Study of safety indicators for obtaining products from dried rose hips

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Abstract. The article presents the data of microbiological changes in the process of processing dried rose hips in water extraction using ultrasonic effects. Changes in safety indicators of various product samples with different parameters of pre-preparation of dried rose hips were investigated. The technological scheme of processing the used plant raw materials is presented. The microbiological indicators of the ultrasonic effect on the microflora of dried rosehip products are described. The results of the study of mechanically crushed dried rosehip fruit samples, hydrated and non-hydrated, are ambiguous. To analyze the risk of microbiological indicators, the “bow tie” method was used, the essence of the method was to display the risk, the sources of risk and all possible consequences associated with its occurrence were considered, as well as the display of risk mitigation measures depicted in one diagram.

1. Introduction
One of the methods of preserving fresh fruits is drying, due to the low moisture content, dry fruits can be stored for a long time and used as needed, both for brewing and for obtaining the necessary products for food production all year round. The choice of rose hips as an object of research is explained by the uniqueness of its chemical composition [1-7]. The technology of obtaining products from dried rose hips using ultrasonic effects is proposed. The use of ultrasound is justified by its properties to sterilize products, thereby reducing microbiological indicators to zero. Additionally, the use of ultrasound in the process of dispersing plant raw materials is aimed at creating products that have been disinfected at low-temperature exposure modes with high technical characteristics.

The article proposes to consider the change in the safety indicators of dried rosehip products on the example of changes in microbiological indicators in the process of processing plant raw materials.

2. Materials and methods
The object of the research is to study the effect of ultrasonic exposure on microbiological changes in products based on dried rose hips.

For the experiment dry rose hips (GOST 1994-93 Rose hips. Specifications.) were used. Pre-preparation included the process of selecting whole and crushed fruits (using a cutting element), and the use of hydration in a ratio of 1:7 (rose hips: distilled water) for 24 hours at an ambient temperature of 20 ± 2° C. Technological processing of plant raw materials consisted of using the principle of...
ultrasonic action as a method of disinfection during low-temperature processing of raw materials at a power of 100 W / cm² for 30 ± 2 minutes. Fruit processing was carried out in glass containers with a nominal value of 1000 ml (figure 1).

Figure 1. Technological scheme for dried rose hips processing.

In the experiments, a setup was used that included: a control device (1, 2), an ultrasonic generator of the type “Volna” series apparatus UZTA-0.4 / 22-OM (3), and a container (4). Measuring equipment: pH meter (5), thermometer (6), stopwatch (7) (figure 2).

Figure 2. Installation for ultrasonic treatment.
The samples after ultrasonic treatment had the form of a saturated aqueous extract and a suspension from the destroyed dried rose hips.

For the study of microbiological indicators, the following samples were used: dry rose hips and fruits processed using the UZTA apparatus in whole and crushed form, as well as in whole and crushed form with preliminary hydration.

Microbiological assessment included:

- NMAFAnM, CFU / g - determination of the number of mesophilic aerobic and facultatively anaerobic microorganisms (GOST 10444.15-94 Food products. Methods for determining the amount of mesophilic aerobic and facultative anaerobic microorganisms);
- Salmonella - determination was carried out according to GOST 31659-2012 (GOST 10444.15-94 Food products. Methods for determining the amount of mesophilic aerobic and facultative anaerobic microorganisms);
- ECB - Escherichia coli bacteria (GOST 31747-2012 Food products. Methods for detecting and determining the amount of Escherichia coli bacteria (coli form bacteria));
- E. coli - to confirm the belonging of microorganisms grown on Kessler's medium to E. coli, they were subcultured onto the surface of Endo agar medium (GOST 30726-2001 Food products. Methods for detecting and determining the number of bacteria of the species Escherichia coli);
- Moldy fungi and yeast (GOST 10444.12-2013 Microbiology of food and animal feed. Methods for detecting and counting the amount of yeast and molds).

The Bow-tie method (“bow tie”, “hourglass”) is proposed to study the processes leading to a decrease in the safety indicators of products. This method was used to investigate risk based on demonstrating a range of possible causes and consequences. It is used when it is difficult to conduct a full analysis of the fault tree, or when the purpose of the investigation is to develop preventive measures or controls in the event of an incident, and also when independent paths leading to failure have already been established.

The work algorithm was reduced to the following stages (GOST R ISO 31000-2019 Risk management. Principles and guidelines, GOST R 54141-2010 Risk management. Guidance on the application of organizational security measures and risk assessment. Reference incident scenarios):

- identify a hazardous event and display it as the central node of the bow tie;
- compiled a list of the causes of the event by investigating the sources of risk or hazard;
- identified the mechanism of the hazard development before the critical event;
- drew lines that separate the cause from the event;
- put vertical barriers across the lines - barriers that should prevent undesirable consequences, the method is also used to discuss positive consequences when barriers reflect controls that stimulate the emergence and development of a desired event;
- identified various consequences of a dangerous event and display them on the right side of the "butterfly", draw lines that connect the event with each possible consequence;
- portrayed barriers as barriers to the aftermath; for positive outcomes, barriers reflect controls that provide beneficial outcomes;
- displaying auxiliary controls under the diagram, such as training and testing, connecting them to the appropriate barriers.

