# Synthesis and Characterization *Parthenium* Mediated Zinc Oxide Nanoparticles and Assessing Its Medicinal Properties

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***Abstract***—The investigation was carried out to determine the biological activities of *Parthenium* (phyto) mediated zinc oxide nanoparticles. Highly stable, spherical zinc oxide nanoparticles were synthesized by using 50% concentration of *Parthenium* leaf extract. Formation of zinc oxide nanoparticles have been characterized by UV-Vis absorption spectroscopy, X-ray diffraction (XRD), Fourier trans- form infrared spectroscopy (FT-IR), scanning electron microscopy (SEM) with Energy dispersive X-ray analysis (EDX) and transmission electron microscopy (TEM) analysis. All the analysis reveals that zinc oxide nanoparticles were 27 ± 5 nm in size. The antibacterial activity (medicinal properties) of green synthesized zinc oxide nanoparticles was investigated under laboratory conditions. Green synthesized zinc oxide nanoparticles were inhibiting the growth of bacteria at different concentrations (25 µg/ml and 50 µg/ml). The highest zone of inhibition was observed in *Klebsiella pneumonia* and the moderate zone inhibition was observed in *Bacillus subtillis*. The results clearly reveal that the low concentration of *Parthenium* mediated zinc oxide nanoparticles act as good antibacterial agents.

***Keywords***—*Parthenium,*zinc oxide, antibacterial, Medicinal properties.

## I. Introduction

ZINC oxide nanoparticles are an important semiconductor material due to unique optical and electrical properties [1, 2]. It has application on solar cells, gas sensors, ceramics, catalysts and cosmetics [3]. Nanotechnology has vital role in advances in medicinal research, reproductive science and technology, transfer of agricultural and food wastes to energy and other useful by-products through enzymatic nanobioprocessing, disease prevention, and treatment in plants using various nanocides [4].The wide application of nanomaterials has caused toxicity to concerned mammals (including mammalian cell cultures) and aquatic species, soil invertebrates, soil microorganisms, or plants [5-7].Engineered nanoparticles could sequester nutrients on their surfaces and thus serve as a nutrient stock to the organisms, particularly those engineered nanoparticles having high specific surface area. These positive effects could be probably due to the antimicrobial properties of engineered nanoparticles, which can enhance strength and resistance of plants and animals to stress [8].Plants and/or their extracts provide a biological synthesis route of several metallic nanoparticles which are more eco-friendly and allow controlled synthesis with well-defined size and shape [8]. The enzymes [9], plant leaf extract [10] and bacteria [11] play vital role in green synthesis of zinc oxide nanoparticles. *Parthenium hysterophorus* L. belongs to family Asteraceae [12]. Itis known to badly affect crop production, biodiversity, animal husbandry, human health and even ecosystem integrity [13]. Phenolics and sesquiterpene lactones primarily cause allelopathic effects. Parthenin is the major sesquiterpene lactone [14] that causes allergy and toxicity in animals [15].In this study, we focused to find out the medicinal values of *Parthenium*mediated zinc oxide nanoparticles such as antibacterial activity against human pathogens.

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## II. Materials and Methods

### *A. Synthesis and Characterization of Parthenium mediated zinc oxide nanoparticles*

All the chemicals and culturing Medias were purchased from Sigma-Aldrich chemicals, India. Laboratory glass wares were soaked overnight in acid cleaning solution and washed thoroughly in tap and deionized water. Deionized water was used for nanoparticles synthesis.

Fresh, healthy and before flowering stage *Parthenium hysterophorus* L. plants were collected from fallow lands in and around Karpagam University, Eachanari, Coimbatore (11˚16̍N; 76˚58'E), India. Plants leaves were washed with tap water and deionized water. *Bacillus subtillis*, *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Klebsiellapneumoniae* were obtained from the Department of Microbiology, School of Life Sciences, Karpagam University, Coimbatore, India. The culture samples were maintained on Nutrient broth at 37º C for 24 h.

