

STUDYING THE PROTEIN COMPLEX OF FLAX CAKE OBTAINED FROM THE SEEDS OF A NEW VARIETY OF KAZAKH SELECTION

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In the Republic of Kazakhstan, pressing of flax seeds (squeezing) is most often used, therefore cake is more common than meal and its resulting physical reserves exceed meal several times. The biochemical characteristics of the protein complex of flaxseed have not been sufficiently studied, which, in our opinion, limits the use of protein products obtained from flax seeds such as flaxseed cake in the production of compound feed for farm animals and poultry. The article presents studies of the protein complex and amino acid composition of flaxseed cake of the Kazakhstan variety "Kostanay 11". Flaxseed cake contains 36,5% protein, the fat content is 7,5%. The fractional composition of flaxseed cake was compared with the flax varieties "Northern" and "Golden" grown in the Republic of Kazakhstan. The amino acid composition of flaxseed cake was compared with other cakes used in feeding farm animals and poultry. The purpose of the study is to study the fractional composition of the protein complex of flaxseed cake from flax variety "Kostanay 11". A characteristic feature of the protein complex of flax seeds is the high total content of water- and salt-soluble proteins – albumins 29,2% and globulins 16,8%, which are considered well digestible. Flaxseed cake from flax variety "Kostanay 11" in its amino acid value is equal to the known cakes common in feed production and is second only to soybean cake. This allows us to assert that flaxseed cake obtained from the seeds of the "Kostanay 11" variety remained a highly digestible and highly nutritious product in terms of protein absorption, suitable for its inclusion in the diets of all types of farm animals and poultry, starting with feed for young animals.

Keywords: flax, Kazakhstan variety, flax cake, fractional composition of protein, amino acid composition.

ИЗУЧЕНИЕ БЕЛКОВОГО КОМПЛЕКСА ЛЬНЯНОГО ЖМЫХА, ПОЛУЧЕННОГО ИЗ СЕМЯН НОВОГО СОРТА КАЗАХСТАНСКОЙ СЕЛЕКЦИИ

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В республике Казахстан наиболее часто применяют прессование семян льна (отжим), поэтому жмых более распространён, чем шрот, и его образующиеся физические запасы превышают шрот в несколько раз. Биохимические характеристики белкового комплекса льняного семени изучены недостаточно, что, на наш взгляд, ограничивает использование белковых продуктов, полученных из семян льна, таких как льняной жмых в производстве комбикормов для сельскохозяйственных животных и птицы. В статье приведены исследования белкового комплекса, аминокислотного состава льняного жмыха Казахского сорта «Костанайский 11». В льняном жмыхе содержится 36,5% протеина, содержание жира составляет 7,5%. Фракционный состав льняного жмыха сравнивали с выращиваемыми на территории Республики Казахстан сортами льна «Северный» и «Золотистый». Аминокислотный состав льняного жмыха сравнивали с другими жмыхами, используемыми в кормлении сельскохозяйственных животных и птицы. Целью исследования является исследование фракционного состава белкового комплекса льняного

жмыха из льна сорта «Костанайский 11». Характерной особенностью белкового комплекса семян льна является высокое суммарное содержание водо- и солерастворимых белков – альбуминов 29,2% и глобулинов 16,8%, которые считаются хорошо усвояемыми. Льняной жмых из льна сорта «Костанайский 11» по своей аминокислотной полноценности уравнён с известными распространёнными в кормопроизводстве жмыхами и уступает только жмыхам сои. Это позволяет утверждать, что льняной жмых, полученный их семян сорта «Костанайский 11», остался высокопереваримым и высокопитательным продуктом в отношении усвоения протеина, пригодным для его включения в рационы всех видов сельскохозяйственных животных и птицы, начиная с комбикормов для молодняка раннего возраста.

Ключевые слова: лен, Казахстанский сорт, льняной жмых, фракционный состав белка, аминокислотный состав.

