

THE INFLUENCE OF WALNUT KERNEL CAKE ON THE DIGESTIBILITY OF NUTRIENT SUBSTANCES FROM THE COMBINED FODDER INTENDED FOR YOUNG SOWS

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Abstract

The work presents the results of the study of the chemical composition of walnut kernel cake and its influence on productive performance, digestibility and the exchange of nutrients in young piglets. When using 4%/t of walnut cake in the feed of the sows, the cost price of 1kg of combined fodder decreased by 1,7 euro cents, an average daily increase of 613g was obtained, with the digestibility of the dry substance - 86.8%, crude protein -79.2%, crude fat - 62.3%, crude cellulose - 62.0%, organic substance - 88.4%, and when using 8%/t the cost price of 1kg of combined fodder decreased with 3,5 euro cents and the indices were 608 g - average daily gain, digestibility of dry matter - 85.4%, crude protein - 78.5%, crude fat - 69.1%, crude cellulose - 37.3%, organic matter - 87.2%.

Key words: *chemical composition, digestibility, specific consumption, walnut kernel cake, young piglets.*

INTRODUCTION

In the Republic of Moldova, is highlighted the need for efficiency of animal nutrition by using non-traditional feed resources with a pronounced nutritional effect and which can certainly reduce the cost of pork and ensure a greater benefit to pig farmers. The main challenge in intensive pork production is high productivity and efficient use of fodder (Makhaev et al., 2016). With the aim of increasing the productivity of pigs and the efficiency of fodder conversion, new ways and products are sought that would optimize the digestive processes and metabolic changes in the pigs' body (Kaisyn, 2010; Coshman et al., 2011). The organization of animal feeding must ensure the conditions for the physiological and morphological adaptation of the digestive system to the efficient use of fodder and the optimization of the microbiological processes of digestion. It is very clear the importance of identifying the requirements of the animals in nutrients and avoiding excess excretion of nutrients. Finding new solutions to increase the ecological productivity of pigs is one of the main tasks of nutrition specialists (Dinu et al., 2002). At the same time, the correct management of many wastes would allow not

only to protect the environment, but also to reduce the cost price of nutrition rations, at the same time it could lead to obtaining an economic income and partially solving the ecological problem. The practical application of new fodder sources for feeding animals requires an in-depth study of the chemical composition and nutritional value, conducting digestibility studies, studying the impact on production, blood and economic indices (Danilov & Donica, 2017; 2020). In the Republic of Moldova, in order to provide animals with protein of plant and animal origin, large quantities of soybean meal, fish meal, skimmed milk, meat and bone meal and others are imported from abroad, at high prices. Taking into account all this, the diversification and increase of the assortment of protein fodder sources for the animal husbandry sector is an ever-present problem in the Republic of Moldova. In this context, it is necessary to find new effective alternative nutritional solutions for partial, total or complementary substitution of these raw materials with new local protein sources.

Nut growing occupies a significant place in the agriculture of the Republic of Moldova because statistical data show that the annual production of nuts is on average over 4.0-4.5 thousand

tons. Currently, there are several small and medium enterprises operating in the republic kernel, using the pressing method, a walnut cake is obtained, which is not further processed, and this product is a true storehouse of vitamins, minerals, amino acids and other valuable components for animals. As with any new ingredient, there are many questions about the nutritional benefits, limitations, and utilization of nut cake in animal feed for maximum economic value.

Regrettably, in the scientific and specialized literature, the information about the use of walnut kernel cake in the structure of combined fodder recipes intended for pigs is very limited or completely missing.

Starting from the premises described, the aim of the research was: to evaluate the nutritional potential of the walnut kernel cake and to study the impact of its use in the diet of young piglets, on the digestibility of nutrients, production performance, blood and economic indices.

MATERIALS AND METHODS

The experimental part of the investigations was carried out in the conditions of the physiological laboratory of the State Enterprise for Research in the Selection and Hybridization of Pigs "Moldsuinhybrid", Orhei district, and the chemical analyzes in the laboratories of the Scientific-Practical Institute of Biotechnologies in Zootechny and Veterinary Medicine.