The construction is based on the principles of brainstorming, represented a combination of methods - a fault tree and an event tree, quite effective in assessing risk in conditions of high uncertainty.
3. Research results
The purpose of our research was to study the microflora of dried rose hips using ultrasonic treatment to obtain a new type of product.

The obtained experimental samples were processed at a power of 100 W / cm$^3$ for 30 ± 2 minutes, indicating the temperature change.

Dried fruits in their whole form mainly contain groups of microorganisms that are associated with the method of collecting raw materials, their number gradually decreases in the process of canning, drying and storage in compliance with moisture regimes. In the study of raw materials (dried rose hips), the predominance of saprophytes and Salmonella was revealed, which remain viable for a long time in the external environment: in drinking water they can live from 11 to 120 days, in soil from 1 to 9 months, on dried fruits, including and fruits from 2 weeks to 2.5 months [8].

The main task of the conducted research was to ensure the production of high quality products and the safety of its use in microbiological terms (table 1).

| The studied indicators (CFU / g) | Raw materials$^a$ | Treated using UZTA | Crushed fruits | ND |
|--------------------------------|-----------------|-------------------|---------------|----|
|                                | with hydration   | no hydration       | with hydration | no hydration |
| NMAFAnM                        | 8.4×10$^4$      | n / f              | 2.70×10$^3$   | 1.16×10$^3$ |
|                                |                 |                   | 2.27×10$^3$   | 5.0×10$^0$  |
| ECB                            | 10$^1$          | n / f              | n / f         | +   |
|                                | 10$^2$          | n / f              | n / f         | +   |
| Salmonella                     | S. paratifica   | n / f              | S. paratifica | n / f |
| E.coli                         | n / f           | n / f              | n / f         | n / f |
| Mold                           | 1.2×10          | n / f              | n / f         | n / f |
| Yeast                          | 3.41×10         | n / f              | 1.30×10$^2$  | n / f |

$^a$ dry whole rose hips; «+» - growth was detected; n / a - in 25 gr. not allowed; n / f - not found; ND - SanPiN 2.3.2.1078-01 n.1.6.2.2

The investigated raw material in the form of whole dried rose hips has low indicators of microbiological safety in accordance with regulatory documents. Almost all indicators, with the exception of the “ECB” indicator, were found in the sample. Further processing of raw materials consisted of ultrasonic treatment or additional grinding, or hydration, or a combination of these processes. The use of only ultrasonic treatment of whole dried rose hips made it possible to reduce the microbiota of dried rose hips by an order of magnitude in terms of the “NMAFAnM” indicator (from 8.4 × 104 to 2.70 × 103 CFU / g), the rest of the indicators were reduced to zero. When comparing the microbiota of dry fruits and whole hydrated fruits, complete disinfection of the finished product was noted. In UZTA-treated samples of dried rose hips, an order of magnitude decrease in the titer of E. coli bacteria (“ECB” index) was observed, the disappearance of the pathogenic species of Salmonella: S. paratifica, detected in an untreated dry sample, as well as of mold and yeast spoilage microorganisms.

The results of the study of samples of mechanically crushed rosehip fruit samples, hydrated and non-hydrated, are ambiguous. In a sample hydrated, crushed for 24 hours at room temperature and treated with UZTA, the growth of microbiota was observed in all the parameters presented. Perhaps this was due to additional seeding during grinding with the cutting mechanism and further growth under favourable conditions in water at room temperature, since in the sample where the rose hips were crushed, but not subjected to gyration for 24 hours, a significant decrease in indicator “NMAFAnM”, and sterility for all identified microorganisms in the original sample.
To analyze the risk of microbiological indicators, the “bow tie” method is proposed, the essence of the method was to display the risk (risk event) – “product safety”, the sources of risk and all possible consequences associated with it, as well as the display of mitigation measures (“Mitigating”) risk in one diagram. This method is chosen to display the visibility and visualization of the cause-and-effect relationships of risk for the problem under consideration (figure 3).

![Diagram](image-url)

**Figure 3.** Method “bow tie” on the example of the study of the “product safety” cause.

Thus, on the studied example of the risk event “product safety”, the effectiveness of the method is visualized. Barriers were described to reduce the likelihood of the occurrence of the risk event under study, as well as the severity of the consequences.

4. Conclusion

As a result of the products safety indicators study from dried rose hips, data on indicators – “NMAFAnM”, “ECB”, “Salmonella”, “E.coli”, “mold and yeast” were summarized. Changes in safety indicators during processing of samples using ultrasound are presented.

The use of the Bow-tie method identified the main causes of the risk and all possible consequences.

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