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Original research

Efficiency assessment of organic protein formulation for quail feeding

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Abstract. The observation presents the comparative analysis of feed additive that produced with ecologically safe organic protein formulation. The practical value of the research lies in the introduction of an organic supplementation, obtained on the base of manure, processed and disinfected, into poultry feeding. The search of fodders and feed additives from non-traditional raw materials, which can be used in poultry feeding, is one of the main ways to improve the full-value and availability of combined feed for poultry. Therefore, the purpose of the study was aimed to assess the efficacy of organic protein supplement for quail feeding. The research was carried out with "Faraon" quail kind in the farm that belongs to the "Agrocenter" poultry farm. To assess the effect of feed additive contained organic protein formulation (OPF) the quails were divided into three groups. Control group (I) fed with basal diet, second group (II) additionally supplemented with 5.0% (PF-5) in respect with feed weight, and third group additionally supplemented with 10.0% (PF-10). Any harmful effect of PF consumption was no observed. Furthermore, the PF supplementation provide the growth of bird weight for 14.2% in PF-5 group in compare to control group. Contrary, PF supplementation in PF-10-exposed group induced decrease in productive index equal aforementioned data. The II experimental group has developed he best results for egg laying per initial and average layer. Quails of the PF-10 group has shown more low results in compare to the PF-5-exposed group, but higher than their peers of the control group. Another result was observed in respect with the measuring of feed consumption per unit of production. Quails of PF-5 group had the lowest feed consumption per 1 kg of egg mass – 3.38 kg, which is by 7.4% lower than the peers from the control group. The research results showed that the OPF produced with using dry poultry manure has no developed a negative effect in respect with the chemical and morphological composition of eggs, quails from the II experimental group had the best indicators. The economic efficiency of PF exposure organic protein supplement in the production of quail egg was established with the introduction of 5.0% into the compound feed. Taking together present results, dry poultry manure can be considered as promising alternative source for OPF feed additive production. Firstly, OPF contains protein and minerals which important for the production of poultry compound feed. The utilization of secondary resources in the agricultural technology cycle has the beneficial consequences for both to reduce significantly compound feed expenditures and to prevent the environment pollution.

Keywords: productivity; preservation; protein supplement; diet; compound feed; eggs; quality indicators.

Ефективність використання органічного білкового концентрату в годівлі перепелів

Анотація. Розглянуто проблему щодо використання екологічно безпечного органічного концентрату в годівлі перепелів. Практична цінність досліджень полягає у впровадженні в годівлю птиці органічного концентрату збагаченої протеїном добавки (ОПД), отриманого на основі посліду, переробленого і знезараженого. Одним з основних шляхів покращення повноцінності й доступності комбікормів для птиці, є пошук імпортозамінних кормів і кормових добавок з нетрадиційної сировини, яку можна використовувати у годівлі птиці. Тому й мета наших досліджень була направлена саме на вивчення ефективності використання органічної білкової добавки у годівлі перепелів. Дослідження були проведені на перепілках породи “Фараон” в умовах птахофабрики “Агроцентр”. Під час проведення досліду було встановлено, що введення у раціон перепелів кормової добавки в кількості 5,0 % та 10,0 % від маси комбікорму, не мало негативного впливу на його споживання. Згодовування комбікорму з введенням до його складу 5,0 % білкового концентрату, сприяло збільшенню продуктивності перепелів другої (ПД-5) групи на 14,2 % у порівнянні з контрольною групою. Перепела третьої (ПД-10) групи, які у складі раціону отримували 10,0 % білкового концентрату, мали нижчі показники продуктивності у порівнянні з контрольною групою. Кращими показниками несучості на початкову та середню несучку характеризувалася ПД-5 дослідна група. Перепела ПД-10 групи мали нижчі результати у порівнянні з другою, але вищі за показники контрольної групи. Аналогічна картина спостерігалася і за показниками витрати кормів на одиницю продукції. Найменша витрата корму на 1 кг яйцемаси була встановлена у перепелів ПД-5 групи – 3,38 кг, що на 7,4 % нижче аналогів контрольної групи. Результати проведених досліджень показали, що