In the research, the following were studied: the chemical composition of walnut kernel cake, combined fodder, excrement, the digestibility of nutrients, the morphological and biochemical parameters of blood, productive and economic indices depending on the share of walnut kernel cake in the combined fodder recipes. Physiological experience of digestibility was performed according to classical methods (Ovsyannikov, 1976), for which 9 biracial sows (Yorkshire x Landrace) were selected and divided into 3 groups: a control group and two experimental groups. According to the developed scheme, the sows from the control group were fed with basic combined fodder and in the combined fodder recipe from the experimental group I, soybean meal was substituted with walnut kernel cake in

specialized in the production of walnut kernel oil. After extracting the oil from the a proportion of 4%/t of combined fodder for the sows from experimental group II, soybean meal was substituted with walnut cake in a proportion of 8%/t (Table 1).

Table 1. Scheme of experience

Lot	Animal number (n)	Average weight (kg/head)	The mode of nutrition
Control	3	61.2	BCF (recipe 1) -
Experimental I	3	60.4	ECF* (recipe 2) -
Experimental II	3	61.6	ECF* (recipe 3) -

Note: BCF = basic compound feed, ECF*= experimental compound feed

The sows benefited from identical climatic conditions and maintained in special individual boxes, with the possibility of collecting the excrement of the sows (feces, urine). The combined fodder used in the experiment was made up of native fodder raw materials, and the concentration of nutrients was in accordance with the fodder norms for young breeding pigs. Scientific research was carried out within the project: 20.80009.5107.12 "Strengthening the food-animal-production chain by using new feed resources, innovative sanitation methods and schemes" using the following methods. The nutritional value of the nut cake, the combined fodder, as well as the droppings from the digestibility experiment was assessed according to classical methods (Petukhova et al., 1989): total moisture - according to general methods by drying, crude ash - by calcination, crude protein - according to Kjeldahl, crude fat - according to Sohlet, crude cellulose - by applying the Kirchner and Ganec method, calcium by the Pamberton method and phosphorus using the method described by Perov.

The sows were selected according to classical methods (Ovsyannikov, 1976).

The development of recipes for combined fodder intended for pigs was carried out based on the nutrition norms (Kalashnisov, 2003) by using the "HYBRIMIN" computer program. The specific consumption (feed conversion) was calculated based on the fodder

administered, relative to the absolute increase in weight obtained during the record period (Petukhova et al., 1989). The digestibility of nutrients was assessed, using the calculation method, based on the data obtained about the chemical composition of the combined fodder, the amount of nutrients ingested with food and eliminated with excrement. The determination of the digestibility coefficients of the nutrients of the administered feeds was carried out according to the following formula:

$$DK = \frac{(a-b) \cdot 100}{a}$$

DKd - digestibility coefficient of nutrients

a - the amount of nutrients ingested with food

b - the amount of nutrients eliminated with excrement.

The analysis of the hematological parameters of the blood was performed using the biochemical analyzer STAT FAX-3300.

The statistical processing of the experimental data and the testing of the significance of the differences was carried out using the computer program EXCEL, using the classical methods (Plokhinsky, 1978).

RESULTS AND DISCUSSIONS

Preliminary investigations have shown that almost all the initial components of the walnut kernel can be found in the walnut kernel cake and the nutritional value can basically be described as raw material quite rich or dense in crude proteins and fats together with some minerals. It has been established that, depending on the thermal regime and the processing technology, the walnut kernel cake has a color variation from gray to dark brown, it is made up of pieces or powder of different sizes, without the presence of impurities, foreign particles and mold, it has a characteristic smell of walnut kernel and a bittersweet taste. The analysis of the chemical composition of the walnut kernel cake obtained by cold pressing showed that it contains: dry substance - 90.11%; nitrogen - 5.51%; crude protein - 344.5 g/kg; digestible protein - 306.6 g/kg; nutritional units - 1.29; crude cellulose - 62.69 g/kg; fats - 133.9 g/kg; metabolizable energy - 15.30 Mj/kg; calcium - 0.27% and phosphorus - 0.71%. The analysis of the quality characteristics and the chemical composition of

the walnut kernel cake and the soybean meal highlights qualitative and quantitative differences of the walnut kernel cake, especially regarding the majority content of fats 133.90 g/kg compared to 78.6 g/kg times higher by 55.3 g/kg and minority of raw cellulose 62.69 g/kg compared to 76.10 g/kg or less by 13.4 g/kg.

