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Study the toxic effects of biologically synthesized CdS quantum dots on the various living systems

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The unique qualities of quantum dots have made them a powerful platform that can help to reveal important biological insights. In particular, they can be useful as fluorescent probes or traceable nanocarriers for *in vivo* applications ranging from imaging to theranostics. Moreover, they may provide unique benefits in diagnostic applications [1]. However, progress toward clinical applications has been delayed by concerns about the potential toxicity of semiconductor quantum dots. The present investigation suggests an assessment of the toxic influence of cadmium sulfide nanoparticles, which were produced by the extracellular way using fungal matrix on different living organisms. We have developed several reproducible methods of extracellular synthesis of CdS quantum dots [2,3,4], but the evaluation of toxic effects was demonstrated at first using CdS nanoparticles obtained by *Pleurotus ostreatus*. In order to study the toxic effects of mentioned quantum dots we have used three biological systems, including *Nicotiana tabacum* protoplasts, HeLa tumor cell line and *Drosophila melanogaster*.

To evaluate the toxic effect of cadmium sulfide nanoparticles on the plant protoplasts we used the following concentrations of quantum dots: 1.87, 0.94, 0.47, 0.23 and 0.11 mg/mL. It has been observed that low concentrations of CdS quantum dots did not cause any significant defects of protoplasts viability. For instance, treatment of cells by 0.47 mg/mL associated with an appearance of 58 % of undamaged protoplasts while treatment by 0.23 mg/mL led to survivability of 71 % of protoplasts, and treatment with 0.11 mg/mL quantum dots exhibited 79 % of living protoplasts. At the same time the treatment of plant cells with higher concentrations of CdS nanoparticles revealed decreasing the percentage of alive cells, namely 1.87 mg/mL was the most toxic and caused total death of *N. tabacum* protoplasts, while 0.94 mg/mL identified that 49 % of plant cells remained viability.

It has been also studied the cytostatic effects of CdS nanoparticles synthesized by the fungus *P. ostreatus* on tumor HeLa cell line. The concentrations of tested CdS nanoparticles were 1.87, 0.94, 0.47 and 0.23 mg/mL. The effects of CdS inorganic salt in 4 mg/mL concentration have been tested in parallel. Number of living cells was evaluated by MTT test. Determination of the adhesive potential of HeLa cells was performed using crystal violet dye. The optimal concentrations of CdS quantum dots which did not cause cytotoxic effect were at the range from 0.47 to 0.23 mg/mL. The concentration of quantum dots at 0.47 mg/mL caused the death of 6.2 % of the HeLa cells. The most toxic was the treatment by inorganic cadmium salt. Treatment of HeLa cells by 0.45 mg / mL CdS led to the increase of the number of apoptotic cells to approximately 45 %, which is 5 times higher than treatment of the cells by CdS quantum dots, produced by fungi matrix. An important indicator of the functional state of cancer cells is their ability to intercellular adhesion. Reducing the adhesive capacity of tumor cells probably means reducing the malignancy of these cells. The results showed that quantum dots CdS, produced by *P. ostreatus*, can reduce the adhesive potential of HeLa cells compared to inorganic CdS salt.

The toxic effects of CdS nanoparticles synthesized using *P. ostreatus* on whole organism have been studied using *Drosophila melanogaster* as a model. For this purpose we have used the same concentrations of CdS nanoparticles, namely 0.23 - 1.87 mg/mL. It has been demonstrated that CdS quantum dots exhibited the moderate toxic effect, but it was significantly lower than such effect of inorganic CdS. CdS nanoparticles in tested concentrations did not possess either genotoxic or mutagenic effects on *D. melanogaster*. Concentration of CdS quantum dots at 0.47 mg / mL did not affect significantly the viability of fly larvaes. The amount of living flies in this case reached 25 specimens. While the treatment by inorganic cadmium sulfide in the same concentration caused 100 % death of flies.

Possibly the toxicity of biologically synthesized CdS quantum dots significantly reduced due to the coating of quantum dot surface by organic biomolecules, which leads to a decrease bioaccumulation of quantum dots *in vivo*. Our results found that CdS quantum dots which were obtained by eco-friendly and convenient method by extracellular way using biological matrices did not cause any significant disturbances in cell viability, which agrees with the hypothesis that the presence of biomolecules around quantum dots capable to reduce their toxicity [5]. CdS quantum dots can be used in a variety of biological and biomedical research, including the study of tumor cells and tissues and *in vivo* experiments.

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