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EFFICIENCY OF THE USE OF VEGETABLE PEA CONCENTRATE IN MIXED FODDER'S OF YOUNG PIGS

It has been established that the introduction of vegetable pea concentrates into the composition of mixed fodder's does not affect the change in the physical properties of bulk mixed fodder's. Biological evaluation carried out on laboratory animals showed that mixed fodder's using vegetable pea concentrate has high biological value. The use of vegetable pea concentrate as an alternative to an expensive source of protein, fish meal, helps to maintain the growth rate of animals and reduce the cost of compound fodder's.

Key words: *peas, quality, concentrate, extrusion, feed, pea protein, amino acid.*

Introduction. The need for high-grade protein is increasing due to the accelerated development of industry, the production of broilers, meat and bacon pork, as well as the intensive fattening of young cattle.

Most feed mills are trying to reduce the cost of the finished feed by replacing some components without losing the balance of the finished product by optimizing the feed recipe. At the same time, the main critical points in the calculation of compound feed recipes are their balancing in terms of crude protein content and metabolizable energy. There are several ways to provide animal rations with protein (Fig. 1).

Currently, the production of various types of feed meal of animal origin in Ukraine has decreased dramatically due to the reduction of livestock of farm animals and poultry, as well as the introduction of resource-saving technologies for processing animal raw materials into food [1, p. 101].

Today, the feed market has fish meal substitutes, fake fish meal, as well as flour with increased bacterial contamination, which can lead to deterioration of feed or the production of poor quality products.

At the same time, according to the Law of Ukraine No. 2264-VIII dated December 21, 2017 "On safety and hygiene of feed", the use of feed of animal origin is prohibited, therefore, the use of vegetable protein concentrates (VPC) in feeds is relevant. VPC allow you to achieve the desired balance of crude protein, as well as a certain ratio of essential amino acids in the feed.

Depending on the degree of protein purification, its concentration after the enzymatic treatment, different types of protein products are obtained. So:

– if the protein concentration in the hydrolyzed product is 50%, it is called the hydrolysate;

– at a concentration of 70–75% – the concentrate;

– at a concentration over 75% – the protein isolate.

The need for hydrolysis is due to the presence in the raw material of a special type of protein – keratin, which is a chemically resistant, hard-to-digest substance [2, p. 34].

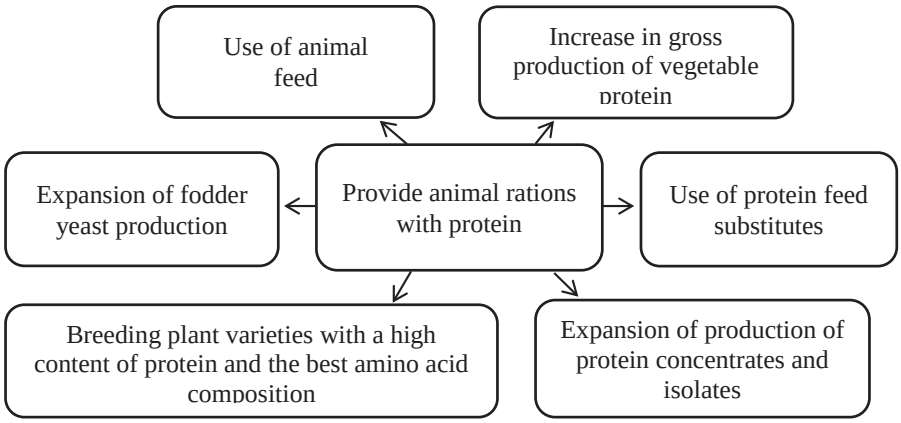

Fig. 1. Ways to provide animal rations with protein

The main raw materials for the production of VPC are leguminous crops – soybeans, peas, chickpeas, which give much more protein per unit of area compared to cereals and one of the cheapest vegetable proteins [3; 4, p. 16; 6, p. 7; 6, p. 76; 7].

Table 1

Norms of the introduction of high-protein raw materials in feed for feeding farm animals [3]

Types of animals	Norms of introduction to compound feed,%			
	Peas	Soybean meal	Meat and bone meal	Fish meal
Young birds of an agricultural bird	0…10	0…20	0…4	2…10
Adult poultry	0…12	0…15	0…7	0…7
Small Pigs	0…10	0…15	0	2…6
Pigs	0…20	0…10	0…5	0…4
Cattle	0…20	0…25	0…3	0

Analysis of recent research and publications. Over the past five years, Ukraine has seen an increase in acreage and pea production. Growing peas is attractive, the ability to restore soil fertility and the profitability of this crop is 55%. Pea grain is an excellent source of protein, which has a high solubility (the amount of water- and salt-soluble fractions reaches 90%). Depending on the variety and pea cultivation technology, the protein content is 21-27% [8, p. 2568; 9, p. 19; 10].