Under the conditions of the combined fodder production section of State Enterprise "Moldsuinhybrid", using local ingredients, the experimental batches of combined fodder were prepared for the entire period of the experience according to the recipes in Table 2.

Table 2. Structure of compound fodder recipes

Ingredients	Group		
	Control	Experimental I	Experimental II
Maize	22.3	22.3	22.3
Barley	38.7	38.7	38.7
Wheat	24.6	24.6	24.6
Soybean meal	12.0	8.0	4.0
Walnut kernel cake	-	4.0	8.0
Chalk	1.0	1.0	1.0
Salt	0.4	0.4	0.4
Premix	1.0	1.0	1.0
Total	100	100	100

The data of the analysis of the chemical composition of the combined fodder used in the experiment showed that its nutritional value was: 14.6; 14.05; 13.94% crude protein, 11.90; 11.86; 11.85 Mj/kg metabolizable energy, crude fat 3.82; 3.62; 3.59%, crude cellulose 4.54; 4.48; 4.17%, non-nitrogenous extractives 70.14; 70.26; 70.63%, calcium 0.64; 0.70; 0.61% in absolute dry substance, which is within the limits of nutrition norms (Kalashnisov et al., 2003).

During the physiological digestibility experiment, the cost of 1 kg of combined fodder used in the control group was 30.1, in experimental group I - 28.4, experimental group II - 26.6 euro cents.

The results of the physiological experiment demonstrated that the replacement of soybean meal with walnut kernel cake in different proportions did not essentially influence the appetite and the intake of combined fodder during the actual experimental period. The average daily intake recorded during the

physiological experience of digestibility was: 2,019 kg, 2,210 kg and 2,011 kg corresponding to the groups (Table 3).

Evidence of the amount of feed consumed and excreta showed that the sows whose feed was supplemented with walnut cake in a proportion

Table 3. Ingest and excrete (medium/head)

Indices	Group		
	Control	Experimental I	Experimental II
Total ingestion, g	16152±81.171	17680±811.832	16088±1001.141
Average intake, g/day	2019±10.271	2210±101.479	2011±137.642
Total excretion, g	8373±487.584	7755±230.639	8525±541.119
Average excretion, g/day	1047±60.948	969±28.829	1066 ± 67.639
Total urine, ml	16394±2282.499	14610±4502.832	9585±1344.337
Urine, ml/day	2049±285.312	1826±562.854	1210±168.042

of 4%/t had a higher intake of combined fodder with 191 g and the proportion of 8%/t, provided an average daily intake of 8 g lower than that of the animals in the control group. At the same time, it was observed that the excreta was in larger quantities in the control and experimental group II, being respectively 1,047 kg/day and 1,066 kg/day. During the experimental period, a decrease in the amount of urine eliminated was observed at the sows from the experimental groups compared to the sows from the control group. At the beginning of the leveling period, the selected sows had very similar body masses, being on average: 60.4-61.6 kg and at the beginning of the record period of 63-64 kg. After processing the data of the digestibility test (Table 4) we found that the average values recorded for the evolution of body weight, achieved by the sows from the

two experimental groups, indicate a superiority compared to those from the control group. The data of the absolute and average daily increase obtained during the record period showed that the animals whose combined fodder was supplemented with walnut cake at the level of 4%/t of combined fodder (recipe 2) achieved an increase daily average amounting to 613 g being with 21 g higher, while the proportion of 8%/t (recipe 3) of 608 g times with 16 g higher than the sows in the control group. Sows from the experimental groups exceeded the control group according to this index by 3.55% and 2.70%, respectively. The best feed conversion index (kg combined fodder/kg weight gain) had the sows of the experimental group II which was lower than in the control group by 2.93%.

