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Short Communication

Synthesis and Identification of Zinc Oxide Nanoparticles as Precursor for Getting Zinc-Based Biologically Active Additives

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Zinc oxide nanoparticles were synthesized in order to get biologically active additive for correction of zinc-deficiency states. Nanosized zinc oxide was derived by through condensation method from zinc acetate and lithium hydroxide dissolved in dehydrated alcohol. Resulted particles were examined through method of small-angle X-ray scattering. Measurement results confirm presence of nanoparticles with average size about 2 nm.

Keywords: Hypozincosis, Precursor, Biologically active additive, Zinc oxide nanoparticles, Small-angle X-ray scattering.

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A certain microelement balance must be supported within the organism for normal behavior of vital processes. Zinc may be marked among dozens of other essential microelements. Zn^{2+} is included in the structure of active centers of more than 100 metalloenzymes, provides healthy state of thymus and immunity, affects growth / aging of neurons and neurotransmitter synthesis, plays a key role in generation of normal sexual function of men [1].

Light or moderate deficiency of zinc comes out in immunity decrease and liability to contagious and non-contagious diseases: ischemic heart disease, atherosclerosis, diabetes mellitus and some others. Serious zinc deficiency of pregnant women may cause congenital malformations [1]. More than 2 billion people around the world do not get enough zinc from their ration. Zink deficiency is an important health protection issue in advanced countries. According to figures from the International Zinc Association, zinc-deficiency states are registered almost everywhere. Moderate hypozincosis is widespread in Europe, Brazil; serious zinc deficiencies are registered in India, South Africa. Zink deficiency cases occur among population of Russia as well [1, 2].

Various zinc-containing biologically active additives may be used for correction of moderate zinc-deficiency states. Different preparations for hypozincosis correction are represented in the pharmaceutical market. Despite their widespread distribution, such preparations can not provide optimal bioavailability of zinc, concentrations of Zn^{2+} are extremely high.

All traditional pharmaceutical forms have a set of fundamental defects: excessive medicinal substance consumption, undirected operation of medical substance, insufficient biocompatibility and bioavailability. The march of modern science allows creating brand new pharmaceutical forms without defects listed above. Their improved properties can be attributed to size reduction. Nanosized medicinal particles have series of advantages: increased bioavailability, provision of optimal dosage, minimization of side effects, etc. [1].

The purpose of this research was to derive and identify nanoparticles of zinc oxide that are proposed to be used as the general component of preparation for zinc-deficiency correction.

Synthesis of nanoparticles was carried out through condensation method in the environment of dehydrated ethanol. Rectified ethanol with 99.6 % concentration was dehydrated through boiling with calcium metal during 3 hours and further distillation.

For derivation of nanoparticles, 0.15 g of lithium hydroxide and 0.55 g of zinc acetate were dissolved in 50 ml of dehydrated alcohol during 15 minutes at continuous stirring with magnetic mixer. Zinc acetate was dissolved at the boiling temperature. After dissolution, lithium hydroxide and zinc acetate solutions were cooled to 0 °C at continuous stirring. After that, zinc acetate solution was added to another solution at a speed of several drops per second. The solution was heated to the room temperature; after that, 60 ml of deionized water were added to it. The resulted suspension was centrifuged. The resulted precipitation was dried during 12 hours under vacuum at 90 °C and re-dried for 3 hours in desiccator at 120 °C.

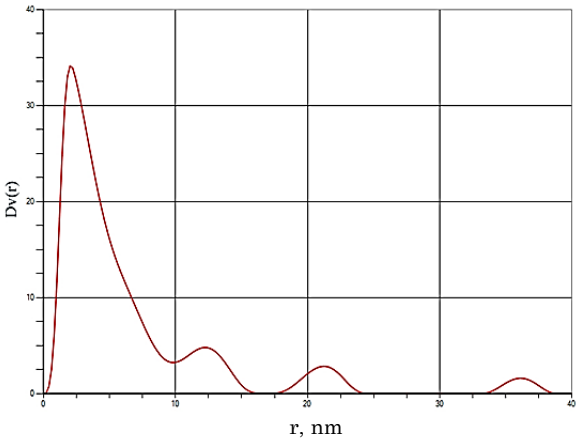

Fig. 1 – Distribution curve by dimensions for zinc oxide nanoparticles according to small-angle X-ray scattering data

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The method of small-angle X-ray scattering was used for identification of zinc oxide nanoparticles. Measurement was carried out by means of small-angle X-ray scattering installation SAXSess mc2 from Anton Paar, Austria. During measurement process, vacuum with pressure of about 0.3 mbar is created in the sample chamber. The installation was set to X-ray wavelength (λ) of 0.1542 nm. Functions of volume distribution of nanoparticles by DV(r) dimensions were calculated on the computer according to small-angle scattering intensity curves. Computer processing of experiment data was carried out with the use of GNOM software. As shown in the figure below, the majority (nearly 80 %) of particles contained in the gel is represented in size of about 2 nm. Larger aggregates are also met – 12 nm, 22 nm and 38 nm.

Therefore, zinc oxide nanoparticles with size of about 2 nm were successfully derived as the result of the experiment. Such particles may be used as active ingredient in a preparation for correction of zinc deficiency.

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