The biological value of pea protein depends on its amino acid composition, the presence of methionine, cystine, tryptophan and threonine. With the introduction of peas in the feed must pay attention to the amount of sulfur-containing amino acids – methionine and cystine. This is due not only to the presence of trypsin inhibitors (pancreatic enzyme), which reduces the rate of separation of amino acids from the protein molecule, mainly methionine. The amount of enzymes – trypsin inhibitors – in the pea grain is in the range from 3 to 18.2 g / kg, depending on the variety [8, p. 2568].

All anti-nutritional substances contained in pea grains are partially destroyed by heat treatment, although to varying degrees, depending on the treatment regimens [1, p. 101; 12, p. 621].

A known technology for the production of feed protein products from green mass of legumes. The green mass of peas after mowing and grinding is fed to the press in presses, and then coagulated to obtain a protein paste, which is then sent for drying. Protein paste from green peas contains 44–65% of crude protein, 2–4% fat, 4–7% fiber, used in feeding young farm animals [11].

The most effective is the use of roasted peas in the composition of animal feed for ruminants and extruded peas in the composition of animal feed for pigs, especially piglets [2, p. 34; 7]. Golushko V. and Golushko A. in their research compared various methods of heat treatment of pea grain. It was found that after extruding pea grain, the content of trypsin inhibitors decreased by 19.7%, and that of chymotrypsin, by 28.1%. Granulation made it possible to reduce these figures by 18.2 and 27.5%, respectively. Thus, only extrusion most improves the feed value of pea grains [8, p. 2568].

Recently, pea protein appeared on the world market, which meets the technological requirements for isolates [13, p. 47; 14]. Pea protein is a type of protein supplement, which is obtained from ordinary peas according to the technological scheme presented in fig. 3 [19, p. 24]. Pea protein is a pea protein isolate with a protein content of up to 90 %. It has many advantages in comparison with other vegetable proteins:

– functional ingredient – has water and fat binding properties;

– safe – the vegetable origin of the protein is easily identified, does not contain genetically modified organisms;

– useful – is a concentrated source of easily digestible protein and its amino acid composition is close to the "ideal protein";

– technological – due to the granular form of the product, the formation of dust, foam and lumps during the production process is reduced.

– has a neutral taste.

Today, pea protein is used in the meat, fish, dairy, oil and fat and confectionery industries [15, p. 110; 16, p. 20; 17, p. 22]. Pea protein, namely pea insulated protein NUTRALYS®, is used in meat processing plants.

NUTRALYS® pea insulated protein is produced by ROQUETTE at a pea processing plant in Northern France.

Pea insulated protein is added during the preparation of minced meat in hydrated form, replacing a certain amount of lean meat raw materials. The results of the studies indicate the feasibility of using pea protein in the production technology of boiled sausages [16, p. 20].

Pisane® Pea Protein Isolate, a natural, highly purified plant vegetable derived from the seeds of traditional traditional yellow peas, is produced in

Tabl. 2

Organoleptic and physical-chemical indicators VPC NUTRALYS®

Name of indicator	Content, characteristics and value of indicators
Organoleptic characteristics	
Appearance, shape and particle size	Fine floor without lumps, 90 % of particles less than 38 microns.
Taste, smell	Sweetish with a faint taste and smell inherent in the original raw materials
Colour	Light-yellow inherent in raw materials
Physical and chemical indicators	
Moisture content, %	8,15
Mass fraction of protein, % on c.d.s.*	54,78
Mass fraction of fiber, % on c.d.s.	3,05
Fat content, % on c.d.s.	3,85
Mass fraction of ash, % on c.d.s.	5,00
Mass fraction of fiber, % on c.d.s.	1,50
Mineral impurities	No

** c.d.s. – completely dry substance*

Belgium by Cosucra Groupe Warocoing. Due to its high nutritional value, digestibility and lack of contraindications, Pisane® is used in the production of specialized types of food (sports, dietary), as well as in the production of fortified and vegetarian products. Pea protein can replace up to 50% caseinate in the production of cheese products [18].

