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ECONOMIC FEASIBILITY OF USING A PHYTO-SUPPLY FROM WALNUT LEAVES IN THE DIETS OF ADULT CHICKENS

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The study was conducted in the production conditions of the State Research Station of Poultry Breeding of Livestock Farming Institute of the NAAS (village Birki, Kharkiv region) on the parent flock of Birkivska barvysta chickens. The effectiveness of using 1% crushed walnut leaves (Juglans regia) as a phytogenic feed additive in the composition of compound feed was studied. During the six months of the experiment, it was found that the use of the phytoadditive contributed to a reduction in the age of the beginning of egg laying, more stable dynamics of egg production, increased egg production intensity, hatching egg yield and bird survival, which indicates a strengthening of the physiological state of the bird and a decrease in the impact of stress factors. Experimental hens that consumed walnut leaves began egg laying five days earlier, and their average egg production during the period increased by 6.8%. Under the influence of biologically active substances of the leaves (phenolic compounds, flavonoids, juglone), an improvement in the quality of incubation products was observed - the yield of incubation eggs increased from 65.1 to 69.0%, while the weight of eggs remained stable, which indicates a balanced use of nutrients without overloading the body. A decrease in feed consumption per 10 eggs by 6.7% confirmed an improvement in feed conversion, which is explained by the positive effect of the phytoadditive on digestion and metabolic balance. The survival rate of the livestock in the experimental group reached 98.9%, which is 2.9% higher than in the control, and indicates the immunomodulatory properties of the additive. Economic calculations confirmed the feasibility of using walnut leaves as a phytogenic additive in the diet of chickens. An increase in profit from the sale of eggs by 18.4% and a decrease in the cost of one incubation egg from 7.32 to 6.43 UAH were recorded, which provided an additional effect of 14.05 thousand UAH for the experimental period. At the same time, the use of self-prepared raw materials made the technology more profitable, but even if raw materials were purchased from suppliers, the use of leaves remained economically justified with an efficiency of 4.47 thousand UAH relative to the control. The results obtained indicate that walnut leaves can be used as an affordable, environmentally safe and effective phytogenic supplement in the diets of parent flock chickens as an alternative to synthetic antioxidants. This approach contributes to increasing the productivity and viability of poultry, improving product quality and improving economic indicators, which makes the technology suitable for implementation in organic poultry farming systems.

Keywords: walnut leaves; phytogenic supplement; parent flock chickens; productivity; economic efficiency; organic poultry farming.

ЕКОНОМІЧНА ДОЦІЛЬНІСТЬ ВИКОРИСТАННЯ ФІТОДОБАВКИ З ЛИСТЯ ГОРІХА ВОЛОСЬКОГО В РАЦІОНАХ ДОРОСЛИХ КУРЕЙ

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Державна дослідна станція птахівництва Інституту тваринництва НААН, с. Бірки, Харківська область, Україна

Дослідження проведено у виробничих умовах Державної дослідної станції птахівництва Інституту тваринництва НААН (с. Бірки, Харківська обл.) на батьківському стаді курей породи Бірківська барвиста. Вивчено ефективність використання 1 % подрібненого листя волоського горіха (Juglans regia) як фітогенної кормової добавки у складі комбікорму. Упродовж шести місяців досліду встановлено, що застосування фітодобавки сприяло скороченню віку початку яйцекладки, стабільнішій динаміці несучості, підвищенню інтенсивності несучості, виходу інкубаційних яєць і збереженості птиці, що свідчить про зміцнення фізіологічного стану птиці та зниження впливу стресових чинників. Дослідні кури, які споживали горіхове листя, почали яйцекладку на п'ять днів раніше, а їх середня несучість за період зросла на 6,8 %. Під впливом біологічно активних речовин листя (фенольних сполук, флавоноїдів, юглону) спостерігалося покращенню якості інкубаційної продукції – вихід інкубаційних яєць підвищився з 65,1 до 69,0 %, тоді як маса яєць залишалася стабільною, що свідчить про збалансоване використання поживних речовин без перевантаження організму. Зменшення витрат корму на 10 яєць на 6,7 % підтвердило поліпшення конверсії корму, що пояснюється позитивним впливом фітодобавки на травлення та метаболічну рівновагу. Збереженість поголів'я у дослідній групі досягала 98,9 %, що на 2,9 % вище, ніж у контролі, і свідчить про імуномодулюючі властивості добавки. Економічні розрахунки підтвердили доцільність використання листя волоського горіха як фітогенної добавки в раціоні курей. Зафіксовано підвищення прибутку від реалізації яєць на 18,4 % і зниження собівартості одного інкубаційного яйця з 7,32 до 6,43 грн, що забезпечило додатковий ефект 14,05 тис. грн за період досліду. При цьому використання власноруч заготовленої сировини зробило технологію більш рентабельною, але й за умови придбання сировини у постачальників використання листя залишалося економічно виправданим з ефективністю на рівні 4,47 тис. грн відносно контролю. Отримані результати свідчать, що листя волоського горіха може бути використане як доступна, екологічно безпечна та ефективна фітогенна добавка у раціонах курей батьківського стада як альтернатива синтетичним антиоксидантам. Такий підхід сприяє підвищенню продуктивності і життєздатності птиці, покращенню якості продукції та поліпшенню економічних показників, що робить технологію придатною для впровадження в системах органічного птахівництва.

