



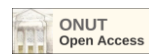
A special highlight of the laboratory is a unique collection of feed raw materials, feed additives, biologically active substances and finished products, which includes about 150 samples.

The management of Odesa National University of Technology highly appreciates the contribution of ADM LLC "Ukrelevatorprom" to the educational process of our students and is confident in the development of further partnership relations in the field of training qualified and conscientious specialists, since a large proportion of the company's employees are graduates of ONTU.

The department of technology of grain and compound feed invites specialized enterprises of the grain processing industry to cooperate.

A. Makarynska, Doctor of Technical Sciences, Associate Professor

Revised 24.09.2022. Approved 04.10.2022



UDC 636.087.7-021.465:[665.117:665.347.8]

DOI <https://doi.org/10.15673/>

¹**B. Iegorov, Doctor of Technical Sciences, Professor, E-mail: bogdanegoroff58@gmail.com,**

ORCID: <https://orcid.org/0000-0001-7526-0315>, Researcher ID: Q-1365-2015, Scopus Author ID: 56578802600

²**O. Kananykhina, PhD, Associate Professor, E-mail: k_elni@ukr.net,**

ORCID: <https://orcid.org/0000-0001-6291-7760>, Researcher ID: D-3386-2016

¹**T. Turpurova, PhD, Associate Professor, E-mail: turpurova.tatyana@gmail.com,**

ORCID: <https://orcid.org/0000-0003-3030-7591>, Researcher ID: C-3755-2017

¹Department of Grain and Feed Technology

²Departments of Biochemistry, Microbiology and Physiology of Nutrition

Odesa National University of Technology, 112, Kanatna Str., Odessa, 65039, Ukraine

ASSESSMENT OF HIGH-PROTEIN QUALITY FEED ADDITIVES FROM BY-PRODUCTS MANUFACTURE OF SUNFLOWER OIL

Abstract

The article states that until 2022, Ukraine will occupy the first place in the world food market in the production of sunflower, sunflower oil and export of sunflower oil. The production of sunflower has always been sufficiently profitable, and the products of its processing competitive on the domestic and world markets. They are also an important component of food and feed protein resources. The production of complete ration compound feed for farm animals and poultry is restrained by a shortage of protein components, a low level of sanitary and hygienic safety of protein raw materials of animal origin. This leads to a decrease in the efficiency of feed, their costs and, as it should be, a shortage of livestock products. Cake and meal are high-protein raw materials, which are obtained in the amount of 1/3 of the mass of processed seeds during the production of sunflower oil. The fodder value of sunflower cake and meal is given. Factors that negatively affect the nutritional value and availability of nutrients of sunflower meal in the feed of farm animals and poultry were analyzed. The choice of components for the production of high-protein feed additive is theoretically justified. The indicators of the quality of sunflower seeds and by-products of their processing, which meet the requirements of DSTU, have been determined. On the basis of theoretical and experimental data, a structural scheme for the production of a high-protein feed supplement based on sunflower cake and meal is proposed, which involves the preliminary preparation of the by-products of sunflower oil production - cake and meal, with the following dosage in the amount: 75% sunflower meal, 10% sunflower cake and 15% limestone flour. The physical properties and microbiological indicators of the quality of a high-protein feed additive were experimentally determined, and it was determined that, compared to a loose, granular high-protein feed additive, it has the following advantages: increased nutritional value, has a greater volumetric weight, sanitary quality, which leads to saving space during transportation and better storage.

Key words: feed additive, sunflower meal, sunflower cake, limestone flour, quality, granulation, physical properties, microbiological indicators, farm animals.

Introduction

In the agro-industrial complex of Ukraine, the oil and fat branch of the food industry occupies a leading place. Oilseed processing enterprises produce oil and fatty products for food, technical and fodder purposes,

including strategic ones. It is known that vegetable oil is a source of energy and contains a number of essential nutrients, in particular unsaturated fatty acids.

