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Effect of Mineral Feed Additives on the Rearing of Young Ducklings: An Experimental Study in Western Kazakhstan

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ABSTRACT

The development of a feeding diet is necessary for the development of the poultry industry. In the West Kazakhstan region, we studied the technology of feeding waterfowl and the chemical composition of feed and feed additives. The analysis of the chemical composition and nutritional value of the feed was carried out, based on which feed mixture formulae for ducks of different sex and age groups bred at the Zhangir Khan Agricultural and Technical University were compiled. The experiment included one control and three experimental groups with different diets. Each group included 50 heads, and the birds were selected by the live weight analog group method. The study showed that when a composite mineral feed additive in a dosage of 4% was added to the ducklings' diet, the ducklings gained more live weight. The study concluded that the incorporation of 4% composite mineral feed additive significantly enhanced the growth rates of young ducklings compared to the control group. This suggests that such feed formulations could improve productivity and offer a cost-effective strategy for poultry development in the region

Key words: Breeding, Cross, Diet, Drake, Duck breeding, Duck meat, Poultry farming

INTRODUCTION

Duck breeding is one of the fields of the poultry industry in agriculture characterized by several important features. Researchers identify the following: first, duck meat is rich in healthy fats, especially unsaturated fats, and is a good source of protein and iron (Adeola 2003; Ali et al. 2007; Lukaszewicz et al. 2011; Tsarenko and Vasilyeva 2016; Mahmood et al. 2022; Kozhanov et al. 2023). Second, duck breeding requires fewer resources than other types of animal husbandry (Bondarev 2001; Kochish et al. 2003; Woloszyn et al. 2006; Amantai et al. 2018; Khalid et al. 2021). Ducks often require less space and adapt better to different environments. Third, ducks, under certain conditions, are hardy birds and may be less susceptible to diseases, including bird flu (Bernacki et al. 2006; Chen et al. 2015; Smolovskaya et al. 2023). This factor can lower veterinary costs and reduce the risk of more bird losses. Fourth, duck breeding is well combined with sustainable farming methods (Gayirbegov and Engurazov 2023). For example, an experiment was conducted where ducks were grown on rice fields and helped to control pests in those fields (Nikelo et al. 2022). Fifth, duck fat and meat have a longer shelf life compared to other poultry, which is an advantage for distribution and storage (Kang et al. 2006; Dyadichkina and Antonova 2007; Kokoszynski 2011; Zhanabayeva et al. 2021).

However, duck meat producers face problems with the complexity of breeding. For modern poultry farming, which is entirely based on the production of hybrid poultry based on the use of the effect of heterosis (overdomination), it is important to create genetically distinct parental lines (Moldazhanov 1991; Alpeisov et al. 2001; Davtyan et al. 2003; Murtazaeva and Skokov 2003; Deus et al. 2023). This is difficult, especially in cases where the breeding material differs phenotypically little. The intensification of poultry farming has led to the widespread distribution of poultry belonging to a relatively limited number of breeds and crosses (Krivopishin 1997; Galpern et al. 2015; Kapitonova et al. 2021).

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Increasing the production of poultry meat and eggs should be due to such intensive factors as breeding, improving the technology of growing and keeping poultry, rational use of cheaply available feed, and saving material and labor resources.

Based on the focus of our study, it should be noted that poultry farming in Kazakhstan is based on the use of foreign highly productive crosses (Krivopishin 2001; Alpeisov and Moldazhanov 2002; Saginbayeva et al. 2023). Based on Kazakhstan's capabilities, on the one hand, to improve the efficiency of duck breeding (Fisinin 2000; Dyadichkina et al. 2014; Ciptaan et al. 2024) and, on the other hand, to increase its food security (Lukashenko and Kavtarashvili 2015; Maikanov et al. 2021), a request arises from government agencies and consumers to create Kazakh breeds and crosses of various poultry. For the population of Kazakhstan, in particular, in rural areas, a rapidly maturing local product is needed, and this is only poultry. Therefore, the possibilities of duck breeding are interesting for researchers, and their studies are in demand.

Some researchers focus on the development of technologies and methods for effective management of the breeding process in poultry farming based on the achievements of biotechnology and modern zootechnical, informational, and statistical methods of breeding. To increase the efficiency of the technology for raising young ducklings, one of the most important factors is the proper feeding of the birds. It is important to determine what kind of feed the ducklings need and what kind of balanced diet should be used for their breeding.

The work aims to determine the effect of mineral feed additives on the rearing of young ducklings in western Kazakhstan.

MATERIALS AND METHODS

Ethical approval

The research methods employed in this study were conducted in accordance with ethical standards and complied with the EU Directive 2010/63/EU (2010).

Study design

To fulfill the tasks set in the Zhangir Khan Agricultural and Technical University in the West Kazakhstan region in 2023, scientific and economic experiments were performed and an analysis of the composition of the main types of feed.

