Multilayer polymer film as a factor of increasing the shelf life of poultry meat products

V Y Ponomarev, E Sh Yunusov, E V Nikitina, D V Khrundin and G O Ezhkova
Department of technology of meat and dairy products, Kazan National Research Technological University, 68 Karl Marx street, Kazan, Republic of Tatarstan, 420015, Russia

E-mail: v.y.ponomarev@gmail.com

Abstract. The paper is aimed at studying the influence of new packaging materials with barrier properties on the quality indicators of semi-finished meat products from poultry meat in comparison with traditional packaging methods. It was found that the use of heat-shrink bags made of multilayer polymer film allows to increase the shelf life of semi-finished products by an average of 30%.

1. Introduction
The safety of food raw materials and food products is a fundamental indicator ensuring the quality of food products. In modern conditions, food can act as a source of not only food substances, but also potentially hazardous to the health of chemical and biological substances formed in the production, storage and sale of products [1]. To preserve the consumer properties of the product in the technological chain of production and sales of products, a significant role is played by protective systems, which are packaging materials [2].

Increasing the shelf life of food products while maintaining their consumer properties and sanitary well-being is one of the most important tasks the enterprises in the agricultural sector have to solve. A significant role in preserving food products from external influences and ensuring safety during storage is played by the method of packaging [3].

Traditional packaging materials provide a certain level of food protection, but they are not able to affect the biochemical and microbiological processes that can occur during storage of products. A variety of polymer films are used as food packaging materials. Recently, more complex multilayer structures have been most widely used, which make it possible to accurately predict the level of vapor and gas permeability [4].

The most common packaging material is films made on the basis of polymeric materials with a number of layers from two to five. In such packages, an outer layer is produced, usually made of polyesters with high strength. This is followed by the middle layers with barrier properties. For these purposes, polyamide films are typically used. For contact with the food product polymeric materials are used, which are distinguished by chemical inertness and physiological harmlessness. As such material, low density polyethylene is often used. All layers of the barrier packaging material are bonded with adhesives in the form of films of ethylene vinyl acetate and ethylene acrylic copolymers [5].
The most important area of application of such materials is packaging of meat and meat products. Meat products are the most consumed products in the Russian domestic market. However, the shelf life of chilled meat is insignificant and amounts to several days. Non-compliance with storage conditions, as well as the use of traditional types of packaging materials, leads to the fact that under the influence of oxygen, light and temperature, processes occur associated with the decomposition of protein substances, as well as with the growth and development of microorganisms. Most intensively, these changes occur in poultry meat, in which signs of spoilage are detected very quickly and are expressed in the form of a darkening of the carcass, the appearance of a green tint and foreign odors. With low-quality gutting and incomplete removal of blood, the storage resistance of such raw materials decreases sharply [6]. Using modern barrier polymer films as packaging material will solve this problem and maintain the quality of the finished product. The aim of this work was to assess the impact of new barrier packaging materials on the safety of semi-finished products from poultry meat during the guaranteed shelf life.

2. Materials and methods

As the objects selected for the study, we used a semi-finished meatless breast without bone obtained from poultry meat produced by the Ak Bars poultry branch of Zelenodolsky district, Osinovo village, (State standard R 31962-2013) [7].

As packaging materials, we selected packages from the new polymer packaging material TBP Mealguard Meat (manufactured by TASMA LLC) [1] with an increased degree of shrinkage for packaging fresh and processed meat in carcasses and cuts (TBP packages). The film refers to barrier packaging materials with high strength, degree of shrinkage, the possibility of overlap welding. The packaging material has a high puncture and sealing resistance. As control packaging materials we took plastic bags used at the poultry farm of the branch "Ak Bars" [8]. The characteristics of the packaging materials are presented in table 1.

| Indicator                                      | Unit of measurement | Mealguard Meat | Control film |
|------------------------------------------------|--------------------|---------------|--------------|
| Film thickness                                 | μm                 | 50±5          | 50±5         |
| Permeability to oxygen (at 23 ºС and humidity 75%) | cm³/(m²·24 hours·atm) | 4             | 18           |
| Tensile strength, not less                     | MPa                | 70            | 16.1         |
| in the longitudinal direction                  |                    | 60            | 14.7         |
| in the transverse direction                    |                    |               |              |
| Elongation at break, no more                   | %                  | 110           | 450          |
| in the longitudinal direction                  |                    | 160           | 450          |

Mealguard Meat films incorporate a layer based on a copolymer of ethylene with vinyl alcohol and polyamide layers, which provides the packaging material with additional barrier properties and high puncturing resistance. Prototypes of packaging with a similar film thickness are characterized by reduced oxygen permeability, which should contribute to less oxidation of the product, as well as greater tensile strength compared to polyethylene films with less elongation.

Packaged products were kept for 5 days at a temperature of 5 ºC, packets were opened daily and the state of semi-finished products was examined. Technochemical studies of the samples were carried out according to the procedure [9]. Analysis of the amount of mesophilic aerobic and facultative anaerobic microorganisms, bacteria of Escherichia coli group according to the method [10].
3. Results and discussion
To assess the quality of semi-finished products from poultry meat and the influence of the type of packaging material on the safety of their consumer properties, we carried out technocchemical studies of control and experimental samples for 5 days (table 2), which make up the guaranteed shelf life of this poultry meat in carcasses [7].

