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Nuclear and related analytical techniques in microbial biotechnology

Marina V Frontasyeva
Joint Institute for Nuclear Research, Russia

Experience from applying instrumental neutron activation analysis (INAA) in medical, environmental, and industrial biotechnology is reviewed. The role of multi-element INAA in development of new pharmaceutical substances based on the blue-green microalga *Spirulinaplatensis* biomass saturated with such essential trace elements as selenium, chromium, and iodine is demonstrated. INAA revealed that the concentrations of various toxic elements present in *Spirulinaplatensis* biomass do not exceed permissible levels. Contents of these elements in important compounds such as C-phycocyanin and DNA isolated from *Spirulinaplatensis* biomass were also studied. Using NAA the capability of removing mercury from wastewater during the growth of *Spirulinaplatensis* was estimated, and it was shown that *Spirulinaplatensis* can be used as a natural sorbent for remediation purposes. Detoxification of the toxic Cr (VI) and Hg(II) by some actinomycetes belonging to the *Arthrobacter* genera, isolated from environmental media in Georgia, was also studied. Natural organic biomass of vegetal origin from peat bogs in West Georgia containing a large microbial community was applied for bacterial leaching of metals from lean ores, rocks, and industrial wastes. The results of NAA showed that bacterial leaching can be used for extraction of such elements as Au, Se, Sr, In, Cd, Ir, Ru, Hf, Ta, and Zr, as well as the radioactive elements U and Th. Methods for microbial synthesis of gold and silver nanoparticles by Spirulinaplatensis biomass as well as by biomass of a few novel actinomycete strains isolated from soils and rocks of Georgia were developed. It was established that the studied microorganisms produce gold and silver nanoparticles mainly extracellularly when acted upon by chloroauric acid and silver nitrate aquatic solutions, respectively. The obtained nanoparticles were characterized by a combination of analytical and spectroscopic methods: Transmission electron microscopy (TEM), scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDAX), X-ray diffraction spectrometry (XRD), atomic absorption spectrometry (AAS), and INAA. The studies described will help to develop rational, non-toxic microbial procedures for synthesis of gold and silver nanoparticles to be used in various branches of science and industry.

Biography

Marina V Frontasyevais Candidate of Physics and Mathematical Sciences and is a graduate of the Department of theoretical and experimental nuclear physics, physical faculty, Saratov State University. Since 1970 she has been working at the Joint Institute for Nuclear Research, Dubna, first in the Laboratory of Nuclear Problems and since 1977 in the Frank Laboratory of Neutron Physics in the field of instrumental neutron activation analysis (INAA). She is one of the founders of the radioanalytical complex REGATA at the reactor IBR-2 designed for studies in the Life Sciences and Material Science. Since 1997 she is the Head of the Department of NAA at FLNP JINR combining her activities with lecturing on nuclear methods for studying the environment at the Department of Chemistry of the International University of Nature, Society and Man of Dubna. She is leader of numerous international projects co-ordinated by the International Atomic Energy Agency (IAEA, Vienna) and by the European Union Frame Programmes. She is a holder of several grants for environmental studies from the JINR member-states mostly connected with studies on biomonitoring trace element deposition based on moss analysis. Since 1994 she is a Scientific Secretary of the Scientific Council on Applied Nuclear Physics of the Russian Academy of Sciences. In 1997 she was elected to the International Committee on Activation Analysis (ICAA).She is the author and co-author of more than 300 scientific publications in refereed journals, two books and two patents of Russian Federation.

marina@nf.jinr.ru