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Prospects for the Development of Duck Breeding in the West Kazakhstan Region

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ABSTRACT

Ducks occupy a special place in increasing and expanding the production of poultry meat products. They are an important reserve for increasing the number of poultry products, including meat, feathers, and down. Ducks are highly adaptable to unstable climatic conditions, making them a promising species for breeding in West Kazakhstan. The study aimed to develop technological methods for intensifying duck meat production in the region. The chemical composition of the primary grain feeds for waterfowl was analyzed to achieve the goal. An experimental formulation for a feed mixture was derived and then used to feed three groups of birds (a control group and two experimental groups). The feed mixture showed high efficiency in increasing the live weight of ducklings. Both experimental groups surpassed the control group in this indicator. The 3rd group, where the nutritional value of the feed mixture slightly exceeded the rest, showed the most significant increase in absolute live weight. The developed feeding technique showed positive results in the intensity of the development of ducklings. Further research can focus on testing the technique on older specimens and improving the economic efficiency of feeding waterfowl.

Keywords: Poultry, Meat production, Feed additives, Weight measurement

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INTRODUCTION

Poultry farming is the largest supplier of high-grade animal protein, occupying an important place in human nutrition (Afanasev et al., 2015; Fisinin et al., 2017). Developing intensive meat poultry farming is an important economic task for the agro-industrial complex in Kazakhstan (Shklyar, 1991). Improving the production base and consistently intensifying meat poultry farming is necessary (Galina & Gadiev, 2013; Ardraim et al., 2023). This process is characterized by widespread industrialization manifested in the fundamental improvement of technologies (Beishova et al., 2024), the use of high-performance equipment, the creation of favorable conditions for animal feeding and keeping (Kashina et al., 2022), and production specialization. The unsatisfactory condition of even one of these leads to disruptions in the production cycle and a decrease in productivity, product quality, and economic indicators (Smolovskaya et al., 2023).

The need to develop poultry farming is also determined by the deepening disparity between the population's growing demand for poultry meat (Sarsekova et al., 2023) and the volume of its production (Kang et al., 2006; Nugmanova et al., 2024). The high demand for poultry meat products requires a comprehensive assessment of the process, which is only possible with study. However, such studies have yet to be conducted.

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In Kazakhstan, there needs to be more data on using specific breeds, lines, and crosses of waterfowl in production and their feeding conditions, keeping, breeding, etc. Almost all breeds are bred arbitrarily without comparing their economic efficiency and adaptability to local conditions. The success of breeding waterfowl depends on breeding work and feeding, growing, and keeping technologies (Kazachkova, 2003; Galina & Gadiev, 2013).

Duck breeding is a traditional and highly profitable sector of poultry meat production in Kazakhstan (Zhanabayeva et al., 2021). Regarding physiological and biological indicators, feed costs per unit of body weight gain, and other economically valuable features, waterfowl differ favorably from other species (Wołoszyn et al., 2006; Ali et al., 2007). They are undemanding, have exceptionally high growth rates, adapt relatively easily to the conditions of industrial poultry farming, and consume and digest feed quickly and in large quantities, resulting in a favorable feed conversion ratio (FCR).

Ducks easily adapt to any climate, are undemanding to feed, and can do without water reservoirs (Fisinin, 2000; Adeola, 2003). Their practical breeding is possible in unstable climates, including the West Kazakhstan region. West Kazakhstan's climate is continental (Ansabayeva & Akhmetbekova, 2024). The region is characterized by instability, air and soil dryness, the intensity of evaporation, and an abundance of direct sunlight throughout the growing season. The terrain is mainly flat (Mussynov et al., 2014), descending from northeast to southwest (Mussynov et al., 2019). The farming system is soil-protective on non-irrigated lands by cultivating cereals, grain forage, and other forage crops (Serekpayev et al., 2016). The most common soil types are dark chestnut, light chestnut, chestnut, and brown. The vegetation cover of pastures is mainly represented by cereal and wormwood communities (Mazina et al., 2022).

