Research of the influence of vacuum packaging on the quality and safety of meat semi-finished products

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Abstract. The paper investigates the effect of vacuum packaging on the quality and safety of semi-finished meat products. The microbiological and organoleptic characteristics of a small-sized semi-finished product from pork pulp (goulash, pieces weighing 20-30 g) were studied, part of which was packed in GN 1/4 gastronorm containers, 0.5 kg each, the other part was packed in a vacuum package of 0.5 kg vacuum packer HVC-260T/1A (DZ-260/PD) using three-layer PA/PE bags (polyamide with polyethylene) with dimensions of 250x350 mm and a thickness of 90 microns. All semi-finished products were stored under the same conditions, in a refrigerator at a temperature of 4 °C. Comparative microbiological analysis showed that the number of mesophilic aerobic and facultative anaerobic microorganisms in semi-finished pork meat products stored using traditional technologies exceeds the semi-finished products stored in vacuum packaging. In terms of sanitary and hygienic indicators, the test products meet the requirements of TR CU 021/2011 and SanPiN 2.3.2.1078-01 for 8 days of storage at a temperature of 4 ± 2 °C. In the investigated semi-finished products revealed shifts in pH (5.12-6.75) during storage and subsequent regeneration. Vacuum packing contributes to the preservation of organoleptic characteristics of meat semi-finished products, in comparison with semi-finished products that were stored traditionally. Analysis of the totality of quality and safety indicators for meat semi-finished products stored in vacuum packaging allows predicting an increase in shelf life up to 8 days. The shelf life of the investigated meat semi-finished products stored in vacuum packaging is 5 times longer than the shelf life established by SanPiN 2.3.2.1324-03.

1. Introduction

Currently, there is a tendency for consumers to switch from frozen to chilled meat on the domestic meat market. At present, its share in the Russian meat market is 34%. Many experts in the meat industry believe that the active development of consumption of chilled meat will continue for the next 3-4 years, and the dynamics will be most vividly traced at the regional level. In general, the use of chilled meat will significantly reduce technological losses associated with freezing and thawing processes, increase the nutritional and biological value of finished products, reduce the risks associated with microbiological and oxidative factors and, in general, significantly increase the consumer characteristics of products, have a positive effect on their consumption. An important factor in the production of meat products is the development of new technologies for storing meat. This applies to both the storage of raw materials in production and the storage of semi-finished and finished products.
Packaging is an additional technical means that allows you to increase the duration of storage and preserve the quality of chilled meat and meat semi-finished products. Today, vacuum packaging is one of the most promising for working with food. The vacuum technology allows to significantly increase the shelf life of almost all food products, reliably protect against the penetration of infections, loss of aromatic qualities, and also maintain an attractive appearance. Vacuum packaging devices are widely used today in grocery stores of all sizes, in catering establishments. Since the problem of storing food for a long period of time is quite acute at catering establishments, there has recently been a tendency to widely use vacuum packaging to keep food fresh. The use of this equipment allows not only to effectively store food, but also to significantly extend the period during which it remains fresh.

The technology of preparing semi-finished products in vacuum packaging from a polymer material is one of the main methods that allows not only to rationalize the production process, but also to simultaneously improve the quality and safety of food products, including microbiological safety [1, 2, 3]. According to a number of researchers, the use of this technology allows you to maintain vitamins, proteins, carbohydrates, fats, macro- and microelements of raw materials in their native state and protects food from unwanted organoleptic changes that occur during traditional heat treatment [4, 5]. Vacuuming removes oxygen from the package, which promotes oxidation or denaturation of many of its components. At the same time, sanitary and hygienic safety is maintained during storage of finished products [6, 7, 8]. Therefore, studies aimed at studying the effect of vacuum packaging on the quality and safety of meat semi-finished products are relevant.

The purpose of the work is to determine the effect of vacuum packaging on the quality and safety of semi-finished meat products at the LLC Public Food company.

To achieve this goal, the following task was solved:

- To investigate the effect of vacuum packaging on the microbiological, physicochemical and organoleptic characteristics of semi-finished meat products.
- Establish an expiration date for meat semi-finished products in vacuum packaging for the company "Public Food".

2. Objects and methods of research
Semi-finished products prepared from pork meat (pork shoulder goulash) were used as objects of research. Sampling methods were carried out in accordance with GOST R 51447-99 "Meat and meat products. Sampling methods."

Sample preparation for testing according to microbiological indicators was carried out in accordance with the requirements of GOST 26669-87 “Food and flavoring products. Sample preparation for microbiological analysis”.

Testing of samples for microbiological indicators was carried out in accordance with the following regulatory documents: GOST 31659-2012 “Food products. Method for detecting bacteria of the genus Salmonella, "GOST 10444.15-94" Food products. Method for determining the amount of mesophilic aerobic and facultative anaerobic microorganisms, GOST 7218-2015 Microbiology of food and animal feed. General requirements and recommendations, "GOST 31747-2012" Food products.

