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The effectiveness of using fennel meal (*Foeniculum vulgare*) in feeding young quails

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Abstract. Fennel seeds are considered a potent phytobiotic and can be used in the feeding of young poultry as an alternative to antibiotics, which are applied to improve poultry performance and prevent a range of gastrointestinal diseases. The conducted scientific and economic study focused on examining the impact of feeding fennel seed cake on the performance and slaughter

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qualities of meat-type quails. According to the results of the experiment, among the investigated doses of fennel seed cake, specifically 0.5%, 1.0%, and 1.5%, the highest productivity was achieved by birds consuming full-feed compound feed containing 1.5% of the mentioned feed additive. The quails in this group exceeded the control group by 9.75 g or 3.44% in weight. With 1.0% fennel seed cake in the compound feed, the body weight of the birds was 7.07 g or 2.50% higher than the control group. When consuming compound feed containing 0.5% fennel seed cake, the quails surpassed the control group by only 4.55 g or 1.61%. It should be noted that the difference between the groups in terms of body weight was not statistically significant. The yield of carcasses slightly differed from the control, with quails consuming 1.5% fennel seed cake in the feed having a 0.1% higher yield. Regarding the yield of edible parts of the carcass, the trend towards an increased yield of breast muscles in the birds of the experimental groups was noteworthy, as well as the increased yield of the stomach, which was confirmed by the statistical significance of the difference between the control group and the birds consuming 1.5% fennel seed cake. Thus, it can be stated that feeding up to 1.5% fennel seed cake in full-feed compound feed has a positive effect on the productivity of meat-type quails

Keywords: phytobiotics; productivity; poultry meat production; slaughter qualities; oil production waste

Introduction

Before the introduction of the ban on the use of antibiotics in poultry farms, these substances were commonly used in the feeding of young poultry for several important reasons. First and foremost, they helped maintain the health of the birds by preventing bacterial infections and reducing the risk of diseases that could negatively affect the growth and development of young individuals. Furthermore, the use of antibiotics contributed to improved livestock survival rates, as they reduced mortality and ensured stable conditions for raising the birds. Another important aspect was their ability to enhance productivity, as antibiotics stimulated growth, improved feed conversion, and facilitated more efficient weight gain. Thus, prior to the ban, antibiotics played a significant role in ensuring high productivity in poultry farming, contributing to the effective raising of poultry and the production of high-quality products (Alabi *et al.*, 2023).

Since poultry farming was the largest consumer of feed antibiotics, it is not surprising that interest in researching alternatives to these substances has grown most significantly in this area. Among the various approaches that can replace feed antibiotics, the use of plant-based products shows promise, as they possess a wide range of beneficial properties. Plant extracts, essential oils, phytobiotics, and other natural components can exhibit antimicrobial effects, stimulate the immune system of poultry, and improve feed utilisation. Many plant compounds, such as flavonoids, alkaloids, tannins, and phenols, have anti-inflammatory and antioxidant properties, which help reduce stress levels in birds and improve their overall health. Additionally, plant-based products can positively impact gut microbiota, stimulating the growth of beneficial bacteria and inhibiting the development of pathogenic microorganisms. This approach not only enhances poultry productivity and survival but also ensures environmentally safe production that meets modern consumer demands for healthy food and the elimination of antibiotics in animal husbandry (Aktaran Bala, 2023; Arif *et al.*, 2024).

According to M. Rafeeq *et al*. (2022), phytobiotics are a wide range of plant-derived compounds with varying chemical compositions that exhibit antimicrobial, anticoccidial, antifungal, antioxidant, immunostimulatory, anti-stress properties and influence the gut microbiota. The scientific works of R. Islam & I. Sheikh (2021) and J. Urban *et al*. (2024) reveal the mechanism of action of active plant substances on physiological processes in animals. In the study by R. Islam & I. Sheikh (2021), a series of experiments were conducted on different types of agricultural animals, examining the impact of various phytobiotic additives on the digestive system. The results showed that the inclusion of extracts from plants such as garlic (*Allium sativum*), ginger (*Zingiber officinale*), and cinnamon (*Cinnamomum verum*) in the diet led to a significant increase in saliva production. This, in turn, facilitated better feed wetting and the initial breakdown of carbohydrates by amylase present in the saliva. Additionally, there was an observed increase in gastric juice secretion, pancreatic enzymes, and bile, which ensured more efficient breakdown of proteins, fats, and carbohydrates in the gastrointestinal tract. These changes resulted in improved dry matter digestibility and an increased absorption rate of key nutrients such as amino acids, fatty acids, and glucose. As a result, the animals showed higher body weight gain and improved feed conversion, which are key performance indicators in animal husbandry.