To reach the study goals, production checks were conducted to study the composition of wheat, barley, soy, wheat bran, sunflower cake, feed yeast, and meat and bone meal feed additives from local resources and prepared feed mixture formulae for each sex and age group of poultry, considering the periods of their productivity. Based on the analysis of feed, various feed mixture formulae were developed with extensive use of local feed resources for each period of rearing young animals.

Description of the experiment

According to the adopted technology, the young ducklings of the Medeo (Beijing white) breed were kept on deep bedding from the age of 1 to 49 days. Ducks of this breed are characterized by endurance, good preservation, simple taste in feed, and especially high productivity. The live weight of ducklings ranged from 48.3 to 51.8g (n=50). All technological parameters during rearing and feeding conditions of young ducklings corresponded to the norms of waterfowl feeding according to A.P. Kalashnikov and keeping standards according to generally accepted methods in animal husbandry.

Feeding scheme of the experiment: For conducting studies at the one-day (1 day) age, control (I) and experimental (II, III, and IV) groups of 50 heads each were formed. The birds were selected by the method of analog groups by live weight (Table 1). The duration of the preparatory period was 7 days (from 1 day to 7 days of age). A composite mineral feed additive in different dosages (from 2 to 4%) was added to the diet of ducklings in the experimental groups. The additive consisted of silica clay (35%), montmorillonite clay (25%), and chalk (35%) and contained such minerals as silicon, calcium, iron, magnesium (Ca, Si, Fe, Mg), and a natural sorbent. This feed additive increases productivity and resistance and normalizes the metabolism of the bird's body.

A CMFA in a dosage of 4% was added to the diet of young ducklings of experimental groups from the age of 1 day. The composition of the additive is shown in Table 1.

Feed formula composition

Based on data on the chemical composition of feed from farms in the West Kazakhstan region, feed mixture formulae were compiled, which we identified as the most effective ones based on the conditions and availability of resources. Thus, for each sex and age group of ducklings in the West Kazakhstan region, a feed mixture formula was developed (Table 2).

The feed mixture formula was designed with an optimal feed ratio for easy assimilation by young ducks. The feed mixture formula for young ducklings of the control group consisted of seven components, and the formula for the experimental group had eight components. To determine the effectiveness of the diet for waterfowl in the conditions of the West Kazakhstan region, the growth, development, and safety of the duck population of experimental groups were studied. One of the important indicators characterizing the level of productivity of young ducks is their live weight and indicators of average daily gain and absolute weight gain.

Table 1: Experiment design

Age	Groups	Total number	Feeding scheme
1-49 days	Control I	50	Main feed mixture formula
	Experimental II	50	Main feed mixture formula + 2% composite mineral feed additive (CMFA)
	Experimental III	50	Main feed mixture formula + 3% CMFA
	Experimental IV	50	Main feed mixture formula + 4% CMFA

Table 2: Feed mixture formula for young ducks of the control and experimental groups for the Western region of Kazakhstan (n=50 in each group)

Indicators		Experimental groups, % of composition			
		Control I	Experimental II	Experimental III	Experimental IV
Wheat		20	20	20	20
Barley		25	23	22	21
Soy		25	25	25	25
Wheat bran		20	20	20	20
Sunflower cake		4	4	4	4
Feed yeast		2	2	2	2
Meat and bone meal		4	4	4	4
CMFA		0	2	3	4
Feed mixture formula contains:					
Metabolizable energy	Kcal/100g	278.016	281.599	282.315	290.436
	MJ/100g	1.164	1.179	1.182	1.216
Crude protein, %		17.21	17.32	17.45	17.52
Lysine, %		3.06	3.23	3.55	3.78
Methionine + cystine, %		1.00	1.18	1.37	1.65
Fat, %		0.47	0.49	0.54	0.53
Crude fiber, %		2.79	2.65	2.61	2.57
Crude ash, %		0.31	0.33	0.30	0.28
Nitrogen-free extractive substances (NFES), %		41.68	42.74	43.51	44.62
Ca, %		25.63	27.15	30.6	31.9
P, %		9.67	1.18	1.24	1.37
Na, %		1.02	1.21	1.28	1.33

Data analysis

During the study period, the following indicators of the experimental groups were recorded and calculated: the chemical composition of feed and the minimum set of indicators for laboratory analysis and control, such as crude protein, crude fiber, crude fat, Ca, P, lysine, methionine, and cystine. The clinical and physiological condition of the birds was determined by daily inspection. Attention was paid to the general behavior, appetite, water consumption, mobility, etc.; the survival rate of the birds and the causes of their death were determined daily. During the experiments, two deaths (4%) were recorded in control group I, and one death (2%) was registered in experimental group II. The dead birds were not replaced. The poultry survival rate was calculated as a percentage of the initial head count for individual periods of breeding, and keeping, and for the entire period; the live weight of poultry was determined by weekly individual weighing of the young birds (10% of the labeled control birds from each experimental group); based on the data of the live weight of young animals for the growing periods, the absolute and relative weight gain was calculated.

