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DEVELOPMENT OF PRODUCTION TECHNOLOGY OF HIGH-PROTEIN FEED ADDITIVE FROM BY-PRODUCTS OF SUNFLOWER OIL PRODUCTION

Abstract

The oil and fat industry of Ukraine is one of the most powerful branches of the food industry, the development of which is of particular importance for assessing the country's food security. The screening showed that Ukraine occupies a leading position in the world market for the production of sunflower and sunflower oil, as well as the export of sunflower oil. The largest Ukrainian companies producing unrefined and refined sunflower oil are listed.

The structural scheme of obtaining by-products, which are formed during the processing of oil crops, which have a rather high feed value and are used in feeding agricultural animals and poultry, is presented. Determining factors affecting the amount of by-products of vegetable oil production are characterized.

Production of a high-protein feed additive based on sunflower meal, sunflower cake and mineral raw materials is proposed.

A technological process scheme for the production of a high-protein feed additive has been developed, which provides for the following technological lines: a line for cleaning oilseeds; fall line of oilseeds; oil seed core pressing line; cake and meal preparation line; mineral raw material preparation line; dosage line; mixing line; granulation line.

The production of the proposed high-protein feed additive in granulated form can be carried out at the existing oil processing enterprise in the meal granulation shop, which will make it possible to effectively use the by-products of sunflower oil production.

Key words: feed additive, sunflower oil, cake, meal, limestone flour, technology, farm animals.

Introduction

One of the most influential and important industries for the economy of Ukraine is agriculture. With its powerful potential, as well as the wealth and diversity of natural resources, agriculture can provide Ukraine with high competitiveness both on the national and world markets. On the world market, Ukraine occupies a leading position in the sale of sunflower oil.

According to the State Standard and the Ministry of Economy, Ukraine exported 6.9 million tons of sunflower oil in 2020, which is 12% more than in 2019 (Fig. 1). It should be noted that there is a steadily growing demand for sunflower oil on the world market. The largest importers of Ukrainian sunflower oil are India and China. Recently, China has tripled its imports (Fig. 2). The share of Ukrainian oil in total imports is 78% in India and 68% in China. [1-3]

In 2020-2021, MR produced 4.26 million tons of refined and 0.59 million tons of unrefined sunflower oil. The largest Ukrainian enterprises producing unrefined and refined sunflower oil are listed in the table. 1 [4].

At the current stage of development of the oil and fat industry of Ukraine, the issue of ensuring the competitiveness of oil processing enterprises is of particular importance. One of the strategic priority directions for increasing the performance indicators of oil processing enterprises is the integrated use of production by-products (Fig. 3) [5].

The rational and effective use of by-products of vegetable oil production enables business entities to ensure competitive advantages of products on the world and domestic markets, which will contribute to improving the financial, economic and food security of the country as a

