

Influence of an antimicrobial alginate covering on a period of storage and quality indicators of the cooled beef liver

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Abstract. To increase the shelf life of chilled beef liver the possibility of using film-forming compositions based on sodium alginate. Developed and substantiated the composition is reported to lower shrinkage and refrigerated semi increase shelf life by 25%. Results were confirmed by sensory and microstructural analyzes, microscopy analysis [Alexanyan I.J., Nugmanov A.X.-X., Titova L.M., Nikulina M.A. **Influence of an antimicrobial alginate covering on a period of storage and quality indicators of the cooled beef liver.** *Life Sci J* 2014;11(11s):579-583] (ISSN:1097-8135). <http://www.lifesciencesite.com>. 132

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Introduction

Today one of the important directions of modern food technology is maintaining the quality and extending the shelf life of fresh meat and meat products. A consumer makes a choice in favor of chilled meat, since it has better palatability and nutritional value than frozen one and the risks of thawing meat during storage and refreezing are eliminated. When using chilled meat significant weight loss that occurs when defrosting meat is stored at a temperature of 18C, can be excluded.

The problem of preserving of the nutritional value and organoleptic characteristics of chilled meat is particularly actual for storing of meat products, which contain a significant amount of water, blood or have a high enzymatic activity. *Beef liver* is a such type of product. This low-fat protein-containing raw material contains a considerable quantity of water - up to 74 %, essential amino acids and mineral substances such as potassium, sodium, calcium, magnesium, copper, chrome [1]. Because of the low calorific capacity - beef liver is a dietary product and it is used in clinical nutrition. It is included in anemia patients' diet, as well it is useful for eye diseases and vision problems, since it contains significant amounts of vitamin A [1]. Beef liver is recommended for athletes and people engaged in rough labor, since it contains keratin, which activates metabolic processes in the body [2].

One of the major problems of using liver for production of foodstuffs is its bitter off-flavor. The research has shown, that individual fatty acid chains and unsaturated fatty acids play a critical part in emerging of an unpleasant taste of the liver [4]. Thus, taking into account the high nutritional value of beef liver and its role in human nutrition, it is necessary to conduct a research to reduce the impact of the environmental factors on the liver, minimizing the

impact of oxidation, allowing this raw material to protect the organoleptic and physico-chemical parameters at the desired level during the entire period of storage [4].

It is known that to increase the shelf life of meat and meat products - *sodium alginate* is used. Sodium alginate is known for its beneficial properties [5; 6; 7]. It is widely used in the food and pharmaceutical industries [8; 9]. To maintain its quality during cold storage pork is coated with film-forming composition comprising active and polysaccharide [10]. The known requirements for such coatings - it must have high structural and mechanical properties, organoleptic characteristics, not only worsen, but improving the appearance of raw materials to be packaged. The technique of creation and of the films should be simple and easy to implement, because the nonantibacterial and low strength properties of sodium alginate films negatively impact their application for food packaging.

The creation of such films from sodium alginate and essential oils allowed to create an antimicrobial coating that reduces microbial activity of beef [11].

The initial microflora of raw meat consists of different microorganisms that break down proteins, fats and carbohydrates [15]. A certain level of decomposition of the organic components of meat and especially glycolytic activity of microbes is useful in the production of meat products. However, the bulk of the microflora constitute harmful microorganisms, significantly reducing the quality of meat products. To preserve the quality of meat - the number of microorganisms on the surface and inside the meat should be limited, to reduce their number and enzymatic activity, while maintaining the quality of meat. There are various methods for this purpose:

smoking, drying, but they are not suitable for the preservation of the quality of such sensitive to external influences as the raw liver. As pointed out by Yue Q. [12], mixing natural polysaccharide acids may become the basis of the composition to maintain the quality of meat and to increase shelf life. The method can solve the problem that the juice seeping from the meat products in the processes of storage, transportation and sale influences the product quality, can effectively control meat fat oxidation, color variation and microbial proliferation in the storage period, obviously raises the product sensory quality and prolong the shelf-life, and provides a novel approach for meat preservation [12].

