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Biosynthesis of Zinc Oxide Nanoparticles Using *Pongamia pinnata* Plant Leaves Extract

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ABSTRACT

We reported a simple, green and eco-friendly approach for the synthesis of zinc oxide nanoparticles using aqueous extract of *Pongamia pinnata* plant leaves acts as reducing agent as well as capping agent. Biosynthesized zinc oxide nanoparticles were characterized by FTIR, X-ray diffraction and field emission scanning electron microscopy. The results suggested that the zinc oxide nanoparticles synthesized by aqueous extract of *Pongamia pinnata* plant leaves with high purity, mostly spherical in shape with an average size of 23.5 nm.

KEYWORDS

Biosynthesis, Nanoparticle, *Pongamia pinnata*, Zinc acetate, Zinc oxide.

INTRODUCTION

In recent years, nanotechnology is a meadow of passionate attentiveness. The development of nanotechnology has been categorized into three procedures: computational, wet and dry. Computational process study the structure of nanosize and dry process gives information about the components present in the cells, tissues and membranes of living organisms. Moreover, the dry process compacts with the synthesis of inorganic materials with the help of physical chemistry techniques [1]. Nanoparticles are being synthesized universally due to different exciting and unique properties, which facilitate their use in completely unrelated fields, such as, nanodiagnostics, nanomediciens, antimicrobials, luminescence, photocatalytic potential, photodiode reaction [2]. In literature different types of nanoparticles are reported like metal nanoparticles, metal oxide nanoparticles and polymer nanoparticles. Among them metal oxide nanoparticles attracts researchers due to their diverse properties and functionalities in medicine, biology, sporting, equipment, cosmetics, electronics, magnetic storage media, solar energy transformation and other industries [3,4]. Among the metal oxide nanoparticles, zinc oxide is utmost favourite due to its numerous applications in optics, magnetism, gas sensor, chemical sensor, bio-sensor, showing high catalytic efficiency, strong adsorption ability, wastewater treatment, cosmetics, solar cells, drug delivery, antimicrobial activities as well as fungicide and antibacterial agents [5-13].

There are several methods reported for the synthesis of zinc oxide nanoparticles which include chemical vapour deposition, gas-phase method, spray pyrolysis, hydrothermal

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synthesis, micro emulsion, electrochemical method, pulsed laser deposition, microwave synthesis and sol-gel method [14]. Some of these reported methods required costly equipment, high temperature, pressure, large space area for setting up of machines and the chemical method involves the use of toxic chemicals which can prove to be hazardous for the environment and the person handling it [15]. The nanoparticles prepared by diverse chemical and physical procedures which may prove harmful in the field of their application in the medical field [16]. However, those methods always include use of toxic reagents and costly instruments along the tedious process control. Hence, there is great demand for developing a simple and green method for synthesizing zinc oxide nanoparticles [17]. In last decade, biosynthesis of nanoparticle was paying attention due to easy to operation, inexpensive and nontoxicity. Also, literature data shows that the metal nanoparticles produced by plants are more stable in comparison with those produced by other methods. Biosynthesis of zinc oxide using plants including *Berberis vulgaris* [18], *Halomons elongate* [19], *Parsley* [20], *Calotropis gigantean* [21], *Solanum nigrum* [22], *Mangifera indica* [23], *Alstonia macrophylla* [24], *Azadirachita indica* [25], *Sageretia thea* [26], *Ocimum basilicum* L. VAR. *Purpurascens* Benth [27], *L. aculeata* [28], *Aloe vera* and *Hisbiscus sabdariffa* [29] has been reported in the literature. Here, we report the biosynthesis of zinc oxide nanoparticle using *Pongamia pinnata* plant leaves extract.

EXPERIMENTAL

Zinc acetate and all analytical grade chemicals were purchased from Loba chemicals. Freshly prepared triple distilled water was used throughout the experiment.

Preparation of leave extract by boiling method: *Pongamia pinnata* plant leaves were selected from Rajgurunagar India. Fresh and healthy leaves were collected locally and rinsed thoroughly first with tap water followed by distilled water to remove all the dust and unwanted visible particles and dried at room temperature. Dried leaves cut into small pieces. About 10 g of these finely incised leaves were weighed and transferred into 250 mL beakers containing 100 mL distilled water and boiled for about 20 min and the extracts were then filtered through Whatman No. 42 to remove particulate matter to get clear solution which were then refrigerated (4 °C) in 250 mL Erlenmeyer flasks for further experiments.