Ключові слова: листя волоського горіха; фітогенна добавка; кури батьківського стада; продуктивність; економічна ефективність; органічне птахівництво.

Introduction. Modern poultry farming operates in conditions of constant growth of feed components cost, high competition and strict requirements for product safety.

According to most analysts, feed costs account for up to 70% of the cost of eggs and poultry meat, therefore, optimization of feeding remains a key factor in increasing the profitability of the industry. At the same time, increased regulatory restrictions on the use of antibiotics as growth promoters have made the search for natural alternatives that can support the productivity and health of poultry without loss of economic efficiency more urgent (Aminullah et al., 2025; Biswas et al., 2024).

In recent years, a significant amount of data has been accumulated in the scientific literature, confirming the feasibility of using phytogenic feed additives as natural growth promoters. Such additives contain a wide range of biologically active substances - essential oils, polyphenols, flavonoids, tannins, which exhibit antioxidant, antimicrobial, anti-inflammatory and immunomodulatory properties (Oni & Oke, 2025; Oke et al., 2024). The use of phytogenic components in compound feeds contributes to the normalization of digestion, improvement of the intestinal microbial balance and increased feed conversion, which provides economic benefits without the use of antibiotics (Ren et al., 2025; Abdelli et al., 2021).

The results of numerous experiments indicate that phytonutrients not only stabilize the physiological state of the bird, but also positively affect the quality of products. In particular, Ren et al. (2025) found that the addition of a phytogenic complex to the diet of broilers improved growth performance, meat quality and the composition of the intestinal microbiota. In the study by Suresh et al. (2023) the use of a plant complex in the feeding of laying hens increased egg production and improved eggshell quality, while Moyano et al. (2023) confirmed the positive effect of phytogenic additives on the productivity of industrial crosses. Similar results were obtained by Bhagwat et al. (2021), who showed an increase in the proportion of hatching eggs in the population of parental forms of chickens with the introduction of phytogenic stimulants. The effectiveness of such approaches is also confirmed by the summarized data of the meta-analysis of Martínez et al. (2020), according to which the addition of phytogenic preparations reduces feed costs per unit of bird body weight gain by 3–6%.

From an economic point of view, the use of plant feed additives often provides higher profitability compared to traditional antibiotic stimulants, even with an initial increase in ingredient costs (Mincheva et al., 2025). Thus, the authors showed that the inclusion of 0.5–1% of a mixture of herbs or essential oils in the diet of broilers increases the profitability of production by 7–12% due to better feed conversion and reduced mortality. Similar conclusions were made by Salihu et al. (2024), noting that the addition of Ocimum spp. leaf powder improves body weight gain and reduces the cost of 1 kg of product. Similar results were obtained by Ghanem et al. (2021) for diets with cinnamon: the increase in the economic efficiency of feeding was more than 10% compared to the control. Taken together, these results indicate that phytoadditives, even in small doses, can significantly improve the financial performance of poultry farming without losing biological safety.

