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MODERN APPROACHES TO QUAIL NUTRITION: ENRICHED FEEDS AS A STRATEGY FOR ENHANCING MEAT PRODUCTIVITY

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Abstract. To enhance the meat productivity of quails, as well as to increase production volumes and improve the quality of poultry products, it is necessary to incorporate unconventional feed additives into the birds' diet. These additives promote the normalization of metabolic processes and improve nutrient digestibility. This article presents research findings on the meat productivity and nutritional value of Texan quail meat when using a compound feed enriched with the phytobiotic BioFeed-P and extruded corn. In the experimental group fed with the formulated compound feed, a 3.84% or 12.5 g advantage in live weight was observed by the end of the experiment. The absolute weight gain in the experimental group was 59.6±5.6 g, compared to 45.5 g in the control group. A notable advantage was also observed in the chemical composition of the meat, with the experimental group having a higher protein content of 21.89%. The fat percentage was slightly higher in the experimental group at 3.16%, with no significant differences in ash content between the groups. These findings are of interest to specialists in poultry farming and animal nutrition, and may prove valuable in formulating diets for fattening quails.

Keywords: Enriched feeds, phytobiotics, extrusion, quails, meat productivity, live weight, average daily gain, slaughter yield, survival rate, meat quality

Introduction. In recent years, the poultry industry in our country has achieved significant progress. With the current increase in poultry meat production, there is a growing need to improve its quality and diversify the range of products. Alongside the development of all types of poultry farming, quail farming stands out as a particularly promising direction, offering an efficient source of dietary and gourmet products, such as eggs and meat.

Quail meat is highly valued in many countries around the world, with its quality so esteemed that specialized farms for its production have been established in countries such as England, Germany, France, Italy, Canada, Yugoslavia, and others, ensuring efficient market distribution.

The wide range of applications of quail, both in dietary nutrition and for medicinal purposes, underpins the continued expansion of quail farming globally [1, 2].

Quail meat is popular among health-conscious consumers due to its high protein-to-fat ratio, low cholesterol content, and minimal intramuscular fat. Quail eggs are also prized for their high levels of fat-soluble vitamins, B vitamins, essential amino acids, and low levels of triglycerides, cholesterol, and saturated fatty acids [3]. Quail meat contains 25-27% dry matter, 21-22% protein, 2.5-4.0% fat, as well as significant amounts of vitamins, minerals, and essential amino acids [4].

The success of a poultry enterprise depends largely on feeding and management practices. Housing systems significantly affect poultry production and product quality [5]. Often, compound feeds are nutritionally incomplete, necessitating the inclusion of additives. Recently, the feed industry has focused considerable attention on a relatively new category of feed additives, known as phytogenic feed additives (PFA), derived from spices, herbs, or aromatic plants [6, 7, 8]. In our study, the compound feed was enriched with our developed phytobiotic feed additive, commercially named BioFeed-P, which contains over 250 biologically active components, including fatty acids, flavonoids, organic acids, essential oils, vitamins A, C, P, B12, trace elements, amino acids, and other biologically active compounds. This feed additive possesses bactericidal, fungicidal, antiviral, anti-inflammatory, antiseptic, immunostimulatory, detoxifying, tonic, regenerative, and analgesic properties, as well as a pronounced hepatoprotective and radioprotective effect.

Whole grain feed is the typical physical form of bird diets. However, the use of pelleted and extruded feed can improve poultry productivity by reducing feed losses, preventing selective feeding, and eliminating pathogenic microorganisms. Since quails have a rapid digestive process, extrusion is an appropriate treatment for feed preparation. In Murakami's study, the effect of feed form on quail productivity was examined. While physical form did not affect egg quality, pelleted feed improved productivity and increased egg weight [9]. In our developed compound feed formula, Finish, extruded corn was included. Moreover, contamination of feeds with mycotoxins, pathogenic microorganisms, and antinutritional factors remains a pressing issue, as they directly impact bird health and productivity. Barothermal treatment can reduce mycotoxin levels to regulatory standards and eliminate harmful microorganisms [10, 11].

Tushar Verma (2019) investigated the effectiveness of twin-screw extrusion in reducing Salmonella levels, considering fat content, moisture, temperature, and screw speed. At temperatures above 65°C, bacterial counts were below the detection limit (<10 CFU/g) [12]. The thermal resistance of different microbial groups varies widely, influenced by their structure, composition, and resistance mechanisms. A notable example of this diversity is the difference in thermal resistance between vegetative cells and spores of the same bacterial species. Bacterial spores are among the most resilient structures in nature, capable of withstanding pasteurization (DT values often exceed 1 minute at 100°C). In contrast, vegetative yeast cells are generally more sensitive to heat than bacterial vegetative cells. Yeasts and molds also exhibit a wide range of thermal resistance depending on their structure (sclerotia, hyphae, ascospores, etc.). Ascospores are particularly heat-resistant, with DT values similar to those of bacterial spores [13].

