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INFLUENCE OF WALNUT FEEDING ON PRODUCTIVITY, MORPHOLOGICAL COMPOSITION OF CARCASSES AND QUALITY OF MEAT AND FAT PRODUCTS OBTAINED FROM MIRGOROD PIGS

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The study was conducted in the conditions of the scientific and economic Department of the Institute of pig breeding and agro-industrial production of the National Academy of Sciences of Ukraine in order to establish the impact of feeding walnuts on the productive qualities, morphological composition of carcasses and the quality of meat and fat products of pigs of the revived mirgorod breed.

The results of the experiment show that the introduction of walnuts into the diet of fattening young animals contributed to an increase in the intensity of growth and development of animals. The average daily live weight gain in pigs of the experimental groups exceeded the indicators of the control group by 2.75% and 6.91%, respectively. At the same time, there was an improvement in feed conversion, which indicates an increase in the efficiency of nutrient use. With almost the same pre-slaughter live weight, the slaughter yield in experimental animals was higher by 1.40% and 3.92% compared to the control. The length of pig carcasses in the experimental groups exceeded the control indicators by 1.57% and 1.64 %, while the thickness of lard was less by 5.48% and 8.45 % ($p < 0.05$), which indicates the formation of a more meat-like type of carcass. The area of the "muscle eye" in pigs of the experimental groups exceeded the control by 1.1 mm and 2.1 mm, which reflects a tendency to increase the proportion of muscle tissue in the carcass structure. Thus, the use of walnuts in feeding contributes to a more intensive growth of muscle mass, which is the most valuable component of slaughter products. It was found that in pigs that consumed nuts, the content of intramuscular fat significantly exceeded the control values — by 0.26 % ($p=0.05$) and 0.5 % ($p=0.05$), which positively affects the taste properties of meat. The results of organoleptic analysis showed that the broth obtained from pig meat of the experimental groups had better indicators in appearance, aroma and richness of taste. This indicates the expediency of using walnuts as a natural feed additive to improve the organoleptic properties of meat and lard products. The revealed changes in the biochemical composition of meat indicate the possible influence of walnut components on metabolic processes in muscle tissue, in particular on the state of the pro-oxidant-antioxidant system of the animal body. Feeding walnuts to pigs of the revived mirgorod breed has a positive effect on their productivity, morphological indicators of carcasses and the quality of meat and fat products. The results obtained give grounds to recommend the use of walnuts as a feed additive in the diets of fattening young animals in order to increase the biological and consumer value of meat products.

Keywords: Walnut, mirgorod pig breed, productivity, morphological composition of carcasses, quality of meat and fat products, biochemical indicators

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ВПЛИВ ЗГОДОВУВАННЯ ГОРІХУ ВОЛОСЬКОГО НА ПРОДУКТИВНІСТЬ, МОРФОЛОГІЧНИЙ СКЛАД ТУШ ТА ЯКІСТЬ М'ЯСО-САЛЬНОЇ ПРОДУКЦІЇ ОТРИМАНОЇ ВІД СВИНЕЙ МИРГОРОДСЬКОЇ ПОРОДИ

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Дослідження проведено в умовах науково-господарського відділу Інституту свинарства і агропромислового виробництва НААН України з метою встановлення впливу згодовування волоського горіха на продуктивні якості, морфологічний склад туш та якість м'ясо-сальної продукції свиней відроджуваної миргородської породи.

Результати експерименту свідчать, що введення волоського горіха до раціону відгодівельного молодняку сприяло підвищенню інтенсивності росту та розвитку тварин. Середньодобові прирости живої маси у свиней дослідних груп перевищували показники контрольної групи відповідно на 2,75 % та 6,91 %. При цьому спостерігалося поліпшення конверсії корму, що вказує на підвищення ефективності використання поживних речовин. За практично однакової передзабійної живої маси забійний вихід у дослідних тварин був вищим на 1,40 % та 3,92 % порівняно з контролем. Довжина туш свиней дослідних груп перевищувала контрольні показники на 1,57 % та 1,64 %, тоді як товщина шпику була меншою на 5,48 % та 8,45 % (P < 0,05), що свідчить про формування більш м'ясного типу туші. Площа «м'язового вічка» у свиней дослідних груп перевищувала контроль на 1,1 мм та 2,1 мм, що відображає тенденцію до збільшення частки м'язової тканини у структурі туші. Таким чином, застосування волоського горіха у годівлі сприяє інтенсивнішому росту м'язової маси, яка є найбільш цінною складовою продукції забою. Встановлено, що у свиней, які споживали горіхи, вміст внутрішньом'язового жиру достовірно перевищував контрольні значення — на 0,26 % (p=0,05) та 0,5 % (p=0,05), що позитивно впливає на смакові властивості м'яса. Результати органолептичного аналізу засвідчили, що бульйон, отриманий із м'яса свиней дослідних груп, мав кращі показники за зовнішнім виглядом, ароматом та насиченістю смаку. Це вказує на доцільність використання волоського горіха як природної кормової добавки для покращення органолептичних властивостей м'ясо-сальної продукції. Виявлені зміни у біохімічному складі м'яса свідчать про можливий вплив компонентів волоського горіха на метаболічні процеси у м'язовій тканині, зокрема на стан прооксидантно-антиоксидантної системи організму тварин. Згодовування волоського горіха свиням відроджуваної миргородської породи позитивно впливає на їх продуктивність, морфологічні показники туш та якість м'ясо-сальної продукції. Отримані результати дають підстави рекомендувати використання волоського горіха як кормової добавки у раціонах відгодівельного молодняку з метою підвищення біологічної та споживчої цінності м'ясної продукції.