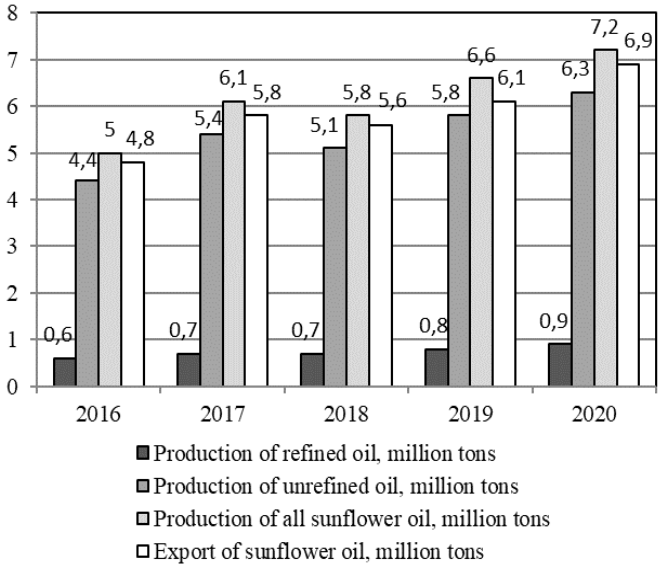

Fig. 1. Production and export of sunflower oil

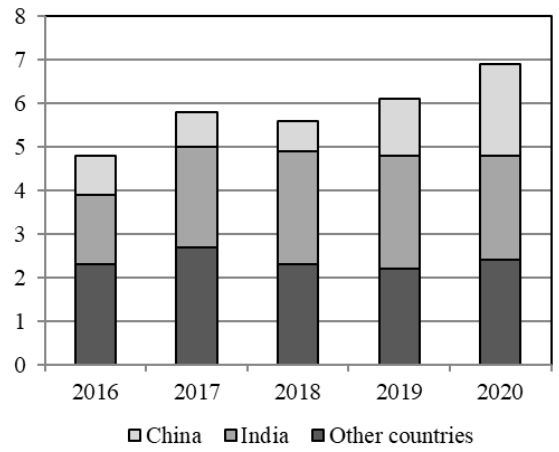

Fig. 2. Importing countries of Ukrainian sunflower oil

whole. However, as practice shows, the management of by-products at oil processing enterprises is a mechanism of an extremely complex set of issues. A significant number of factors affect the amount of by-products in oil processing (Fig. 4) [6].

The by-products that are formed during the processing of oil crops have a fairly high feed value and are used in the diets of animals and poultry. The problem of protein deficiency in the feeding of farm animals can be solved, among other things, by introducing high-protein fodder, in particular cake and meal of oil crops.

The purpose of the study

The purpose of the work is to develop a technology for the production of a high-protein feed additive based on the by-products of processing oilseeds - cake

Table 1 – The largest companies producing sunflower oil [4]

№	Name of Company	2019-2020 MY	2020-2021 MY
Production volumes of unrefined sunflower oil, %			
1.	"European Transport Stevedoring Company" LLC	7,7	8,3
2.	"Otpymusagrotrade" LLC	6	6,6
3.	LLC "Prydniprovsky OEZ" (Kernel)	5	6,1
4.	LLC "Ukrainian Black Sea Industry"	4,6	5,2
5.	PJSC "Vinnytsia oil and fat plant" (ViOil)	4,3	5,1
Production volumes of unrefined sunflower oil, %			
1.	PJSC "Dnipropetrovsk Oil Extraction Plant" (Bunge)	15,5	19,6
2.	"Delta Wilmar Ukraine" LLC (Wilmar International)	16,6	14
3.	PJSC "Poltava Oil Extraction Plant - Kernel Group" (Kernel)	10,4	12
4.	"Prykolotnyansky OEZ" LLC (Kernel)	7,9	8,6
5.	PP "Oliyar"	8,8	8,2