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додавання органічного концентрату виробленого на основі сухого пташиного посліду до складу комбікормів не мало негативного впливу на хімічний та морфологічний склад яєць. Економічна доцільність використання органічного білкового концентрату в яєчному перепелівництві була встановлена за умов додавання у комбікорм 5,0 %. Загалом, представлені результати дозволяють розглядати сухий пташиний послід як перспективне альтернативне джерело, перш за все, протеїну та мінеральних речовин при виробництві комбікормів для птиці. Використання вторинних ресурсів у технологічному циклі сільськогосподарського виробництва не тільки суттєво знизить витрати концентрованих кормів і собівартість продукції, а й збереже довкілля від забруднення.

Ключові слова: продуктивність; збереженість; білкова добавка; раціон; комбікорм; яйця; якісні показники.

Introduction

Worldwide progress in order to provide human with meat requires extensive farming to produce animal origin protein where special attention is paid to the development of the poultry industry. Poultry farming progress leads not only to an increase in the production of meat and eggs, but also to an increase in the amount of poultry manure, which cannot be utilized used fully on farms and pollutes the environment (Orishhuk, 2019; Kucheruk, 2019; Osipenko & Merzlov, 2022). According to the legislation of most developed countries, processing and rational use of bird manure is a mandatory element in the technological process of poultry production (Mylovanov, 2018).

The applying of dry poultry manure as a feed additive in ruminant diets has been studied for a long time. For example, in Great Britain, the production of concentrated fodder for cattle, containing up to 50% of dry manure, has been put on an industrial base. In Slovenia a special instruction has been approved to provide feeding animals with poultry manure, but in compliance with sanitary conditions.

The recent published data indicate that a greater economic effect is noted with using dry poultry manure as a feed supplement than its application as an organic mineral fertilizer (Gacenko, 2014; Osipenko & Merzlov, 2023). Detailed calculation of several study showed that poultry manure contains 30-35% of dry matter; 28-33% of crude protein; 28% of raw ash; 3.4-5.0% of crude fat; 14-15% of crude fibre and 46-48% of nitrogen-free extractive substance, as well as 2.6% of calcium and 1.6% of phosphorus (Mel'nyk, 2016; Pepper & Dunlop, 2021).

The supplementation of dry poultry manure with dose 8.0% in respect to total compound feed instead of the same amount of sunflower mill cake for broilers demonstrated the highest intensity of weight gains in the exposed to manure group (Mel'nyk, 2018). Therefore, the applicatgion of organic products will allow to reduce significantly the cost of protein raw materials for the production of compound feed, on the one hand, and to reduce environmental pollution from poultry manure, on the other hand (Kanda, et al., 2015; Ryabinina & Melnik, 2022). Thus, the use of poultry biowaste, in particular, manure, processed and disinfected, as a highly effective feed supplement in the diet for animals and poultry is relevant. This will solve simultaneously the problem of manure disposal, thereby reducing the anthropogenic impact on agroecosystems and improving the ecological state of the environment (Jacenko, 2015; Orishchuk & Tsap, 2020; Tsap & Orishhuk, 2021; 2023).

The aim of our study was to assess the effectiveness of using organic protein supplement on quail productivity and egg quality indicators.

Materials and methods

The organic protein supplement was material for the study. In order to achieve the set goal, a scientific and economic experiment was carried out in the conditions of the Agricultural Centre "Agrocentr", the Dnipropetrovsk region. The study carried out with use 90 quails. The "Faraon" breed quails of 30 days aging were selected and caged accordingly farm requires. Taking into the account gender, body weight and general physiological state, three groups were formed accordingly the method of analogue groups including one control and two experimental groups. The quails of control group were fed with standard compound feed (CF) of the "Agrocentr" production. The quails of experimental groups PF-5 and PF-10 were fed with compound feed supplement with OPF in the doses 5.0% and 10,0%, respectively (Table 1). The duration of the experiment was 90 days.

