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STUDY ON PLANT-EXTRACT-ASSISTED GREEN SYNTHESIS OF SILVER NANOPARTICLES AND THEIR IMPORTANCE

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ABSTRACT

The importance of this study includes a precise and specific analysis of silver nanoparticles from biological systems that may support and revolutionize the art of synthesis. Nanotechnology is a modern field of science which plays a significant role in day to day life aspects.The present paper briefly describes the biosynthesis of silver nanoparticles and their application in different fields. Biosynthesis is a novel way to synthesize nanoparticles by using biological sources.It is gaining much attention due to its cost effective, eco friendly and large scale production possibilities. Generally physical, mechanical and chemical methods are involved for the synthesis of such important nanoparticles. But these methods are very expensive and some methods involve harmful chemicals. With the aim of developing clean, nontoxic and eco-friendly technologies, a wide range of biological sources has been used for the formation of nanoparticles.

Keywords: Green Synthesis, Nanoparticles, Plants.

1. Introduction

Nanotechnology is a modern field of science which plays a significant role in day to day life aspects. Nanotechnology is the study and application of small object which can be used across all fields suchas physics, chemistry, biology, material science and engineering. Nanotechnology deals with production, manipulation and use of material ranging in nanometers1. Nanotechnology has got directimpact on human life2. Nanotechnology mainly deals with the nanoparticle synthesis having a size of 1-100 nm in one dimension used significantly concerning medicinal chemistry, atomic physics, and all other known fields too3. Nanomaterials arethe atomic

and molecular building blocks (~0.2 nm) of matter. Nanoparticles belong to a wider groupof nanomaterials having amorphous or crystalline form and their surfaces can act as carriers for liquiddroplets or gases4.Richard Feynman was the first person who gave a talk on Nanoparticles in the year 1959. It later on inspired the conceptual foundations of nanotechnology. Nanoparticles have been in use in pottery and medicine since ancient times. Since last decade the most effectively studied nanoparticles are those made from the noble metals such as silver, gold andplatinum. Due to excellent physicochemical properties, nanoparticles have potential applications in all fields of science and technology. Since ancient times human society use medicines, from gold,silver, mercury, sulphur, mica, arsenic, zinc, other minerals, gems, shells, horns treated with indigenous herbs as bhasmas (a fine ash obtained through Incineration) and chendurams (prepared bythe process of sublimation and they are much more potent than bhasmas). Hippocrates explained the beneficial healing and anti-disease properties of silver. Ancestors used silver bottles for storing water,wine and milk to prevent spoiling. Siddha medicine is a form of South Indian medicine which is believed to have been developed by the Siddhars5. Silver nanoparticles were developed as a potentantibacterial, antifungal, anti-viral and anti-inflammatory agent. The biomedical applications of silvernanoparticle can be effective by the use of biologically synthesized nanoparticles which minimize the factors such as toxicity, cost and are found to be exceptionally stable. The targeting of cancer cells using silver nanoparticles has proven to be effective6.

2. Methods used to synthesize nanoparticles

Traditionally Nanoparticles were produced only by physical and chemical methods. Some of the commonly used physical and chemical methods are ion sputtering, solvothermal synthesis, and sol gel technique. Basically there are two approaches for Nanoparticles synthesis namely the Bottom up approach and the Top down approach7. The Nanoparticles are synthesis by Physical and chemical methods like Sol-gel technique, Solvothermal synthesis, Chemical reduction, Laser ablation, Inert gas condensation and Biosynthesis of nanoparticles8.

Green syntheses of silver nanoparticles using plant extracts

Biosynthesis of nanoparticles using plant extracts is the latest most favorite method of green, ecofriendly production of nanoparticles as it offers one step. Currently it is exploited to a vast extentbecause the plants are widely distributed, easily available, safe to handle and with a range of metabolites9. The use of plants as the production assembly of Silver nanoparticles has drawnattention, because of its rapid, eco -friendly, nonpathogenic, economical protocol and providing a single step technique for the biosynthetic processes10. Silver nanoparticles have also gained significance due to their broad spectrum activity against bacterial infections Flavonone and terpenoid components of leaf broth are being predicted to stabilize the formation of Nanoparticles in comparisonto high