ҚАЗАҚСТАНДЫҚ СЕЛЕКЦИЯНЫҢ ЖАҢА СҰРЫПЫ ТҰҚЫМЫНАН АЛЫНҒАН ЗЫҒЫР КҮНЖАРАСЫНЫҢ АҚУЫЗДЫҚ КЕШЕНІН ЗЕРТТЕУ

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Қазақстан Республикасында көбінесе зығыр дәнін сығымдау қарастырылған, сондықтан шротқа қарағанда күнжара кең қолданылады, өйткені оның қоры шротпен салыстырғанда бірнеше есе көп. Зығыр тұқымының ақуыздық кешенінің биохимиялық сипаттамасы жеткілікті зерттелмеген, сондықтан оның ақуыздық өнімдері- күнжарасының ауылшаруашылығы малдары мен құстарына арналған құрама жем өндірісінде қолданылуы шектеулі. Мақалада «Костанайлық 11» зығыр сұрыпы күнжарасының ақуыздық кешенін, аминқышқылдық құрамын зерттеу нәтижесі берілген. Зығыр дәнінде ақуыз 36,5%, майлылығы 7,5% қамтылған. Зығыр күнжарасының фракциялық құрамы Қазақстан Республикасында өсірілетін зығырдың «Северный» және «Золотистый» сұрыптарынан алынған күнжаралардың фракциялық құрамымен салыстырылды. Зығыр күнжарасының аминқышқылдық құрамы ауыл шаруашылығы құстары мен малдарының азығында қолданылатын басқа күнжаралармен салыстырылды. Зерттеу мақсаты «Костанайский 11» зығыр сұрыпының күнжарасының ақуыздық кешенінің фракциялық құрамын зерттеу болып табылады. Зығыр тұқымының ақуыздық кешенінің ерекшелігі ағзаға жақсы сіңетін, суда және тұзда еритін ақуыздар – альбуминдер 29,2% мен глобулиндердің 16,8% қосындысын көп мөлшерде сақтауы. «Костанайлық 11» зығыр сұрыпынан алынған зығыр күнжарасының аминқышқылдық толыққұндылығы жемішөп өндірісінде кең қолданылатын күнжаралармен тең, тек қытайбұршақ күнжарасымен салыстырғанда ғана төмен болып келеді. Алынған деректер «Костанайлық 11» зығыр сұрыпынан алынған зығыр күнжарасының протеині қорытылуы жоғары өнімге жататынын және ауыл шаруашылығы құстары мен малдарының барлық түріне балапандар мен төлдерге арналған құрама жемнен бастап кең қолдануға болатынын көрсетеді.

Негізгі сөздер: зығыр, Қазақстандық сұрып, зығыр күнжарасы, ақуыздың фракциялық құрамы, аминқышқылдық құрам.

Introduction

The problem of providing food supply in the farms of the Republic of Kazakhstan is mainly solved independently due to established traditions and the availability of components. One of the reasons hindering the production of compound feed for farm animals and poultry is the insufficient supply of protein and energy raw materials, the need for which is met only by 30 - 40% from Kazakhstan's own resources. Not all, but most of the by-products from processing industries con-

tain high levels of nutrients and biologically active substances and, as a result, can serve as alternative feed resources [1]. These fairly significant yields include flaxseed processing products. Considering the high nutritional value and low price of flaxseed cake, research aimed at partial replacement and reduction of expensive soybean cake in the diets of farm animals and poultry is important [2].

Kazakhstan is one of the five largest flaxseed growing countries. Flaxseed is a promising

crop for our country; its plantings have been constantly growing in recent years and have already reached more than 1.3 million hectares.

The successes of Kazakhstani selection have made it possible to obtain new, promising varieties of oilseed flax with large seeds and high oil content.