**Table 2. Physical and chemical indicators of semi-finished products.**

| Sample | The exposure time, days | pH     | Moisture contents, % | The protein content, % | Sensory evaluation, score |
|--------|-------------------------|--------|----------------------|------------------------|--------------------------|
| Control| 1                       | 6.34±0.1 | 66.8±0.5             | 23.8±0.4               | 9.0                      |
|        | 2                       | 6.36±0.2 | 66.3±0.5             | 23.6±0.4               | 9.0                      |
|        | 3                       | 6.74±0.2 | 65.4±0.5             | 23.6±0.4               | 8.5                      |
|        | 4                       | 6.8±0.1  | 63.2±0.5             | 23.1±0.4               | 7.0                      |
|        | 5                       | 6.86±0.1 | 60.1±0.5             | 22.8±0.4               | 6.0                      |
|        | 1                       | 6.22±0.2 | 70.2±0.5             | 23.6±0.4               | 9.0                      |
|        | 2                       | 6.27±0.1 | 70.0±0.5             | 23.4±0.4               | 9.0                      |
| Experiment| 3                       | 6.42±0.1 | 68.3±0.5             | 23.4±0.4               | 8.5                      |
|        | 4                       | 6.46±0.1 | 67.7±0.5             | 23.2±0.4               | 8.0                      |
|        | 5                       | 6.66±0.2 | 67.4±0.5             | 23.1±0.4               | 7.0                      |

The use of all types of packaging materials made it possible to maintain the basic indicators of semi-finished products within normal limits. During storage, an increase in pH was noted, with a maximum after 5 days. During the storage of semi-finished products, a slight decrease in the amount of moisture and protein was observed, which occurs more intensely in control samples packed in plastic film.

The sensory characteristics of the samples (experience and control) in the first three days of storage did not differ and fully corresponded to freshness indicators. Subsequently, in control samples of products, a deterioration in sensory characteristics was noted, in particular, the meat consistency became loose, with pressure, the muscle tissue did not restore its shape. On the fifth day of the experiment, the control samples acquired an acidic smell, indicating the decomposition of protein molecules. For prototypes, the beginning of such changes was recorded only after five days of storage, while the organoleptic of semi-finished products remained satisfactory with a marked deterioration in consistency.

According to TR TS 034/2013 and 021/2011, the mesophilic aerobic and facultative anaerobic microorganisms indicator for semi-finished small-piece boneless meat from poultry meat should not exceed $10^6$ CFU/cm³, and bacteria of Escherichia coli group should not be found in 0.001 g of product. It was revealed that after 5 days of storage, the control sample did not meet this requirement, while in the experimental sample the mesophilic aerobic and facultative anaerobic microorganisms indicator was within the acceptable value (table 3). Bacteria of Escherichia coli group was found only in the control sample.

**Table 3. Microbiological indicators of semi-finished products.**

| Sample  | The exposure time, days | Mesophilic aerobic and facultative anaerobic microorganisms indicator, CFU/cm³ | Bacteria of Escherichia coli group, in 0.001 g of the product |
|---------|-------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------|
| Control | 0                       | $3,1\pm0,8\times10^7$                                                           | -                                                           |
|         | 2                       | $6,7\pm0,3\times10^5$                                                           | -                                                           |
|         | 5                       | $8,7\pm0,3\times10^6$                                                           | +                                                           |
The study revealed that the use of a plastic film allows you to maintain the quality and safety of the semi-finished chicken breast for 2 days, which make up a guaranteed shelf life. The use of experimental polymer films allows to extend the shelf life of semi-finished products by an average of 30%, to preserve the high organoleptic properties of poultry meat, as well as its sanitary well-being for a longer period, which will certainly have a positive effect on the consumer properties of this type of product.

References
[1] Garipov R M., Ezhkova MS, Efremova AA, Nosov VV, Ponomarev V Y and Ezhkov DV 2014 *Bul of Kazan Tech Univ* 21 232-5
[2] Yezhkova G, Ponomarev V, Yunusov E and Sechenkova E 2011 *Polimer Science “Advances in Polymer Science and Technology 2” Johannes Kepler University* 94
[3] Guryeva K B, Magayumova O N and Beletsky S L 2018 Innovative technologies for the production and storage of material assets for state needs 10 82-96
[4] White J L and Choi D D 2005 *Polyolefins - Processing, Structure Development, and Properties* (Hanser Publishers)
[5] Abdel-Bary E 2003 *Handbook of Plastic Films* (Rapra Technology Limited)
[6] Kudryashev I S 2008 *Physico-chemical and biochemical principles of the production of meat and meat products* (DeLiPrint)
[7] State standard R 31962-2013 *Chicken meat (carcasses of hens, chickens, broiler chickens and parts thereof)* Technical specifications (Moscow: Rosstandart)
[8] State standard R 10354-82. *The film is polyethylene* Technical specifications (Moscow: Rosstandart)
[9] Antipova L V, Glotova I A and Horns I A 2001 *Research methods for meat and meat products* (Kolos)
[10] State standard R 54354-2011 *Meat and meat products. General requirements and methods of microbiological analysis* (Moscow: Rosstandart)