Green Synthesis of Zinc Oxide, Nanoparticles from Plant, *Hybanthus Enneaspermus*

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Abstract: In this paper, we describe a green technique for the manufacture of Zinc oxide (ZnO) nanoparticles from aqueous extracts of Hybanthus enneaspermus (L.) F. Muell leaves, stems, and roots. Although the H. enneaspermus plant has been employed in India's traditional medicine system, it has yet to be evaluated for the production of zinc oxide nanoparticles. Zinc Nitrate hexahydrate [Zn(NO3)2.6H2O] solution was used to make the nanoparticles. The Zinc Nitrate solution was lowered after being exposed to the herbal extracts, and nanoparticles were formed. The colour change in the reaction mixture confirmed the creation of nanoparticles. UV-Vis spectrophotometeric analysis was used to analyse the produced ZnO nanoparticles. Leaf extract had an absorbance peak at 300 nm, stem extract at 290 nm, and root extract at 288 nm in the reaction mixture. Keywords: zinc oxide nanoparticles - green synthesis Hybanthus enneaspermus (Hybanthus enneaspermus)

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1. Introduction:

Nanoparticles are fascinating to scientists because they serve as a link between bulk materials and molecules. Nanoparticles were previously investigated because of their size-dependent physical and chemical features, but currently they are being explored commercially for a wide range of uses (Shearer et al., 2000). Metal nanoparticles' intrinsic qualities are determined by their size, composition, and shape (Dickson & Lyon 2000). Researchers have been drawn to these nano-sized metal oxides because of their potential to survive extreme conditions while remaining safe for humans (Fu et al., 2005).

Zinc oxide nanoparticles (ZnONPs) are versatile elements with antimicrobial (Rajendran et al., 2010), antibacterial (Zhang et al., 2010), and other biological capabilities. ZnO nanoparticles are one of the most widely utilised photocatalysts for disinfecting waste water and decomposing pesticides and herbicides (Zhao et al., 2010). Many authors have reported on the biosynthesis of ZnO nanoparticles and their use in many sectors (Bagabas et al., 2013, Malarkodi et al., 2013).

Biogenesis of Zinc oxide nanoparticles using plant parts was reported in Corriandrum sativum, Acalypa indica (Gnanasangeetha & Sarala 2013a,b), Aloe barbadensis (Sangeetha et al., 2011), Morinda pubescens, Passiflora foetida (Shekhawat et al., 2014a,b) etc.

Hybanthus enneaspermus (L.) F. Muell. belongs to family Violaceae, is commonly called Ratanpurus, Sthalakamala, Gem for men, Spade flower etc. (Kirtikar & Basu 1975). Traditionally H. enneaspermus plant is used to treat malaria, diabetes, male sterility, gonorrhea, urinary tract infection, jaundice, Cholera etc. (Sarita et al., 2004, Patel et al., 2011, Kheraro & Bouquet 1950, Pushpangadan & Atal 1984, Gopal & Shah 1985). This plant is also used to improve memory and to treat asthma, tuberculosis, eye diseases etc. (Udayan & Indira 2009).

The aqueous extract of H. enneaspermus was used for the biosynthesis of silver nanoparticles by Sripriya et al., (2013). As per the literature survey no data were available regarding the biogenesis of Zinc oxide nanoparticles using H. enneaspermus. The present study intended to synthesize and characterize ZnO nanoparticles from various extracts of this valuable medicinal plant for the first time.

2. MATERIAL AND METHODS

Collection of plant material and preparation of broth solutions

Figure 1. *Hybanthus enneaspermus* (L.) F. Muell.

Hybanthus enneaspermus is an important ethno-medicinal herb. The plant material for the present study was collected from the Salem Kaveri River, Tamilnadu, India. The leaf, stem and roots were collected from the healthy plants and washed thoroughly with distilled water, and finely cut into small pieces.

Figures 2, Mature leaves, Leaves in small pieces, Zinc Nitrate solution, aqueous extract of leaves and the mixture.

Figures 3, Stem cuttings; Zinc Nitrate solution, aqueous extract of stem and the mixture.

5 gm of chopped plant parts were boiled in a clean and sterilized conical flask of desired size with 50 ml of double distilled water for 5 min. to prepare broth solution. The extracts were filtered with Whatman filter paper No.1 after boiling and stored in refrigerator for further study.

2.1 Preparation of precursors and synthesis of Zinc oxide nanoparticles

Figures 4. Root cuttings; Zinc Nitrate solution, aqueous extract of roots and the mixture.

