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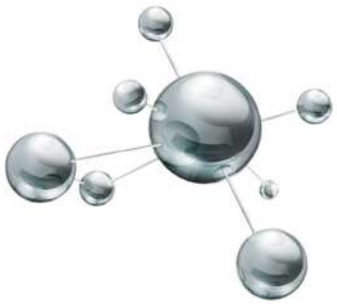
IX ВСЕУКРАЇНСЬКА НАУКОВА КОНФЕРЕНЦІЯ



АКТУАЛЬНІ ЗАДАЧІ ХІМІЇ:
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"GREEN" NANOPARTICLES OF METALS AND NONMETALS IN ANIMAL AND POULTRY FEEDING

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Modern veterinary medicine and animal husbandry actively integrate nanotechnology to increase the bioavailability of nutrients, optimise metabolism and modulate the immune response of organisms. One of the most promising areas of research is the use of green metal and non-metal nanoparticles synthesised using biological methods involving plant extracts, microorganisms and enzymatic systems. 'Green synthesis is based on the use of natural biological agents that act as reducing agents and stabilisers of nanoparticles, reducing the need for toxic chemicals. Plant extracts contain a wide range of bioactive compounds, such as flavonoids, phenolic acids, alkaloids, which contribute to the formation of nanoparticles with a given size and morphology. Microorganisms, including bacteria and fungi, play a dual role - they both reduce metal ions and provide a shell of protein and polysaccharide matrices that increase the stability and bioavailability of nanoparticles. The enzymatic systems used in biosynthesis act as catalysts for oxidation-reduction reactions, which allows the formation of nanostructures with precise crystal structure and high functionality. Thanks to these mechanisms, green synthesis provides an environmentally friendly and energy-efficient approach to creating nanoparticles with improved biological properties. These nanomaterials have unique physicochemical and biological characteristics that make them promising agents for innovative feed additives. They have low toxicity, high stability and the ability to control the bioavailability of key elements in animal metabolic processes [5].

The process of biosynthesis of green nanoparticles is based on the use of natural reducing agents, such as flavonoids, terpene compounds, phenolic acids contained in plant extracts, and metabolites of bacterial cultures. For example, silver nanoparticles (AgNPs) demonstrate pronounced antimicrobial properties by disrupting the cell membrane structure of pathogens and inhibiting their enzymatic activity [3]. They also affect cell signalling pathways, inhibiting the growth and proliferation of bacteria and fungal pathogens. Zinc nanoparticles (ZnO NPs) help to improve the absorption of nutrients, participate in the regulation of intestinal microflora activity, and also have an antioxidant effect, contributing to the normalisation of intestinal mucosal functions [4].

Copper nanoparticles (CuNPs) are capable of catalysing redox reactions, positively affecting the metabolism of proteins and lipids. Studies have shown that their addition to feed improves growth and reduces inflammation in animals. Of particular interest are selenium nanoparticles (SeNPs), as they act as effective bioregulators of the body's antioxidant status, participate in the synthesis of selenium proteins and ensure the stability of the endocrine system, in particular by activating thyroid hormones. Silicon nanoparticles (SiO_2 NPs) help strengthen bone tissue by participating in osteocyte mineralisation and regulating calcium and phosphorus metabolism.

The integration of green nanoparticles into the animal feeding system not only improves productivity but also increases resistance to pathogenic agents by modulating the immune system. It has been found that the addition of AgNPs, ZnONPs, CrO_2NPs and SeNPs to feeds increases the expression of antioxidant enzymes (superoxide dismutase, catalase, glutathione peroxidase), which provides effective protection against oxidative stress [1, 7]. In addition, the use of nanomaterials can reduce the need for antibiotics, which is especially important in the context of the global fight against antimicrobial resistance. Research also suggests that nanoparticles can act as prebiotics, stimulating the growth of beneficial intestinal microflora [9].