Pea protein satisfies almost all of the requirements for the protein standard amino acid composition [19, p. 24]. The use of pea protein in the production of feed products is a very promising direction. Replacing flour of animal origin with pea protein in animal feed will significantly reduce the import of this raw material, reduce the cost of the finished feed.

The purpose of the work is to study the effectiveness of the use of pea concentrate in the production of extruded pig feed.

Objectives of the study:

– to analyze and characterize the existing methods of preparing peas in the production of animal feed, as well as vegetable pea concentrates (VPC);

– to investigate the physical-chemical properties of the VPC;

Table 3

Recipes feed for young pigs 2–4 months old

Component	Content, %		
	Control recipe 1	Recipe 2	Recipe 3
Wheat	20,00	9,50	10,00
Barley without films	9,35	40,00	39,30
Oat without films	30,00	20,00	19,00
Corn	6,40	-	-
Wheat bran	5,00	10,00	10,00
Sunflower meal СП 30%, СК 20%	11,00	4,90	6,55
Soybean meal СП 40%, СК 18%	10,00	8,00	7,00
Fish flour	4,91	-	-
Crushed peas	-	4,97	-
PVC	-	-	5,00
Lysine monohydrochloride 98%	0,09	0,18	0,18
Table salt	0,19	0,25	0,23
Chalk feed	0,13	1,20	1,20
Tricalcium phosphate	0,98	-	0,54
Limestone flour	0,95	-	-
Premix П52-1 [25]	1,00	1,00	1,00
Nutritional value			
OE pigs Mj	13,5	13,5	13,5
Feed units	120,0	118,5	120,0
Crude protein	19,02	18,81	19,13
Crude fiber	5,01	5,05	5,00
Lysin	0,99	0,98	0,99
Metionin	0,36	0,38	0,35
Metionin+Cys	0,72	0,73	0,72
Ca	0,80	0,80	0,80
P	0,60	0,60	0,60
NaCl	0,30	0,40	0,30

– calculate recipes for complete feed using VPC;

– to develop technological methods for the introduction of VPC in the production of animal feed;

– to determine the physical properties of compound feeds using VPC;

– to evaluate the biological effectiveness of VPC.

Results of research and discussion. In this work, NUTRALYS® VPCs were used, for which the physicochemical properties were studied, the results of the studies are presented in Table. 2.

The study of the physical properties of VPC allows you to choose the right conditions and storage modes, technological modes of preparation of raw materials,

Tabl. 4

Physical properties of extruded feed for young pigs aged 2–4 months

Indicator Value	Meaning		
	Recipe 1	Recipe 2	Recipe 3
Appearance	Homogeneous dry mix no lumps and mold		
Smell, color	Characteristic of the set of components		
Mass fraction of moisture, %	11,5	11,4	11,2
Angle of repose, hail	45	45	45
Flowability, cm / sec	3,12	3,25	3,18
Bulk density, kg / m^3	460	455	458
The modulus of size, mm	1,56	1,60	1,52

the angle of gravity, the design and the angle of the bottom of the bunkers.

If you're introducing VPC into combined feed:

– preparation of mineral raw materials and meals;

– through the composition of the protein-vitamin supplements, protein-vitamin-mineral supplements;

– on the line of extrusion of leguminous crops;

– on the line of extrusion of ready loose feed;

– as a filler on the premix production line [20].

In order to reduce the cost and increase the productive effect of animal feed for farm and domestic animals, we propose the replacement of fish meal in recipes at the PVC, as well as the production of animal feed in extruded form. Taking into account the need for nutrients were calculated and optimized using the software complex KormOptimaExpert (Voronezh), recipes of feed for repairing young pigs (Tabl. 3).

According to the calculated recipes, experimental batches of extruded feed were produced. For the obtained feeds, the main physical indicators were studied: mass fraction of moisture, angle of repose, bulk weight, flowability, size. The research results are presented in Tabl. 4.

As can be seen from the data, the replacement in the recipe for young pigs aged 2–4 months. Fish meal on crushed peas or VPC does not significantly affect the performance of the physical properties of bulk feed. Thus, loose feed for young pigs using RGC is characterized by satisfactory physical properties.

The total nutritional value of compound feeds using RGCs was determined using a biological assessment, which is characterized by the final product of feeding, i.e. full-fledged, productive action – improving the physiological state of animals, increasing average daily weight gain and reducing feed costs.

To conduct a biological assessment of the effectiveness of animal feed, an in vivo experiment was conducted on laboratory animals. To do this, on the basis of the laboratory of biochemistry of the Institute of Dentistry of the Academy of Medical Sciences of Ukraine, two groups of white laboratory rats with an average live weight of 230 g were formed. The duration of the experiment was 14 days.