### *B. Synthesis and Characterization of Parthenium mediated zinc oxide nanoparticles*

Zinc oxide nanoparticles were synthesized via biological reduction of zinc nitrate by 50% plant extract of *Parthenium hysterophorus* L., as described by Sangeethaet al. [10] with small modification. Synthesized nanoparticle's purity and grain size were analysed using X-ray diffraction (Perkin-Elmer spectrum one instrument). Phyto mediated zinc oxide nanoparticle's functional groups were characterized by Fourier

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trans- form infrared spectroscopy (Perkin-Elmer 1725x). The nanoparticles average size and shape were determined by Transmission electron microscopy (TEM) (Model JSM 6390LV, JOEL, USA).

*C. Antibacterial activity of Parthenium mediated zinc oxide nanoparticles*

The antibacterial activity of Phyto mediated zinc oxide nanoparticles were determined using bacterial pathogens by a modified Kirby Bauer disc diffusion method [16]. The bacteria were cultured in Nutrient broth and incubated at 37° C for 12 h. A 100 µL of broth bacterial culture was prepared and spread on Muller Hinton agar plates. After that plates were allowed to stand for 10 min to allow for culture absorption. The 5 mm size wells were punched into the agar with help of sterile gel puncher. A 100 µL (25 µg/ml and 50µg/ml) of the zinc oxide nanoparticles and 100 µL (10 µg/ml) of Tetracycline (positive control) were poured into the wells on all plates using micropipette. After incubation at room temperature for 24 h, the size of the zone of inhibition diameter in millimeter was measured. Each screening treatment was conducted with three replicates and the results are presented as mean ± SE (standard error of the mean).

*D. Statistical analysis*

Experiments were carried out in a randomized block design with three replications and repeated twice. The data were analysed using one way analysis of variance (ANOVA) by software SPS version 16.

## III. Results and Discussion

X-ray diffraction was taken for confirmation of zinc oxide phase of the nanoparticles. The XRD pattern of zinc oxide nanoparticles is shown in Fig. 1. The XRD peaks were identified as (100), (002), (101), (102), (110), (112) and (202) reflections, respectively. The narrow and strong diffraction peaks indicate spherical and well crystalline nature of zinc oxide is comparison with the data from JCPDS card No. 89-7102. The Scherrer formula was used for calculate the particles sizes and was found to be in the range of 22–35 nm [17].

The Raman spectra of zinc oxide nanoparticles are shown in Fig. 2. The strong peak of 437 $cm^{-1}$ denotes the zinc oxide nanoparticles phase. The peak 437 $cm^{-1}$ is due to the Raman active $E_2$ optical phonon mode from the zinc oxide nanoparticles. This peak confirmed that zinc oxide nanoparticles have the crystal structure. Other peak at 580 $cm^{-1}$ characterizes the EIL mode and it attributed to zinc interstitials or oxygen vacancies. High intensity $E_2$ mode was present and conforms to pure crystalline zinc oxide nanoparticles.

Fig. 3 shows the transmission electron micrograph of the zinc oxide sample. These Figures undoubtedly indicate the morphology of the particles to be spherical. Some of the particles are agglomerates. TEM image confirms the formation of zinc oxide nanoparticles and it has an average size about 27 ± 5 nm, which is very similar to previous studies [10, 18].