An Analysis of Variance (ANOVA) was employed to assess the significance of differences in live weight and absolute weight gain among the control and experimental groups at various stages of the ducklings' growth. All statistical tests were conducted using a significance level of alpha = 0.05. Data were processed and analyzed using statistical software SPSS.

RESULTS AND DISCUSSION

Our results showed that the content of metabolizable energy in grain feeds ranged from 9.2 to 13.0MJ, the highest level of metabolizable energy was noted in soybeans (13.0MJ), and technical byproducts (sunflower cake and yeast) had the same amount of metabolizable energy (10.2MJ). The highest crude protein content per 1kg was observed in feed made of technical byproducts, sunflower cake, meat, and bone meal, and feed yeast (349.9 to 439.6g). Among grain feeds, soy contained more protein than barley and wheat by 65.1g (31.0%) and 89.5g (42.7%), respectively.

The results are confirmed by studies. In bird feeding, one of the important indicators is the percentage of amino acids (Podobed 2013; Mendybayeva et al. 2023), such as lysine, methionine, and cystine, which have a direct impact on productivity and full development of the body. The highest content of amino acids is observed in soy and feed yeast (lysine content: 20.6-29.9). In addition, according to research (Mohamed and Hassan 2023), industrial poultry farming of waterfowl is invariably associated with the development of non-contagious and contagious gastrointestinal diseases that rank second after viral diseases. Therefore, the need to develop an effective diet, in our opinion, will reduce the mortality of young birds which causes significant economic damage to poultry farming.

Our results showed that with the same keeping technology, but with different compositions of the diet, the ducks' live weight changed in different ways (Table 3).

The results in Table 3 confirm that the addition of composite mineral feed additive (CMFA) significantly impacts the growth of young ducklings. Notably, higher CMFA dosages consistently result in greater live weight across all age points, with the most substantial growth observed in the group receiving the highest CMFA dosage. This demonstrates a clear, positive correlation between CMFA concentration and duckling growth, underscoring its potential utility in enhancing poultry production efficiency.

Differences in live weight and growth dynamics of young animals aged 1-7 days for ducks and drakes were insignificant; they were almost at the same level (169.5 to 179.2g). From the age of 14 days, a relatively high live weight of ducklings of experimental group IV (560.1g) was observed. This trend continued in subsequent growth periods, and at 42 days of age, the young of experimental group IV outperformed the peers of control group I and

experimental groups II and III, respectively, in live weight by 378.9g (14.0%), 214.5g (7.9%), and 138.4g (5.1%) and at 49 days by 383.7g (11.7 %), 253.8g (7.7 %), and 140.4g (4.3%). The study showed that when the CMFA in a dosage of 4% was added to the ducklings' diet, the ducklings gained more live weight.

Furthermore, along with the live weight dynamics, the absolute and average daily weight gain of ducklings in the experimental groups were determined (Table 4 and 5).

The analysis of the results showed that ducklings of experimental group IV for the entire period of cultivation had a higher live weight compared to the birds of control group I and experimental groups II and III by 385.0g (11.9 %), 252.9g (7.8%), and 138.2g (4.3%).

According to the indicator of the average daily gain, ducklings of experimental group IV consistently had a relatively high increase compared to the birds of other experimental groups. This, in turn, proves the effectiveness of using a composite mineral supplement in the ducks' diet.

Our results indicate the high survival rate of young ducks. The survival rate was higher in young birds which received an additional 3 and 4% of the composite mineral supplement in the feeding diet.

The economic indicators of young animals in all experimental groups were also determined. The use of CMFA contributed to an additional live weight gain in ducks and drakes of the experimental groups (Table 5).

This finding aligns with previous research demonstrating the economic benefits of mineral supplementation in poultry production. For instance, studies by Rafiq et al. (2022) and Alagawany et al. (2020) have shown that incorporating mineral additives into poultry diets can enhance feed conversion efficiency and promote weight gain, leading to improved profitability for farmers.

Table 5 provides data on the cost of keeping ducks in various experimental groups. In the experimental groups, feed intake varied from 6,541.1 to 6,712.8g, which shows differences in the ducks' diet in different experimental groups. One can note live weight gain from 2,826.6 to 3,211.6g in various experimental groups. This suggests that certain methods or conditions of duck keeping contribute to more efficient growth. This indicator explains the efficiency of feed use.

