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Synthesis of Nanosilver Coated Sand Using Plant Extracts

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Abstract

Silver nanoparticles are gaining more attention now-a-days in environmental application due to their high surface area to volume ration and antimicrobial property. The commonly used methods for silver nanoparticle synthesis are the physical and chemical methods. The drawback of chemical and physical methods is that the synthesis is expensive and also involves the use of toxic, hazardous chemicals, which may pose potential environmental and biological risks. The biological method provides a feasible alternative for this problem. The major biological systems involved are bacteria, fungi, and plant extracts. Plants are better synthesizers as compared to the other biological methods. Due to the practical difficulties of silver nanoparticles for water treatment, these nanoparticles must be coated onto some supports. From energy dispersive spectroscopy, all the nanosilver coated sand showed 0.91%-1.35% of silver on coated sand whereas silver coated sand showed only 0.39% of silver on sand. The size of nanosilver coated sand synthesised using papaya fruit extract was found to be about 43.8nm by X- ray diffraction spectrum. The Scanning electron microscopic image of nanosilver coated sand synthesised using papaya fruit extract showed nearly spherical shape and discontinuous coating. This study focuses on the preparation of silver nanoparticles coated on sand using different plant extracts.

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Keywords: silver nanoparticles; energy dispersive spectroscopy; x-ray diffraction spectrum; scanning electron microscope

1. Introduction

Silver is one of the basic elements in our planet. It is a rare, but naturally occurring element, very ductile and malleable and which is slightly harder than gold.Silver has been positioned as the 47th elementin the periodictable,

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having an atomic weight of 107.8 and two natural isotopes 106.90 Ag and 108.90 Ag with abundance of 52% and 48% respectively. Colloidal silver is of particular interest because of its distinctive properties such as good conductivity, chemical stability, catalytic and antibacterial activity [1, 2, 3, 4, 5].

Silver is an excellent antimicrobial and has been used for this purpose for ages. Silver ions and silver-based compounds are highly toxic to microorganisms especially for 16 major species of bacteria. Silver nanoparticles (AgNPs) have many unique properties which results in their extensive application in antimicrobial materials, biological labeling, optoelectronics, and catalysis systems. AgNPs have extremely large surface area-to-mass ratios and a high percentage of component atoms on the surface, thus giving them unique toxicity towards microorganisms [6,7].

There are many ways to synthesize AgNPs. These include physical, chemical, and biological methods. Many techniques of synthesizing AgNPs such as chemical reduction of silver ions in aqueous solutions (with or without stabilizing agents), thermal decomposition in organic solvents, chemical reduction and photo-reduction in reverse micelles, evaporation-condensation using tube furnace, laser ablation and radiation chemical reduction are normally employed methods. The physical and chemical methods are numerous in number, and many of these are expensive or use toxic substances which make them unfavourable method for synthesis. Thus need to develop an eco-friendly and economically feasible technologies for material synthesis led to the search for biological methods of synthesis. Three major sources of biosynthesizing of AgNPs are: bacteria, fungi, and plant extracts [2,8,9].

Biosynthesis of AgNPs is a bottom-up approach that mostly involves reduction/oxidation reactions. The phytochemicals/ microbial enzymes with reducing properties act on the respective compounds to give the desired nanoparticles. The three major components involved in the preparation of nanoparticles using biological methods are the solvent medium for synthesis, the eco-friendly reducing agent, and a nontoxic stabilizing agent. Plants are better synthesizers as compared to the other biological methods (bacteria and fungi) because of the following reasons

- They can avoid the elaborated process of culturing and maintaining the cell.
- Reduces the cost of isolating microorganisms.
- Plants are easily available, safe to handle and possess a broad variability of secondary metabolites [1,2,10,11,12].

When silver nanoparticles are applied in flow through systems, it faces some problems such as agglomeration of particles, difficult in separation from treated water, low hydraulic conductivity and excessive pressure drops. Thus for practical application AgNPs must be coated onto some supports such as sand, polyurethane foam, zeolite, fiberglass etc. [13].

Hence, this study focuses on the preparation of nanosilver coated sand using three different plant extracts namely bamboo leaf, neem leaf, and papaya fruit.

2. Materials and methods

2.1. Coating of silver on sand

River sand of gradation between 0.85 mm and 0.3 mm was used. A.R. grade $AgNO_3$ (1 mM) dissolved in 1 litre of distilled water and which was mixed with 500 gm of washed and dried sand. It was mixed thoroughly and allowed to mature for one hour. Then the mixture is treated with 0.17M pure NaOH. After that the sand was treated with 1:1 NH_4OH solution and reducing solution (9% sugar solution) respectively, mixed thoroughly as before and left for 1 hour between each addition. The treated sand after solar drying was washed with distilled water to pH 7 and finally dried at 100-110°C[14].

2.2. Synthesis of nanosilver coated sand using bamboo leaf extract

20 g of bamboo leaves were washed thoroughly with distilled water and washed leaves were dried at room temperature for 24hrs. Finally, the extract solution was prepared by boiling dried leaves in Erlenmeyer flask with