Extrusion's effectiveness is explained by the combined effects of temperature, which in this process ranges between 150-180°C, and pressure of 50 atm. Additionally, extrusion extends feed shelf life by significantly reducing moisture content. Using extruded by-products of grains and legumes provides nutritional, economic, and ecological advantages. Processing these wastes through extrusion improves their nutritional properties, while thermal treatment helps stabilize rancidity and provides microbiological control [14].

Data analysis suggests the necessity of studying the impact of phytobiotics and extruded feeds in quail diets on bird health and productivity, as well as the quality and safety of quail products. In this study, we present data on the effect of the developed Finish feed formula on the meat productivity and nutritional value of quail meat.

Materials and Methods. The experiments were conducted at a base farm in the Akmola region from June to August 2023. The object of the study was Texas quail (meat breed) with a total of 160 birds. Two groups were formed for the experiments: control and experimental (n=80 each).

Quails in the control group were fed a standard farm diet, while the birds in the experimental group were given an enriched compound feed, developed by LLP "NFT-KATU" at Saken Seifullin Kazakh Agrotechnical Research University. The feed composition was formulated based on recommendations from the Nutrient Requirements of Ring-Necked Pheasants (1994) and guidelines from the All-Russian Research and Technological Institute of Poultry (VNIITIP). The chemical composition of the compound feed was analyzed using the NIRS DS2500 infrared analyzer (FOSS Analytical A/S, Denmark).

The quail chicks were housed in cages equipped with water dispensers, and temperature and humidity sensors. The stocking density was 118–119 birds/m², in accordance with the recommended standards for quail rearing. The quails were raised from 7 days of age until 63 days, but the article reports data on the weight gain of quails from 45 days of age to analyze the Finish feed formula.

Weighing was carried out using standard zootechnical methods at the beginning, middle, and end of the fattening period. Birds were weighed individually upon arrival (160 birds) and then every 7 days until the end of the experiment using digital scales. During the trial, both groups of birds were kept under identical housing conditions. Feed was distributed manually according to the experimental scheme: during the first 2 weeks, chicks were fed 3 times a day, and thereafter, 2 times a day. At 63 days of age, the birds were slaughtered to study meat productivity and the chemical composition of the meat. Morphological composition of internal organs and tissues was examined after slaughter by anatomical dissection following standard guidelines.

All the parameters, except for live weight, were determined during the anatomical dissection of carcasses, conducted according to the unified methodology developed by VNIITIP, as well as the Interstate GOST 18292-2012 "Agricultural birds for slaughter. Technical conditions," GOST 31962-2013 "Chicken meat (whole carcasses and parts)," and GOST R 54673-2011 "Quail meat (carcasses). Technical conditions."

The chemical composition of quail muscle tissue was determined using standard methods: sample collection was carried out in accordance with GOST 9792-73, moisture content was determined by GOST 9793-74, fat content by GOST 23042-78, and protein content by GOST 25011-81.

Results and discussion. Achieving high productivity and quality products is impossible without providing birds with a complete and balanced diet, which should be formulated in accordance with the intended production direction. In this case, the experiment was conducted on meat-type quails. The formulation of the Finish compound feed included the following components: wheat – 39.54%, soybean meal/cake – 33%, fish meal – 13%, extruded corn – 10%, feed yeast – 2%, tricalcium phosphate – 1%, crushed shell and chalk – 1%, phytobiotic feed additive BioFeed-P – 0.060%, and table salt (NaCl) – 0.40%. The crude protein content in the experimental group was 27.6%, crude fat – 5.0%, and crude fiber – 3.49%. The metabolizable energy of the finished compound feed was 3357 kcal/kg, which is considered a high level. For comparison, the NRC recommends a diet with metabolizable energy (ME) of 2900 kcal/kg for Japanese quails during the initial phase and laying phase. Silva & Costa recommend similar values but divide quails into three distinct phases: 2900, 3050, and 2800-2850 kcal/kg ME for quails aged 1 to 21 days, 22 to 42 days, and during the first and second laying phases, respectively. Rostagno et al. recommend 2900 and 2800 kcal/kg ME for Japanese quails during the first and second growth phases, as well as the laying phase, when quails at this stage have a body weight of 177 g [15, 16, 17]. Table 1 shows the growth dynamics of quails from day 45 to day 63 when using the Finish feed formula.