In turn, J. Urban *et al*. (2024) focused on studying the impact of phytobiotics on the gut microbiota and its role in the digestion process. The study showed that the inclusion of plant extracts rich in essential oils, such as oregano (*Origanum vulgare*) and thyme (*Thymus vulgaris*), in the animals' diet contributed to the modulation of the gut microbiota composition. Specifically, there was an increase in the number of beneficial bacteria from the genera *Lactobacillus* and *Bifidobacterium*, which play an important role in the fermentation of undigested feed residues and the synthesis of short-chain fatty acids. These acids serve as an additional energy source for the intestinal epithelium and help maintain its barrier function. Moreover, under the influence of phytobiotics, the number of pathogenic microorganisms, such as *Escherichia coli* and *Salmonella* spp., decreased, reducing the risk of infectious diseases and inflammatory processes in the gut. The improvement of the microbial balance and reduction of inflammation contributed to the optimisation of digestion and nutrient absorption processes, which in turn positively affected the overall productivity of the animals. Both studies highlight the importance of a comprehensive approach to using phytobiotics in the feeding of agricultural animals. Stimulating endogenous digestive processes through increased saliva, enzyme, and bile secretion, as well as modulating the gut microbiota, are key mechanisms by which plant additives improve digestibility and nutrient absorption. This, in turn, leads to increased animal productivity, reduced feed costs, and improved economic indicators for farms.

After analysing a significant number of scientific works, M. Alghirani *et al.* (2021) state that it has been experimentally confirmed that phytobiotics such as cinnamon, caraway, oregano, clove, thyme, rosemary, sage, green tea, garlic, fenugreek, pepper, ginger, and others, due to their properties, contribute to improving feed consumption and nutrient absorption, which results in increased poultry productivity, improved carcass characteristics, and meat quality. The research by Yu. Balji *et al*. (2024) confirms the positive impact of compound feed with extruded components and phytobiotics on the quail organism, while I. Ibatullin *et al*. (2022) demonstrate their effectiveness in increasing the productivity of meat-type quail.

One of the numerous groups of phytobiotics is fennel. According to A. Ullah *et al*. (2024), the seeds of this plant and its processed products have shown effectiveness in the prevention and treatment of respiratory and gastrointestinal disorders due to their antibacterial, antioxidant, and immunomodulatory properties, which contribute to improved poultry productivity and strengthened health. Including fennel in the poultry diet can reduce oxidative stress, enhance immune response, and improve the overall health of the birds. Most of the studies described in the current scientific literature use fennel seeds or fennel oil as a feed additive in animal feeding. Previous research has demonstrated the positive effects of fennel oil and seeds on the productivity of meat-type quail. However, fennel cake – the by-product of oil production – remains less studied. The aim of this study was to evaluate how the inclusion of fennel seed cake in the diet of meat-type quail affects their growth and meat quality.

Materials and Methods

The scientific and production experiment was conducted in the spring of 2024 at the “Schambachtal Alpakas” farm (Germany). For the scientific and production experiment to determine the optimal share of fennel cake, 400 one-day-old Pharaoh quail chicks were selected and divided into four analogous groups, with 100 birds in each group. The first group was the control group, while the second, third, and fourth groups were experimental. The animals were kept in cages located in a facility with regulated microclimate parameters. The birds had 24/7 access to water and feed. The control group quails were fed complete compound feeds formulated based on standard recipes, while the feed for the third and fourth groups included fennel meal in the amounts indicated in Table 1.

The recipes of compound feeds consumed by meat-type quail during the scientific and economic experiment are presented in Table 2.

Table 1. *Scheme of scientific and economic experiment*

№ of group	Purpose of group	Feeding conditions
1	Control	Complete feed (CF)
2	Experimental	CF with fennel seed meal content of 5 g/kg (0.5%)
3	Experimental	CF with fennel seed meal content of 10 g/kg (1.0%)
4	Experimental	CF with fennel seed meal content of 15 g/kg (1.5%)

Source: developed by the authors

Table 2. *Composition of complete feeds for feeding quail, %*

Indicator	Age of quail 1-21 days				Age of quail 22-42 days			
	Group							
	Control	Experimental			Control	Experimental		
	1	2	3	4	1	2	3	4
Corn	47.41	47.80	48.20	48.40	59.20	59.31	59.61	60.00
Soybean meal	26.10	26.70	27.30	28.10	20.80	21.55	22.10	22.60
Sunflower meal	5.50	4.00	2.50	1.00	5.50	4.00	2.70	1.30
Fennel seed meal	-	0.50	1.00	1.50	-	0.50	1.00	1.50
Soybean oil	1.55				2.40	2.50		
Fish meal	5.00					4.00		
Gluten meal	2.00					3.50		
Blood meal	8.00					-		
Table salt	0.30					0.50		
Monocalcium phosphate	1.00					1.00		

