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INFLUENCE OF ADDITIVES OF MINERAL ORIGIN ON LIVESTOCK PRODUCTS

ВПЛИВ ДОБАВОК МІНЕРАЛЬНОГО ПОХОДЖЕННЯ НА ТВАРИННИЦЬКУ ПРОДУКЦІЮ

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Abstract. *Their chelated compounds with essential amino acids, which are the most optimal form of biogenic metals, are extremely important in increasing the bioavailability of trace elements and providing them to animals. When using chelate compounds, antagonistic relationships between individual trace elements (ME) are eliminated, they are transported to the place of absorption without dissociating, and are transformed in the organs into a metabolically active form. Microelement diseases of animals refer to enzootic diseases of individual biogeochemical zones and provinces, arising from a deficiency, excess, or imbalance of mobile forms of biotic microelements in soils, water sources, and plants. Microelementoses of cattle cause significant damage to farms due to a decrease in the efficiency of the use of feed nutrients, a decrease in resistance and productivity.*

Key words: *trace elements, supplements of mineral origin, cattle.*

Introduction. Laboratory regulations for the synthesis of iron, cobalt, iodine and selenium lysinates have been developed. For the first time, the intensity of the course of physiological processes and the productivity of animals under the influence of methionates and lysinates of microelements were studied. New data were obtained that characterize the activity of erythropoiesis, the state of protein metabolism, and the veterinary-sanitary quality of beef after feeding different doses of trace element compounds with essential amino acids (methionine and lysine) on hematological indicators, productivity, and meat quality of fattening animals.

The obtained results make it possible to correct the rations of experimental animals according to deficient trace elements. It has been proven that the introduction of microelements in the form of chelated compounds (methionates and lysinates) into the diet of animals has a positive effect on erythropoiesis, the respiratory function of the blood, certain areas of protein, energy and carbohydrate metabolism in the body of young cattle, leads to an increase in their productivity and an improvement in the quality of the obtained beef from them.

The use of minerals and metals for medicinal purposes has been known since the ancient civilizations of China, India and Mesopotamia. However, the description of the impact of trace elements on the health of people and animals was episodic and systematized. In particular, in 89 BC described the death of cattle from an unknown cause, although they grazed on excellent pastures [2]. Two different methods are used to assess the trace element status of the body: determination of the trace element content (for example, plasma or liver concentration of the trace element) or determination of the functional state (for example, thyroid hormones, etc.). There are data on different threshold values (norms) for assessing the content of the main microelements, which are necessary for optimizing the diet and increasing productivity.

The composition and quality of the ration affect the daily requirement of livestock in trace elements. The need for trace elements will be minimal with a complete balanced feed. If there is a large amount of acidic forage in the diet (silage, pulp, bard, etc.) or if there is an excess of phosphoric and sulfuric acid in it, which happens with a highly concentrated type of feeding, the animal's need for trace elements increases [17]. Not only an excess or lack of microelements can lead to the development of a pathological process, but also an imbalance between essential elements causes severe violations of body functions [12]. An imbalance of trace elements is one of the causes of the membrane-toxic enzymatic effect of disruption of the structure and function of cells, imbalance of the body's microflora, and intensification of lipid peroxidation.

A complex of various chemical elements enters the body of cattle with feed. Therefore, when forming rations and supplementing with trace elements, their mutual regulation, antagonism and synergism should be taken into account. Yes, the antagonists of Cobalt are Manganese and Strontium; Zinc - Calcium; Copper - Molybdenum, Zinc, Manganese and Plumbum; Molybdenum - Cuprum and Manganese; Manganese - Molybdenum and Iodine; antagonists of Iodine - Calcium, Manganese, Lead, Fluorine, Bromine [10]. Iodine is part of thyroid hormones that regulate all types of metabolism. With a lack of iodine in the body, there is a delay in the growth and development of young animals, a violation of metabolism, the functions of the cardiovascular, hematopoietic, reproductive systems, and the liver. Large doses of free Iodine are toxic, so a dose of 2-3 g is fatal for humans. At the same time, in the form of iodide, it is allowed to be taken inside in large doses. If a significant amount of inorganic salts of iodine is introduced into the body with food, its concentration in the blood increases up to 1000 times, but after 24 hours its content returns to normal. Moreover, the excess of iodine is compensated by several mechanisms.

Iodine deficiency can be assessed using its content or functional markers. For this, plasma inorganic Iodine is determined, its concentration fluctuates significantly according to feeding time and diet. The assessment of the functional state of the hypothalamus-pituitary-thyroid system (thyroid-stimulating hormone, thyroxine, triiodothyronine) [1] is used as functional markers, but the physiological status of animals (pregnancy, circadian rhythm, age) should be taken into account. Thyroid hormone analysis is commonly used to diagnose hypothyroidism in cattle caused by iodine deficiency. Cuprum participates in the formation of hemoglobin, promoting the assimilation of iron by transferring it from trivalent to divalent, regulates the exchange of vitamin C, and stimulates the function of the thyroid gland. Activates a number of enzymes, regulates protein, carbohydrate, pigment and vitamin metabolism. Its lack in the body leads to a violation of hematopoiesis, metabolism and functions of the thyroid gland [16]. The storage depot for Cuprum is the liver.

The content of this element in the liver reflects its long-term availability. A reduced concentration of copper in the liver is an early marker of copper deficiency in the diet. Therefore, liver biopsy is the most sensitive way to assess copper deficiency. However, blood tests are more often used to diagnose cuprum deficiency [16]. Ceruloplasmin - an inflammatory protein contains about 80% of all copper in the blood. There is a curvilinear relationship between the concentration of copper in the liver, blood and ceruloplasmin content. However, the liver concentration of Cuprum decreases earlier than the decrease in the concentration in the blood with its deficiency in the diet [17].

