



Synthesis, Characterization and Antimicrobial Activities of Bio-functionalized Ag and Au Metal Nanoparticles: (A Mini-Review)

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<http://dx.doi.org/10.13005/ojc/370203>

(Received: January 26, 2021; Accepted: March 04, 2021)

ABSTRACT

Nanotechnology play vital role in the science and technology form the fabrication or synthesis, design and analysis of nano material. Nanoparticles in the desired range of nanoscale in μm and nm which are important in various fields. Amongst all nanoparticles Silver and Gold Nanoparticles were synthesized by various methods like sol-gel, precipitation, mechano-chemical. Over the all-green synthesis is the newer and better environment friendly. The present review is based on only greener or biogenic way for the synthesis of nanoparticles. Biological material like different plant parts, tea, coffee, polyphenols present in plant materials biomolecules as proteins, enzymes. Bacteria, yeast, algae and viruses were used as reducing agents and capping agents to reduce the size to prepare the NPs by ecofriendly approach. The synthesized Nanoparticles were characterized by X-ray diffraction, SEM, TEM, FTIR and UV-Vis spectroscopic methods, and data obtained for further interpretation of results. A major aim to recognize the material for nano conversion and their antimicrobial activity. Many researchers used biological materials for sizing outs. In this regard to try to critically analyze the literature of Au and Ag metals and biological material searches. The scope of paper only silver and gold metal Nanoparticles and biomolecules from natural sources by investigators.

Keywords: Silver NPs, Gold NPs, Antimicrobial activity, X-ray diffraction, SEM, TEM.

INTRODUCTION

A nanoscience technology is a technology to understand and functionalize the material size which is very close to atomic dimension. The physicochemical properties of nanosized material changes from Pico and macro size. There is significant attention of researcher towards nanoparticle because of its potential records¹ in the

field of medical and technology as such materials are chemically active. Especially, transition metal nanosized materials are studied over last decades for their optical, sensors, catalytic, insulating, antimicrobial properties.

Furthermore, nanosized particles of Ag, and Au are also having enormous attention and hence they are prepared through various routes such



as combustion, chemical reduction, photochemical reduction², laser ablation³, microwave; sol-gel⁴. The method thermal decomposition of the matrices produces fine particles at particular temperature. Such methods possess many adversative effects like health hazard, produces very less yield and time consuming. Many of the health hazardous effects are not known yet. Amid, biogenic synthesis is more dangerous, and require to take extreme care while synthesis.

The importance material produced is in technologically functional material, practically in the field of heterogeneous catalysis and electronic sensors.

The synthesis of NPs was derived from transition and inner transition metal salts, oxides and sulphides, and characterized by X-ray powder diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). IR, UV, Thermal Analyses (TGA, DTA). Numerous literatures have been reviewed on biological synthesis and antimicrobial activities of NPs. For the present review certain data is tabulated which is diverse than earlier.

Biological synthesis

The synthesis using biological route ensures the formation of nanosized particles. The method was rapid and ecofriendly. The main key aspects of the route are the effortlessly availability of precursor as they are natural sources and also there is no any special requirement to maintain physical properties corresponding high pressure, temperature, energy and specific chemicals.

Biological synthetic route by natural material mediated

The synthesis of nanoparticles using biological path from the precursor of plant extract mediated as leaves, fruits, flowers, roots, stem bark recently witness more attention hence environmentally favorable attempts are made. The purpose of attempt was to avoid the adverse effects in biomedical applications. The numerous varieties of plant extract as biological agent employ for the synthesis. The exhaustive literature survey was reported for the NPs synthesis using natural materials. Herein, it is reported that the biological methods are safe, cost effective,

sustainable and environment friendly processes for the synthesis of NPs.

The morphological, textural and structural properties of the material were studied by the X-ray powder diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Thermal analysis, Fourier Transform Infrared Spectroscopy (FTIR), Dynamic Light Scattering (DLS) techniques.

Silver nanoparticles

The production of Silver Nanoparticles is extremely expensive and also involved the use of hazardous chemicals, which may pose potential biological and environment problems, which leads the investigators to search for new and newer biomaterials for the fabrication of Nanomaterials. The demanded methods for the synthesis were easy, cost effective for their effective utilization. Hence, researcher receives considerable attentions on Greener method of synthesis. Additionally, biosynthesis method for the synthesis of nanoparticles using different kinds of microorganism such as bacteria and fungi are also notified. There are three important sources for the synthesis of nanoparticles namely bacteria, fungi and plant part extracts. It is evident the use of *Solanum xanthocarpum* L. Silver nanoparticles (AgNps), having a surface plasmon resonance (SPR) band centered at 406 nm, were synthesized by reacting SXE (as capping as well as reducing agent) with AgNO₃ during a 25 min process at 45°C. The synthesized AgNps were characterized using UV-Visible spectrophotometry, powdered X-ray diffraction⁵ *Hibiscus rosa sinensis*, *Jatropha curcas*⁶⁻⁷ and green algae *Cinnamomum camphora*, *Botryococcus braunii*, *Caulerpa serrulata*⁸⁻¹⁰. Brown algae *Pithophora oedogonia*¹¹. *Microalgae Bifurcaria bifurcate*, *Scendosmus* sp.¹²⁻¹³ and extremophilic yeast¹⁴. Fungal biosynthesis as *Trichoderma viride*¹⁵, *Fusarium solani*¹⁶, *Aspergillus niger*¹⁷. Bacterial source as *Escherichia coli*¹⁸ plant part Indicum leaf extract²⁰, as a reducing agent and characterized.

