Practical aspects of the new approach to creating feed products based on a multicomponent mixture of sunflower fuzz-sludge and zeolite subjected to cavitation treatment

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Abstract. The problem of waste management in Russia is one of the fundamental. Moreover, in addition to European standard, according to which our society tends to consider the fact that an effective economy can only exist on the basis of non-waste production. The level of social development for a variety of symptoms can largely be characterized by the effective use of agricultural waste. Waste oil industry are characterized by a high content of protein and fat, which makes them indispensable in balancing rations. In this context shows how to obtain feed product based on waste vegetable oil extraction industry, enriched zeolite powder. The method is based on joint ultrasound treatment of fatty foods (sunflower Pusan), and mineral – zeolite. The efficiency of the product in poultry feeding.

1. Introduction
A quantitative analysis of secondary material resources in the agro-industrial complex (AIC) shows that the annual volume increases sharply due to the plant materials that are harvested and processed [1–2].

At the present stage of development of the society, the use of agricultural waste is reduced to processing at feed mills in small volumes, or by burning as fossil fuels, which in turn leads to environmental degradation [3–6].

At present, it is necessary to develop and apply effective non-reagent methods for processing organic waste of the agro-industrial complex with obtaining highly effective feed substrates. Therefore, it is necessary to conduct research and update scientific and technical information on the composition and physicochemical properties of modern plant waste materials, as well as apply highly effective physicochemical methods for its processing [7–10].

To date, it is advisable to study the effect of cavitation treatment on the waste products of the oil and fat industry.

2. Materials and methods
Development of the technology for the production of feed additives by the method of cavitation destruction of sunflower fuzz included obtaining laboratory samples of cavitation hydrolyzed products, assessing the digestibility of the obtained feed product in vitro and in vivo. The chemical composition was determined by standard methods.

A magnetostrictive emitter with a power of 100 W, an oscillation amplitude of 50 μm, a frequency of 27 kHz was used as basic equipment for obtaining cavitation products. In order to have a deeper
To determine the effectiveness of the use of the obtained product in animal feeding, experiments were carried out on broiler chickens cross "Smena-7". By the method of pair-analogues, four groups were formed (n = 30), which were in the same conditions of feeding and keeping. The search scheme is presented in Table 1.

Table 1. Scheme of experience

| Object of study          | Group                   | Experience period          |
|--------------------------|-------------------------|----------------------------|
|                          |                         | preparatory                | accounting          |
|                          |                         | age, days                  |                      |
| Chickens broilers of     | control                 | 7-28                       | 14-42               |
| cross "Smena-7"          | 1st experimental group  | BD                         | BD_1                |
|                          | 2d experimental group    | BD                         | BD_2                |
|                          | 3d experimental group    | BD                         | BD_3                |
|                          | 4th experimental group   | BD                         | BD_4                |

Note:
BD – basic diet (control);
BD_1 – diet containing 6 % of raw sunflower fuzz-sludge;
BD_2 – diet containing 6 % processed sunflower feed.
BD_3 – diet with a content of 6 % untreated sunflower fuzz-sludge and 2 % (by weight of fuzz-sludge) of zeolite particles, particle size up to 1 mm;
BD_4 – diet with a content of 6 % of the processed sunflower fuzz-sludge together with 2 % (by weight of the fuzz-sludge) of zeolite particles, particle size up to 1 mm

The basic data were subjected to statistical processing using the Statistica 10.0 program and finding the arithmetic mean error of the mean and standard deviation.

3. Results and discussion
The digestibility of dry matter of cavitation-treated products depended on the moisture content of the feedstock and its gravimetric composition.

In order to optimize the process of ultrasonic processing of the sunflower fuzz-sludge, studies were conducted on the effect of the addition of zeolite powder of different dispersion on the performance of the ultrasonic apparatus, as well as on the quality indicators of finished feed products.

For cavitation treatment, we took a sunflower fuz moistened with water to a moisture content of 55 %, since it was at this humidity that the maximum performance of the ultrasonic apparatus was observed for this type of product.

An analysis of the fatty acid composition of the obtained cavitationally processed products indicates that the content of palmitoleic, linolenic, arachidonic and erucic acid changed most significantly as a result of the ultrasonic processing of raw materials (Table 2).