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Ключові слова: горіх волоський, миргородська порода свиней, продуктивність, морфологічний склад туш, якість м'ясо-сальної продукції, біохімічні показники.

In recent years, consumer interest in the relationship between nutrition and health has increased the demand for high-quality food products (Chernaya N. P., 2016).

It is known that technological aspects of feeding and feeding animals can affect the quality of meat. Thus, with the help of a diet, we can change the quality of an animal product, which has a positive impact on the health of consumers. But at the same time, meat quality is a complex and multifactorial phenomenon, which is influenced by factors such as breed, genotype, feeding, pre-slaughter processing, stun and slaughter method, cooling and storage conditions (Chalaya O. S. 2015).

Since pigs are animals with a single-chamber stomach, they directly absorb the fats they consume (fatty acids). This means that the diet is responsible for the composition of fatty acids in their adipose tissue (Cho, J. H., & Kim, I. H., 2012). The diet is more important for the fatty acid composition of subcutaneous fat than for intramuscular fat, since the latter consists mainly of phospholipids. The composition of fatty acids is important for the resistance of fats to oxidation. The nature of fat hydrolysis and oxidation strongly affects the organoleptic characteristics of dried ham. Although unsaturated fatty acids are important precursors of aromatic compounds, it is desirable to have a higher proportion of NLCS in raw Ham, which are less susceptible to oxidation, in order to avoid problems associated with bitterness, oiliness and soft texture (Wood, J. D., 2008; Vossen, E., 2017; Schumacher, M. et al. 2022).

The feeding strategy can affect the formation of adipose tissue. Limiting feeding reduces the deposition of fat in the body, and also increases the proportion of unsaturated fatty acids. A high-protein diet has been shown to reduce the amount of intramuscular fat, while a low-protein/high-energy diet or a moderately low-calorie and protein diet has been shown to increase the content of intramuscular fat itself (Pugliese, C., & Sirtori, F., 2012; V. V. Bondarenko, V. A. Glavatchuk, 2021).

The feeding strategy affects not only the amount and composition of fat, but may also be important for proteolytic activity due to its effect on protein metabolism and, consequently, growth rate. Therefore, for the production of raw meat products, especially in the case of a long maturation process, it is desirable to use pigs with a slower growth rate and, consequently, with less intensive protein metabolism (which also means lower proteolytic activity). Such breeds, as a rule, are old greasy and meat-greasy breeds of pigs equipped with special protection. In Ukraine, a similar breed is the Mirgorod pig breed. Mirgorod breed according to the instructions for boniting pigs (2003) belongs to the third group of breeds, was created as a breed of fat productivity with a high fat content in carcasses. Therefore, pigs of the modern mirgorod breed also have a larger fat thickness compared to meat breeds. The mirgorod pig breed should also be associated with the production of a certain niche product, taking into account the high taste qualities of meat and fat products (Škorput, D., 2024; Szulc, K., 2024; Kušec, I. D., 2021; Tserenyuk, O. M. 2024; Tsybenko, V. G., & Vashchenko, P. A. 2022).

Feeding starch-rich foods, such as Acorns or chestnuts, to pigs of breeds with low muscle growth potential, such as Iberian, turopol or mirgorod, leads to relatively rapid development of adipose tissue and the deposition of large amounts of lipids under the skin and/or between the muscles. The properties of free-range pork are also improved, as many unique compounds such as fatty acids and antioxidants derived from acorns, chestnuts, nuts, grass and other natural feeds that pigs extract directly in forests and meadows are absorbed and stored in adipose and other tissues. The quantity and quality

of these fat deposits are considered important indicators of improving the suitability of pork for dry-dried processing and the final quality of the product in terms of its analytical and organoleptic properties. (Sarmiento-García, Ainhoa, 2023; Tomažin, U., 2020).