Table 4. Livestock dynamics and weight gain

Indices		Group		
		Control	Experimental I	Experimental II
Spore Live weight	at the beginning of the preceding period, kg	61.2±0.648	60.4±0.869	61.6±0.552
	at the beginning of the record period, kg	63.20±0.648	63.53±0.511	64.17±0.715
	at the end of the experience, kg	67.93±0.804	68.43±0.502	69.03±0.708
Spore Live weight	absolute, kg	4.733±0.163	4.900±0.308	4.867±0.108
	daily average, g	592±20.412	613±38.527	608±13.501
Feed conversion, kg fodder/kg weight gain, kg		3.41	3.61	3.31

The data on the evidence of ingestion and excretion, as well as the results of their chemical analyzes served as the basis for calculating the digestibility coefficients of the nutrients in the administered rations (Table 5; Figure 1). From the statistical processing of the data, a general trend of insignificant increase of these indices in the experimental groups is observed. The obtained results confirm that the

animals of the experimental group I showed a higher dry matter digestibility than those of the control group by 1.98% and those of the experimental group II by 0.57%. A better protein digestibility was established at the sows from experimental group I, where it was by 2.09% higher than in the control group. At the same time, a lower fat digestibility was established in this group by 3.75% and in

experimental group II this index was by 3.53% higher than in the control group. The digestibility test showed that the supplementation of the combined fodder with

walnut kernel cake at the level of 4%/t favored a better digestibility of the raw cellulose, at a level of 62% or by 8.6% higher than at the sows from the control group.

Table 5. Digestibility of nutritional substances in experience, %

Indices	Group		
	Control	Experimental I	Experimental II
Dry substance	84.82±1.320	86.80±0.572	85.39±0.214
Azote	77.14±1.141	79.23±1.189	78.52±0.891
Crude protein	77.09±1.470	79.33±1.276	78.52±0.855
Crude fat	66.08±6.363	62.33±3.744	69.61±1.388
Crude cellulose	53.42±4.450	62.04±3.744	37.27±4.231
Ash	42.38±3.872	52.62±2.048	47.72±0.802
NNES	91.72±0.743	*93.15±0.210	92.58±0.150
Organic substance	86.76±1.204	88.40±0.510	87.24±0.185

Note: NNES = non-nitrogen extractive substances; *P<0.01

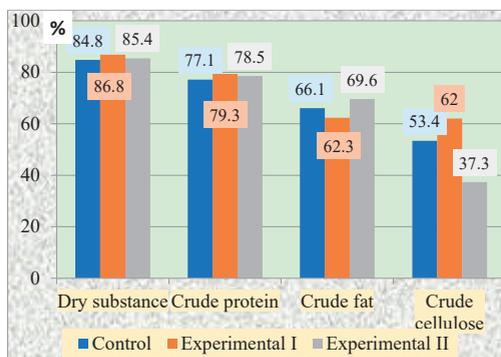


Figure 1. Digestibility of nutrients

From the group of organic substances, pigs make good use of non-nitrogenous extractive substances and in our research their digestibility was at a fairly high level with indices of: 91.72% in the control group and 93.15% the one that was with 1.43% (p<0.01)

and respectively 92.58% with 0.86% more than the control group.

The digestibility of the organic substance in the experimental groups was 1.64% and 0.48% higher than at the sows from the control group.

The data on the evolution of the daily nitrogen balance prove that the sows in the experimental groups showed the best use of nitrogen both from the intake and from the digest. More nitrogen was ingested daily in experimental group I, being at the level of 43.32g, or by 6.75% more than in the control group.

The nitrogen balance was positive in all groups of animals, at the same time, by the sows from the experimental groups, more nitrogen was deposited from the ingested one, respectively by 3.64% and 7.01% (P<0.05) compared to this index at the sows from the control group (Table 6).

