ETHANOL EFFECT ON THE RADIOLYSIS OF PORK MUSCLE TISSUE

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Abstract
Conventional preservation with the use of ionizing radiation is most modern and highly economical technology of production of safe food. We used pH-metry and microscopy methods to investigate the effect of short-term treatment of full piece sample muscle tissue surface with ethanol on the radiolysis of his restructured samples of muscle tissue and muscle fibers. Autolytic and microbial processes during storage of samples in sealed post-radiation period at +4 ^{o}C were differentiated on the timeline display as a result of ethanol treatment. Overall stabilizing effect of ethanol and electron-beam exposure (variable absorbed dose 12.5 – 50.0 kGy) on the acidity of the restructured samples muscle tissue with preservation of their pH level standards within 3 – 4 weeks, depending on the absorbed dose was marked.
Key words: electron-beam irradiation, muscle tissue, the radiolysis

Introduction
Radiation preservation in which it is used ionizing radiation in majority scientist's opinion considered to be the most modern and highly economical technology production of safe food, including meat or meat food as it gives opportunity to store it without freezing (Васильев и др., 2000; Костенко и др., 1992; O'Bryan et al., 2008; Пикаев, 1995; Элиас, Кохен, 1983). Actually, for radiation treatment of food it is used either gamma- and X-ray or electron beams, generated by electron accelerators (Васильев и др., 2000; Мякин и др., 2006; Zhu et al., 2009). In recent times of radiotechnology development the energy of accelerated electrons is used much wider than the one of gamma and X-ray source. It is due to greater radiation safety and larger power of electron accelerator.
With a sufficient dosage of ionizing radiation, having a bactericidal effect, it provides a complete sterilization in a short time (tens of seconds). However the long-term storage of irradiated meat at cool temperatures is opposed by activity of proteases. Radiation dose, sufficient for achieving of practical sterility incompletely inactivate proteolytic enzymes in meat. Usage of different types of protease inhibitors to repress autolytic activity couldn't become common use. Therefore, practical solution of meat-food sterilization is concerned with the necessity in inactivating of muscle cathepsins. Studies in this field hasn't given final results yet.
The goal of this study is to investigate the influence of preliminary sterilization of full-piece sample surface of pork muscle tissue by 96% ethanol on radiolysis of samples, exposed to electron-beam treatment after its chopping. The sterilization by ethanol was used to find an opportunity of time-sharing the beginning of microbial and autolysis of muscle tissue processes, usually associating and strengthening each other. The research was conducted with pH-metry and microscopy methods.

Materials and Methods
In this work restructured pork muscle tissue (pH=5.82) and muscle fiber (pH=6.28) were tested and exposed to radiation. After preliminary sterilization of full-piece sample surface of pork sirloin by 96% ethanol for 2.0 minutes, muscle tissue was ground in meat mincing-machine with 2.5 mm holes on the disk. Muscle fiber was obtained from restructured muscle tissue with the help of extraction of water-soluble constituents of sarcoplasm by bidistilled water during 12 hours. Parallely, unsterilized by ethanol intact samples, obtained from muscle tissue were tested. After grinding, samples (2.0–2.5 g) were packed in polyethylene film

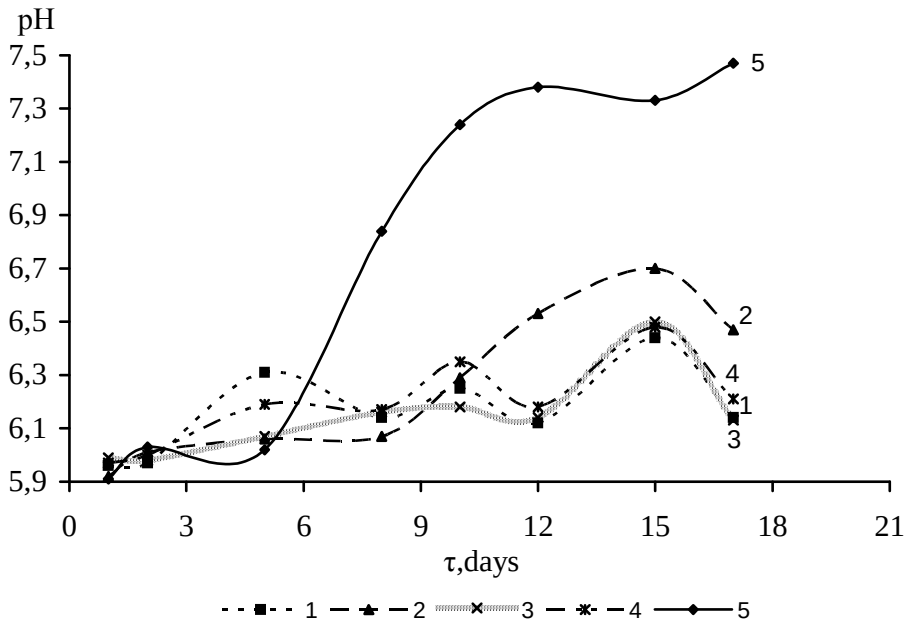
(0.03 mm thickness), airproofed and exposed to radiation. In post-radiation period samples were stored at +4 °C during 17−37 days.