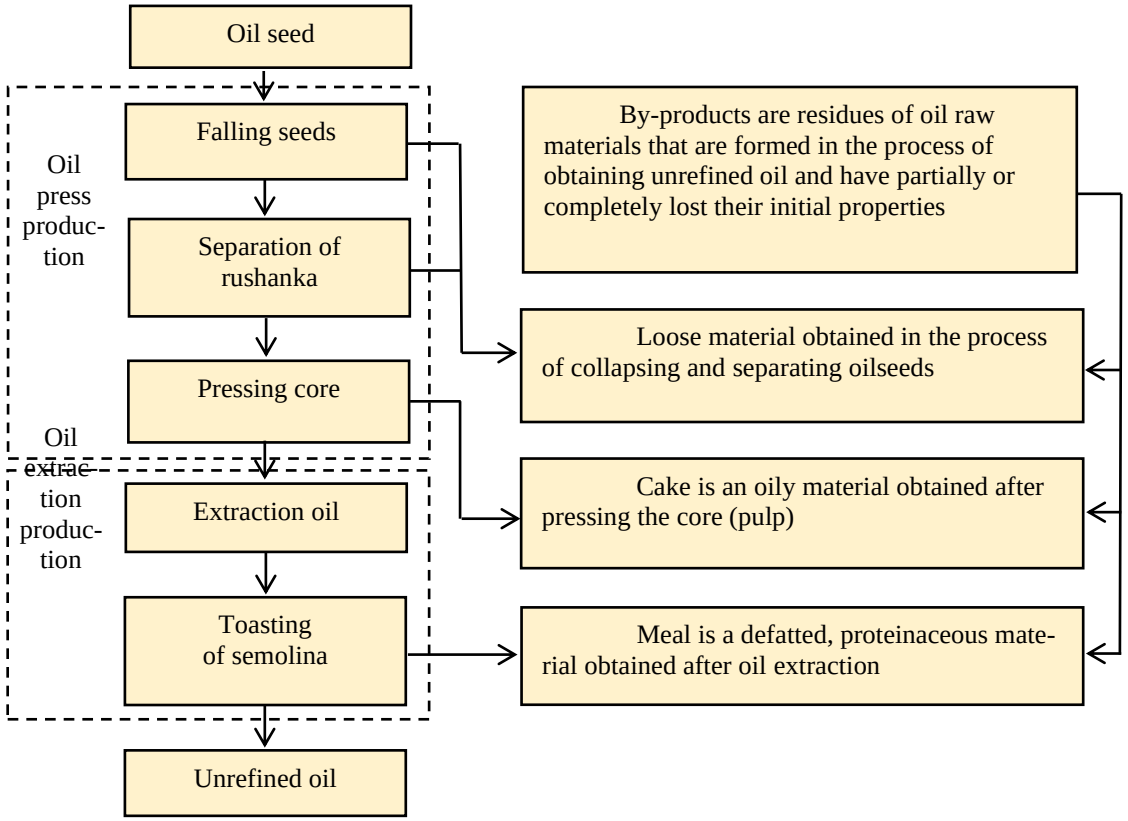

Fig. 3. Structural diagram of obtaining by-products in the oil processing industry

and meal, as a promising raw material for the production of energetic and nutritionally balanced compound feed for poultry and farm animals.

Results and its discussion

During the production of sunflower oil, about 36% of by-products are obtained from the mass of processed oilseeds - cake and meal, which contain up to 48% easily digestible protein, fiber, vitamins of group B and vitamin E. [7]

Features of by-products are technology and fat content: the cake is obtained by pressing, the fat content is up to 10%; meal - by extraction with a solvent and toasting, as a result, loose meal with a fat content of 1-2% is obtained. [7]

In addition to the quality indicators of cake and meal, appearance is important for the sale of these by-products. Cake is produced in the form of a shell or in loose form, meal - in loose and granulated form. Granulated meal is the most popular product, which is easy to transport.

Large agroholdings for the processing of oilseeds are aimed at obtaining the maximum amount of oil by extraction, therefore they receive meal with a low fat content, which allows using this by-product as a source of protein for the production of compound feed products. Screening of the oil processing industry products market shows that it is more profitable for oilseed processing enterprises to produce granulated meal with as low a fat content as possible and to make a profit from the sale of vegetable oil.

Makuha is a popular protein component of compound feed in Ukraine, it has a very high energy and nutritional value. Depending on the oil content of sunflower seeds and the previous preparation process, the fat content in the cake can reach up to 20%, which leads to the deterioration of the physical and technological properties of the cake.

The use of a high-protein feed additive based on the by-products of sunflower oil production and mineral raw materials will allow not only to balance the diet of animals in terms of protein, but also provide the energy and mineral needs of farm animals and poultry.