The following methods of poultry keeping are generally practiced in Kazakhstan’s duck breeding industry:

1. The industrial method with the technology of growing and keeping in isolation from the natural environment with integrated mechanization of production processes. This method is mainly practiced by large poultry farms with populations of at least 500-700 heads, and
2. Free-range breeding and keeping with/without reservoirs in private subsidiary farms with populations of no more than 500 heads.

There are no large poultry farms engaged in duck breeding in West Kazakhstan. All duck livestock is bred in household plots with natural or artificial water reservoirs if no water bodies are nearby (Alpeisov & Moldazhanov, 2002). The duck diet is usually diverse, consisting mainly of (concentrated) grain feeds, succulent feeds, root crops, highly nutritious animal products, and various mineral supplements (Lyapin, 1996; Okolelova & Kuzmina, 2004). Based on the scale of duck breeding in West Kazakhstan, the study aims to develop technological methods for intensifying the production of waterfowl meat in the region.

MATERIALS & METHODS

Ethical Approval

The research methods employed in this study met ethical standards. They complied with the guidelines for the care and use of animals established by the Ethical Review Board of Zhangir Khan West Kazakhstan Agrarian and Technical University. The study also adhered to the principles outlined in the EU Directive 2010/63/EU (2010) on the protection of animals used for scientific purposes.

Experimental Place and Time

The study was conducted in 2023 in the Zhayylgan-S LLP in West Kazakhstan; the results were processed in the Zhangir Khan West Kazakhstan Agrarian and Technical University.

Methods

We performed laboratory studies of the chemical composition of the main types of feed and feed supplements and scientific and economic experiments on the experimental cultivation of waterfowl fed with a feed mixture developed after nutritional analysis. This included the study of the mixture's effect on each sex and age group of rearing ducklings.

Materials

The source material for the work consisted of ducks of the Medeo breed. The choice of the source material was associated with the breed's relatively high productivity indicators and prevalence in the poultry market. The birds were selected based on the analog group method regarding live weight and overall development. To develop the experimental food mixture, we selected samples of the main types of concentrated feeds (soy, barley, wheat, rye, peas, and wheat bran). The formulation was carefully designed to balance the nutritional needs of the ducks, with the following proportions: barley (20-30%), wheat (20-25%), rye (5-18%), soy (10-15%), sunflower cake (9-12%), wheat bran (18-20%), and smaller amounts of fodder yeast, meat and bone meal, enriched feed premix, protein feed premix, and other supplements.

Stages

Based on the chemical composition, balanced formulations of feed mixtures for the experimental groups of ducks were developed. The control (CG) (1, n=50/50) and experimental (EG) (2, n=50/50; 3, n=50/50) groups were formed (Table 1). The conditions in the groups were identical; all technological parameters were observed during breeding and feeding (Alpeisov et al., 2001; Moldazhanov, 1991). According to the accepted technology, birds aged 1 to 49 days were kept in a deep litter (Bernacki et al., 2006).

Table 1: Experiment design

Age, weeks	Groups	Total number, n	Feeding scheme
14-49 days	Control 1	50 50	Basic feed mixture formulation (BFMF)
	Experimental 2	50 50	BFMF+ premix + mineral supplement
	Experimental 3	50 50	BFMF+ premix + mineral supplement

A two-phase feeding scheme was developed for the following growing periods: 1 to 14 and 15 to 49 days. According to the methodology, the feed accounting was performed daily, and the feed intake was recorded once a week for two adjacent days.

During the first two weeks (1-14 days) of rearing ducklings, we used the start enriched feed for birds and the Chiktonic supplement containing vitamins and amino acids in addition to the basic diet. Chictonic stimulated overall growth and development and increased productivity and nonspecific resistance (Alekseev et al., 1997). Its dosage was 1 ml/1 l of water.

Subsequently (from 15 days), protein vitamin-mineral concentrate (PVMC), a protein-feed mixture in different dosages, and a mineral composite supplement were added to the diet. At the end of the experimental feeding, we measured the live weight of ducklings in all groups (Amantai et al., 2018).

