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ВИВІЛЬНЕННЯ ПОЖИВНИХ РЕЧОВИН КОРМІВ ШЛЯХОМ ЕКСТРУЗІЇ ЗЕРНОБОБОВОГО ФУРАЖУ

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RELEASE OF FEED NUTRIENTS BY EXTRUSION OF LEGUMES

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АНОТАЦІЯ

Виробництво екструдованих комбікормів для сільськогосподарських тварин є перспективним напрямком кормовиробництва. Використання такого обладнання економічно доцільно, оскільки забезпечує можливість оперативного зміни рецептур комбікормів з урахуванням наявної сировинної бази.

У роботі досліджено вплив технологічних параметрів процесу екструдування: температури і ступеня помелу сировини на зміну хімічного складу і руйнування клітковини в бобових культурах: сої, кормових бобах, горосі і нуті. Згідно з отриманими даними, використання методу екструдування при обробці сої, кормових бобів, гороху та нуту дозволяє збільшити в них, в порівнянні з натуральним зерном, весь комплекс поживних речовин (кількість обмінної енергії, вміст сухої речовини, сирого і перетравного протеїну, БЕР, цукру) і, навпаки, знизити вміст сирої клітковини.

ABSTRACT

The production of extruded feed for farm animals is a promising area of feed production. The use of such equipment is economically feasible, as it provides the ability to quickly change the formulations of feed, taking into account the available raw material base.

The paper investigates the influence of technological parameters of the extrusion process: temperature and degree of grinding of raw materials on the change of chemical composition and destruction of fiber in legumes: soybeans, fodder beans, peas and chickpeas. According to the obtained data, the use of extrusion method in the processing of soybeans, fodder beans, peas and chickpeas allows them to increase, compared to natural grain, the whole range of nutrients (metabolic energy, dry matter, crude and digestible protein, NE, sugar) and, conversely, reduce the crude fiber content.

Ключові слова: комбікорми, екструдування, екструдер, сирий протеїн, сирий жир, сира клітковина, безазотисті екстрактивні речовини (БЕР).

Keywords: compound feeds, extrusion, extruder, crude protein, crude fat, crude fiber, nitrogen-free extractives (NE).

To increase the nutritional value and more rational use of feed grain, various methods of its processing are used - grinding, roasting, cooking and steaming, sweetening, extrusion, micronization, flattening, flaking, recovery, yeasting.

Extrusion is the processing of grain under the action of high pressure and temperature. Pre-cleaned grain is fed into an extruder in which the pressure is 28 atm and the temperature is 130–150 °C. Grain extrusion leads to an increase in its composition of sugar, dextrins, hemicellulose and a decrease in the content of starch and cellulose (true fiber). The extrusion process has a significant effect on the protein complex of the grain, increases its biological value.

The extrusion process is as follows. In special devices, the feed components are crushed, mixed into a homogeneous mass, compacted. The resulting high temperature destroys harmful microorganisms and toxins. Most soybeans are extruded in special screw-type devices - extruders (Fig. 1). Extruder Insta-Pro 2000 allows to extrude legumes of natural humidity at an outlet temperature from 140 to 160 ℃.

The value of the pressure on the feed mass inside the extruder reaches 28-30 atm. This is due to repeated compression of the soybean mass with the screws of the auger, the pitch of which is constantly decreasing towards the output of the product. Therefore, the pressure significantly depends on the design features of the auger, its speed of rotation, the initial humidity of the raw material. As a result of the interaction of high pressure and temperature in the feed mass, deep biochemical processes occur, which significantly improve the assimilation of feed and neutralize anti-nutritional factors.

Fig. 1. Extruder Insta-Pro 2000

Extrusion as a technological process differs favorably from cold pressing, as it allows to increase the nutritional properties of the processed feed components. As a result of such processing complex structures of proteins and carbohydrates break down into simpler ones, fiber into secondary sugars, starch into simple sugars, and in legumes neutralization of protease inhibitors: trypsin and urease. In addition, the temperature exposure leads to improved hygienic condition of feed components due to the destruction of unwanted microflora [1].

The use of extrusion has a number of advantages:

- mechanical grinding: the obtained fine feed structure is quite desirable for optimal digestion. Expansion at the outlet of the extruder nozzle leads to the destruction of the internal structure of the material, facilitating its digestion, as well as to increase the surface area of the feed, which accelerates the absorption of nutrients in the digestive tract;

- destruction of the structure (denaturation) of proteins: short-term heating above 100 ° C with simultaneous exposure to high pressure in the extruder very effectively changes the structure of proteins (coagulation, denaturation), thereby increasing the energy value of feed;

- deactivation of unwanted enzymes;

- radical reduction of antinutrients and natural toxins: extrusion very effectively neutralizes a number of antinutrients. For example, in soybeans after extrusion, urease activity is clearly reduced. In the feed for monogastric animals a very positive point is the decrease in trypsin inhibitor;

- sterilization: temperature and pressure in the extruder reliably destroy all bacteria, fungi and other unwanted microorganisms and pests. The growth of mold and the release of mycotoxins stops, which allows you to extend the shelf life;

- jelly formation of starch: starch is a very frequent and important element of feed. In the process of extrusion, complex starchy carbohydrates and sugar are converted into simple ones, which simplifies the digestibility of feed;

- homogenization and the possibility of formation: in the extruder all the components of the feed are mixed. Squeezing through the molding matrix, the feed can be given different shapes. The condition for obtaining and maintaining the required shape is the correct composition of the extruded raw material - a sufficient content of binders (most often - starch) [2].