Table 2. Fatty acid composition of the sunflower body in %

| Fatty Acid Conventions | Name of fatty acid | Raw fuzz | Processed fuzz | Treated fuzz with zeolite |
|------------------------|--------------------|----------|----------------|--------------------------|
| C_{16:0}               | Palmitic           | 8.0      | 5.2            | 4.3                      |
| C_{16:1}               | Palmitoleic        | 2.5      | –              | –                        |
| C_{18:0}               | Stearin            | 3.3      | 3.1            | 2.7                      |
| C_{18:1}               | Oleic              | 20.4     | 20.6           | 20.8                     |
| C_{18:2}               | Linoleic           | 56.4     | 63.8           | 69.6                     |
| C_{18:3}               | Linolenic          | 0.4      | 0.2            | 0.6                      |
| C_{20:0}               | Arachidonic        | 1.61     | 1.2            | 0.15                     |
| C_{20:2}               | Erucidic           | 7.36     | 5.91           | 1.91                     |

For instance, at the beginning of the experiment, the content of erucic acid was 7.36 %, after cavitation treatment it was 5.91 %, arachidonic 1.61 % after treatment 0.12 % (without adding zeolite)
and with the addition of zeolite was 1.91 and 0.15 %, respectively, at pH of 6.6. For linoleic acid, the opposite tendency is observed; since the untreated fus contains an average of 56.4 %, after being processed together with the zeolite, the acid content increases to 69.6 %. Thus, we found out that the process of cavitation treatment of this product in the presence of a zeolite powder allows to reduce the amount of fatty acids with long carbon chains and to increase the content of acids with a lower molecular weight, which in turn will reduce the energy cost for digestibility of this type of product.

Digestibility is characterized by the ability of animals according to their abilities to process and assimilate nutrients of the feed. The study of the digestibility of fatty waste after cavitation treatment “in vitro” is of great practical and scientific interest. Digestibility of fats in the in vitro study was carried out using the “artificial scar KPL 01” according to the method of V.V. Popova, E.T. Rybina in the modification of G.I. Levakhin, A.G. Meshcheryakov. The degree of disintegration of the sunflower fuzz-sludge in the native state was 32.6 %, after cavitation treatment 46.9 % and with the addition of zeolite in the amount of 2 % of the mass of the fuzz-sludge was 64.8 %.

To confirm the effectiveness of the claimed processing method, experiments were carried out on broiler chickens cross “Smena-7”. Experimental poultry was fed with compound feed developed according to the recommendations of the All-Russian Scientific Research and Technological Institute of Poultry (2004). During the experiment, broiler chickens up to 4 weeks of age received a starting composition, and then a growth composition.

The basis of the rations was the wheat-barley-corn mixture, which constitutes 49.3 % in the starting one, and 63.2 % in the compound feed. The amount of exchange energy and crude protein in the growth composition of animal feed in the control group was 12.34 MJ/kg and 217 g/kg, in the experimental groups – 12.7–12.93 and 197–211, respectively. The content of crude fiber in this case changed from 36.8–42.5 g/kg in the control, to 31.7–36.1 in the experimental groups, respectively.

In order to establish changes in the assimilation of nutrients during research, the feed consumption by the experimental bird was recorded daily (Table 3).

| Table 3. Actual consumption of feed by experimental broiler chickens by growing periods, g/head |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Index                                           | control         | 1st experimental | 2d experimental | 3d experimental | 4th experimental |
| Starting                                        | 925             | 855             | 888             | 796             | 866             |
| Growth                                          | 1478            | 1500            | 1488            | 1507            | 1506            |
| For the entire period                           | 2403            | 2335            | 2376            | 2303            | 2372            |

Feed intake for the entire experiment in the experimental groups was less than in the control. The difference in group I was 68 g/head, in group II – 27, in group III – 100 and in group IV – 31 g/head, which is 2.82 lower than in the control; 1.12; 4.16 and 1.29 %, respectively.

Thus, in general, a change in the composition of the diet did not significantly affect the food intake of experimental broiler chickens.

| Table 4                                                                 |
|------------------------------------------------------------------------|
| Group                                                                  | Live weight at the beginning of the experiment, g | Live weight at the end of the experiment, g | Growth, g | K / k consumption for growth |
|------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|------------|-----------------------------|
| control                                                                | 200,00                                       | 1499,33                                      | 1299,33    | 1,85                        |
| 1st experimental group                                                  | 199,67                                       | 1458,00                                      | 1258,33    | 1,86                        |
| 2d experimental group                                                   | 200,67                                       | 1577,00                                      | 1376,33    | 1,73                        |
| 3d experimental group                                                   | 199,33                                       | 1772,50                                      | 1573,17    | 1,46                        |
| 4th experimental group                                                  | 197,33                                       | 1357,50                                      | 1160,17    | 2,04                        |

