Influence of fat-containing feed components subjected to ultrasonic treatment in combination with zeolite on broilers’ body

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Abstract. Based on the study on morphological and biochemical parameters of blood, it can be stated that the introduction of cavitation-treated sunflower sludge into the diet of the experimental bird together with zeolite powder results in the basic blood parameters improvement. All biochemical and morphological parameters were within the physiological norm. The results obtained indicated that the cavitation treatment of sunflower sludge together with particles of zeolite being part of the feed mixture with an additional increase in the level of exchange energy led to an increase in the content of macro- and microelements against the background of a significant decrease in antagonist elements. The greatest changes were observed in the 2nd experimental group subjected to the diet with an exchange energy content of 14.9 MJ/kg DM (6% of processed sludge by cavitation with 4% zeolite).

1. Introduction
Processing technologies applying non-reactive influences are the most beneficial with regards to the safety and ecological properties of end products including feed for the agro-industrial complex. The use of various physical effects can significantly speed up and facilitate technological processes, including the outcomes impossible to gain with the use of other technologies [1-2].

Cavitation is a type of acoustic methods used for food processing, including feed. During this process, pulsating bubbles (cavities) filled with steam, gas or their mixtures are formed in the liquid at a certain sound intensity [3-5].

Sunflower sludge is of particular interest for domestic animal husbandry. This production waste is a good source of fat and valuable protein, inferior to animal protein only in lysine content [6-8].

2. Materials and Methods
The digestibility of dry matter of cavitation-treated products was determined in the course of the pilot studies. Dependence of this indicator on the moisture content of the feedstock and its gravimetric composition was also determined.

The effect of adding zeolite powder characterized by the dispersion with an equivalent diameter of not more than 1.5 mm on the performance of the ultrasonic apparatus, as well as on the quality indicators of end feed products was studied with the objective to optimize sunflower sludge ultrasonic processing.
The technological scheme of processing sunflower sludge on feed implies double sonication. The first one is implemented when we mix sunflower seed and water, and the second, when we add zeolite particles to the prepared product.

For cavitation processing, a sunflower seed moistened with water to a humidity of 55% was applied. The percentage of humidity was stipulated by the fact that it provided the maximum efficiency of the ultrasonic apparatus for this type of product.

To conduct an experiment of the influence of applying fat-containing waste on the mineral status of broiler chickens after ultrasonic treatment, 120 heads of weekly broiler chickens were selected. They were divided into 4 groups using the analog method (n=30). During the experiment, all birds were provided with the same conditions of keeping and feeding. The experiment lasted for 42 days, including the preparatory period from 7 to 13 days and the reference period from 14 to 42 days (Table 1).

Table 1. Schematic course of experiment

| Group | Experiment period | age, days | Reference period      |
|-------|------------------|-----------|----------------------|
|       | introductory     | 7-13      | 14-42                |
| Control | Basic diet      | Basic diet| Diet with 6% unprocessed sunflower sludge |
| 1      | Basic diet      |           | Diet with 3% processed sunflower sludge |
| 2      | Basic diet      |           | Diet with 6% processed sunflower sludge |

Keeping poultry and the procedures for performing the experiments corresponded to the requirements of the instructions and recommendations of the Russian regulations (Order of the Ministry of Health of the USSR-755 dated December 08, 1977) and “The Guide for Care and Use of Laboratory Animals (National Academy Press, Washington, D.C., 1996)”. Every effort has been made to minimize animal suffering and to reduce the number of samples used.

Morphological parameters of blood were determined using an automatic hematological analyzer URIT-2900 Vet Plus (URIT Medial Electronic Co., China). Biochemical analysis of blood serum was carried out on an automatic biochemical analyzer CS-T240 (Dirui Industrial Co., Ltd, China) using commercial biochemical kits for veterinary medicine DiaVetTest (Russia) and commercial biochemical kits Randox (Laboratories Limited, UK).

The elemental composition of biosubstrates was studied using atomic emission and mass spectrometry (AES-ICP and MS-ICP) in the testing laboratory of ANO “Center for Biotic Medicine”, Moscow (accreditation certificate GSEN. RU.COA.311, registration number in the state register is Russian RU 0001.513118 dated May 29, 2003; Registration Certificate of ISO 9001: 2000, Number 4017 - 5.04.06). When performing studies by ICP-AES and ICP-MS methods, biosubstrates were ashed using a microwave decomposition system MD-2000 (USA). The content of elements in the resulting ash was estimated using an Elan 9000 mass spectrometer (Perkin Elmer, USA) and an Optima 2000 V atomic emission spectrometer (Perkin Elmer, USA). In total, the content of the following 25 chemical elements was determined: Ca, Cu, Fe, Li, Mg, Mn, Ni, As, Cr, K, Na, P, Zn, I, V, Co, Se, Ti, Al, Be, Cd, Pb, Hg, Sn, Sr.

Statistical processing was carried out using the IBM SPSS Statistics Version 20 software, calculating the mean (M), standard deviation (σ), standard deviation error (m). The level of significance was considered authoritative at p <0.05.

3. Results and discussions

3.1. Morphological and biochemical blood parameters

Conducting any experiments involves a great physiological load on birds’ bodies. At the slightest mistake in the preparation of feed mixtures or feeding technology, this can cause irreversible changes
in the metabolism of poultry leading to nutritional diseases [10]. One of the ways to identify these disorders is the life-time diagnostics of metabolic disorders by morphological and biochemical parameters of blood. These studies are especially important when assessing the effect of new feed substances.