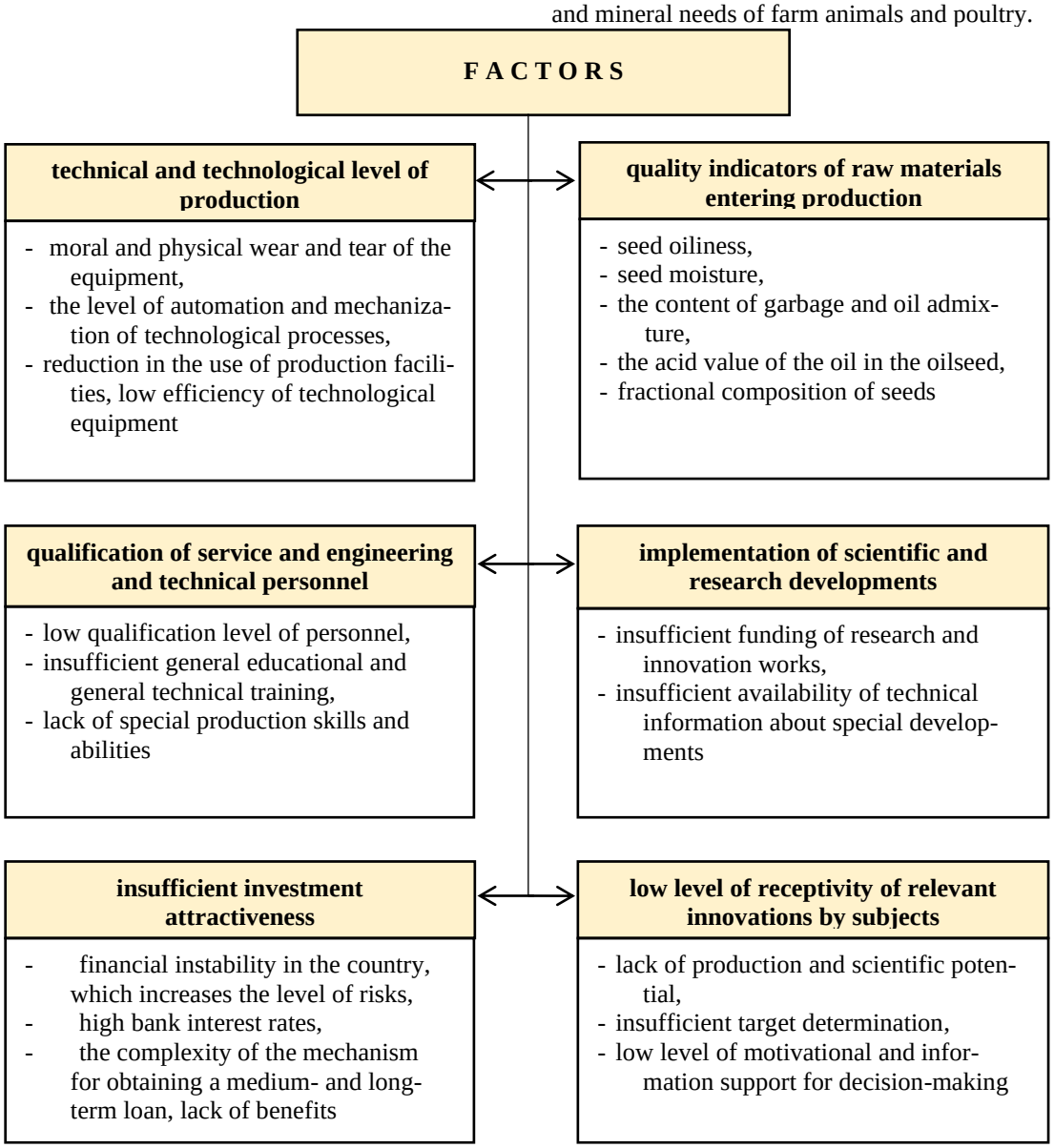

Fig. 4. Determining factors affecting the amount of by-products of vegetable oil production [6]

Sunflower meal (75%), sunflower cake (10%) and limestone flour (15%) were used as raw materials for the production of a high-protein feed supplement. [7-8]

The proposed method of producing a high-protein feed additive from the by-products of sunflower oil production can be implemented using the following scheme of the technological process (Fig. 5).

The technological scheme is based on the option of building a technological process with the formation of a preliminary mixture of components. In accordance with the proposed scheme of the technological process of the production of high-protein feed additive (Fig. 5), the following technological lines are provided:

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

The line for cleaning oilseeds. Sunflower seeds that are sent for processing into production are a mixture consisting of seeds of the main crop and various impurities (organic, mineral, metallomagnetic). The cleaning of seeds from impurities is based on the difference in the physical, aerodynamic properties of oilseeds and accompanying impurities. Cleaning of seeds from organic impurities is carried out by sifting clogged seeds through sieves with different sizes of holes, cleaning of metallomagnetic impurities is carried out on a magnetic separator, light impurities are separated by air flow in a pneumatic channel.

Sunflower seeds from the warehouse with the help of a noria (2) are fed to the magnetic separator (3), where the seeds are cleaned of metallomagnetic impurities. From the magnetic separator (3), the seed passes through the operational hopper (4) into the sieve-air separator (5), where it is cleaned of impurities through 2 levels of sieves: the exit from the upper sieve PR No. 100-160 or SD No. 8-14 is large garbage impurities; passage of the lower sieve PR No. 10-14 or SD No. 085 - small garbage impurities. Coarse and fine impurities are sent to the waste hopper, and metallomagnetic impurities are collected in the box of metallomagnetic impurities. The sunflower seeds, which have been cleaned in the separator (5), are fed to the distribution conveyor (1) with the help of a noria (2) to separate the seed coat (husk).