Walnut leaves (Juglans regia), which are an available and renewable raw material in Ukraine, attract special attention among phytogenic agents. The study by Miłek et al. (2022) showed that walnut leaves contain a high concentration of polyphenols, catechins, juglone, as well as significant amounts of minerals (Ca, Mg, Fe) and vitamins. Due to this composition, it has antioxidant, bactericidal and antiparasitic activity. Similar conclusions were obtained in the work of Gaviley et al. (2024), where it was determined that the total content of phenolic compounds in walnut leaves reaches 2.7 mg/g, which indicates its high bioactivity and potential as a phytoadditive in animal nutrition. Studies by Untea et al. (2020) and Popescu et al. (2020) proved that the inclusion of 1% walnut or blueberry leaf powder in the diets of laying hens increases the antioxidant properties of the yolk,

reduces the level of lipid peroxidation and improves the safety of the bird. This indicates that the use of local plant raw materials has not only biological but also economic advantages – the ability to reduce the need for expensive imported additives and reduce costs for veterinary drugs.

In addition to the beneficial effect on physiological processes, phytobiotics can significantly increase the profitability of production. According to Ignatovich (2023), the introduction of phytobiotics into the diets of laying hens of various crosses contributed to better feed utilization, increased egg yield and increased economic returns. Economic efficiency was also confirmed by Vinus et al. (2018), who summarized the results of numerous experiments and showed that plant additives, being components from nature, are considered not only safe and environmentally friendly, but also, due to their availability, contribute to reducing the cost of feed. At the same time, as noted by Kholif et al. (2020), the optimal level of introduction and economic returns depend on the composition of the basic diet, conditions of maintenance and quality of raw materials.

In conclusion, it can be noted that recent studies convincingly demonstrate both the biological and economic efficiency of the use of phytogenic feed additives in poultry farming. Among them, walnut leaves are distinguished by their availability, rich bioactive composition and ability to simultaneously increase productivity, improve product quality and reduce treatment costs. However, the scientific literature still lacks comprehensive assessments of the economic feasibility of using this additive in feeding chickens in production conditions, which led to the conduct of this study.

The purpose of the work is to assess the economic feasibility of using walnut leaves as a phytogenic feed additive in the diet of adult chickens, taking into account the impact on productivity and maintenance costs.

Materials and methods of research. The research was conducted in the production conditions of the State Research Station of Poultry Breeding of Livestock Farming Institute of the NAAS (village Birki, Kharkiv region) on the parent flock of Birkivska barvysta chickens.

For the experiment, two groups of poultry were formed, each consisting of 200 heads - control and experimental, selected by age and live weight. The chickens were kept in group two-tier cage batteries (8 hens and 1 rooster in a cage) under conditions of natural mating, at a stocking density of 14 heads/m² with observance of the optimal microclimate, natural lighting and ventilation. Feeding was carried out in a standardized manner, 115 g of compound feed per head per day, in accordance with the needs of the parent forms of the egg direction of productivity. The poultry had constant access to clean drinking water.

The control group received basic complete compound feed (PC), balanced in terms of energy, protein, macro- and microelements. The basic diet in terms of basic nutritional indicators corresponded to the standards for laying hens (crude protein content – 17%, metabolizable energy – 2650 kcal/kg). The diet of the experimental group was additionally supplemented with 1% of crushed dry walnut leaves by weight of the compound feed. The duration of the experiment was six months, which covered the period of intensive egg-laying.

Crushed walnut leaves were harvested in the Kharkiv region during the period of active tree vegetation (June–July). To preserve biologically active substances, the leaves were dried in a ventilated room at a temperature not exceeding 40 °C, after which they were crushed to a particle size of 1–3 mm and stored in paper bags in a dry, dark place. If necessary in production conditions, the leaves can be purchased from suppliers or harvested independently. The cost-effectiveness calculations considered the option of own raw material procurement, as well as the alternative - purchase from suppliers, for which the actual purchase price of the supplement was taken into account.

The chemical composition and nutritional value of walnut leaf raw material (content of crude protein, crude fat, fiber, calcium, phosphorus, concentration of vitamin E and β-carotene) were studied using generally accepted methods (Kostenko et al., 2015). Quantitative assessment of the content of polyphenolic compounds in phytogenic raw materials was carried out by the spectrophotometric method. For all optical density measurements, an SF-26 spectrophotometer and 10-mm quartz cuvettes were used. The determination of the total amount of hydroxycinnamic acids present in walnut leaf extracts was carried out in terms of chlorogenic acid (Proskurina et al., 2021), the total content of phenolic compounds in terms of gallic acid (Fedosov et al., 2018), the total content of flavonoids in terms of rutin (Vronska et al., 2015), the amount of tannins in terms of tannin (Cobzaru et al., 2019), the content of naphthoquinones in terms of juglone equivalent (Kocaçalışkan et al., 2020).