Processing the Results

For the subsequent comprehensive assessment of meat productivity, we recorded all groups' absolute and average daily live weight gain.

Data Analysis

The data collected during the study were analyzed using descriptive statistics to summarize the results. For each group of ducks, the mean and standard deviation (mean±SD) were calculated to understand each group's average performance and variability clearly. These statistics were applied to key measurements across the different experimental periods, including live weight and average daily weight gain.

RESULTS

Our studies showed that in grain feeds (soy, barley, wheat, rye, and peas), the content of metabolizable energy (ME) ranged from 9.8 to 13.2MJ and amounted to 13.2, 11.0, 10.2, 9.8, and 10.5MJ, respectively (Table 2). The dry matter and moisture content in all grain feeds amounted to 85 and 15%, respectively. The content of crude protein necessary for the synthesis of specific proteins (Mironova et al., 2021) was higher in soy by 12.1-52.2% compared with other concentrates; it amounted to 219.5, 150.4, 123.0, 105.0, and 192.8g, respectively.

The amino acid content is essential for the physiology of highly productive poultry. It is important to balance the diet according to optimal normalized amounts of essential amino acids. According to our results, soy, barley, wheat, rye, and peas contain 42.3, 4.8, 2.3, 3.3, and 12.2g of lysine, 4.3, 2.0, 2.9, 2.8, and 4.5g of methionine and cystine, and 3.2, 1.0, 1.1, 1.1, and 1.8g of tryptophan. The crude fat, crude fiber, and NFES content ranged from 15.0 to 44.1 g, 16.2 to 62.0 g, and 515.0 to 880.0g, respectively.

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Table 2: Chemical composition of grain feed

Indicators	Grain feed				
	Barley	Wheat	Rye	Peas	Soy
Energetic feed unit (EFU), kJ	1.10	1.02	0.98	1.05	1.32
ME, MJ	11.0	10.2	9.8	10.5	13.2
Dry matter, g	850	850	850	850	850
Crude protein, g	150.4	123	105	192.8	219.5
Splitting protein (SP), g	125.1	90.5	75.7	159.1	0
Non-splitting protein (NSP), g	23.5	32.2	31	40.6	112.7
Digestible protein (DP), g	98	97.3	85.2	160.5	174.5
Lysine, g	4.8	2.3	3.3	12.2	42.3
Methionine+cystine, g	2	2.9	2.8	4.5	4.3
Tryptophan, g	1	1.1	1.1	1.8	3.2
Crude fat, g	12	17	15	16	44.1
Crude fiber, g	25	16.2	20	50.5	62
Nitrogen-free extractive substances (NFES), g	850	590	624	515	0
Calcium, g	0.2	0.5	0.7	1.5	3.8
Phosphorus, g	1.2	2.5	1.8	2.3	6.1
Magnesium, g	1.3	0.8	1	1	2.8
Potassium, g	4.1	2.4	3.8	9.7	20.7
Iron, mg	0	27	50.7	55	12.2
Copper, mg	7.7	5.6	4.3	6.2	13.2
Zinc, mg	30	15	16.2	24.7	31
Manganese, mg	39	33.5	19.5	19.2	26
Cobalt, mg	0.1	0.1	0.05	0.15	0.9
Carotene, mg	0	0.9	1.9	0.1	0.1

Feeding Ducks

The feed mixture formulation developed for the first growing period contained 10.21-11.35 MJ (2,438.616-2,710.901kcal). The crude protein content in the EG3 diet was higher than in CG1 and EG2 by 7.3 and 15.2%, respectively (Table 3). The composition of the feeds developed for feeding birds after the age of 15 days is shown in Table 4. The total content of grain feeds (including wheat bran, which has lower nutritional value) in the diet formulation from 15 to 49 days was 64 to 80% in all groups.

