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Influence of Copper Nanopowder and Its Salt on the Physiological State and Growth Dynamics of Animals.

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ABSTRACT

This paper deals with the effect of copper nanopowder added to the diet of animals on adaptive processes of their organisms, which can give out completely because of the prolonged impact of harmful environmental conditions. Homeostasis, including regulation mechanisms, fully ensures the vital processes in the body. Homeostasis depends on the activity of different functional systems. The obtained results suggest a positive impact of copper nanopowder on the homeostasis indices of the animals (morphological pattern of blood, blood biochemistry, blood reaction, etc.).

Keywords: trace elements, blood, nanopowder, homeostasis.

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INTRODUCTION

The impact of hazardous chemicals emitted into the atmosphere and water, the endless soil fertilization with pesticides, nitrates and the accumulated pathogenic biological objects such as viruses, bacteria, fungi, etc. in the environment suggest that both pets and farm animals are kept in the conditions far from their original [1]. All this adversely affects the biological nature of animal body, the functional state and reserves of organs and systems, its reactivity, resistance and ability to adequately adapt to changing environmental conditions. Only healthy farm animals are able to provide the high quality products. The animal body needs a continuous supply of minerals (especially trace elements) and vitamins, along with other nutrients [2]. The insufficient supply of minerals in the diet, disturbances in mineral metabolism result in the worsen palatability and digestibility of feed, which affects further the growth rate of animals, shift in homeostasis and productivity [3, 4].

As the feed from nonchernozem belt is deficient in trace elements, it is essential to add micronutrient supplements in various forms, since they ensure normalization of metabolism and stabilization of homeostasis. In recent years (1998-2010), many scientists studied the use of micronutrient supplements in the form of UFMP (ultrafine metal powders), which is the actual and prospective objective [5, 6].

Objective of this paper is to study the influence of the ultrafine copper powder on the physiological state, metabolism, including mineral one, and productivity in Hereford steers.

TASKS

The following tasks have been defined to achieve the set objective: to determine both the effect of UFMPs on the homeostasis indices of a body (morphological and biochemical blood parameters), the growth rate of Hereford steers, which are kept outdoors all year round, and the economic effectiveness of UDPMs.

The studies involved three groups of steers formed by analog pair method taking into account their age (5 months), condition, body weight, etc., of 5 animals in each group. During the study, the animals were kept under the same conditions of feeding and housing in accordance with the requirements of zoological hygiene.

The basal of the steers diet consisted of pasture grass (20 kg per day) and the grain mix (2 kg per day). Salt bricks was continuously accessible (about 30 g per steer per day). The grain mix consisted of wheat and oats at a ratio of 1:1.

The first experimental group received nanopowder copper in the amount of 0.02 mg/kg body weight of the animal (0.01 mg/kg in the morning and evening) for 30 days in addition to the basic diet, according to the manufacturer's recommendations. The supplement was mixed with the feed mix (wheat + oats).

The second experimental group was keeping its basic diet added with copper salt CuSO_4 (copper sulfate) in the amount of 8 mg per 1 kg of feed dry matter.

RESULTS

Our studies revealed an increase in the number of erythrocytes in the first experimental group by 10.3% and in the second experimental group by 6% as compared to the control (in 2 months after the start of the experiment).

The content of hemoglobin in the blood of experimental animals increased by 18.4% and 14%, respectively, as compared to controls, which indicates the increased hematopoietic functions of the organism of experimental animals and may suggest an increased metabolic rate under the influence of copper nanopowders and copper salts.

According to the results of laboratory tests of blood, the leukocyte count in the animals of the first experimental group decreased by 28%, in the second experimental group by 25% as compared to the control, which indicates the absence of any disease in the experimental animals.

An indicator of the percentage ratio of different types of white blood cells in the blood of animals is the differential count. The differential count indicators may vary in the presence of infectious diseases [7].