During the experiment, the following indicators were recorded:

– age at the beginning of egg laying (days);

– average intensity (%) and egg production level (pcs.);

– average egg weight (g);

– proportion of incubation eggs in the total collection (%);

– the survival of the livestock during the observation period (%).

All indicators were determined according to the methods adopted in poultry farming. The obtained data were processed by methods of variational statistics using the Student's t-test.

Economic efficiency was determined by calculating the cost of one incubation egg, profit and level of profitability of production. Calculations were performed taking into account the cost of feed and additives, actual productivity of chickens and revenue from sales of products. This allowed a comprehensive assessment of the feasibility of using phytoadditives in the technology of keeping the parent herd.

Research results. Before the start of the experiment, the chemical composition of dry crushed walnut leaves used as a phytogenic additive in the composition of compound feed was evaluated. The data obtained indicate that the raw material had significant nutritional and biological value (Table 1).

Table 1

Chemical composition of dry crushed walnut leaves

Nutritional parameters	Content in raw material, %	Biologically active substances	Content in raw material
Dry matter	90,25	Vitamin E, μg/g	127,7
Crude protein	13,10	β-carotene, μg/g	295,1
Crude fat	2,10	Hydroxycinnamic acids in chlorogenic acid equivalent, mg/g	21,9
Crude fiber	11,11	Phenols in gallic acid equivalent, mg/g	13,8
Ash	9,98	Flavonoids in rutin equivalent, mg/g	19,5
Calcium	2,10	Tannins in tannin equivalent, mg/g	121,7
Phosphorus	0,32	Naphthoquinones in juglone equivalent, mg/g	2,52

According to the results of laboratory analysis, it was found that dry walnut leaves are characterized by a high content of dry matter (90.3%), crude protein (13.1%), fiber (11.1%), ash (9.9%), calcium (2.1%) and phosphorus (0.32%). The concentration of

biologically active substances was significant: vitamin E – 127.7 μg/g, β-carotene – 295.1 μg/g, hydroxycinnamic acids (calculated as chlorogenic acid) – 21.9 mg/g, phenolic compounds (calculated as gallic acid) – 13.8 mg/g, flavonoids (in rutin equivalent) – 19.5 mg/g, tannins (calculated as tannin) – 121.7 mg/g, juglone – 2.52 mg/g of dry matter. This composition confirms the presence of significant antioxidant potential of the leaves, which led to its use as a phytoadditive.

After the trial was completed, an analysis of the main indicators of chicken productivity and the economic efficiency of using crushed walnut leaves in their diet was conducted. Primary attention was paid to the dynamics of egg production intensity, which reflects the course of egg laying throughout the entire observation period (Fig. 1).

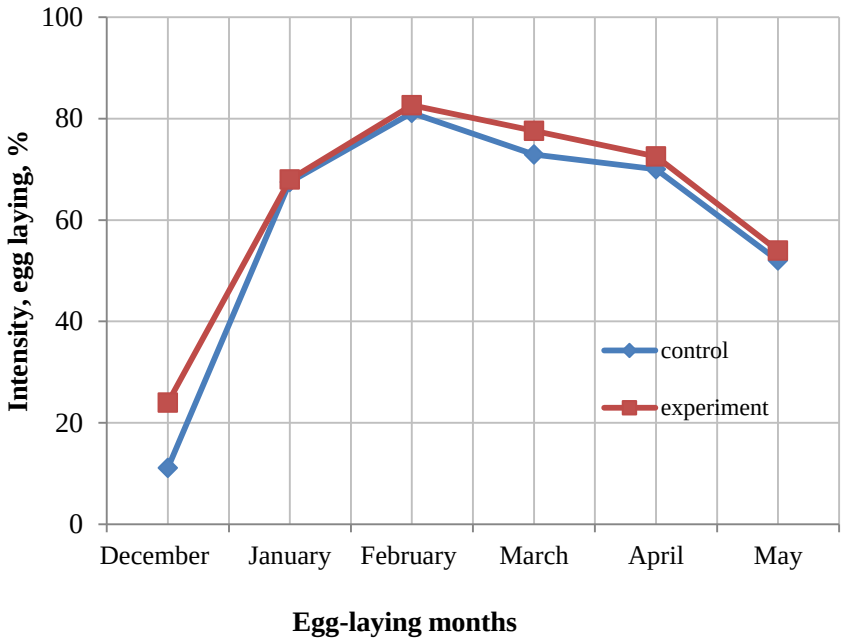

Fig. 1. **Dynamics of egg laying intensity in hens during the experimental period**

