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## Ways to Reduce the Oxidative Activity of Raw Meat after a Treatment By Pulsed Discharge Technology.

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### ABSTRACT

In this work, we were studying influence of the electro-hydraulic effect on the oxidative activity of raw meat, and possibility to reduce formation free radicals by use antioxidant supplements into the processing treatment. There was calculating oxidant activity of experimental and control samples of raw meat, which treated by pulsed discharge technology, before and after input anti-oxidant supplements, contains flavonoids. The calculation results confirmed to use antioxidant additives as growth inhibitor of free radicals in the raw meat.

**Keywords:** pulsed discharge technology, flavonoids, antioxidant activity, free radicals.

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## INTRODUCTION

Increased speed and productivity technological equipment, reducing its energy and material consumption, improving product quality are main goals that engineers had set for development new or upgrade used machines and apparatus. To achieve these goals, developed and produced a new high-performance equipment, there are various physical and chemical effects based on scientific and technological progress and new technological approaches in the manufacture of various products. One of most effective ways to solve problem intensification technological processing of raw meat and improve quality of products can use pulsed discharge technology. The pulsed discharge technology belong to the field of electrical engineering and based on pulsed discharge, which occurs when into the circuit is created a short electromagnetic pulse. At the time of breakdown, into the gap of between two electrodes are forming channel of discharge, where a ten thousandth of a second converted tens of kilojoules of electrical energy. The process conversion of electrical energy into other its forms was call electrohydraulic effect [5].

Electrohydraulic effect is accompanied set of physical and chemical phenomena, capable to providing useful work to improve structural, mechanical, functional and technological characteristics of meat, and contributing to intensification salting, which was proved by research, described in [6-8].

For this moment, using the pulsed discharge technology for salting meat, based on formation electrohydraulic effect into system of brine-meat, is one of priorities of innovative thinking in field of meat processing and improve quality of raw meat, which is support by status resident of Skolkovo, which got project in 2015. However, despite a number of advantages by using pulsed discharge technology for salting, the authors identified some shortcomings, which need to solve for full implementation this technology into production cycle.

Electro hydraulic shocks can cause creation into the water free radicals, reactive oxygen and hydrogen, the formation of nitrogen compounds, and even the simplest amino acids [5]. Reactive oxygen species are usually strong oxidants and extremely reactive free radicals. Most of reactive oxygen contains unpaired electrons, that resulting in their extremely high reactivity and short half-life. Such reactive oxygen in short period recombine with each other or react with the substrate [2]. In processing meat, occurrence free radicals into the brine, capable significant impact on oxidative system of meat, acselerating the process to oxidation fat and reducing shelf life of processed product.

Antioxidant system of muscle consists of two subsystems - enzymatic (superoxide dismutase, catalase, peroxidase, glutathione-S-transferase, etc.) and non-enzymatic (tocopherols, ubiquinone, vitamin C, and other sulfur compounds.). The antioxidant activity of these compounds is determined by their ability to act as reducing agents (electron donors) in relation to any substrate radical  $R \bullet$ , passing in a stable, inactive form radical  $A \bullet$  [1, 9].

The energy dissociation molecules is smaller than the ionization energy, so in the plasma of electric discharge into a liquid the concentration of free radicals will be more higher than the ion concentration, and therefore the natural antioxidant system muscle tissue may be drained.

For support the antioxidant activity of meat at the high level, in the preparation of brine expedient to use antioxidants, which during pulsed discharge technology will trap free radicals.

Some aliphatic alcohols, including ethanol (Burnett et al., 1951), propylene glycol (Alexander et al., 1955), glycerol (Alper et al., 1962), etc. are good interceptors of free radicals.

The organic acids such as, ascorbic acid, pyruvic acid, formic acid, octoic acid, and salicylic acid (Alexander et al., 1955) has antioxidant action like aliphatic alcohols too. In the meat industry, into the brine added reducing sugars and ascorbic acid to reduce the risk of premature oxidation fats [2]. In the presence ascorbic acid, the nature of which is determine the rate of reactions cycle peroxidase, free radicals are inactivated. The basis for this phenomenon is the fact that such reducing agents as ascorbic acid, glutathione, ubiquinone are substrates of true peroxidases and capable to inhibiting the catalysis of peroxidase reaction [3].