The Kostanay Scientific Research Institute of Agriculture developed the oil flax variety “Kostanay 11”, the weight of 1000 seeds is 6,5-7 g, and the oil content in the seeds exceeds 42.6%. This variety is less damaged by pests and produces a higher yield. Designed to produce high-quality technical oil and short fiber.

Flax seed proteins are characterized by a balanced amino acid composition and high nutritional value [3]. The protein complex of flax seeds contains all amino acids essential for the human body and meets the Food standard and Agricultural Organization of the United Nation (UN food and agriculture organization). Flaxseed proteins have not only high biological value, but also functional and technological properties comparable to those of the widely used soy protein [4].

Depending on the method of oil extraction (extraction or pressing), by-products of oil extraction production are flaxseed meal or press flaxseed cake.

Cold-pressed flaxseed cake after oil extraction is a valuable by-product for animal and poultry feeding. Flaxseed cake is a protein supplement that can seriously compete in nutritional value and productivity with traditional high-protein components in poultry feed [5]. In studies by Kislova et al. [6] recommend using up to 20% flaxseed cake as a protein source in the diet of lactating goats.

Flaxseed cake is more nutritious in terms of energy content than cake, but contains slightly less protein. 100 g of cake contains about 370 kcal of metabolic energy and 33-35% crude protein. It contains residual oil that is rich in alpha linolenic acid, which positively contributes to good animal health. After pressing, up to 19% of crude fat remains in it, 50% of which is linolenic (omega 3) acid. For this reason, the accumulation of linoleic acid in the cake is reduced to 12%, and oleic acid to 25%. Consequently, flax cake is more suitable for poultry diets in terms of fatty acid composition than sunflower and soybean rape cakes, in which linolenic acid is minimized and the level of linoleic acid is excessively high. Flaxseed cake ensures the accumulation of ω -3 acids in meat, improving its taste and dietary properties. Flaxseed cake is not much different from other types of cake in terms of the content of calcium, phosphorus, sele-

nium, zinc and iron. Flaxseed cake is a valuable source of protein and essential amino acids, with arginine being the most important [7]. Arginine helps to increase the live weight of meat-producing poultry.

As for the information on the fractional composition of flax proteins, it is extremely contradictory. Data on the fractional composition of flaxseed proteins varies widely, which is associated with varietal characteristics, growing region, and seed processing conditions.

The purpose of our work is to study the fractional composition of the protein complex of flaxseed cake from flax variety “Kostanay 11”.

Materials and research methods

In this work physicochemical studies were carried out on a laboratory sample of flaxseed cake from flax variety “Kostanay 11”.

This sample was produced by cold pressing at the “Dynasty Agro” LLP enterprise (North Kazakhstan region) during the processing of the 2023 flax harvest. Organoleptic characteristics of flaxseed cake were determined according to GOST 10974-95 [8].

– The mass fraction of crude protein of flaxseed cake was determined according to GOST 13496.4-2019 “Feed, compound feed, compound feed raw materials. Methods for determining nitrogen and crude protein content” [9]. The protein content was calculated from the amount of nitrogen released by titration. The crude protein content of the product is calculated by multiplying the nitrogen content by a factor of 6.25.

– The mass fraction of fat in raw materials was determined according to GOST 13496.15-97 “Feed, compound feed, compound feed raw materials. Methods for determining crude fat content”, Soxhlet method [10]. 10 g of raw material was weighed into a cartridge made of filter paper, cotton wool soaked in ether was placed in the cartridge, and then the cartridge prepared in this way was placed in the extractor of the Soxhlet apparatus. The extraction lasts approximately 3-4 hours. Subsequently, the flask of the Soxhlet apparatus is dried at a temperature of 105 ± 5 °C for 30 minutes and after cooling, the extracted fat is weighed and determined by gravimetric method.