molecular weight proteins of fungal biomass11. Nanoparticles produced by plants are morestable and the rate of synthesis is faster than that in other case of other organism. The reduction andstabilization of silver ions by combination of biomolecules such as proteins, amino acids, enzymes,polysaccharides, alkaloids, tannins, phenolics, saponins, terpinoids and vitamins which are alreadyestablished in the plant extracts having medicinal values and are environmental benign, yetchemically complex structures. In each and every steps of the experiment, sterility conditions weremaintained for the effectiveness and accuracy in results without contamination12. Silver nitrate (AgNO3) was used as received without further purification. 5mL leaf broth was added to 100mL 10-3 M silver nitrate and allowed to react at ambient conditions. The observed colour change of reactionmixture from transparent yellow to dark brown indicates the formation of Silver nanoparticles. The suspension of Silver nanoparticles was allowed to settle and the excess liquid was removed. Theparticles were then rinsed to remove any organic residue and resuspended in 95% ethanol for furthercharacterization13. Characterization of Silver nanoparticles The characterization study of silver nanoparticle was doneby the examining size, shape and quantity of particles. Number of technique is used for this purpose,including UV-visible spectroscopy, Scanning Electron Microscopy (SEM), Fourior TransmissionInfrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), and Dynamic Light Scattering (DLS)19. Table: The synthesized Nanoparticles from different Plants

Name of the Plants	**Size (nm)**	**Pharmacological Applications**	**Refe rances**
Aloe vera	50-350	Antimicrobial	14
Allium sativum	4-22	Antibacterial	15
Azadirachta indica	50-100	Antibacterial	15
Argemone mexicana	20-50	Antimicrobial	16
Caria papaya	20-25	Antimicrobial	16
Cassia fistula	55-98	Antihypoglycemic	17
Catharanthus roseus	48-67	Antibacterial	15
Calotropis procera	150- 1000	Antimicrobial	15
Citrullus colocynthis	31	Antihypoglycemic	16

Datura metel	16-40	Antimicrobial	15
Emblica officinalis	10-20	Anticancer	18
Ocimum sanctum	~10	Antimicrobial	14
Zingiber officinale Rosc	10	Drug dilivery	17
Melia azedarach	78	Anticancer	18
Moringa oleifera	57	Antimicrobial	14
Tinospora cordifolia	34	Antimicrobial	16
Withania somnifera	5-40	Antimicrobial	14
Coccinia indica	10-20	Antimicrobial	16
Vitex negundo	10-30	Antiproliferative	16
Thevetia peruviana	10-30	Antimicrobial	16
Vitis vinifera	30-40	Antimicrobial	16
Musa balbisiana	20-40	Antibacterial	15
Oscimum tenuiflorum	10-30	Antibacterial	15

Applications of nanoparticles

The main application involved in use of Nanoparticles for biomedical applications, such as drug andgene delivery, cancer treatment and diagnostic tools, food etc. has been extensively studiedthroughout the past decade. The Nanoparticles created a huge interest due to their very small size and large surface-to-volume ratio, and they display absolutely novel uniqueness contrast to the largeparticles of bulk material. Very recently, Nanoparticles have gained significance in the field of biomedicine and bioremediation. Nanoparticles have potential application in medical field including diagnostics and therapeutics.

1. **Anti-microbial, Anti-bactrial and Anti- Fungal Action 15,16,**

The antimicrobial properties of Silver nanoparticles have also been exploited both in the medicine and at home. Silver sulfadiazine creams use sometimes to prevent infection at the burn site and at least one appliance

company has incorporated silver into their washing machines. Currently silver isused and appears in many consumer products likes that include baby pacifiers, acne creams, and computer‟s keyboard, clothing (e.g. socks and athletic wear) that protects from emitting body odourin addition to deodorizing sprays. The Silver nanoparticles exhibited antifungal action against various fungi. Actualmechanism behind the antifungal activity is not fully. The disrupting the structure of the cell membrane by destructing the membrane integrity, thereby the inhibition of the budding process has been attributed to be responsible for the antifungal action of Silver nanoparticles against C. albanicans species.

2. **Drug delivery17**

Nanoparticle involved in drug delivery. The Nanoparticles get entrapment of drugs are either enhanced delivery to, or uptake by target cells and/or a reduction in the toxicity of the free drug to non-target organs.

3. **Food20**

There are several purposes for the development of nanofood. These include improvement of food safety, enhancement of nutrition and flavor, and cutting production and consumer costs. In addition,nanofood provides various benefits by which include health promoting additives, longer shelf lives and new flavor varieties The application of nanotechnology in food is rapidly emerging and is involving all areas of the food chain from agricultural applications to food processingand enhancing bioavailability of nutrients.

4. **Gene delivery21**

Gene delivery it is a technique that plays a vital role that can efficiently introduce a gene of interest in order to express its encoded protein in a suitable host or host cell. Now a day, there are different types of primary gene delivery systems that mainly employ viral vectors like retroviruses and adenoviruses, nucleic acid electroporation, and nucleic acid transfection.