Table 6. Daily nitrogen balance in digestibility experience

Indices	Group		
	Control	Experimental I	Experimental II
Fed up with the fodder, g	40.58±0.206	43.32±1.989	39.21±2.683
Eliminated in faeces, g	9.27±0.544	9.02±0.856	8.39±0.254
Digested, g	31.31±0.732	34.29±1.307	30.82±2.442
Eliminated in the urine, g	5.04±0.724	4.68±1.298	2.65±0.609
Stored in the body, g	26.26±0.893	29.62±2.201	28.17±2.445
Stored in the body, %			
From the fed up amount	64.72±0.290	68.36±3.886	*71.73±2.115
From the digested amount	83.95±1.906	86.24±4.001	**91.34±2.088

Note: *P<0.05; **P<0.10

It was determined that the sows from the experimental groups showed the best use of nitrogen from the digested, being higher by

2.29% and 7.39% (P<0.10) compared to the control group. The percentage of nitrogen utilization from the ingested as well as the

digested in the group fed with recipe 3 indicated statistically guaranteed values ($P<0.05$; $P<0.10$). The mineral balance data (Table 7; Figure 2) show us that the calcium intake at animals from experimental group I was higher by 2.60 g ($p<0.01$) and

experimental group II by 2.34 g compared to the control group. The assimilation of calcium from the digested one was by 1.79% higher in the experimental group I and 3.82% in the experimental group II than at the sows from the control group.

Table 7. Calcium utilization in the physiological experience of digestibility

Indices	Group		
	Control	Experimental I	Experimental II
Fed up with the fodder, g	13.53±0.069	*16.13±0.741	15.87±0.881
Eliminated in faeces, g	5.61±0.404	6.23±1.806	8.33±0.760
Digested, g	7.92±0.466	9.90±2.068	7.54±0.044
Eliminated in the urine, g	4.42±0.732	5.55±1.867	3.92±0.777
Stored in the body, g	3.50±1.166	4.36±0.203	3.62±0.596
Stored in the body, g, %			
From the fed up amount	25.87±1.191	27.03±1.362	22.81±1.439
From the digested amount	44.19±8.461	45.98±7.226	48.01±3.938

Note: * $P<0.01$

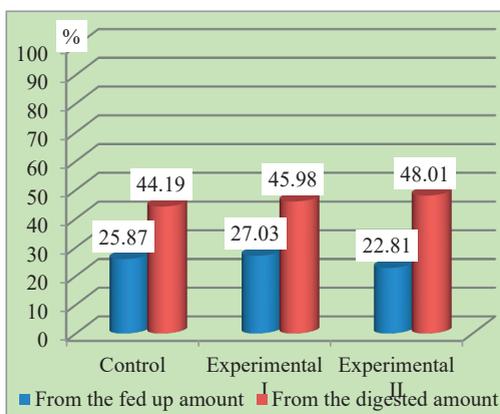


Figure 2. Calcium balance in experience

In the experimental groups, phosphorus, as a component of mineral metabolism, was eliminated from the body with fecal masses by 0.39 g and 0.66 g ($P<0.005$) more than by the sows from the control group. The use of walnut

kernel cake in different proportions of the combined fodder recipes intended for sows did not have a negative impact on the blood morphological and biochemical profile. The results of the analyzes of the blood biochemical indices at the beginning and end of the experimental period demonstrated that all the animals were healthy and the blood indices did not show essential changes between the groups and were characterized by average values of the limits of the physiological norms for this category of animals (Table 8). According to the results obtained at the end of the experiment, improvements in protein and mineral metabolism were observed at animals from all groups. An increase in the content of proteins and albumins in the blood was reported at animals from all groups compared to the indices obtained at the beginning of the experiment (Figure 3).

Table 8. Average values of hematological indices at the end of the experiment

Indices	Unit of measure	Norm	Lot		
			Control	Experimental I	Experimental II
Hemoglobin	g/l	90-130	132.51±13.611	139.97±26.345	132.46±14.162
Erythrocytes	$\times 10^{12}$ g/l	5-7	7.2±1.435	8.233±1.096	7.667±0.852
Leucocyte	$\times 10^9$ g/l	11-22	8.4±0.787	8.70±1.812	10.10±1.412
ESR*	mm/oră	1.0-9.0	5.00±0.707	7.00±0.707	6.00±1.414
Lymphocytes	$\times 10^9$ g/l	35-75	63.67±3.894	71.33±2.483	68.00±5.612
Eosinophils	%	0-15	14.0±2.549	9.0±2.121	8.67±3.559
Unsegmented neutrophils	%	20-70	11.67±2.549	11.66±0.816	12.0±1.414
Segmented neutrophils	%	4-8	10.67±3.189	8.00±0.707	11.33±2.041

Note: * ESR- erythrocyte sedimentation rate.

