To Develop a Novel Approach for the Green Synthesis of Silver Nanoparticles using Aqueous Leaves Extracts

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Abstract:

Silver nanoparticles synthesized by green chemistry offer a novel and potential alternative to chemically synthesized nanoparticles. G*reen nanoparticle synthesis has been achieved using environmentally acceptable plant extract and ecofriendly reducing and capping agents. Various plants are used for nanoparticle synthesis. The use of plants for synthesis of nanoparticles is rapid, low cost, ecofriendly, and a single-step method for biosynthesis process. In this paper, we will discuss the green synthesis of silver nanoparticles, UV visible spectroscopy, X-ray diffraction patterns and application of silver nanoparticles as antimicrobial agents.*

Keywords: ***Nanoparticles, green synthesis, antimicrobial activity, Silver nanoparticles***

1. INTRODUCTION

Nanoparticles represent a particle with a size of 1-100 nm. The Nano scale material has new, unique, and superior physical and chemical properties compared to its bulk structure, due to an increase in the ratio of the surface area per volume of the material or particle. The most widely studied nanoparticle materials are metal nanoparticles because they are easier to synthesize. Moreover, these materials have a wide range of applications like detectors, catalysts, surface coating agents, and antibacterial, antimicrobials among many others. Some of the most studied metallic nanoparticles include silver (Ag) gold (Au), platinum (Pt), and palladium (Pd). Ag nanoparticle is an interesting metal to be studied, especially in the field of health and medicine. Ag is a strong antibacterial and also toxic to cells. Silver has long been recognized as having inhibitory effect on microbes present in medical and industrial processes. The most important application of silver and silver nanoparticles is in medical industry such as topical ointments to prevent infection against burn and open wounds. Further Among the various known synthesis methods, plant mediated nanoparticles synthesis is preferred as it is cost-effective, environment mediated nanoparticles synthesis is pre ferred as it is cost-effective, environment friendly, and safe for human therapeutic.

2. METHODOLOGY

SYNTHESIS

The fresh leaves of Aloe-Vera, Coconut, Dhatura, Sweet Flag, Senna, Gokarna solution was prepared by taking, 10 g of thoroughly washed and finely cut leaves in a 300 mL flask, along with 100 mL of distilled water and then boiling the mixture for 5 min. The extract was filtered through Whatman's filter paper no.1. The filtrate was treated with aqueous 10 ml. $AgNO_3$ solution in conical flask. As a result, a brown-yellow solution was formed, indicating the formation of silver nanoparticles. It shows that silver ions could be reduced by aqueous extract of leaves parts to generate extremely stable silver nanoparticles in water.

Fig-Leaves extract of plants Aloe-Vera, Coconut, Dhatura, Sweet Flag, Senna, Gokarna

Fig-Synthesized colloid of silver nanoparticles

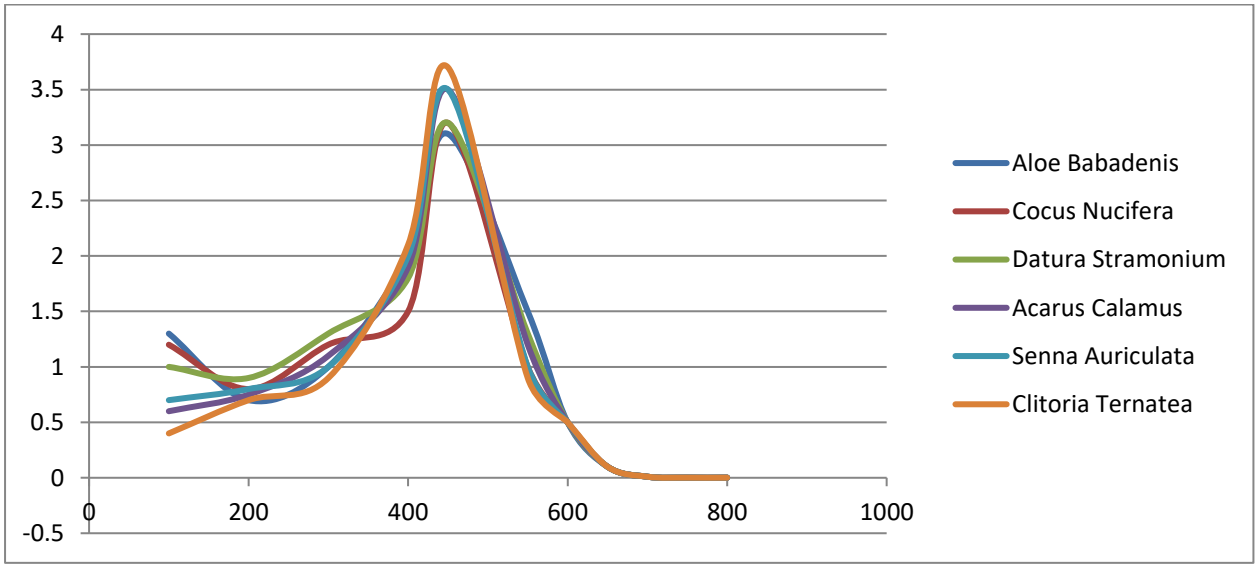
Check points in the synthesis of silver nanoparticles from leaves extract