Using polysaccharides as the basis for creating antimicrobial composition is very promising, especially for perishable meat offal, such as beef liver. As a result of exploratory experiments – the optimal composition of an antimicrobial composition has been found:

purified Water
Sodium alginate, 2.5%
Glycerol 0.8 %
Salt - 0.15%
Citric acid: 0.1 %

This balance allows to provide a good mix of components, no lumps, uniform coating onto the surface.

Each sample of the liver has been coated with the composition which is shown above. The weight of each sample before and after coating drying has been determined. The composition was applied by immersion in a liquid solution. The sample was then air dried for 3 seconds immersed into a solution of calcium gluconate for fixing the shell. After the fixation, the surface of the samples was dried for 30 seconds by placing the drying chamber with a temperature of 35°C and a blowout velocity of 2 m / s. Next step is conduction of cold storing of the beef liver samples in 14 days at a temperature of 3°C. Several samples of the liver are the control ones, they were not coated with the composition. Their cold storing was carried out under the same conditions - at a temperature of 3°C.

During the storage period samples – the bacteriological and microstructural analysis was conducted for the determination of quality and shelf life of chilled liver.

Materials and methods

Material. We used beef liver samples obtained from healthy animals that had passed all stages of the preparation of pre-slaughter, including veterinary inspection. Shelf life of all liver samples obtained from meat processing enterprises of the Russian Federation was 2 days at +1 °C.

Chemicals. Chemicals used in the research were purchased in the Russian Federation: powder sodium alginate, natural citric acid monohydrate crystals, calcium gluconate, glycerol (99.7% purity).

Methods. To determine the purity of samples of beef liver – it has been conducted a Bacterioscopy research including preparing smears from the surface of the liver, with a depth of 2.5 cm and 4 cm and their Gram staining. Each smear was studied not less than 5 fields of view, which counted the number of bacteria and observed structural changes of meat that have occurred during the storage. Determination of dry matter was conducted using an instrument VAD-40m (the Russian Federation). To determine the pH liver (2 g) was ground in a mortar and pestle with distilled water (10 mL). A standard pH meter, Hanna99161 (Hanna Instruments Co., Padova Italy), equipped with a glass electrode, was used. Measurements of pH were calculated from the average of three replicates. To assess the impact of the formulation and storage conditions of each sample, the data were analyzed by estimating uncertainty of measurement, correlation analysis in order to evaluate the impact of created composition in full. The analysis of fresh meat was as well performed by reaction with copper sulfate in the broth. For the research the conical flask was charged with 20 g of meat minced liver with addition of 60 ml of distilled water. It was thoroughly mixed, sealed with a glass cap and placed in a boiling water bath for 10 min. Hot broth was cooled and filtered through a pad of cotton wool or filter paper. 2 mL of the filtrate were poured to a test tube, and 3 drops of a 5% solution of copper sulphate were added. The tube was shaken and the results of the reaction were noted [13,14].

Microstructure of the slices of beef liver samples was determined by photomicrography. Microphotography was conducted with using an optical microscope AltamiBIO 2T. Micrographs were processed using the software package AltamiStudio. Microstructural analysis gives an indication of the structure of the product as a whole and the changes taking place in some parts and components of the objects.

Statistical analysis.

To assess the effect of composition and storage conditions of each sample, the data were analyzed by estimating uncertainty of measurement, correlation analysis in order to evaluate the impact of created composition in full. All statistical analyses were performed using Excel 2007 (Microsoft, Redmond, USA).

The main part

For research the initial seeding of liver samples was carefully monitored. The selected

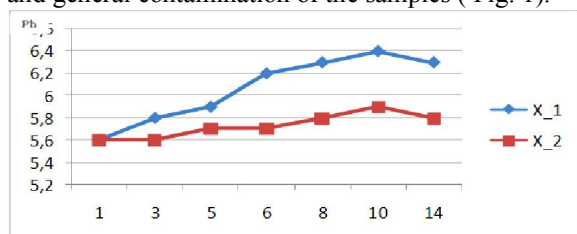
samples had Determination of the Germ Count of Aerobic and facultatively Anaerobic, Mesophilic Bacteria- QMAFAnM (Plate Count Method) CFU/1g 1×10^3 were pre-cooled. Sample X₁-chilled fresh beef liver. Sample X₂ beef liver coated with the antimicrobial coating. The initial performance of the chemical composition and nutritional value are shown in Table 1.