Table 2. Continued

Indicator	Age of quail 1-21 days				Age of quail 22-42 days			
	Group							
	Control	Experimental			Control	Experimental		
	1	2	3	4	1	2	3	4
Crushed shell	1.00					1.00		
L-Lysine	0.04	0.03		0.02	0.11	0.08	0.07	
L-Threonine	-	0.01			-			
DL-Methionine	0.10	0.11		0.12	0.02			0.03
Premix	2.00				2.00			

Source: developed by the authors

To incorporate fennel seed meal into the composition of compound feeds for poultry, the proportion of sunflower meal and oil was reduced, while the amount of soybean meal was increased. The concentration of corn in the compound feeds also underwent minor changes. To adjust amino acid nutrition at the same level, the inclusion of necessary amino acids was modified. At the same time, the content of nutrients and energy was carefully considered, keeping them at a consistent level. Thus, at the age of 1-21 days, the quail feed contained 28.0% crude protein, 6.5% crude fat, 3.5% crude fibre, 1.79% lysine, 1.01% methionine with cystine, 1.15% threonine, 0.35% tryptophan, 1.0% calcium, 0.8% phosphorus, and 0.4% sodium, with an energy value of 12.5 MJ per kg. Birds aged 22 days and older consumed compound feed with an energy value of 12.9 MJ and a crude protein content of 20.5%, crude fat – 7.3%, crude fibre – 3.4%, lysine – 1.03%, methionine with cystine – 0.74%, threonine – 0.77%, tryptophan – 0.21%, calcium – 1.0%, phosphorus – 0.8%, and sodium – 0.5%. Thus, the nutritional value of the compound feeds for the main nutrients and energy was kept at the same level.

Every week, the quails were weighed, and the survival rate of the chicks and feed consumption were monitored. At the age of 42 days, a control slaughter of the birds was conducted, for which 4 birds were selected from each group, with their weights being as close as possible to the average for the group. The maintenance and slaughter of the birds were carried out in accordance with the requirements of current legislation (European Convention, 1986; Council Directive 1998/58/EU, 1998; Council Directive 1999/74/EC, 1999; Council Directive 2010/63/EU, 2010; Law of Ukraine No. 3447-IV, 2006).

Results and Discussion

Body weight is the primary method for assessing poultry productivity during meat production. During the scientific and economic experiment, these indicators were monitored weekly by weighing the quails (Table 3).

Table 3. *Dynamics of body weight of the experimental quails, g*

Group	Age, days						
	1	7	14	21	28	35	42
1 Control	10.01± 0.053	39.98± 0.317	93.73± 0.482	148.73± 2.278	202.03± 2.546	241.07± 3.142	283.25± 4.454
2 Experimental	10.05± 0.057	40.34± 0.304	94.55± 0.601	151.69± 1.923	205.08± 2.680	245.10± 3.498	287.80± 4.487
3 Experimental	10.02± 0.058	40.58± 0.321	95.51± 0.594*	151.99± 2.076	206.43± 2.618	247.42± 3.528	290.32± 4.110

Table 3. Continued

Group	Age, days						
	1	7	14	21	28	35	42
4 Experimental	9.98± 0.050	40.77± 0.318	96.96± 0.574**	152.73± 2.112	207.98± 2.622	249.33± 3.313	293.00± 4.462

Note: *P < 0.05, **P < 0.01 compared to the 1st control group
Source: developed by the authors

At the beginning of the scientific and economic experiment, the birds of the control and experimental groups were balanced by body weight, so the difference between the groups did not exceed 0.07 g or 0.7%. At the age of 7 days, the quails of the 4th experimental group showed the greatest advantage over the control in live weight – by 0.79 g or 1.98%. The advantage of the birds in the 3rd experimental group was somewhat smaller – 0.60 g or 1.50%. The quails of the 2nd experimental group differed least from the control, surpassing the control birds by 0.36 g or 0.90%. This difference was not statistically significant. Two weeks after the start of the scientific and economic experiment, the difference between the birds in the 3rd and 4th experimental groups and the control was 1.78 g or 1.90% and 2.23 g or 2.38%, respectively, and was statistically significant. The advantage of the birds in the 2nd experimental group at this age was 0.82 g or 0.87%.

Weighing of the quails at the age of 21 days showed the previously established trend. The leading body weight indicators were observed in the birds of the 4th experimental group, exceeding the control counterparts by 4.00 g or 2.69%. The birds in the 3rd and 2nd experimental groups exceeded the control by 3.26 g and 2.96 g, or 2.19% and 1.99%, respectively. The difference in body weight between the groups at this age was not statistically significant. At the end of the fourth week of rearing, the body weight of the birds in the 4th experimental group showed an advantage over the control by 5.95 g or 2.95%. The difference between the control and the birds in the 3rd experimental group was somewhat smaller – 4.40 g or 2.18% in favour of the experimental group. The birds in the 2nd experimental group surpassed the control counterparts in body weight by the least amount – by 3.05 g or 1.51%. As in the previous weighing, at the age of 28 days, the difference in body weight between the groups was not statistically significant.