Hypocuperosis is manifested by a violation of hematopoiesis and the development of hypochromic anemia. In severe cases of hypocuporosis, the central nervous system is affected, especially the cerebellum. Demyelination of brain tissue occurs, which leads to encephalomalacia and hydrocephalus, which, in turn, leads to ataxia, paresis and paralysis. Most often and massively, such lesions of the central nervous system occur in lambs. In such cases, the disease is called enzootic ataxia. A typical external clinical manifestation of copper deficiency in dark-colored animals is partial depigmentation of the coat. At the same time, light stripes alternate with dark ones, which causes the so-called tiger color.

Zinc activates sex hormones, pituitary and pancreatic hormones. It regulates many types of metabolism. With a deficiency of zinc in the body of animals, the reproductive function, metabolism, especially protein and carbohydrate, is impaired, growth and development of young animals is delayed. Zinc is an essential component of more than 70 enzymes found in mammalian tissues. Zinc is also important for the normal development and functioning of the immune system, the stability of cell membranes, and gene expression [19]. Diagnosis of zinc deficiency is a complex process. It was found that the content of Zn in the liver of cattle decreases slightly after a long-term deficiency, therefore, determining its content in plasma or blood serum is the best test of metal deficiency. There are known data on the manifestation of clinical signs of zinc deficiency before a decrease in its content in the blood. Therefore, a low concentration of serum Zn indicates its deficiency, while a normal level does not necessarily indicate its sufficient content in the animal's body [12].

The reactions of dairy cattle to different levels of zinc in the diet varies significantly, suggesting that the main factors of the completeness of the diet in terms of zinc are not its absolute content in the diet, but biological availability [12]. There is evidence that the high content of calcium in the diet of cattle reduces the availability of zinc. A number of laboratories have found a decrease in zinc levels in cows after repeated calving. Moreover, excessive content of copper and selenium in the liver of these cows was established. Obviously, an excess of Copper and Selenium can interfere with the absorption of Zinc. Thus, low zinc levels are likely a secondary effect [16]. Zinc deficiency is characterized by impaired reproductive function, delayed growth and development of young animals, metabolic and hematopoietic disorders. The most typical symptom of zinc deficiency in animals, especially in pigs, is a peculiar skin lesion in the form of parakeratosis [12].

Manganese in Europe is determined in dairy cattle on a regular basis. Lower levels of Manganese in the blood of dairy cattle may be the result of high levels of

Calcium and Phosphorus, which are antagonistic to Manganese [19]. The most informative in the study of Manganese deficiency in the body of cattle is the determination of its content in the liver, followed by whole blood and serum. Hemolysis of erythrocytes can lead to a false increase in the manganese content in the experimental sample. Research on the content of Manganese in feed is not informative, since its various salts have different bioavailability. For example, manganese oxide is absorbed rather poorly [23]. Manganese deficiency in livestock is characterized by a violation of calcium-phosphorus metabolism. At the same time, there is a delay in growth in length and deformation of tubular bones, joints, and displacement of tendons [91]. Anemia is often manifested as a result of impaired hematopoiesis [22]. Ferrum is part of hemoglobin, iron-protein complexes, myoglobin, some enzymes and tissues. With its deficiency in the body, anemia occurs, metabolism is disturbed, growth and development of young animals are delayed. With a simultaneous deficiency in the body of Ferrum, Copper and Cobalt, malignant anemia develops [4]. Ferrum enters the body with food and drinking water, but it is absorbed only up to 10%, the rest passes through transit. In addition, Ferum is excreted with urine, bile, and in lactating animals - also with milk. The presence of copper and vitamin B12 in the body has a significant effect on the assimilation of Ferrum [4]. Ferrum is needed not only for the formation of hemoglobin, but also for the normal functioning of many vital enzymes of the animal body that actively participate in metabolic processes [4]. Significant reserves of Ferrum (up to 20%) are deposited in the liver, spleen and bone marrow in the form of ferritin and hemosiderin. In addition, Ferum is contained in myoglobin (10-15%), oxidases, cytochrome enzymes and in a small amount in blood plasma (non-hemized Ferum) - no more than 0.1% [1].

Not only the lack, but also the excess of individual microelements affects the vital activity of the animal organism, their productivity and resistance. Thus, a lack of Fluorine in the body causes dental caries, and its excess leads to fluorosis. An excess of Nickel in the body is accompanied by damage to the cornea of the eyes, and an excess of Molybdenum, Boron, Lead, Cadmium - to poisoning, Beryllium - to lesions of bone tissue [22]. Up to 70% of the total number of heavy metal ions polluting the internal environment of the body enter the body from the outside. Microelements should enter the body of animals in such quantities and ratios that will ensure the realization of the genetic potential of animals, preserve their health and reproductive functions. The supply of trace elements in sufficient quantities with feed and inorganic salts does not guarantee 100% supply of Mn, Cu and Zn to animals, because only a certain part of them can acquire a functionally active form in the body. In this connection, the concept of bioavailability of trace elements was introduced. Most researchers understand the quantitative assimilation and use of trace elements by the animal organism or their accumulation in the animal organs by biological availability. The biological availability of trace elements depends on the forms and sources of their entry into the animal body and on the physiological state of the organism [5]. Trace elements in organic forms, especially chelated compounds of trace elements with amino acids, are characterized by high biological availability. Inorganic salts of trace elements (chloride, nitrate, sulfate, carbonate) have low bioavailability, so they are absorbed by the body of animals worse than organic ones. Removal of crystallized water from the molecule of sulfuric acid salts of trace elements leads to a decrease in their biological availability [7]. The assimilation of trace elements in the gastrointestinal tract depends on their interaction with other feed nutrients and the formation of new forms of complex compounds in it, which are significantly different from the forms of compounds. The degree of stability and solubility of the compounds formed has important physiological significance [12].