The experimental groups demonstrated a more efficient use of feed, as they had a lower feed consumption per 1kg of live weight gain. This finding underscores the considerable impact of the dietary interventions, particularly the incorporation of the composite mineral feed additive (CMFA), in optimizing nutrient utilization and promoting efficient growth in ducklings. Study by Apdraim et al. (2023) have consistently demonstrated that mineral-enriched diets contribute to enhanced nutrient absorption, metabolic efficiency, and feed conversion ratios, thereby facilitating greater weight gain per unit of feed consumed.

The growth efficiency and feed use differed in the experimental groups, which may be due to different methods of keeping, feed quality, or environmental conditions. The observed discrepancies in growth efficiency and feed utilization highlight the multifaceted nature of poultry management and the need for comprehensive strategies that address both nutritional and environmental factors to optimize productivity and performance in duck farming operations.

The cost of live weight gain decreased in the experimental groups, which indicates a more efficient and economical production system. Previous studies (Biesek et al. 2022; Belkhanchi et al. 2023) have consistently reported lower production costs and improved profitability associated with the incorporation of mineral additives in poultry feeding programs. The cost savings observed in our study underscore the potential of CMFA as a valuable tool. By minimizing feed wastage and optimizing nutrient utilization, CMFA offers a sustainable solution for improving productivity and profitability in poultry farming, ultimately contributing to the long-term viability of the industry.

Table 3: Dynamics of live weight (g; X±Sx) of young ducklings in the production experiment

Age, days	Experimental groups				
	Control I	Experimental II	Experimental III	Experimental IV	P-value
1	51.8±0.45	49.6±0.52	48.3±0.41	50.5±0.37	0.073
7	170.2±0.38	179.2±0.89	169.5±0.86	178.3±0.51	0.049*
14	524.2±0.69	548.1±0.95	531.8±1.12	560.1±0.83	0.035*
21	950.3±1.63	963.9±0.86	981.4±0.95	1,033.6±0.98	0.021*
28	1,399.1±1.24	1,367.4±1.64	1,472.5±1.36	1,583.8±1.49	0.012*
35	1,886.7±0.78	1,927.7±1.19	2,021.0±1.42	2,114.6±1.92	0.009*
42	2,320.0±1.25	2,484.4±1.57	2,560.5±1.87	2,698.9±2.01	0.005*
49	2,878.4±1.14	3,008.3±1.65	3,121.7±1.52	3,262.1±1.78	0.003*

* Indicates statistical significance (P<0.05).

Table 4: Absolute weight gain in young ducklings in the production experiment, g (X±Sx).

Age period, days	Experimental groups				
	Control I	Experimental II	Experimental III	Experimental IV	P-value
1-7	118.5±0.34	129.6±0.12	121.2±0.27	127.8±0.25	0.032*
7-14	354.0±0.29	368.9±0.31	362.3±0.45	381.8±0.36	0.028*
14-21	426.1±0.51	415.8±0.59	449.6±0.62	473.5±0.82	0.015*
21-28	448.8±0.62	403.5±0.43	491.1±0.57	550.2±0.65	0.005*
28-35	487.6±0.58	560.3±0.68	548.5±0.61	530.8±0.74	0.025*
35-42	433.3±0.69	556.7±0.72	539.5±0.55	584.3±0.58	0.010*
42-49	558.4±0.83	523.9±0.96	561.2±0.74	563.2±0.83	0.045*
1-49	2,826.6±0.74	2,958.7±1.01	3,073.4±85	3,211.6±0.87	0.002*

* Indicates statistical significance (P<0.05).

Table 5: The duck keeping cost

Indicators	Experimental groups			
	Control I	Experimental II	Experimental III	Experimental IV
Feed consumption for the entire period (g)	6,598.5	6,712.8	6,521.6	6,541.1
Absolute live weight gain for the entire period (g)	2,826.6	2,958.7	3,073.4	3,211.6
Feed consumption/ 1kg of live weight gain (kg/kg)	2.33	2.27	2.12	2.04
Keeping cost per head (tenge?)	2,003.9	2,014.2	1,996.9	1,998.7
Cost of 1g of weight gain (tenge?)	34.81	33.48	31.98	30.64

Conclusion

One of the conditions for obtaining maximum productivity of poultry is balanced feeding. Bird diets based on the physiological needs of the body for nutrients contribute to the effective growth of birds. All experimental data were registered under identical conditions; there were no differences in natural and climatic conditions and the technology of bird keeping. Based on our data, we concluded that under different feeding conditions, it is possible to increase the birds' productivity by more than 15-20%. When the CMFA was added to the birds' diet (experimental group IV), growth and development indicators, as well as meat quality, were significantly better compared to other groups.

Authors contribution

AN and AS conceptualized the research study, designed and implemented the experimental protocols. AS, AN contributed to the data collection and analysis. ZM and SN interpreted the results and drafted the manuscript. AN supervised the project. All authors have reviewed and approved the final manuscript for publication.

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