The penultimate control weighing showed no changes in the distribution of leading positions between the groups. The animals in the 4th experimental group continued to demonstrate the highest body weight, exceeding the control counterparts by 8.26 g or 3.43%. The birds in the 3rd experimental group surpassed the control by 6.35 g or 2.63%. The birds in the 2nd experimental group differed least from the control during this period, surpassing the control by 4.03 g or 1.67%. No statistically significant difference between the groups was found during this weighing. The final weighing of the birds, conducted at the age of 42 days, once again confirmed that the greatest advantage in body weight over the control animals was recorded in the birds of the 4th experimental group – by 9.75 g or 3.44%. The quails in the 3rd experimental group also surpassed the control counterparts in this indicator by 7.07 g or 2.50%. The quails in the 2nd experimental group had the smallest difference in body weight from the control animals – by 4.55 g or 1.61%. It is worth noting that there was no statistically significant difference between the animals of the different groups.

Analysing the survival rate of the quails, it can be stated that there was no dependence between the proportion of fennel seed meal in the compound feeds and the mortality of the birds.

During the entire scientific and economic experiment, the losses of quails in the 1st control, 3rd, and 4th experimental groups amounted to 7 birds in each group, which is 7% in percentage terms. The mortality rate in the 2nd experimental group was 8 birds, or 8%, which was 1% higher than the control value. Analysing the feed consumption per unit of body weight gain in quails throughout the entire scientific and economic experiment, it can be noted that this indicator was the highest in the birds of the 1st control group and the lowest in the animals of the 4th experimental group. Therefore, the birds in the 4th experimental group had a disadvantage compared to the control group by 125 mg/g or 3.30%. At the same time, the birds in the 3rd and 2nd experimental groups also had a disadvantage compared to the control animals by 69 mg or 1.82% and 47 mg or 1.24%, respectively.

Most often, quail are marketed to the final consumer in the form of dressed carcasses. According to the research results, the weight of the dressed carcass of the birds in the 2nd experimental group was 2.8 g or 1.33% higher than the control indicator. The advantage of the birds in the 3rd experimental group over the control was 5.4 g or 2.57%. The quails in the 4th experimental group surpassed the control by 7.4 g or 3.52% in the weight of the dressed carcass. The difference between the birds in the 4th experimental group and the control group for the weight of the dressed carcass was statistically significant. For an objective assessment of the slaughter qualities of the quails, a comparison of the yield of semi-dressed and dressed carcasses was conducted (Table 4).

The yield of semi-dressed carcass in the 2nd and 3rd experimental groups was identical to the control indicator. In the birds of the 4th experimental group, the yield of the semi-dressed carcass was 0.1% higher than in the control counterparts. A similar difference was observed between the animals of the different groups for the weight of the dressed carcass. Specifically, the quails of the 2nd and 3rd experimental groups were equal to the control animals, while the 4th experimental group surpassed the control by 0.1%. Changes in the feeding of quails had an impact on their growth, but it is important to know which tissues and organs contributed to the increase in body weight (Table 5).

Table 4. *Slaughter qualities of quails, % of pre-slaughter weight*

Indicator	Group			
	Control	Experimental		
	1	2	3	4
Yield of semi-dressed carcass	81.0±0.20	81.0±0.20	81.0±0.17	81.1±0.20
Yield of dressed carcass	73.8±0.25	73.8±0.23	73.8±0.25	73.9±0.25

Source: developed by the authors

Table 5. *Weight of edible parts, g*

Indicator	Group			
	Control	Experimental		
	1	2	3	4
Breast muscles	47.9±0.68	48.9±0.59	49.4±0.65	49.8±0.24
Leg muscles	29.4±0.27	30.1±0.32	30.3±0.34	30.4±0.37
Skin	17.9±0.28	18.1±0.17	18.2±0.38	18.3±0.24
Internal fat	2.2±0.11	2.3±0.09	2.3±0.08	2.3±0.09
Liver	6.8±0.09	6.8±0.08	6.9±0.10	6.9±0.04
Lungs	2.5±0.06	2.5±0.07	2.5±0.08	2.6±0.09
Kidneys	1.5±0.05	1.5±0.05	1.5±0.13	1.5±0.05

Table 5. Continued

Indicator	Group			
	Control	Experimental		
	1	2	3	4
Gizzard muscles	5.2±0.09	5.4±0.19	5.5±0.18	5.6±0.06*
Heart	2.2±0.05	2.3±0.11	2.4±0.13	2.4±0.12

