To the question of the possibilities of reducing the microbiological contamination of spices

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Abstract. In order to improve the palatability of food products, vegetable spices with specific persistent aromas and tastes are added in small quantities to the cooking technology. Dried spices, as a rule, are abundantly seeded with microorganisms. Their microflora is very diverse. Food production includes strict microbiological control of raw materials. Various physical methods are used to eliminate microorganisms that inhabit spices: sterilization, ultraviolet radiation, radiation exposure, etc. It is not always possible to use these methods in production. The aim of this study was to study the possibility of reducing the microbiological contamination of spices. The objects of study were ground black pepper and bay leaf. The method of exposure to microorganisms was electron-ion processing.

1. Introduction
In food technology, in order to change their taste characteristics, the addition of vegetable spices is practiced in small quantities. Spices have unique unusually persistent odors and tastes that give a new sensation, they contain essential oils, tannins and other burning and aromatic substances. As spices, the use of leaves (bay leaf), fruits (pepper), stems, inflorescences, roots and other parts of plants is practiced. Spices highlight the overall taste of the product, place accents in shades of flavors. Today, like many centuries ago, the main spice used in all countries is pepper [1].

Spice black pepper (Lat. *Pípernígrum*) is produced from not fully ripened berries of a plant of the genus Pepper (*Piper*) of the family Peppers (*Piperaceae*). The berries are poured with boiling water and dried, while the shell of the berry becomes dark and wrinkled [10]. Pepper consists of 6-12% of fatty oil, burning substances (alkaloid piperine 5–9%), essential oils (0.9–2.5%), starch [2].

Spice bay leaf is the foliage of the noble Laurel (Lat. *Láurusnóbilis*), plants of the genus Laurel (*Laurus*) of the family Laurel (*Lauraceae*), growing in the subtropics. Spice bay leaf adds a special taste and has many beneficial properties: it contains numerous trace elements, vitamins, essential oils. A part of 100 g of the product includes 48 g of carbohydrates, 8 g of protein, 7 g of fat, 313 kcal. It has a spicy, sweetish aroma, woody taste, tart tarry taste [3].

In the manufacture of food products, spices are used in small volumes. Dried spices are most often heavily seeded with microorganisms. According to numerous data, from the outer side of bay leaves there are from hundreds to several thousand microorganisms, the spread of ground pepper reaches up to several million microbial cells in 1 g. The microflora of dry spices is diverse - these are aerobic and anaerobic bacteria, many of which are thermophilic microorganisms, are also found opportunistic and pathogenic species: bacteria of the *Escherichia coli* group, *Clostridium perfringens*, *Bacillus cereus*,...
Salmonella, etc. In modern industries for packaging spices in Sachet packages small dosage chet (sachet) to reduce the number of microorganisms on the surface of spices, various physical methods are used to eliminate them: sterilization, ultraviolet radiation, radiation exposure, ethylene oxide, etc. [4].

2. Methods and Equipment
The aim of this study was to study the possibility of reducing the microbiological contamination of spices.

The objects of study were ground black pepper in accordance with GOST 29050-91, Technical Regulation of the Customs Union TR CU 021/2011 “On Food Safety”, bay leaf in accordance with GOST 17594-81, Technical Regulation of the Customs Union TR CU 021/2011 “On the Safety of Food Products”[5].

Microbiological studies of spices were carried out using a pilot plant for managing the vital activity of microorganisms “UAM-1” in the conditions of a testing and production laboratory of a meat processing enterprise (Veliky Novgorod). Before the experiments, the setup was made: the distance between the corona and grounded electrodes was adjusted, the voltage was set to create an electric field in the interelectrode space of 8 kW / cm. Then the “UAM-1” unit was sanitized: it was rubbed with alcohol and was exposed to ultraviolet radiation for 2 hours. The tests were carried out under sterile conditions, in compliance with all the rules.

Samples for research, namely black pepper, bay leaf, were taken from the raw material base of the enterprise and placed in special sterile plastic bags.

Before electron-ion processing (EIP), the samples were weighed. Four samples were prepared with black pepper and bay leaf of 10 g in each Petri dish. One of the samples was a control and was not exposed, the remaining three were exposed at different time intervals. Samples with bay leaves were prepared and investigated in a similar way.

Exposure to EIP - 1 prototype - 30 sec, 2 prototype - 2 min, 3 prototype - 5 min.

After the EIP of each sample, static electricity appeared on the grounded electrode of the «UAM-1» installation, which was removed using a copper ground wire installed on it.

Each sample was poured into a sterile bag, filled with nutrient medium, sieved on Petri dishes with appropriate nutrient media for each group of microorganisms, sent to a thermostat for growing, and then counted the grown colonies. Then, according to the formulas, the result of microbiological tests for the content was calculated: KMAFAnM, BGKP (coliforms), sulfite-reducing clostridia, salmonella, mold. Studies were conducted in five replicates.

3. Results
The results of experiments on the effect of EIP on black pepper are presented in table 1, the average values are given.

According to table 1 BGKP (coliforms), pathogenic microorganisms, incl. salmonella, sulfide-reducing clostridia were not found in all test variants.

From the data of table 1 it can be seen that after EIP at exposure from 30 s to 5 min, there is no decrease in microbiological parameters. If the exposure is not continuous, not even a significant increase in KMAFAnMis observed. The mold content during exposure from 2 to 5 minutes did not significantly decrease by 14-18%. Moreover, with a decrease in EIP exposure to electromagnetic radiation, the result of exposure was 67%.

