Ways to reduce the total bacterial contamination of grain raw materials and bran in the production of all-mash

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Abstract. For the most complete satisfaction of human needs in food products and, especially, in products of animal origin, special importance is attached to the accelerated development of animal husbandry, which causes the development and strengthening of the domestic feed base. The main role in providing farm animals with high-grade high-quality feed belongs to the feed industry. Along with the fact that feed must meet all quality standards, they must meet the animal's veterinary and sanitary standards. The sanitary state of feed is currently very relevant, since the successful development of animal husbandry implies a stable veterinary and sanitary well-being of the external environment for farm animals. The sanitary condition of all-mash depends largely on the microbiological characteristics of the raw material included in the recipe. Microorganisms are a serious cause of reduced quality and spoilage of products. Raw materials (wheat, corn, barley, bran, oats) supplied to feed mills for the production of compound feeds are largely seeded with saprophytic microflora and pathogenic microorganisms. Studies were conducted to determine the total bacterial contamination of wheat, corn, barley, oats and bran used for the production of all-mash, to identify the disinfecting effect of roasting processes, extrusion of raw materials and granulation of all-mash.

1. Introduction
The priority of the socio-economic policy of our state, a strategic task in the economic field today is the development of the agro-industrial complex. The accelerated growth of animal husbandry is of great importance in order to meet the needs of the population for animal products. The main role in providing livestock with complete feed belongs to the feed industry. All-mash on all quality indicators must meet the requirements of standards and satisfy animals and poultry on veterinary and sanitary indicators [1].

The sanitary condition of mixed feeds depends largely on the microbiological characteristics of the raw material. Feed raw materials used in the formula of all-mash are largely seeded with saprophytic microflora and pathogenic microorganisms.

The presence of a large number of microorganisms indicates bacterial contamination and possible spoilage of products. The presence of a significant number of aerobic mesophilic microorganisms in the feed indicates that either low-efficiency hydrothermal treatment of feed raw materials is used, or storage is carried out in unfavorable conditions [2].
The leading role in the deterioration of the quality and spoilation of raw materials and feed is played by microorganisms, primarily fungi, which intensively destroy nutrients and, often, give toxic properties [3]. To reduce losses and prevent feed poisoning and diseases, effective ways of affecting raw materials and finished products have been developed. Nowadays, deep processing operations are increasingly used in feed production [4]. At the same time, biological changes occur, such as gelatinization and dextrinization of starch, denaturation of proteins and changes in fiber and fat, and increased use of phosphorus, protein, and metabolic energy by animals. The applied water-heat treatment leads to disinfection of feed raw materials and improves the sanitary and veterinary condition of products [5].

2. The purpose of the study
Grain raw materials from the soil and through other environmental objects, as well as products of grain processing, are seeded with saprophytic microflora, which quickly multiplies and can give harmful properties to the raw materials [6] if storage conditions are violated.

The aim of the research was to study the effect of roasting, extrusion and granulation processes on the overall bacterial contamination of grain raw materials and wheat bran used for the production of all-mash.

3. The object of the study
The object of the research was wheat, corn, barley and oats supplied to the feed industry, as well as wheat bran.

4. Materials and methods
Sampling was performed in accordance with the requirements of the relevant standards: grain [GOST 13586.3-2015] and wheat bran [GOST 27668-88]. Organoleptic analysis was performed in accordance with the method set out in the Guidelines for sanitary and mycological assessment and improvement of feed quality. According to current standards, the total bacterial contamination of raw materials was determined [GOST R 55453-2013], the peroxide number of fat [GOST 31485-2012], the acid number of fat [GOST 31700-2012], the total acidity [GOST 13496.12-98] and the humidity [GOST 13586.5-2015]. The analysis of the sanitary condition of grain and products of its processing was carried out in the summer-autumn and winter-spring periods.

5. Discussion of the results
It was revealed that the number of aerobic mesophilic bacteria in corn on average for the entire period of the study was 232.5 thousand of microbial cells in 1 g. the lowest content of bacteria in 1 g of corn was at the level of 25.9 thousand, and the highest - 354.6 thousand of microbial cells. The total bacterial contamination of wheat grain for the entire period of the study was 415.8 thousand of microbial cells in 1 g, in barley grain 1080.8 thousand of microbial cells in 1 g, in oat grain 1010.3 thousand of microbial cells in 1 g. It was found that the contamination of grain with bacteria increases more in the spring and summer period. Along with the study of the total bacterial contamination of raw materials, the presence of E. coli in it was also investigated [1, 6].

All the grain raw materials studied contained E. coli. The highest intensity of Escherichia coli contamination was typical for barley grain, 22.5 % of barley samples had a coli-titer of 0.0001.

The total bacterial contamination of wheat grain for the entire period of the study was 322.7 thousand, while in the summer and autumn seasons it was 395.8 thousand, and in the winter and spring-248.9 thousand. 85.7 % of the samples had a total bacterial contamination of up to 500 thousand microbial cells in 1 g and 17.6% of the samples contained more than 500 thousand cells.