When assessing the impact of cavitation-treated sunflower sludge together with zeolite powder on the birds’ body, the following morphological blood parameters were obtained.

The morphological parameters of the blood of the experimental bird were within the physiological norm during the period of the experiment. In turn, it should be noted that the highest hemoglobin level was in the 3\textsuperscript{rd} experimental group and exceeded the same indicator by 10.5% in the control group, 8.9% in the 1\textsuperscript{st} experimental group, and 1.1% in the 2\textsuperscript{nd} experimental group. The maximum leucite content was also recorded in the 3\textsuperscript{rd} experimental group and made the 14.6% difference with the control group, 4.2% difference with the 1\textsuperscript{st} experimental group and 4.5% difference with the 2\textsuperscript{nd} experimental group.

Analysis of leucogram and its indicators in all experimental groups were within the physiological norm. The lymphocyte concentration ranged from 63.1% to 64.9%, which indicates lack of inflammatory processes in the experimental bird. The indicators of the number of basophils and eosinophils state lack of allergic reaction to the introduction of the studied feed additives and parasitic diseases.

On the basis of the data obtained, it can be stated that the introduction of sunflower seed into the feed after cavitation treatment together with zeolite powder does not have pronounced changes in the morphological composition of the blood of the bird in the experimental groups.

At the same time, the main biochemical parameters of blood were determined during the study of the effectiveness of applying the additives under consideration.

Based on the data obtained, it can be concluded that the content of total protein in the 3\textsuperscript{rd} experimental group was 2.9% larger than similar values in the control group, 1.7% in the 1\textsuperscript{st} experimental group, 0.2% in the 2\textsuperscript{nd} experimental group.

The amount of urea is determined by the difference between the amount of nitrogen ingested with food and the amount of nitrogen in the excreted compounds. Urea excretion is reduced if nitrogen balance is positive. If there is an increase in nitrogen excretion due to the breakdown of body proteins, an increase in serum nitrogen is due to urea. Thus, the formation of urea is a regulatory mechanism through which nitrogen equilibrium is maintained. Based on the biochemical analysis of the blood of the experimental bird, it can be concluded that the introduction of cavitation-treated sunflower sludge into the diet together with zeolite leads to a decrease in the amount of urea in the blood serum by two times as compared to the control.

The creatinine content also led to a decrease with the introduction of the studied feed additives. Thus, the creatinine content in the control group was 66.4 Mmol/l. At the same time, the difference with the control of this indicator was 8.5% in experimental group 1, 16.9% in experimental group 2, and 21.2% in group 3.

Based on the study of the morphological and biochemical parameters of blood, it can be stated that the introduction of cavitation-treated sunflower sludge into the diet of the experimental bird together with zeolite powder leads to an improvement in the main blood parameters. All biochemical and morphological parameters were within the physiological norm.

3.2. Evaluating the effect of different dosages of zeolite powder on mineral metabolism in the body of broiler chickens

Changes in the metabolic energy level of the diet affected the content of minerals in the body of the experimental bird [11].

The elemental body profile of broiler chickens was as follows:

- for essential and conditionally essential microelements
  \[ \text{As, Cr, Cu, Fe, I} \uparrow \]
  \[ \text{Co, Ni, Se} \downarrow \]

- for macroelements
  \[ \text{K, Na} \uparrow \]
  \[ \text{Ca, P} \downarrow \]
It was found that an increase in the level of metabolic energy led to a decrease in the rate of Co, Ni, Se, Ca, P, Pb, Sr accumulated in the body tissues of a bird against the background of an increase in As, Cr, Cu, Fe, I, K, Na, Al, Cd being within normal limits [12].

To confirm the products safety, a trace element analysis of the muscle tissue (meat) of experimental animals was carried out. Figures 1-3 show the content of essential and conditionally essential elements in muscle tissue in the body of the experimental groups relative to the control group.

**Figure 1.** Difference in the content of essential and conditionally essential elements in muscle tissue in body of experimental groups relative to control group

**Figure 2.** Difference in content of macronutrients in muscle tissue in body of experimental groups relative to control group

**Figure 3.** Difference in content of toxic elements in muscle tissue in body of experimental groups relative to control group
Today it cannot be denied that a good feed base is the key to the success of the livestock and poultry sectors. To increase the productivity of poultry, it is necessary to provide them with diets using a variety of high-quality feeds balanced in energy and nutrients. At the same time, a further increase in the efficiency of poultry farming is hindered by the high cost of feed, in some cases, by the microbiological failure of the feed used [13-15]. Applying physical methods of processing feed including cavitation seems to be one of the solutions to the problem [16]. Cavitation impact on the treated medium is one of the most effective methods for intensifying hydrodynamic and mass transfer processes in liquids, destruction of substances, etc. [17-18]. Cavitation treatment of plant raw materials and cellulose-containing waste allows using a wide range of raw materials, producing goods with a given composition and properties, while simultaneously using the beneficial properties of individual components to achieve better digestibility of nutrients [19].

When testing the diets of farm animals, which included cavitated processed feed, an improvement in digestibility and assimilation was noted mainly caused by an increase in the area of interaction of feed with microorganisms in the rumen and digestive enzymes in the lower intestine [20, 21].

4. Conclusion
The results obtained indicate a positive effect of cavitation treatment of sunflower sludge together with zeolite particles, which is part of the feed mixture. An additional increase in the level of exchange energy leads to an increase in the content of macro- and microelements against the background of a significant decrease in antagonist elements. The greatest changes are observed in the 2nd experimental group, a diet with an exchange energy content of 14.9 MJ/kg DM (6% of processed sludge by cavitation with 4% zeolite).

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