The grain of almost all legumes requires appropriate treatment before feeding, which significantly increases the efficiency of its use by animals.

Soybeans are the leader among grain feeds in terms of energy, protein and fat nutrition. 1 kg of soybeans contains 1.45 feed. units, 14.7 - 15.0 MJ of metabolic energy. The content of crude protein is 35-45%, fat - 16-22%, crude fiber - 7%. Soybeans can be fed to all species of animals as a protein supplement for deficiencies in feed rations of protein and to balance them in amino acids.

1 kg of soy contains the following number of amino acids (g): lysine - 21.1, methionine - 4.6, histidine - 7.6, tryptophan - 4.3, threonine - 12.6, valine - 18.0, arginine - 26.6, leucine - 26.2, isoleucine - 17.6, phenylalanine - 17.0. The digestibility of soybean organic matter averages 85–87%.

Assimilation of soy protein reduces the presence of anti-nutrients in its composition.

The most significant anti-nutritional factors in soy are inhibitors of proteolytic enzymes: trypsin and chymotrypsin. These inhibitors are factors of protein nature, which account for at least 3 - 6% by weight of soybean protein. Protein nature is characterized by anti-nutrient enzymes of soy - urease and lipoxidase. The first enzyme urease - destroys quality proteins and amino acids in food in the body and converts them into a toxic substance - ammonia. Lipoxidase destroys the vitamins of the finished feed, in particular irreversibly breaks down vitamin A - retinol, which causes typical hypovitaminosis and avitaminosis A. Hematoglutinins and specific soy protein also have a negative effect on feed consumption and digestibility [3].

To inactivate anti-nutrient factors, soybeans should be subjected to heat treatment before feeding: steaming, autoclaving, extrusion, etc. The best method of inactivation of soybean anti-nutrients [4] is the processing of grain in a barothermal chamber, where it is heated by contact heat transfer from the surface of the

heating elements, active mixing of grain mass and steaming due to moisture of soybean grain. Soy milk production includes soaking soybeans for 14–16 hours, homogenizing, and cooking at 103–105 °C for 40–60 minutes.

The composition of compound feeds and feed mixtures rations processed soybeans can include: for adult pigs and young animals older than 2 months of age - up to 15%, pigs for fattening - up to 10%; for cattle - up to 10%.

Peas are one of the best legumes for animals. It has an advantage over other legumes because it contains significantly fewer anti-nutrients that adversely affect digestion, nutrient use and animal health.

1 kg of pea grain contains an average of 1.18 feed. units, 218 g of digestible protein and 14.2 g of lysine. The dry matter content is low in fat - 1.9% and fiber - 5.4%. The digestibility of organic matter is 87%.

Peas are fed to all species of animals. Its inclusion in the diets of dairy cows (1 - 2 kg per day) leads to increased milk yield and improved milk composition. In the diets of pigs for fattening peas helps to improve the quality of meat and the formation of dense granular fat. Peas are included in the feed mixtures of calves to reduce the rate of whole milk. Peas should be fed crushed (in the form of grits) or ground. Cooking or steaming peas before feeding significantly improves the use of nutrients by animals.

The norms of inclusion of pea grits in the composition of feed and feed mixtures of rations are for cattle: cows and fattening - up to 15%, calves up to 6 months of age - up to 6%, young cattle - up to 10-15%, breeding bulls - up to 5 %; for pigs: adults - up to 15-20%, piglets up to 2 months of age - up to 5%, piglets from 2 to 4 months - up to 10%, during fattening - up to 20%; for sheep: adults - up to 10%, lambs - up to 5%; for horses - up to 10%; for poultry: adult chickens, ducks, geese, turkeys - up to 12%, young - up to 10% (by weight). Fodder beans have recently become increasingly common as a source of protein (the content of which is from 25 to 33%). Bean protein contains all the essential amino acids for animals. Bean protein consists of almost 90-95% protein. Digestibility of nutrients by beans by animals is quite high. For example, in pigs the digestibility of protein is 84%, fat - 75%, nitrogen-free extractives - 88%.

1 kg of feed beans contains an average of 1.1 feed. units, 12.4 MJ of metabolic energy, 227 g of digestible protein, 16.2 g of lysine.

