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ORIGINAL PAPER

Changes in the *Dunaliella salina* biomass composition during silver nanoparticles formation

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Abstract

For the first time, microalga *Dunaliella salina* was successfully applied for synthesis of silver nanoparticles. The process of nanoparticles production was monitored using UV–Vis spectroscopy which exhibited surface plasmon resonance band at 432 nm. Scanning electron microscopy confirmed the presence of spherical silver nanoparticles having diameter in the range of 15–40 nm. Crystalline nature of produced nanoparticles was confirmed by X-ray diffraction, and Fourier transform infrared spectroscopy revealed the involvement of functional groups in nanoparticles formation. The changes in the biomass biochemical composition during silver nanoparticles biosynthesis were assessed as well. Formation of silver nanoparticles was accompanied by the decrease in proteins, β-carotene and lipids content in biomass.

Keywords *Dunaliella salina* · Silver nanoparticles · Microalga · Biochemical analysis

Introduction

Silver nanoparticles (AgNPs) are one of the most exciting and necessary nanomaterials developed today. Due to their optical, electrical, and thermal properties, high electrical conductivity, and biological activity, AgNPs have different applications, for example in health care-related products, medical device coatings, optical sensors, and cosmetics, in the pharmaceutical, food, and textile industries, in diagnostics, orthopedics, production of wound dressings, etc. AgNPs are used in conductive inks and integrated into composites to enhance thermal and electrical conductivity. Also, they are used to harvest efficiently light and for enhanced optical spectroscopies, including metal-enhanced fluorescence and surface-enhanced Raman scattering [1]. Among the biological properties of AgNPs can be mentioned, in particular, the antibacterial [1–4], antifungal [1, 2, 5–8] and antiviral [9–12].

Synthesis of AgNPs has been carried out using three different approaches: physical, chemical, and biological. The physical methods, such as evaporation–condensation, laser ablation, spark discharging, and pyrolysis are fast, use radiation as reducing agents, and do not involve hazardous chemicals. The disadvantages of the physical methods of nanoparticle production consist of low yield and high energy consumption [13]. The most common approach for the synthesis of AgNPs is the chemical reduction by organic and inorganic reducing agents, which is part of the "bottom-up" group of methods together with electrochemical methods and sono-decomposition. Chemical methods are easy to achieve have low cost and high yield. The main disadvantage of these methods is the use of chemical reducing agents, which are harmful to living organisms [1, 13].

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