Synthesis zinc oxide nanoparticles: In the typical procedure, 20 mL of the *Pongamia pinnata* leaf extract was added slowly into the 0.2 M of zinc acetate solution with constant stirring at 60 °C with normal atmosphere pressure for 4 h. After adding *Pongamia pinnata* leaf extract into zinc acetate solution within 2 min a visible colour changes were observed, the white colour aqueous solution of zinc acetate turned to yellow. The pale white solid product was collected by centrifugation at 8000 rpm for 20 min and washed with water and ethanol. The powdered zinc oxide nanoparticle was dried in oven at 70 °C and used for further study.

RESULTS AND DISCUSSION

We collected the *Pongamia pinnata* leaves from Rajgurunagar and these leaves dried and cut into small parts and washed with tap water to remove dust particles. These leaves boiled in distilled water to dissolve organic compounds. After few minutes boiling the water solution acquires brown colour, which indicates that organic compounds are dissolved in water and stored in refrigerator. Next we prepared 0.2 M of zinc acetate solution by dissolving 2.34 g of zinc acetate in 35 mL water and in this solution 20 mL of *Pongamia pinnata* leave extract added and we observed that change in colour of zinc acetate solution. The synthesized zinc oxide nanoparticles are characterized by XRD, FTIR and FESEM. The colour of the solution changes from white to yellow. The size of the zinc oxide nanoparticles calculated from XRD.

FTIR spectra: The FTIR spectrum of *Pongamia pinnata* plant leave extract shows the characteristics peak at 3328 cm^{-1} for amino groups of alkaloids and amino acids (Fig. 1). This peak is disappeared in FTIR spectra of zinc oxide nanoparticles and confirms the zinc form bonds with plant extract. The peaks at 1623 cm^{-1} indicates the presence of carbon-carbon double bond. The spectra of zinc oxide nanoparticles shows stretching vibrations at 1363 cm^{-1} for C-O-C and OH absorptions bands at 3365 and 3410 cm^{-1} (Fig. 2) respectively. The zinc oxide nanoparticles also show the characteristics peaks at 584 and 550 cm^{-1}.

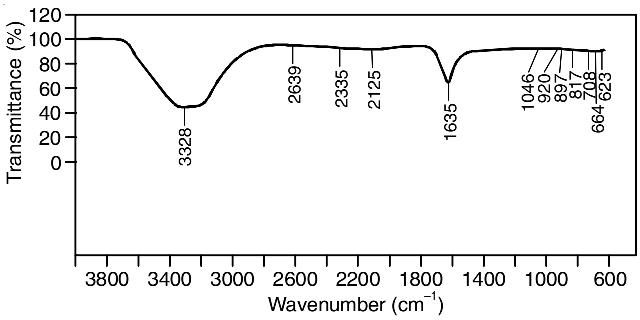

Fig. 1. FTIR spectra of *Pongamia pinnata* plant leaves extract

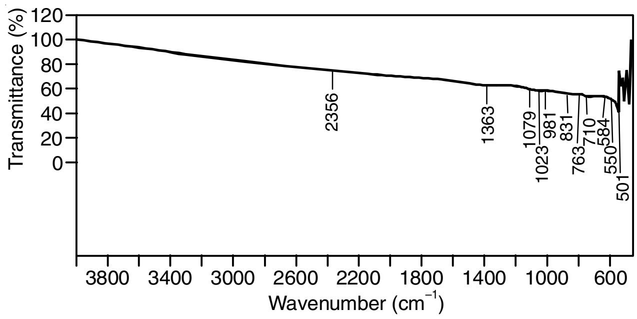

Fig. 2. FTIR spectra of zinc oxide nanoparticles

XRD spectra: The sample of zinc oxide nanoparticles was characterized by X-ray diffraction analysis of dry powders. The diffraction intensities were recorded from 10° to 80° at 2θ angles. The results for zinc oxide revealed seven diffraction peaks [31.8 (100), 34.4 (002), 36.29 (101), 47.57 (102), 56.61 (110), 67.96 (112) and 69.07 (201)] are indexed as face centred cubic (Fig. 3). The mean size of nanoparticles is calculated using Debye-Scherrer's equation. The size of zinc oxide nanoparticles found by calculation is 23.5 nm.