Beans contain less trypsin inhibitors than soy and lupine, but their use is limited by tannins, which can cause digestive disorders in animals. Therefore, when feeding beans, it is recommended to include wheat bran and chalk mass, which have a laxative effect, in the diet, or to carry out their heat treatment.

Due to extrusion, the level of introduction of legumes into compound feeds for growing young pigs up to 4 months of age reaches 25-30%. During this, the digestibility of protein and the absorption of metabolic energy increases by 20-25%. Experiments conducted at the Institute of Agriculture and Animal Husbandry of the western region showed that the introduction of compound feeds for young pigs 12.5% by weight of extruded and crushed lupine grain improved the physiological condition of pigs, the average daily gain increased by 6.4%. The introduction of extruded soybeans in the diets of pregnant sows in the amount of 20% by dry matter increases the content of linoleic acid to 2.9% of dry matter, which increases the fertility, milk yield and safety of piglets. The addition of extruded and barothermally treated soybeans in the feed of piglets increases the growth rate by 19.6 - 14.6% with a decrease in feed costs per 1 kg of growth by 16.3 - 13.1% [4].

The purpose of this work was to investigate the forage capacity of extruded forage.

Materials and methods

The objects of the study were samples of legumes used in the production of feed - soybeans, fodder beans, peas and chickpeas.

Extrusion of feed raw materials was performed on a single-screw extruder Insta Pro 2000 made in the USA with a capacity of 600-900 kg / h (2000R). Extruders of this type are "dry" extruders and have a simple and economical process. At rather small dimensions they have rather high productivity. Rational parameters of feed extrusion are established: fineness of grinding of raw materials with a nozzle diameter of 7,5 mm; product temperature at the outlet of the extruder – 140 ºC.

Results and discussion

To study the effect of extrusion on the transformation of nutritional properties, the chemical composition of feed crops of components before and after extrusion at a temperature of 140 ºC was studied.

Data on changes in the chemical composition of feed components in natural and completely dry matter before and after extrusion are given in tables 1 and 2.

Table 1

Chemical composition in natural substance, % in samples of soybeans, fodder beans, peas, chickpeas before and after extrusion

№	Chemical indicator	The name of the legume							
		Soybean		Fodder beans		Pea		Chickpea	
		original	extruded	original	extruded	original	extruded	original	extruded
1.	Dry matter	92,53	93,19	91,28	92,35	91,93	91,88	93,15	93,51
2.	Protein	36,88	38,76	24,24	25,04	20,80	20,68	21,81	21,05
3.	Fat	20,09	16,91	0,49	1,15	1,44	1,28	6,70	6,38
4.	Cellulose	8,33	5,42	8,53	7,82	6,10	6,06	3,17	2,35
5.	Ash	5,64	5,96	3,55	2,64	3,33	3,20	3,60	3,64
6.	NE	21,59	26,14	54,47	55,70	60,26	60,66	57,87	60,09

Table 2

Chemical composition in absolutely dry matter,% in samples of soybeans, fodder beans, peas, chickpeas before and after extrusion

№	Chemical indicator	The name of the legume							
		Soybean		Fodder beans		Pea		Chickpea	
		original	extruded	original	extruded	original	extruded	original	extruded
1.	Protein	39,86	41,59	26,56	27,11	22,63	22,51	23,41	22,51
2.	Fat	21,71	18,15	0,54	1,24	1,57	1,39	7,19	6,82
3.	Cellulose	9,00	5,82	9,34	8,47	6,64	6,60	3,40	2,51
4.	Ash	6,10	6,40	3,89	2,86	3,62	3,48	3,86	3,89
5.	NE	23,33	28,05	59,67	60,32	65,55	66,02	62,13	64,26

According to the chemical composition of the nutrients of the complete zootechnical analysis, the content of crude protein in extruded samples of soybeans and fodder beans increases, while in peas and chickpeas it remains virtually unchanged. The extrusion process promotes the increase of crude fat content in feed beans. This is due to the fact that in the process of friction of the raw material in the extruder was the destruction of cell walls, which caused the release of fat. The amount of fiber after extrusion in all tested samples decreases. It should also be noted the increase in the share of nitrogen-free extractives (NE), which combine carbohydrates and proteins that significantly increase the caloric content of the products formed.

The obtained results are consistent with the literature data [5, 6, 7], according to which during the extrusion of grain and oilseeds the crude protein content underwent significant changes, and at high crude fat content in the seeds there were losses. As a result, there was a redistribution and increase in ash content, the amount of protein and carbohydrates in the extruded product.

Conclusions

1. The use of the extrusion method in the processing of legumes allows them to increase, compared to natural grain, the whole complex of nutrients (metabolic energy, dry matter, crude and digestible protein, NE) and, conversely, reduce the crude fiber content.

2. The introduction of extruded compound feeds-concentrates in the diets of farm animals and poultry increases the intensity of metabolic processes in the body of animals, helping to improve productivity.

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