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Biological Synthesis of Silver Nanoparticles

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ABSTRACT

Nanotechnology is a promising area that is advancing in generating new type of nanomaterial with various biomedical applications including antimicrobials. Silver is a metal of choice for the nanotechnologists for fabrication of nanoparticles as nanosilver is less reactive than silver ions and is expected to be more suitable for medical applications. Silver nanoparticles are therefore considered the most suitable choice for the production of a new class of antimicrobials that may open up a completely new way to overcome a wide range of microbial infections. Hence a lot of work in going on for developing reliable and fast methods for silver nanoparticle production which may include bacteria, fungi, and as a source of reducing agents in the process. The present research focuses on such investigations in recent years that have been valuable to declare biological agents as a good source of synthesizing silver nanoparticles for application as an antimicrobial agent

INTRODUCTION

Nanotechnology as an art and science of manipulating matter at atomic and molecular scale promises to provide a significant improvement in technologies for protecting our environment [1]. It is an interdisciplinary branch emerging rapidly during recent years as a cutting edge technology in the new world. Use of nonomaterial in biotechnology unites the fields of biology and material science. Nanoparticles are considered to be very useful due to their exclusive properties that arise from a variety of aspects, including the similar size of nanoparticles and biomolecules [2]. The nanoparticles can be synthesized by bottom up approach using physical, chemical as well as biological methods. The physical and chemical methods are extremely costly and may involve release of certain toxic material in nature [3]. Whereas those synthesized by biogenic approach are having good poly-dispersity, dimensions and stability [4]. The use of biological methods helps in developing more economical, eco-friendly and rapid processes for the synthesis of nanoparticles. Among various metal nanoparticles, silver nanoparticles had attracted considerable interest due to wide application in biological sciences. This demands the development of easy and rapid processes for the production of silver nanoparticles. The present research is to draw attention towards plant, bacteria and fungi mediated silver nanoparticle synthesis for their potential application for diverse functions [5,6].

EXPERIMENTAL DETAILS

All the cultures to be studied were grown in an aerobic condition on Nutrient agar petriplates containing 3.5nM silver nitrate. The control was maintained which contains only the culture strain and only silver nitrate (without silver nitrate and without culture strain respectively). After the identification of the cultures of experimental studies through their morphological & biochemical studies the culture cells were analyzed by visual and characterization techniques [7]. Visual observation is carried out by visualization of color change from yellow to brown whereas no color change was observed in the control cultures. The characterization techniques used for the

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characterization of biological silver nanoparticles includes UV-Vis spectrum (UV), Scanning and Transmission Electron Microscopy (SEM & TEM), X-ray diffraction (XRD), Energy Dispersive X-ray (EDX) [7].

RESULT AND DISCUSSION

Biological synthesis of silver nanoparticles

The three main steps in the preparation of nanoparticles that should be evaluated from a green chemistry (green synthesis) [8] approach are the choice of the solvent medium used for the synthesis, the choice of an environmentally benign reducing agent and the choice of a non-toxic material for the stabilization of the nanoparticles. Most of the synthetic methods reported to date rely heavily on organic solvents. This is mainly due to the hydrophobicity of the capping agents used. Synthesis using bio-organisms is compatible with the green chemistry principles: the bio-organism is (i) eco-friendly as are (ii) the reducing agent employed and (iii) the capping agent in the reaction. Often chemical synthesis methods lead to the presence of some toxic chemical species adsorbed on the surface that may have adverse effects in medical applications. This is not an issue when it comes to biosynthesized nanoparticles as they are eco-friendly and biocompatible for pharmaceutical applications [9-12].

Table1: Characteristics of biological synthesized silver nanoparticles.

Source	Size (nm)	Characterization	Shape	References
Bacteria				
Bacillus sp.	35-46	TEM	Spherical	[13,14]
Pseudomonas	35–46	TEM, EXD	Spherical	[15]
Escherichia coli	15-57	SEM, TEM	Spherical	[16,17,18]
Fungi				
Aspergillus flavus	7	SEM	Spherical	[19,20]
Aspergillus terreus	15-29	SEM	Spherical	[21,22]
Fusarium oxysporum	20–50	SEM	Spherical	[23,24]
Trichoderma viride	2–4	SEM	Mostly spherical	[25-29]
Amylomyces rouxii	5–27	SEM	Spherical	[30,31,32]
Aspergillus clavitus	55–65	SEM	Mostly spherical	[33-36]
Verticillum sp.	25	SEM	Spherical	[37,38]
Fusarium oxyporum	5-15	SEM	Highly variable	[39]
Fusarium oxyporum	10-25	SEM	Aggregates	[40,41]
Aspergillus niger	3-30	SEM	Spherical	[42,43,44]
Penicillium fellutanum	5-25	SEM	Mostly spherical	[45-48]
Trichoderma viride	5-40	SEM	Spherical, rod - like	[49,50]
Trichoderma viride	2-4	SEM	Mostly spherical	[51]
Rhizopus stolonifer	25–30	SEM	Quasi-spherical	[52]
Yeast				
Candida glabrata	2–5	TEM, UV-Vis	Twinned or Multitwinned	[53,54]
Plants				
Aloe vera	287.5–293.2	SEM, UV-Vis	Spherical	[55]
Annona muricata	5–35	TEM	Polydispersed, spherical	[56]
Catharanthus roseus	20-50	SEM, XRD	Spherical	[57,58]
Elettaria cardamom	30-80	TEM	Spherical	[59,60,61]
Glycyrrhiza glabra	7-45	TEM	Spherical	[62,63]
Gracelliaria edulis		TEM	Spherical	[64,65,66]
Morinda tinctoria	60-95	SEM	Spherical	[67,68]
Ocimum sanctum	15-45	XRD	Spherical, Oval/Elliptical	[69]
Phyllanthus amarus	15.7-29.78	SEM	Spherical	[70]
Piper nigrum	40-100	SEM	Spherical & Cuboidal	[72,73]
syringodium isoetifolium.		SEM	Spherical	[74]
Terminalia arjuna	8-16	SEM	Spherical and irregular	[75]
Tinospora cordifolia	9.3-23.8	SEM	Spherical	[75]

Applying biological agents for nanomaterial fabrication is referred to as Biomimetics approach [10]. One of the primary processes for the synthesis of silver nanoparticles in biomimetics involves bioreduction of silver ions using Bacteria, Fungi, Yeast and more recently plants [11,12]. The Table 1 provides an overview of various reports that focuses the production of silver nanoparticles by biological source.

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