A DITHIZONE METHOD FOR DETERMINING ZINC IN OF ZINC-BASED NANOSTRUCTURED BIOMATERIALS

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MOTIVATION

Nanostructured materials have been suggested to be used as a source of dietary zinc for livestock animals. Importantly, Zn-based nanomaterials have been proposed as a potential alternative source of dietary zinc for animals, since their unique properties, which are mediated by nanostructures, can increase zinc's bioavailability, resulting in faster absorption in the gut and rapid distribution between the tissues [1]. However, the limitations of their widespread introduction into livestock and poultry farming are caused by the possible toxic effect, which is due to their physicochemical characteristics (route of administration, dosage, etc.).

In our previous works, we have shown that the synthesized nanostructured zinc carbonate hydroxide (ZnCH)$Zn_5(CO_3)(OH)_6$ (ZnCH) microflakes have low toxicity and can be used in veterinary medicine [2,3].

EXPERIMENTAL

Synthesis of zinc carbonate hydroxide (ZnCH) NPs and its characterization

Initially, 50 ml of Na_3Cit (Sigma Aldrich, USA) 0.075 M water solution was mixed with 50 ml of $Zn(Ac)_2$ (Sigma Aldrich, USA) 0.1 M water solution. Then, 50 mL of Na_2CO_3 (Sigma Aldrich, USA) 0.15 M water solution was added to the mixture under vigorous stirring. The obtained mixture was heated to 85 °C using a water bath during 45 min at constant stirring. The obtained colloidal solution was dialyzed against water for 120 min in a cellulose dialysis sack (pore d = 2.5 nm, MWCO 12,000 kDa). Water was changed every 30 min. The final pH value of the solution was 7.5. Thereafter, 150 ml of 0.6% polyvinylpyrrolidone used as a stabilizing agent was added to the solution to obtain 300 ml of ZnCH NPs. The final concentration of solid phase (ZnCH NPs) was 2 g/L with 0.3 w% of polyvinylpyrrolidone.

Morphology of the as-synthesized ZnCH NPs was analyzed by scanning electron microscopy (SEM, JSM-6390LV, JEOL Company, USA). TEM image was acquired by a TEM-125K electron microscope (Selmi, Ukraine) using 100 kV electron beam.

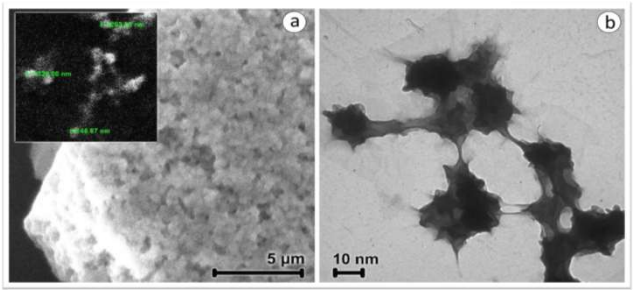


Fig. 1 SEM (a) and TEM (b) images of the synthesized ZnCH NPs.

NO TOXICITY OF ZnCH NPs

Some indicators (hemoglobin, erythrocytes) after ad- ministration of 25–50 mg/kg b. w. of ZnCN NPs showed a posi-tive trend in the dynamics of changes, which indicates an improvement in the metabolic profiles of rats in experimental groups 1 and 2.

. Therefore, the ZnCN NPs studied in this experiment did not show pronounced signs of hematotoxicity.

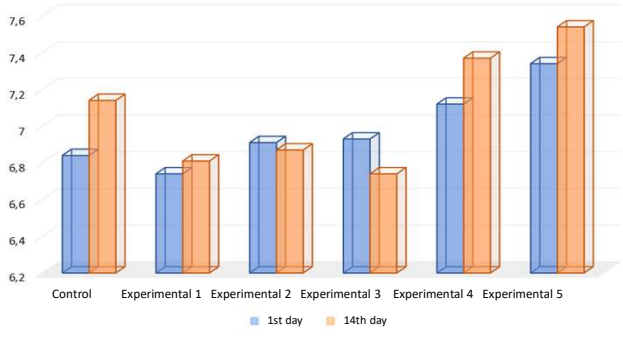
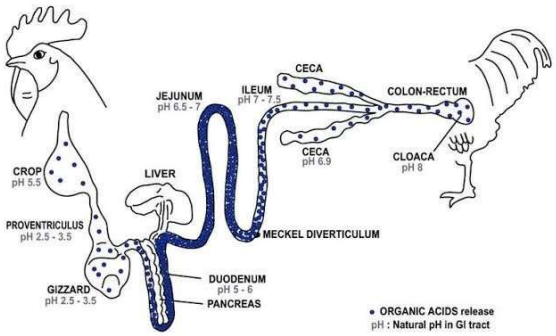


Fig. 4 Dynamics of glucose content in the blood plasma of rats after acute administration of ZnCH NPs , µmol/dm³.

AIMS

For this purpose, a method for determining zinc through the formation of a complex with diphenylthiocarbazone (dithizone H2Dz) by optical absorption spectroscopy has been developed. The rate of zinc release from ZnCH microflakes has been shown by model systems to be influenced by pH values from 2.1 (stomach) to 7.3 (rectal cat).

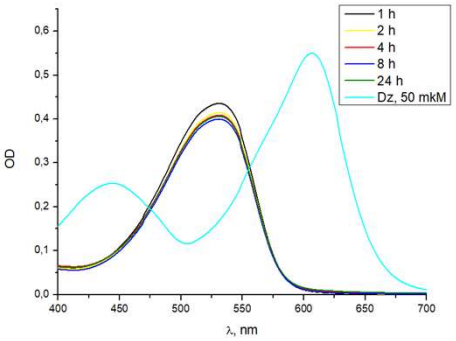
In this study, to understand the degree of bioavailability of Zn-based nanomaterials, research was conducted to determine the rate of zinc release from nanostructure materials under different conditions, in this case, in different physiological pH of animal's esophagus.



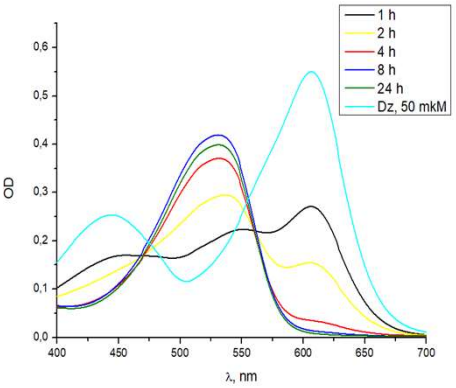
Adapted and redrawn from Riis & Jokobsen, 1969 Hill, 1971, Simon & Versteeg, 1989 and Herpol and Van Grembergen, 1967

DITHIZONE H_2O EXTRACTION AFTER DIALYSIS OF ZnCH NPs AT DIFFERENT Ph

pH = 2,0



pH =7,2



CONCLUSIONS

- √ The acute toxicity criteria indicate that hydrosols of ZnCH NPs are virtually non-toxic substances.
- √ These nanoparticles can be utilized in veterinary medicine as intended.
- √ In a model system, it was shown that the release of zinc from nanoparticles occurs slowly.
- √ The release time is sufficient for complete absorption in the corresponding part of the esophagus.

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