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EFFECT OF COPPER (Cu) AND MANGANESE (Mn) MICROELEMENTS ON CERTAIN PHYSIOLOGICAL PARAMETERS OF KARAKUL LAMBS

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Abstract
This study examines the influence of copper (Cu) and manganese (Mn) microelements supplied through the mineral complex Introvit WS on growth performance, hematological indices, and selected biochemical parameters of Karakul lambs. The experiment was conducted on 20 female Karakul lambs of the Jaydari type, divided into control and experimental groups. Lambs in the experimental group received Introvit WS at a dose of 10 g/L of drinking water for four consecutive days. Live body weight dynamics, morphological blood parameters, and serum biochemical indicators were analyzed on days 30, 60, and 90. The results demonstrated an increase in average live body weight by 100–200 g in the experimental group compared to the control. Erythrocyte count and hemoglobin concentration increased by 7–14%, while serum copper and manganese levels significantly increased, indicating improved mineral metabolism. The findings confirm that mineral supplementation with Cu and Mn positively affects the physiological status of Karakul lambs and contributes to improved adaptation and productivity.

Keywords: Karakul lambs, microelements, copper, manganese, Introvit WS, hematological parameters, mineral metabolism, physiological status.

Introduction

In modern livestock production, ensuring optimal growth, development, and productivity of animals largely depends on the adequacy of mineral nutrition. Microelements play a critical role in regulating metabolic processes, hematopoiesis, immune responses, and antioxidant defense mechanisms. Among them, copper and manganese are essential trace elements involved in numerous enzymatic and physiological pathways [1, 2].

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Copper deficiency in ruminants is associated with anemia, impaired erythropoiesis, reduced growth rates, and decreased resistance to infectious diseases. Manganese deficiency leads to disturbances in carbohydrate and lipid metabolism, skeletal deformities, and reduced reproductive performance [3, 4]. These deficiencies are especially common in pasture-based livestock systems where the mineral composition of soil and forage is insufficient [5].

Studies conducted in the CIS countries indicate that biogeochemical characteristics of pasture ecosystems significantly influence the microelement status of grazing animals [6]. In the Samarkand region, previous observations revealed relatively low levels of copper and manganese in soil and forage, which may predispose Karakul sheep to latent forms of microelement deficiency [7].

Therefore, studying the effects of mineral supplementation on physiological parameters of Karakul lambs is of high scientific and practical relevance. This research aims to evaluate the effectiveness of the Introvit WS mineral complex enriched with copper and manganese in improving growth performance and blood parameters of Karakul lambs.

Theoretical Background

Copper is an integral component of several metalloenzymes, including cytochrome oxidase, superoxide dismutase, and ceruloplasmin. Through these enzymes, copper participates in oxidative metabolism, iron transport, and hemoglobin synthesis [8]. Ceruloplasmin facilitates iron mobilization and transfer to transferrin, thereby enhancing erythropoiesis in bone marrow [9].

Manganese plays a vital role in carbohydrate, lipid, and protein metabolism. It is involved in the activation of enzymes such as pyruvate carboxylase and arginase and is essential for mitochondrial function and antioxidant defense [10]. Additionally, manganese contributes to bone formation and connective tissue development [11].

Several authors have emphasized the synergistic effect of copper and manganese supplementation, noting improved mineral utilization, enhanced hematological indices, and increased productivity in ruminants [12, 13].

Materials and Methods

The experiment was carried out at the “Toxir Zuxra Tog‘” farm in the Nurobod district of Samarkand region. Twenty clinically healthy female Karakul lambs (Jaydari type) aged one month were selected and randomly divided into two groups of 10 animals each.

The control group was fed a standard farm ration without additional mineral supplementation. The experimental group received the Introvit WS mineral complex at a dose of 10 g/L of drinking water for four consecutive days at monthly intervals. The composition of Introvit WS included copper sulfate, manganese sulfate, cobalt sulfate, iron sulfate, zinc sulfate, sodium molybdate, and other supportive components.

Live body weight was measured at the beginning of the experiment and on days 30, 60, and 90. Blood samples were collected from the jugular vein following aseptic procedures. Hematological parameters (erythrocytes, leukocytes, hemoglobin) were determined using an

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automated hematological analyzer. Serum biochemical indicators (total protein, albumin, copper, and manganese) were analyzed using standard laboratory methods.

Statistical analysis was performed using Student's *t*-test. Differences were considered statistically significant at $P < 0.05$ [14].

Results and Discussion

The administration of the Introvit WS mineral complex resulted in a consistent increase in live body weight of lambs in the experimental group. By day 90, the average live weight exceeded that of the control group by 100–200 g, indicating improved growth performance.

Hematological analysis revealed a significant increase in erythrocyte count and hemoglobin concentration in the experimental group, particularly at 60 and 90 days. These changes reflect enhanced erythropoiesis and improved oxygen transport capacity of the blood, which is consistent with the biological role of copper in iron metabolism [15].

Serum biochemical analysis showed increased levels of copper and manganese in the experimental group, confirming improved mineral absorption and utilization. No significant changes were observed in total protein and albumin levels, indicating that mineral supplementation did not adversely affect protein metabolism.

These findings align with previous studies reporting positive effects of trace mineral supplementation on physiological and hematological parameters in young ruminants [16–18].

Conclusion

The results of this study demonstrate that supplementation of Karakul lambs with the Introvit WS mineral complex enriched with copper and manganese positively influences growth performance, hematological indices, and mineral metabolism. Administration of the preparation at the recommended dose and duration effectively prevents microelement deficiency and enhances physiological stability in young animals. The findings support the practical use of mineral complexes in pasture-based sheep farming to improve animal health and productivity.

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