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# THE EFFECT OF PACKAGING ON THE COOKED SAUSAGES STABILITY DURING STORAGE

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***Abstract:*** *The article is devoted to the study of the different types packaging influence on the microbiological stability and resistance to oxidation of cooked sausages. The modified atmosphere packaging, oxygen scavengers, and oxygen scavengers with an evaporator ethanol use has been found to more effectively inhibit the microflora development compared to control. At the same time, according to the obtained data an ethanol evaporator with an oxygen scavenger use has no significant effect on the quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms in sausages cooked compared to using only an oxygen scavenger on the 20 days of storage ($7,0\times10^6$ cfu/g and $5,5\times10^6$ cfu/g respectively). It can be concluded that the evaporator ethanol presence in the package does not lead to significant changes in the microflora during cooked sausages storage. During the experiment, the acid value of all test samples increased during entire storage, however, the control sample growth rate was the highest, the lowest for the sample with the oxygen scaveng. The rate of oxidation products accumulation has been increasing on the 3 day of storage. The samples with the oxygen scavenger had lower peroxide value during the entire storage period. It confirms the efficiency of oxygen scavengers use for cooked sausages.*

***Keywords:*** *cooked sausages, active packaging, oxygen scavengers, stability, storage.*

## INTRODUCTION

Food losses constitute a remarkable economic concern for the food industry, whereas foodborne outbreaks denote a major threat to public health. The presence of spoilage microorganisms on raw materials and on processed foodstuffs due to cross contamination can reduce the shelf-life of food as well as increase the risks of various food-borne infections causing serious illness to human (Devlieghere, F., Vermeiren, L., & Debevere, J. 2004.). This results in alterations of nutritional and sensory characteristics of food, such as oxidation, production of off-flavors and off-odors as well as undesirable changes in texture and color.

As a result, new technologies have been studied in order to provide safer food products. The selection of the packaging solution plays an important role: it has to guarantee the safety of the product but at the same time it favors its shelf life extension.

Active packaging stands out as an emerging technology, in which the packaging material interacts with the packaged food in a desirable way, overcoming the passive role of advertising and protecting food products from the outside environment. There are different concepts of active food packaging, including oxygen scavengers, evaporator ethanol, moisture absorbers and other mechanisms delivering antioxidant, flavoring or antimicrobial activity.

Consequently, the development of antimicrobial packaging has become a significant area of research over the past two decades, as the incorporation of antimicrobial agents into or on antimicrobial packaging materials could provide greater safety assurance, shelf life extension and quality maintenance of food products by inhibiting microbial spoilage and suppressing microbial food-borne illnesses (Appendini, P., & Hotchkiss, J. H. 2002.).

## EXPOSITION

Antimicrobial active packaging constitutes a promising form of food packaging, especially for meat products. Antimicrobial substances incorporated into packaging materials can control microbial contamination by reducing the growth rate and expansion of the lag phase of the target microorganism, or by inactivation of microorganisms by contact. Incorporation of GRAS (Generally Recognized As Safe), non-GRAS and natural antimicrobials, such us metal nanoparticles (silver, gold and zinc), metal oxide nanomaterials and carbon nanotubes, into plastic matrix intend their slowly migration on the product surface and inhibition of the growth of microorganisms, increasing the shelf life and safety of the product (Silvestre, C., Duraccio, D., & Cimmino, S. 2011.).

The use of silver (Ag) in antimicrobial packaging offers numerous advantages including high thermal stability, ease of incorporation into or onto numerous materials such as polyester, polyamide, and polypropylene. Silver can be introduced in different forms such as ions, complexes, salts and in metallic form. Ag/low density polyethylene nanocomposite films extended the shelf life of the chicken breast fillets and significantly enhanced oxidative stability compared to control films without adding silver (Azlin-Hasim, S., et al. 2015.).

Oxygen can have detrimental effects on the quality of different food products as it promotes growth of aerobic microorganisms and induces oxidation reactions. While growth of microorganisms may limit the shelf life and endanger the safety of the product, oxidation reactions may result in a decrease in nutritional value, change of texture, production of off-flavors, or change in color of the products.

To reduce the access of oxygen, foods are packaged with barrier materials and the headspace of packagings is flushed with nitrogen or nitrogen/carbon dioxide mixtures. However, residual oxygen can remain in the headspace, it can permeate from the environment into the packaging or it is gotten into packagings as solved oxygen in food (Chaix, E., Guillaume, C., & Guillard, V. 2014.). A strategy to reduce the oxygen permeability of plastic packagings and to absorb oxygen from packaged food and from packaging headspace is the application of oxygen scavengers. Oxygen scavengers remove oxygen from the inner package environment and, thus, from the food product itself through partial pressure.

The effect of different types packaging on microbiological stability and oxidation stability of a cooked sausages during storage was investigated.

Sausage samples were packaged use the following systems:

Variant 1 (control) - the sample was stored in a paper bag;

Variant 2 - the sample was stored in a paper bag treated with silver;

Variant 3 - the sample was stored in a plastic bag use inert gases ($CO_2/N_2$ in a ratio of 1/99%);

Variant 4 - a sample treated with silver was stored in a plastic bag;

Variant 5 - a sample treated with silver and ethanol was stored in a plastic bag;

Variant 6 - a sample treated with silver use an oxygen scavenger;

Variant 7 - a sample treated with silver, use an oxygen scavenger and an ethanol evaporator.

Analysis of sausages was carried out after manufacture, on days 3, 7, 10 and 20 of storage at a temperature of 4 ± 2 °C.

The Quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms (QMAFAnM) for unpacked sausages immediately after manufacture was $7{,}3 \times 10^3$ CFU/g.