Until 2022, Ukraine took first place in the world food market in terms of sunflower, sunflower oil and



sunflower oil exports. Sunflower production has always been sufficiently profitable, the products of its processing competitive on the domestic and world markets. They are also an important component of food and feed protein resources. [1]

During the production of sunflower oil, up to 36% of the mass of processed seeds is obtained by by-products - cake and meal. It is known that the by-products contain all the components of the nutritive value of the seed, with the exception of crude fat, which is reduced to 8-17% in the pulp and 2% in the meal. Cake and meal are high-protein feed for animals. The high feed value is due to the content of certain essential amino acids, calcium and phosphorus, vitamins of group E and group B. [2,3]

On average, sunflower cake contains: protein - 39.6%, fat - 1.6%, crude fiber - 12.3%, BER - 23.5%, ash - 6.0%. There are slightly more essential amino acids than in meal. Cake, like meal, is fed as part of compound feed, feed mixes and separately. Feed conversion is 3-5 kg/kg. [2,4]

However, there are factors that negatively affect the nutritional value and availability of nutrients of sunflower meal in the feed of farm animals and poultry [5]:

- increased crude fiber content of 12-18%, which leads to swelling and retention of feed in the intestinal tract, which can be a problem for young farm animals and poultry;
- a large number of non-starchy polysaccharides (up to 40%), which animals are unable to digest due to a lack of appropriate enzymes;
- the content of chlorogenic and quinic acids, the level of which is 1.56 and 0.48%, respectively, the negative effect of which is manifested in the inhibition of digestive enzymes of the gastrointestinal tract, and accordingly affects the digestibility of protein and the assimilation of the amino acids lysine and methionine;
- deficiency of such an important amino acid as lysine, which requires additional inclusion of a synthetic drug;
- low resistance to oxidation.

One of the most important problems with long-term storage of cakes is the deterioration of quality indicators. The cake turns rancid quickly due to the presence of residual amounts of fatty acids, and as humidity increases, the destruction of nutrients increases. The critical moisture level for cake is 8-10%. The low resistance of lipids to oxidation, especially those containing unsaturated fatty acids, leads to the

accumulation of peroxides, hydroxy acids, ketones, aldehydes, which have a toxic effect on the body of farm animals and poultry.

To ensure the stability of cakes before storage, the level of fat content is reduced. However, in recent years, the production of sunflower cake with a higher fat content is increasingly being practiced to ensure the energy needs of farm animals and poultry, as well as to avoid the additional introduction of fats during the production of compound feed.

Along with the problem of improving cake quality indicators, calcium imbalance is a big problem for poultry farming, namely calcium deficiency in laying hens during the ovulation period. All this determines the need to include mineral raw materials in the composition of the feed additive.

Limestone flour is characterized by low cost and high calcium content, which is why it has gained such popularity among other mineral raw materials. In addition, limestone flour has adsorption properties, allows you to increase the percentage of cake application, reduces the cost of raw materials, which is an important factor in the calculation of compound feed recipes for poultry. [6]

A high-protein feed additive based on the by-products of sunflower oil production has been developed, which can be used for feeding farm animals and poultry.

The scheme of the technological process of the production of a high-protein feed additive consists of the following lines: [7]

- Line for cleaning oilseeds;
- The line of falling oilseeds;
- Line for pressing kernels of oilseeds;
- Cake and meal preparation line;
- Dosing line;
- Mixing line;
- Granulation line.

The purpose of the study

The purpose of the work is to study the quality indicators of a high-protein feed additive from the by-products of sunflower oil production.

Results and its discussion

Screening showed that sunflower seed processing yields about 41% sunflower oil, 33% cake and 26% husk. [7]

Table 1 shows the quality indicators of sunflower seeds and the quality indicators of the by-products of its processing - cake and meal.