Falling line of oilseeds. In order to increase the oiliness of oil raw materials, improve the quality of oil, reduce oil losses in production, prevent the wear and tear of working organs of machines and increase their efficiency, it is advisable to carry out a preliminary separation of shells (husks) from the core. For this purpose, the process of collapsing oilseeds is used, with subsequent division into fractions on the cotyledons, for collapsing, the impact method is used. Due to the variety of seeds, the method of multiple blows in the seed bag is used to obtain a seed bag. Rushanka is a mixture of unbroken seeds (colic), clean seeds (kernel), undamaged seeds (nedorush), husk, oil dust, and crushed seeds (sichka).

With the help of a conveyor (1), the sunflower seeds are fed to the seed hoppers (6), where the seeds collapse to obtain a mixture of hoppers. The dust enters the seed cilia (7), which have three rows of sieves: the upper row – Ø of holes 6/7.0 mm, the middle row – Ø of holes 4.5/5.0 mm, the lower row – Ø of holes 3 mm. Before entering the main sieve frame, the fraction of small kernel parts is separated on two parallel sieves with a hole size of 3 mm, which ensures less contact of the husk with the kernel particles and, as a result, a decrease in the degree of oiliness of the husk. The aspiration chamber receives 5 fractions, which pass through the shutter of its channel, are blown with air, and are taken from the workshop by a fan. As a result, light components are removed: husk, oil dust, empty seeds. The husk, as the lightest fraction of the rusanka, is collected in the most distant pockets, and the mixture of husk, chaff, and empty seeds is deposited in the next pocket. By the exit from the shutters of the aspiration chamber, the scum and core fall, which are sent to the corresponding pockets. Separated products in the seed pods (7) are sent to the appropriate conveyors: the waste through the conveyor (1) falls on the noria (2) for re-falling into the seed pods (6); husk through conveyors (1) is sent to the husk warehouse; the pass through the conveyor (1) enters the noria (2) for rewinding in the seed cilia (7); the core is sent to the pressing line through conveyors (1). During the crushing process, the following products are obtained: core - 55%, husk - 15%, undergrowth - 20%, rind - 10%.

Line for pressing the core of oilseeds. The core cleaned of metallomagnetic impurities in the magnetic separator (3) is fed to rolling machines (8), where the cellular structure of the material is destroyed. The gap between the rollers is regulated by changing the pressure in the pneumatic system. The crushed core (mint) goes to the roaster (9), where it undergoes wet-heat treatment due to the supply of dead steam with a pressure of up to 8 kgf/cm3. Wet-heat treatment of mint is carried out in order to reduce the forces of connection between oil and mint, to inactivate enzymes. If necessary, to regulate humidity, it is possible to supply water to 1 tank, as well as hot steam to other tanks. From the roasters, the pulp enters the feeder of the press (10), and from it directly into the press (11), where the oil is squeezed out. The pressed material with the remaining oil (cake) with a moisture content of 4-7% leaves the press and enters the conveyor (1), and then it is sent to the extraction or to the cake and meal preparation line for the production of high-protein feed additive.

The released vapors during pressing are removed with the help of a fan in a cyclone and then released into the atmosphere. The condensate formed in the vats of the roasting plant enters the condensate tank, from which the condensate is then pumped to the boiler room by a pump. In the press, the oil is pressed under pressure, which enters the screw conveyor (1), which supplies the pressed oil for extraction.

