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BIOSYNTHESIS AND STRUCTURAL CHARACTERIZATION OF ZNO NANOPARTICLES USING PLANT EXTRACT OF *CHAMAECOSTUS CUSPIDATUS*

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ABSTRACT

The biosynthesis of Zinc Oxide [ZnO] nanoparticles using green processes is an important growth in the field of nanoscience because of its extensive applications in diverse fields such as biomedical, cosmetic industries, biotechnology, sensors, catalysis, optical devices, and drug delivery and also in the fabrication of new generation nanodevices. Typically ZnO nanoparticles are synthesized by physical, chemical and biological means. But here Chamaecostus Cuspidatus fresh plant extract was used in the synthesis of nanoparticles because plants are habitually indulgence due to its cost effectiveness, easy to scale up, easy availability and environmentally friendly nature. Furthermore, plants also contain numerous phytochemicals and compounds which may act both as biological reducing and stabilizing agent and the ZnO nanoparticles thus produced are more stable. The synthesized nanoparticles were characterized using standard characterization techniques such as X-ray diffraction (XRD) and Scanning Electron Microscopic (SEM) studies. XRD and SEM analysis spectacle that the synthesized ZnO nanoparticles are of primitive hexagonal structure and the size is found to be around 20 nm. Both these results indicated that the plant extract acted as the reducing and capping agents on the surface of ZnO nanoparticles.

KEYWORDS: *Zinc oxide, Plant extract, Chamaecostus Cuspidatus and Nanoparticles*

1. INTRODUCTION

In recent years nanoparticles are being synthesized worldwide owing to its applications in diverse fields such as nanodiagnostics, nanomedicine, nanosensors, transducers, microelectronics, laser devices and biomedical science because it is bio-safe [1]. Among them Zinc Oxide (ZnO) nanoparticles have peculiar properties such as semiconducting, piezoelectric and pyroelectric properties and these unique structures have shown that Zinc Oxide (ZnO) is the promising candidate among all nanostructures in both structure and properties [2]. Zinc Oxide is an n-type semiconductor with a wide band gap of 3.37eV and binding energy of 60 meV at room temperature. Generally, ZnO nanoparticles are synthesized from predictable methods like chemical reduction, laser ablation, solvothermal, inert gas condensation and sol-gel method. But these methods require highly toxic chemicals, difficult fabrication and expensive [3, 4]. Nowadays, green synthesis of nanoparticles was achieved because they are less toxic, easy synthesis and environmentally friendly nature. The biological synthesis of ZnO nanoparticles from plants such as *Moringa oleifera*, *Melia Dubia* and *Ulva Lactuca Seeweed* has already been reported [5-7]. In addition to that Zinc Oxide nanoparticle using *Costus Pictus D. Don* plant extract with Zinc nitrate [$Zn(NO_3)_2 \cdot 6H_2O$] as precursor have already been synthesized [8] but here we used *Chamaecostus Cuspidatus* with Zinc acetate as the precursor. Normally, Zinc Oxide is an inorganic compound with the general formula ZnO and is insoluble in water. The element present in ZnO is Zinc and Oxygen which belongs to 2^{nd} and 6^{th} groups of periodic table and it is also called as II-VI semiconductor. Various metal oxide nanoparticles such as Fe_3O_4, TiO_2, CuO and ZnO have been investigated for various biological activities. Among the enormous group of metal oxide nanoparticle, ZnO nanoparticle have been used in various biological applications such as biological sensing, biological labeling, gene delivery, drug delivery and nanomedicine along with its antibacterial, antifungal, acaricidal, pediculocidal, larvicidal and anti-diabetic activities [9, 10].