Table 1 – Quality indicators of sunflower seeds and by-products of their processing

Indexes	Sunflower seeds		Sunflower cake		Sunflower meal	
	research	DSTU 7011:2009	research	DSTU 8096	research	DSTU 11246-96
Humidity, no more than %	6,8	8	4,4	8,5	8,9	10
Crude protein, not less than %	14,8	–	36,2	38	34,7	39
Crude fiber, not more than %	–	–	17,4	20	19,2	23
Crude fat, no more than %	45,2	–	19,7	6	0,95	1
Acid number, no more than %	1,6	2,2	–	–	–	–
Oleic acid, %	85,7	–	–	–	–	–

**Table 2 – Physical properties of components for the production of high-protein feed additive**

Indexes	Sunflower meal	Sunflower cake	Limestone flour
Nature, kg/m ³	458	1028	1416
Flowability, cm/s	12,9	2,2	0,9
Angle of natural slope, degree.	37	42	45
Mass fraction of moisture, %	8,9	4,4	0,4

The physical properties of the components for the production of a high-protein feed additive were determined experimentally (Table 2).

As a result of the obtained data, it can be concluded that the meal is characterized by low nature and high flowability, and the cake, due to the high fat content, has low flowability.

According to the studies, the determination of the coefficient of variation in the distribution of limestone flour and the coefficient of variation in the distribution of sunflower cake showed that the most effective additive is mixed, which includes 75% sunflower meal, 10% sunflower cake and 15% limestone flour. [8]

On the basis of theoretical and experimental data, a structural scheme for the production of a high-protein feed supplement based on cake and meal is proposed (Fig. 1), which provides for the preliminary preparation of the by-products of sunflower oil production - cake and meal, with the following dosing in the amount: 75% sunflower meal, 10 % sunflower cake and 15% limestone flour.

The dosed components of the high-protein feed additive are mixed in a batch mixer, as a result, a loose high-protein feed additive is obtained, which is sent for granulation in a press-granulator. The resulting granules are sent to a cooler for cooling to a temperature no higher 10 °C of the environment.

By analyzing the physical properties of raw materials and finished products, it is possible to judge the degree of their freshness and suitability for further consumption. The finished products were evaluated according to such physical properties as appearance, color, smell, particle size, angle of natural slope, moisture, flowability, nature.

The organoleptic and physical properties of the loose and granular high-protein feed additive were determined experimentally (Table 3).

The bulk feed additive has the following disadvantages - it is hygroscopic and has a small volumetric mass. During its transportation, storage and use, self-sorting, sawing, clumping will be observed. To eliminate these shortcomings, save and rationally use the high-energy additive for the production of compound feed, it is necessary to produce it in a compressed form in the form of granules. Compared to the loose, granular additive has the following advantages: increased nutritional value, sanitary quality, better storage, has a larger volumetric mass, which leads to saving space during transportation and storage.

Table 3 – Physico-mechanical parameters of the high-protein feed supplement

Indexes	High-protein feed additive	
	loose	granulated
Appearance	homogeneous loose mass	granules
Color	different shades of gray	
Scent	characteristic of sunflower meal and cake without extraneous smell	
Mass fraction of moisture,%	9,4	9,1
Flowability, cm/s	4,3	7,7
Angle of natural slope, degree.	48	39-
Nature, kg/m ³	446	865
L/D ratio	–	2,6
Water resistance, min.	–	7
Water absorption coefficient, %	–	1,05
Fragility, %	–	7,4

All compound feed products must meet the requirements of veterinary and sanitary standards. It is known that microorganisms are the main reason for the deterioration of the quality indicators of compound feed products. In this regard, it is necessary to have a clear idea of the microflora of the additive and to know how the production methods and storage conditions of the manufactured products affect it.

We determined the effect of heat treatment (granulation) on the change in the microbiota of a high-protein feed supplement, which was produced according to the developed recipe [8] and improved technology [7].

In the experimental samples, the following were determined:

- the number of mesophilic aerobic and facultative anaerobic microorganisms (MAFAnM), CFU in 1 g of product;
- the presence of mold fungi in 1 g of the product;
- the presence of Escherichia coli bacteria (E. coli) in 0.1 g of the product;
- the presence of bacteria of the paratyphoid group (salmonella), in 25 g of the product;
- presence of Pr. vulgaris in 0.1 g of the product;
- the presence of Staphylococcus aureus.

The results of research on the determination of microbial contamination of loose and granular high-protein feed additives are shown in Table 4.