Table 1 – Fattening results when using the Finish recipe, g

Age, day	Average weight, g	
	control groups	**experimental groups**
45	280,1±3,96	278,5±3,6
56	324,1±5,02	319,0±4,27
63	325,6±5,14	338,1±4,48

At the onset of the fattening period, the quails in the experimental groups exhibited a weight difference of 2 g. By the midpoint, the quails in the experimental group (EG) weighed nearly 4 g less than those in the control group (CG), with weights of 319.0±4.27 g and 324.1±5.02 g, respectively. However, by the end of the trial, the weight gain in the CG plateaued, with a mere 1.5 g increase over the course of a week, indicating that the birds had reached their maximum potential for weight gain based on the nutritional value of the feed they were provided. In contrast, the EG birds continued to gain weight, showing an increase of 20 g. By the end of the fattening period, the quails in the EG weighed 338.1±4.48 g, while the CG quails weighed 325.6±5.14 g. The values for absolute, average daily, and relative weight gain during the fattening period are shown in Table 2.

Table 2 – Indicators of absolute, average daily and relative growth during the fattening period

Indicator	control groups	experimental groups
Absolute weight gain, g	45,5±6,14	59,6±5,6
Average Daily weight gain, g	3,3±0,44	4,3±0,4
Relative weight gain, %	17,5±2,29	22,8±2,26

When calculating the absolute increase, it was revealed that the difference between the groups was 15.1±8.6 g. The average daily increase in poultry was 3.3± 0.44 g in KG, and 4.3± 0.4 g in OG, which is 1 g more. The relative increase, which shows the intensity of growth in OG, was higher by 5.6±3.33%.

Meat productivity was assessed based on the values of pre-slaughter live weight, gutted and semi-gutted weight, slaughter yield and mass of internal organs. During the veterinary and sanitary examination of quail carcasses, pathoanatomical changes and hemorrhages were not observed. All carcasses according to the results of the post-slaughter examination were benign. The results of meat productivity studies are presented in Table 3.

Table 3 – Meat productivity indicators

Indicator	Group (n=50)	
	control groups	**experimental groups**
Pre-slaughter mass, g	339±12,66	323±14,81
The mass of a half-gutted carcass, g	259±10,16	253±24,75
The mass of an eviscerated carcass, g	225±12,50	200±20,70
Slaughter yield, %	66,3	61,9
The mass of internal organs		
Muscular stomach, g	3,39±0,40	3,41±0,52
Heart, g	2,34±0,07	2,27±0,15
Liver, g	4,68±1,16	6,12±1,05

As shown in Table 3, the highest slaughter characteristics were observed in the experimental group. The data indicate that in the experimental group, where birds were fed according to the developed formula, the pre-slaughter weight was higher (339 g compared to 323 g in the control group), with a difference of 4.95% or 16 g. The weight of the semi-eviscerated carcass was also higher in the experimental group by 6 g. Regarding the eviscerated carcass, the experimental group exceeded the control group by 12.5%.

Additionally, the slaughter yield (the percentage ratio of the eviscerated carcass weight to the pre-slaughter weight) was higher in the experimental group (66.3%) compared to the control group (61.9%). This suggests more efficient utilization of bird mass in the experimental group.

Thus, the data show that the use of the developed feed formula can contribute to an increase in pre-slaughter weight, carcass weight, and slaughter yield in birds.

For a scientific interpretation of the data regarding the effects of the feed formula with phytobiotic and extruded components in the diet of quails, we analyzed changes in the weight of the gizzard, heart, and liver between the experimental and control groups.

In the experimental group, the average gizzard weight was 3.39 g with a standard deviation of 0.40, while in the control group, it was 3.41 g with a standard deviation of 0.52. These results indicate no significant difference in gizzard weight between the experimental and control groups.

In the experimental group, the average heart weight was 2.34 g with a standard deviation of 0.07, compared to 2.27 g with a standard deviation of 0.15 in the control group. The results show that the average heart weight in the experimental group was slightly higher than in the control group.

In the experimental group, the average liver weight was 4.68 g with a standard deviation of 1.16, while in the control group, it was 6.12 g with a standard deviation of 1.05. The data suggest that the average liver weight was lower in the experimental group compared to the control group, possibly indicating the influence of the developed feed formula on liver size in quails. In addition to meat productivity, the mineral composition of quail meat was also studied, as reflected in Table 4.