At the beginning of the experiment (December), egg laying activity in both groups was low, but a clear difference was observed between them: in the control group, the egg laying intensity was only 11.1%, while in the experimental group – 24%. This indicates that adding 1% of crushed walnut leaves to the diet contributed to a faster entry of chickens into the productive period. It can be assumed that biologically active substances of the leaves, in particular polyphenols and flavonoids, had a positive effect on physiological adaptation and reproductive activity during the period of the beginning of egg laying.

In January, a sharp increase in egg laying was observed in both groups – up to 67.5% in the control and 68% in the experimental, i.e. the difference between the options decreased. This is explained by the stabilization of productivity, when most chickens reached the peak of physiological readiness for egg laying. At the same time, since February, the advantage of the experimental group was again observed: the egg-laying intensity reached 82.6% against 81.1% in the control. Although the difference at this stage was insignificant, it persisted throughout the entire productive period, which indicates a stable effect of the phytoadditive.

In March and April, the egg-laying intensity remained high, with a slight fluctuation within 70–78%, typical for the middle of the productive cycle. At this time, the experimental group had an indicator of 77.6 and 72.5%, respectively, while in the

control - 72.9 and 70%. Despite the fact that the difference in percentages is small, it is stable, which is especially important in long-term experiments with poultry. An increase in productivity even by a few percentage points over several months provides a significant increase in the total number of eggs per head.

At the end of the observation period (May), a natural decrease in egg production was recorded in both groups, which is associated with a natural decrease in egg production intensity in the second half of the cycle. However, even at this time, the hens of the experimental group continued to lay more actively (54% versus 52% in the control), which confirms the positive effect of the phytoadditive on the duration of the productive period.

On average, over the entire observation period, the egg production intensity was 63.1% in the experimental group, which is 4.0% higher compared to the control (59.1%). Thus, under the influence of 1% of crushed walnut leaves, not only was the onset of egg production accelerated, but also a stable level of productivity was maintained throughout the experiment.

The dynamics of egg production, presented in Figure 1, clearly demonstrates that in experimental hens, the egg production curve has a smoother character, without sharp declines or jumps, while in the control, a more noticeable fluctuation in intensity is observed. This may indicate a reduction in the impact of stress factors and better physiological stability of the bird when using a phytogenic feed additive. In general, the data obtained indicate a positive regulatory effect of walnut leaf components on the reproductive function of chickens, which creates the prerequisites for increasing the overall productivity of the flock.

The final average productivity indicators of chickens in the control and experimental groups are given in Table 2. They summarize the results of the six-month experimental period and allow us to assess the impact of including 1% of crushed walnut leaves in the diet on the main economic and useful characteristics of the parent flock.

Table 2

Productivity of chickens during the period of using the walnut leaf feed additive

Indicator	Group	
	К (Base)	D (New)
Age of first egg laying, days	144,7±0,97	139,3±1,15**
Egg production per average layer, pcs.	107,56±1,68	114,84±1,81**
Average egg weight, g	57,14±0,83	57,25±0,33
Yield of incubation eggs, %	65,1	69,0
Feed consumption per 10 eggs, kg	1,95	1,82
Feed consumption per 1 kg of egg mass, kg	3,41	3,18
Livestock survival, %	96,0	98,9

*Note. ** – The difference is significant compared to the control group (p<0.01)*

One of the first indicators that responds to changes in feeding is the age of laying the first egg. In the control group, it was 144.7 days, while in the experimental group it was 139.3 days, which is significantly less ($p<0.01$). Thus, under the influence of the phytogenic supplement, the hens began laying eggs on average 5 days earlier. This pattern is also recorded in the dynamics of egg production, shown in Fig. 1, which reflects its twice as high intensity in the first month of laying in the hens of the experimental group. This indicates the stimulating effect of biologically active compounds of walnut leaves on sexual maturation and functioning of the reproductive system of the bird. Accelerating

the beginning of the productive period is important for economic efficiency, as it ensures a longer duration of intensive egg laying during the year.