Source: developed by the authors

The difference in the mass of breast muscles between the control and experimental groups of quails was quite significant, though statistically not meaningful. The birds in the second experimental group had 1.0 g or 2.09% more breast muscle mass compared to the control group, the third experimental group had 1.5 g or 3.13% more, and the fourth experimental group had 1.9 g or 3.97% more. The mass of the lower limb muscles in the birds of the second experimental group was 0.7 g or 2.38% higher than that of the control animals. The third experimental group had 0.9 g or 3.06% more, and the fourth experimental group had 1.0 g or 3.40% more. The animals in the second experimental group had 0.2 g or 1.26% more skin mass than the control group. The third experimental group had a slightly greater advantage, 0.3 g or 1.68%, over the control group. The largest difference was observed in the fourth experimental group, with a 0.4 g or 2.23% higher skin mass than the control animals.

Due to the mass of internal fat, quails in all experimental groups exceeded the control animals by 0.1 g or 4.55%. The liver mass of the quails in the second experimental group was identical to the control value. The animals in the third and fourth experimental groups exceeded the control animals by 0.1 g or 1.47%. The quails in the second and third experimental groups had equal lung mass to the control counterparts. However, the animals in the fourth experimental group exceeded the control animals in this indicator by 0.1 g or 4.00%. In terms of kidney mass, the quails in the experimental groups were equal to the control counterparts. The muscle stomach mass in the birds of the second experimental group was greater than that of the control group by 0.2 g or 3.85%. The quails in the third experimental group exceeded the control counterparts by 0.3 g or 5.77%. The greatest and statistically significant advantage over the control was observed in the animals of the fourth experimental group, which was 0.4 g or 7.69%. In the birds of the second experimental group, the heart mass was higher than the control value by 0.1 g or 4.55%. The quails in the third and fourth experimental groups exceeded the control animals in heart mass by 0.2 g or 9.09%. To simplify the evaluation of the changes that occurred upon the introduction of fennel meal into the compound feed, a calculation was made of the yield of edible body parts of the quails – the ratio of their mass to the mass of the dressed carcass (Table 6).

Table 6. *Yield of edible parts, % of the pre-slaughter body weight*

Indicator	Group			
	Control	Experimental		
	1	2	3	4
Breast muscles	16.82±0.170	16.95±0.130	16.94±0.180	16.91±0.090
Leg muscles	10.35±0.060	10.44±0.050	10.37±0.120	10.33±0.150
Skin	6.30±0.110	6.27±0.090	6.24±0.110	6.23±0.090
Internal fat	0.78±0.040	0.78±0.030	0.78±0.030	0.79±0.030

Table 6. Continued

Indicator	Group			
	Control	Experimental		
	1	2	3	4
Liver	2.39±0.020	2.37±0.020	2.36±0.020	2.35±0.010
Lungs	0.87±0.020	0.87±0.020	0.87±0.020	0.88±0.030
Kidneys	0.52±0.020	0.51±0.020	0.51±0.040	0.51±0.020
Gizzard muscles	1.83±0.020	1.88±0.050	1.89±0.050	1.91±0.020
Heart	0.79±0.010	0.79±0.040	0.81±0.040	0.81±0.040

Source: developed by the authors

The leader among the experimental groups in terms of the yield of breast muscles was the quails of the second experimental group, exceeding the control animals by 0.13%. The advantage of the birds in the third experimental group over the control counterparts was slightly lower, specifically 0.12%. The smallest difference from the control was observed in the animals of the fourth experimental group, which exceeded the control value by 0.09%. In terms of the yield of lower limb muscles, quails in the second and third experimental groups surpassed the control animals by 0.09% and 0.02%, respectively, while the birds in the fourth experimental group were inferior to the controls by 0.02%. The skin yield in quails of the second, third, and fourth experimental groups was lower than the control by 0.03%, 0.06%.

In the quails of the second and third experimental groups, as well as the first control group, the yield of internal fat was the same. The animals in the fourth experimental group exceeded the control animals by 0.01% in this indicator. The liver yield in the quails of the second experimental group was 0.02% lower than the control. The animals in the third experimental group were inferior to the control counterparts by 0.03%, and the birds in the fourth experimental group by 0.04%. The birds in the second and third experimental groups, as well as the quails in the first control group, had the same lung yield. The animals in the fourth experimental group exceeded the control animals by 0.01% in this indicator. The kidney yield in the birds of the experimental groups was the same and 0.01% lower than the control value. The advantage of the birds in the second experimental group over the control in terms of muscle stomach yield was 0.05%. The animals in the third experimental group exceeded the control counterparts by 0.06%, and the representatives of the fourth experimental group by 0.08%. The animals in the third and fourth experimental groups exceeded the control in terms of heart yield by 0.02%, while the birds in the second experimental group were equal to the control in this indicator.