5. **Cancer treatment18**

There are a variety of Nanoparticles systems currently under investigation to be applied in biomedicalwith the emphasis on cancer therapeutics.The unique up conversion process of UCNanoparticles may be utilized toactivate photosensitive therapeutic agents for applications in cancer treatment.

6. **Biosensor21**

Metal Nanoparticles are feasible in different biological and electrochemical sensing system due to itschemical and physical property. Nanoparticles are coated with biological or molecular materials suchas antibodies and collagen which act as bioinorganic interface. By controlling Nanoparticles size efficient fluorescent probe can be created that release fine illumination in broad array of wavelength. DNA and protein can be immobilized on surface of Nanoparticles after that intensity and wavelength of Nanoparticles are observed and acts as a DNA

and protein biosensor respectively. The shape of the Silver nanoparticles has a significant effect on the anti-microbial activity.

7. Anti-Parasitic Action22

The Silver nanoparticles have been found to be effective larvicidal agents against dengue vector Aedes aegypt and Culex quinquefasciatus, filariasis vector C. quinquefasciatus and malarial vector
A. subpictus, Aedes aegypti, A. subpictu and other parasites.

8. Anti-Fouling Action22

The Silver nanoparticles synthesized from Rhizopus oryzae fungal species have been used for treating contaminated water and adsorption of pesticides and that from Lactobacillus fermentum cells have been used as anti-bio fouling agent. The Silver nanoparticles are being used to treat manyenvironmental concerns like; air disinfection, water disinfection, ground water and biological water disinfection and surface disinfection.

9. Other applications of nanoparticles23 In recent years Nanoparticles are involved with new applications in areas like information and communication technology, power engineering, industrial engineering, environmental engineering etc. For decades some nanoscale materials have beeninvolved whereas others are newly discovered are used as sunscreens and cosmetics, textiles, coatings, sports goods, explosives, propellants and pyrotechnics or their applications are currently under development. All in all, the number of nano products and methods of their use increase continually. This paper has reviewed recent knowledge and built a data base of Nanoparticles. This review provides an overview of nanoparticle based upon the characterization methods, types, protocols based upon Strategies used to synthesize Nanoparticles and wide range ofapplications. Our study concludes that Nanoparticles has a tremendous growth in recent years. A widerange of opportunities or upcoming projects are available some of the Nanoparticles get synthesized are cost effectiveness. For example Nanoparticles synthesis using plant sources is largely adopted due to its eco-friendly nature and cost effectiveness etc.,

Future Perspective

Nanoscale technologies can be improved and brought about new area towards revolutionizing the fundamentals of disease diagnosis, treatment, therapy and prevention by innovating nanomedicines.Because of its small size, have the potential to alter molecular discoveries arising from genomics andproteomics which can be benefit for patients. The advantage of biological production systems is in the controlled production at a molecular level. Nanoparticles are formed in highly defined structures, complex morphologies and narrow particle size distribution25. As nanotechnology has gained interest in the last few years, and is expected to developmore in

the future, the foremost challenge is to expand experimental protocols for the synthesis of silver nanoparticle by microbial sources, Fungal Sources and Plant sources. In addition, an enhanced understanding of the mechanism of the formation of nanoparticles and the bioreduction phenomenon of metal ions is needed. Today, with the help of modern technologies of impregnation of silver nanoparticles can solve the burning problem of resistance against antibiotics. Microbes are not able to develop resistance against silver, because they can develop against conventional and narrow target antibiotics. Metallic silver in the form of silver nanoparticles has made a beneficial comeback as a potential antimicrobial agent and has developed into diverse medical applications ranging from silver based dressings, silver coated medicinal devices, e.g. nanogels and nanolotions among others26.

Conclusion

This paper has reviewed recent knowledge and built a data base of bioreductive approaches to formation of silver nanoparticles using different plant derivatives. The exact mechanism for the formation of nanoparticle by using biological resources is still being investigated and several possible ways have been proposed24. Current aspects of process which includes plant sources should focus towards the use of highly structured physical and biosynthetic activities of plant cells to achieve better controlled manipulation of the size and shape of the particles.Furthermore effect is needed in order to develop more productive process for metallic nanoparticle production. In addition, improvements on biogenesis process are needed for the development of cheaper processes. It can be concluded that in plants where carboxylic groups, amino groups, proteinsand carbohydrates are present in the source extract, believed to play a key role in the biosorption and bioreduction processfor the formation of nanoparticles. There is great need for further investigation to understand the effect of time, temperature, light and other parameters regarding the green synthesis of silver nanoparticles. The Silver nanoparticles synthesis using plant sources is largely adopted due to its eco- friendly nature and cost effectiveness. The synthesized Silver nanoparticles are very much important in different disciplines of life and are widely used for the benefit of mankind.