The results of the QMAFAnM changes during storage of sausages depending on the packaging type are presented in the table 1.

Table 1 - Changes in QMAFAnM during storage of sausages

| | QMAFAnM, CFU/g | | | |
|---|---|---|---|---|
| | 3 days | 7 days | 10 days | 20 days |
| Variant 1 | $4{,}5x10^4$ | $8{,}0x10^5$ | $2{,}0x10^6$ | $7{,}5x10^7$ |

| | | | | |
|---|---|---|---|---|
| Variant 2 | $3,5x10^4$ | $1,2x10^5$ | $3,5x10^5$ | $2,4x10^7$ |
| Variant 3 | $1,2x10^4$ | $5,5x10^5$ | $9,0x10^5$ | $1,7x10^6$ |
| Variant 4 | $1,0x10^5$ | $8,5x10^5$ | $5,5x10^6$ | $8,0x10^7$ |
| Variant 5 | $2,9x10^4$ | $1,7x10^5$ | $6,0x10^5$ | $2,2x10^7$ |
| Variant 6 | $8,0x10^3$ | $7,5x10^4$ | $1,7x10^5$ | $7,0x10^6$ |
| Variant 7 | $2,2x10^4$ | $6,0x10^4$ | $5,0x10^5$ | $5,5x10^6$ |

The data obtained shows that on the 3th days of storage, the highest QMAFAnM was for sausages treated with silver stored in a plastic bag, the lowest for sausages treated with silver stored use oxygen scavenger. On the seventh day of storage, QMAFAnM for the samples use the oxygen scavenger and oxygen scavenger together with the ethanol evaporator were significantly lower than the other samples. At the 10th day of storage, QMAFAnM for all sausages were almost the same, except for the control and sample in the plastic bag, for which it was an order of magnitude higher and amounted to $2,0x10^6$ CFU/g and $5,5x10^6$ CFU/g, respectively.

As can be seen from the results obtained after 20 days of storage, for the cooked sausages packaging with inert gases, oxygen scavenger and oxygen scavenger together with the ethanol evaporator, a lower growth of microorganisms is observed in terms of storage.

It can be concluded that the use of these packaging exhibit more stabilizing effect on the total microbial contamination comparative to the control.

There was no significant difference between QMAFAnM for samples use oxygen scavengers and oxygen scavengers with an ethanol evaporator at all control points. This indicates that the presence of an ethanol evaporator in the package does not lead to a significant change in microflora during storage of cooked sausages.

The kinetics of fat oxidation during the sausages storage were characterized by acid and peroxide values. The depth of the fat hydrolytic changes was determined use an acid value that shows the amount of free fatty acids formed during the fat hydrolysis.

The acid value for unpacked sausages immediately after manufacture is insignificant amount 0,75 mg KOH/g. The results of further studies are presented in table 2.

Table 2 - Changes in acid value during sausages storage

| | Acid value, mg KOH/g | | | |
|---|---|---|---|---|
| | 3 days | 7 days | 10 days | 20 days |
| Variant 1 | 1,99 | 2,57 | 3,96 | 4,52 |
| Variant 2 | 2,21 | 2,73 | 3,15 | 3,99 |
| Variant 3 | 1,46 | 1,92 | 2,46 | 3,01 |
| Variant 4 | 2,67 | 3,12 | 4,05 | 4,74 |
| Variant 5 | 2,34 | 2,97 | 3,68 | 4,46 |
| Variant 6 | 1,36 | 2,19 | 3,01 | 3,87 |
| Variant 7 | 1,53 | 1,98 | 2,62 | 3,74 |

During the experiment, the acid value increased for all samples, however, for the control and the sample treated with silver stored in a plastic bag, the growth rate was highest. The dynamics of acid value changing on the 20th days of storage for sausages packed use inert gases, oxygen scavenger and oxygen scavenger with the ethanol evaporator showed the slightest increase compared to the control, which indicates the inhibition of the hydrolysis process.

To determine the primary oxidation products of sausages was evaluated peroxide value, with which you can determine the damage degree of fat, which affects the product shelf life.

For unpackaged sausages, the peroxide value was 1,96 ½Ommol/kg immediately after manufacture.

The results of further studies are presented in table 3.

Table 3 - Changes in peroxide value during sausages storage

| | Peroxide value, ½Ommol/kg | | | |
|---|---|---|---|---|
| | 3 days | 7 days | 10 days | 20 days |
| Variant 1 | 3,07 | 3,86 | 4,11 | 5,96 |
| Variant 2 | 2,36 | 3,17 | 3,74 | 4,43 |
| Variant 3 | 1,98 | 2,37 | 3,01 | 3,16 |
| Variant 4 | 2,22 | 2,91 | 3,23 | 3,94 |
| Variant 5 | 2,47 | 3,15 | 3,82 | 4,11 |
| Variant 6 | 2,12 | 2,39 | 2,64 | 2,86 |
| Variant 7 | 2,03 | 2,43 | 2,76 | 2,99 |

The results showed that among the test samples control sample peroxide value increased more intensively and the use of inert gases, oxygen scavenger and oxygen scavenger with the ethanol evaporator slowed down the oxidation processes.

## CONCLUSION

Packaging of sausages use inert gases, oxygen scavengers and oxygen scavengers with an ethanol evaporator, can inhibit the growth of microorganisms during storage and slow the rate of fat oxidation.

This allows us to conclude that the use of these packaging exhibit more stabilizing effect on the total microbial contamination comparative to the control.

QMAFAnM, acid and peroxide values for samples use oxygen scavengers and oxygen scavengers with an ethanol evaporator practically were not significantly different at all control points. This indicates that the ethanol evaporator presence in the package does not lead to a significant effect on the cooked sausages during storage.

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