It has been proven that the use of chelated compounds of trace elements as feed additives provides better assimilation of the metal than when it is introduced into the diet in an inorganic form. This, in turn, helps to increase the productivity of animals and reduce feed costs per unit of production. All this allows us to consider internal complex chelate compounds of biogenic metals as a means that improves the quality of mineral supplements, which in turn contributes to a targeted effect on the metabolism of animals. Chelated compounds of biogenic metals are able to cross the placental barrier and nourish the fetus [7, 14]. The functional activity of microelements depends on their chelating ability, which increases when they are combined with organic compounds and is carried out when they are included in organometallic compounds of a certain shape and structure [20]. The biological effect of chelates on the animal's body is determined by their stability and the properties of the ligands included in the complex [2]. Microelements of various metalloproteins have different properties that depend on the nature of the functional groups included in the coordination complexes. The role of chelating complexes in the body depends on the nature of the chelating compound, the nature of the ligands included in its composition, their size, and configuration [2]. The lack or excess of biogenic macro- and microelements in feed reduces their productive effect, restrains the growth of animals, reduces productivity, worsens the quality of products, causes disease and death. Calcium, Manganese and Zinc in the acidic environment of the small intestine form a strong insoluble complex with phytic acid, from which the cations are not absorbed.

When evaluating the bioavailability of zinc from 13 chemical compounds, it was found that chelated compounds with methionine and tryptophan, as well as complexes of this element with caprylic and acetic acids, have high bioavailability [13]. Among the microelement complexes with proteins is Zinc, which is transported in the form of easily dissociable complexes with albumin and a tightly bound compound with globulins [13]. Manganese in plant feed is mainly bound by chelated compounds, and therefore is absorbed better. It is believed that the element is absorbed in a divalent form and competes with iron and cobalt for absorption sites [11, 12]. So, the importance of individual microelements for the animal body has been comprehensively investigated, however, certain aspects of the impact of different levels of microelements on protein metabolism indicators and hematological indicators of cows, depending on the territory of their existence, have remained out of the attention of researchers. Deficiency or excess of trace elements in the animal body is the cause not only of a decrease in productivity, but also of the occurrence of peculiar diseases - trace element diseases, which are most common in biogeochemical zones and provinces - localities whose soils and water sources have a very low or very high content of mobile (assimilable) forms trace elements. Such content of chemical elements causes a certain reaction of local flora and fauna, can lead to diseases of plants, animals and people.

The need for trace elements is also determined by the age, productivity and physiological state of animals. Thus, during the period of intensive growth, high productivity and in the second half of the cow's body, the need for trace elements increases by 1.5-2 times. The symptoms of trace element diseases are peculiar and not always clearly manifested, which complicates the clinical diagnosis of trace element diseases in productive animals. In today's conditions, large losses to animal husbandry are caused by trace element diseases caused, in particular, by a lack or excess of certain trace elements. The problem of trace element diseases in agriculture has been thoroughly studied. On the one hand, most of the soils of Ukraine are poor in certain essential microelements, but there are more and more man-made zones in which the content of heavy metals in the soil significantly exceeds the optimal parameters. Given the fact that there are a large number of biogeochemical zones and provinces on the territory of our country, which differ significantly, researchers mainly conduct tests in different regions of Ukraine. Most of the research in this direction is devoted to the study of lactating cows, while the dry period of cows is neglected, although it is at this time that the most intensive development of the fetus takes place and the future productivity of the cow is formed. Unbalanced feeding of dry cows and heifers is often the main reason for poor calving, weakened offspring, poor development of calves and low milk productivity of cows in the next lactation.

Despite the fundamental and comprehensive research of trace element diseases of animals in the conditions of different biogeochemical provinces of Ukraine, urgent issues related to this issue still remain unanswered, in particular, there are no data on the physiological, biochemical and clinical status of dry cows and the calves obtained from them in different biogeochemical zones and with different levels and ratios of trace elements in the blood. There are no data on the intensity of hematopoiesis and protein metabolism in the body of newborn calves obtained from cows with manifestations of trace element diseases. The effect of different content and ratio of microelements in the blood of dry cows on the microelement status of calves obtained from them has not been clarified. The dependence of hematological indicators and protein metabolism on the deficiency of microelements in the blood serum of dry cows and calves obtained from them of different biogeochemical provinces has not been investigated. So, a brief review of the literature proves that there are certain relationships between mineral elements among themselves, with organic substances, vitamins, enzymes and hormones. These relationships determine the participation of microelements in the regulation of the exchange of proteins, fats and carbohydrates, mineral elements, as well as the possibility of their influence on such physiological vital processes as tissue respiration, hematopoiesis, cell division, reproduction, growth.

Chelated Zinc reduces the number of somatic cells by 22-50% depending on the dosage of Zinc used and increases the productivity of animals. Addition of Bioplex® Zntm (Alltech company) to the diet reduces the risk of reinfection in the mammary gland [12, 13]. According to Jr.B. Harris, in 90 days, the number of somatic cells in the milk of the cows of the experimental group decreased by 30–40% from the beginning of the experiment compared to the control group. Somatic cell content is a common indicator for assessing the health of the mammary gland and the quality of raw milk. An increase in the content of somatic cells in milk is observed in various inflammations of the mammary gland [12]. They report that chelated zinc reduces the number of somatic cells (SCC) by 22-50% in eight trials, depending on the dosage of zinc used, and increases milk yield. Most research on this issue has focused on the reduction of CSC under the influence of supplemental use of organic zinc, which is many times more bioavailable to ruminants than inorganic forms. Addition to the diet of Bioplex® Zn (Alltech company) reduces the risk of reinfections in the mammary gland [15]. The theoretical basis for detecting an increase in the number of somatic cells in mastitis is that their number in milk correlates with changes in the content of sodium, potassium, chlorides, lactose and whey proteins in milk, that is, with signs that reflect the state of the mammary gland. The number of somatic cells is affected by a number of factors: lactation stage, calving season, productivity [14]. An increase in the content of somatic cells is more often observed in various inflammatory processes in the mammary gland, although it can also be caused by the influence of such factors as the stage of lactation, the calving season, the amount of milk yield.

