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Biosynthesis of silver and gold nanoparticles using microbial biomass

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Biotechnology of silver nanoparticles

- > nonlinear optics
- ➤ medicine
- electronics
- ➤ catalysis
- microelectronics

Objects of study



Bacteria Streptomyces glaucus 71MD

Blue-green **microalga** Spirulina platensis

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Experiment



UV-Vis spectra recorded after one week for the reaction mixture prepared using 1mM silver nitrate and 1 g *Streptomyces glaucus* 71MD

Scanning electron microscope



Resolution 1.2 nm

Magnification 5000–150000x

Voltage 1–30 kV

Quanta 3D FEG

The Netherlands' Firm "Systems for Microscopy and Analysis" (Moscow, Russia)



SEM micrographs of *Spirulina platensis* cells with silver nanoparticles



EDAX spectrum recorded from *Spirulina platensis* cells after formation of silver nanoparticles

Transmission electron microscope



Particle sizes 5 – 20 nm with an average of 10 nm

TEM micrograph recorded from *Spirulina platensis*



Irradiation time - 8 s neutron flux density $\approx 10^{14}$ n cm⁻² s⁻¹.

SAFARI-1 of the NECSA (Nuclear Energy Corporation of South Africa), Pelindaba, South Africa.



The silver concentrations in biomass of *S. platensis* versus the time of exposure to silver nitrate



SEM micrographs of *Streptomyces glaucus* 71MD cells with silver nanoparticles



exposure to silver nitrate solution

Transmission electron microscope



Particle sizes 4 – 25 nm with an average of 13 nm

TEM micrograph recorded from Streptomyces glaucus 71MD

Biotechnology of gold nanoparticles

Application of gold nanoparticles

Catalysis

> Chemical sensing

➢ Biosensing

> Medicine

Objects of study



Blue-green microalga Spirulina platensis

Experiment



 $HAuCl_4 =$



yellow

red purple

Experiment I Incubation time = constant C_{HAuCl4} : 10⁻⁴ - 10⁻²M Experiment II $C_{HAuCl4} = 1mM$ Incubation time: 1 - 6d



UV-Vis spectra recorded after one week for the reaction mixture prepared using 1mM hydrated gold chloride and 1 g biomass of *A. globiformis* 151B

Experiment II





Radioanalytical complex REGATA at the reactor IBR-2 of FLNP

Irradiation time − 60 s thermal neutron flux density ≈ 1.6×1013 n·cm-2·s-1.



The gold concentrations in biomass of *S. platensis* versus the concentration of hydrated gold chloride



Chlorine and phosphorus redistribution in S. Platensis biomass

Experiment I



SEM micrographs of *Spirulina platensis* cells with gold nanoparticles at different incubation time



EDAX spectrum of *S. platensis* cells after exposure to hydrated gold chloride solution

Transmission electron microscope



Particle sizes 15 – 40 nm with an average of 30 nm



TEM micrograph recorded from *Spirulina platensis*



The gold concentrations in biomass of *S. platensis* versus the time of exposure to hydrated gold chloride

- 1. Production of silver and gold nanoparticles by blue-green microalgae *Spirulina platens*is and bacteria *Streptomyces glaucus* 71MD proceeds extra-cellularly
- 2. SEM and EDAX were used to characterize the silver and gold nanoparticles. TEM showed formation of nanoparticles in the range of:
- a) 4 25 nm for *Streptomyces glaucus* 71MD
- b) 5 20 nm for *Spirulina platensis* (silver nanoparticles)
- c) 14 40 nm–7 µm for *Spirulina platensis* (gold nanoparticles)

3. For quantitative analysis of samples the neutron activation analysis (NAA) in the SAFARI-1 reactor and radioanalytical complex REGATA at the reactor IBR-2M was carried out.

Thank you for attention!