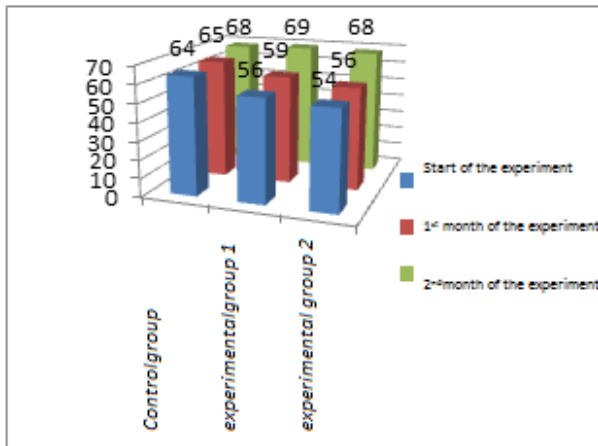


Figure 1 – Lymphocytes count, %

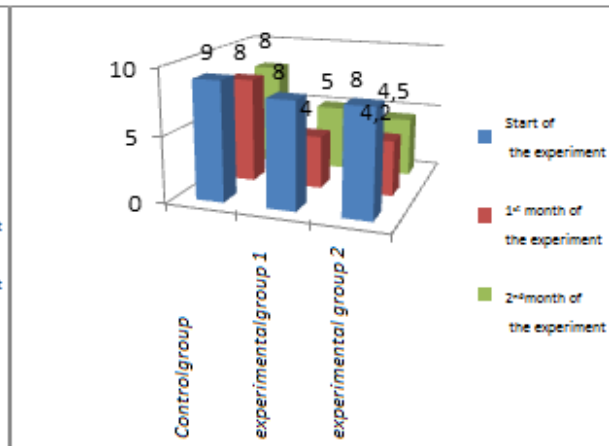


Figure 2 – Monocytes count, %

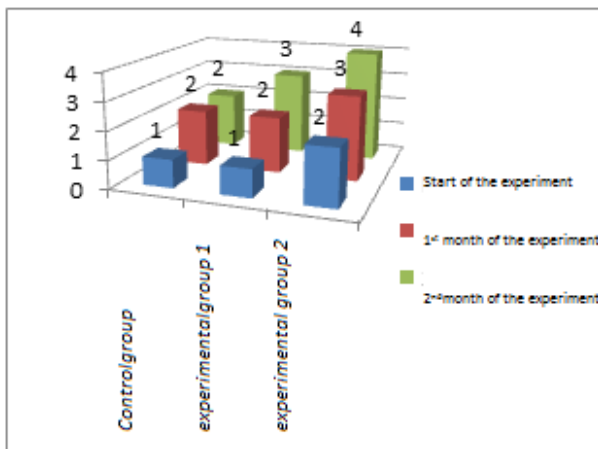


Figure 3 – Stab neutrophils count, %

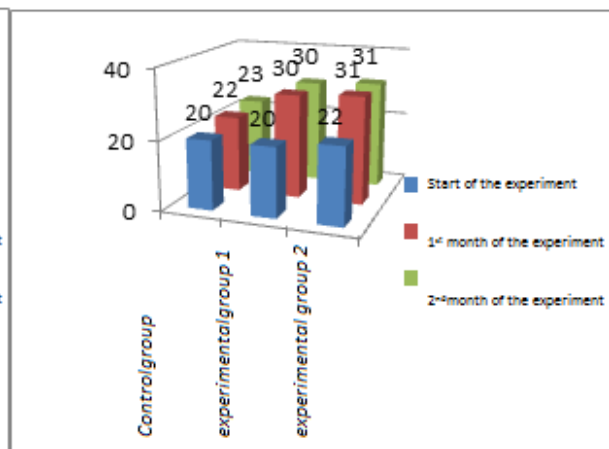


Figure 4 – Segmented neutrophils count, %

In the course of our experiment we found out that the number of lymphocytes in the blood of animals of the first experimental group decreased by 12%, while in the second experimental group - by 15% as compared to the control, and was within the normal range, which indicates an improved cellular and humoral immunity of steers of experimental groups, i.e. an improved immune response of the body. The content of monocytes in the animals' blood of all experimental and control groups was within normal limits. It was revealed that the number of stab neutrophils in the blood of animals of the first and the second experimental groups had increased 2 times as compared to the control group.

An increase in segmented neutrophils in the blood of steers of the first experimental group by 30%, and in the second - by 34% as compared to the control group indicates an improvement in the protective functions of the animals' organisms. Segmented neutrophils protect the body from foreign particles, viruses, fungi, and bacteria through absorption function (phagocytosis).

In the course of our experiment, we observed a 2-fold increase in the blood eosinophil count of animals in the two experimental groups as compared to the control group.

Thus, based on the results of laboratory studies, we can conclude that the copper nanopowder stabilizes homeostasis indices of the body and improves the immune system, as well as involves an increase in the intensity of redox processes in the body, which affects the growth rate of the animals.