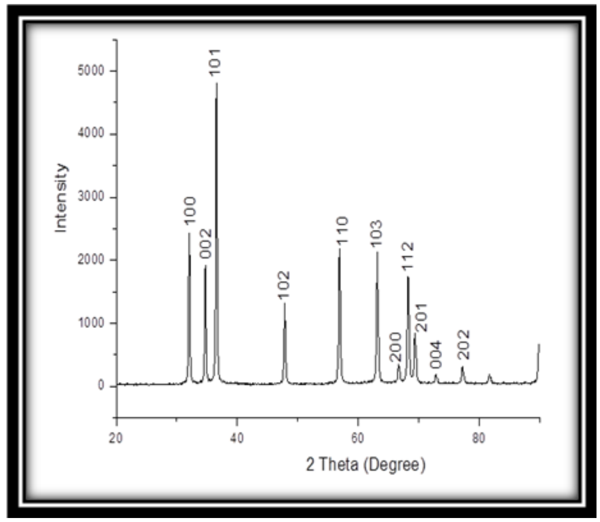


Fig. 1 X-ray diffraction patterns of *Parthenium* mediated zinc oxide nanoparticles

Fig. 4 shows the antibacterial activities of phyto mediated zinc oxide nanoparticles. Highest zone of inhibition was detected in *Klebsiella pneumonia* and the lowest zone of inhibition in *Bacillus subtillis.* The moderate antibacterial activity was found in *Staphylococcus aureus*and *Streptococcus pneumonia.* This antibacterial activity was very similar to the positive control (tetracycline). The previous studies show the growth inhibition of microorganisms by six metal oxides nanoparticles (MgO, $TiO_2$, CuO, CaO, $CeO_2$, and ZnO). Among them, zinc oxide nanoparticles show that significant growth inhibition in a size-dependent manner under normal ambient lighting conditions [18].Raghupathiet al.[19] explained that the antibacterial activity of the zinc oxide nanoparticles was inversely proportional to the size of the nanoparticles in *S. aureus.*