The study of microbiological indicators of the quality of loose and granular high-protein feed additives was carried out using the experimental base of the Department of Biochemistry, Microbiology and Physiology of Nutrition of ONTU. The mass fraction of moisture of the granulated additive was 9.2%, the amount of MAFAnM - 7*10⁵ CFU/g, mycelial fungi - 17 CFU/g, pathogenic forms of Salmonella and Staphylococcus aureus were not detected.

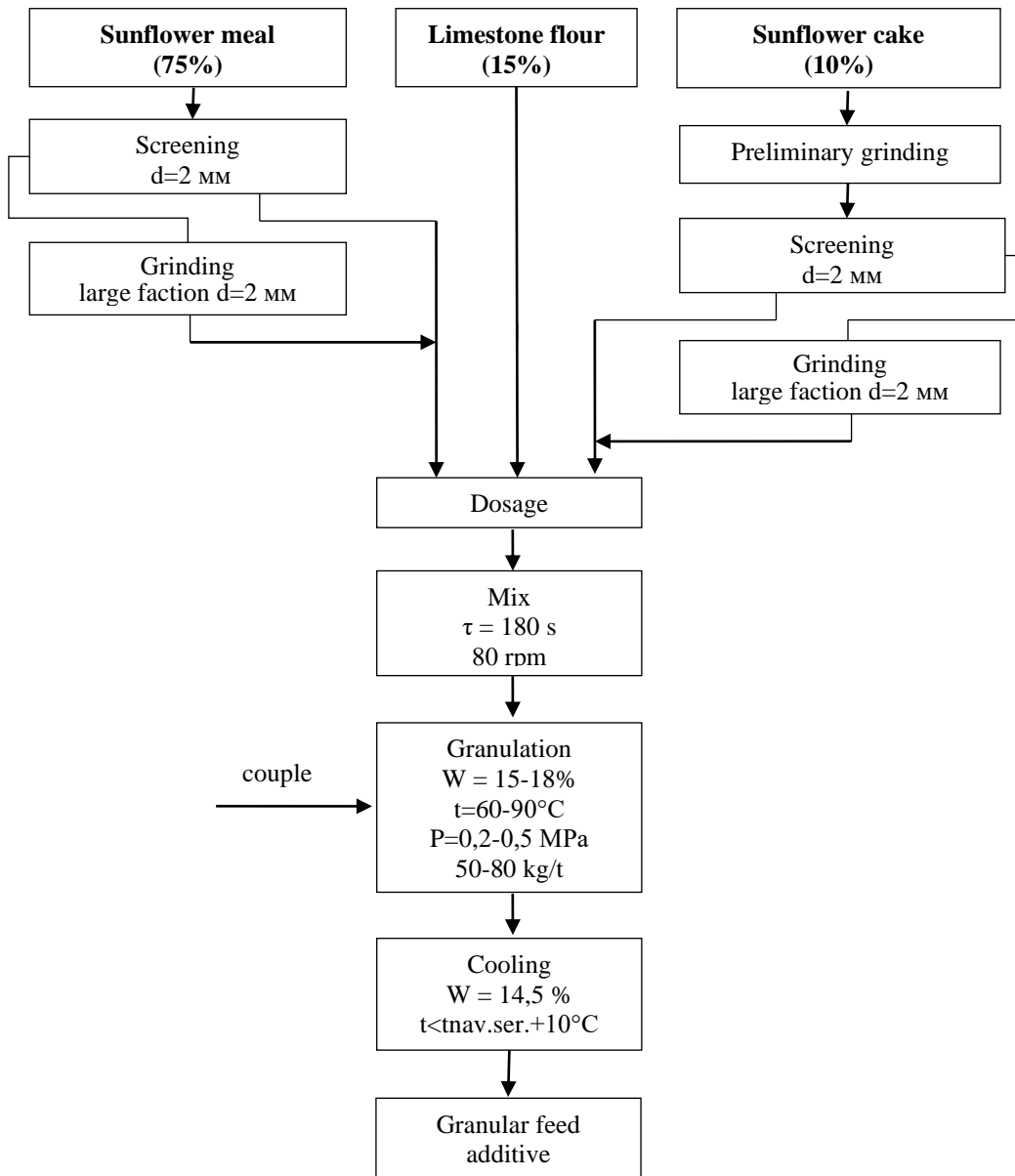


Fig. 1 – Functional diagram of the production of a high-protein feed supplement based on the by-products of sunflower oil production