Methods for detecting and determining the amount of bacteria of the group of E. coli (coliform bacteria), "GOST 32031-2012" Food products.

Methods for the detection of bacteria Listeriamonocytogenes "Organoleptic characteristics were determined according to GOST 9959-2015 “Meat and meat products. General conditions for carrying out sensory evaluation”.

3. Research results
For the experiment, a semi-finished goulash product was cut from pork pulp - pieces weighing 20-30 g. -260T/1A (DZ-260/PD) using three-layer PA/PE bags (polyamide with polyethylene) with dimensions of 250x350 mm and a thickness of 90 microns.
All semi-finished products were stored under the same conditions, at OOO Public Food, in a refrigerator at a temperature of 4 °C. Throughout the entire storage period, the following parameters were studied for samples of semi-finished products: KMAFANM, bacteria of the Escherichia coli group (BGKP), pathogenic including salmonella, Listeria monocytogenes.

Determination of microbiological parameters was carried out in accordance with MUK 4.2.1847-04 - background, 1, 3, 4, 6, 8, and 12 days of storage. For the study on microbiological indicators, 7 samples were taken: 1 sample of raw materials (pulp of the shoulder of pork) and chilled semi-finished meat products (pork goulash), 3 samples of semi-finished products stored in a gastronorm container, 3 samples of semi-finished products stored in a vacuum package. Sampling was carried out by OV Bychkova, a technician of the branch of the FBUZ "Center for Hygiene and Epidemiology in the Krasnoyarsk Territory" in the city of Minusinsk, T. Yu. Tarasova, Director of Public Food LLC. Samples were delivered to the laboratory in a thermal container with a cooling hours.

For the purity of the experiment, the microbiological parameters of the feedstock were determined. Research data showed that the feedstock meets the requirements. For semi-finished products stored in gastronorm containers, microbiological indicators were determined after - 1, 3, 6 days. As a result of the research, it was revealed that the semi-finished products stored in the gastronorm container according to the microbiological indicators of "bacteria of the group of E. coli (BGKP (coliforms)”, "pathogenic microorganisms, including salmonella”, "L. Monocytogenes” throughout the experiment (6 days) meet the requirements of Chapter 13, Clause 129 (Appendix 1) of TR CU 034/2013, Chapter 2, Article 7 Clause 2 (Appendix 1) TR CU 021/2011. stored at a temperature of 4 °C for 3 days, were in the range of 1.0 · 10³ - 1.2 · 10⁵ CFU/g and met the standards (1.0 · 10⁶ CFU/g) established by TR CU 034/2013. on the 6th day of storage, this indicator exceeded the established norms for semi-finished products and amounted to 2.4 · 10⁶, which does not meet the standards (1.0 · 10⁶ CFU/g) established by TR CU 034/2013.

For semi-finished products stored in a vacuum package, microbiological indicators were determined after - 4, 8, 12 days. It was determined that semi-finished products stored in a vacuum package for the microbiological indicators of "bacteria of the group of Escherichia coli (BGKP (coliforms)”, "pathogenic microorganisms, including salmonella”, "L. Monocytogenes” throughout the experiment (12 days) meet the requirements Chapter 13, paragraph 129 (Appendix 1) TR CU 034/2013, Chapter 2, Article 7, Clause 2 (Appendix 1) TR CU 021/2011. The results of microbiological studies on the indicators of KMAFANM indicate that semi-finished products in vacuum packaging stored at a temperature of 4 °C for 8 days were in the range of 1.0 · 10²-4.9 · 10⁴ CFU/g and met the standards (1.0 · 10⁶ CFU/g) established by TR CU 034/2013. on the 12th day of storage, this indicator exceeded the established norms for semi-finished products and amounted to 1.4 · 10⁶, which does not meet the standards (1.0 · 10⁶ CFU/g) established by TR CU 034/2013.

The storage capacity of semi-finished meat products allows predicting pH. The most favorable pH range for most pathogenic bacteria is considered to be pH 6.8-7.4, which corresponds to the concentration of hydrogen ions in the body of warm-blooded animals, in which these bacteria are adapted to growth. The pH value inside the bacterial cell is close to neutral, and is optimal for its reproduction. An increase in acidity or a transition to an alkaline environment leads to a decrease in the activity of microorganisms. Cell reproduction in an acidic environment slows down or stops, as microorganisms have to spend additional energy to maintain the necessary intracellular balance. At high pH values, products will not be sufficiently resistant to microbiological spoilage. To stabilize the quality of semi-finished meat products, it is recommended to use meat with a pH of 6.3. Raw meats with a pH above 7.0 are considered spoiled.

