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Article

Effect of Probiotic Supplementation on The Mineral Composition of Broiler Chicken Meat

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Abstract: This study investigated the effect of probiotic supplementation on the mineral composition of muscle tissues in broiler chickens. The concentrations of major macro- and microelements, including calcium, phosphorus, potassium, sodium, iron, manganese, copper, and zinc, were determined in the breast and thigh muscles of broiler chickens. The results showed that probiotic supplementation was associated with changes in the mineral composition of muscle tissues, particularly an increase in the concentrations of calcium, phosphorus, iron, and zinc. In the breast muscle, phosphorus content increased by 26.7% and iron content by 17.1% in the second experimental group compared with the control group, while zinc content increased by 3.7%. In the thigh muscle, calcium content increased by 29.2% in the first experimental group, iron by 22.6%, and zinc by 16.2% in the second experimental group. Several of these differences were statistically significant at $p<0.05$. The findings indicate that probiotic supplementation may contribute to improved mineral utilization and metabolic processes in broiler chickens and may enhance the biological value of poultry meat.

Keywords: Broiler Chickens, Probiotics, Poultry Meat, Mineral Composition, Calcium, Phosphorus, Iron, Zinc, Muscle Tissue, Mineral Metabolism

Introduction

Mineral elements in broiler chicken meat play an important role in meeting the physiological requirements of the human body. The presence of calcium, phosphorus, potassium, sodium, iron, zinc, copper, and manganese in muscle tissue contributes to the nutritional and biological value of poultry meat.[1][2]

The accumulation of mineral elements in muscle tissue depends on several factors, including the age and breed of birds, nutritional status, housing conditions, feed composition, and the use of biologically active feed additives. In this regard, probiotic preparations may influence not only growth and productive performance but also the digestion and utilization of nutrients and mineral elements.[3]

Probiotic microorganisms contribute to maintaining a balanced intestinal microbiota, improving nutrient digestion and absorption, and regulating metabolic processes in the body. Therefore, investigation of changes in the mineral composition of broiler chicken meat under probiotic supplementation is of considerable scientific and practical interest.[4]

The objective of this study was to determine changes in the concentrations of major macro- and microelements in the breast and thigh muscle tissues of broiler chickens following probiotic supplementation.[5]

The Aim of the Study

The aim of the study was to comparatively evaluate the effects of INNOPROVET™ and MAXLAC probiotics on the macro- and microelement composition of broiler chicken meat.[6]

Materials and Methods

The study was conducted on 150 broiler chickens of the Ross 308 cross at the "Mironkul Agrozoovetservice Scientific and Practical Center" LLC, located in Samarkand District, Uzbekistan. Laboratory examinations were performed at the Veterinary Sanitary Examination Laboratory of the Department of Veterinary Sanitary Examination, Samarkand State University of Veterinary Medicine, Livestock and Biotechnologies.[7]

The birds were randomly allocated into three groups of 50 birds each: one control group and two experimental groups. The control group received a complete and balanced commercial diet without additional probiotic supplementation. The first and second groups were designated as experimental groups.[8]

In the first experimental group (INNOPROVET™), the probiotic suspension was administered with drinking water in addition to the complete balanced diet. The probiotic was given at a dose of 0.5 mL/L during the starter period, 1.0 mL/L during the grower period, and 0.3 mL/L during the finisher period.

In the second experimental group (MAXLAC), the birds received the farm's standard diet supplemented with the MAXLAC probiotic at a dose of 30 g/L of drinking water.[9]

At the end of the experimental period, breast and thigh muscle tissues were collected from representative birds in each group and used for laboratory analysis. Five samples were obtained from each group, resulting in a total of 15 muscle tissue samples (n=15).

The concentrations of the following macro- and microelements were determined in the muscle tissues: calcium (Ca), phosphorus (P), potassium (K), sodium (Na), iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn).[10]

The experimental data were expressed as the mean (M) ± standard error (m). Statistical analysis was performed using Microsoft Excel 2010. Differences among the experimental groups were evaluated using one-way analysis of variance (ANOVA), followed by Student's t-test for pairwise comparisons. Differences were considered statistically significant at $p<0.05$.[11]

Results and Discussion

The obtained results demonstrated that probiotic supplementation affected the mineral composition of broiler chicken muscle tissue to varying degrees.

The calcium concentration in the breast muscle of the control group was 0.034±0.006%, compared with 0.036±0.007% in the first experimental group and 0.037±0.004% in the second experimental group. Thus, calcium content increased by 5.9% and 8.8%, respectively, compared with the control group.[12]

The phosphorus concentration was 0.195±0.011% in the control group, 0.222±0.019% in the first experimental group, and 0.247±0.023% in the second experimental group. Therefore, phosphorus content increased by 13.8% and 26.7%, respectively. The difference observed in the second experimental group was statistically significant ($p<0.05$).[13]

Potassium concentration also showed an increasing trend following probiotic supplementation. The value increased from 3.69±0.08 g/kg in the control group to 3.79±0.09 g/kg and 3.91±0.06 g/kg in the first and second experimental groups, respectively. These values corresponded to increases of 2.7% and 6.0%.