The number of somatic cells in 1 ml of milk from a healthy udder is approximately 50–250 thousand, with a minor infection – about 250–300, with a severe infection – more than 600 thousand. This does not affect the technological properties of the milk. However, even with the number of somatic cells of 400 thousand/ml, up to 40% of cows and 17% of mammary gland quarters are infected. In studies aimed at studying the influence of organic forms of trace elements on the productivity and reproductive qualities of dairy cows, the use of Bioplex® caused a significant decrease in the number of somatic cells (by 40%). Although the coefficient of insemination at first calving was within the normal range in both groups, it was higher in the group of cows receiving Bioplex® (65 vs. 57%). The results confirm that the microelements that are part of Bioplex® have a positive effect on the reproduction of dairy cattle, ensure the normal content of minerals in the blood [14]. According to research carried out in England, for the number of somatic cells less than 250 thousand in 1 ml of milk, milk yield losses amounted to 190 kg, with 500–749 thousand – 340 kg, with 750–999 thousand – 770 kg, and with the content of somatic cells of more than 1 million cells in 1 ml, the loss was already equal to 890 kg of milk from a cow per year.

Thus, the dairy laboratory of the Estonian Animal Husbandry and Veterinary Institute examined 30,000 milk samples and found a correlation between the number of somatic cells and the following components: negative - with the content of lactose and potassium, positive - with the content of sodium and chlorine. When the number of somatic cells increases from 104.5 thousand to 14–20 million/ml, the content of total protein – from 3 to 3.8% and chloride – from 0.13 to 0.29% increases significantly in milk from the affected quarters of the udder. % [17]. The best way to classify mastitis is to divide cows into risk groups depending on the level of somatic cells in 1 ml of milk, for example: up to 250,000 - the possibility of infection is unlikely; 250–400 thousand – the possibility of infection is limited; 400–750 thousand – the probability of infection is high, more than 750 thousand – the probability of infection is very high.

In Finland, a slightly different ratio is adopted regarding the number of somatic cells and the state of health of the cow: less than 125 thousand - the condition of the udder is excellent; 125–250 thousand – udder condition is good; 250–500 thousand – the beginning of the inflammatory process; 500–1000 thousand – clear violations of secretion; 1000–2000 thousand – mastitis, more than 2000 thousand – severe inflammation. The threshold of a normal number of somatic cells should be considered: for whole milk - 1 million/ml, for daily milking cows - 660 thousand; for individual quarters of the udder - 300 thousand/ml [17]. Such a classification of cows according to the level of somatic cell content in milk does not exist in the CIS countries. The requirements for the indicator are developed only in the standard for purchased raw cow's milk (DSTU 3662 - 18). The norm of the content of somatic cells for the highest grade of milk is no more than 500,000, for the first grade - no more than 1,000,000 in 1 ml. Milk intended for the production of baby food products must meet the requirements of higher or I grades, but with a somatic cell content of no more than 500,000/ml.

Today, the content of somatic cells in cow's milk is one of the most reliable methods for assessing the state of the mammary gland. The special commission of the International Dairy Federation on mastitis and a number of scientists believe that 1 ml of milk from healthy cows should contain up to 500,000 somatic cells. According to the data of English scientists, if there are less than 250 thousand somatic cells in 1 ml of milk, milk yield loss is 190 kg, with 500–749 thousand – 340 kg, with 750–999 thousand – 770 kg of milk from a cow per year. In dairy farming, there are significant problems with fertilization, which are aggravated by increasing milk productivity. It is important to prove that organic forms of trace elements have a positive effect on various systems of the cow's body, including reproductive function. Thus, the use of microelement proteinates effectively affects not only the productivity of cows and the quality of milk, but also contributes to the strengthening of reproductive qualities and the preservation of livestock. In addition, it increases the efficiency of the use of fodder, extends the period of productive use of breeding animals [13].

The data available in the literature suggest that the introduction of organic forms of microelements as feed additives into rations will have a significant impact on solving the problem of micromineral supply of cattle. However, there is not enough information on the use of organic forms of microelements, such as Bioplex® Zn-, Cu-, Mn, in the diets of highly productive Holstein cows in the industrial complexes of the Steppe of Ukraine. But even those data obtained even in short-term experiments indicate an increase in the productivity of animals [15]. One of the solutions is to increase the use of minerals in organic form in animal husbandry by replacing inorganic minerals with organic chelates, such as Bioplex®. Bioplex® minerals are chelated into peptides in the same way as in nature, which significantly increases their digestibility. Therefore, when using a feed additive, Bioplex® can be used to completely replace the current levels of inorganic minerals. This allows producers to reduce the quantitative level of mineral additives in feed, which will cause a decrease in animal growth rates [14, 15]. As a result of feeding microelements in the form of chelating compounds, the intestinal microflora grows significantly. This increases the intensity of the entire process of digestion and fermentation of feed in the digestive tract.

Therefore, research on the use of regional mineral additives in the diets of high-yielding cows with the aim of increasing their productivity has today an important scientific and economic significance and is relevant for every biogeochemical zone of Ukraine. An important role in the prevention of trace element diseases is played by the rational feeding of animals with good quality feed. Microelements come with feed in the form of complex organometallic compounds, from which they are easily absorbed. However, feed alone does not satisfy the need of high-yielding cows in individual microelements, so various premixes and combined feeds containing inorganic salts are introduced into their diets. Inorganic salts of microelements, as part of compound feed, are not always safe for animal health and have low bioavailability [9].