Cake and meal preparation line. After pressing (1), the resulting cake with a moisture content of 4-7% is sent to the cake crusher (12) using a conveyor (1). The crushed cake from the bread crusher (12) is fed into the magnetic separator (3) for the separation of metallomagnetic impurities and is sent to the screening machine (13), in which one sieve PR No. 2 is installed. additional grinding. The crushed cake is combined through the pas-

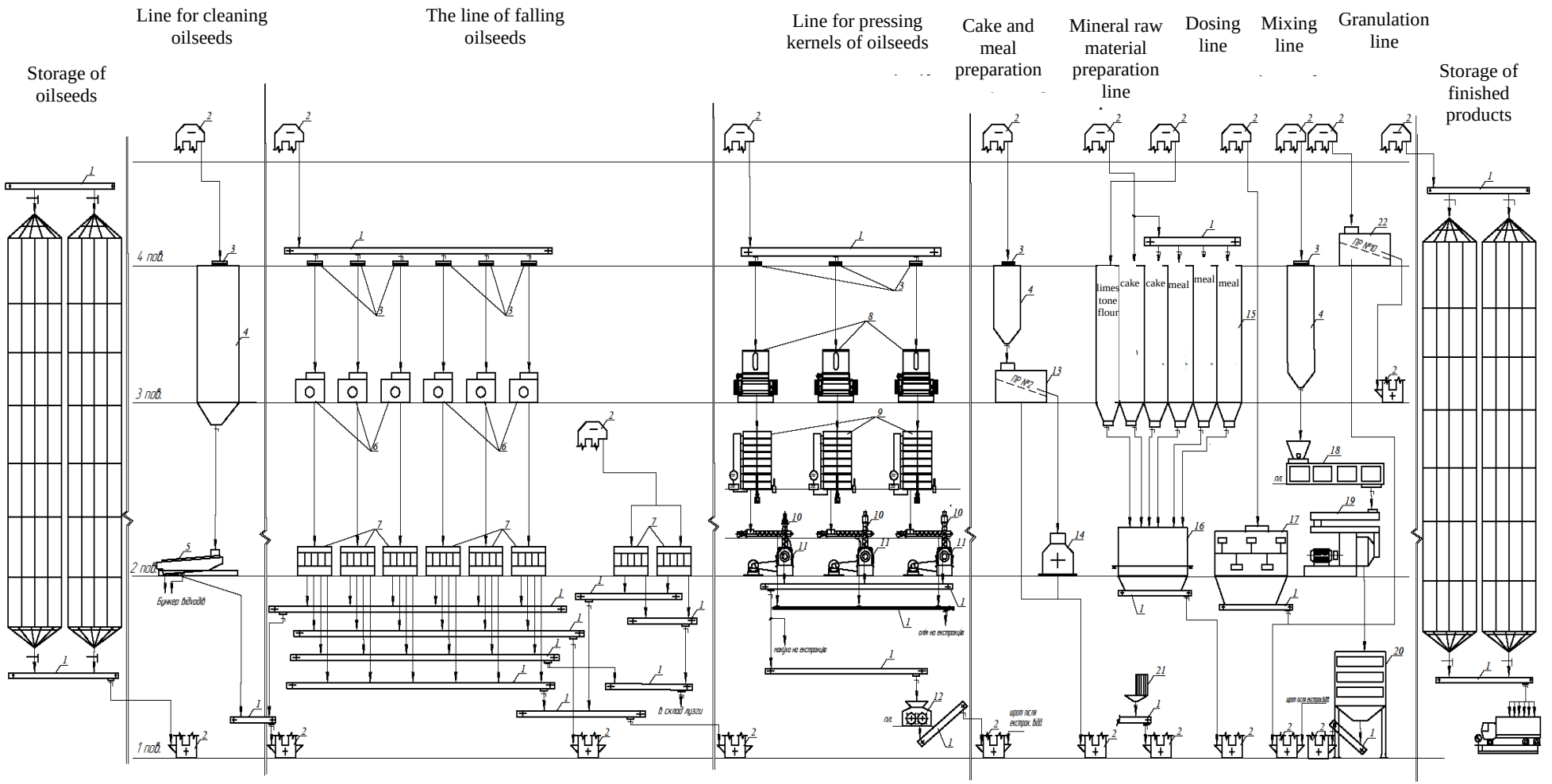

Fig. 5. Basic technological scheme for the production of high-protein feed additive from the by-products of sunflower oil production

1 – conveyor; 2 – noria; 3 – magnetic separator; 4 – operational bunker; 5 – sieve-air separator; 6 – seed pod; 7 – seminal cilium; 8 – rolling machines; 9 – roaster; 10 – press feeder; 11 – press; 12 – bread breaker; 13 – sieving machine; 14 – hammer crusher; 15 – over dosing hoppers; 16 – multi-component weighing dispenser; 17 – mixer; 18 – air conditioner; 19 – press granulator; 20 – cooling column; 21 – grinding machine; 22 - sieving machine.

sage of the sieving machine (13) and fed into the overdosing hoppers (15) with the help of a noria (1).