Zinc Nitrate hexahydrate [$Zn(NO_3)_2.6H_2O$] was used as precursor to synthesizeZnO nanoparticles using *H. enneaspermus.* 1mM Zinc nitrate solution was prepared using Zinc Nitrate hexahydrate with double distilled water and stored in refrigerator at 4^{o}C for further use. Three boiling tubes were taken for the synthesis process; one containing 10 ml of 1 mM Zinc nitrate solution as control, the second tube containing 10 ml of broth solution from appropriate part of the plant to observe the color change and the third tube containing 9 ml of 1 mM Zinc nitrate solution and 1 ml of plant extracts as test solution.

3. Characterization of Nanoparticles

The synthesized Zinc oxide nanoparticles using the plant extracts were centrifuged at 5000 rpm for 15 min to obtain the pellet which was used for further study. Supernatant was discarded and the pellet dissolved in deionized water. The synthesis of Zinc oxide nanoparticles was confirmed and characterized by using UV- Visible spectrophotometer. The UV-Vis absorption spectra of the zinc colloids from various parts of the plants were confirmed by using wavelength scan between 200 nm and 500nm.

4. RESULTS AND DISCUSSION

The ethnobotanical herb *Hybanthus enneaspermus* has been reported to have anti-inflammatory, antitussive, antiplasmodial, anticonvulsant, anti-bacterial, anti-oxidant, antifungal, hypolipidemic and free radical scavenging activities (Boominathan *et al.,* 2004, Sahoo *et al.,* 2006, Satheesh & Kottai 2012, Patel *et al.*, 2011, Arumugam *et al.,* 2011). This plant is said to be rare because of its seasonal habitat and sporadic distribution (Prakash *et al.*, 1999).

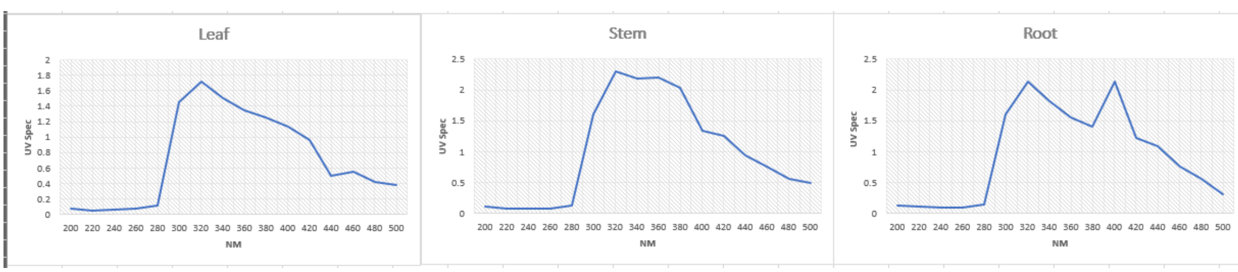
The bio-nano-synthesis of zinc oxide nanoparticles using leaf, stem and root extracts of *Hybanthus enneaspermus* was investigated in the present study. The color change was observed in the test solution of leaf and stem from colorless to pale yellow when 1 ml of broth solution was challenged with 9 ml of Zinc nitrate solution. The color was not changed in case of root extract without heating the mixture even after two hours. Color change from colorless to pale yellow was observed when the test solution was heated in the oven at 60^{o} C for ten minutes, which was disappeared while cooling. The present observations were also confirmed by our previous study (Shekhawat *et al.*, 2014a, 2014b).

Plants attributed the way to synthesize nanoparticles through green method because of their green chemistry principle. Sripriya *et al.,* (2013) biosynthesized silver nanoparticles using *H. enneaspermus* and used these nanoparticles in antibacterial coatings and drug delivery applications. Zinc oxide nanoparticles are very special among the existing nanomaterials due to their organometallic properties. Now it is possible to prepare individual nano metal or oxide particles.

The whole plant body of *H. enneaspermus* has evident to possess aphrodisiac activities and it has significant role in maintaining maleness. The Siddha medicine explains it as rejuvenating herb and it is known to possess coumarin, which is responsible for the hypolipidemic activity (Senthil *et al.,* 2013, Narayanaswamy *et al.*, 2007). We strongly believe that the phytochemicals, like coumarin are working as reducing agent and responsible for the conversion of metallic oxide into nanoparticles.