Their complex compounds with amino acids and other organic substances, the so-called ligands, increase the bioavailability of trace elements. The interaction of metal ions with ligands consists in their coordination, mostly ligands bind to ions of trace elements through amino and carboxyl groups [16]. Microelements of the chelate complex, which consists of metals and ligands, have high biological activity and digestibility (95–100%). Due to the gradual breaking of chelate bonds, the drugs have a prolonged effect. Ligands are effectively used by the body when microelements are broken down. All this makes it possible to reduce the doses of trace elements, as well as positively solve environmental and economic problems. One of the main directions of increasing the productivity of animals and improving the quality of their products is a complete and balanced feeding of the main nutrients and biologically active substances (BAR). However, both a lack and an excess of the latter can lead to a violation of metabolism in animals and people, which leads to the occurrence of various diseases.

The study of the trace element (ME) composition of feed, water and tissues of fattening cattle within specific farms established that the content of trace elements in feed changes under the influence of various agrotechnical and atmospheric factors and the type of soil. At the same time, it was established that the most deficient are iron, cobalt, iodine and selenium. Fe deficiency is 39.2%; Co - 54.5%; I – 46.4% and Se – 73.2%. Such a low percentage of providing animals with individual trace elements leads to overspending of feed per unit of production, deterioration of the general physiological condition of animals, and as a result - a decrease in meat productivity and the quality of the obtained products, which do not meet the physiological needs of humans [13, 14, 15].

For a more thorough and in-depth study of the effect of chelated trace element premixes on animal growth, we determined the speed and intensity of growth, in addition to total and average daily growth. These data are shown in Table 1. As can be seen from Table 1, the live weight of bulls of the control and experimental groups when put on fattening was practically the same. Supplementation of bulls of the experimental groups (II - X) led to an increase in average daily and total growth, as well as an increase in the live weight of animals at the end of the experiment. In animals of II-IV groups, which were fed with microelement methionates, the total and average daily growth increased by 3.7, respectively; 5.1 and 3.1% relative to the control. Animals of groups V - VII were fed Fe, Co, I and Se lysinates, and this led to an increase in the above-mentioned indicators by 0.6; 2.9 and 1.1%, respectively, compared to the control group.

Table 1 - Productivity of experimental steers when feeding them methionates and lysinates of deficient TE, M±m, n=10.

Groups of animals	Live weight, kg		Increase		Growth rate, %	Growth intensity, g/kg/era
	At the beginning of the experiment	Finally research	General, kg	medium-daily, г		
I	190±3,5	251,2±3,7	61,2±1,4	680±5,1	27,7±0,7	3,6±0,06
II	192±3,2	255,4±3,3	63,4±1,8	705±6,2**	28,4±0,6	3,7±0,04
III	188±3,9	252,3±3,0	64,3±1,5	715±6,6***	29,2±0,7	3,8±0,05*
IV	186±3,7	249,1±3,9	63,1±1,9	701±5,6*	29,0±0,5	3,8±0,06*
V	190±3,1	251,6±3,2	61,6±1,8	684±5,0	27,9±0,6	3,6±0,05
VI	188±3,8	251,0±3,1	63,0±1,7	700±5,1**	28,7±0,7	3,7±0,04
VII	185±3,1	246,9±3,2	61,9±2,0	688±5,4	28,7±0,7	3,7±0,05
VIII	184±3,4	247,9±3,6	63,9±1,6	710±6,1***	29,6±0,5	3,9±0,09**
IX	187±3,9	252,7±3,5	65,7±1,3 *	730±6,0****	29,9±0,4*	3,9±0,08**
X	188±3,9	252,9±3,6	64,9±1,8	721±6,8****	29,4±0,5	3,8±0,06*

Animals of VIII-X groups were fed both methionates and lysinates of trace elements. This supplement provided an increase in average daily and total growth by 4.4, respectively; 7.3 and 6.0% compared to the control group. From the data in the table, it can be seen that the growth rate of the animals of the experimental groups increased compared to the control group. The increase in live weight of the animals of the experimental groups was more intense compared to the control. Thus, in animals of II - IV groups, the intensity of growth increased by 2.8; 5.5 and 5.5% compared to the control group. For a broader study of the effect of chelates of microelements on the productivity of cattle, we conducted a second experiment, the data of which show that the premix developed by us has a positive effect on the productivity of animals. Productivity of experimental bulls when using methionates and lysinates of deficient microelements in feeding is given in the table. 2.

Thus, the average live weight at the end of the second experiment in the animals of the experimental groups was 62.9 kg higher than in the control due to the fact that the average daily gain increased by an average of 21.3% compared to the control. An increase in growth rate by 40.9% and growth intensity by 18.3% compared to the control was also established. Supplementation of animals of the second group with methionates in the doses mentioned above led to an increase in their live weight by 51.5 kg compared to animals of the control (first) group.

Table 2. - Productivity of experimental steers when feeding them methionates and lysinates of deficient TE, M±m, n=15.