The toasted meal, not granulated, after the extraction department is fed to the screening machine (13), if necessary, it is crushed in a hammer crusher (14) and sent to the overdosing hoppers (15).

Mineral raw material preparation line. Limestone flour is crushed using a crushing machine (21) and fed to the overdosing hoppers (15) using a noria (2) and a conveyor (1).

Dosage line. The prepared cake, meal, and limestone flour from the overdosing hoppers (15) is sent to the multi-component weighing doser (16). The dosed components according to the recipe are fed to the mixing line using a conveyor (1) and a noria (2).

Mixing line. The mixing line is designed for the production of additives in loose form from pre-prepared components according to the recipe. Mixing takes place with the help of a batch mixer (17).

Granulation line. The granulation line is designed for obtaining granulated additives. The bulk high-protein additive is fed to the magnetic separator (3) for the separation of metallomagnetic impurities using a noria (2) and is fed to the long-term conditioner (18), where it is subjected to wet-heat treatment. The processed product is fed into the press granulator (19) and heated to a temperature of +100 - 110 ˚C, after which it is given the shape of cylindrical granules (diameter of granules 6 - 10 mm, length of granules 10-26 mm).

From the press-granulator, the granulated product is fed into the cooler (20) to cool the granules to a temperature no more than 10 °C higher than the ambient temperature and is dried to a humidity of 9-11% by passing air through it. The cooled granulated product is fed to the screening machine (22) using a noria (1) to control the size. The passage of the sieve PR No. 10 is directed by the noria (1) for repeated granulation, and the finished granules are directed to the warehouse of finished products.

Conclusions

The developed technology for the production of high-protein feed additive from the by-products of sunflower oil production can be implemented at an existing oil processing enterprise that has a pressing and extraction shop, with the installation of additional equipment for the preparation of raw materials and obtaining a homogeneous mixture with subsequent granulation.

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РОЗРОБКА ТЕХНОЛОГІЇ ВИРОБНИЦТВА ВИСОКОБІЛКОВОЇ КОРМОВОЇ ДОБАВКИ З ПОБІЧНИХ ПРОДУКТІВ ВИРОБНИЦТВА СОНЯШНИКОВОЇ ОЛІЇ

Анотація

Олійно-жирова промисловість України – одна з найбільш потужних галузей харчової промисловості, розвиток якої має особливе значення для оцінки продовольчої безпеки країни. Скринінг показав, що Україна займає лідируючі позиції на світовому ринку з виробництва соняшнику та соняшникової олії, а також експорту

соняшникової олії. Наведено найбільших українських підприємств-виробників нерафінованої та рафінованої соняшникової олії .

Представлена структурна схема отримання побічних продуктів, які утворюються при переробці олійних культур, що мають досить високу кормову цінність і використовуються у годівлі сільськогосподарських тварин і птиці. Охарактеризовано визначальні фактори, що впливають на обсяг утворення побічних продуктів виробництва рослинної олії.

Запропоновано виробництво високобілкової кормової добавки на основі шроту соняшникового, макухи соняшникової та мінеральної сировини.

Розроблено схему технологічного процесу виробництва високобілкової кормової добавки, яка передбачає наступні технологічні лінії: лінія очистки насіння олійних культур; лінія обрушення насіння олійних культур; лінія пресування ядра насіння олійних культур; лінія підготовки макухи та шротів; лінія підготовки мінеральної сировини; лінія дозування; лінія змішування; лінія гранулювання.

Виробництво запропонованої високобілкової кормової добавки в гранульованому вигляді може бути здійснено на діючому олійно-переробному підприємстві в цеху гранулювання шроту, що дасть можливість ефективно використовувати побічні продукти виробництва соняшникової олії.

Ключові слова: кормова добавка, соняшникова олія, макуха, шрот, вапнякова мука, технологія, сільськогосподарські тварини.

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