Studies have shown that along with the presence of General bacterial contamination, all the studied grain raw materials contain E. coli and coli-titer. The highest intensity of Escherichia coli contamination is typical for barley grain, 22.5 % of barley samples had a coli-titer of 0.0001.
Methods for evaluating grain quality are based on changes in organoleptic and biochemical quality indicators. Organoleptic signs are quite subjective, biochemical parameters (acid, peroxide number of fat, total acidity) are subject to significant fluctuations. Due to complex metabolic processes, these indicators may change during the development of microorganisms in feeds raw materials [4, 7].

Analyzing the quality of grain raw materials by the acid number of fat depending on the season, it was determined that in the summer and autumn season, this indicator tended to increase. However, the relationship between the indicators of good quality (acid number of fat, acidity) and the quantitative content of bacteria was not revealed.

In order to reduce the level of total bacterial contamination of grain raw materials and compound feeds and improve their sanitary condition, studies were conducted to identify the disinfecting effect of roasting, extrusion and granulation processes [8, 9].

Roasting of the grain was carried out at a temperature from 70 to 98 °C for 15...135 minutes. This type of treatment resulted in almost complete destruction of bacterial and fungal microflora [8]. The results of studies of the effect of the roasting process on the total number of bacteria in the barley grain showed that when roasting barley for 30 ... 45 minutes at a temperature of 77 ... 98 °C, the number of bacteria decreased by 81.0...92.0 %, and complete disinfection was achieved when exposed to raw materials for 105...135 minutes (Figure 1).

![Figure 1. Change in the number of microbial cells, PCs (1) and the level of disinfection, % (2) as a result of roasting the grain](image)

The parameters of the extrusion process were used as follows: the humidity of the initial product was 17.5...22.5 %; the temperature of the mixture in front of the extruder matrix was assumed to be 380...410 K; the screw of the extruder rotated at a speed of 5.1...6.8 s-1; the pressure of the mixture in front of the matrix was 5.5...6.6 MPa [10].

Processing the product on the extrusion line proved to be a highly effective method of disinfection. With this method, the bacteria in the barley grain and bran died completely.

For decontamination of compound feeds that have an increased total bacterial contamination, it is recommended to use granulation, which stops or slows down the development of toxic fungi [10, 11].
Table 1. Influence of the extrusion process on the sanitary condition of the raw material under study

| Feed raw materials | Number of microbial cells in 1 g, pieces | Disinfected, % |
|--------------------|-----------------------------------------|----------------|
| Up to extrusion    | 1551000                                 |                |
| After extrusion at 100 °C | 579                                    | 99.5          |
| After extrusion at 120 °C | No                                     | 100           |

A series of experiments on granulation of grain raw materials and wheat bran was performed (table 2).

Table 2. Technical parameters of the granulation process

| Raw materials | Steam pressure, MPa | Source product | Steamed product | Temperature of pellets at the outlet of the press, °C | Press performance, kg / h | Specific consumption of El. energy, kW / h | Moisture content of the finished granules, % | Pass through a sieve with holes, Ø 2 mm, % |
|---------------|---------------------|----------------|-----------------|-----------------------------------------------------|---------------------------|-------------------------------------------|----------------------------------------|------------------------------------------|
| wheat         | 0.4                 | 8.9            | 14.8            | 78                                                  | 287                       | 13.1                                      | 12.4                                   | 2.2                                      |
| corn          | 0.4                 | 7.1            | 14.1            | 75                                                  | 380                       | 11.8                                      | 11.5                                   | 1.3                                      |
| barley        | 0.4                 | 11.0           | 16.3            | 81                                                  | 265                       | 14.6                                      | 12.8                                   | 2.5                                      |
| oats          | 0.4                 | 11.4           | 15.9            | 79                                                  | 228                       | 15.3                                      | 13.1                                   | 2.0                                      |
| bran          | 0.4                 | 7.5            | 14.9            | 76                                                  | 327                       | 12.8                                      | 12.1                                   | 1.7                                      |
| All-mash      | 0.4                 | 10.7           | 15.3            | 80                                                  | 252                       | 14.4                                      | 12.2                                   | 4.3                                      |

The conducted research revealed a good disinfecting effect of the granulation process. The level of total bacterial contamination of the studied feed raw materials is reduced by 95.3 ... 97.0 % (table 3).

Table 3. Influence of the granulation process on the sanitary condition of mixed feeds

| All-mash | Feed quantity of microbial cells in 1 g |
|----------|----------------------------------------|
| Before processing | 1959000             |
| After processing  | 491                   |

6. Conclusion
The results of research on the use of roasting methods, extrusion of feed raw materials and granulation of compound feeds have shown that their use leads to a decrease in the total bacterial contamination, guarantees quality improvement and eliminates the risk of bacterial infection of the produced product.
The products obtained met the sanitary and veterinary requirements. The total bacterial contamination of grain raw materials and feed did not exceed 500 thousand microbial cells in 1 g.

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