According to feeding standards, after 15 days, the ME slightly increased, and the protein level decreased. The ME of the diets of all groups ranged from 11.26-12.71 MJ (2,689.404-3,035.731 kcal). The protein level in EG3 was higher by 6.8 and 13.4%. In amino acid composition, a similar trend was observed with the advantage of the EG3 formulation for lysine (2.6-7.8%) and methionine and cystine (1.5-6.7%). The content of minerals in the EG2 and EG3 formulations was relatively higher than in CG1. The calcium and phosphorus content was also higher by 6.3-10.5% and 4.2-9.6%, respectively. Thus, the developed feed mixture diet for ducklings in the EGs has a slight nutritional and mineral composition advantage.

Growth and Development

The dynamics of live weight showed a positive effect of feed supplements on productive performance. The live weight at the initial stages of the experiment was almost identical in all groups; at 1 day, it ranged from 47.6 to 52.4g, and at 7 days, from 213.8 to 220.0g. From 14 days, there was a tendency towards an increase in the live weight (Table 5).

Table 3: Formulation for the feed mixture in the CG and EGs for the growing period from day 1 to 14

Indicators	Groups, % of input		
	CG1	EG2	EG3
Barley	20	20	20
Wheat	20	20	20
Rye	18	13	13
Soy	15	15	10
Sunflower cake	12	12	12
Fodder yeast	10	10	10
Meat and bone meal	3.5	3.5	3.5
Enriched feed premix	-	5	10
Cottage cheese	0.6	0.6	0.6
Chalk	0.7	0.7	0.7
Salt	0.2	0.2	0.2
Diet contains			
ME, MJ	10.21	10.62	11.35
kCal	2,438.616	2,536.543	2,710.901
Crude protein, g	14.47	14.81	16.66
Lysine, g	0.96	0.99	1.02
Methionine+cystine, g	0.31	0.32	0.33
Tryptophan, g	0.14	0.15	0.15
Crude fat, g	2.54	2.59	2.65
Crude fiber, g	4.16	4.31	4.44
NFES, g	50.89	56.27	60.52
Calcium, g	0.13	0.13	0.13
Phosphorus, g	0.39	0.39	0.40
Magnesium, g	0.19	0.19	0.20
Potassium, g	0.74	0.76	0.78
Iron, mg	5.78	5.53	5.53
Copper, mg	0.80	0.86	0.90
Zinc, mg	3.66	3.88	4.03
Manganese, mg	4.74	5.03	5.23
Cobalt, mg	0.04	0.04	0.04
Carotene, mg	0.09	0.09	0.09

Table 4: Formulation for the feed mixture in the CG and EGs for the growing period from day 15 to 49

Indicators	Groups, % of input		
	CG1	EG2	EG3
Barley	30	20	20
Wheat	25	23	21
Rye	5	5	5
Wheat bran	20	20	18
Sunflower cake	10	10	9
Fodder yeast	7	7	6
Meat and bone meal	1.5	1.5	1.5
PVMC premix	-	5	9
Protein feed premix	-	5	5
Composite mineral supplement	-	2	4
Chalk	1	1	1
Salt	0.5	0.5	0.5
Diet contains			
ME, MJ	11.26	11.66	12.21
kCal	2,689.404	2,784.943	2,916.308
Crude protein, g	16.32	17.42	18.50
Lysine, g	1.02	1.04	1.09
Methionine+cystine, g	0.33	0.34	0.35
Tryptophan, g	0.15	0.16	0.17
Crude fat, g	2.66	2.74	2.89
Crude fiber, g	4.46	4.61	4.82
NFES, g	61.20	63.24	63.37
Calcium, g	0.13	0.139	0.15
Phosphorus, g	0.40	0.41	0.43
Magnesium, g	0.20	0.21	0.22
Potassium, g	0.78	0.82	0.88
Iron, mg	5.53	5.61	5.69
Copper, mg	0.90	0.94	0.98
Zinc, mg	4.05	4.18	4.30
Manganese, mg	5.26	5.41	5.52
Cobalt, mg	0.04	0.04	0.05
Carotene, mg	0.09	0.09	0.09

At 2 weeks, the live weight index of males in CG1 was 618.1g, which was lower than in the EG2 and EG3 by 4.6g (0.74%) and 12.2g (1.9%). A similar trend was observed in the live weight of females, which amounted to 613.2g in CG1, which was 4.6g (0.75%) lower than in EG3. This trend was also observed in subsequent periods. Thus, EG3 ducklings outnumbered their peers in the CG1 and EG2 by 122.7g (10.5%) and 102.3g (8.8%) in males and by 25.2g (2.4%) and 15.9g (1.5%) in females in live weight at 21 days. At 28 days, the difference was 98.6 g (18.3%) and 102.2g (6.3%) in males, 90.8g (6.5%), and 45.2g (3.1%) in females. At 49 days, the live weight of EG3 ducklings was also higher than in other groups.