In a study, feeding acorns to fattened pigs (2 kg per head per day) as part of a mixed diet resulted in less weight loss during Ham processing and a higher yield of dried product, as well as a decrease in protein content and a higher proteolysis index in hams made from meat from pigs fattened with Acorns. This result may be due to a lower protein content (2.5% in Acorns versus 15% in the control grain feed, respectively) and a high starch content in Acorns (20.7%), which may contribute to deposition and increased adipose tissue thickness, which reduces losses from dehydration during Ham processing. Indeed, the thickness of lard in pigs treated with acorns in this study was higher than in the control group (on average, 43.1±6.8 mm vs. 38.6±5.9 mm). However, the intramuscular fat content, a trait that is positively associated with the juiciness of the product and consumer preferences, did not increase with the acorn diet (Tomažin, U., 2020).

Walnut kernels contain up to 65-75% essential oil, amino acids, vitamin E, carotene, vitamin C, K, Ca, Mg, S, P. The predominant fatty acid of walnut oil is linoleic polyunsaturated fatty acid, which makes up 54.64% of all the acids that make up its composition, followed by oleic monounsaturated fatty acid (28.72%). Nut kernels also contain yuglon (11.75 ± 2.60 mg/100 g), iron (5.1 ± 1.3 mg/100 g), zinc (3.2 ± 0.9 mg/100 g), copper (1.0 ± 0.26 mg/100 g), manganese (3.9 ± 1.1 mg/100 g), nickel (0.21 ± 0.08 mg/100 g), cobalt (7.5 ± 2.5 MCG/100 g), chromium (7.0 ± 0.88 MCG/100 g). In addition, the plant is rich in fluoride salts (Amit Gupta, 2019; Nisha Panth, 2016). The Walnut kernel contains a fairly high content of folate and vitamin E, which can contribute to the production of high-quality meat products. Walnut oil contains quite little saturated (SFA) fatty acids – 8-9 %, monounsaturated (MUFA) fatty acids contain 15-20 %. However, polyunsaturated fatty acids (PUFA) contain an average of more than 70 %. However, the fatty acid composition of nuts can vary quite significantly depending on the variety and place of cultivation, SFA 8.8 – 9.9%, MUFA 15-21%, 69-75 % (Pereira, J.A., 2008; Muradoglu, F., 2010; Gao, P., 2018).

This is especially important given that the possibility of free grazing using Acorns and chestnuts is limited by the spread of ASF, which can be spread by wild pigs (Dubrovna A. A. 2023.).

In connection with all the above, the purpose of our research was to study the effect of feeding walnuts on the productivity, morphological composition of carcasses and the quality of meat and fat products obtained from pigs of the Mirgorod breed in order to further obtain a high-quality meat product.

Materials and methods of research. In the conditions of the scientific and economic Department of the Institute of pig breeding and APV Naas, a study was conducted to study the effect of feeding walnuts on the quality of meat and fat products obtained from pigs of the revived Mirgorod pig breed in order to further obtain a high-quality meat product.

The studies were conducted in accordance with the international principles of the European Convention for the protection of vertebrates used for experiments and other scientific purposes[iii] and in accordance with Directive 2010/63/EU of the European

[iii] European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (ETS No. 123) (Strasbourg, 18.03.1986). Verkhovna Rada Ukrainy: zakonodavstvo Ukrainy [Official site of Verkhovna Rada of Ukraine: Legislation of Ukraine]. Retrieved from https://zakon.rada.gov.ua/laws/show/994_137#Text [in Ukrainian].

Parliament and of the Council of the European Union of 22 September 2010 on the protection of animals used for scientific purposes[iv] .

To conduct the research, three groups of mirgorod pigs of 20 heads each were formed.

Pigs were kept in Group machines of 5 heads, with free access to feed and water. During the period of raising pigs, the state of their health, the intensity of growth and development were monitored. The growth rate of experimental livestock was determined by monthly individual weighing and calculating absolute and average daily increments (ed. by I. I. Ibatullin, O. M. Zhukorsky 2017; ed. by O. I. Sobolev 2022).

Table 1

General scheme of the experiment

Experimental groups	feeding conditions for experimental pigs	number of animals
Control	basic ration (or) (BR)	20
W1	OP + 10 % unpeeled nuts	20
W2	OP + 20 % unpeeled nuts	20

Note. W – Walnuts

Since the farm where the research was conducted uses feeding pigs with dry mixed feed using a troso-washer Feed distribution system, and water is supplied from teat drinkers, the corresponding suspension of unpeeled nuts was added to the feeders after the distribution of the main feed feed.