– The content of dietary fiber in raw materials was determined according to GOST 13496.2-91 [11]. The method is based on removing acid-base-soluble substances from the product and determining the mass of the residue, which is conventionally taken as fiber. To do this, a 1g sample was poured into 150 ml of a 1.25% sulfuric acid solution. The mixture was stirred and brought to a

boil on an electric stove. The hot solution was sucked off using a Komovsky's pump. 25 ml of acetone was poured into the precipitate washed from sulfuric acid. Then it was brought to a constant mass in a drying oven at 105 °C. The resulting mass minus the mass of the crucible is the mass of crude fiber and ash.

– The amino acid composition of flaxseed cake was determined according to GOST 32195-2013 “Method for determining amino acid content” [12]. Amino acids are separated by Sykam ion exchange chromatography S-433-DS. Amino acids are separated by ion exchange chromatog-

raphy, reacted with ninhydrin, and their content is determined by photometric detection at a wavelength of 570 nm.

– The fractional composition of seed proteins based on solubility was determined according to Osborne [13].

Results and discussion

The chemical composition of flaxseed cake was determined at the All-Russian Scientific Research Institute of Fats. Compare the chemical composition of flaxseed cake with other typical cakes traditionally used in feeding poultry (Table 1).

Table 1. Comparative chemical composition of oilseed by-products

Index	Flaxseed cake		Hemp cake	Sunflower cake	Soy cake
	“Kostanay 11”	Tabular data			
Crude protein, %	36,5	33,30	34	36	36,0
Crude fat, %	7,5	6,46	6,97	18,5	5,8
Crude fiber, %	11,30	9,8	24,7	17,0	7,3

Analysis of the chemical composition of flaxseed cake indicates that it can be classified as a highly digestible feed protein concentrate that can provide a significant correction of the protein and amino acid nutrition of farm animals and poultry. Table 1 shows that flaxseed cake in terms of protein content exceeds sunflower and soybean cakes by 0.5%, hemp cake by 2,5%. In terms of fat content, flaxseed cake exceeds hemp cake by 0,53%, soybean cake by 1,7%, but is inferior to sunflower cake by 11%. However, an increased accumulation of crude fiber is recorded in flaxseed cake, although the level of fiber remains lower in comparison with hemp and sunflower cake. The results of our research are similar to the research of Professor Podobed [14], in his works flaxseed cake is compared with sunflower and soybean cakes, but, unfortunately, the flax variety from which the flaxseed cake is obtained is not indicated. Podobed L.I. concludes that the energy nutritional value of flaxseed cake is as close as possible to soybean cake, and in terms of the level of crude protein it is almost equal to it. Flaxseed cake differs positively from sunflower cake in its low concentration of crude fiber. The professor

concludes that the digestibility of flaxseed cake will be high and recommends the use of flaxseed cake in feeding farm animals and poultry.

The quality of protein for poultry is determined by the amino acid composition, as well as physicochemical characteristics and, first of all, solubility. The content of soluble fractions in protein, especially those soluble in water and saline solutions, as well as amino acids, depends on the degree of moisture-heat treatment. It is believed that with an increase in fractions soluble in water and salts in the feed composition, the digestibility of protein as a whole also increases [15]. Therefore, indirectly, by the ratio of individual fractions in the protein of the feed, one can judge its ability to be effectively digested.

In our studies, we compared data on the solubility of flax proteins grown on the territory of the Republic of Kazakhstan with the solubility of protein fractions of flaxseed cake obtained from the processing of flax variety “Kostanay 11” (Table 2). Data indicate the predominance of the albumin fraction in the protein complex of flax seeds.