The data on absolute growth showed that from 14 to 21 days, EG3 males were ahead of their peers in live weight by 110.4g (26.4%) and, 94.6g (17.9%), and females by 20.6g (5.0%) and 3.7g (0.9%) compared with CG1 and EG2. All groups' average daily weight gain from 7 to 21 days ranged from 55.9 to 60.9g. From 42 to 49 days, EG2 and EG3 males had surprisingly high average daily weight gain (79.1 and 79.5g). Over the entire period of the experiment, EG3 males exceeded CG1 and EG2 by 54g (11.1%) and 22.5g (4.6%). The same trend was observed for females. EG2 females outperformed CG1 peers by 49.8g (10.8%) and EG2 peers by 23.9g (5.1%) (Table 6). The viability in all groups from 1 to 28 days was from 96 to 100%.

DISCUSSION

Our results showed that the developed feed mixture diet has a high potential for accelerated development of ducklings due to increased nutritional and mineral composition indicators. Thus, the best growth indicators, depending on the dosage of the mineral composite supplement and protein/vitamin premixes, were observed in EG3. EG3 live weight at the end of the study exceeded the indicators in CG1 and EG2 by 376.1g (10.9%) and 155.5g (4.5%) in males and 306.3g (9.4%) and 163.6g (5.0%) in females.

The health and meal productivity of poultry birds directly depend on the quality of their feed. Proper nutrition plays a key role in ensuring their health and growth. Deficiencies or excesses of certain substances in the diet can cause serious health problems, reduce productivity, and lead to financial losses for farmers (Shastak & Pelletier, 2023).

First, it is necessary to calculate the dietary energy in the formulated diet, considering that different amounts of calories are required for young and adult ducks. Depending on the duck breed, many studies recommend a diet containing 2750 - 3000 kcal in the first weeks of age to gain weight (Mandal, 2022). Our results demonstrate that the raring conditions for ducks of the Medeo breed in EG3, where the caloric content at 1-14 weeks was 2710 kcal, were more optimal than CG1 and EG2, where the caloric content was lower. It was recommended for older ducks to reduce the energy level of the diet slightly; however, in EG3, the energy value was increased to 2916 kcal, which did not prevent the trend of weight gain. Also, high-quality protein in the diet is required for normal development. As with calories, it is believed that the percentage of crude protein in the feed should be higher

Table 5: Dynamics of live weight, g (X±Sx)

Age, days	Age and sex group					
	CG1		EG2		EG3	
	Males	Females	Males	Females	Males	Females
At birth	52.1±1.01	49.5±0.98	52.4±1.28	50.8±0.89	50.4±1.0	47.6±1.52
7	217.9±1.08	216.0±1.47	216.6±2.04	213.8±1.67	219.3±1.37	216.8±2.21
14	618.1±3.49	613.2±2.34	622.7±3.86	605.6±2.18	630.4±2.25	617.8±3.04
21	1,075.2±4.34	1,059.1±5.81	1,095.6±4.72	1,068.4±5.28	1,197.9±3.32	1,084.3±3.87
28	1,583.2±5.47	1,418.7±6.01	1,579.6±4.16	1,464.3±6.35	1,681.8±6.14	1,509.5±5.51
35	1,946.3±8.52	1,900.6±7.26	2,071.8±6.27	2,008.7±8.41	2,229.4±9.17	2,116.1±7.08
42	2,534.9±8.38	2,494.1±9.02	2,718.5±7.09	2,554.7±9.56	2,876.4±7.65	2,732.8±8.24
49	3,054.6±9.07	2,920.6±10.68	3,275.2±8.53	3,103.3±8.47	3,430.7±9.58	3,266.9±10.28