The silver nanoparticles synthesized using leaf extract, were optimized by various parameters such as temperature, pH, and time. When temperature increases, the rate of silver nanoparticles formation is increased. The size is reduced initially due to the reduction in aggregation of the growing nanoparticles. The acidic condition overturns the formation of silver nanoparticles but the basic condition boosts the formation of silver nanoparticles. Large nanoparticles were formed at lower pH (pH 4), whereas small and highly dispersed nanoparticles were formed at high pH (pH 9). At neutral pH, the normal size of the nanoparticles is formed. The duration of reaction increases and more silver nanoparticles are formed. Due to the instability of the silver nanoparticles formed, an optimum duration is required as silver nanoparticles agglomeration after the optimum duration resulting in larger particle sizes. The optimum time required for the completion of reaction from our study was 50 min.

3. CHARACTERIZATION

Ultraviolet-visible (UV-Vis) spectrophotometry

Characterizations were determined by using ultraviolet-visible (UV-Vis) spectrophotometry. The production of the Silver Nanoparticles synthesized using leaf extract of Aloe Vera was evaluated through a UV-Vis spectrophotometer in a wavelength range of 200 to 700 nm. This revealed a peak at 440 nm in N. oleander leaf extracts, indicating the production of Silver Nanoparticles. The wavelength of the silver nano-particles varies in this range depending on their shape and size. Nanoparticles have unique optical properties that are sensitive to the size, shape, concentration, agglomeration state, and refractive index near the nanoparticle surface, which makes UV-Vis a valuable tool for identifying, characterizing, and studying nanomaterials. Silver nanoparticles absorb and scatter light with extraordinary efficiency. Their strong interaction with light occurs because the conduction electrons on the metal surface undergo a collective oscillation when they are excited by light at specific wavelengths. Synthesized silver nanoparticles are yellow in colour as yellow silver nanoparticles seem to be the most stable.



X-ray diffraction (XRD) analysis

X-ray diffraction (XRD) patterns for samples of nanoparticles having different sizes and shapes can look different, and careful analysis of the XRD data can provide useful information and also help correlate microscopic observations with the bulk sample. It is a powerful method for the study of nanomaterials. The wavelength of X-rays is on the atomic scale, so it is a primary tool for probing structure of nano-materials. The particle size and nature of the silver nanoparticle were determined using XRD. This was carried out using Shimadzu XRD-6000/6100 model with 30 kv, 30 mA with Cu kα radians at 2θ angle. X-ray powder diffraction is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions. The analyzed material is finely ground, and average bulk composition is determined. X Ray Diffraction study reveals the existence of silver nanoparticles in the sample. The Braggs reflections were observed in the XRD pattern at 2θ= 31.4, 45.4 and 27.0. These Braggs reflections clearly shows the presence of (111), (200) and (311) sets of lattice planes and further on the basis that they can be indexed as face-centered-cubic (FCC) structure of silver. Hence XRD pattern thus clearly illustrated that the silver nanoparticles formed in this present synthesis are crystalline in nature.