The positive effect of the supplement is also observed in the egg production per average laying hen, which in the experimental group was significantly higher by 6.8% (114.84±1.81 versus 107.56±1.68 eggs in the control, $p<0.01$). This is also consistent with the previous analysis of egg-laying dynamics (Fig. 1), where a stable dominance of the experimental group in egg-laying intensity was observed throughout the period. An increase in total productivity by 7 eggs per hen over six months is a tangible result for parent flocks, where each additional incubation egg has a high cost. The average egg weight in the experimental group was 57.25±0.33 g, which practically corresponded to the control (57.14±0.83 g). Despite the close average values, the larger error of the average in the control group indicates significant fluctuations in the size and morphological parameters of eggs, i.e., less stability of the egg formation process. This is fully consistent with the lower yield of incubation eggs in the control (65.1% versus 69.0% in the experiment). At the same time, the proportion of eggs suitable for incubation is an important criterion for the efficiency of the parent flock and in our experiment the effect of the phytogenic supplement was manifested not only in an increase in the number of laid eggs, but also in a certain stabilization of the physiological processes of egg formation, which ensured a higher yield of products that met incubation standards. The increase in the proportion of incubation eggs in the experimental group can be explained by a more uniform course of the reproductive function of the bird under the influence of biologically active components of walnut leaves. They probably contributed to better absorption of nutrients and reduced the impact of stress factors, which in the complex provided more stable morphological characteristics of eggs without changing their average weight.

Of significant importance for economic calculations is the feed consumption per unit of production. With standardized feeding (115 g per head per day) in the experimental group, feed consumption per 10 eggs was 1.82 kg versus 1.95 kg in the control, i.e. 6.7% less. A similar trend was found for feed consumption per 1 kg of egg mass – 3.18 kg versus 3.41 kg, respectively. Thus, the phytogenic additive not only increased egg production, but also improved the use of feed nutrients, reducing costs per unit of production. This is especially important for production conditions where the efficiency of feed conversion directly affects the cost of incubation eggs.

The survival rate of the flock for the entire period of the experiment in the experimental group was 98.9%, while in the control group it was 96.0%. An increase in this indicator by 2.9% indicates an improvement in the general physiological condition of the chickens and a decrease in the influence of stress factors. This is fully consistent with the antioxidant properties of phenolic compounds inherent in walnut leaves, which are able to maintain the stability of cell membranes and increase the immune reactivity of the body. In general, the analysis of the economic and useful characteristics given in Table 2 shows that the addition of 1% of crushed walnut leaves to the diet had a positive effect on all the main indicators of the productivity of the parent flock. The chickens of the experimental group were characterized by earlier entry into egg laying, higher egg production, higher hatching egg yield, better feed utilization and higher survival rate of the flock. The absence of changes in egg weight confirms that the increase in productivity was not accompanied by a deterioration in this indicator. The combination of these factors creates the prerequisites for increasing the economic efficiency of hatching egg production.

The increase in chicken productivity and hatching egg yield in the experimental group that consumed the walnut leaf supplement contributed to the improvement of the

main economic indicators of production. The economic assessment of the results of the experiment was carried out on the basis of a comparison of productivity, cost and profitability of hatching egg production in the control and experimental groups. The generalized results of the calculations are given in Table 3.

The increase in chicken productivity due to the use of the phytoadditive contributed to the growth of gross egg production from 21.08 to 22.85 thousand pcs. (by 8.4%), including hatching eggs – from 13.70 to 15.77 thousand pcs., i.e. by 15.1%. According to the production structure, the share of hatching eggs in the experimental group was 69%, while in the control group – 65.1%. (Table 2). This difference has significant economic significance, since hatching eggs are the main product of the parent flock. As a result of the increase in sales volumes, income from the sale of eggs in the experimental group increased from 310.96 to 350.80 thousand UAH, or by 12.8%. The main share of this increase is due to the increase in the sale of hatching eggs (from 274.07 to 315.38 thousand UAH), while the sales volume of food eggs remained practically at the same level. Calculations were made based on the average sales prices: hatching eggs - 20 UAH/piece, food eggs - 5 UAH/piece.