Table 4 – Study of microbiological indicators of the quality of a high-protein feed supplement (n=3, P≥0.95)

Indexes	High-protein feed additive		Зміни, %
	loose	granulated	
MAFAnM (CUO/1g)	1,3×10 ⁶	0,7×10 ⁶	47
Mycelial mushrooms, CFU/1 g	55	17	70
BGKP title, g	not found	not found	–
Salmonella	not found	not found	–
Proteus vulgaris	found	not found	100
Staphylococcus aureus	not found	not found	–

and mycelial fungi by 70%. Granulation made it possible to get rid of *Proteus vulgaris*, which had contaminated the bulk feed additive. Thus, the effect of high temperature allows to ensure a significant degree of reduction of the microflora of the additive.

Conclusions

The physical properties and microbiological indicators of the quality of the high-protein feed additive show that, compared to the loose, granular high-protein feed additive, it has the following advantages: increased nutritional value, has a greater volumetric weight, a smaller amount of MAFAnM and mycelial fungi, which leads to saving space during transportation and better storage.

As a regulation of the quantitative and qualitative composition of microorganisms, the norms for sunflower meal were adopted, that is, the total number of microorganisms should not exceed 1.5×10⁶ CFU/g [9].

Research analysis shows that as a result of granulation, microbial contamination of the additive decreased by 47% according to the MAFAnM indicator,



REFERENCES

1. Agravery [Веб-сайт]. - URL: <https://agravery.com/uk/posts/show/ukraina-zalisitsa-svitovim-liderom-iz-virobnictva-ta-eksportu-sonasnikovoi-olii-ekspert> (дата звернення: 20.04.2022)
2. Peshuk I.v L. V., Nosenko T. T. Biokhimiya ta tekhnolohiya oliye-zhrovoyi sirovini: navch. posib. Kiyiv: TSUL, 2011. 296 s.
3. Raes K, De Smet S, Demeyer D. Effect of dietary fatty acids on incorporation of long chain polyunsaturated fatty acids and conjugated linoleic acid in lamb, beef and pork meat: a review. *Animal Feed Science and Technology* 2004. 113: 199–221.
4. Sunflower, virgin-olive and fish oils differentially effect the progression of aortic lesions in rabbits with experimental atherosclerosis / C. M. Aguilera, M. C. Ramirez-Tortosa, M. D. Mesa [et al.] // *Atherosclerosis (КЭ)*. 2002. 162, № 2. P. 335–344.
5. Fijalovych, L., Kyrlyiv, Y., & Paskevych, G. (2019). Features of providing broiler chickens with exchange energy and protein as important indicators of productivity and quality of the obtained products. *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series: Agricultural Sciences*, 21(91), 60-64. <https://doi.org/10.32718/nvlvet-a9110>
6. Iegorov B., Kananykhina O., Turpurova T. Probiotic feed additives in fattening of agricultural animals. *Grain Products and Mixed Fodder's*, 2021; 21 (4, 84): 25-31. DOI <https://doi.org/10.15673/gpmf.v21i4.2250>
7. Iegorov B., Kananykhina O., Turpurova T. Development of production technology of high-protein feed additive from by-products of sunflower oil production. *Grain Products and Mixed Fodder's*, 2022; 22 (2, 86): 17-23. DOI <https://doi.org/10.15673/gpmf.v22i2.2442>
8. Yegorov, B., Turpurova, T., Sharabaeva, E., & Bondar, Y. (2019). Prospects of using by-products of sunflower oil production in compound feed industry. *Journal of Food Science Technology Ukraine*, 13, 106–113. doi: 10.15673/fst.v13i1.1337
9. Nalivayko L. I., Bezrukava I. Yu., Bondarenko A. L. Sanitarno-mikrobiolohichna otsinka kormiv // *Ptakhivnitstvo: Mizhvid. temat. nauk. zb. / IP UAAN. Birki*, 2008.# 61. S. 90-94.