Groups of animals	Live weight, kg		Increase		Growth rate, %
	Finals researcher	Finally research	General, kg	Medium-daily, g	
I	230±3,7	488,8±3,8	258,8±3,5	719±5,5	72,0±1,2
II	218,5±3,7	528,8±3,7 ****	310,3±3,5 ****	862±5,5 ****	83,1±1,0 ****
III	242,4±3,9 *	547,7±3,9 ****	305,3±3,6 ****	848±5,7 ****	77,3±1,1 ***
IV	252,5±3,9 ****	578,7±3,8 ****	326,2±3,8 ****	906±6,1 ****	78,5±1,2 ***

Animals of the III group, in addition to the basic diet, additionally received lysinates of microelements in doses: Fe - 0.05 mg/kg of live weight; Co – 0.04; I - 0.05 and Se - 0.02 mg/kg of live weight at the end of the experiment had 46.5 kg (which is 12.0%) more live weight than animals of the control group. They increased: average daily and total growth by 18.0%; growth rate by 5.3%; growth intensity by 12.9% compared to similar indicators of animals of the I group (control).

Biotic levels and synergistic ratios of individual microelements in premixes allow their use throughout the feeding, ensuring optimal metabolism in the contents of the rumen and body tissues, stable productivity of livestock and obtaining ecologically clean products [12]. In order to eliminate the deficiency of certain microelements in the body of animals of the experimental farm, it is advisable to carry out the correction of microelement nutrition after a preliminary analysis of ME composition of soils, fodder, water and body tissues. Feeding animals compound feed with premixes developed by us, which include optimal levels, in certain ratios of chelated compounds of deficient microelements, allows to increase the meat productivity of livestock by an average of 21.3%, as well as to improve the biological and nutritional value of products. Extremely important indicators at slaughter are carcass yield, slaughter yield and internal fat yield, which always depend on the fatness of the cattle. Meat and its qualitative composition is determined by the quantitative ratio of tissues, namely, its morphological composition, which depends on the species, breed, age, sex, feeding and conditions of keeping livestock.

We conducted a production inspection (second test). The obtained results (Table 3) more significantly confirmed the data of the first experiment. Analyzing these data, it can be seen that feeding the animals of the experimental groups with chelates slightly improves the slaughter qualities of the experimental bulls.

Yes, supplementing animals of the II group with methionates in a dose: iron 0.05 mg/kg body weight. m., cobalt - 0.04, selenium - 0.02 and iodine 0.05 mg/kg of live weight helped to increase the slaughter yield, carcass yield and internal fat yield by 3.78, 3.5 and 0.28%, respectively, compared with control In animals of the III group, which received lysinates in a dose: Fe - 0.05 mg/kg body weight; Co – 0.04; Se – 0.02 and I 0.05 mg/kg of live weight, slaughter output, carcass output and internal fat output increased by 3.01, respectively; 2.8 and 0.21% compared to the control (I group). It should be noted that all these data were statistically reliable. Animals of the IV group were fed ME methionates in doses: Fe - 0.025; Co - 0.02; I - 0.025; Se - 0.01 mg/kg of live weight and Fe lysinates - 0.025; Co - 0.02; I - 0.025 and Se - 0.01 mg/kg live weight and this contributed to an increase in slaughter yield by 5.2%, carcass yield by 4.8% and visceral fat yield by 0.4% compared to the control group. Therefore, comparing the obtained experimental data, it can be seen that the use of ME methionates and lysinates has a positive effect on the slaughter performance of experimental bulls.

Table 3 - Slaughter quality of experimental cattle when fed with methionate and lysinates of deficient trace elements, M±m; n=15.

Groups of animals	Pre-slaughter w/m, kg	Slaughter weight, kg	Slaughter output, %	Mass steam room carcasses, kg	Mass stem rum Tsartsass, kg, %	Mass of internal fat, kg	Output of internal fat, %
I	482±2,4	233,3±3,7	48,41±0,60	224,6±3,33	46,6±0,59	8,72±0,36	1,81±0,04
II	522±2,4 ****	272,5±3,6 ****	52,19±0,51 ****	261,6±3,36 ****	50,1±0,56 ****	10,92±0,41 ***	2,09±0,06 ***
III	541±2,5 ****	278,2±3,8 ****	51,42±0,62 ***	267,3±3,40 ****	49,4±0,56 ***	10,93±0,43 ***	2,02±0,05 ***
IV	570±2,4 ****	305,6±3,4 ****	53,61±0,57 ****	292,9±3,35 ****	51,4±0,59 ****	12,65±0,40 ****	2,21±0,05 ****

Analyzing the data obtained in Table 4, which shows the change in the chemical composition of the meat of the cattle of the second experiment, it can be seen that the results of the second experiment confirm the results obtained in the first experiment and indicate that chelated compounds of trace elements with essential amino acids improve the chemical composition and increase calorie content of the longest muscle of the back. Meat of animals of the second group, which were fed ME lysinates in the dose: Fe - 0.05 mg/kg body weight; Co – 0.04; Se - 0.02 and I 0.05 mg/kg of live weight, contained 1.53% more dry matter than the meat of animals of the control group, protein - 1.46%, fat - 0.09%, ash - 0.1, caloric content was higher by 5.9%, tryptophan by 0.16% and protein qualitative index increased by 1.08% compared to the control group. In the meat of animals of the III group, which were fed ME methionates in a dose: iron 0.05 mg/kg body weight. m., cobalt - 0.04, selenium - 0.02 and iodine 0.05 mg/kg live weight, the content of dry matter increased by 0.75%, protein by 0.77%, fat - 0.04%, ash - 0.04%, caloric content increased by 2.9%, tryptophan by 0.13%, and the protein qualitative indicator increased by 0.8% compared to similar indicators of animals in the experimental group.

Animals of the IV group were fed ME methionates in doses: Fe - 0.025; Co - 0.02; I - 0.025; Se - 0.01 mg/kg of live weight and Fe lysinates - 0.025; Co - 0.02; I - 0.025 and Se - 0.01 mg/kg of live weight. At the same time, the content of dry matter increased by 2.32%, protein by 1.78, fat by 0.28, ash by 0.17, caloric content by 9.5, tryptophan by 0.22, and protein quality index by 1.45% compared to the control group. The amount of oxyproline decreased in all three experimental groups. In group

II by 0.03%, group III by 0.021% and group IV by 0.037% compared to the control group. So, summarizing the results of Tables 3 and 4, it can be stated that feeding cattle with methionates and lysinates of ME improves the chemical composition and nutritional value of beef.