The formula of mixed feed for feeding young pigs contained the following components (by weight): barley turf – 35 %, corn turf – 52 %, sunflower cake – 10 %, BMVD – 2 %, chalk – 1.0 %. Taking into account the live weight of animals, feeding rations were compiled for each of them, which ensured the maximum level of mixed feed consumption (Ibatullin I. I. et al., 2016, NRC, 2012). The chemical composition and nutritional value of the Walnut kernel used in the studies are shown in Table 2. (Sinitsyn O. S., Zinoviev S. G., 2025).

Table 2

Chemical composition and energy value of the Walnut kernel used in the study, X ± SX

Moisture, %	Crude protein, %	Crude fat, %	Carbohydrates, %	crude ash, %	energy value (kcal)
4,07 ± 0,03	15,65 ± 0,22	72,14 ± 0,27	3,88 ± 0,10	4,23 ± 0,02	727,4

To study the meat productivity of experimental pigs after they reached a live weight of 100 kg, a control slaughter of 5 heads from each group was carried out, followed

[iv] Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes (Text with EEA relevance). Official Journal of the European Union. 2010. L 276/33. Retrieved from https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:276:0033:0079:en:PDF

by boning, analysis of the morphological composition of carcasses and some chemical and biochemical parameters of muscle tissue. For physical, chemical and biochemical studies of muscle and adipose tissue, samples of the longest back muscle and subcutaneous fat between 9-12 thoracic vertebrae were taken after 48-hour maturation of half-carcasses, in the amount of 400 g of muscle tissue and 200 g of subcutaneous fat (edited by I. I. Ibatullin, a.m. Zhukorsky 2017; edited by O. I. Sobolev 2022).

Based on the results of the assessment of fattening and meat characteristics, an evaluation index (B. Tyler index) was used for their complex characteristics, which has the following structure:

$$I = 100 + (242 \times K) – (4.13 \times L),$$

where I is the complex index of fattening and meat qualities; K is the average daily gain, kg; L is the thickness of lard at the level of 6-7 thoracic vertebrae, mm; 242; 4.13 are constant coefficients (Grishina L. P., 2019. Ladyka V. I., 2023).

Determination of the quality of meat and lard was carried out in accordance with DSTU ISO 2917-2001[v] , DSTU ISO 1442:2005[vi] ; DSTU ISO 1443:2005[vii] ; DSTU ISO 937:2005[viii] , DSTU ISO 936:2008[ix] ; DSTU ISO 2294:2005[x] and guidelines for the use of methods of biochemical studies of biological material in state laboratories of Veterinary Medicine in the diagnosis of diseases of non-infectious pathology.[xi]

Organoleptic studies were conducted in accordance with DSTU 7992:2015[xii] , DSTU 4823.1:2007[xiii] , DSTU 4823.2:2007 [xiv]. Biochemical studies of meat were carried out according to the methods described in the following sources (Yancheva M. A., 2009;

[v] DSTU ISO 2917-2001 Meat and meat products. Determination of pH (reference method) (ISO 2917:1974, IDT)

[vi] DSTU ISO 1442:2005 Meat and meat products. Method for determination of moisture content (test method) (ISO 1442:1997, IDT)

[vii] DSTU ISO 1443:2005 Meat and meat products. Method for determination of total fat content (ISO 1443:1973, IDT)

[viii] DSTU ISO 937:2005 Meat and meat products. Determination of nitrogen content (control method)

[ix] DSTU ISO 936:2008 Meat and meat products. Method for determination of the mass fraction of total ash

[x] DSTU ISO 2294:2005 Meat and meat products. Method for determination of total phosphorus (reference method)

[xi] Guidelines for the use of methods of biochemical studies of biological material in state laboratories of Veterinary Medicine in the diagnosis of diseases of non-infectious pathology. / Approved by the State Department of Veterinary Medicine on July 3, 2000.

[xii] DSTU 7992:2015 Meat and meat raw materials. Methods of sampling and organoleptic evaluation of freshness

[xiii] DSTU 4823.1:2007 Meat products. Organoleptic evaluation of quality indicators. Part 1: Terms and definitions. With Amendment (IPS No. 11-2011)

[xiv] DSTU 4823.2:2007 Meat products. Organoleptic evaluation of quality indicators. Part 2. General requirements. Amended

edited by Kaidashev I. P., 1996; utility model Patent No. 112608[xv], utility model Patent No. 115101[xvi] , Vlezlo V. V. , 2012; AOAC 2023).