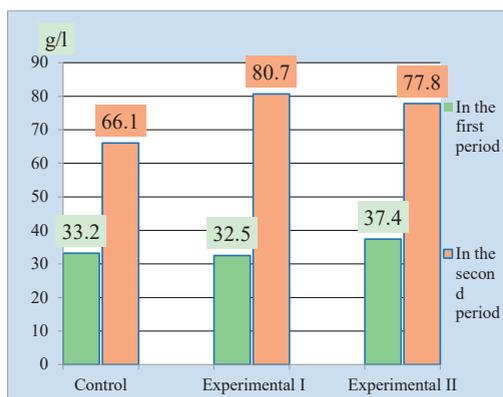


Figure 3. The amount of protein blood serum

The results of the biochemical analyzes of the blood serum showed that, at the end of the digestibility experiment, the total protein content was by 22.1% ($P < 0.10$) and 17.7% higher than in the control group. It was found that the albumin content in the blood serum at animals from all groups had close values, being at the level of 35.1; 28.5 and 35.5 g/l, respectively.

We find that the amount of blood creatinine at the end of the experiment was maintained in the range of 212; 193; 168 mmol/l corresponding to the groups, which fell within the limits of the reference values (70-208 mmol/l).

In our investigations, the level of uric acid was important, an important marker of the efficiency of the use of protein from food, which was in the range of 3.83 mol/l, 6.67 mol/l ($P < 0.10$) and 5.20 mol/l, this fell within the limits of admissible norms (2.8-8.8 mmol/l).

The investigated dynamics of serum alkaline phosphatase revealed average values of 144.85 u/l; 130.83 u/l and 148.20 u/l, which fell within the limits of physiological norms (41-176 u/l).

We consider that, due to the organoleptic qualities and the rich content of natural proteins, fats, mineral substances and the effect on growth and development, the walnut kernel cake can represent a viable solution to partially replace soybean meal in combined fodder recipes intended for sows.

CONCLUSIONS

It was found that the walnut kernel cake (obtained by cold pressing), has a color

variation from gray to dark brown, is made up of pieces or powder of different sizes, without the presence of impurities, foreign particles and mold, has a specific smell of walnut kernels and a bittersweet taste. The nutritive value of the walnut cake used in this study was: dry matter - 90.11%; nitrogen - 5.51%; crude protein - 344.5 g/kg; digestible protein - 306.6 g/kg; nutritional units - 1.29; crude cellulose - 62.69 g/kg; fats -133.9 g/kg; metabolizable energy - 15.30 Mj/kg; calcium - 0.27% and phosphorus - 0.71%, and due to the organoleptic qualities and the rich content of natural proteins, fats, minerals and the low content of crude cellulose, can represent a viable solution for partial replacement of soybean meal in recipes of combined fodder intended for sows.

The results of the hematological investigations of the blood at the beginning and end of the digestibility test showed that the blood indices were within the limits of the reference norms. It was determined that the average daily growth rate was consistent with the digestibility of protein, cellulose and the balance of nitrogen, calcium and phosphorus in the ration.

The use in the feed of sows of walnut cake in the amount of 4%/t reduces the cost price of 1kg of combined fodder by 1.7 euro cents, ensures an average daily gain of 613 g, with digestibility of dry matter - 86.8%, crude protein - 79.3%, crude fat 62.3%, crude cellulose - 62.0%, organic substance - 88.4%, and the use of 8%/t reduces the cost price of 1kg of combined fodder with 3.5 euro cents, provides an average daily gain of 608 g, with digestibility of dry matter - 85.4%, crude protein -78.5%, crude fat - 69.1%, crude cellulose - 37.3%, organic matter - 87.2%.

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