However, it should be hold in mind that ascorbic acid is rapidly reacted with sodium nitrite at its introduction into brine, and therefore ascorbic acid should not be add to the brines with sodium nitrite simultaneously.

Thus, all of these facts primarily have academic interest, so as alcohols and organic acids in the concentrations, required for antioxidant protection, may form in the brine (during pulsed discharge technology) and into the product itself (during thermal treatment) very toxic compound. Therefore, to solve the indicated problem, need to use different, non-traditional antioxidant agent that has already successfully established itself in to technology of meat [11].

Nutritional antioxidant supplement, based on marc of red grapes is a natural source of the most powerful antioxidants - resveratrol, quercetin, rutin, catechin, epicatechin, epicatechin gallate, and others [10]. The mechanism of action most of common antioxidants is brake the reactive chain, and then anti-oxidant active molecules interact with radicals to form inactive compounds. Oxidation also slowe down in the presence of substances that deplete the hydroperoxide. In this case, the speed of formation free radicals are down. Even a small amount (0.01-0.001%) of antioxidants are reduce the rate of oxidation, so for some time (braking period induction) the products of oxidation were not detect. So based on the foregoing, it has studied the possibility to use antioxidant food additives as an inhibitor to formation free radicals.

### MATERIALS AND METHODS

In the experiment was use the chilled beef from the silverside, with traditional condition autolysis (pH = 5,6-6,2). The pieces weight was approximately  $400 \pm 50$  grams. The treatment of meat was carrying out by the same level of stored energy - 5 kJ. In the experiment, were using three samples. Samples were placing into the brine and exposed to pulse of 100, 200 and 300. The frequency of pulses into the experiment, were a variable factor. Control and test samples were keeping into the brine of the same composition for 24 hours. The compositions of brine were: 7% salt, 1,5% sugar, 0,0015% of sodium nitrite. To study effect of flavonoids to antioxidant system of muscle tissue, to the same brine was adding 0.05% antioxidant food additives.

Storing control and experimental samples of meat were carry out in a chilled state by 1,2-1,5 °C.

For study an antioxidant activity were get water extract of meat samples. Mass concentration water-soluble antioxidants, equivalent to gallic acid, were defining on a liquid chromatography "Color Yauza-01-AA." The concentration antioxidants of test samples were determine by calibration curve of output signal depending of concentration of gallic acid. The acid number of the samples was determine by standard technique, based on titration free fatty acids with solution of potassium hydroxide.

The reaction to the peroxidase was carrying out in conventional manner. Into the test-tube was add 2 ml extract (which are prepared by minced meat and distilled water in the ratio 1:4), 5 drops of 0.2% alcoholic solution of benzidine, after that contents of test-tube were shaking, and then added two drops 1% solution of hydrogen peroxide.

Antioxidant activity of food additive was determining by conventional methodology [12]. There was studying the rate of lipid oxidation by peroxide value change, characterized accumulation primary products of lipid breakdown. As a model lipid system was use a butter, to which was add antioxidant supplement in the amount of 3% per 100 grams of model system (quantitative flavonoid content is about 0,15%), and placed in an incubator by 37 °C.

### RESULTS AND DISCUSSION

Histogram (Fig. 1) shows that treatment by pulsed discharge technology contributes to significant decrease antioxidant activity of meat raw, which fully corresponds hypothesis about negative effects of free radicals, arising by electrohydraulic effect on the antioxidant system of meat.

It is worth noting that the reduction of the investigated parameter of depending duration processing is nonlinear. The sample which treated by 300 pulses has antioxidant activity by 21% higher than sample by 200 pulses and 15% by 100 pulses. This fact may be due by several factors. Firstly, free radicals are unstable

and hyperactive, in free form they are stay about 2,10 - 3,10 sec, second, occurrence free radicals are directly relating with value of pressure, temperature and acoustic waves in the discharge channel [5]. According to calculated data, the pressure in the center of channel is reaching 15,2 MPa, and temperature - 3000 K [7]. When initiating 300 impulses perhaps an appearance free radicals or their recombination, because this process is reversible. Nevertheless, summarizing the data obtained, the antioxidant activity of control samples was higher than experienced by 50-70%, which should eventually affect the more rapid oxidation of fat in the processed samples. Shelf life of raw meat, which is treatment by pulsed discharge technology, will be limited, and significantly lower than classical salting meat.