Table 1 Initial indicators QMAFAnM of liver samples

Indicator	The index value	
	X ₁	X ₂
Water g/100	73	72

The obtained data if the chemical composition indicate the high quality of all samples and are correlated with the known parameters of the liver [1].

To determine the purity of samples of beef liver it was conducted a Bacterioscopy research with preparing smears from the surface of the liver surface from a depth of 2.5 cm and 4 cm and their Gram staining. During the first 3 days of storage bacteriological freshness of raw materials were almost identical. However, with further storage, there were considerable differences in the structure and general contamination of the samples (Fig. 1).



Pic. 2 The dynamics overall dissemination increase of the samples of beef liver

Table 2 - Bacteriological evaluation of freshness of beef liver

№	ph	Freshness degree	Bacterioscopy pattern of specimens slices of beef liver		
			On a surface	At a depth of 2,5 cm	At a depth of 4 cm
X ₁	6,4	The lowered freshness	In smears no more than 10 cells and cocci single sticks	In smears from depth of meat find 25-30 cocci and the single sticks, the broken-up fibers	In smears from depth of meat find 20-30 cocci and single sticks
X ₂	5,9	Fresh	On gram stain or not there are single bacterial cocci	In smears the single cocci, no more than 10 are found	In smears no bacterial cells

Bacteriological analysis of the data proves by the micrographs images of slices of beef liver.

Picture 3 represents the image of the cut liver sample X1 depth of 2.5 cm. The certain amount of broken fibers of meat is visible, which indicates the beginning of deep percolation process of autolysis, the decay of fiber segments on myofibrils. The organoleptical analysis has showed that the

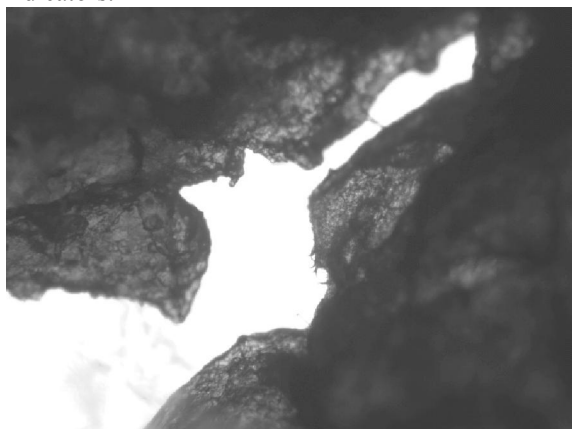
As seen from the graph, the initial degree of freshness of all the samples was the same. During storage at a predetermined temperature there was a significant jump in ph in the fifth and sixth days of storage, in the samples, it is possible to explain taking into account the development of microorganisms. The growth of microorganisms in the acidic environment slows down, however, the ph increase creates the conditions which active the growth of microorganisms. Similarly, one of the factors deteriorating the quality may be lipid.

Organoleptic characteristics analysis showed that after the storage of the sample X1 for more than 3 days, there is a smell of stale meat, liver surface becomes dense, pigmentation appears. After 6-7 days of storage pigmentation increases, there are patches of dark maroon. After 10 days of storage smell liver practically disappears, the sample of the liver almost completely loses water, the color becomes almost black. Beef liver sample X2 retains the original organoleptic characteristics within 10 days of storage. After this period there is the seal surface of the sample. After 12-14 days of storage there is the slight pigmentation on a surface, expressed in the formation of spots of dark brown color. Based on the presented data it is reasonable to suggest that the optimum shelf life liver sample X2 - 10 days. After 10 days the acidity of the sample decreases. Optimum shelf life of sample X1 - 3 days. When this term storage acidity prevents excessive amount of microorganisms, and there is significant positive impact of the activities of its own enzymes. Bacteriological assessment of freshness of the liver samples are presented in Table 2.