Table 4 – Chemical composition of quail meat

Indicator	control groups	experimental groups
Физико-химические показатели:		
Mass fraction of protein, %	21,89±0,41	21,49±0,64
Mass fraction of fat, %	3,16±1,21	3,13±1,49
Mass fraction of carbohydrates, %	not detected	not detected
Mass fraction of ash content, %	1,28±0,02	1,29±0,02

The mass fraction of protein in the quail meat from the experimental group, which was fed the enriched feed, is 21.89±0.41%. The margin of error indicates the relative precision of this measurement. Comparing the results of the two groups, it is evident that the protein content in the quail meat from the experimental group (21.89%) is slightly higher than in the control group (21.49%). No carbohydrates were detected in the meat, which underscores its dietary properties.

The average fat content in the quail meat from the experimental group is 3.16±1.21%. This means that the quail meat from the experimental group contains approximately 3.16 g of fat per 100 g of meat. The average fat content in the quail meat from the control group is 3.13±1.49%. Based on the provided data, the fat content in quail meat from both the experimental and control groups is nearly identical—3.16% and 3.13%, respectively. The deviations are also relatively close—1.21% and 1.49%.

There is no significant difference in the ash content between the two groups, with the experimental group showing 1.28±0.02% and the control group 1.29±0.02%. The results of the study of the mineral composition of quail meat are presented in Table 1.

Table 1 – Mineral composition of quail meat

Indicator	control groups	experimental groups
Mineral elements, mg/100 g		
1. potassium	223,3±3,35	240±0,86
2. phosphorus	174,3±1,50	178±1,71
3. iron	2,08±0,10	2,14±0,09
4. Copper	0,18±0,006	0,18±0,007
5. selenium	0,007±0,0005	0,007±0,001
6. Calcium	14,94±0,70	15,22±0,60
7. Magnesium	20,62±0,39	21,05±0,37
8. sodium	42,34±0,48	42,82±0,26
9. chlorine	not detected	not detected

The results indicate that both groups exhibit relatively high levels of minerals; however, some differences between the groups require interpretation. In the control group, the potassium content is 223.3±3.35 mg/100 g, while in the experimental group, it is 240±0.86 mg/100 g. This increase of 16.7 mg/100 g in the experimental group suggests a positive effect of the developed feed on potassium levels in quail meat. Potassium is an essential element that helps regulate fluid balance and supports optimal muscle function. The calcium content in the control group is 14.94±0.70 mg/100 g, compared to 15.22±0.60 mg/100 g in the experimental group. Although the difference is only 0.28 mg/100 g, this slight increase in the experimental group may indicate improved absorption of calcium, which is beneficial for bone tissue formation.

The magnesium level in the control group was 20.62±0.39 mg/100 g, while in the experimental group it was 21.05±0.37 mg/100 g. This increase of 0.43 mg/100 g may also be a positive outcome of the dietary changes, as magnesium is necessary for proper muscle and nervous system function, as well as for metabolism. Sodium levels in the control group were 42.34±0.48 mg/100 g, and in the experimental group, 42.82±0.26 mg/100 g. The difference of 0.48 mg/100 g suggests a slight improvement in the experimental group, which may be important for maintaining electrolyte balance. For elements such as copper and selenium, no differences were found between the groups. The absence of chlorine in the quail meat samples from both groups confirms compliance with safety and quality standards. This is significant, as the presence of chlorine in meat can be undesirable and potentially harmful for consumption.

Thus, the results show that feeding the experimental group of quails with the developed feed leads to higher concentrations of potassium, calcium, magnesium, and sodium compared to the control group. This suggests that the feed formulation promotes better absorption of these essential microelements, which can ultimately improve bird health and the quality of the meat produced. Importantly, all data fall within the normal range for these minerals, indicating a well-balanced diet.

Conclusion

The enriched feeds formulated with highly nutritious, easily digestible, and natural plant-based components in the Finish recipe demonstrated a clear advantage over commercial feed in terms of weight gain. While the birds fed with the standard farm feed ceased to gain weight by the midpoint of the fattening period—with a weight increase of just 1 g between the midpoint and the end—the birds in the experimental group (EG) gained nearly 20 g during the second phase of fattening. By the end of the fattening period, the birds in the EG weighed 338.1±4.48 g, while those in the control group (CG) weighed 325.6±5.14 g, a difference of 15 g in favor of the EG. Moreover, despite the increase in meat productivity in the experimental group, the quality of the meat did not deteriorate. On the contrary, the results show positive outcomes, with an increase in protein and fat content in the quail meat of the experimental group. Therefore, the developed feed formulation for meat quails can be effectively utilized in quail farming to improve meat productivity and ensure the production of high-quality, safe quail products.

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