The productive effect of compound feed was evaluated by the average daily weight gain of rats and the conversion of feed. The research results are presented in Fig. 2 and Fig. 3.

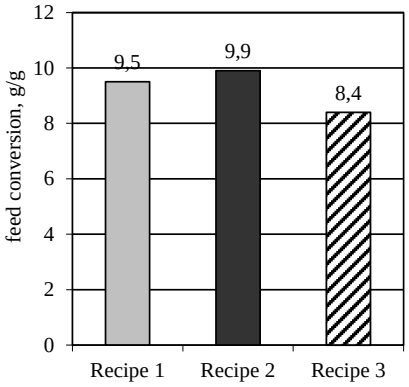

Fig. 2. Average daily gain of rats of the control and experimental groups

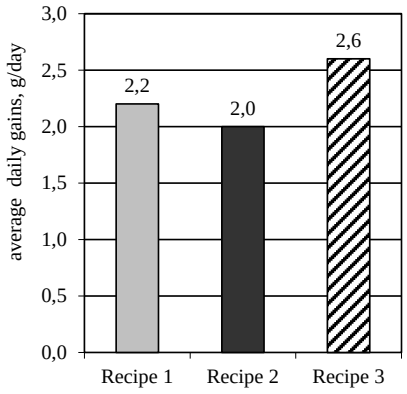

Fig. 3. Conversion of feed in the control and experienced groups

The average daily weight gains of rats in the control group were 2.2 g / day, and in the experimental group receiving feed according to the recipe of 3 – 2.6 g / day, which is 18.2% more than in the control, respectively.

The cost of feed per 1 gram of increase in live weight of rats in the control group was 9.5 g / g, and in the experimental group – 8.4 g / g, which is 11.6% less than in the control group.

Thus, the obtained results indicate a high biological efficiency of the use of RGC in the diets of pigs.

Conclusions. The use of vegetable proteins can solve the problem of protein deficiency in the production of animal feed products. Analysis of the cost of "raw" protein and the amino acid composition of the s compared with other protein types of feed raw materials is economically beneficial in the production of animal feed.

Defined quality indicators of feed on the physical-chemical parameters. It has been established that the introduction of VPCs into the composition of mixed feeds does not affect the change in the physical properties of bulk mixed feeds.

Biological evaluation carried out on laboratory animals showed that mixed feed using VPC has high biological value, since the average daily increase in live weight in the experimental group was 18,2% higher than in the control group; the cost of compound feeds for the increase in live weight in the experimental group was 11,6% less than in the control group.

The use of VPCs as an alternative to an expensive source of protein, fish meal, helps to maintain the growth rate of animals and reduce the cost of compound feed.

References:

1. Martens S.D., Tiemann T.T., Bindelle J., Peters M., Lascano C.E. Alternative plant protein sources for pigs and chickens in the tropics – nutritional value and constraints: a review. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*. 2012. V. 113. №2. P. 101–123.

2. Макаринська А.В., Чернега І.С., Оганесян А.А. Переваги використання білкових рослинних концентратів при виробництві комбікормової продукції. *Зернові продукти і комбікорми*. 2018. № 3 (71). С. 34-39. DOI: 10.15673/gpmf.v18i3.1077.

3. Єгоров Б.В. Технологія виробництва комбікормів. Одеса : Друкарський дім, 2011. 448 с.

4. Burstin J., Duc G. Protein content and protein composition of pea seeds. The relationship between protein content and protein composition of pea seeds. *Grain Legumes*, 2006. V. 44. P. 16–17

5. Кудинов П.И., Щеколдина Т.В., Слизькая А.С. Современное состояние и структура мировых ресурсов растительного белка. *Известия вузов. Пищевая технология.* 2012. № 5–6. С. 7–10.

6. Егоров Б.В. Повышение эффективности использования кормового потенциала зерна при производстве комбикормовой продукции / Б.В. Егоров, Т.М. Давиденко. *Наукові праці ОДАХТ.* Одеса, 2007. Вип. 30, т. 2. С. 76–79.

7. Єгоров Б.В. Вдосконалення підготовки концентрованих кормів при виробництві повноцінних комбікормів для сільськогосподарських тварин Б.В. Єгоров, Т.М. Давиденко. Корми і кормовир-во : міжвідом. темат. наук. зб. Ін-ту кормів УААН. Вінниця, 2008. Вип. 61. С. 135–140.

