SYNTHESIS OF SILVER NANOPARTICLES FROM RUELLIA TUBERSE LINN PLANT

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Abstract

Nanobiotechnology is emerging as a field of applied biological sciences and nanotechnology. The synthesis of nanoparticles is done by various physical and chemical methods, But biological methods are relatively simple, inexpensive, nontoxic and environmentally friendly methods. The current review focuses on the synthesis of nanoparticles, with particular emphasis on the use of parts of plants for the synthesis process, its applications and future prospectus.

Key words : Ruellia tuberose Linn, silver nanoparticle , Spectroscopy,antibacterial activity

Introduction

Inspite of tremendous advances made by modern medicine, drugs for viral diseases like AIDS, certain type of cancers, arthritis, Parkinsonism are yet to come. The newer concepts about herbal drugs have Immunomodulators and Adaptogens gaining importance and are recognized for prophylactic and preventive therapy.

Surprisingly, a recent survey revealed that more than 50% of all prescription drugs are either directly derived from the natural sources or synthesized from the natural models as the sole ingredient or as one of the several ingredients. It seems certain that the continued scientific study of medicinal plants affords a plethora of novel, structurally diverse and bioactive compounds. Multidisciplinary research on plants has led to many new drugs as well as prototype active molecules and biological tools (Bhanua *et al*., 2003).

Nanotechnology

The field of nanotechnology has opened up new worlds of possibility and has spawned a proliferation of new terminology. The two fundamentally different approaches to nanotechnology are graphically termed 'top down' and 'bottom up'. 'Top-down' refers to making nanoscale structures by machining and etching techniques, whereas 'bottom-up', or molecular nanotechnology, applies to building organic and inorganic structures atom-by-atom, or molecule-by-molecule. Top down or bottom-up is a measure of the level of advancement of nanotechnology. Nanotechnology, as applied today, is still in the main at what may be considered the more primitive 'top-down' stage. A breakthrough that may signal the beginning of the 'bottom-up' stage of nanotechnology has been the discovery of elemental and molecular structures. These may open the door to huge applications for medicine and information technology (Seeman and Belcher; *et al*., 2002). Another feature of nanotechnology is that it is an area of research and development that is truly multidisciplinary. Research at the nanoscale is unified by the need to share knowledge on tools and techniques, as well as information on the physics affecting atomic and molecular interactions in this new realm. Materials scientists, mechanical and electronic engineers and medical researchers are now forming teams with biologists, physicists and chemists. New applications of nanomaterials are emerging rapidly. The synthesis of nanoparticles is a cornerstone of nanotechnology. New methods to study synthesis of nanoparticles are an area of active research. The methods currently being used encompass chemical routes. A big impediment to encouragement of these methods is that the byproducts associated with metal production have become a great concern with respect to environmental pollution, additionally; some of these processes are expensive.

In addition, the synthetic procedures involve conditions such as high temperature, pressure and environmental inertness, which are cost intensive (Rao *et al*., 2003). Alternative metal recovery/removal methods are being considered which are based on metal sequestering and or metal uptake from solution by biological systems. Nature however, is no stranger to nanotechnology; living organisms from bacteria to beetles rely on nano-sized protein-based machines that do everything from whipping flagella to flexing muscles. The molecular machinery of nature out performs anything that mankind knows how to construct with conventional manufacturing technology by many orders of magnitude (Lowe, 2000). Biological systems have a unique ability to control the structure, phase, orientation and nano-structural topography of inorganic crystals. It is well known that inactivated biological systems interact with metal ions; the connection between the two is more in depth. As is well known that many elements in trace concentration are essential to plant growth and propagation; however, these very elements become toxic to the plants at higher concentrations (Gardea-Torresdey *et al*., 2002). It has been shown that many plants as well as bacteria can actively uptake and reduce metal ions from soil and solutions. A wellknown example of reduction and production of nanoparticles is the magneto-tactic bacteria that can synthesize magnetic nanoparticles (Schuller and Frankel, 1999) which have an enormous number of applications (Safarik and Safarikova, 2002). Another example is the production of gold nanoparticles using inactivated Alfalfa biomass (Gardea-Torresdey *et al*., 2002). The possibility of using Lactic acid bacteria in the whey of buttermilk has shown the production of gold-silver composite materials when challenged to a mixture the ions of the two metals (Nair and Pradeep, 2003). These are some examples that show the biotechnological solutions to material-science. Although many biotechnological applications such as remediation of toxic metals employ microorganisms such as bacteria and yeast, it is only relatively recently that material science has been viewing these as possible ecofriendly nano-factories (Ahmad *et al*., 2002a).