Table 4 - Chemical composition and caloric content of the longest back muscle of cattle when fed with methionates and lysinates of deficient trace elements, %, M±m; n=15.

Indicators	Groups of animals			
	I	II	III	IV
Dry matter	23,57±0,18	25,10±0,20****	24,32±0,20**	25,89±0,21****
Protein	19,25±0,27	20,71±0,30***	20,02±0,25	21,03±0,30****
Fat	2,92±0,05	3,01±0,05	2,96±0,06	3,20±0,06***
Ash	0,90±0,03	1,00±0,03*	0,94±0,03	1,07±0,03****
Calorie content, kJ/kg	4530±30	4796±32****	4661±30***	4961±34****
Tryptophan	1,32±0,03	1,48±0,03***	1,45±0,03***	1,54±0,03****
Oxyproline	0,300±0,01	0,270±0,01*	0,279±0,01	0,263±0,01**
Protein quality indicator	4,4±0,21	5,48±0,21***	5,20±0,20**	5,85±0,21****

The issue of micronutrient nutrition of animals is receiving special attention today in connection with the low level of mineral supply of feed, which, in turn, leads to a decrease in animal productivity. Therefore, in recent years, research related to the study of the influence of trace elements on the course of morpho-biochemical processes in the body of animals, and their influence on the productivity and non-specific resistance of cattle has gained great importance and relevance. A prerequisite for increasing beef production, improving its quality, and increasing the profitability of the industry as a whole is full and balanced feeding of animals. This is possible only on the condition of knowledge about the need of animals for nutrients, vitamins and microelements, and their full use by the animal's body from feed.

Since ME are cofactors of enzymes, components of hormones, vitamins and many metalloproteins, they regulate the processes of metabolism and the initiation of anabolism, their deficiency in the body of animals leads to significant metabolic disorders and the occurrence of microelement diseases. Studies have established that medical and preventive measures should be based on the study not only of the peculiarities of biogeochemical provinces, but also of individual farms [16]. In order to effectively manage animal husbandry in the region, it is necessary to constantly monitor the content of trace elements in feed, water and body tissues of various biogeochemical zones, provinces and individual farms and, on this basis, develop measures to eliminate the corresponding deficiency of an element or group of elements. Optimal concentration of trace elements, vitamins, etc. BAR in body tissues depends on their content in diets and the biological availability of each of them. If the content of ME in diets can be adjusted to a certain extent due to the additional introduction of one or a mixture of them, then the biological availability of the element for the body can be increased only through the appropriate level of mineral and organic components in feed, the physiologically approximate ratio of ME in premixes and more effective inclusion in them chelate compounds of biogenic metals. The effectiveness of the biological action of chelates is determined by their structure and stability of ME and the chelating ligand.

Feeding animals with standard premixes does not always ensure the realization of the genetic potential of the organism, productivity, quality of livestock products and the prevention of microelement diseases, since they do not take into account the zonal peculiarities of ME composition of feeds of individual provinces and farms [10, 11]. In order to increase the physiological action and biological availability, as well as reduce the negative impact of certain deficient MEs on the animal body, we have developed new approaches and directions for balancing rations with premixes containing chelated (organic) compounds with essential amino acids and BAR.

It is traditionally accepted to compensate for the lack of macro- and microelements in diets by introducing them into premixes in an inorganic form (in the composition of sulfates, chlorides, carbonates). Compared to organic compounds, the inorganic compounds of individual MEs in the animal body are insufficiently assimilated, and increasing the dose to achieve a normal level of assimilation in the animal body causes toxicosis in them. Chelate compounds, which are the most optimal form of biogenic metals, play an important role in increasing the bioavailability of trace elements for animals. The use of trace elements in the form of organometallic compounds with amino acids significantly increases the level of assimilation by body tissues and increases the total biological effect several times when feeding animals even with biotic (minimally optimal) doses, which is manifested by the intensification of metabolic processes, increased productivity and improvement of the quality and biological value of livestock products. At the same time, ME costs per head decrease. The use of ME chelate compounds eliminates competitive (antagonistic) relationships between individual microelements, since chelate complexes are transported to the site of absorption without dissociating, and in this state can be deposited in organs and tissues, turning into a metabolically active form.

The use of ME chelating compounds together with limiting amino acids (methionine, lysine, etc.) ensures the latter metabolic processes, stimulates the growth and reproduction of scar microflora, promotes the synthesis of LFA, in particular propionate in the scar content, which is intensively used in energetic and plastic processes. At the same time, the resistance of animals to the disease increases. In connection with the peculiarities of the ecological situation in Ukraine and the presence of separate biogeochemical zones, the use of chelated compounds of metals and other BARs also has the advantage that MEs, easily penetrating through cell membranes and competing with xenobiotics, radionuclides and other non-physiological substances, displace them from metabolism and ensure proper exchange of substances and energy. Based on this, there was a need to find an easily applicable form of ME, an available semi-industrial technology for the synthesis of chelate compounds of scarce elements with essential amino acids and the development of a recipe for premixes for fattening cattle and cows, taking into account the economic characteristics and biogeochemical zones of the region. We, together with university employees, have developed the technology of laboratory and semi-industrial synthesis of chelate compounds with cobalt, selenium, iodine, iron (methionates and lysinates), which enables their wide application in animal husbandry. The choice of methionine and lysine for the synthesis of chelates is appropriate for ruminants and poultry, as they are the initiators of the initial stages of protein synthesis, and also facilitate the transmembrane transfer of the ME chelate into cells. The synthesis technology of ME chelate compounds is simple and available for industrial production.