Statistical processing of the obtained data was carried out using Microsoft Exel 365 and Statistica 12.0 programs, having previously checked the normality of their distribution over W using the Shapiro-Wilk test and the Liliefors test. Such indicators of descriptive statistics as: mean and its error ($X \pm S_X$), confidence interval (95% CI), standard deviation (S) and coefficient of variation (Cv) for the sample were calculated. The probability of difference (P) was calculated using the analysis of variance (ANOVA) and the Tukey posterior criterion (Glantz S.A., 2012.).

The following designations are used in the text of the article * - $p < 0.05$, * * - $p < 0.01$, *** – 0,001.

Research results. The use of nuts in feeding fattening young pigs had a positive effect on the intensity of their growth and development. The average daily growth of young animals of the experimental groups exceeded the productivity level of analogues of the control group of 2.75% and 6.91 % ($p < 0.05$), respectively, for the first and second experimental groups (Table 3). Feed conversion in the animals of the study groups was also better.

Table 3

Effect of nut feeding on average daily gains and conversion of animal feed, $X \pm S_X$

Animal groups	average daily weight gain for the fattening period, G	feed conversion, kg / kg of weight gain
Control	768,3±35,2	2,75±0,15
W1	789,4±23,7	2,65±0,14
W2	821,4±35,2*	2,60±0,13

The results of the control slaughter indicate a positive effect of adding nuts to the diets of animals (table. 4) on fattening and meat qualities, which is largely due to the intensity of their growth.

Thus, in groups of pigs whose diets nuts were added, higher growth energy was noted during fattening, and slaughter rates were better. With almost the same pre-slaughter live weight, the slaughter yield in pigs of the experimental groups was 1.40% and 3.92% higher than in animals of the control group. It should be noted that the length of carcasses in pigs of the experimental groups compared to the control group was 1.57% and 1.64% longer, and the thickness of lard was 5.48% and 8.45% less ($p < 0.05$).

Data on the morphological composition of carcasses indicate that the introduction of nuts into the diet of pigs generally had a positive effect on the ratio of edible and inedible parts of pig carcasses.

[xv] Shostya AM, Kanyuka OY, Zinoviev SG, Tsybenko VG. Method for determining the content of histidine-containing dipeptides in meat and meat products. Utility model patent UA 112608 U for 26.12.2016, Bulletin No. 14

[xvi] Shostia A.M., Kanyuka O.Y., Zinoviev S.G. Tsybenko V.G. Method for determining the content of total cholesterol in meat, eggs and other livestock products. Patent for utility model No. 115101 of 10.04.2017, bulletin No. 7

Table 4

Slaughter and meat qualities of pigs of experimental groups, X ± Sx

Indicator	Group		
	К	W1	W2
Pre-slaughter weight, kg	101,50±0,78	102,50±0,54	102,00±0,54
Weight of the paired carcass, kg	66,85±0,71	68,45±0,54	69,81±0,53
Killer output, %	65,86±0,34	66,78±0,18	68,44±0,19
Weight of chilled carcass, kg	65,18±0,71	66,94±0,55	68,48±0,56
Cooling losses, kg	1,67±0,08	1,51±0,08	1,33±0,06
Cooling losses, %	2,5±0,16	2,2±0,12	1,9±0,11
Lard thickness, mm	38,50±0,87	36,50±0,54*	35,50±0,49*
Area of the "muscle eye", cm^2	64,8±2,38	65,9±2,23	66,9±2,34
Weight of internal fat, kg	2,55±0,14	2,50±0,14	2,47 ±0,14
Internal fat output, %	2,51±0,12	2,45±0,15	2,42±0,15
Carcass length, CM	98,15±0,65	99,72±0,63	99,76±0,63
Meat weight, kg	39,42±0,67	40,42±0,41	40,56±0,47
Meat yield, %	59,28±0,50	60,58±0,20*	60,70±0,20*
Fat weight, kg	17,25±0,22	16,57±0,05*	16,48±0,05*
Fat output, %	25,94±0,52	24,84±0,21	24,65±0,22
B. Tyler index, points	126,93	140,28	152,16

The amount of meat in carcasses was: in the control group 59.28 %, and in the experimental group 60.58% and 60.70 %, which is 1.30% and 1.42% more, respectively (P<0.05). At the same time, the fat content in pig carcasses of experimental groups was lower by 1.10% and 1.29%, respectively. The area of the "muscle eye", which characterizes the meat content of carcasses, in pigs of the experimental group exceeded the control ones by 1.1 mm and 2.1 mm. Thus, in animals of the experimental group, there is a more intense increase in carcass mass due to its most valuable part - muscle tissue.

