5-th CONGRESS OF MACEDONIAN MICROBIOLOGISTS
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BOOK OF ABSTRACTS
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Охрид | Ohrid
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Synthesis of pullulan-based silver nanoparticles and their antimicrobial activity for prevention of food spoilage

Djuric A\textsuperscript{1}, Ilic D\textsuperscript{1}, Stefanovic Kojic J\textsuperscript{1}, Gogic-Cujovic G\textsuperscript{1}, Jakovljevic D\textsuperscript{2}, Beskoski V\textsuperscript{3}, Vrnic M\textsuperscript{1}
Faculty of Chemistry, University of Belgrade, Belgrade\textsuperscript{1}, Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Belgrade\textsuperscript{2}, Serbia

Introduction: Microbial polysaccharides have been used as stabilization agent for the synthesis of silver nanoparticles. A new class of materials based on such nanoparticles may find a wide range of potential applications including prevention of food spoilage.

Aim: The aim of the presented work was the synthesis of silver nanoparticles (Ag-NPs) based on periodate oxidized pullulan and investigation thus obtained material as an antibacterial agent.

Material and methods: Pullulan used in this work is produced by the yeast-like fungus \textit{A. pullulans}, strain CH-1. Ag-NPs were synthesized by heating solutions of silver nitrate and oxidized pullulan at temperature of 121°C. Formation of nanoparticles was visually monitored by changing the color of the solution from colorless to yellow brown. The characterization of Ag-NPs was performed by UV–Vis spectroscopy, scanning electron microscopy (SEM), and electron diffraction spectroscopy (EDX). The antibacterial activity of produced Ag-NPs was tested using the strain of \textit{Micrococcus lysodeikticus} and it was shown significant activity against them.

Results: Pullulan CH-1 is a linear \(\alpha\)-D-glucan having glucose residues connected by (1,4)- and (1,6)-glucosidic linkages, with some (7\%) maltotetraosyl units. The results present in this work showed improved procedure for production of Ag-NPs based on polyaldehyde polymer obtained by treatment pullulan with periodate ions. Ag-NPs produced were characterized by UV-VIS data. Ultraviolet visible absorption spectra of these solutions showed sharp absorption at 400-440 nm, relating to the plasmon resonance of silver ions. SEM data indicated that nanoparticles formed were polydispersed. EDX spectrum showed presence of silver, by sharp signal in the silver region at 3 keV. Antibacterial activity of Ag-NPs was proven, too.

Conclusion: Obtained results showed that synthesized antibacterial material, based on oxidized pullulan Ag-NPs is promising candidate for a wide range applications, among them is very important food industry, as food packaging products, as barrier materials and antimicrobials for prevention of food spoilage.

Keywords: pullulan, nanoparticles, antibacterial activity
SYNTHESIS OF PULLULAN-BASED SILVER NANOPARTICLES AND THEIR ANTIMICROBIAL ACTIVITY FOR PREVENTION OF FOOD SPOILAGE


Faculty of Chemistry, University of Belgrade, Studentski trg 16, 11180 Belgrade, P.O. Box 51, Serbia;
Institute of Chemistry, Technology and Metallurgy, University of Belgrade, Nigodića 12, 11180 Belgrade, P.O. Box 473, Serbia

Abstract

In this work we investigated the synthesis and antimicrobial properties of pullulan-based silver nanoparticles. Pullulan is nontoxic and biodegradable polysaccharide, therefore has wide applications, from food, as additive, to environmental remediation agents [1].

Introduction

Nanoparticles can be usually synthesized in different ways: by physical, chemical and biological methods. The aim of the presented work was the synthesis of silver nanoparticles by periodate oxidized pullulan, pullulan that produced by the yeast-like fungus Aureobasidium pullulans, strain CH-1 [2] [3]. Collection of Microorganisms). It is a linear α-1,6-polyglucan consisting of (1,4)- and (1,6)-glucosidic linkages. The maltotriose repeating unit, connected by (1,6)-glucosidic linkages (Fig. 1), maltotetraose units (about 7%) being randomly inserted in the polyglucose chain are the main structural characteristics of this polysaccharide [2,3]. Potential application of pullulan through various chemical modifications obtaining new biologically active derivatives is very relevant.

Fig. 1. Pullulan

Polyglucosyl derivatives of pullulan were obtained by reaction with periodate salts in aqueous solution. In the polyglucose thus prepared the aldohexose content can be varied in a wide range, depending on the reaction conditions. Pullulan contains three different anhydroglucoside molecules in the repeating unit and it contains different types of anhydro d-glucose groups, therefore, periodate oxidation of this glucan results in different types of cleavage structure (Fig. 2).

Fig. 2. Different places of oxidation in periodate-oxidized pullulan. Am, Bm and Cm are singly oxidized units. Ad is a doubly oxidized unit.

Aim

The aim of the present work was to test synthesis of pullulan-based silver nanoparticles of periodate oxidized pullulan and silver ions with the aim of broadening knowledge in this area. Thus obtained silver nanoparticles can be used in many applications, including the food industry.

Material and Methods

Pullulan-based silver nanoparticles of oxidized pullulan and silver ions were synthesized by reducing silver nitrate salts with 1% solution of periodate oxidized pullulan by heating at temperature of 121 °C. After cooling at room temperature the solution was used for the characterization of obtained nanoparticles.

Results and Discussion

The aqueous silver ions were reduced to metallic silver by reaction with periodate oxidized pullulan. Formation of nanoparticles was visually monitored by changing the color of the solution from colorless to yellow brown. Ultraviolet-visible absorption spectra (UV-Vis) of these solutions (Fig. 3) showed sharp absorption maxima at range 400-440 nm, relating to the plasmon resonance of silver ions.

Fig. 3. UV-Vis spectrum of the solution of pullulan-based silver nanoparticles

The characterization of obtained products was performed by scanning electron microscopy (SEM) and energy dispersive spectrometry (EDS), too (Fig. 4, a, b).

Fig. 4. SEM micrograph (a) and EDS spectrum (b) of dried sample nanoparticles obtained by reducing silver nitrate with periodate oxidized pullulan

Antimicrobial activity of silver nanoparticles

The antibacterial activity of silver nanoparticles was tested using the strain of Micrococcus luteus, which was shown significant activity against them (Fig. 5).

Fig. 5. Results of antitcobal test of pullulan-based silver nanoparticles using the strain Micrococcus luteus

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References