The plant *Chamaecostus Cuspidatus* belonging to the *Costaceae* family and its common name is fiery costus or spiral flag. It is an herbaceous plant native to eastern Brazil. In India, it is called as insulin plant because it has anti-diabetic properties in Ayurvedic medicine. To the best of our knowledge biosynthesis of ZnO nanoparticles using plant extract of *Chamaecostus Cuspidatus* and Zinc acetate has been used for the first time in research and the extract was used as the reducing and stabilizing agent for the synthesis of ZnO nanoparticles. In order to study the structural, phase and morphology, the synthesized nanoparticles were investigated by standard characterization techniques such as X-ray diffraction (XRD) and Scanning Electron Microscopic (SEM) studies.

2. MATERIALS AND METHODS

2.1 Materials Required

Zinc acetate [Zn $(O_2CCH_3)_2(H_2O)_2$], Sodium hydroxide [NaOH] pellet and glasswares were purchased from Merck and used as received and *Chamaecostus Cuspidatus* plants were collected from SDNB Vaishnav College Campus. The plant and all the glasswares were washed with double distilled water before use.

2.2 Preparation of *Chamaecostus Cuspidatus* Plant Extract

10 g of fresh plant of *Chamaecostus Cuspidatus* were washed numerous times with running tap water to remove dust particles followed by distilled water and then cut into small pieces. The cutted fresh plants were soaked in 250 ml Erlenmeyer flask containing 100 ml distilled water. The solution was boiled at 60°C for 10 minutes and after that the plant extract was allowed to cool to room temperature and it is filtered through Whatman Number-1 filter paper and the residue was dried in oven and stored in air tight containers for further characterization studies.

2.3 Synthesis of Zinc Oxide Nanoparticles

1 mM Zinc acetate [Zn $(O_2CCH_3)_2$ (H_2O) $_2$] was dissolved in 50 ml of distilled water and kept in stirrer for 1 hr respectively. Then 1mM of Sodium hydroxide [NaOH] Pellets was dissolved in 20 ml of distilled water and kept in stirrer for 1 hr respectively. These both are added together and kept in stirrer. Now required quantity of *Chamaecostus Cuspidatus* plant extract was slowly added to the same and the color of the reaction mixture was changed after 1 hr. The resultant solution was left in stirrer for 3 h and light pale yellow color appeared and this confirmed the presence of ZnO nanoparticles. The precipitate was centrifuged at 10000 rpm at 50 °C for 20 min and powdered sample was collected. This powdered sample was dried using a hot air oven operating at 70 °C for 2 h and grinded using ceramic mortar and pestle to get finer nature of specimen and preserved in air-tight bottles for further characterization studies [9].

2.4 X-ray diffraction (XRD) studies

Structural studies of dried ZnO nanoparticles were performed using Siefert Model SF60 X-ray diffraction system with monochromatic CuKα radiation at the wavelength of 1.5406 Å. XRD was performed with glancing angle 2θ in the range of 10-70° with a step size of 0.02°/min and at the operating voltage and current of 40kV and 30mA

2.5 Scanning electron microscopic (SEM) studies

The surface morphology of the Zinc Oxide (ZnO) nanoparticle was observed using a SEM, Hitachi-S 3400 Model (Japan) with an accelerating voltage of 15 kV and the depiction was obtained by fracturing the sample in liquid nitrogen. The specimen was then dried under vacuum and to minimize electrostatic charging it is coated with gold particles up to 30 seconds by using sample holder attached to the instrument [11].

3. RESULTS AND DISCUSSION

3.1 XRD results

X-ray diffraction pattern obtained for Zinc Oxide (ZnO) nanoparticles using green synthesis is depicted in Fig. 1. The diffraction peaks observed at 2θ = 31.8, 34.4, 36.3, 47.7, 56.8, 63.1 and 68° corresponds to lattice planes [100], [002], [101], [102], [110], [103] and [112] respectively [12] and the different structural parameters calculated are shown in Table 1. The crystallite size L of the ZnO nanoparticles has been calculated using Debye-Scherrer formula.