Feeding different types of animals and poultry compound feed with developed premixes, which include optimal levels in certain ratios of salt deficient ME with a complex of fat- and water-soluble vitamins, will prevent various microelement diseases, increase the meat productivity of livestock by an average of 14-20%. milk by 8-10.3%, as well as improve the biological and nutritional value of products. Therefore, the animals of the experimental farm were provided with copper for 76.8% of the need, zinc - 70.4%, manganese - 67.35%, iron - 60.8%, iodine - 53.6%, cobalt - 44.5% and selenium by 26.8% of the need. The obtained data indicate the impossibility of balancing the rations of cattle in normal conditions according to the most deficient trace elements (iron, cobalt, iodine and selenium) only at the expense of the available feed in the farm. The content of these elements is so low that it can lead to the disease of animals with trace element diseases, especially in the winter and spring periods. Therefore, in our opinion, it is advisable to additionally introduce deficient trace elements (Fe, Co, I and Se) into the diet of cattle in the form of chelate complexes with essential amino acids methionine and lysine (methionates and lysinates).

These microelements enter the body mainly with feed, where they are absorbed in the small intestine, mainly in the duodenum. There, iron, cobalt, iodine and selenium are easily absorbed through villous membranes and are easily fixed by their components. Blood indicators are a "mirror" of the general state of metabolism and energy in the body, therefore the study of its composition is of important clinical importance in veterinary practice and science. With a relatively normal physiological state of the animal organism, the composition and properties of the peripheral blood are more or less constant. But even minor changes in the functioning of the organs and systems of the body necessarily lead to certain changes in the peripheral blood. The greater the changes in the body's metabolism, the stronger and more significant the changes in the blood will be. With significant physiological changes in the body, fluctuations in the composition and properties of blood approach pathological ones to such an extent that it is impossible to draw a line between a physiological and a pathological state.

Changes in blood parameters are observed not only in diseases of hematopoietic organs, but also in various diseases of other systems and organs, so blood tests can be used for diagnosis and prognosis of many internal non-contagious, surgical, infectious and invasive diseases. As it is known, the growth of gains simultaneously leads to a significant improvement in the slaughtering qualities of animals. The slaughter yield, carcass yield, and internal fat yield increased by 3.78%, 3.5, and 0.28%, respectively, in bulls of the II group, which were fed ME methionates, compared to similar indicators of the bulls of the control group. The same indicators in animals fed ME lysinates (III group) increased by 3.0%, 2.8 and 0.21% relative to the control. Supplementation of IV group animals with methionate together with lysinates contributed to an increase in slaughter yield by 5.2%, carcass yield by 4.8%, and internal fat yield by 0.4% compared to the control group. The chemical composition of meat is complex and depends on the type of animal, age, sex, fattening, method of fattening, etc. The main and most nutritionally valuable part of meat is muscle tissue, the constituent parts of which are: water, proteins, nitrogenous and non-nitrogenous substances, lipids, minerals, enzymes, hormones and vitamins. And the results of the chemical composition of meat and meat products serve as a criterion for evaluating the quality of the product and allow judging its nutritional and sanitary quality.

Analyzing the data obtained on the chemical composition of meat as a result of feeding cattle with different doses of methionates and lysinates of Fe, Co, Se, I, we can talk about positive changes in the chemical composition of meat in all experimental groups, in relation to the control group. The data show that the content of dry matter in the longest muscle of the back increased by 0.15 - 1.54% in animals of the II - X experimental groups compared to the control. Longer feeding of cattle with ME chelate compounds (II experiment) confirmed the previously obtained data. According to which an increase in dry matter by 0.75 – 2.32% in relation to the control was also observed in all experimental groups (II – IV). Moreover, it should be noted that such an increase in all experimental groups was statistically probable ($P<0.05$ - 0.001). The most important component of food products of animal origin is protein, which is the main part of the organic substances of muscle tissue and its main biological value. Proteins are the basis of structural elements of cells and tissues. Proteins are associated with the implementation of the main manifestations of life, metabolism, contractility, irritability, the ability to grow, reproduce, and even the highest form of movement of matter - thinking. Our studies have shown that feeding bulls on fattening with iron methionate at a dose of 0.025 mg/kg body weight. m., cobalt - 0.02, selenium - 0.01, iodine - 0.025 mg/kg body weight together with iron lysinates in a dose of 0.025 mg/kg body weight. m., cobalt - 0.02, selenium - 0.01, iodine - 0.025 mg/kg body weight accelerates the intensity of physiological and biochemical processes in the body, increases their productivity, improves the biological value and availability of the products obtained from them, increases food the value of meat, allows to increase the profitability of production and, as a result, to obtain a significant economic effect from their use.

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Анотація. *Надзвичайно важливе значення в підвищенні біологічної доступності мікроелементів і забезпеченні ними тварин належить їх хелатним сполукам з незамінними амінокислотами, які є найоптимальнішою формою біогенних металів. При застосуванні хелатних сполук усуваються антагоністичні взаємовідношення між окремими мікроелементами (МЕ), вони транспортуються до місця абсорбції не дисоціюючи, перетворюються в органах в метаболічно активну форму.*

Мікроелементози тварин відносяться до ензоотичних захворювань окремих біогеохімічних зон і провінцій, що виникають за дефіциту, надлишку або дисбалансу рухомих форм біотичних мікроелементів у ґрунтах, водних джерелах і рослинах. Мікроелементози великої рогатої худоби завдають значних збитків господарствам внаслідок зниження ефективності використання поживних речовин корму, зниження резистентності та продуктивності.

Ключові слова: *мікроелементи, добавки мінерального походження, велика рогата худоба.*