

GREEN SYNTHESIS OF METAL NANOPARTICLES- CHARACTERIZATION AND THEIR APPLICATIONS

SUMMARY OF THE FINDINGS

The bio-nanotechnology research has important role in medicinal application during the past two decades. However, the non biological method based syntheses of nanoparticles are more toxic to environment and side effects also encouraged in medical applications. Hence, the various recent scientists have recommended that the biological method based synthesis of NPs is more suitable for the medicinal application and non toxic than chemical methods based one. Therefore, the present study were conducted with the total of thirteen different medicinal plant leaves for the green synthesis of silver, gold, copper, platinum, palladium and selenium NPs and their antimicrobial activity and pollution control in dye removal was evaluated. The association of plant phytochemistry and nanotechnology will assure a secured manner of curing diversified diseases in nearby future.

Silver nanoparticles (AgNPs) have emerged as a powerful weapon against antibiotic resistant microorganisms. The AgNPs synthesized in this work have promising properties for applications in the biomedical field. The plant based synthesis is a reproducible and sustainable method for the generation of stable antimicrobial silver nanoparticles with low cytotoxicity to human cells. The biosynthesized silver nanoparticles exhibits excellent photocatalytic activity against dye molecules and can be used in water purification systems and dye effluent treatment. The photocatalytic study showed that these biosynthesized Ag nanoparticles possess effective photocatalytic property for degrading organic dyes in the presence of sunlight. Hence, they can be used in wastewater treatment and textile effluent technologies as well. The use of natural renewable and eco-friendly reducing agent used for synthesis of copper nanoparticles exhibits excellent photocatalytic activity against dye molecules and can be used in water purification systems and dye effluent treatment.

The simple, convenient and eco-friendly method of synthesis of gold nanoparticles adopted in this study can find their applications in various fields such as biomedical, tissue engineering, health care, environmental, drug delivery, gene delivery, optics, mechanics, non-linear optical devices, food industry, space industry etc. The application of these novel AuNPs be further applied in cancer targeting, thermal ablation of tumors, imaging, delivery

of therapeutics and gene targeting. The present study demonstrated the potential of using gold nanoparticles prepared by a green method for the effective removal of methylene blue dye from industrial effluents. We have taken up a greener approach toward the synthesis of platinum nanoparticles, using plant leaf material as reducing and capping agent which has many advantages such as ease with which the process can be scaled up, economic viability, environmentally benign and renewable, there is no need to use high pressure, energy, temperature and toxic chemicals. Platinum nanoparticles synthesized have been found to be effective antibacterial agents. A fast and eco-benign procedure to synthesis palladium nanoparticle was reported in this project. Applications of these ecofriendly palladium nanoparticles in bactericidal, wound healing and other medical and electronic applications are potentially exciting for their large-scale synthesis. Advancement of biological process of nanoparticles synthesis is evolving into a key area of nanotechnology. A rapid, simple, economic and environmentally benign method for synthesis of selenium nanoparticles using leaves extract as reducing and capping agent without adding chemicals was reported in this study. The photocatalytic activity of the synthesized selenium nanoparticles was observed to have potential efficacy to degrade organic dyes under sunlight irradiation. This new green chemistry holds several valuable attractions and offers an effective and economic way to environmental bioremediation protection.

CONTRIBUTION TO THE SOCIETY

Keeping in view of the aesthetic sense, the green syntheses are rendering themselves as key procedure and proving their potential at the top. Though there are lots of medicinal plants in Kerala, studies on these plants for their medicinal uses were not conducted very often. So far a few species of these plants have been studied for the synthesis of nanoparticles. Microorganisms can also be utilized to produce nanoparticles but the rate of syntheses is slow compared to routes involving plants mediated synthesis. Although, the potential of higher plants as source for this purpose is still largely unexplored. The conventional methods of synthesizing nanoparticles using chemical method were found to be more expensive and also involve the use of toxic, hazardous chemicals that are responsible for various biological risks. Synthesis of nanoparticles using plant extracts is the most adopted method of cost effective, green, eco-friendly production of nanoparticles and also has a special advantage that the plants are widely distributed, easily available, much safer to handle and act as a source of several metabolites. From the initial studies carried out in our lab, we found that leaves can be good source for synthesis of metal nanoparticles. Use of plants in synthesis of nanoparticles is quite novel leading to truly 'green chemistry' route. We thereby enhance the importance of plant sources and implementing green chemistry for future research.