$$L \approx \frac{k\lambda}{\beta Cos\theta} \qquad (1)$$

where k is the Scherrer shape factor (k = 0.94), λ is the wavelength of light used which is 1.5406 Å, β is the full width at half maximum intensity of the diffraction peak which is calculated by deconvoluting the X-ray diffraction peak using Origin Pro 8 peak separation software as shown in Fig. 2 and θ is the Bragg diffraction angle [13]. The inter-chain separation R was calculated using the formula [14]

$$R \approx \frac{5\lambda}{8Sin\theta} \qquad (2)$$

From the XRD results it is clear that the synthesized Zinc Oxide (ZnO) nanoparticles using *Chamaecostus Cuspidatus* extract exhibits primitive hexagonal shaped face centered cubic (fcc) lattice with Wurtzite structure which is correlated with JCPDS data. The particle size was calculated for each prominent peak and the synthesized Zinc Oxide (ZnO) nanoparticles shows peak around 20 nm as evidenced from Table 1.

3.2 SEM results

The surface morphology of Zinc Oxide (ZnO) nanoparticles is shown in Fig. 3 and the micrograph shows hexagonal shaped particle exhibiting numerous rumple indicating that the synthesized Zinc Oxide (ZnO) nanoparticles are crystalline in nature [15] which is correlated with the XRD results. The SEM image depicts the formation of individual Zinc Oxide (ZnO) nanoparticles as well as aggregates uniformly distributed over entire surface.

4. CONCLUSIONS

Green synthesis of nanoparticles using plant extract is an eco-friendly in the field of nanotechnology as it does not involve any harmful chemicals. The phytochemicals present in the plant extract acts as stabilizing agent for the synthesis of nanoparticles. Furthermore, the XRD and SEM analysis showed the crystalline nature of Zinc Oxide (ZnO) nanoparticle and the average particle size was found to be around 20 nm. In recent research the plant based nanostructures have novel applications in many fields such as cosmetics, optoelectronics, sensors, transducers, and biomedical science because it is bio-safe and biocompatible making them a superlative candidate for biological applications.