Table 2. Fractional composition of flaxseed cake from flax variety “Kostanay 11” according to solubility in various solvents

Name of indicator, units of measurement	Flax-seed Variety "Northern"	Linen seed Variety "Golden"	Linen seed Variety "Kostanay 11"	Flaxseed cake variety "Kostanay 11"
Water-soluble protein fraction, % of crude protein content	38	39,9	36,1	29,2
Salt-soluble protein fraction, % of crude protein content	19,8	18,2	18,6	16,8
Alcohol-soluble protein fraction, % of crude protein content	-	4,2	4,1	3,7
Alkali-soluble protein fraction, % of crude protein content	20,5	20,9	20,2	24,1
Insoluble protein residue, % of crude protein content (by difference)	21,3	16,6	20,9	26,1

From Table 2 it can be seen a characteristic feature of the protein complex of flax seeds is the high total content of water- and salt-soluble proteins - albumins and globulins, which are considered well digestible, especially albumins. Difficult to digest prolamins (alcohol-soluble fraction), which constitute a significant part of the protein complex of grain crops, are either absent or minimized in flax seeds of the compared varieties. This indicates that in the compared varieties of flax as feed, the level of the indigestible fraction is minimized, which will undoubtedly affect the overall digestibility of protein substances in the feed. In addition, regardless of the flax variety, they contain a sum of water- and salt-soluble fractions close to 50%, which indicates the high nutritional value of the proteins of the studied feed product.

In our studies, in flaxseed cake from flax variety “Kostanay 11”, prolamine fractions significantly predominate, and the glutelin fraction exceeds 10%. According to Polyakov *et al.* [16], the presence of the prolamine fraction, increases the adaptive potential of plants of wild species to unfavorable environmental conditions, starting from the germination stage, and subsequently has a positive effect on plant growth and development. Based on the data obtained, we can assert that data on the fractional composition of flax seed proteins of different varieties varies widely, which is associated with varietal characteristics. This factor must be taken into account when assessing the nutritional value of flax cake as a feed additive.

In addition, there is no doubt that the heat treatment used was specific and it significantly affected the ratio of soluble protein fractions when converting flax seeds into cake.

Under the influence of heat treatment in flaxseed cake from flax variety “Kostanay 11”, the level of water- and salt-soluble fractions decreased, a small fraction of the alcohol-soluble part appeared, and the concentration of protein soluble in alkalis and the non-extractable residue increased.

Research by Yanova *et al.* [17] indicate that this is a natural process during any heat treatment. However, with the chosen method of thermal exposure in the process of obtaining linseed oil, the proportion of the water-soluble fraction in the flaxseed cake remained the highest in concentration among all others, and the sum of the water- and salt-soluble fractions amounted to about half of all fractions. This allows us to assert that flaxseed cake obtained from the seeds of the “Kostanay 11” variety remained a highly digestible and highly nutritious product in terms of protein absorption, suitable for its inclusion in the diets of all types of animals and poultry, starting with compound feeds for young animals of early age.

For animals with a monochamber stomach, it is not so much the overall concentration of protein substances in the form of the “crude protein” indicator that is of great importance, but the quality of this protein in terms of the concentration of individual amino acids and their availability to the body. It is useful to compare the amino acid composition of flaxseed cake protein in terms of the amino acid ratio with other typical cake types traditionally used in animal and poultry feeding. A comparative analysis of the amino acid composition of the cakes is given in Table 3.

Table 3. Comparative analysis of the amino acid composition of oilseed cakes

The name of indicators	Mass fraction of amino acids, %				
	Flaxseed cake		Hemp cake	Sunflower cake	Soybean cake
	“Kostanay 11”	Tabular data			
Arginine	3,25	3,33	0,75	3,0	2,6
Lysine	1,32	1,42	0,35	1,27	2,26
Tyrosine	0,86	1,0	0,41	1,06	-
Aspartic acid	3,23	2,80	4,9	2,44	5,7
Glutamic acid	6,59	5,80	5,99	4,96	8,7
Phenylalanine	1,63	1,67	0,41	1,61	2,21
Histidine	0,74	0,86	0,37	1,06	0,96
Leucine	1,98	2,17	0,25	1,68	2,93
Isoleucine	1,45	1,53	0,25	1,68	2,93
Methionine	0,65	0,59	0,54	0,83	0,45
Cystine	0,66	0,61	0,75	0,62	0,49
Valin	1,76	1,78	0,37	1,9	2,13
Proline	1,22	0,27	0,40	0,22	0,26
Threonine	1,28	1,34	0,24	1,34	1,51
Serin	1,49	0,71	0,24	0,16	0,19
Alanin	1,55	0,5	0,28	0,16	0,21
Glycine	2,01	2,0	1,5	2,42	-
Tryptophan	0,98	0,55	0,5	0,46	0,55