4. BIOLOGICAL EVALUATION OF SILVER NANOPARTICLE

Silver nanoparticles possess excellent anticancer as well as antimicrobial efficacy, hence found major and wide applications as antimicrobial, wound healing, antidiarrheal, and antifungal agents. The nanoparticles displayed dose-dependent antibacterial properties against *Porphyromonas gingivalis* and *Fusobacterium nucleatum*, without showing noticeable cytotoxicity. The membranes with silver nanoparticles evoked a similar inflammatory response compared with the membranes without silver nanoparticles.

5. RESULTS

Ultraviolet (UV) visible spectrophotometer analysis shows peaks in range between 440 to 450 nm for all leaf extract indicating the production of Silver Nanoparticles. X-ray diffraction analysis showed that the particles were crystalline in nature with face centered cubic structure of the bulk silver with the broad peaks at 31.4, 45.4 and 27.0. Silver nanoparticle shows remarkable antimicrobial activity, antiviral activity, and antifungal activity.

6. CONCLUSIONS

It can be concluded that the leaves of Aloe-Vera, Coconut, Dhatura, Sweet Flag, Senna, and Gokarna can be good source for synthesis of silver nanoparticle which shows various biological activities. The important outcome of the study will be the development of value-added products from medicinal plants.

7. BIBLIOGRAPHY

1. Narayanaswamy Krithiga,[1]Athimoolam Rajalakshmi,[1]and **Ayyavoo Jayachitra,** , Journal of nanoscience, volume 2015
2. Anupam Roy, Onur Bulut, Sudip Some, Amit Kumar Mandal and M. Deniz Yilmaz, Green synthesis of silver nanoparticles: biomolecule-nanoparticle organizations targeting antimicrobial activity,2019
3. S. Azizi , M. B. Ahmad , F. Namvar and R. Mohamad , *Mater. Lett.*, 2014, **116** , 275 —277
4. M. Zhou , M. Lin , L. Chen , Y. Wang , X. Guo , L. Peng , X. Guo and W. Ding , *Chem. Commun.*, 2015, **51** , 5116 —5119
5. M. Baghayeri , B. Mahdavi , Z. Hosseinpor-Mohsen Abadi and S. Farhadi , *Appl. Organomet. Chem.*, 2018, **32** , e4057
6. L. Wang , C. Hu and L. Shao , *Int. J. Nanomed.*, 2017, **12** , 1227 —1249
7. Y. He , F. Wei , Z. Ma , H. Zhang , Q. Yang , B. Yao , Z. Huang , J. Li , C. Zeng and Q. Zhang , *RSC Adv.*, 2017, **7** , 39842 —39851
8. Y. He , X. Li , Y. Zheng , Z. Wang , Z. Ma , Q. Yang , B. Yao , Y. Zhao and H. Zhang , *New J. Chem.*, 2018, **42** , 2882 —2888
9. M. N. Gallucci , J. C. Fraire , A. P. V. Ferreyra Maillard , P. L. Páez , I. M. Aiassa Martínez , E. V. Pannunzio Miner , E. A. Coronado and P. R. Dalmasso , *Mater. Lett.*, 2017, **197** , 98 —101
10. S. Hamedi , S. A. Shojaosadati and A. Mohammadi , *J. Photochem. Photobiol., B*, 2017, **167** , 36 —44
11. M. A. Asghar , E. Zahir , S. M. Shahid , M. N. Khan , M. A. Asghar , J. Iqbal and G. Walker , *Lebensm.-Wiss. -Technol.*, 2018, **90** , 98 —107
12. B. Ajitha , Y. A. K. Reddy , H.-J. Jeon and C. W. Ahn , *Adv. Powder Technol.*, 2018, **29** , 86 —93
13. A. R. Allafchian , S. Z. Mirahmadi-Zare , S. A. H. Jalali , S. S. Hashemi and M. R. Vahabi , *J. Nanostruct. Chem.*, 2016, **6** , 129 —135
14. A. Ravichandran , P. Subramanian , V. Manoharan , T. Muthu , R. Periyannan , M. Thangapandi , K. Ponnuchamy , B. Pandi and P. N. Marimuthu , *J. Photochem. Photobiol., B*, 2018, **185** , 117 —125
15. K. Anandalakshmi , J. Venugobal and V. Ramasamy , *Appl. Nanosci.*, 2016, **6** , 399 —408