Gold nanoparticles

For the preparation of gold NPs employ small biomolecules and biopolymers used both in combination with other reducing and stabilizing agents. The gold NPs are non-toxic particles with large surface area and can be modified with other

molecules²¹. Gold is a precious metal, and the synthesis of gold NPs is possible various biological agents. The tetrachloroaurate ($\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$) has been reduced and synthesized to Gold Nanoparticles, further characterized and proved the formation of nanocages, gold nanospheres, and gold nanorods, nanowires by near infrared irradiation absorption which produces wide range of sizes. There was the rising resistance for antibiotics therefore the researchers were expecting another therapy in the combination with gold Nanoparticles for betterment which is used in sensors as a drug and in drug delivery. The several techniques and resources have been employed for their synthesis. With this report we are contributing that on biogenic

synthesis, a green algae mediated *Prasiola cripsa*²², Biosynthesis of gold nanoparticles using different parts *Geranium* plant used²³, biomolecules like Serum albumins liberate their chemical constituents and DNA²⁴⁻²⁵, cashew nuts *Anacardium occidentale*²⁶, Banana pith extract²⁷, *Fusarium oxysporum*²⁸, Tuber extract of *Dioscorea bulbifera*, used for reduction, it requires 5-6 h for synthesis of Au NPs²⁹. Aloe Vera³⁰, *Syzygium aromaticum*³¹ also it associates with green synthesis. The methods for synthesizing gold nanoparticles with the use of synthetic and natural biopolymers that can act simultaneously as reducing agents and surface stabilizers³³. The biosynthesized Nanomaterial route is shown in Figure 1.

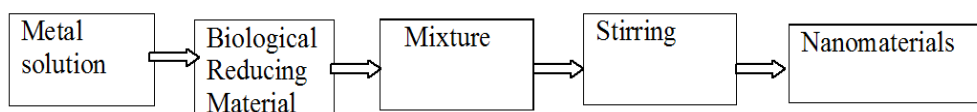


Fig. 1. Biological synthesis of nanomaterial

Table 1: Synthetic method, sources and activity of Silver Nanoparticles

Metal NPs	Method	Source for Synthesis	Active against	References
Silver (Ag)	Biological Plant part	<i>Solanum Xanthocarpum</i> L	<i>Helicobacter pylori</i>	[5]
		Berry <i>Hibiscus rosa sinensis</i>		[6]
		<i>Jatropha curcas</i>	<i>Staphylococcus aureus</i>	[7]
	Biological Green algae Mediated	<i>Cinnamomum Camphora</i>	Antimicrobial activity	[8]
		<i>Botryococcus braunii</i>		[9]
		<i>Caulerpa serrulata</i>		[10]
		Fresh water algae	Antimicrobial activity	[11]
	Brown algae	<i>Pithophora oedogonia</i>		
		<i>Bifurcaria bifurcate</i>		[12,13]
	Micoalage	<i>Scendosmus</i> sps.		
		Extremophilic yeast		[14]
		Trichoderma viride		[15,16]
	Biological mediated	<i>Fusarium solani</i>		
		<i>Aspergillus niger</i>		[17]
		Bacteria		
	Biological Bacteria mediated	<i>Escherichia coli</i>	Antimicrobial activity	[18]
		<i>Acillus indicus</i> and		
		<i>Bacillus cecembensis</i>		[19]

Table 2: Synthetic method, sources and activity of Gold Nanoparticles

Metal NPs	Method	Source for Synthesis	Active against	References	
Gold (Au)	Biological Green algae mediated	<i>Prasiola cripsa</i>		[22]	
		Biological Plant part mediated	<i>Indicum</i> leaf extracta	Antimicrobial activity	[20]
	Biological biomolecules	<i>Geranium</i> plant parts			
		Cashew nuts		[23,32]	
	(Anacardium occidentale)	Bactericidal activity might become an alternative to antibiotics used in fishery and aquaculture industry		[26]	
		Banana pith extract	<i>Bacillus</i> , <i>Pseudomonas</i> , <i>Escherichia coli</i>	[27]	
		Mentha piperita or peppermint	<i>Gram-positive</i>	[34]	
	Bacteria mediated	Serum albumins, Deoxy ribose nucleic acid (DNA)	<i>Escherichia coli</i>	Antimicrobial activity	[24]
		<i>Fusarium oxysporum</i>	<i>P. aeruginosa</i> and more effective against <i>Gram-positive</i> bacteria	[28]	

CONCLUSION

Silver and gold NPs are witnessed attention in all the fields due to their potential applications. In the present review, there is forcing need to develop an ecofriendly benign biogenic technology in the synthesis of gold and silver NPs than other toxic and chemical methods. The biosynthesis of metal silver NPs using the kind of microorganism such as fungi, bacteria, different plants and their parts like leaf, flowers, seeds, stem bark and root, biomolecules like serum, DNA have been applied as reducing method with stabilizing agents. The novel is the use of antimicrobial agents owing to maintain volume to high surface area ratio. Greener way to synthesis nanoparticles gold and silver provides advantageous over physical and chemical

method because their cost effective, non-toxic, safe reagent handled easily and eco or environment friendly system. This makes review some sort of data documented for further nanomaterial research.

ACKNOWLEDGEMENT

We wish to gratefully acknowledge Hon'ble Govindrao Holkar, Secretary, Principal, N.V.P. Mandals, Lasalgaon (Nashik) and Dr. Sureshchandra G. Kulkarni (Pune), and Principal, M.E.S. Abasaheb Garware College, Karve Road, Pune for their constant support and encouragement.

Conflict of interest

Authors of this paper have no conflict of interest.

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