Studying samples meat (control and experienced), with use antioxidant food additive into brine composition (Fig. 2) revealed, that flavonoids, into the brine, has played a role of trap free radicals. The antioxidant activity of control samples was still higher than in the test, but the difference in the case of using flavonoids was 12-24% and the reducing of researching of parameter was proportional processing intensity.

The process of storage chilled meat of all investigated samples was accompanied by accumulation natural volatile components, qualitative composition of which are due to oxidative processes into the adipose tissue, and denaturation proteins, destruction free amino acids by free radicals and enzymes developing microorganisms. As has been revealed, the least effect from activity free radicals should be observe in the control samples due to the most high-grade antioxidant system. However, treatment by pulsed discharge technology has 100% bactericidal effect, the effect of metabolic microorganisms in the test samples should appear in lesser degree than in control. To 10 days of storage, the odor of control sample is intensity to increase by compared to test sample. Character smell is different. Perhaps, this is due to the fact that damage into the control meat was get largely by enzymatic hydrolysis (preferably formed of low molecular weight nitrogenous compounds and volatile fatty acids), and test meat - by oxidation of free radicals (aldehydes, ketones, hydroperoxides). Further storage, marked intensity growth dynamics odor of in all the samples.

Thus, in the test pieces of meat enzymatic oxidation of lipids and hydrolysis were the main factors that cause spoilage. As a result, deterioration of fat increases the acid number, the trend changes which may provide an explanation for the changes taking place in the samples. Since damage can examine the negative reaction to the peroxidase, in parallel with the determination of the acid number of the study conducted depletion of natural reserves peroxidase.

The results are summarize in Table 1.

**Table 1: Results of determination of acid number and the reaction to peroxidase into the studying meat samples during the storage**

Sample	acid number				reaction to peroxidase *			
	3 days	6 days	9 days	12 days	3 days	6 days	9 days	12 days
without flavonoids								
Control	0,61	0,88	1,27	2,03	+	+	+	-
Test 100 pulses	0,73	0,92	1,31	2,07	+	+	+	-
Test 200 pulses	0,92	1,8	2,11	2,29	+	+	-	-
Test 300 pulses	0,76	1,45	1,73	2,14	+	+	+	-
with flavonoids								
Control	0,55	0,84	1,33	1,89	+	+	+	-
Test 100 pulses	0,74	0,97	1,33	1,93	+	+	+	-
Test 200 pulses	0,77	1,12	1,4	2,06	+	+	+	-
Test 300 pulses	0,87	1,19	1,47	2,12	+	+	+	-

\* reaction to peroxidase: if «+», the meat does not spoiled, if «-», meat is spoiled

The data indicate that during treatment by pulsed discharge technology with antioxidant food additive containing flavonoids, decreases the rate of fat oxidation. Therefore, the acid number in the test sample treated by 300 pulses on the 9th day of storage was 1,47, which is 16% lower than when processing without using flavonoids. In processing 200 pulses is small difference in determining indicator - on the 9th day the difference was 34%, this indicating that adding into a brine additive with flavonoids can solve the problem of reducing the antioxidant activity of meat treatment by pulsed discharge technology. The reaction to the

peroxidase significant difference between the methods did not identify - on the 12th day of storage, all samples were exposing to final damage.