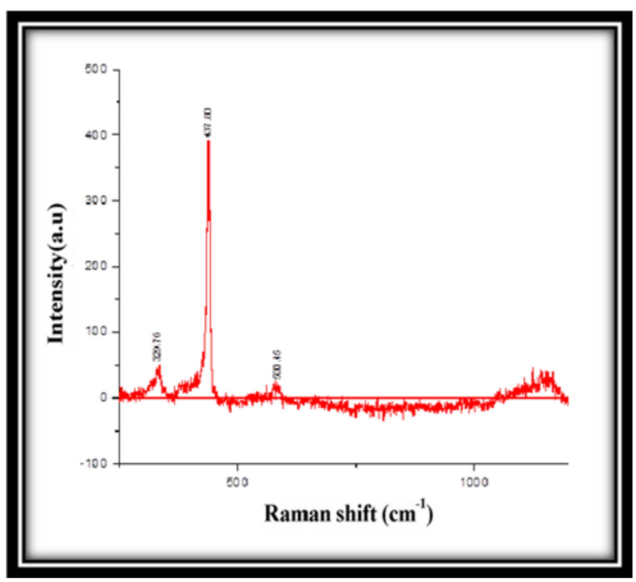


Fig. 2 Raman spectra of*Parthenium* mediated zinc oxide nanoparticles

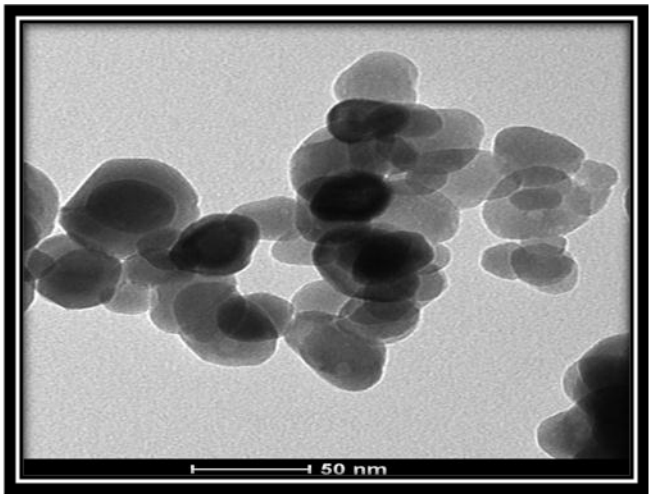


Fig. 3 TEM images of *Parthenium* mediated zinc oxide nanoparticles

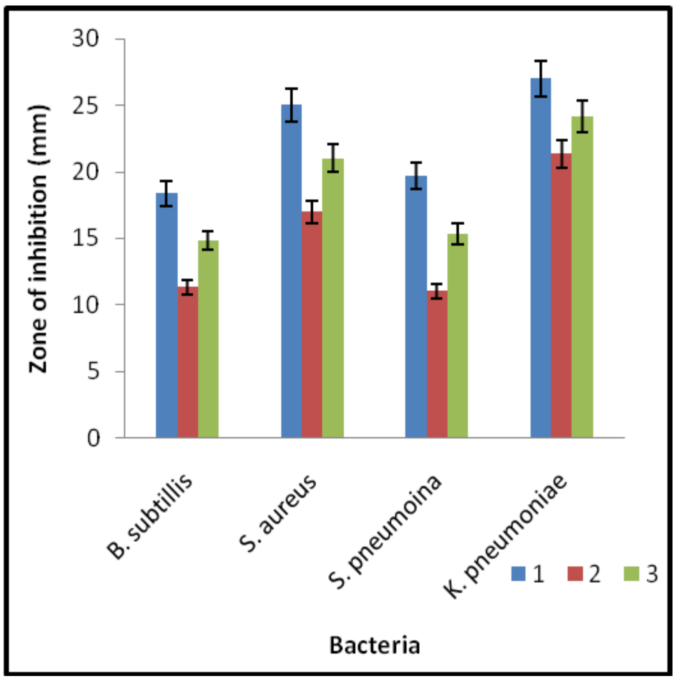


Fig. 4 Antibacterial activity of *Parthenium* mediated zinc oxide nanoparticles (1-50 µg/ml zinc oxide nanoparticles, 2-25 µg/ml zinc oxide nanoparticles, 3-10 µg/ml positive control)

## IV. Conclusion

The experiments clearly prove that *Parthenium*mediated zinc oxide nanoparticles act as good antibacterial agents.

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## References

[1] M. H. Huang, S. Mao, H. Feick, H. Y. Yan, Wu, H. Kind, E. Weber, R. Russo, P. Yang, "Room-temperature ultraviolet nanowire nanolasers." *Science,*vol 292, 2001, pp. 1897-1899. http://dx.doi.org/10.1126/science.1060367

[2] L. Vayssieres, K. Keis, A. Hagfeldt, S. E. Lindquist, "Three-dimensional array of highly oriented crystalline ZnOmicrotubes." *Chem. Mater.,*vol 13, 2001, p. 4395. http://dx.doi.org/10.1021/cm011160s

[3] R. Wahab, Y. S. Kim, D. S. Lee, J. M. Seo, H. S. Shin, "Controlled synthesis of zinc oxide nanoneedles and their transformation to microflowers." *Sci. Adv. Mater.,*vol 2, 2010, pp. 424-435 http://dx.doi.org/10.1166/sam.2010.1064

[4] I. U. Carmen, P. Chithra, Q. Huang, P. Takhistov, S. Liu, J. L. Kokini, "Nanotechnology - A New Frontier in Food Science." *FoodSci. Technol.,*vol 57, 2001, pp. 24-29.

[5] US-EPA, "US Environmental Protection Agency Nanotechnology White Paper". US Environmental Protection Agency. 2007, p 132.

