AN EFFECT OF THE ELECTROMAGNETIC FIELD ON MICROBIOLOGICAL SAFETY OF MEAT SEMI-PREPARED PRODUCTS

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Abstract – The modern technological level of meat product storage is energy-consuming and does not allow manufacturing low cost products. Therefore, the development of new, ecologically friendly, low cost technologies for extending meat product shelf-life is a topical task of the agricultural production. The aim of this study was to analyze and assess an impact of the electromagnetic field (EMS) of the plasma electromagnetic generator developed on the basis of the self-generating (SG) discharge on the organoleptic and microbiological indicators of meat semi-prepared products in small pieces during storage. The samples of beef and pork semi-prepared products in small pieces processed with the electromagnetic field were studied. It was found that microbial growth was delayed in the processed semi-prepared products during storage. It was especially noticeable upon processing with the electromagnetic field for 126 s, when microbial contamination was significantly lower compared to the control samples, which correlated with the results of the organoleptic investigations.

Key Words – microstructure of samples, organoleptic indicators, plasma electromagnetic generator.

I. INTRODUCTION

Currently, the efforts of Russian and foreign researches in the field of food and processing industries have been directed at using new and non-traditional methods of physical, thermal and power impact, extrusion and membrane technologies with the aim of food technology intensification, which allows producing foods with new physico-chemical properties [1]. With that, food quality is increased, its shelf life is extended, sanitary and hygienic conditions in food enterprises are improved and ecological safety of processes is enhanced, which enables exclusion of the anthropogenic effect on the environment [2,3].

In recent years, researchers are interested in the electromagnetic field (EMF) of the self-generating (SG) discharge as most actively influencing the processes of vital activities of ecological systems, in particularly, biological objects.

The EMF of the SG discharge has a high capacity to penetrate through electrically conductive media enabling management of reactions in biological objects.

This type of processing was used to extend shelf life of vegetables and fruit. The results of the studies showed that processing of strawberries and tomatoes with the electromagnetic field (EMF) emissions led to a two- and three-fold increase in storage duration of strawberries and tomatoes, respectively [4].

The present study assessed an impact of electromagnetic processing on the microbiological, organoleptic and functional and technological indicators of meat (beef and pork) after processing and during storage [5].

II. MATERIALS AND METHODS

Meat was processed using the experimental equipment that consisted of the plasma electromagnetic generator based on the self-generating (SG) discharge for generating strong electromagnetic oscillations.

The equipment includes the power supply unit connected to an alternating current network with a voltage of 220 V, a commutation unit, which is used to set the parameters of a generator that provides pulsed supply to the high voltage unit. The oscillations are formed in the unit, to which a discharge lamp is attached. Specific peculiarities

of the EMP generator of the SG discharge include its high penetration power, movement through electrically conductive media, spreading over large distances via a single-wire line practically without attenuation.

Chilled pork and beef samples were the subjects of research. Beef and pork were cut into pieces (30-40 g) and placed into trays or bags from film materials and put into the central area of a chamber between pads of a specially designed condenser with the regulated clearance, which was connected to a SG generator.

A degree of an impact was regulated by changes in exposure time under constant conditions of generator operation with duration of 5 to 200 s. Generator output voltage (U) was varied from 1200 to 1800 Volt. After processing, the experimental and control samples were stored at a temperature of 0-4ºC and relative air humidity of 70%. Changes in appearance, consistency, color and odor of the samples were monitored daily.

During the experiment we

- analyzed the quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM). The method is based on plating of a product or a dilution of a product specimen into a culture medium, incubation of plates and counting of all grown visible colonies;
- carried out the organoleptic assessment of semi-prepared products for sensory determination of appearance, color, taste, odor (aroma) and consistency by tasters having an experience in meat product quality assessment;
- carried out microstructural examinations by the traditional histological methods. The histological sections with a width of 14 µm were prepared on a cryostat MICROM – HM525 (Thermo Scientific), mounted on slides Menzel-Glazer (Thermo Scientific) and stained with Ehrlich hematoxylin and 1% aqueous-alcoholic solution of eosin (BioVitrum). An analysis of the histological preparations was carried out on a light microscope Axio Imager A1 (Carl Zeiss) using the AxioVision Imaging System 4.7.1.0 (Carl Zeiss).

III. RESULTS AND DISCUSSION

The samples of meat semi-prepared products in small pieces produced from beef and pork and processed under the regimes presented in Table 1 were studied.

Table 1 Processing regimes for meat semi-prepared products in pieces

Item	Processing duration, s	U on a condenser, Volt
semi-prepared product from beef	126	1500
	130	1600
	140	1700
semi-prepared product from pork	126	1500
	135	1600

The results of the microbiological analysis of the samples of meat semi-prepared products in small pieces during storage are presented in Fig. 1 and 2.