Microbes affect the redistribution of metal by oxidation, reduction or biosorption. Microbes may solubilize the metals as in the case of uranium, or reduce them, as in the case of iron and manganese. Microbial biomass can retain relatively high quantities of metal by biosorption (passive mode) or by bioaccumulation (actively by viable cells) (Volesky, 1995). It has been recently shown that several types of inactivated biomasses and living organisms have the ability to remove high concentrations of Au3+ from solution by converting it to Au0 (Gardea-Torresdey *et al*., 2003). Fungi, due to their tolerance and bioaccumulation ability of metals, are taking the centre-stage of studies on biological metal nanoparticle generation (Sastry *et al*., 2003). A few advantages of using fungal mediated green approach for the synthesis of nanoparticles are as follow: Economic viability. Ease in scale up as in thin solid substrate fermentation method, thus making it possible to easily obtain biomass for processing. Large-scale secretion of extracellular enzymes (fungi are extremely efficient producers and secretors of extracellular enzymes).

Botanical name:

Ruellia tuberose Linn

Collection of Plant Material

The plant material was collected from the Madurai District of Tamil Nadu in India during the period of December 2017 – April 2018.

Solvents and Chemicals

All the chemicals and solvents at AR grade (S.D. Fine-Chemicals Ltd., Qualigens Chemicals Ltd., and Hi-Media Laboratories Pvt. Ltd., Mumbai, India).

Preparation of Plant Extraction

i)Aqueous Extraction

The plant materials were collected separately , washed thoroughly thrice with distilled water, shade-dried up to 5 days and prepared fine powder by grinding. The fine powder of the plant material was sterilized at 121°C for 15 min and weighed. Sterilized fine powder, 20 g each was taken, mixed with 200 ml of Milli Q water and kept in boiling water bath at 60°C for 10 min. The extracts were filtered with Whatman No 1 filter paper and the filtered extracts were stored in a refrigerator at 4°C for further studies to avoid microbial contamination.

ii) Biosynthesis of nanoparticles

For the synthesis of silver nanoparticles, silver nitrate prepared at the concentration of 10^{-3} M with pre-sterilized Milli Q water was used respectively. A quantity of 1.5 ml of each extract was mixed with 30 ml of 10^{-3} M of silver nitrate for the synthesis of silver nanoparticles. Silver nitrate has taken in similar quantities of 1.5 ml each without adding plant extracts to main respective controls. The saline bottles were tightly covered with aluminium foil in order to avoid photo reduction of silver ions, incubated at room temperature under dark condition and observations were recorded.

By using given instruments to characteristics the nanoparticle

UV-VIS Spectroscopy

Fourier Transform-Infra Red (FT-IR) Spectroscopy

Dynamic Light Scattering Particle size analyzer

Dynamic Light Scattering Zeta Potential Measurement

Scanning electron microscope (SEM)

X-ray Diffraction method

Test Microorganisms

Bacterial Strains

Gram-Positive

Bacillus cereus	-	MTCC Code: 430
Staphylococcus aureus	-	MTCC Code: 96

Gram-Negative

Klebsiella pneumoniae	-	MTCC Code: 432
Salmonella typhi	-	MTCC Code: 733

Antibacterial Activity

Agar well diffusion method was followed. Muller-Hinton Agar (MHA) plates were swabbed (sterile cotton swabs) with 8 h old broth culture of the respective bacteria. A sterile cork borer was used to place four wells, each measuring 8 mm in diameter, in each of the plates. About 0.1 ml each of 2.5, 5 and 10 mg/ml of the concentrated test samples were added into the wells using sterilized dropping micropipettes and allowed for diffusion at room temperature for 2 h. The plates were incubated at 37°C for 18-24 h. Diameter of the inhibition zones was recorded. The experiment was repeated thrice and the average values were calculated for antibacterial activity.