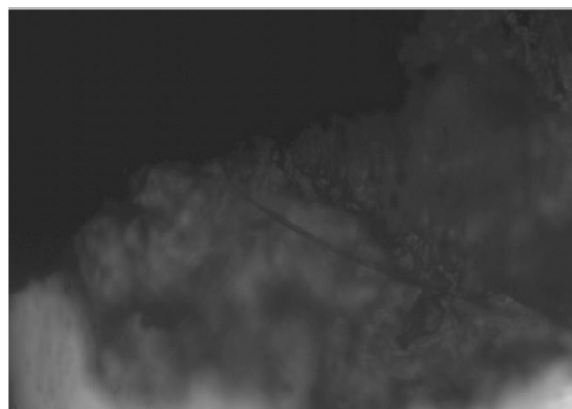
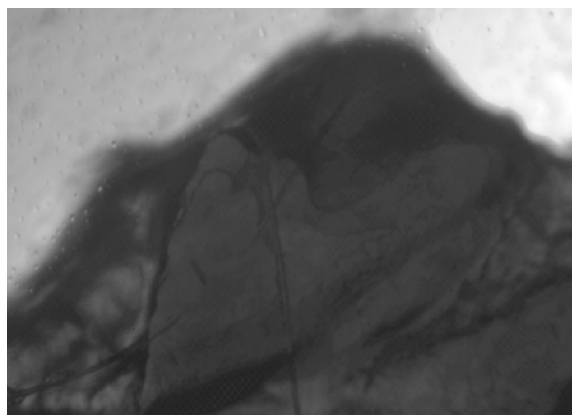
pigmentation has appeared on the surface of the liver sample, and lack of luster gloss. Pigmentation is characterized by the appearance of pigment spots on the surface that appear in the accumulation of chromogenic aerobic bacteria. Obviously, in the sample X1 has reduced freshness.

Picture 4 represents that the sample X2 was kept for 10 days in the developed coating

composition with citric acid content of 0.1 %, has outlined fibers and explicit structures. The organoleptic analysis of meat shows that after 10 days of storage – the surface kept moist liver glossy shine, pigmentation was absent. On Cut depth of 2.5 cm and 4 has showed that the odor, color and flavor of the meat corresponded with the fresh liver indicators.



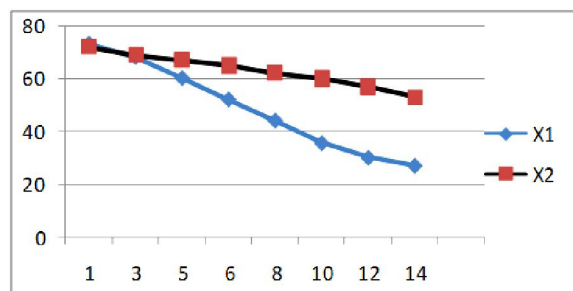
Pic.3 Microstructure of beef liver X1



Pic. 4, 5 Microstructure beef liver X2 after 12 and 14 days of storage

X2 sample after 12 days of storage (Pic. 4) and 14 days of storage (Pic. 5) showed a deterioration in the quality of the bundle of the internal structure due to the lower water content and changes in pH.

Analysis of moisture content after storage for 10 days showed that the moisture of various liver samples is significantly different from each other (Pic. 6)



Pic.6 Change of the moisture content (W,%) in liver samples of beef during storage at a predetermined temperature

The sharp drop in moisture content of the sample X1 (not coated with sodium alginate solution, etc.) is due evaporation of moisture from the product. Table 3 - Water content in beef liver samples after storage at $t = 3^{\circ}\text{C}$ within 10 days

Indicator	The index value	
	X_1	X_2
Water g/100	35,5	53

For the beef liver covered with the developed solution there is a insignificant fall of moisture content, due to the appearance of alginate on a surface. This coating allowed to hold meat juice in a liver, to reduce shrinkages during the storage period and desiccation of the surface of a test sample.

The weight loss at a sample X2 is 22% less than at X1 sample.

The analysis of freshness of meat as was conducted by means of reaction with sulfate copper in broth. Broth from a sample of a liver of X2 stored within 10 days at maintenance of the set temperature mode, remained transparent. Chemical reaction with broth from X1 sample has showed that broth became muddy, and further in it flakes dropped out.

Conclusion

That reveals the fact that the storage of beef liver for more than 10 days cases the significant deterioration. While the beef liver sample that was coated with the composition made of sodium alginate and other components allowed to keep the quality, decrease the dissemination of bacteria, to retain the

structure of meat fibers. It has been proved that the broth (i.e. muscle juice) of such liver sample retains the characteristics of fresh meat juice.

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