To determine the storage capacity of semi-finished meat products, the pH of raw materials and semi-finished products stored in gastronorm containers and vacuum packaging was determined. It was found that during storage of the studied samples and their subsequent regeneration, slight shifts in pH occurred, which can be explained by a change in the ratio of charged (acidic and basic) groups due to the ongoing physicochemical processes. The value of the pH shift is influenced by the anatomical origin of the muscles of the raw meat. The shift to higher pH values occurs as a result of the cleavage of hydrogen
bonds and the release of additional positive charges. Despite the shifts in pH during storage, this indicator for all studied samples was in the range of 5.12 - 6.75. All investigated semi-finished meat products belong to good quality semi-finished products. In addition to semi-finished products, which have a shelf life of 8 days in a gastronome container and 12 days in a vacuum package, they have a pH of 6.75 and 6.54, respectively, therefore these semi-finished products are of dubious quality.

Research of organoleptic properties. The organoleptic characteristics of the feedstock were investigated. The research results confirmed that the feedstock meets all the requirements. The surface of the pieces of raw meat raw materials and the resulting semi-finished products was clean, without signs of mucking, the color of all samples corresponded to the type of meat from which they were obtained. The specific smell inherent in pork was noted. The muscles were dense, elastic, when pressed with a finger or a sterile instrument, the fossa quickly leveled out, the appearance of fat was positive.

For semi-finished products stored in gastronorm containers, organoleptic indicators were determined after - 1, 3, 6 days. During storage, there is a decrease in the quality of semi-finished products stored in the gastronorm container. So, when stored for 6 days, the surface of the meat was sticky, the color corresponded to the type of meat, but dry. The smell is sour. Muscles have reduced elasticity, when pressed with a finger or a sterile instrument, the fossa was leveled slowly, the appearance of fat was positive. Conveniently stored semi-finished products had an average organoleptic score corresponding to "good".

For semi-finished products stored in a vacuum package, organoleptic indicators were determined after - 4.8.12 days. As a result of the study, it was revealed that during storage there is a slow decrease in the quality of semi-finished products stored in vacuum packaging. So, when stored for 12 days, the color corresponded to the type of meat from which they were obtained. The specific smell inherent in pork was noted. The smell is sour. Muscles have reduced elasticity, when pressed with a finger or a sterile instrument, the fossa was leveled slowly, the appearance of fat was positive. Semi-finished products, stored in vacuum packaging, an average organoleptic score corresponding to the ratings of "excellent" and "very good".

Determination of the shelf life of meat semi-finished products stored in vacuum packaging. Based on the totality of microbiological indicators of the quality and safety of vacuum-packed semi-finished meat products, it is possible to predict an increase in shelf life up to 8 days (temperature (4 ± 2 °C), reserve coefficient - 1.3) with the corresponding results of organoleptic and physicochemical studies. According to MUK 4.2.1847-04 “Methodical instructions. Sanitary and epidemiological assessment of the justification of the shelf life and storage conditions of food products” established the shelf life of meat semi-finished products in vacuum packaging, taking into account the safety factor (1.3) –8 days, which is 5 times shorter than the terms of the test sample. The duration of storage is determined by the characteristics of the packaging material, the quality of the raw materials and the observance of the sanitary regime in production.

4. Conclusion
Comparative microbiological analysis showed that the traditional storage of semi-finished pork meat products leads to an increase in the number of mesophilic aerobic and facultative anaerobic microorganisms (CMAPAnM), as compared to semi-finished products stored in vacuum packaging. The obtained microbiological data confirmed the compliance of the sanitary and hygienic indicators of the investigated products with the requirements of TR CU 021/2011 and SanPiN 2.3.2.1078-01 for 8 days of storage at a temperature of 4 ± 2 °C.

In the studied semi-finished products, pH shifts (5.12-6.75) were observed during storage and subsequent regeneration. In this range, the growth and reproduction of neutrophilic microorganisms is possible, but the obtained pH values are not optimal for the active reproduction of pathogenic microorganisms characteristic of semi-finished meat products stored in vacuum packaging (E. coli, Staphilococcus aureus, Salmonella spp., Listeria monocytogenes, Clostridium perfringens).

Analysis of the totality of indicators of quality and safety of semi-finished meat products stored in vacuum packaging allows predicting an increase in shelf life up to 8 days (temperature (4 ± 2 °C),
reserve ratio - 1.3). The shelf life of the investigated meat semi-finished products stored in vacuum packaging is 5 times longer than the shelf life established by SanPiN 2.3.2.1324-03. The duration of storage is due to the use of vacuum packaging, which slows down the processes of oxidative reactions and reduces the growth of aerobic bacteria. It was found that semi-finished meat products stored in a vacuum package have high consumer properties during 8 days of storage in conditions of low positive temperatures (4 ± 2 °C).

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