8. Stein H.H., Benzoni G., Bohlke R.A., Peters D.N. Assessment of the feeding value of South Dakota-grown field peas (Pisum sativum L.) for growing pigs. *Journal of Animal Science.* 2004. V. 82. №9. P. 2568–2578. DOI: 10.2527/2004.8292568x.

9. Jansman A.J.M. Bioavailability of protein single gumeseeds. *Grain Legumes*, 1996. № 11. P.19.

10. Экспертиза кормов и кормовых добавок : учеб.-справ. пособие / Мотовилов К.Я. та ін. Новосибирск: Сиб. унив. изд-во, 2004. 303 с.

11. Петрухин И.В. Корма и кормовые добавки : Справочник. Москва : Росагропром-издат, 1989. 526 с.

12. Grosjean F., Bastianelli D., Bourdillon A., Cerneau P. Feeding value of pea (Pisum sativum, L.) 2. Nutritional value in the pig. Animal Science. 1998. V. 67. №3. P. 621-625. DOI: 10.1017/S1357729800033063

13. Бобков С.В., Уварова О.В. Перспектива использования гороха для производства изолятов запасных белков. *Земледелие,* 2012. С. 47–48.

14. Компанцев Д.В., Попов А.В., Привалов И.М., Степанова Э.Ф. Белковые изоляты из растительного сырья: обзор современного состояния и анализ перспектив развития технологии получения белковых изолятов из растительного сырья. *Современные проблемы науки и образования.* 2016. № 1. URL: http://www.science-education.ru/ru/article/view?id=24132.

15. Шелепина Н.В. Использование продуктов переработки зерна гороха в пищевых технологиях. *Известия ВУЗов. Прикладная химия и биотехнология*, 2016. №4, Том 6. С. 110–117.

16. Магзумова Н.В., Малиновская Е.Е., Келешян М.В. Изучение возможности применения горохового белка при производстве колбас вареной ассортиментной группы. *Харчова наука і технологія*, 2013. №2. С. 20–22.

17. Улицкий З.З. Гороховый протеин для переработчиков мяса – не только функциональная добавка. *Мясной Бизнес.* 2009. № 3. С. 22.

18. Гороховый белок, Бельгия. URL: https://agroserver.ru/b/gorokhovyy-belok-belgiya-362657.htm

19. Хрулев А.А., Бесчетникова Н.А., Федотов И.А. Тенденции развития и экономические аспекты производства горохового протеина. *Пищевая промышленность*. №4. 2016. С. 24–28.

20. Технологія виробництва премікслів / Б.В. Єгоров, О.І. Шаповаленко, А.В. Макаринська. Підручник. Київ : Центр учбової літератури, 2007. 288с.

ЕФЕКТИВНІСТЬ ВИКОРИСТАННЯ РОСЛИННОГО ГОРОХОВОГО КОНЦЕНТРАТУ В КОМБІКОРМАХ ДЛЯ МОЛОДНЯКА СВИНЕЙ

Встановлено, що введення рослинного горохового концентрату до складу комбікормів не впливає на зміну фізичних властивостей розсипних комбікормів. Біологічна оцінка, проведена на лабораторних тваринах, показала, що комбікорм з використанням рослинного горохового концентрату має високу біологічну цінність. Використання рослинного горохового концентрату в якості альтернативи дорогому джерелу протеїну – рибному борошну, сприяє підтримці швидкості росту тварин і зменшенню вартості комбікормів.

Ключові слова: *горох, якість, концентрат, екструдування, комбікорм, гороховий протеїн, амінокислота.*

ЭФФЕКТИВНОСТЬ ИСПОЛЬЗОВАНИЯ РАСТИТЕЛЬНОГО ГОРОХОВОГО КОНЦЕНТРАТА В КОМБИКОРМАХ ДЛЯ МОЛОДНЯКА СВИНЕЙ

Установлено, что введение растительного горохового концентрата в состав комбикормов не влияет на изменение физических свойств рассыпных комбикормов. Биологическая оценка, проведенная на лабораторных животных, показала, что комбикорм с использованием растительного горохового концентрата имеет высокую биологическую ценность. Использование растительного горохового концентрата в качестве альтернативы дорогому источнику протеина – рыбной муке, способствует поддержанию скорости роста животных и уменьшению стоимости комбикормов.

Ключевые слова: *горох, качество, концентрат, экструдирование, комбикорм, гороховый белок, аминокислоты.*