Measuring of pH of water slurry samples during storage was performed on pH-meter "Expert" with the glass electrode; batch weight of the sample was 0.3 g, liquid phase volume was 20 ml. In post-irradiation period history curve of pH samples were plotted on pH=f(τ) coordinates, where τ is the time measured in days.

Semiquantitative evaluation of bacterial growth was performed by microscopic examination gram-stained (Сидоренко и др., 2002) touch smears, taken from the surfaces of samples using Zeizz Axiostar plus microscope (x1000). Sample radiation was carried out, using medium energy electron accelerator (RTE-1B). Absorbed dose in series was: 12.5; 25.0; 37.5 and 50.0 kGy.

Results and Discussion

Fig. 1 and 2 shows the changing of acidity curves of samples, which were restructured from pork muscle tissue, exposed to radiation and stored at +4 °C during 17 days. Samples in series 1 were obtained by restructuring of intact muscle tissue. Series 2 is shown by samples of forcemeat prepared from muscle tissue pretreated by 96% ethanol.



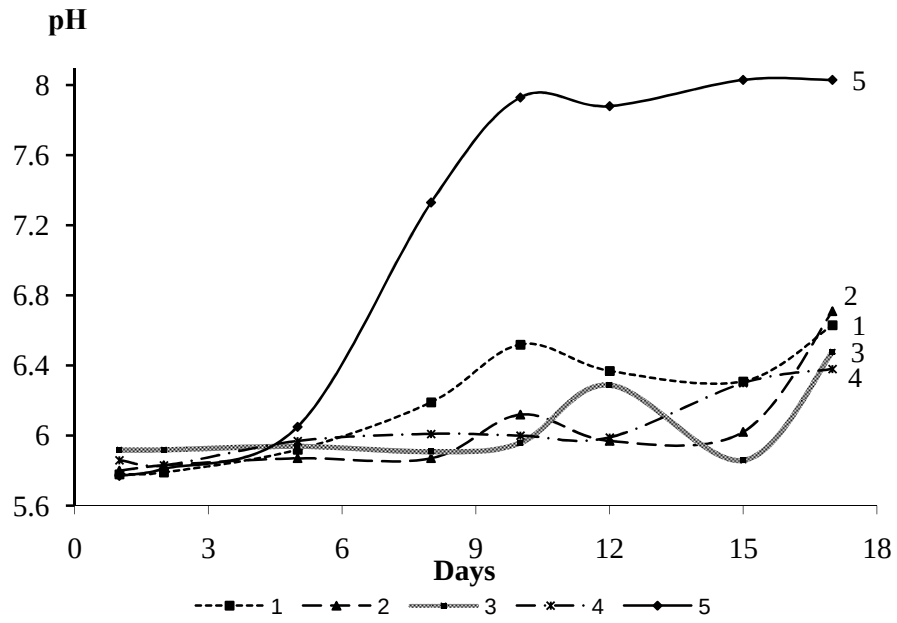
1 – 12.5; 2 – 25.0; 3 – 37.5; 4 – 50.0 κGy; 5 – is a control

Fig.1. Changing of acidity of intact muscle tissue samples plotted against absorbed dose at storage in post-radiation period

On Fig. 1 it is shown curves of pH change in water suspension, plotted against storage time of samples in series 1. The first thing that stands out here is that treatment of intact sample by ionizing radiation, regardless of absorbed dose, leads to stabilization of variation range of pH of water suspension samples. While the curve 5, describing pH change in water suspension of control sample, as early as 5 days points to decrease of it acidity.

The second thing, appeared from fig. 1 is the periodic relation of pH=f(τ) for irradiated samples (1–4). Periodicity in interchanging of dominant role of proceeding processes shows their selectivity and dependence from acidity of sample within the range pH=6.15–6.35. Synchronism in forming three maximums $pH_{max.}$ (5, 10 and 15 days) is presented only on

curves obtained for samples 1 and 4 within pH range 6.1–6.5. It can point to repeatability of post-radiation processes in samples, absorbed doses of 12.5 and 50.0 kGy during irradiation.
From the whole picture sample 2 is visibly falling out. On the curve of this sample where pH=f(τ) it is seen the broad band (8–17 days). The pH variance is within its range 6.0–6.6. It says about greater variety of processes in samples, absorbed dose 25.0 kGy, total algebraic effect of which is shown at pH increasing. However, with the dose 37.5 kGy this broad band differentiates with formation of two maximums (10 and 15 days), which is accompanied by decreasing of pH. Dose absorbance of 50.0 kGy leads again to appearance of three maximums on the curve 4. Linear dependence of pH_{max} in extreme points on time of their appearance in this curve says about densification of substances decreasing pH of system.