In contrast, sodium concentration decreased slightly from 0.474±0.010 g/kg in the control group to 0.465±0.011 g/kg and 0.458±0.017 g/kg in the first and second experimental groups, respectively. This change may indicate alterations in electrolyte balance associated with probiotic supplementation.

Iron concentration in the breast muscle increased from 18.1±0.81 mg/kg in the control group to 19.6±1.04 mg/kg in the first experimental group and 21.2±1.37 mg/kg in the second experimental group, representing increases of 8.3% and 17.1%, respectively.[14]

Zinc concentration increased from 9.70±0.15 mg/kg in the control group to 9.88±0.19 mg/kg and 10.06±0.21 mg/kg in the first and second experimental groups, respectively. No substantial changes were observed in manganese and copper concentrations.[15]

Table 1. Mineral composition of broiler chicken muscle tissue (M±m, n=15)

Parameter	Groups		
	Control, n=5	**Experimental Group 1, n=5**	**Experimental Group 2, n=5**
	Breast muscle		
Calcium (Ca), %	0,034±0,006	0,036±0,007	0,037±0,004
Phosphorus (P), %	0,195±0,011	0,222±0,019	0,247±0,023*
Potassium (K), g/kg	3,69±0,08	3,79±0,09	3,91±0,06
Sodium (Na), g/kg	0,474±0,010	0,465±0,011	0,458±0,017
Iron (Fe), mg/kg	18,1±0,81	19,6±1,04	21,2±1,37
Manganese (Mn), mg/kg	0,40±0,03	0,38±0,02	0,39±0,03
Copper (Cu), mg/kg	0,30±0,05	0,28±0,04	0,32±0,03
Zinc (Zn), mg/kg	9,70±0,15	9,88±0,19	10,06±0,21
	Thigh muscle		
Calcium (Ca), %	0,024±0,002	0,031±0,007*	0,029±0,006*
Phosphorus (P), %	0,238±0,019	0,241±0,011	0,245±0,012
Potassium (K), g/kg	3,68±0,07	3,82±0,05*	3,79±0,06
Sodium (Na), g/kg	0,569±0,019	0,553±0,021	0,585±0,024
Iron (Fe), mg/kg	14,6±1,4	17,9±1,9	16,8±1,6
Manganese (Mn), mg/kg	0,43±0,03	0,41±0,03	0,45±0,02
Copper (Cu), mg/kg	0,36±0,06	0,33±0,05	0,37±0,04
Zinc (Zn), mg/kg	16,7±0,8	18,2±0,9	21,4±1,1

The effect of probiotic supplementation was more pronounced for several mineral elements in the thigh muscle.

Calcium concentration was 0.024±0.002% in the control group, compared with 0.031±0.007% in the first experimental group and 0.029±0.006% in the second experimental group. These values were 29.2% and 20.8% higher than the control, respectively, and the differences were statistically significant ($p<0.05$).

Phosphorus concentration increased from 0.238±0.019% in the control group to 0.241±0.011% and 0.245±0.012% in the first and second experimental groups, corresponding to increases of 1.3% and 2.9%.

Potassium concentration increased from 3.68±0.07 g/kg in the control group to 3.82±0.05 g/kg in the first experimental group and 3.79±0.06 g/kg in the second experimental group. The increase in the first experimental group was 3.8% and was statistically significant.

Iron concentration was 14.6±1.4 mg/kg in the control group, 17.9±1.9 mg/kg in the first experimental group, and 16.8±1.6 mg/kg in the second experimental group. Thus, iron content increased by 22.6% and 15.1%, respectively, compared with the control group.

Zinc concentration increased from 16.7±0.8 mg/kg in the control group to 18.2±0.9 mg/kg in the first experimental group and 19.4±1.1 mg/kg in the second experimental group. The latter represented a 16.2% increase compared with the control.

No substantial differences were observed in manganese and copper concentrations among the experimental groups, indicating that the concentrations of these elements in muscle tissue were relatively stable under the conditions of the experiment.

Conclusion

The results of the study demonstrated that probiotic supplementation influenced the mineral composition of broiler chicken muscle tissue.

In the breast muscle, increasing trends were observed for calcium, phosphorus, potassium, iron, and zinc. The most pronounced changes were recorded in the second experimental group, where phosphorus increased by 26.7%, iron by 17.1%, and zinc by 3.7% compared with the control group.

In the thigh muscle, calcium concentration increased by 29.2% in the first experimental group, iron by 22.6%, and zinc by 16.2% in the second experimental group. Several differences were statistically significant at $p<0.05$.

Overall, the findings suggest that probiotic supplementation may improve mineral utilization and contribute to the regulation of mineral metabolism in broiler chickens. The observed changes in calcium, phosphorus, iron, and zinc concentrations may also contribute to improving the biological and nutritional value of broiler meat.

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