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FIGURES & TABLE

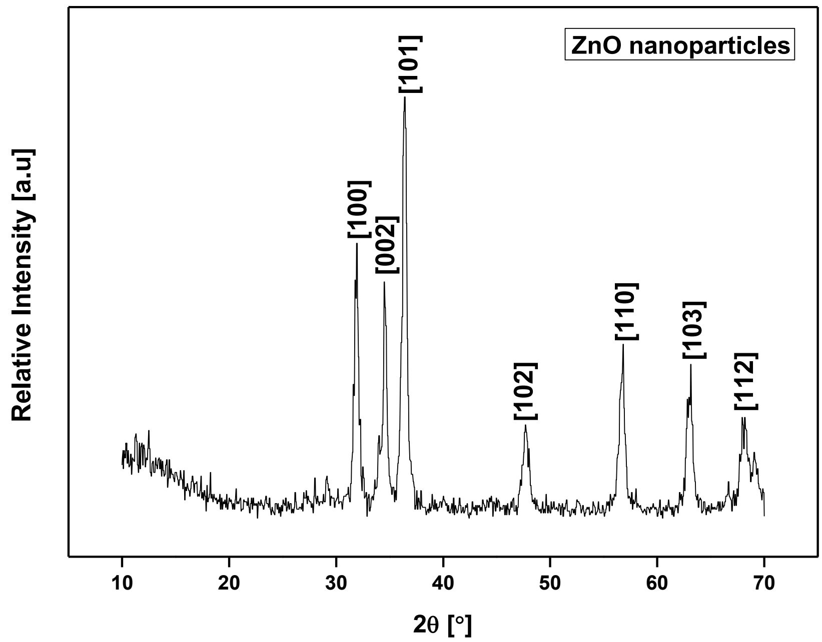

Fig. 1 X-ray diffraction pattern obtained for Zinc Oxide (ZnO) nanoparticles

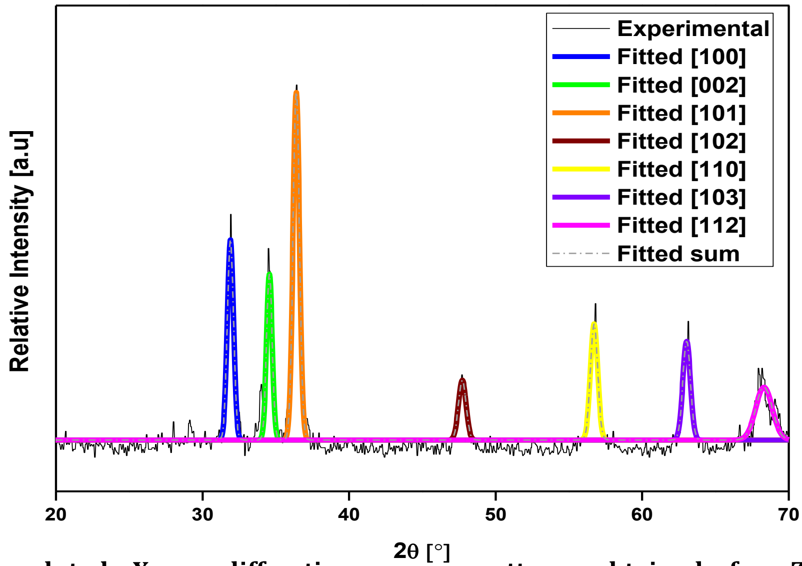

Fig. 2 Deconvoluted X-ray diffraction pattern obtained for ZnO nanoparticles showing Gaussian fittings of [100], [002], [101], [102], [110], [103] and [112] planes

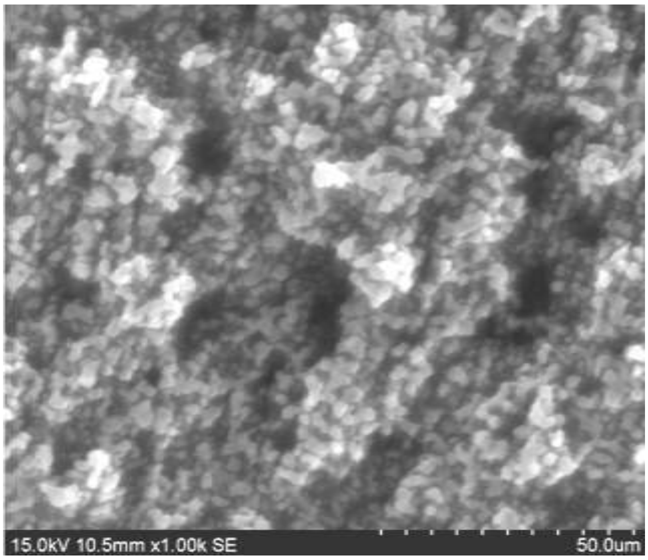

Fig. 3 SEM image of Zinc Oxide (ZnO) nanoparticles

Table 1: Structural parameters obtained for Zinc Oxide (ZnO) nanoparticles

Peak position 2θ [°]	hkl planes	Interplanar spacing d [Å]	$Sin^2\theta$	Full width Half maximum β [radians]	Crystallite size L [nm]	Interchain separation R [Å]
31.8	100	2.81	0.0749	7.46×10^{-3}	20.2	3.51
34.4	002	2.6	0.0876	7.26×10^{-3}	20.8	3.26
36.3	101	2.47	0.0968	7.52×10^{-3}	20.3	3.09
47.7	102	1.91	0.1625	7.69×10^{-3}	20.6	2.38
56.8	110	1.62	0.2248	8.19×10^{-3}	20.1	2.02
63.1	103	1.48	0.2720	8.28×10^{-3}	20.5	1.84
68	112	1.38	0.3124	8.44×10^{-3}	20.7	1.72

