addition to requiring a good presentation of the packaged product in packaging, must ensure adequate protection of nutritional content values and quality product sustainability. In order to achieve these requirements, depending on the type and sensitivity of the product, it is necessary to apply optimal types and combinations of packaging materials, shapes and types of sealings, as well as to access the most favorable ways and conditions of the packaging. New packaging methods which meet the increasingly stringent requirements of customers are continually inveneted. It is necessary to protect the product from spoilage, but also to ensure the least possible exposure of food to undesirable changes during the manufacturing process. This is only possible if all the points of the process are strictly controlled, and the packaging process itself is one of the critical stages in the process of obtaining final product safe for consumption. From the technological point of view, the guidelines for advancing the packaging system are: achieving the highest quality product, which is a product changed as little as possible in relation to the starting raw material and making sure the obtained product is safe for consumption. The obtained results indicate that according to the characteristics of ham and the desired sustainability, packaging conditions in a vacuum that will optimally preserved the product can be selected.

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УТИЦАЈ РАЗЛИЧИТИХ УСЛОВА ПАКОВАЊА НА РОК ТРАЈАЊА СУВОГ СВИЊСКОГ МЕСА

Апстракт

Паковање је саставни и завршни део сваке производне линије и има за циљ да омогући финалном производу сигурнију манипулацију, складиштење и транспорт до купца, док амбалажа чини неодвојиви део производа и њена улога је да чува производ као и да га на најбољи начин презентује купцу. Савремена достигнућа у технологији омогућавају да се квалитет хране, произведен разним технолошким поступцима сачува у одабраној амбалажи оптималним поступком паковања. У раду су дати резултати анализе утицаја различитих врста паковања (под нормалним атмосферским условима и вакуум паковање) на одрживост производа какво је суво месо. У вакуумском паковању није констатована значајнија промена у боји, конзистенцији, структури и другим сензорним карактеристикама тестираног узорка до краја истраживања. Дужа одрживост испитиваног производа захтева паковање у вакууму или инертној атмосфери.

Кључне речи: *Амбалажни материјали, суво свињско месо, паковање, одрживост.*