References

1. Kavitha, K.S.et.al. (2013). Plantsas green source towards synthesis ofnanoparticles. Int. Res. J. Biol. Sci.,2(6): 66 76.

2. Jannathul Firdhouse et.al 2012. Novel synthesis of silver nanoparticles using leaf ethanol extract ofPisonia grandis (R. Br). Der Pharma Chemica, 4(6):2320 2326.

3. Amudha Murugan et.al 92014).Biosynthesis and characterization of silver nanoparticles using the aqueous extract

of vitex negundo. linn. World J. Pharm. pharm. Sci., 3(8): 1385 1393.

4. Buzea, C. et.al (20070. Nanomateriales and nanoparticles: Sources and toxicity. Biointerphses, 2(4): 17-71

5. Arun Sudha. et.al (2009). Standardization of Metal-Based Herbal Medicines. American Journal ofInfectious Diseases 5 (3): 193-199, 2009.

6. R.Vaidyanathan. (2009). Biotechnology Advances, 27:924–937. 7. Sepeur S. (2008) Nanotechnology: technical basics and applications. 8. Jitendra Mittal et.al (2014). Phytofabrication ofnanoparticles through plant as nanofactories. Adv. Natural Sci. Nanosci. Nanotechnol., 5:10.

9. Kulkarni N et.al (2014)Biosynthesis of metal nanoparticles: a review. J Nanotechnol:1–8.

10. Huang J. et.al (2007) Biosynthesis of silver and gold nanoparticles by novel sundried Cinnamomum camphora leaf. Nanotechnology 18: 105104-105115. 11. Shankar SS. (2004). Rapid synthesis of Au, Ag, and bimetallic Au core–Ag shell nanoparticles using Neem (Azadirachta indica)leaf broth. Journal of Colloid and Interface Science275: 496-502.

12. Sahayaraj K et.al. Bionanoparticles: synthesis and antimicrobial applications, science against microbial pathogens: communicating current research and technological advances. In: Mendez-Vilas, editor, FORMATEX; 2011. P. 228-44.

13. Kasthuri, J et.al (2009). Biological synthesis of silver and gold nanoparticles using apiin as reducing agent. Colloids Surf. B: Biointerf. 68, 55–60.

14. Raghunandan,et.al,(2011). Anti-cancer studies of noble metal nanoparticles synthesized using different plant extracts. Cancer Nanotechnol. 2, 57–65. 15. MubarakAli et.al (2011). Plant extract mediated synthesis of silver and gold nanoparticles and its antibacterial activity against clinically isolated pathogens. Colloid Surf. B 85, 360–365.

16. Sondi, I et.al, (2004). Silver nanoparticles as antimicrobialagent: a case study on E. coli as a modelfor Gram-negative bacteria. J. Colloids Interface Sci. 275, 177–182. 17. Nelson Durán (2005)
Mechanistic aspects of biosynthesis of silver nanoparticles by

several Fusarium oxysporumtrains, Journal of Nanobiotechnology 3:8, 18. Balprasad Ankamwar, Biosynthesis of Gold Nanoparticles (Green-Gold) Using Leaf Extract of Terminalia catappa, E- Journal of Chemistry, 7(4), 1334-1339, (2010) 3. 19. Z. L.Wang, (2000) “Transmission electron microscopy and spectroscopy of nanoparticles,” in Characterization of Nanophase Materials, Z. L. Wang, Ed., chapter 3, pp. 37– 80, Wiley-VCH, Weinheim, Germany,

20. Nasongkla N et.al (2006) Multifunctional polymeric micelles as cancer-targeted, MRI- ultrasensitive drug delivery systems, Nano Lett, 6 (11): 2427-2430

21. Bozhevolnyi SI et.al (2006) Silver Nanoparticles, Project Group N344, P3 Project, Institute of Physics and

Technology, AalborgUnivercity.

22. A.A.Haleemkhan et.al(2015) Synthesis of Nanoparticles from Plant Extracts International Journalof Modern Chemistry and Applied Science, 2(3),195-203 23. Siavash Iravani et.al (2013). Green synthesis of silver nanoparticles using Pinus eldarica bark extract. Hindawi Publishing Corporation,Biomed. Res. Int., doi: 10.1155/2013/639725.

24. Rai M, Yadav et.al (2008). Current trends in photosynthesis of metal nanoparticles Critical Reviews in Biotechnology 28: 277-284.

25. Sharma NC. Et.al (2007). Synthesis of plant-mediated gold nanoparticles and catalytic role of biomatrixembedded nanomaterials. Environmental Science and Technology 41: 5137-5142.

26. Rai M,Yadav. et.al (2009). Silver nanoparticles as a new generation of antimicrobials. Biotechnology Advances 27: 76-83.