Feeding the test food to an experimental bird led to a change in the digestibility of substances (Table 5).
Table 5. The digestibility of the nutrients of the starting feed, %

| Group               | Organic matter | Crude protein | Crude fat | Carbohydrates on average |
|---------------------|----------------|---------------|-----------|--------------------------|
|                     | 3–4 weeks of the accounting period |               |           |                          |
| control             | 75.1±2.08      | 85.0±1.63     | 76.9±1.27 | 71.5±2.52                |
| 1st experimental group | 77.7±1.26      | 83.9±1.12     | 72.1±0.98 | 78.5±1.35                |
| 2d experimental group | 79.5±1.24      | 84.0±1.17     | 76.4±0.84 | 80.7±1.31                |
| 3d experimental group | 79.3±1.99      | 82.0±2.01     | 81.1±1.93 | 82.3±1.99                |
| 4th experimental group | 81.2±1.90      | 88.0±1.62     | 75.6±1.43 | 81.9±2.07                |
|                     | 5–6 week of the accounting period |               |           |                          |
| control             | 77.2±1.48      | 86.0±1.31     | 72.8±1.15 | 73.4±1.72                |
| 1st experimental group | 80.6±2.11      | 90.8±1.73     | 73.1±1.26 | 78.0±2.40                |
| 2d experimental group | 89.8±2.17      | 87.9±1.94     | 84.8±1.66 | 88.8±1.57                |
| 3d experimental group | 76.8±1.89      | 82.0±1.34     | 71.2±1.07 | 71.8±1.13                |
| 4th experimental group | 78.9±1.93      | 88.3±2.36     | 75.0±2.13 | 76.6±2.20                |

Note: a – P<0.05 when compared with control; 
b – P<0.05 when comparing with 1st group; 
c – P<0.05 when comparing with 2d group; 
d – P<0.05 when comparing with 3d group.

The digestibility of the organic matter of the starting feed in the experimental groups exceeded the control value by 2.6–6.1 %, but the difference was statistically unreliable.

The degree of use of raw protein by the experimental bird was the highest in the 4th experimental group (88.0 %) and exceeded this indicator in the control group by 3.0 %, in the 1st experimental group – by 4.1 %, 2d – by 4.0 % and 3d – by 6.0 %.

The highest degree of raw fat digestion in the starting period was observed in group 3d – 81.1 %, which exceeded the same indicator in the control group by 4.2 % (P≤0.05), in 1st – by 9.0, in 2d – by 4.7, in 4th – by 5.5 %. When comparing this indicator in the experimental groups, the following significant differences were revealed: fat digestibility in the 3d experimental group was 9.0 % higher than in the 1st experimental group and 4.7 % higher than in the 2d group.

The digestibility of carbohydrates in the starting feed in all experimental groups exceeded this indicator of the control group. The difference with group 1st was 7.0 %, with 2d – 9.2 (P≤0.05), with 3d – 10.8 (P≤0.05) and with 4th – 10.4 % (P≤0.05).

A similar picture was noted by the degree of digestion of nutrients of growth compound feed.

It is possible to note an insignificant excess of digestibility in the experimental group 1 in comparison with the control and the experimental groups 2, 3, 4 of organic matter by 3.4 and 0.8–3.8 %; crude protein by 4.8 and 2.0–6.0 %; for raw fat by 0.3 and 1.1–1.9 %. Digestibility of carbohydrates was the largest in the 2d experimental group and exceeded this indicator of the control group by 5.9 % and the indicator of 1st, 3d, 4th experimental groups by 0.3–3.0 %.

The assessment of the mechanism of action of cavitation at the cellular level is actively considered by researchers [11]. For example, the properties of cavitation agents and cells, the parameters of acoustic motion and the microbial bubble/cell, etc. In addition, we are aware of the ability of zeolites to optimize the effect of cavitation on a specific structure of a substance [12], thereby increasing the efficiency of the process. This fact is consistent with studies on poultry feed. The ability of cavitation [13] and extraction [14–16] to actively contribute to the extraction of biologically active substances from plant materials, as well as to the interaction between a feed particle or individual components [14], and to the taste of plant substances [15], positively affects the quality of feed and bird productivity in the future.

4. Conclusion

Thus, based on the results of a study of the fatty acid composition of sunflower seeds before and after sonication, it can be concluded that this method of exposure reduces the amount of fatty acids with long carbon chains and increases the content of acids with a lower molecular weight. The introduction of products of sunflower seeds cavitation processing with the addition of zeolite into the diet of broiler chickens has a positive effect on the productive qualities of animals and can increase the gain in live
weight. The digestibility rate of raw fat is increased by 9%. Feed consumption decreases with the introduction of cavitation-treated fuzz-sludge in animal feed by from 1.85 to 1.46 units.

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