Table 3

Economic efficiency of using a phytogenic supplement from walnut leaves in feeding a parent flock of chickens

Indicator	Group	
	K (base)	D (new)
Initial livestock, heads	200	200
Gross egg production, thousand pcs.	21,08	22,85
of which: - incubation, thousand pcs.	13,70	15,77
- food, thousand pcs.	7,38	7,08
Total income from the sale of eggs, thousand UAH	310,96	350,80
including: - incubation, thousand UAH	274,07	315,38
- market, thousand UAH	36,89	35,42
Feed costs for the trial period, kg	4102,28	4165,07
Need for walnut leaves, kg	–	41,65
Feeding costs, thousand UAH	49,23	49,98
Total costs for keeping poultry, thousand UAH	100,32	101,40
Profit, thousand UAH	210,6	249,4
Cost of 1 incubation egg, UAH	7,32	6,43
Economic effect, thousand UAH	–	14,05

Total costs included the cost of keeping poultry during the experimental period, including the cost of purchasing pullets (at a price of 150 UAH/head) and feed costs, which accounted for about 70% of total costs. In the control group, they reached 100.32 thousand UAH, in the experimental group - 101.40 thousand UAH, i.e. they increased by only 1.1%. The small increase in costs for keeping poultry is explained by the higher survival rate of the livestock in the experimental group (98.9% versus 96% in the control, as shown in Table 1), as a result of which the number of chickens in the productive period increased and, accordingly, the costs for their feeding. The crushed walnut leaves were prepared by the company itself, so additional costs for its purchase were not taken into account, and the technological operations for its preparation (drying, crushing, storage)

did not require additional financial costs. According to the results of the calculations, the profit from the sale of eggs in the experimental group was 249.4 thousand UAH, which is 18.4% more than in the control group (210.6 thousand UAH). The higher financial result is due to the increase in the gross production of eggs, primarily hatching eggs, which have a significantly higher market price. At the same time, the cost of one hatching egg decreased from 7.32 to 6.43 UAH, which indicates a more rational use of feed resources and production capacities. The overall economic effect of using 1% of walnut leaves in the diet was 14.05 thousand UAH. This confirms the feasibility of using the phytoadditive provided that it is prepared on its own, when there are no additional costs, and the profit increases due to increased productivity and safety of the livestock. At the same time, if we consider the alternative option of purchasing leaves from suppliers at an average market price of 230 UAH/kg (the need for this phytoraw material for the period is 41.65 kg), the total costs would increase to 110.98 thousand UAH. In this case, the profit would be 239.8 thousand UAH, and the economic effect would decrease to 4.47 thousand UAH. At the same time, the cost of one incubation egg would increase to 7.04 UAH, but would not come close to the indicator of the control group (7.32 UAH), having a 3.9% lower value. Therefore, even with the purchase of raw materials, the use of phytoadditives remains economically justified, however, the highest efficiency is provided by the farm's own procurement of walnut leaves, which allows reducing the cost of the incubation egg and increasing the profitability of production without additional financial costs.

Discussion. The results obtained indicate that the inclusion of 1% crushed walnut leaves in the diet of parent hens had a positive effect on their productivity, survival and economic performance. An increase in egg production by 6.8% and a reduction in the age of onset of egg laying by 5 days compared to the control confirm the reproductive-stimulating effect of leaf bioactive substances. A similar trend was noted by Bhagwat et al. (2021) and Moyano et al. (2023), who found an increase in egg production and hatching egg yield when phytogenic supplements were introduced into the diet of laying hens. According to a meta-analysis by Darmawan et al. (2022), phytogenic extracts on average increase chicken productivity and feed conversion by 3–6%, which fully coincides with our results.

The positive dynamics of productivity in our experiment is likely due to the optimal dosage of the supplement. Popescu et al. (2020) showed that excessive walnut leaf supplementation may not increase performance, while moderate levels improve digestive health and nutrient absorption efficiency. At the same time, Untea et al. (2020) noted the enrichment of yolk with antioxidant compounds without a negative impact on egg production. Thus, our results are consistent with the findings of these authors, but show a more pronounced effect, presumably due to the use of parent stock with a different level of stress and a better balance of the diet. Maintaining stable egg weight while increasing egg production indicates the absence of energy deficit and efficient nutrient use. Similar observations were made by Sharma et al. (2020) and Suresh et al. (2023), where the introduction of phytonutrients did not change egg weight, but contributed to better shell quality. However, some studies have reported a decrease in egg weight with excessive polyphenols (Untea et al., 2020). Therefore, the stability of the indicators in our work confirms the correctness of the selected dose of 1%, which is consistent with the recommendations of Abdelli et al. (2021) and Biswas et al. (2024) on the advisability of using low concentrations of phytogenic substances to avoid the inhibitory effect of tannins. The high survival of the livestock (98.9% vs. 96.0% in the control) is consistent with numerous works that note the immunomodulatory effect of phytogenic substances. According to Huang & Lee (2018) and Mahfuz et al. (2021), phenolic compounds and