Table 6: Average daily live weight gain, g (X±Sx)

Age period, days	Age and sex group					
	CG1		EG2		EG3	
	Males	Females	Males	Females	Males	Females
From birth to 7	23.6±0.21	23.7±0.24	23.4±0.19	23.3±0.17	24.1±0.12	24.1±0.26
7-14	57.1±0.18	56.7±0.26	58.0±0.36	55.9±0.24	58.7±0.24	57.2±0.35
14-21	65.3±0.24	63.6±0.31	67.5±0.29	66.1±0.37	81.0±0.36	66.6±0.22
21-28	72.5±0.35	51.3±0.33	69.1±0.18	56.5±0.28	69.1±0.21	60.7±0.31
28-35	51.8±0.27	68.8±0.28	70.3±0.27	77.7±0.21	78.2±0.28	86.6±0.28
35-42	84.0±0.31	84.7±0.44	92.3±0.21	78.0±0.39	92.4±0.29	88.1±0.51
42-49	74.2±0.38	60.9±0.27	79.5±0.32	78.3±0.42	79.1±0.33	76.3±0.39
From birth to day 49	428.9	410.1	460.4	436.0	482.9	459.9

than for growing ducks, 20-22%, and then decrease to 17-19% after the 14th week. However, according to our data, a higher protein level led to high weight indicators of ducks in EG3 (Baéza, 2016).

In addition to food energy and protein, vitamins and minerals affect ducks' development and health. They are needed to form bone, blood cells, blood clotting, enzymes, healthy muscle, neuron, and immune system function, and food metabolism. Lack of minerals and vitamins causes mortality at the early growth stage and weight loss. To avoid such consequences, vitamin and mineral premixes should be included in poultry diets. Young ducks are especially sensitive to the lack of macronutrients; they require 0.1 g and 0.4 g per kg of calcium and phosphorus, respectively (Nishat et al., 2021). During the first 14 weeks, ducks from EG3 were fed a diet with 0.13 mg of calcium, which met the standards and did not differ from the other groups, and 0.4 mg of phosphorus, slightly higher than in CG1 and EG2. In addition, the increased content of zinc and manganese, as in the diet for EG3, helps to optimize the functioning of antioxidant systems, which improves the immunity of ducks, which can be associated with greater weight of ducks (Fouad et al., 2018). The most critical vitamins are vitamin A, riboflavin, vitamin D3, vitamin K, and niacin. Fouad et al. (2018) found that high levels of vitamin A improved duck meal productivity. Ducks from EG3, which had a higher percentage of PVMC premix, were heavier than those from EG2, which had a lower concentration of PVMC premix.

The vast majority of studies using PVMC premixes were conducted on broiler chickens. note that the use of PVMC contributed to an increase in the weight of chickens in the experimental groups by 5.4-2.5% and by 1.51-3.25 g per day (Kovaleva et al., 2023). Results from other authors have shown that the live weight of the experimental group, where PVMC (S) was used as an additive in compound feed in the amount of 7.5, 10, and 12%, respectively, during the start, growth, and finish, was 2612.76 g. The weight of the control group chickens was 2370.80 g. Chickens in the experimental groups outperformed the control in digestibility, with the dry matter being 0.27-0.57% higher, crude protein 0.45-1.48% higher, crude fiber 0.7-2.53% higher, and crude fat 0.94-2.29% higher (Lipova et al., 2022). Thus, our data on weight gain from dietary supplements are consistent with other studies.

Conclusion

The study contributes to the development of meat poultry farming by improving the technology of breeding ducks and other waterfowl. The accelerated development increases the productivity of poultry production and the total volume of its valuable products (meat, feathers, down). Using the developed feeding technique can temporarily increase costs for improved nutrition. Further optimization of feeding and efficient allocation of waterfowl breeding resources are necessary. The study focuses only on the initial stage of ducks' development. It is also necessary to study how such nutrition affects further development.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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