BIOLOGICAL AND PHYSIOLOGICAL ROLE AND USING OF SELENIUM COMPOUNDS IN LIVESTOCK AND POULTRY

Tsekhmistrenko Oksana,
Ph.D., Associate Professor
Bila Tserkva National Agrarian University

Tsekhmistrenko Svitlana,
Doctor of Agricultural Sciences, Professor
Bila Tserkva National Agrarian University

Bityutskyy Volodymyr
Doctor of Agricultural Sciences, Professor
Bila Tserkva National Agrarian University

Among many trace elements, selenium is unique and vital. The role of Se as a bioelement is evidenced by the following facts: 1) in microquantities it is contained in almost all tissues of animals and poultry, except adipose; 2) its prophylactic and therapeutic effect in a number of diseases (liver necrosis in rats, exudative diathesis of chickens, white muscle disease of lambs, calves and piglets); 3) stimulating effect on the development of animals in biogeochemical zones with selenium deficiency; 4) the presence of Se in the retina and its participation in photochemical reactions of light perception; 5) affinity of Se to the well-known chemically active compound α-tocopherol. Today, selenium is not included in the list of trace elements that are part of the detailed norms of feeding, despite its important biological significance for the body [1].

Se deficiency in the body is observed when it is received in the amount of 0.0008 mg / kg, toxic effects is when consumed in the amount of 0.75 mg / kg. Optimal doses of Se are estimated to be 0.0025–0.0033 mg / kg.

It was found that a number of nanoparticles, in particular Se, show enzymatic activity of some enzymes. By changing the degree of oxidation, these particles can regenerate and constantly catalyze the neutralization reactions of the superoxidanion radical, thus performing the function of SOD and they are the first link in protecting tissues and cells from oxidative stress in physiological and pathological conditions [24].

Selenium (Se) with a powerful antioxidant potential, is widely used as a feed additive to reduce oxidative stress in living systems. Selenium is widely found in organic and inorganic compounds and is an important part of many enzymes (selenoproteins) [10]. Glutathione peroxidase is the first selenoprotein found in biological systems with antioxidant activity [11]. Selenium is mainly known for its antioxidant activity and plays a major role in optimizing redox potential, reproductive processes, thyroid hormone metabolism, muscle development and anticancer genesis. Nano-Se leads to higher Se retention activity due to smaller size and greater bioavailability.

The bioavailability of Se in plant feeds ranges from 60 to 88%, and in animal feeds ranged from 8.5 to 25%. This difference is probably due to the fact that a significant amount of Se contained in some feeds is in complex compounds with feed nutrients [12, 17].

Selenium is absorbed through the digestive tract, skin and lungs. Assimilation of soluble forms in the digestive tract takes place by 80-100%. Organic forms of selenium are better absorbed than inorganic ones. The most intensive absorption of selenium takes place in the duodenum and to a lesser extent in the jejunum and longitudinal intestines. In the stomach, selenium is practically not digested. It is absorbed by the kidneys by 87%.

Selenium is eliminated from the body in three main ways - through the kidneys, intestines and exhaled air [14].

Selenium increases the activity of enzymes involved in the synthesis of coenzyme A, which in turn is one of the catalysts for the metabolism of fats, proteins and carbohydrates [2]. In addition, selenide activates some functional proteins and enzymes associated with redox processes, enhances the synthesis of nucleic acids in the liver, supports the normal functioning of the pancreas. Selenium in the enzymes glutathione peroxidase and thioreduxin reductase catalyzes the breakdown of peroxides formed from unsaturated fatty acids, and thus stabilizes the physicochemical structure of plasma cell membranes, protects vitamin E and lipids of biological membranes from oxidation. It regulates the absorption and consumption of vitamins A, C and K in the body, increases the content of vitamin B12 in the liver. Selenium in combination with Cadmium, Arsenic, Tungsten, Mercury and Copper significantly reduces the toxic effect caused by these elements when administered separately.

Selenium's biological role may also be related to its effect on sulfur metabolism. Selenium metabolism is probably partially similar to Sulfur metabolism, but there are significant differences between them in a number of ways. Thus, selenium is characterized by active participation in redox and antioxidant processes, cell respiration, as well as in the synthesis of specific functional proteins. The role of selenium to increase the body's resistance has been established [5].