flavonoids reduce oxidative stress, inhibit the development of pathogens and enhance the nonspecific resistance of the bird's body. Similarly, Popescu et al. (2020) observed improved digestive health in laying hens fed walnut and blueberry leaves. Our data also suggest that antioxidant compounds in the leaves stabilize the physiological state of the bird, which was manifested in lower mortality and more even egg production dynamics.

Improved feed conversion (6.7% reduction in expenditure) reflects more efficient nutrient absorption and less energy loss to overcome stress factors. Similar results were reported by Ren et al. (2025) and Gadde et al. (2017), where phytogenic supplements contributed to the optimization of intestinal microflora and improved feed utilization. Similarly, Ignatovich (2023) reported an increase in feed intake in laying hens of different crosses when using phytobiotics. Thus, our improvement in feed conversion confirms the data of other authors and demonstrates the potential of walnut leaves as a natural stimulator of metabolic processes.

The economic effect recorded in our experiment (an increase in profit by 18.4%) is fully consistent with the results of studies by Ghanem et al. (2021), which showed that the addition of herbal supplements within the range of 0.5–1% increases profitability by 7–12% due to better feed conversion and reduced mortality of laying hens. Similarly, Salihu et al. (2024) and Mincheva et al. (2025) noted that the use of herbal supplements increases the profitability of broiler production. Therefore, the economic feasibility of using walnut leaves is confirmed both by our calculations and by the generalized data of other authors. The biological activity of walnut leaves is due to the high content of polyphenols, juglone and flavonoids, which have antioxidant and antimicrobial properties (Miłek et al., 2022; Gaviley et al., 2024). Their complex effect contributes to the normalization of digestion, improvement of immune status and restoration of energy metabolism, which, in turn, ensures a stable increase in productivity without a negative impact on product quality. These properties coincide with the conclusions of Oke et al. (2024) and Oni & Oke (2025), which describe the mechanisms of antioxidant and anti-inflammatory effects of phytogenic additives in poultry farming.

Thus, the results of our study complement current scientific data on the effectiveness of phytogenic feed additives. They confirm that the use of walnut leaves at a dose of 1% is able to improve reproductive performance, survival and economic efficiency of the parent flock of chickens without deteriorating product quality. From the review Based on the natural origin of the raw materials and their compliance with the principles of organic production, such technology can be recommended for integration into environmentally friendly poultry farming systems.

Conclusions

1. It was found that adding 1% of crushed walnut leaves to the diet of parent hens contributed to an increase in their reproductive capacity. The hens of the experimental group began laying eggs 5 days earlier, had a significantly higher egg production (by 6.8%) and a higher yield of incubation eggs (69.0 versus 65.1% in the control). This indicates a positive effect of biologically active substances of the leaves on the physiological state of the bird and the stability of egg formation processes.

2. Under the influence of the phytoadditive, feed utilization and viability of the livestock improved. Feed consumption per 10 eggs and 1 kg of egg mass decreased by 6.7–6.8%, and the survival rate of the bird increased from 96.0 to 98.9%. This confirms the antioxidant and tonic properties of phytogenic components of walnut leaves, which provide better conversion of nutrients and the body's resistance to stress factors.

3. Increasing the productivity of chickens and the survival of the livestock led to an improvement in the economic indicators of the production of hatching eggs. Profit in the experimental group increased by 18.4%, the cost of one hatching egg decreased from

7.32 to 6.43 UAH, and the total economic effect was 14.05 thousand UAH provided that the phytoraw material was procured by the company itself. In the case of purchasing walnut leaves from suppliers, the economic effect decreased to 4.47 thousand UAH, but remained positive.

4. The use of walnut leaves in the diet of parent hens is a promising direction for increasing productivity and profitability of production. Own procurement of raw materials allows realizing the phytogenic potential of the plant without additional costs, which ensures a stable increase in the biological and economic efficiency of poultry farming. Given the natural origin of the raw materials and the absence of synthetic components, such technology can be integrated into organic poultry production systems, contributing to the expansion of the range of safe and environmentally friendly products.

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