УДК 636.087.7-021.465:[665.117:665.347.8]

¹Б.В. Єгоров, д-р техн. наук, професор, E-mail: bogdanegoroff58@gmail.com

²О.М. Кананихіна, канд. техн. наук, доцент, E-mail: k_elnii@ukr.net

¹Т.М. Турпунова, канд. техн. наук, доцент, E-mail: turpurova.tatyana@gmail.com

¹Кафедра технології зерна і комбікормів

²Кафедра біохімії, мікробіології та фізіології харчування

Одеський національний технологічний університет, вул. Канатна, 112, м. Одеса, 65039, Україна

ОЦІНКА ЯКОСТІ ВИСОКОБІЛКОВОЇ КОРМОВОЇ ДОБАВКИ З ПОБІЧНИХ ПРОДУКТІВ ВИРОБНИЦТВА СОНЯШНИКОВОЇ ОЛІЇ

Анотація

У статті зазначено, що Україна до 2022 року займала перше місце на світовому ринку продовольства за виробництвом соняшника, соняшникової олії та експорту соняшникової олії. Виробництво соняшнику завжди було достатньо рентабельним, а продукти його переробки конкурентоспроможними на внутрішньому і світовому ринках. Вони також є важливою складовою продовольчих і кормових білкових ресурсів. Виробництво повнораціонних комбікормів для сільськогосподарських тварин і птиці стримується дефіцитом білкових компонентів, низьким рівнем санітарної та гігієнічної безпеки білкової сировини тваринного походження. Це призводить до зниження ефективності кормів, їхнім витратами та, як слід, недоотримання тваринницької продукції. Макуха та шрот – високобілкова сировина, яку отримують в кількості 1/3 від маси переробленого насіння при виробництві соняшникової олії. Наведено кормову цінність соняшникової макухи та шроту. Проаналізовано фактори, які негативно впливають на поживну цінність та доступність поживних речовин соняшникового шроту у годівлі сільськогосподарських тварин та птиці. Теоретично обґрунтовано вибір компонентів для виробництва високобілкової кормової добавки. Визначено показники якості насіння соняшника та побічних продуктів його переробки, що відповідають вимогам ДСТУ. На основі теоретичних та експериментальних даних запропоновано структурну схему виробництва високобілкової кормової добавки на основі соняшникової макухи та шроту, яка передбачає попередню підготовку побічних продуктів виробництва соняшникової олії – макухи та шротів, з наступним дозуванням в кількості: 75 % соняшникового шроту, 10 % соняшникової макухи та 15 % вапнякової муки. Експериментально визначено фізичні властивості та мікробіологічні показники якості високобілкової кормової добавки, визначено, що в порівнянні з розсипною, гранульована високобілкова кормова добавка має наступні переваги: підвищену поживну цінність, має більшу об'ємну масу, санітарну якість, а саме кількість МАФАНМ та мікроміцетів, що призводить до економії площ при транспортуванні і кращого зберігання.

Ключові слова: кормова добавка, соняшниковий шрот, соняшникова макуха, вапнякова мука, якість, гранулювання, фізичні властивості, мікробіологічні показники, сільськогосподарські тварини.

Received 31.08.2022

Reviewed 16.09.2022

Revised 27.09.2022

Approved 04.10.2022



Cite as Vancouver Citation Style

Yegorov B., Kananykhina O., Turpurova T. Assessment of high-protein quality feed additives from by-products manufacture of sunflower oil. *Grain Products and Mixed Fodder's*, 2022; 22 (3, 87): 20-24. DOI <https://doi.org/10.15673/>

Cite as State Standard of Ukraine 8302:2015

Assessment of high-protein quality feed additives from by-products manufacture of sunflower oil. / Yegorov B. et al. // *Grain Products and Mixed Fodder's*. 2022. Vol. 22, Issue 3 (87). P. 20-24. DOI <https://doi.org/10.15673/>

