In vitro evaluation of boron nanoparticles produced by laser fragmentation for boron neutron capture therapy

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Nowadays, boron neutron capture therapy (BNCT) is becoming increasingly widespread, driving active research and development of boron delivery agents. There exists a set of characteristics for an ideal boron delivery system such as absence of toxicity, boron concentration in tumor greater than 20 μg/g, tumor/blood and tumor/healthy tissues boron concentration ratios of 3 : 1 or more, maintenance of sufficient concentration in the tumor throughout the entire irradiation period, and rapid elimination of the drug from surrounding tissues and organs. Boron delivery drug development based on nanosystems is underway, focusing on ensuring their delivery to tumor tissues. This work investigated elemental boron nanoparticles produced by laser fragmentation in isopropanol from boron micropowder enriched to 85% with the boron-10 isotope, featuring a modified surface coated with Silane-PEG.

It was established that these nanoparticles do not exert a cytotoxic effect on U87, BT474, and BJ-5TA cell cultures at boron-10 concentrations required for BNCT. During the assessment of boron accumulation in cells using ICP-AES, it was found that the highest boron concentration was detected in BT474 cells and was 1.85 μg/10^6, boron concentration in U87 was 0.73 μg/10^6 and in BJ-5ta it was 0.33 μg/10^6 cells.

All cell cultures, pre-incubated with elemental boron nanoparticles, were irradiated with a neutron flux using the accelerator-based neutron source VITA at Budker Institute of Nuclear Physics SB RAS. According to clonogenic assay data, the greatest effect after BNCT with the studied nanoparticles was observed for the BT474 cell line, where the surviving fraction was less than 1%. The surviving fraction of U87 cells after BNCT was 35%, which is significantly different from the results obtained in control groups At the same time, dermal fibroblasts BJ-5TA were the most

resistant to the action of the BNCT reaction products, with the percentage of surviving cells decreasing to 42% relative to the control group. Irradiation of cells with a beam of epithermal neutrons without boron did not lead to a significant reduction in survival, indicating the safety of the chosen irradiation parameters.

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