Our studies have confirmed that the addition of selenium nanoparticles (SeNPs) to the feed of broiler chickens and quail has a positive effect on their growth, development and immune status [8]. An increase in the level of antioxidant defence was observed due to an increase in the activity of antioxidant system enzymes and a decrease in oxidative stress. In addition, the use of SeNPs contributed to the improvement of morphological parameters of the small intestine, indicating improved absorption of nutrients. An increase in the level of selenium proteins in the blood of

broilers indicated an optimisation of metabolic processes and a strengthening of the body's immune response. An improvement in survival rate was recorded in quail, which may be due to increased resistance to infectious agents. These results underline the effectiveness of SeNPs in poultry feeding as a means of increasing productivity and promoting health [2].

In terms of environmental safety, green nanoparticles are significantly superior to their chemically synthesised counterparts, as they decompose faster in the biological environment without the formation of toxic by-products. An important task remains to determine the optimal dosage, biodegradation mechanisms and impact on the body's functional systems during long-term use. In addition, it is necessary to investigate the possible long-term effects of their accumulation in animal tissues, the impact on reproductive function and their potential to increase resistance to environmental stress [6].

Thus, the use of 'green' metal and non-metal nanoparticles in animal and poultry feeding is an innovative strategy with significant potential in veterinary medicine and the agricultural sector. Given their multifunctionality, safety and high efficiency, further research in this area could help create new biotechnological products that will ensure sustainable livestock production. Given the current trends, it is worth considering the possibility of combining nanoparticles with other biologically active agents to obtain complex preparations that combine the properties of antioxidants, antimicrobial agents and modulators of intestinal microflora.

1. Цехмістренко О. С., Цехмістренко С. І., Бітюцький В. С., Мельниченко О. М., Олешко О. А. Біоміметична та антиоксидантна активність нанокристалічного діоксиду церію. Мир медицины и биологии. – 2018. - (1 (63)). - 196-201.
2. Цехмістренко С.І., Бітюцький В.С., Цехмістренко О.С., Демченко О.А., Тимошок Н.О., Мельниченко О.М. Екологічні біотехнології "зеленого" синтезу наночастинок металів, оксидів металів, металоїдів та їх використання: за редакцією С.І. Цехмістренко. Біла Церква.- 2022. - 270.
3. Demchenko A., Bityutskii V., Tsekhmistrenko S., Tsekhmistrenko O., Kharchyshyn, V. Synthesis of functionalized selenium nanoparticles with the participation of flavonoids. International Science Group. – 2022. - ISG-KONF. COM.
4. Fatima A., Zaheer T., Pal K., Abbas R. Z., Akhtar T., Ali S., Mahmood M. S. Zinc oxide nanoparticles significant role in poultry and novel toxicological mechanisms // *Biological Trace Element Research*. - *2022*. - (1). - 268-290.
5. Frippiat T., Art T. Silver Nanoparticles as Antimicrobial Agents in Veterinary Medicine: Current Applications and Future Perspectives. *Nanomaterials* - 2025. - *15*(3), 202.
6. Nechitailo K. S., Sizova E. A., Lebedev S. V., Miroshnikov S. A., Ryazantseva K. V., Yausheva,E. V., Fisinin V. I. Modern approaches to the use of ultrafine and nanoparticles as components of feed additives in poultry farming. *World's Poultry Science Journal*. – 2025. - 1-40.
7. Tsekhmistrenko O. S., Bityutskyy V. S., TsekhmistrenkoS. I., Spivak M. Y. Influence of cerium dioxide nanoparticles on biochemical indicators in the organism of broiler chicken. *Veterinary science, technologies of animal husbandryand nature management* – 2025. – 6-112-117.
8. Tsekhmistrenko S. I., Bityutskyy V. S., Tsekhmistrenko O. S., Kharchishin V. M., Tymoshok N. O., Demchenko A. A., Tokarchuk T. S. Ecological and toxicological characteristics of selenium nanocompounds. *Ukrainian Journal of Ecology*. - 2021. - 11(3). - 199-204.
9. Tsekhmistrenko S. C., Bityutskyy V., Tsekhmistrenko O., Merzlo S., Tymoshok N., Melnichenko A., Yakymenko I. Bionanotechnologies: synthesis of metals'nanoparticles with using plants and their applications in the food industry: A review. *The Journal of Microbiology, Biotechnology and Food Sciences*. – 2021. - 10(6). - e1513.