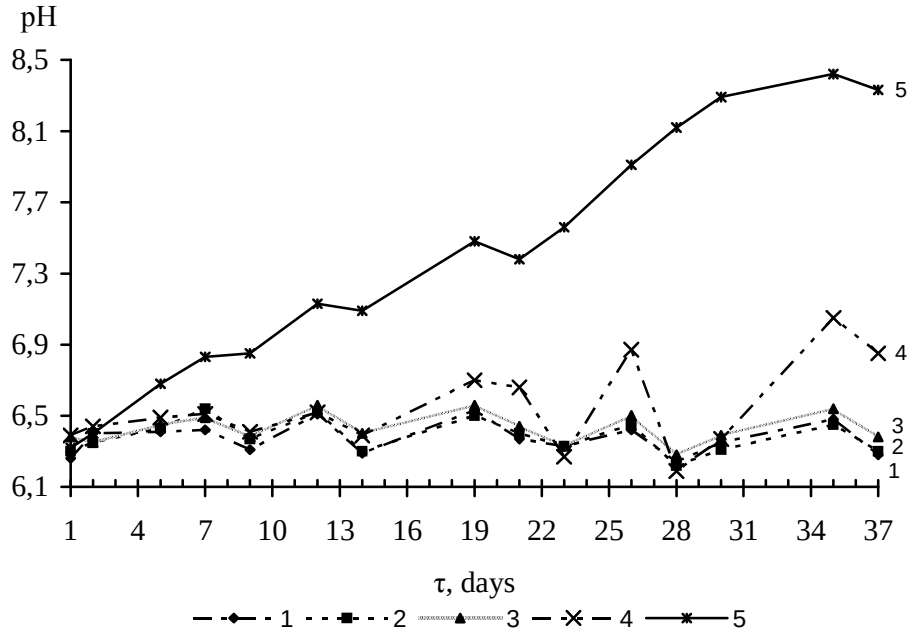


1 – 12.5; 2 – 25.0; 3 – 37.5; 4 – 50.0 kGy; 5 - is the control

Fig. 2. Changing of acidity of muscle tissue samples, treated by ethanol depending on absorbed dose at storage in post-radiation period

In fig. 2 curves1-4 show the changing in acidity during the storage procedure of parallel series two of muscle tissue samples, treated by ethanol before grinding and radiation. In dynamics of changing of acidity in samples of this series from absorbed doses of ionizing radiation it is pointed out quite another behavior. But what really stands out here is the absence of synchronism in appearance of first maximums on curves received at a preset time interval. Moreover, for all samples regardless of absorbed doses, it is exhibited the stabilizing effect of ethanol during first 8 days and this effect strengthens each time with increasing of absorbed doses. Stabilization of pH by pH=f(τ) curves point to excess of free radicals in analyzed system, which cant influence on changing pH of water suspension.
Only for samples 1 and 2 of current series the first maximum on pH=f(τ) curves forms on tenth day. But for sample 2 it is lower on pH scale. In the nature the dependence of pH=f(τ) for sample 1 is closer to curve 5, where the change of pH of control samples is presented. The first maximums on curves, gained for samples 3 and 4 are displaced on 12 and 17-th days. The forming of first maximums on pH=f(τ) curves is indicative of that the beginning of periodic changes in samples system is the result of the beginning of directed processes.
Comparison of curves 5 for control samples of both series (Fig. 1 and 2) shows that short-term treatment of full piece meat with ethanol without following exposure of ionizing radiation on forcemeat leads to more dynamic decrease of its acidity comparably to radiation-exposed

samples in post-radiation period. If full piece meat surface was pretreated by ethanol, than ground to the forcemeat followed by ionizing radiation that manipulations stabilized pH samples noticeably. Moreover, stabilizing effect of ethanol increases with the increasing of absorbed dose.



1 – 12.5; 2 – 25.0; 3 – 37.5; 4 – 50.0 κGy; 5 - is the control

Fig.3 Changing of acidity of muscle fiber samples depending on absorbed dose at storage in post-radiation period

In Fig. 3 it is presented the curves 1–4 of changing pH in water slurry of pork muscle fiber samples gained from meat sterilized by ethanol and exposed to electron beam treatment forcemeat. Rate of curves for all samples, which were stored from 7 to 37 days regardless of absorbed dose also is declarative of periodicity of their changing of pH in range 6.2–6.6. This fact correspond the process intensification which are slowed down by radiolysis the first week after radiation as in forcemeat samples of series 2. Synchronism in forming of maximums (pH_{max}) on all obtained dependences of pH=f(τ) and their closeness on pH scale can point to uniformity of type of processes, taking place in muscle fiber in post-radiation period. Moreover pH = f(τ) curves, received for samples 1 and 2 are completely coinside with throughout the whole storage life. The variation in change of pH of sample with increase of absorbed dose becomes noticeable two weeks later after storage.

Conclusions

1. The investigation has shown that ethanol pretreatment of surface of the compact sample pork muscle exhibits in dynamics change of the acidity of restructured samples in post-irradiation period.
2. The ethanol treatment has shown pH stabilization of irradiated tissues. The periodic changes of pH=f(τ) is connected with two directional processes that proceeds in parallel.

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