As a result of studies, it was found that the use of nuts in pig feeding significantly improves the tenderness of meat by 9.27 % (p=0.05) and by 16.23 % (p=0.01), moisture retention capacity and heat treatment losses in pigs that received nuts improves, but not significantly (table 5). These data generally correlate well with the results of other authors (Lavinia IDRICEANU et al. 2020).

Table 5

Results of Physico-Chemical Analysis of pig meat, X ± SX

no.	Group	pH (48 hours.)	Tenderness, sec.	moisture-retaining properties ability, %	loss during thermal conditions. processing, %
1.	К	5,42±0,16	12,96±0,34	54,50±2,26	19,38±0,71
	C_v	7,18	6,62	13,35	8,1
2.	W1	5,46±0,17	11,84±0,15*	57,71±1,31	18,79±0,82
	C_v	6,4	2,90	5,16	9,78
3.	W2	5,65±0,29	11,15±0,19**	58,19±0,96	17,92±0,55
	C_v	2,64	4,13	3,68	7,49

On the effect of the use of nuts in pig feeding on the chemical composition of pig meat (table. 6) it should be noted that no significant impact on the main indicators has been established. It was found that in pigs that consumed nuts, the content of internal muscle fat is significantly higher. By 0.26 % (p=0.05) and 0.5 % (p=0.05), respectively. It should be noted that the content of intra-muscle fat was in the range of 2.11-2.61 %, which is slightly lower than in pigs of the classic mirgorod breed before the outbreak of ASF (Voitenko S. L., 2012).

Table 6

Results of chemical analysis of pig meat, X ± S_X

No.	group	Total Moisture, %	dry matter, %	Ash, %	Protein, %	Fat, %
1	K	74,58±0,45	26,25±1,32	1,278±0,009	22,45±1,50	2,11±0,08
	C_v	1,28	11,26	1,56	14,89	8,55
2	W1	73,68±0,41	26,73±0,85	1,286±0,075	23,16±0,90	2,37±0,07*
	C_v	1,27	7,04	12,97	8,73	6,29
3	W2	72,51±1,01	27,15±2,03	1,341±0,092	23,92±0,30	2,61±0,05*
	C_v	3,21	16,74	15,41	2,83	3,90

Relative to the results of Physico-Chemical Analysis of supravertebral lard (table 7) then it is necessary to note a decrease in the melting point of lard in both experimental groups, which indicates an increase in the content of unsaturated fatty acids in it. For the production of dried products, such an effect of feeding nuts is generally positive (Leite, A. et al., 2024; Lebret B., Čandek-Potokar M.; 2021).

Table 7

Results of Physico-Chemical Analysis of supravertebral lard, X ± S_X

No	Group	Hygroscopic moisture, %	Melting Point, ° C	refractive index, units
1.	K	4,43±0,26	31,16±1,72	1,4584±0,0008
	C_v	13,03	12,33	0,09
2.	W1	4,65±0,29	29,70±2,43	1,4564±0,0005
	C_v	14,08	18,31	0,08
3.	W2	4,73±0,26	28,86±1,46	1,4534±0,0004
	C_v	12,34	11,23	0,08

Organoleptic evaluation of boiled meat and broth revealed that in appearance, the best broth was obtained from pig meat of the third experimental group and on average, according to the assessment of all tasters, it received 4.22 points (table 8). Among the quality indicators evaluated, the best scores were given by tasters for the smell and taste of boiled meat obtained from animals that consumed nuts. This indicates the possibility of using nuts as a feed additive in order to improve the quality of meat and fat products (Lebret B., Čandek-Potokar M.; 2021; Fu, Y. et al., 2022).

Table 8

Result of pork tasting assessment, X ± SX

Organoleptic parameters		animal group		
		Control	W1	W2
Broth				
1	Appearance	4,2±0,35	4,2±0,33	4,3±0,28
2	Smell	4,2±0,32	4,3±0,28	4,4±0,31
3	Taste	4,3±0,21	4,3±0,26	4,5±0,26
4	Richness	3,7±0,14	4,8±0,29	3,9±0,27
5	Transparency	3,5±0,18	3,3±0,19	4,0±0,29
6	Average rating	*3,98±0,28*	*4,18±0,30*	*4,22±0,27*
Boiled meat				
1	Appearance	4,1±0,27	4,2±0,28	4,4±0,26
2	Smell	4,3±0,38	4,4±0,30	4,5±0,19
3	Taste	4,2±0,32	4,5±0,27	4,7±0,27
4	Consistency	4,0±0,28	4,2±0,25	4,1±0,28
5	Juiciness	3,8±0,25	4,1±0,31	4,4±0,32
6	Average rating	*4,06±0,27*	*4,28±0,32*	*4,42±0,35*

In pigs treated with nuts, certain changes in the biochemical parameters of meat were detected (table 9).