FESEM analysis: Field emission scanning electron microscope is used to examine the surface morphology of the nanoparticles. The FESEM images shown the rod like morpho-

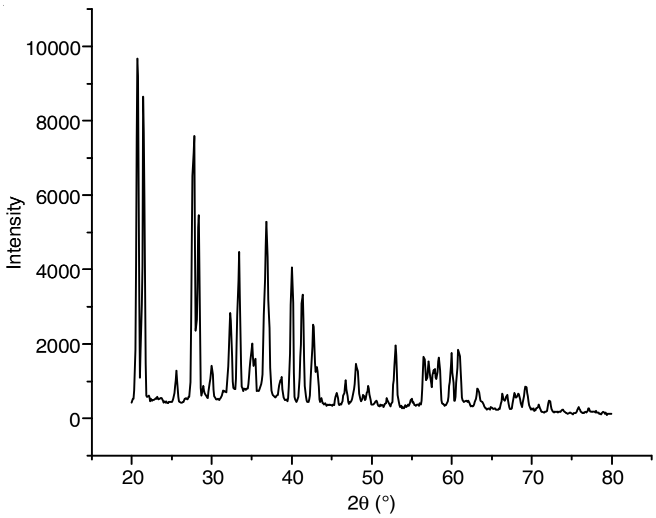

Fig. 3. XRD spectra of zinc oxide nanoparticles

logy and the shape of zinc oxide nanoparticles are hexagonal. FESEM analysis also indicates uniformly distributed zinc oxide nanoparticles indicating the stabilization of nanoparticles by capping agents (Fig. 4).

Conclusion

The leave extract of *Pongamia pinnata* plant may be capable of producing zinc oxide nanoparticles. The colour changes were also remarkable when zinc acetate was mixed with the reducing agent of plant extract. The biosynthesized zinc oxide was characterized by FTIR spectroscopy, XRD and FESEM.

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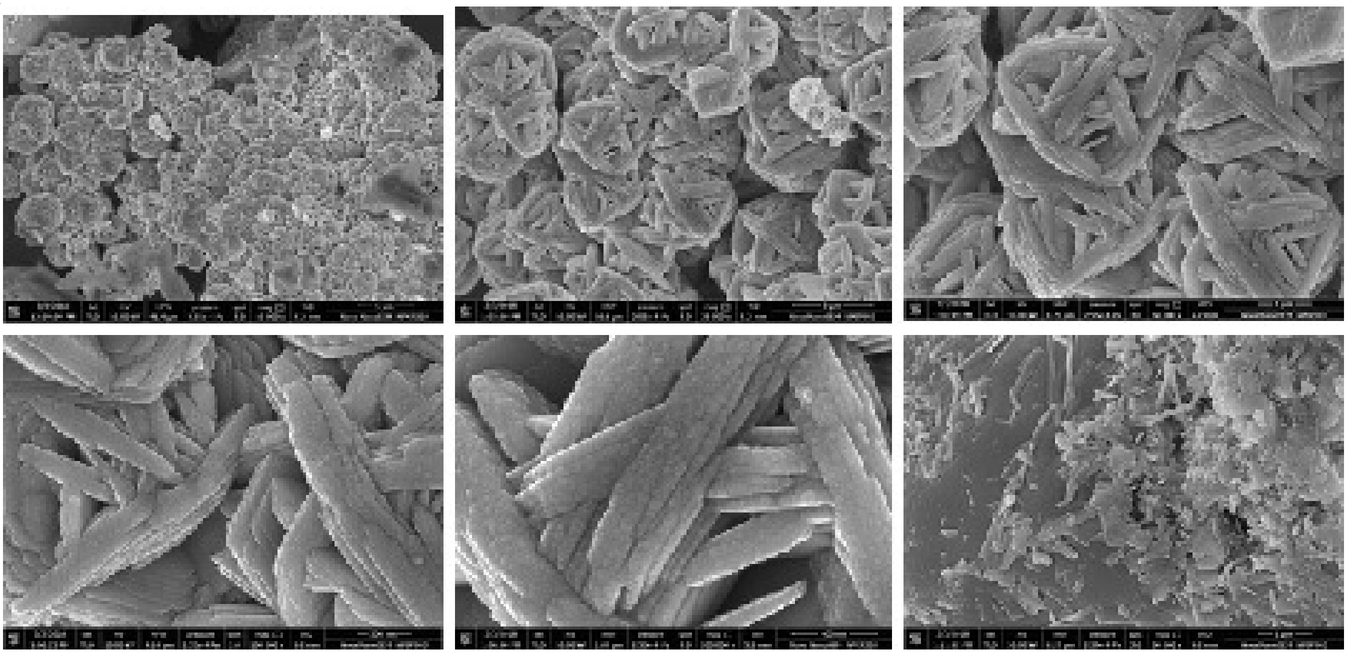

Fig. 4. FESEM images of zinc oxide nanoparticle

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