1. Identification of indigenous eco-friendly plants that can serve as reducing/capping agents for the synthesis of nanoparticles instead of toxic and expensive chemicals.
2. Metal nanoparticles can be produced at low concentration of leaf extract without using any additional harmful chemical/physical methods.
3. Development of novel ecofriendly metal nanoparticles by simple and inexpensive method of green synthesis was carried out using medicinal plants in this project.
4. The success of this research will enable us to explore new avenues of green synthesis for synthesizing novel nanoparticles like silver, gold, copper, platinum, palladium and selenium and its applications.
5. The important outcome of this project is the development of value added products from medicinal plants for biomedical, antimicrobial therapy in modern medicine and nanotechnology based industries.

6. Due to the attractive physical and chemical properties of silver at the nanoscale, the development of silver nanoparticles is expanding in recent years and is nowadays significant for consumer and medical products. Silver and platinum nanoparticles synthesized are potential antibacterial agents. Silver, Gold, copper and selenium nanoparticles can be applied for the effective removal of methylene blue dye from industrial effluents. Large scale synthesis of silver nanoparticles can be done by eco-friendly method as mentioned above and these nanoparticles have a great application in the field of pharmacological and electrical industries as well as large commercial production.

7. From the point of view of nanotechnology, this was a significant advancement to synthesize gold nanoparticles at room temperature, atmospheric pressure and in water (universal solvent), indicating a green process that presents a reliable and economic method. The synthesized novel nanoparticles can find their applications in various fields such as biomedical, tissue engineering, health care, environmental, drug delivery, gene delivery, optics, mechanics, non-linear optical devices, food industry, space industry etc.

LIST OF PUBLICATIONS

1. "Biosynthesis of gold nanoparticles: A green approach" Jaysurya T.J, Reshmi. R, Latha M.S, Proceedings of the 28th Swadeshi Science Congress at CSIR- National Institute of Interdisciplinary Science, Thrivananthapuram (November 7-9th, 2018).
2. "Eco-friendly synthesis of palladium nanoparticles: An environmentally benign approach" Sreeprabha. S, Reshmi. R, Latha M.S, Proceedings of the 28th Swadeshi Science Congress at CSIR- National Institute of Interdisciplinary Science, Thrivananthapuram (November 7-9th, 2018).
3. "Facile Green synthesis of Silver nanoparticles: Characterization and its photocatalytic activity", Reshma. P, Reshmi. R, Latha M.S, International Seminar on Material Science and Organic Synthesis, Department of Chemistry, St.Albert's College, Ernakulam (January 4-5th, 2019)- Oral Presentation.
4. "Gold nanoparticle fabrication by plant extracts: Synthesis, Characterization and its photocatalytic activity", Seema Thomas, Reshmi.R, Latha M.S, National seminar on Nanoscience & Nanotechnology", Bishop Moore College, Mavellikara. (Feb12-14th, 2019)- Poster presentation.

5. Biosynthesis, Characterization and application of silver nanoparticles”, Reshma.P, Reshmi.R, Latha M.S, National seminar on Nanoscience & Nanotechnology”, Bishop Moore College, Mavellikara. (Feb12-14th, 2019)- Oral presentation.
6. “Evaluation of Antimicrobial characteristics of Bioinspired silver nanoparticles”, P.Reshma, R.Reshmi, M.S.Latha, National Seminar on recent advances in Photochemistry (NSPC-2019), St.Michael’s College, Cherthala (February 21-22, 2019)- Oral presentation.
7. “Biogenic synthesis of gold nanoparticles and their applications as adsorbents for dye removal”, Seema Thomas, Reshmi.R, M.S.Latha, National Seminar on Recent advances in Photochemistry (NSPC-2019), St.Michael’s College, Cherthala (February 21-22, 2019)- Oral presentation.