Table 1 – The scheme of study

Group, (n = 30)	Feeding features
Control	Compound feed complete diet (CF)
PF-5	CF +5 % organic protein supplement
PF-10	CF +10 % organic protein supplement

Feeding was carried out twice a day, there was constant access to drinking water.

The study of the chemical composition of compound feed and egg samples was carried out with using next basic methods: the initial moisture content was determined by drying the samples in a drying oven at a temperature of 60-65 °C to a constant mass; hygroscopic moisture – by drying the samples at a temperature of 100-105 ºC to a constant mass; crude fibre – according to the method of Henneberg and Shtoman; crude fat – according to the Rushkovski method, counting to the amount of defatted residue in the Soxhlet apparatus when ether is used as a solvent; crude protein – according to the Kjeldahl method; raw ash – by the dry combustion method, i.e. burning the sample in a muffle furnace at a temperature of 450-500 °C. Exchangeable energy in feeds was determined by the calculation method based on the data of chemical analysis of feeds. Amino-acid composition of feeds was determined on automatic analyser AAA-881.

Results

The content of exchange energy and crude protein in the diet of quails from the control group was 1.32 MJ and 21%, respectively, the level of crude fibre was 4.0%. But quails' need for protein depends primarily on the availability of amino-acids in the feed, especially during the first two weeks of rearing. In compound feed, the level of lysine was 1.62%; methionine – 0.78%; tryptophan – 0.24%; threonine – 0.64%; calcium and phosphorus – 2.6 and 0.6%, respectively. The combined feed in the experimental groups was balanced in terms of all nutrients.

During the entire experimental period, the difference in feed consumption between the groups was insignificant and unreliable, which indicates a sufficiently high adaptation of the quails from the experimental groups to the new feed supplement. During the period of the experiment, the quails from the control group consumed 30.8 g of feed per head per day on average. Quails from the II experimental group consumed by 0.32% feed more, quails from the III group consumed by 0.62% less feed, respectively, compared to the control poultry. Thus, the use of organic supplement based on DPM for quail feeding in the doses of 5.0 and 10.0% of compound feed total weight did not induced a negative effect of feed additive consumption.

Table 2 – Chemical composition of experimental quail egg, %

Parameter, n = 10	Control	PF-5	PF-10
Egg white			
Moisture	86.3 ± 0.23	86.4 ± 0.22	86.7 ± 0.34
Dry matter	13.7 ± 0.24	13.6 ± 0.22	13.3 ± 0.31
Dry protein	11.3 ± 0.17	11.6 ± 0.23	10.9 ± 0.42*
Yolk			
Moisture	51.2 ± 0.39	52.3 ± 0.71	52.2 ± 0.39
Dry matter	48.8 ± 0.39	47.7 ± 0.70	47.8 ± 0.39
Dry protein	16.1 ± 0.21	16.2 ± 0.22	15.9 ± 0.08
Crude fat	29.4 ± 0.63	29.5 ± 0.64	29.1 ± 0.11

To assess the survival rate of livestock in groups PF-5 and PF-10 exposed to organic protein supplement of a standard diet was assessed as 100%.

The highest gross production of eggs was observed in the PF-5 group of quails with the consumption 5.0% of organic supplement in compound feed, and was 752 eggs (in 90 days), which is higher by 14.2% than in the control group. In the PF-10 group, which consumed 10.0% of the organic supplement. The egg production was lower in PF-10 group and amounted average 4.2% in compare to PF-5 group. The laying rate per initial layer in the PF-5 group was 66.02 pieces, which is by 19.9% higher than in the control group. Quails from the PF-10 group had worse results (2.63%) compared to the PF-5 group, but higher than the peers from the control group.