An analysis of these experimental results showed the following:
1. EIP at a voltage of 8 kW/cm leads to a change in the proportion of mold microorganisms that inhabit the outer shell of black pepper.
2. The content of mold microorganisms during the exposure of EIP from 2 to 5 min did not decrease significantly - by 14-18%.
3. The content of mold microorganisms during the exposure of EIP 30 s decreased slightly by 67%.
4. At exposure time from 30 s to 5 min, there is no decrease in the proportion of mesophilic aerobic and facultative anaerobic microorganisms that populate the outer shell of black pepper.
5. If the exposure is not continuous, even a slight increase in the KMAFAnM indicator is noted - by 15–30%.

Table 1. Microbiological tests of spices of black pepper exposed to EIP.

| SampleName         | KMAFAnM, CFU / g | BGKP (coliforms), in 0.01 g are not allowed | Pathogenic, including salmonella, in 0.01 g are not allowed | Sulphite-reducing clostridia, in 0.01 g are not allowed | Mold no more than 1 * 10^3 CFU / g |
|--------------------|------------------|--------------------------------------|--------------------------------------------------|-----------------------------------------------------|----------------------------------|
| Control            | 8.1*10^4         | Not detected                          | Not detected                                     | Not detected                                        | 2.2*10^2                        |
| Black pepper:      | 1.3*10^5         | Not detected                          | Not detected                                     | Not detected                                        | 7.3*10^1                        |
| EIP Exposure 30 sec|                  |                                      |                                                  |                                                     |                                  |
| Black pepper:      | 1.0*10^5         | Not detected                          | Not detected                                     | Not detected                                        | 1.8*10^2                        |
| EIP Exposure 2 min |                  |                                      |                                                  |                                                     |                                  |
| Black pepper:      | 9.5*10^4         | Not detected                          | Not detected                                     | Not detected                                        | 1.9*10^2                        |
| EIP Exposure 5 min |                  |                                      |                                                  |                                                     |                                  |

The results of experiments on the effect of EI on the bay leaf are presented in table 2, the average values are given.

According to table 2 BGKP (coliforms), pathogenic microorganisms, incl. salmonella, sulfide-reducing clostridia were not found in all test variants.

Table 2. Microbiological tests of spices of bay leaf exposed to EIP.

| SampleName         | KMAFAnM, CFU / g | BGKP (coliforms), in 0.01 g are not allowed | Pathogenic, including salmonella, in 0.01 g are not allowed | Sulphite-reducing clostridia, in 0.01 g are not allowed | Mold no more than 1 * 10^3 CFU / g |
|--------------------|------------------|--------------------------------------|--------------------------------------------------|-----------------------------------------------------|----------------------------------|
| Control            | 1.1*10^4         | Not detected                          | Not detected                                     | Not detected                                        | 2.5*10^2                        |
| Bay leaf: EIP      | 9.0*10^5         | Not detected                          | Not detected                                     | Not detected                                        | 1.7*10^2                        |
| Exposure 30 sec    |                  |                                      |                                                  |                                                     |                                  |
| Bay leaf: EIP      | 8.0*10^5         | Not detected                          | Not detected                                     | Not detected                                        | 2.5*10^2                        |
| Exposure 2 min     |                  |                                      |                                                  |                                                     |                                  |
| Bay leaf: EIP      | 8.0*10^5         | Not detected                          | Not detected                                     | Not detected                                        | 2.5*10^2                        |
| Exposure 5 min     |                  |                                      |                                                  |                                                     |                                  |

From the data of table 2 it can be seen that after EIP with exposure from 30 s to 5 min, there is no significant decrease in microbiological parameters. A slight decrease in KMAFAnM by 18–27% is noted. The mold content during the exposure of the EIP from 2 to 5 min practically did not change, there is no significant decrease at the exposure of 30 s – by 32%.

An analysis of these experimental results showed the following:
1. EIP at a voltage of 8 kW/cm and exposure from 30 s to 5 min practically does not lead to a change in the proportion of mold microorganisms that inhabit the outer shell of the bay leaf.
2. The content of mold microorganisms during the exposure of EIP 30 s did not decrease significantly — by 32%.
3. When the exposure from 30 s to 5 min, there is a slight decrease in the proportion of mesophilic aerobic and facultative anaerobic microorganisms that inhabit the outer shell of the bay leaf.
4. With an increase in exposure, KMAFAnM decreases from 18% to 27%.

4. Conclusion
It has been experimentally established that EIP has an effect on microorganisms that populate spices.

During the experiments, bacteria of the escherichia coli group (coli forms), pathogenic microorganisms, incl. salmonella sulfide-reducing clostridia were not found in the studied samples of black pepper and bay leaf.

After exposure of EIP to black pepper, it was found that treatment with an electric field in the interelectrode space of 8 kW/cm leads to a change in the proportion of mold microorganisms that inhabit the outer shell of black pepper. However, we consider this change insignificant.

When exposure to EIP is up to 5 min, there is no decrease in the proportion of mesophilic aerobic and facultative anaerobic microorganisms populating the outer shell of black pepper.

The results of exposure to electromagnetic radiation on the bay leaf showed that with exposure up to 5 min, there is no significant decrease in microbiological parameters. A slight decrease in KMAFAnM by 18-27% is noted. The mold content during the exposure to 2–5 min practically did not change; a slight decrease was noted at an exposure of 30 s — by 32%.

With an increase in exposure of EIP to electromagnetic radiation from 30 s to 5 min, there is a slight decrease in the proportion of mesophilic aerobic and facultative anaerobic microorganisms that populate the outer shell of the bay leaf (up to 27%).

We believe that in order to achieve a more significant decrease in the microbiological parameters of mesophilic aerobic and facultative anaerobic microorganisms and mold microorganisms on spices, in particular on black pepper and bay leaves, it is necessary to conduct additional studies with a change in the parameters established in this experimental block: electric field strength in interelectrode space and exposure.

References
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