In the last two decades, phytogenic substances found in plants have become increasingly popular as feed additives in poultry farming. In their review, M. Kumar *et al*. (2014) propose over 20 different feed additives with antimicrobial, anti-inflammatory, antioxidant, and immunostimulatory properties for use in animal feeding. N. Abdelli *et al*. (2021) add that the positive impact of phytobiotic feed additives on animal productivity can be explained by their ability to enhance feed efficiency by stimulating the production of digestive secretions, improving nutrient absorption, as well as reducing pathogenic load in the intestine and decreasing the strain on the animals' immune system.

There is limited data in the available scientific literature on the use of fennel meal in animal and poultry feeding. In studies by M. Henda (2014) conducted on young Japanese quails, the effectiveness of including fennel meal at 0.25 g, 0.50 g, or 0.75 g per 1 kg of compound feed was examined. The best feed conversion and body weight gains were observed at a fennel meal dose of 0.5 g/kg, but other tested levels of the feed additive also contributed to improved poultry productivity and feed efficiency. Additionally, the study noted a slight increase in the yield of the heart, liver, and stomach. These results align with current research findings, which recorded increased productivity, feed consumption, and yields of the stomach and heart. However, the liver yield, according to the experiment described in this article, was reduced.

It is also worth considering the results of feeding Japanese quails aged 15-42 days with complete compound feeds containing 5-15% papaya leaf meal, published by K. Ampode (2019). Positive changes in quail productivity and feed conversion were noted only at the 5% papaya leaf meal dose. At 10% of this feed additive, the productivity of the birds was equal to the control, but feed conversion was better than the control values. The inclusion of 15% papaya leaf meal in the compound feed was worse than the control data in both productivity and feed conversion.

Conflicting data were obtained from the use of ginger meal in broiler chick feeding. S. Ndams *et al*. (2024), when feeding chicks with 0.1%, 0.2%, and 0.3% ginger meal in the compound feed, noted a positive effect only at the 0.2% dose. At this level of ginger meal in the feed, an increase in body weight gain, feed consumption, and feed conversion was recorded. It is important to note that similar indicators in the birds consuming diets with 0.1% and 0.3% ginger meal were lower than the control.

Feeding broiler chicks with various doses of cashew nut meal in compound feeds showed that the addition of 2% positively affected chick growth, feed consumption, and feed conversion. H. Yusuf & M. Aliyu-Paiko (2020) claim that increasing the proportion of cashew nut meal to 4% negatively affected these indicators, as their levels worsened relative to the control.

Regarding the use of fennel, most of the conducted studies focus on the use of oil or ground seeds in poultry feeding. In particular, K. Premavalli & A. Omprakash (2020) concluded that the highest productivity in terms of body weight, feed conversion, and survival of young quails was achieved at a 1.5% fennel seed dose in the compound feed. At the same time, the inclusion of this feed additive at 0.5% and 1.0% was also effective, but with lower results.

Slaughter quality of adult quails fed 2.0% fennel seed in the complete compound feed in the studies by N. Coşkun Çetin *et al*. (2022) was significantly higher than the control values. Positive effects on the slaughter qualities of quails were also observed at 1.0% and 4.0% fennel seed concentrations in the feed mixture.

In previous studies by the authors of this paper, the inclusion of 0.1-0.3% fennel oil in the compound feed resulted in an increase in average daily weight gain by 0.34-0.46 g, or 5.22-7.07% compared to the control, an increase in feed consumption by 2.41-4.49%, a decrease in feed conversion by 5.04-6.97%, and an improvement in the slaughter qualities of the birds. The best results were observed in quails whose compound feed contained 0.3% fennel oil. Thus, the inclusion of fennel meal has a slight positive effect on the productivity of quails with a meat production focus. However, the addition of fennel oil or seeds has a greater impact on the productivity of these animals, as evidenced by the results of various studies.

Conclusions

The main biologically active compounds of fennel that have antimicrobial properties are found in its oil, the content of which in the meal is minimal. This is why the effect on productivity was minimal with the addition of a small amount of this phytobiotic. Based on the results of the experiment, it can be stated that the use of fennel seed meal in the feeding of meat-type quails aged up to 42 days, at a dose of 0.5-1.5% in complete compound feeds, positively affects the growth of these animals, their survival, and slaughter indicators.

Among the tested doses of the specified feed additive, the highest growth rates were observed in the birds whose compound feed contained 1.5%. The weighing results showed that the quails in this experimental group demonstrated the greatest growth dynamics. At 7 days of age, their weight exceeded the control by 1.98%, and by 42 days, this difference increased to 3.44%. At the same time, the quails in the second and third experimental groups also had higher body weight, but with a less pronounced trend. The animals in this group also demonstrated the best feed conversion rate. Lower concentrations of fennel meal also had a positive effect on the animals' productivity, but the difference compared to the control group was minimal.