The laying rate per average layer with the introduction of organic supplement in compound feed in the amount 5.0% of the total weight was 66.02 pieces, which is higher by 24.2% than in the control and, in comparison with quails which received 10.0% – by 8.5%, respectively. It is important to note that egg-laying in the experimental groups of the quails began by 3 days earlier than in the control group, which indicates the stimulating effect of the supplement on egg-laying. Over the entire period of the experiment, the highest egg-laying intensity was observed in the II experimental group of quails, and was 77.85%, which is by 7.64% higher than in the control group.

Quails from the II group had the lowest feed consumption per 1 kg of egg mass – 3.38 kg, which is by 7.36% lower than the control value. Feed consumption per 100 eggs in the II experimental group of quails was 4.11 kg, which was lower than in the control group by 8.9%, while in the PF-10 this indicator was worse compared to the control.

The largest proportion of crude protein in the egg white mass was in the second experimental group – 11.6%, which is by 3.2% higher than in the control group. Quails that consumed 10.0% of the supplement had a worse result in terms of the level of protein in the egg white, it was 10.9%, which is by 2.74% lower than the control (Table 2).

The use of OPF supplement in the compound feed in a dose 10.0% (PF-10) led to decrease the protein content by 3.34% in dry matter.

The chemical composition of the yolk of the eggs in the control and exposed to OPF groups was differed slightly where some parameters were even at the same level as in the control group.

According to the morphological studies of eggs (Table 3), it was established that the highest weight of the yolk was noted in PF-5 group (3.66 g), which is by 1.05% higher compared to the analogues from the control and PF-10 groups. An increase in the yolk mass in the eggs from the experimental groups contributed to an increase in the ratio of white to yolk by 1.61 and 3.22%, respectively.

The results of the study have established that the addition of an organic supplement based on DPM to compound feed led to an increase in the shell thickness of quail eggs from the experimental groups by 4.54 and 9.10% compared to the control (Table 4).

The results showed that the eggs collected in PF-5 and PF-10 groups demonstrated dry matter content of the shell equal to 0.84% and 1.27%, and the raw ash content equal to 4.13% and 4.32% higher in compare to the egg shells and raw ash respectively of control group. The egg loss in exposed to OPF PF-5 and PF-10 groups was insignificant and amounted to 0.52%. Therefore, the supplementation of PF with compound feed in both exposed groups induced an increase in egg shell strength.

Table 3 – Morphological parameters of quail egg

Parameters, n=10	Control	PF-5	PF-10
Egg mass, g	11.53 ± 0.06	11.88 ± 0.09	11.36 ± 0.05
Mass of parts, g			
White	6.77 ± 0.08	6.92 ± 0.05	6.75 ± 0.11
Yolk	3.64 ± 0.025	3.66 ± 0.13	3.50 ± 0.05
Shell	1.12 ± 0.02	1.30 ± 0.02	1.11 ± 0.02
Ratio of the egg parts, %			
White	58.71 ± 0.36	58.25 ± 0.78	59.16 ± 0.65*
Yolk	31.57 ± 0.26	30.81 ± 0.78	30.81 ± 0.65*
Shell	9.71 ± 0.14	10.94 ± 0.07	9.78 ± 0.06
Ratio of white to yolk	1.86 ± 0.03	1.89 ± 0.07	1.92 ± 0.06
The changes in respect to control, %	100.00	101.61	103.22

Table 4 – Qualitative indicators of egg shells

Indicator, n = 10	Control	PF-5	PF-10
Thickness, mm	0.22 ± 0.037	0.23 ± 0.026	0.24 ± 0.026
Dry matter, %	97.27 ± 0.04	98.11 ± 0.04*	98.54 ± 0.07*
Crude ash, %	78.41 ± 1.11	82.54 ± 1.07*	82.73 ± 1.55*
Collected eggs, pcs.	658.0	752.0	686.0
Egg waste, pcs.	12.0	6.0	6.0
Egg breakage, pcs.	6.0	4.0	3.0
Egg breakage, %	0.93	0.52	0.52

The economic efficiency of PF application using organic supplement in quail egg production is established by blend it into the compound feed with the content of 5.0%. Feed costs per 1 kg of egg mass were by 16.2% lower, and nett profit was by 17.3% more compared to the control.