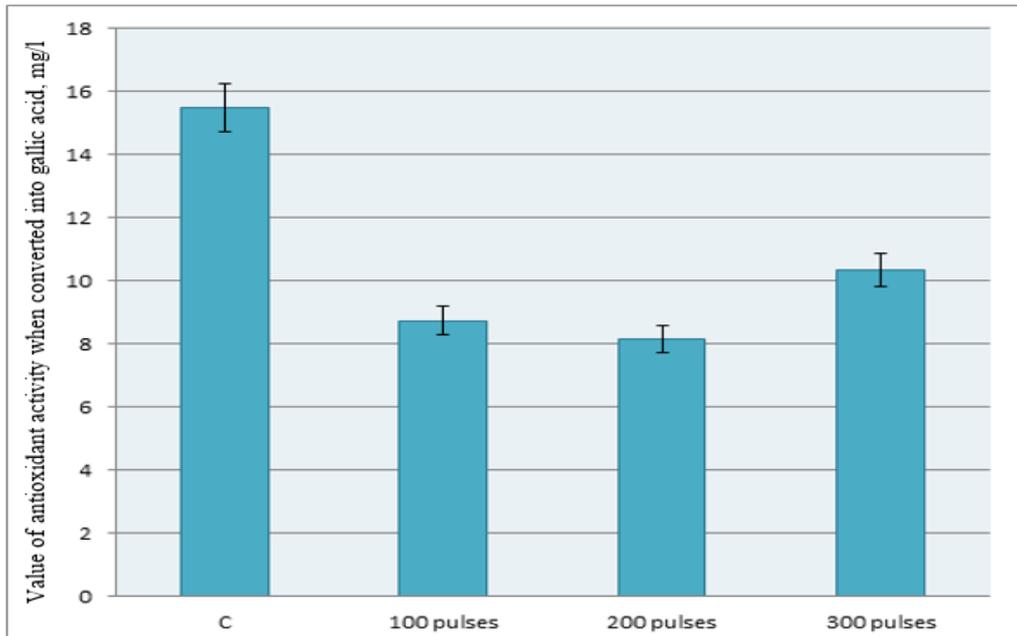


Figure 1: Results of study the antioxidant activity of muscle tissue of control sample and processed meat sample

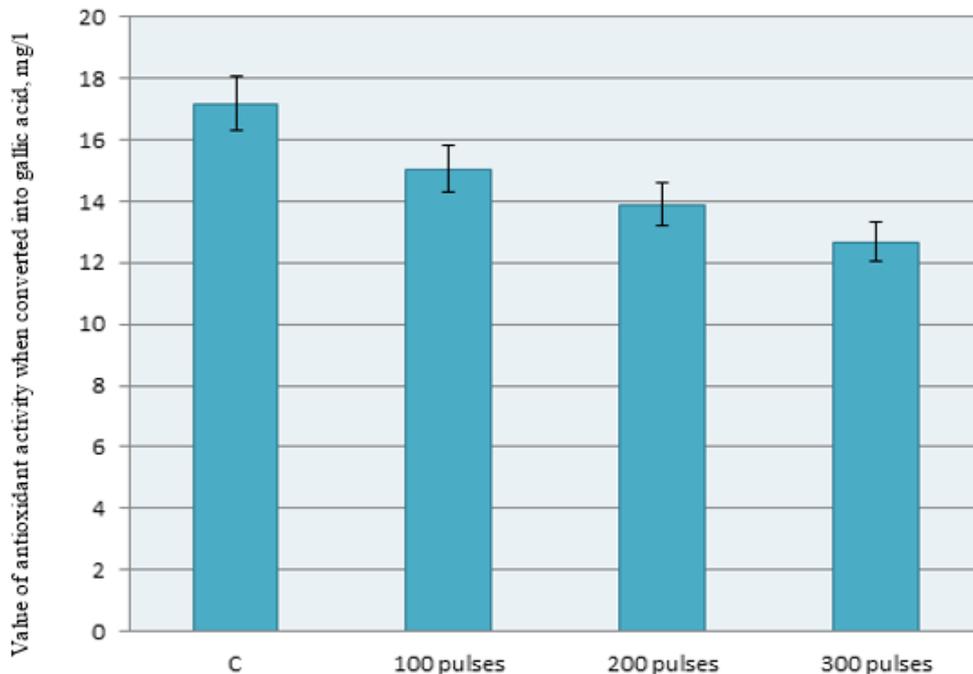


Figure 2: Results of study the antioxidant activity of muscle tissue of control and processed meat with antioxidant food additives

**CONCLUSION**

Thus, the study antioxidant activity of the control and test samples of meat found that treatment by pulsed discharge technology by generating into the system brine-meat free radicals significantly reduces potential antioxidant system of muscle tissue. However, the introduction flavonoids, antioxidant activity of treated meat is subject to less change.

Nevertheless, the shelf life of the control and test samples, according to study of acid number and reaction to peroxidase, were not significantly different. This is because, despite a lower antioxidant activity in the test samples in lesser extent was enzymatic hydrolysis, so as treatment by pulsed discharge technology is characterize bactericidal effect.

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