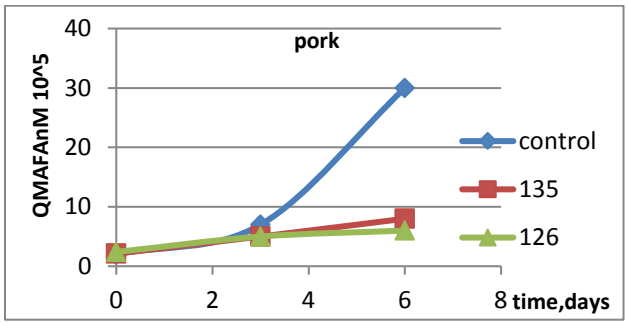

Figure 1. Changes in QMAFAnM in pork semi-prepared products processed with EMP of SG generator

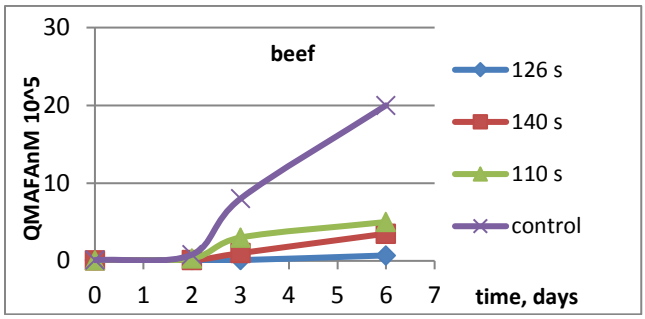

Figure 2. Changes in QMAFAnM in beef semi-prepared products processed with EMP of SG generator

As can be seen from the presented data (Fig. 1 and 2), after processing of semi-prepared products from pork and beef with the EMP of the SG generator, the significant microbial growth retardation was observed during storage. This was especially noticeable in the sample exposed to the electromagnetic field for 126 s, in

which microbial contamination was significantly lower compared to the control sample.

The organoleptic examinations showed that at the end of the storage period, the processed samples of semi-prepared products were different from the control samples by appearance, odor, color and consistency. The processed beef and pork samples had a dry crust of pale pink color, a meat cut surface was firm, a pit formed by pressing leveled out quickly, and the samples had odor characteristic of fresh meat. In the control samples of beef and pork, a meat surface was moist in places, slightly sticky and darkened. A meat cut surface was less firm and springy; a pit formed by pressing leveled out slowly; meat had stale odor.

As a result of the conducted microstructural examinations of the test samples of semi-prepared products, it can be noted that general architectonics of the constituent tissues (muscle, connective and fatty tissues) corresponded to the typical composition. Histological differences between the control and experimental samples were not revealed (Fig.3).

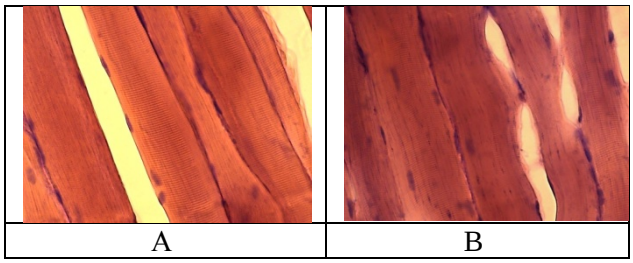

Figure 3. Microstructure of the control (A) and experimental (B) beef samples, day 0, longitudinal section (40 x)

On day 6, the destructive changes characteristic of the autolysis process were observed in the control and experimental samples. Microbial growth in the connective tissue layers and the areas of tissue mincing was revealed with higher growth in the control compared to the experimental sample (Fig. 4).

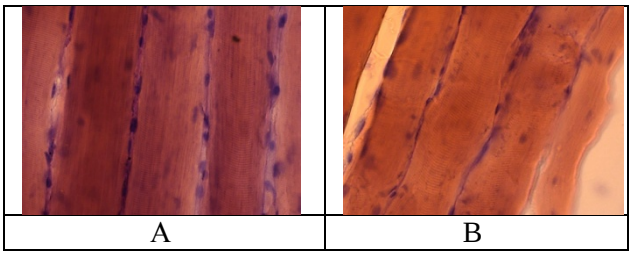

Figure 4. Microstructure of the control (A) and experimental (B) beef samples, day 6, longitudinal section (40 x)

IV. CONCLUSION

The obtained preliminary experimental data show that the electromagnetic field of the SG generator is biologically active with regard to the mesophilic aerobic and facultative anaerobic microorganisms causing the significant microbial growth retardation in meat semi-prepared products in small pieces.

This can be used as the basis for developing new ecologically friendly technology of meat product storage.

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