Table 9

Some biochemical parameters of pig meat for the use of nuts in pig feeding, (X ± SX)

Indicator	Group		
	Control	W1	W2
Water-soluble proteins, G%	0,78±0,059	0,79±0,059	0,79±0,059
Cv	12,684	13,016	13,016
Salt-soluble proteins, G%	0,55±0,050	0,57±0,024	0,59±0,022
Cv	14,697	9,083	7,083
Alkali-soluble proteins, G%	2,35± 0,141	2,37±0,074	2,39±0,045
Cv	10,356	5,352	3,242
Creatinine, mmol / kg	3675,89±278,940	3825,76±347,127	3924,88±357,217
Cv	13,151	14,766	15,776
HCDs, mmol / G	640,20±6,742	650,41±7,973	656,96±8,663
Cv	1,760	1,910	2,310
Cholesterol, mmol / kg	1,11±0,064	1,23±0,049*	1,43±0,042*
Cv	9,897	5,984	5,145
Cytochrome oxidase, indof. units	0,10±0,008	0,12±0,003	0,12±0,003
Cv	13,229	5,078	5,078
MDA, mmol / kg	37,25±2,120	31,95±2,120*	28,86±2,230*
Cv	13,478	10,962	9,982
POM, mmol / L	41,61±1,266	35,25±1,414*	32,20±1,314*
Cv	6,164	5,288	5,268

The fractional composition of the proteins of the longest back muscle has not changed significantly. The content of water-soluble (sarcoplasmic proteins) and alkali-soluble (stoma fraction) proteins decreased by 2.56% and 1.70 %, respectively, while Salt-soluble (myofibrillary) proteins increased by 9.26 %. At the same time, if the variability in the concentration of water - soluble proteins almost did not change, then salt-and alkali-soluble proteins decreased by 7.614% and 7.114 %. Since the greatest biological value is inherent in myofibrillary specialized skeletal muscle proteins: myosin, actin and their complex combination, an increase in their content indicates an increase in its quality (Matarneh et al. 2021.; Ouali, A., 1991; Toldrá, F. & Reig, Milagro, 2014).

The creatinine content in the meat of animals of the experimental group increased by 6.75 %, and the variability of the indicator increased from 13.151% to 15.776 %. Such changes may indicate a positive effect of feeding nuts on the taste of meat, since creatinine is one of the substances that determine the aroma and taste of meat products and is a precursor of heterocyclic amines in meat (Ouali, A., 1991; Mora, L., et al. 2008).

When using diets with nuts, the content of histidine-containing dipeptides (HCDs) increased slightly. In the meat of animals of the experimental groups, they were 1.59% and 2.62% more. Since carnosine prevents damage to membrane lipids and proteins under oxidative stress, and anzerine inhibits the accumulation of the final product of lipid peroxidation – Malone dialaldehyde. An increase in their content indicates an increase in the quality of meat (Mora, L., et al. 2008; Xing, L., 2019; Kanyuka O. Yu., Tsebrzhinsky O. I., 2013).

In the meat of pigs of the experimental group who received a diet with nuts, the cholesterol content is significantly higher by 27.93 % ($p = 0.05$). However, the variability was slightly lower: 9.897% in the control group and 5.145% in the control group. Cholesterol ensures the stability of cell membranes. In the liver, cholesterol esters with polyunsaturated fatty acids are converted to bile acids. Cholesterol produces vitamin D, steroid hormones (cortisol, aldosterone, estrogens and progesterone, testosterone). It plays an important role in the activity of brain synapses and the immune system, including protection against the development of tumors. However, when consumed excessively, excess cholesterol accumulates on the artery walls, forming plaques that constrict blood vessels (Matarneh et al. 2021.; Ouali, A., 1991; Toldrá, F. & Reig, Milagro, 2014).

When using diets with nuts, the level of cytochrome oxidase slightly increased to 0.10 indof. units, in the control and 0.12, respectively, in the experiment. These changes may indicate an increase in the energy capabilities of the muscle under study.

The content of malonic dialaldehyde (MDA) in the meat of pigs of the experimental group was significantly lower by 35.27 % ($P = 0.032$). The data obtained indicate an antioxidant effect of feeding nuts on pig meat. This is due to the fact that MDA is the end product of lipid peroxidation and one of the most characteristic products of lipid peroxidation. The rate of MDA formation can be used to estimate the activation of lipid peroxidation (Zhang, W., 2013; Bao, Y., & Ertbjerg, P., 2018).