REFERENCES

1. *Jamdagni, P., Khatri, P., & Rana, J. S. (2018). Green synthesis of zinc oxide nanoparticles using flower extract of Nyctanthes arbor-tristis and their antifungal activity. J. King Saud University – Science, 30(2), 168-175.*
2. *Wang, Z. L. (2004). Nanostructures of Zinc Oxide. Materials Today, 26-33.*
3. *Raut, S., Thorat, P. V., & Thakre, R. (2015). Green Synthesis of Zinc Oxide (ZnO) Nanoparticles Using Ocimum Tenuiflorum Leaves. International Journal of Science and Research, 4(5), 1225-1228.*
4. *Deng, R., Yao, B., Li, Y. F., Yang, T., Li, B. H., Zhang Z. Z., Shan, C. X., Zhang, J. Y., & Shen, D. Z. (2010). Influence of oxygen/argon ratio on structural, electrical and optical properties of Ag-doped ZnO thin films. Journal of Crystal Growth, 312, 1813–1816.*
5. *Elumalai, K., Velmurugan, S., Ravi, S., Kathiravan, V., & Ashok Kumar, S. (2015). Spectrochimica Acta A Molecular Biomolecular Spectroscopy, 143(1), 58-64.*
6. *Prabhu, S., Vaideki, K., Anitha, S., & Rajendran, R. (2017). Synthesis of ZnO nanoparticles using Melia Dubia leaf extract. IET Nanobiotechnology, 11(1), 62-65.*
7. *Ishwarya, R., Vaseeharan, B., Kalyani, S., Banumathi, B., Govindarajan, M., Alharbi, N. S., Kadaikunnan, S., Al-Anbr, M. N., Khaled, J. M., & Benelli, G. (2018). Facile green synthesis of ZnO nanoparticles using Ulva Lactuca Seaweed extract and evaluation of their photocatalytic antibiofilm and insecticidal activity. Journal of Photochemistry and Photobiology B, 178, 249-258.*
8. *Suresh, J., Pradheesh, G., Alexramani, V., Sundrarajan, M., & Hong, S. I. (2018). Green synthesis and characterization of zinc oxide nanoparticle using insulin plant (Costus pictus D. Don) and investigation of its antimicrobial as well as anticancer activities. Advances in Natural Sciences: Nanoscience and Nanotechnology, 9, 015008.*
9. *Santhoshkumar, J., Venkat Kumar, S., & Rajeshkumar, S. (2017). Synthesis of zinc oxide nanoparticles using plant leaf extract against urinary tract infection pathogen. Resource-Efficient Technologies, 1–7.*
10. *Bala, N., Saha, S., Chakraborty, M., Maiti, M., Das, S., Basu, R., Nandy, P. (2015). Green synthesis of zinc oxide nanoparticles using Hibiscus subdariffa leaf extract: effect of temperature on synthesis, anti-bacterial activity and anti-diabetic activity. RSC Advances, 5, 4993-5003.*
11. *Amudha, S., & Austin Suthanthiraraj, S. (2015). Silver ion conducting characteristics of a polyethylene oxide-based composite polymer electrolyte and application in solid state batteries. Advanced Material Letters, 6(7), 585-591.*
12. *JCPDS File No: 890511.*
13. *Sownthari, K., & Suthanthiraraj, S. A. (2013). Synthesis and characterization of an electrolyte system based on a biodegradable polymer. eXPRESS Polymer Letters, 7(6), 495–504.*
14. *Vidya, C., Shilpa Hiremath., Chandraprabha, M. N., Lourdu Antonyraj, M. A., Indu Venu Gopal., Aayushi Jain., & Bansal., K. (2013). Green synthesis of ZnO nanoparticles by Calotropis Gigantea. International Journal of Current Engineering and Technology, 118-120.*
15. *Geetha, M. S., Nagabhushana, H., & Shivananjaiah, H. N. (2016).Green mediated synthesis and characterization of ZnO nanoparticles using Euphorbia Jatropa latex as reducing agent. Journal of Science: Advanced Materials and Devices, 1, 301-310.*