The analysis of slaughter qualities of the quails indicates a positive effect of feeding with fennel meal on the final productivity of the birds. The highest carcass weight was recorded in the quails of the experimental group, whose compound feed contained 1.5% fennel meal. It is worth noting that in the birds of the experimental groups, an increase in the weight of the breast muscles, lower limb muscles, and the gizzard was observed. The highest indicators for these criteria were also observed in the quails that consumed compound feed with 1.5% fennel meal. In the future, it will be relevant to study the optimal combination of different forms of fennel (oil, seeds, and meal) in the compound feeds of meat-type quails to achieve the best zootechnical indicators, product quality, and economic efficiency.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

[1] Abdelli, N., Solà-Oriol, D., & Perez, J.F. (2021). Phytogenic feed additives in poultry: Achievements, prospective and challenges. *Animals*, 11(12), article number 3471. doi: 10.3390/ani11123471.

[2] Aktaran Bala, D. (2023). Physiological effects and uses of some phytobiotic compounds – a review. *Agrarian Bulletin of the Black Sea Littoral*, 108, 123-127. doi: 10.37000/abbsl.2023.108.19.

[3] Alabi, O.J., Makinde, O.J., Egena, S.S.A., Mbajiorgu, F.E., & Adewara, O. (2023). Antibiotics in broilers chicken production: A review of impacts, challenges and potential alternatives. *Veterinary Integrative Sciences*, 22(2), 559-578. doi: 10.12982/VIS.2024.039.

[4] Alghirani, M.M., Chung, E.L.T., Jesse, F.F.A., Sazili, A.Q., & Loh, T.C. (2021). Could phytobiotics replace antibiotics as feed additives to stimulate production performance and health status in poultry? An overview. *Journal of Advanced Veterinary Research*, 11(4), 254-265.

[5] Ampode, K.M.B. (2019). Papaya (*Carica papaya* Linn.) leaf meal as phytobiotic feed supplement improves the production performance of growing Japanese quails. *International Journal of Biosciences*, 14 (5), 534-541. doi: 10.12692/ijb/14.5.534-541.

[6] Arif, M.S., Hamid, M.M.A., Raheem, A., & Khalil, M.Z. (2024). Phytobiotics as an alternative to antibiotics in poultry. *Biological Times*, 3(6), 21-22.

[7] Balji, Yu., Zhanabayeva, D., Sultanayeva, L., Yeszhanova, G., & Mussagiyeva, D. (2024). Effect of feed with extruded components and phytobiotics on quail. *Scientific Horizons*, 27(9), 32-41. doi: 10.48077/scihor9.2024.32.

[8] Coşkun Çetin, N., Erdem, İ., Durusoy, Ö.F., Alaşahan, S., & Çimrin, T. (2022). The effect of supplementation of fennel (*Foeniculum vulgare* Mill.) to the feed on egg production, slaughter and carcass characteristics, formation of parasites in the intestine and spermatological quality in Japanese quail during the laying period. *Dicle University Journal of Faculty of Veterinary Medicine*, 15(2), 85-92. doi: 10.47027/duvetfd.1159507.

[9] Council Directive 1998/58/EU Concerning the Protection of Animals Kept for Farming Purposes. (1998, July). Retrieved from https://surl.li/osyhnq.

[10] Council Directive 1999/74/EC Laying Down Minimum Standards for the Protection of Laying Hens. (1999, July). Retrieved from https://surl.li/obtobk.

[11] Directive 2010/63/EU of the European Parliament and of the Council on the Protection of Animals Used for Scientific Purposes. (2010, September). Retrieved from https://surl.li/gqgdbs.

[12] European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes. (1986, March). Retrieved from https://rm.coe.int/168007a67b.

[13] Henda, A.M. (2014). Response of growing Japanese quail to different level of fennel seed meal. *Egyptian Poultry Science Journal*, 34(3), 795-807. doi: 10.21608/epsj.2014.5362.

[14] Ibatullin, I., *et al*. (2022). Influence of feeding wormwood (*Artemisia Capillaris*) on quail meat productivity. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 70(4-5), 307-316. doi: 10.11118/actaun.2022.023.

[15] Islam, R., & Sheikh, I.U. (2021). Phytobiotics in poultry production. In S. Sreedhar & S. Bindumadhuri (Eds.), *Recent research in animal husbandry and veterinary sciences* (Vol. 2) (pp. 13-36). Delhi: Integrated Publications. doi: 10.22271/int.book.71.