In the longest muscle of pigs in the experimental group, the level of protein oxidative modifications (POM) was significantly lower by 25.33 % ($P=0.015$) compared to control animals. OMB causes at least three types of changes in the physicochemical properties of a protein molecule-fragmentation, aggregation, and propensity to proteolysis. As a result, either products with high functional activity are formed, or active enzyme centers are inactivated, or protein molecules are modified, which can cause certain metabolic disorders (Zhang, W., et al. 2013; Bao, Y., & Ertbjerg, P., 2018).

Such changes in the biochemical composition of meat from pigs that consumed nuts may indicate their positive effect on certain indicators of pig muscle tissue, especially the pro-oxidant-antioxidant system.

Discussion. The results of the study confirm that the inclusion of walnut kernels in the diet of Mirgorod pigs has a positive effect on their productivity, meat and biochemical parameters. The increase in average daily gains and reduced feed conversion is consistent with data from other authors (Cho & Kim, 2012; Bondarenko & Hlavatshuk, 2021), which indicate an improvement in energy metabolism when feeding feeds rich in polyunsaturated fatty acids (PUFAs).

A decrease in the thickness of lard and an increase in the proportion of muscle tissue in carcasses indicate the formation of a more meat-like type of pigs while maintaining the quality of fat characteristic of the breed. Similar trends were observed in Tomažin et al. (2020) and Lebret & Čandek-Potokar (2022), which states that the introduction of natural sources of PUFAs (nuts, chestnuts, olive products) into the diet helps to optimize the ratio of muscle and adipose tissue and improves the suitability of meat for processing.

The increase in intramuscular fat recorded in experimental animals is of important sensory importance, since this indicator is directly related to the juiciness, tenderness and taste characteristics of meat (Pugliese & Sirtori, 2012; Idriceanu et al., 2020). So, the use of walnuts as a feed additive can be considered as an effective natural way to increase the organoleptic properties of pork.

Biochemical studies have confirmed the antioxidant effect of walnuts, as evidenced by a decrease in the levels of malondialdehyde (MDA) and oxidative modification of proteins (OMB). This indicates a decrease in the intensity of lipid peroxidation and stabilization of protein structures in muscle tissue. Similar results are presented in Zhang et al. (2013) and Bao & Oobjerg (2018), where natural antioxidant compounds (vitamin E, polyphenols, tocopherols) have been shown to significantly increase the stability of the protein-lipid complex of meat during storage.

The observed increase in the concentration of histidine-containing dipeptides (carnosine and anzerine) is also consistent with the known physiological effects of these compounds, which exhibit antioxidant and membrane-stabilizing effects (Xing et al., 2019; Kanuka & Tsebrzhynskyi, 2013). Therefore, nut feeding can help increase the resistance of meat to oxidative processes and, accordingly, improve its storage.

Thus, the results show that the inclusion of walnuts in the diets of Mirgorod pigs not only increases their productivity, but also optimizes the quality of meat through biochemical mechanisms associated with improving the lipid and antioxidant status. This makes the use of nuts a promising direction in the production of functional meat products of increased biological value.

Conclusions. Encouraging preliminary data were obtained on the effect of nut feeding on the quality of pig meat and fat products. It was found that the use of nuts in feeding fattening young pigs had a positive effect on the intensity of their growth and development. The average daily growth of young animals of the experimental groups exceeded the productivity level of analogues of the control group by 2.75% and 6.91% feed conversion in animals of the experimental groups was also better.

With almost the same pre-slaughter live weight, the slaughter yield in pigs of the experimental groups was 1.40% and 3.92% higher than in animals of the control group. The length of carcasses in pigs of the experimental groups compared to the control group was 1.57% and 1.64% longer, and the thickness of lard was 5.48% and 8.45% less ($p < 0.05$).

The area of the "muscle eye", which characterizes the meat content of carcasses, in pigs of the experimental group exceeded the control ones by 1.1 mm and 2.1 mm. Thus, in animals of the experimental group, there is a more intense increase in carcass mass due to its most valuable part - muscle tissue.

It was found that in pigs that consumed nuts, the content of intra-muscle fat is significantly higher. By 0.26 % (p=0.05) and 0.5 % (p=0.05), respectively.

Organoleptic evaluation of cooked meat and broth revealed that in appearance the best broth is obtained from the meat of pigs that received nuts, this indicates the possibility of using nuts as a feed additive in order to improve the quality of meat and fat products.

Changes in the biochemical composition of pig meat that consumed nuts may indicate their specific effect on certain indicators of pig muscle tissue, especially the pro-oxidant-antioxidant system.

Thus, walnuts can be used in the process of fattening pigs in order to obtain a high-quality meat product.

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