Ruminants have a multi-chamber stomach, consisting of an abomasum (true stomach), a net, a manifold, and a rumen. A tripe plays the main function in the digestive process of ruminants, as it contains the bacteria and protozoa, which release the enzymes and ensure thereby the digestion of roughage feed (fiber). Reaction of the rumen content ranges pH 6.5-7.4. This is the optimum medium for microorganisms reproduction. Our studies have shown that the pH levels in the rumen of all groups of animals were within the physiological norm [8].

Cellulolytic activity of microorganisms in rumen fluid of animals of the first experimental group exceeded the same of the control by 15%, and the second experimental group - by 11%. Proteolytic activity in the rumen of animals of the first experimental group increased by 8.4% as compared to the control group, and in the second experimental group - by 4%. The content of protozoa (ciliates) in rumen fluid of animals of the first experimental group exceeded the same of the control by 22%, and in the second experimental group - by 11,5%. The ammonia content in the rumen fluid of the experimental animals increased on average by 16.8% as compared to the control. Thus, there is intensification of rumen digestion in the rumen fluid of the first experimental group of animals due to adding the above supplements into the diet. According to studies by I.E. Pivniak and B.V. Tarakanov (1982), copper enhances the activity of enzymes secreted by rumen bacteria and protozoa, as well as forms a part of the enzymes. The intensification of rumen digestion, accordingly, ensures large amounts of energy to a living organism, which affects the dynamics of the animal's growth.

At the beginning of the experiment, the steers were weighed to define further the dynamics of body weight and average daily weight gain. Average live weight of animals at the beginning of the experiment was as follows: control group - 189.2 kg, the first experimental group - 180.6 kg, and the second experimental group - 183.2 kg. As the applied nanopowder-based supplements have a prolonged effect, the steers were weighed 30 days after the start of the experiment and then after 60 days.

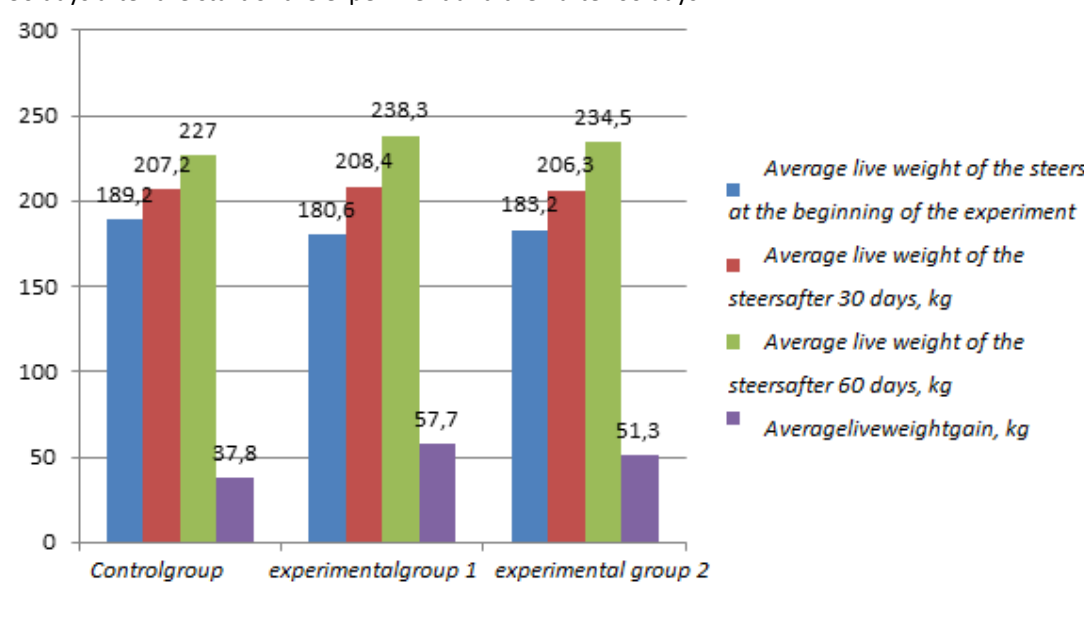


Figure 5 – The steer live weight dynamics, kg

SUMMARY

Nutritional intervention of the deficient trace element (copper) in its different forms into the diet of Hereford steers has a positive effect on both the homeostasis and the growth rate of the body.

CONCLUSION

The findings have shown that the ultrafine copper powder at a dose of 0.02 mg/kg is more effective supplement as compared to the salt (CuSO_4). It ensures increase in profit by 6692.5 ruble in growing the Hereford steers, as well as in the level of profitability by up to 18.7%.

Thus, the use of ultrafine copper powder ensures activation of physiological processes in animals, and is a cost-effective and efficient area in the investigation of mineral metabolism.

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