Analysis of Table 3 shows that flaxseed cake occupies an intermediate position between sunflower and soybean cakes. It is richer in lysine 1,32%, than sunflower 1,27%, but poorer in methionine by 0,18%. The flaxseed cake under consideration differs from other cakes, including soybean cake, by its increased concentration of essential amino acids arginine 3,25 % and tryptophan 0,98%. The considered flaxseed cake “Kostanay 11” differs from other cakes, including soybean, in its increased concentration of arginine 3,25%. Flaxseed cake from flax of the Kazakhstan variety “Kostanay 11” is slightly different from the average table data to the downside in terms of the total amount of essential amino acids. However, the total amount of critical amino acids 4,23% in the analyzed cake is higher than the table values by 0,33%, higher than that of hemp cake by 2,6% and sunflower cake by 0,33%. This means that when forming feed rations using flaxseed cake, it is possible to optimize the arginine: lysine ratio in the diet without resorting to the use of synthetic additives of this amino acid. This is especially true for meat and egg poultry farming. Therefore, using flaxseed cake can simplify the optimization of feed recipes. The results of our studies can be compared with the results of studies by Kapitonova *et al.* [18], where the amino acid composition of flaxseed cake, soybean and sunflower cake was

studied. The authors conclude that flaxseed cake has a fairly high availability of essential amino acids for poultry, although its amino acid composition is inferior to cake.

We have developed recipes for feed using flaxseed cake from flax variety “Kostanay 11” for broiler chickens of the Cobb 500 cross, studied the indicators of granule crumbliness and specific energy costs of pilot batches of granulated feed for broilers [19].

The above data indicate that different varieties of flax determine a wide range of variations in the chemical composition and nutritional value of the feed product, as well as the productive effect obtained from them. Therefore, it is of scientific and practical interest to give a detailed assessment of the chemical composition of flaxseed cake from flax of the Kazakhstan variety “Kostanay 11”. The research carried out in this direction will allow us to obtain data on the nutritional value of flax cake and the feasibility of its use in the practice of poultry farming in Kazakhstan. This, in turn, makes it possible to eliminate protein deficiency in diets and increase the efficiency of production of livestock and poultry products in the region.

Conclusion

The zoning and widespread distribution of the flax variety “Kostanay 11” and some others on the

territory of the Republic of Kazakhstan has led to great interest in them from processors. Nevertheless, the features of the chemical composition and nutritional value of cakes and cakes obtained from such varieties remain unstudied. This hinders the activity in their use as feed and does not allow us to establish their true effectiveness in feeding poultry. Flaxseed cake obtained by processing flax of the Kazakhstan variety "Kostanay 11" is a complete protein supplement, a source of highly nutritious protein with a relatively low accumulation of crude fiber, which gives it a number of advantages in relation to sunflower cake and brings it closer to soybean cake. Flaxseed cake contains 36.5% protein, the fat content is 7.5%. Studies the fractional composition of the protein in flaxseed cake, show that the proportion of the water-soluble fraction remained the largest in flaxseed cake 29.2% in concentration among all others, and the sum of water- and salt-soluble fractions amounted to about half of all fractions 46%.

Analysis of the chemical composition of flaxseed cake indicates that it can be classified as a group of highly digestible feed protein concentrates that can provide a significant correction of the protein and amino acid nutrition of animals and poultry. This expands the range of rates for its introduction into mixed feed and allows it to be used in feeding farm animals and poultry.

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