[6] P. Christian, F. Von der Kammer, M. Baalousha, T. Hofmann, "Nanoparticles: Structure, properties, preparation and behaviour in environmental media." *Ecotoxicology*, vol 17, 2008, pp. 326- 343 http://dx.doi.org/10.1007/s10646-008-0213-1

[7] S. J. Klaine, P. J. J. Alvarez, G. E. Batley, T. F. Fernandes, R. D. Handy, D. Y. Lyon, S. Mahendra, M. J. McLaughlin, J. R. Lead, "Nanomaterials in the environment: Behavior, fate, bioavailability and effects." *Environ. Toxicol. Chem.,*vol 27, 2008, pp. 1825–1851 http://dx.doi.org/10.1897/08-090.1

[8] H. Bar, D. K. Bhui, G. P. Sahoo, P. Sarkar, S. Pyne, A. Misra, "Green synthesis of silver nanoparticles using seed extract of *Jatrophacurcas*."*Colloid Surf. A-Physicochem. Eng. Asp.,*vol348, 2009, pp.212-216. http://dx.doi.org/10.1016/j.colsurfa.2009.07.021

[9] K. Prasad, A. K. Jha, "ZnO nanoparticles: synthesis and adsorption study." *Natural Science,*vol 1, 2009, pp. 129-135. http://dx.doi.org/10.4236/ns.2009.12016

[10] G. Sangeetha, S. Rajeshwari, R. Venckatesh, "Green synthesis of zinc oxide nanoparticles by *aloe barbadensis miller* leaf extract: Structure and optical properties."*Mater. Res. Bull.,*vol 12, 2011, pp. 2560-2566 http://dx.doi.org/10.1016/j.materresbull.2011.07.046

[11] C. Jayaseelan, A. Abdul Rahuman, A. Vishnu Kirthi, S. Marimuthu, T. Bagavan, A. Santhoshkumar, K. Gaurav, L. Karthik, K. V. Bhaskara Rao, "Novel microbial route to synthesize ZnO nanoparticles using *Aeromonashydrophila* and their activity against pathogenic bacteria and fungi." *SpectrochimicaActa Part A.,*vol 90, 2012, pp. 78-84. http://dx.doi.org/10.1016/j.saa.2012.01.006

[12] R. S. Rao, "Parthenium: a new record for India." *J. Bombay Nat. Hist. Soc.,*vol 54, 1956, pp. 218-220.

[13] R. K. Kohli, D. R. Batish, "Exhibition of allelopathy by *Parthenium hysterophorus* L. in agroecosystems." *Tropical Ecology,*vol 35, 1994, pp. 295-307.

[14] R. G. Belz, M. V. D. Laan, C. F. Reinhardt, K. Hurle, "Soil degradation of parthenin-does it contradict the role of allelopathy in the invasive weed Parthenium hysterophorus L.?" *J. Chem. Ecol.,*vol 35, 2009, pp. 1137-1150. http://dx.doi.org/10.1007/s10886-009-9698-1

[15] H. C. Evans, "Parthenium hysterophorus: a review of its weed status and the possibilities for biological control." *Biocontrol News Information,*vol 18, 1997, pp. 89-98.

[16] W. Bauer, W. M. Kirby, J. C. Sherris, M. Turck, Antibiotic susceptibility testing by a standardized single disk method. *Am. J. Clin. Pathol.,*vol 45, 1966, pp. 493–496.

[17] H. Borchert, E. V. Shevchenko, A. Robert, I. Mekis, A. Kornowski, G. Grabel, H. Weller, "Determination of Nanocrystal Sizes: A Comparison of TEM, SAXS, and XRD Studies of Highly Monodisperse CoPt3 Particles." *Langmuir,* vol21, 2005, pp. 1931-1936. http://dx.doi.org/10.1021/la0477183

[18] N. Jones, B. Ray, R. T. Koodali, A. C. Manna, "Antibacterial activity of ZnO nanoparticle suspensions on broad spectrum of microorganisms."*FEMS Microbiol. Lett.,* 279, 2008, pp. 71-76. http://dx.doi.org/10.1111/j.1574-6968.2007.01012.x

[19] K. R. Raghupathi, R. T. Koodali, A. C.Manna, "Size-dependent bacterial growth inhibition and mechanism of antibacterial activity of zinc oxide nanoparticles." *Langmuir,* 27, 2011, pp. 4020–4028. http://dx.doi.org/10.1021/la104825u