Table: 1

Measurement of Zeta Potential

Zeta potential [mV]	Stability behaviour of the colloid
from 0 to ±5,	Rapid coagulation or flocculation
from ±10 to ±30	Incipient instability
from ±30 to ±40	Moderate stability
from ±40 to ±60	Good stability
more than ±61	Excellent stability

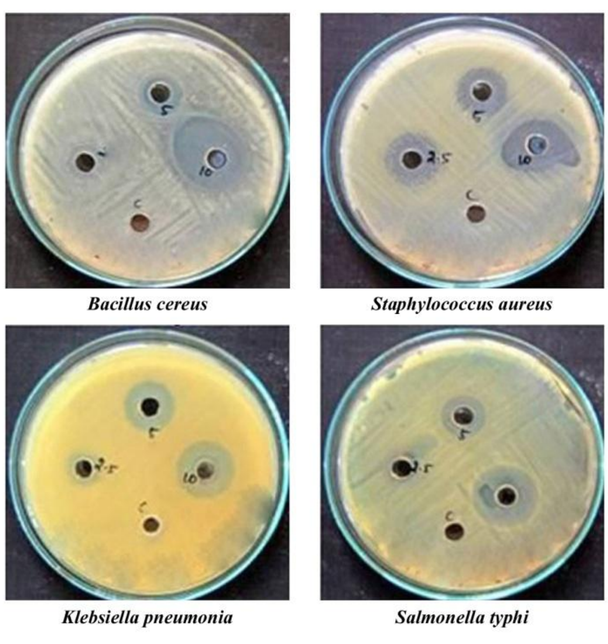
RESULT

Synthesis of Ag Nanoparticles by green synthesis process

For the synthesis of silver nanoparticles, silver nitrate has selected in the present study. Besides, *R. tuberose* has considered as important medicinal plants in the Indian indigenous traditional systems of medicine.

Metal-Plant interaction

During silver nanoparticles synthesis, the change of color from pale green to brownish color suggested the formation of silver nanoparticles. The tubes were observed periodically for change in color from green to different shades of brown by silver nanoparticles; it was found that aqueous silver ions when exposed to herbal extracts were reduced in solution, thereby leading to the formation of silver nanoparticles.



Antibacterial assay of the Ag Nanoparticles Synthesized by treating *R. tuberose* extract.

CONCLUSION

The conclusion drawn from the present investigations are as follows

A bioreductive approach to the synthesis of silver nanoparticles in the leaves of *R. tuberose* demonstrates the formation of spherical silver nanoparticles   marked difference in the shape of the silver nanoparticles may be attributed to the comparative advantage of protective biomolecules and reductive biomolecules. The compounds in the leaves of *R. tuberose* are mainly responsible for the reduction of silver ions and their stabilization.

Instead of the boiled leaf broth method followed in the previous studies, leaves of *R. tuberose* appear to be environmental-friendly and low-cost candidate as a reductant for synthesizing of silver nanoparticles. This procedure can be extended to the synthesis of other nanoparticles from different chemical compositions. Synthesis of nanoparticles has many advantages by scale up of each process because of its economic viability, possibility of covering large surface area easily by suitable growth of the filaments, etc.

Equally the synthesis of metal ion reduction or reaction process in cellular metabolism explaining whether the nanoparticles formed as byproducts of the process has role to play in a cellular activity. Generally, the plants do not express high activity to bacteria and fungi even when it expresses it are at the low profile. But in the present study, the nanoparticles were exhibited a wide range of activities towards the bacteria. In this low cost procedure, effective synthesis of nanoparticles will have greater implication and application in biomedical research.

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