Selenium affects the activity of nonspecific phosphatases and the rate of formation of macroergic compounds, in particular ATP, enhances the overall activity of oxidase enzymes, acids, activates the decarboxylation of pyruvate by catalytic oxidation of lipoic acid and thiogroups of dehydrogenases [16].

Selenium deficiency causes many diseases such as arthritis, renal autolysis, encephalomyelitis and exudative diathesis in chickens, white muscle disease, muscle necrosis, tubular nephrosis, hemolysis of erythrocytes. These diseases are treated with selenium and vitamin E. The addition of selenium compounds normalizes the morphological structure of organs and tissues [19]. The latter has an antioxidant effect through mechanisms that inactivate free radicals, while selenium, which is part of the GPO, catalyzes the reduction of toxic hydrogen peroxides [13].

Feeding saponin supplements and selenium to animals helps reducing the number of cases of manure retention in cows, improves reproductive capacity, and increases their productivity.

Along with vitamins A, C, E and β-carotene, selenium is one of the strongest antioxidants [23].

The stimulating effect of selenium on product quality and feed efficiency, growth and development of the intestinal tract has been established, selenium compounds increase resistance and immunity [22].

The development of probiotics, in particular selenium-enriched bacteria, is of great interest because of the properties of selenium to be part of at least 30 selenoproteins that provide the activity of the immune system and affect life expectancy. Selenium is part of glutathione peroxidase, thyroreductase and selenocysteine - the 21st amino acid involved in cysteine biosynthesis (Cys) and reactions that reduce oxidative processes in the body [4, 5]. Recently, selenium-based probiotics obtained by the biological method, using the extract of various parts of plants, microorganisms, in particular bacteria, have become increasingly common [21, 25]. Such methods are called "green" synthesis [6, 7]. Bacterial organic Se had a positive effect on the height of the villi of the small intestine, which led to high absorption and retention of Se. Thus, this resulted in a better effect of Se on hematological parameters and the immune response [15]. The use of such modern probiotics serves as an innovative potential for addressing environmental safety [8, 9].

Treatment of eggs before incubation with 0.01% sodium selenite solution improves the vitamin, enzyme and antioxidant status of embryos, which increases egg hatchability and hatching, improves their resistance, viability and growth rate.

The addition of selenium to the diet of chickens at a dose of 0.3 mg / kg of feed improves egg fertility and embryogenesis of chickens, which reduces incubation waste by almost 3 times, increases hatchability, preservation of chickens. Selenium significantly improves the state of the antioxidant system and increases the activity of aminotransferases (AST, ALT) [20].

The effect of selenium on the oxygen transport function of the blood under the conditions of heavy metals was established [18].

Pre-incubation treatment of eggs with 0.01% sodium selenite solution and subsequent increase in the level of selenium to 0.2 mg / kg of feed helps to increase the hatching of chickens by 6.2%, the intensity of their growth compared to the control by 10.2% and live growth masses at 13.5%. The increase in the level of selenium to 0.2–0.3 mg / kg of compound feed caused an increase in its amount in egg white.

Previously, sodium selenite was used in poultry farming. Currently, the number of organic selenium-containing drugs has expanded significantly. The active substances of these drugs are selenium methionine (basic form), selenocysteine and other selenoamino acids. Selenoamino acids are easily absorbed by the body and are used for the synthesis of selenoproteins. Selenomethionine is able to replace methionine in any body protein, thus creating reserves of selenium in tissues and eggs.

The use of compound feeds enriched with selenium helps to increase the use of the main components of feed and its conversion, the accumulation of vitamin E, carotenoids and polyunsaturated fatty acids in egg yolk.

The organic form of selenium has a high biological activity, less toxic to sodium selenite and therefore has an advantage in the feeding of laying hens [3].

Analysis of the literature data allows us to assume the existence of a balanced mechanism in the body what maintains the homeostasis of selenium [5]. This trace element is actively involved in the metabolic processes of the cell.

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