Discussion

The results of numerous studies confirm that the use of various non-traditional feed additives including processed and disinfected dry poultry manure in bird feeding had a positive effect on productivity and contributed to increasing the profitability of the poultry industry (Kanda et al., 2015; Pavlenko, 2016; Tsap & Orishhuk, 2021). Analysis of the results of recent research shows that today there is a wide range of studies of non-traditional feed additives that could be a source of nutrients in feeding poultry of various species (Orischuk et al., 2017; Osipenko & Merzlov, 2023). Therefore, in recent years, scientists have been conducting research on obtaining biologically pure products from production manure and its reuse as feed additives in poultry feeding (Shen et al., 2015; Abdigaliyeva et al., 2017).

The results of recent study of the feed composition showed that the compound feed, used in poultry feeding, can be deficient in terms of both energy and protein. Therefore, the problem of finding additional energy and protein sources is particularly relevant today (Artemieva & Logvinova, 2018; Orishchuk et al., 2019). Data observed in our study have showed that the introduction of protein supplement into the compound feed of quails (PF-5) in a dose of 5% increased productivity by 14.2%. At the same time, the laying rate per initial and average layer increased by 19.9 and 24.2%. The indicators of our research on the use of protein supplements are substantiated to some extent with other researchers (Otchenashko, 2013; Ibatullin et al., 2016). At the same time, the positive influence of the protein supplement on the chemical composition of eggs was confirmed experimentally. The level of crude protein in the egg white and yolk from the PF-5 group was 11.6 and 16.2%; from III experimental group – 10.9 and 15.9%. The introduction of organic supplement into the compound feed did not have a negative effect on the chemical composition, since the difference between the groups in this indicator was insignificant and statistically unreliable. The results of our research on egg quality indicators are confirmed by the data of other researchers (Inatomi, 2016; Lu et al., 2019).

A beneficial effect of OPF feed supplement on the morphological parameters of edible eggs was observed in present study. Feeding quails with 5% and 10% of protein supplement in compound feed was accompanied by a tendency to increase shell thickness by 4.5% and 9.1%. The data of our research are confirmed by the data of other scientists (Yalcin, 2014; Wang et al., 2017). There is an evidence that an increase in economic indicators is carried out due to an increase in the cost of selling eggs and a decrease in the cost of their production. In our research, feed consumption per 1 kg of egg mass was by 16.2% lower (PF-5 group) with using 5% protein supplement. The use of the supplement contributed to an increase in profitability by 17.3%. The present in our study data on reducing feed costs and increasing the level of profitability of egg production are agreed with the results reported other authors (Jessica & David, 2013). Feeding layers with protein concentrate in the dose of 10% increased productivity by 9.4% and improved the using of nutrients in the diet (Łozowicka et al., 2017).

Several authors claim that the addition of dry poultry manure to the compound feed of broiler chickens contributed to increase in weight gains and improved feed conversion (Orishhuk, 2019). The best effect in quail feeding can be obtained with the combined use of an untraditional supplement with a probiotic. After all, feed supplements for complete feeding play an important role as maintain high productivity, prevent stress and, ultimately, create a tool for efficient poultry production (Ibatullin et al., 2016).

Taking together literature data and the results present in our study, the current evidence showed that using the organic protein supplement as part of compound feed allowed to obtain additional production of quails and profits. Thus, present results construct the backgrounds for recommending this feed supplement to poultry farmers of different ownership types.

Conclusion

Organic protein supplement produced with dry poultry manure recycling is an ecologically safe feed additive. The introduction 5.0% of feed supplement into quail diets increased productivity by 14.2% and led to a 16.2% decrease in feed costs for the production of 1 kg of egg mass. It was proven experimentally that the addition of a feed supplement based on dry poultry manure to quail diets had a positive effect on the qualitative and morphological composition of quail egg.

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