[16] Kumar, M., Kumar, V., Roy, D., Kushwaha, R.B., & Vaiswani, S. (2014). Application of herbal feed additives in animal nutrition – a review. *International Journal of Livestock Research*, 4(9), 1-8. doi: 10.5455/ijlr.20141205105218.

[17] Law of Ukraine No. 3447-IV “On the Protection of Animals from Cruelty”. (2006, February). Retrieved from https://zakon.rada.gov.ua/laws/show/3447-15#Text.

[18] Ndams, S.S., Dare, T.A., & Elaigwu, S. (2024). Assessment of growth performance of finished broiler chickens fed supplemented ginger meal as a phytobiotic feed additive. *Animal Research International*, 21(2), 5548-5552.

[19] Premavalli, K., & Omprakash, A.V. (2020). Effect of dietary supplementation of fennel seeds (*Foeniculum vulgare* Mill.) on production performance of Japanese quail (*Coturnix japonica*). *Journal of Entomology and Zoology Studies*, 8(2), 1588-1590.

[20] Rafeeq, M., Bilal, R.M., Alagawany, M., Batool, F., Yameen, K., Farag, M.R., Ali, S., Elnesr, S.S., & El-Shall, N.A. (2022). The use of some herbal plants as effective alternatives to antibiotic growth enhancers in poultry nutrition. *World's Poultry Science Journal*, 78(4), 1067-1085. doi: 10.1080/00439339.2022.2108362.

[21] Ullah, A., Ramzan, M., Hussain, J., Waqas, M., Hameed, S., Nadeem, M.A., Suleman, M., Mushtaq, M., Abdullah, O.M., & Gulzar, M.W. (2024). Use of botanicals for prevention and treatment of different poultry diseases. In R.Z. Abbas, A.M.A. Khan, W. Qamar & S. Mehnaz (Eds.), *Complementary and alternative medicine: Botanicals/homeopathy/herbal medicine* (pp. 65-75). Faisalabad: Unique Scientific Publishers. doi: 10.47278/book.CAM/2024.041.

[22] Urban, J., Kareem, K.Y., Matuszewski, A., Bień, D., Ciborowska, P., Lutostanski, K., & Michalczuk, M. (2024). Enhancing broiler chicken health and performance: The impact of phytobiotics on growth, gut microbiota, antioxidants, and immunity. *Phytochemistry Reviews*. doi: 10.1007/s11101-024-09994-0.

[23] Yusuf, H.U., & Aliyu-Paiko, M. (2020). Evaluation of cashew nut meal as phytobiotics in diet of broiler chickens and effects on feed efficiency, growth performance, blood metabolic and antioxidant profiles. *International Journal of Veterinary Sciences and Animal Husbandry*, 5(1), 108-114.

Ефективність використання шроту фенхелю (*Foeniculum vulgare*) у годівлі молодняку перепелів

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Анотація. Насіння фенхелю вважається потужним фітобіотиком і може бути використане у годівлі молодняку птиці як альтернатива антибіотикам, які застосовують з метою покращення продуктивності птиці та профілактики низки захворювань шлунково-кишкового тракту. Проведений науково-господарський дослід був присвячений дослідженню впливу згодовування шроту з насіння фенхелю на продуктивність та забійні якості перепелів м'ясного напряму продуктивності. За результатами експерименту серед досліджуваних доз шроту фенхелю, а саме 0,5 %, 1,0 % та 1,5 %, найвищої продуктивності досягла птиця, яка споживала повнораціонні комбікорми з вмістом 1,5 % вказаної кормової добавки. Перепели цієї групи перевищили контрольні показники за масою на 9,75 г або 3,44 %. За вмісту 1,0 % шроту фенхелю у складі комбікорму маса тіла птиці була на 7,07 г або 2,50 % вищою за контроль. Споживаючи комбікорми з вмістом 0,5 % шроту фенхелю, перепели переважали контрольний показник за масою тіла лише на 4,55 г або 1,61 %. Різниця між групами за масою тіла не була статистично значущою. За виходом тушки від контролю незначно відрізнялися, а саме переважали на 0,1 % лише перепели, що споживали з кормом 1,5 % шроту фенхелю. За виходом їстівних частин тушки привернула увагу тенденція до збільшення виходу м'язів грудей у птиці дослідних груп, а також підвищення виходу шлунку, яке було підтверджене статистичною значущістю різниці між контрольною групою перепелів та птицею, яка споживала 1,5 % шроту фенхелю. Таким чином, можна стверджувати, що згодовування до 1,5 % шроту фенхелю у складі повнораціонних комбікормів позитивно впливає на продуктивність перепелів м'ясного напряму продуктивності

Ключові слова: фітобіотики; продуктивність; м'ясне птахівництво; забійні якості; відходи олійноекстракційного виробництва