The synthesized ZnO nanoparticles were characterized by UV-Vis spectrophotometeric analysis. The aqueous leaf extract showed absorption peak at 320 nm, stem extract at 380 nm and the root extract at 400nm (Fig. 5). Jain *et al.*, (2014) also observed same types of results and described the biological approach for the synthesis of Zinc oxide nanoparticles.

The absorption wavelength at about 300 nm of ZnO suggested the excitonic character of Zinc at room temperature. Vanheusden *et al.,* (1996) described that the UV emission is attributed to the radiative recombination between the electrons in the conduction band and the holes in the valence band while working onZnO phosphor powders.



Figures 5, Spectrophotometric absorbance peak of leaf reaction mixture; Spectrophotometric absorbance peak of root reaction mixture; Spectrophotometric absorbance peak of stem reaction mixture.

5. CONCLUSION

This is the first study to develop an efficient protocol for the biosynthesis of ZnO nanoparticles using *H. enneaspermus* to highlight eco-friendly approach for commercial application of Zinc nanoparticles in agricultureas nano-bio-fertilizers and in the field of medicine.

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REFERENCE:

[1] Arumugam, N., Sasikumar, K., Malipeddi, H., & Sekar, M. (2011). Antifungal activity of Hybanthus enneaspermus on wet clothes. *International Journal of Research in Ayurveda and Pharmacy (IJRAP)*, *2*(4), 1184-1185.

[2] Bagabas, A., Alshammari, A., Aboud, M. F., & Kosslick, H. (2013). Room-temperature synthesis of zinc oxide nanoparticles in different media and their application in cyanide photodegradation. *Nanoscale research letters*, *8*(1), 1-10.

[3] Boominathan R, Parimaladevi B, Mandal SC & Ghoshal SK (2004) Anti-inflamattory evaluation of *Ionidium suffruticosum* Ging. in rats. *Journal of Ethnopharmacology* 91: 367–370.

[4] Dickson, R. M., & Lyon, L. A. (2000). Unidirectional plasmon propagation in metallic nanowires. *The Journal of Physical Chemistry B*, *104*(26), 6095-6098.

[5] Shekhawat, M. S., Ravindran, C. P., & Manokari, M. (2014). A biomimetic approach towards synthesis of zinc oxide nanoparticles using Hybanthus enneaspermus (L.) F. Muell. *Tropical Plant Research*, *1*(2), 55-59.

[6] Gnanasangeetha, D., & Thambavani, D. S. (2013). Biogenic production of zinc oxide nanoparticles using Acalypha indica. *Journal of Chemical, Biological and Physical Sciences (JCBPS)*, *4*(1), 238.

[7] Gopal, G. V., & Shah, G. L. (1985). Some folk medicinal plants used for jaundice in Gujarat, India. *Journal of Research Education in Indian Medicine*, *4*, 44-49.

[8] Kirtikar, K. R., & Basu, B. D. (1975). Indian medicinal plants 2nd edition. *M/S Bishen Singh Pal Singh*, *Delhi*, 1465-1472.

[9] Malarkodi, C., & Annadurai, G. (2013). A novel biological approach on extracellular synthesis and characterization of semiconductor zinc sulfide nanoparticles. *Applied Nanoscience*, *3*(5), 389-395.

[10] Narayanswamy, V. B., Setty, M. M., Malini, S., & Shirwaikar, A. (2007). Preliminary aphrodisiac activity of Hybanthus enneaspermus in rats. *Pharmacologyonline*, *1*, 152-161.

[11] Pushpangadan, P., & Atal, C. K. (1984). Ethno-Medico-Botanical investigations in Kerala I. Some primitive tribals of Western Ghats and their herbal medicine. *Journal of ethnopharmacology*, *11*(1), 59-77.

[12] Sangeetha, G., Rajeshwari, S., & Venckatesh, R. (2011). Green synthesis of zinc oxide nanoparticles by aloe barbadensis miller leaf extract: Structure and optical properties. *Materials Research Bulletin*, *46*(12), 2560-2566.

[13] Sripriya, J., Anandhakumar, S., Achiraman, S., Antony, J. J., Siva, D., & Raichur, A. M. (2013). Laser receptive polyelectrolyte thin films doped with biosynthesized silver nanoparticles for antibacterial coatings and drug delivery applications. *International journal of pharmaceutics*, *457*(1), 206-213.

[14] Udayan, P. S., & Balachandran, I. (2009). Medicinal plants of Arya Vaidya Sala.

[15] Zhang, L., Jiang, Y., Ding, Y., Daskalakis, N., Jeuken, L., Povey, M., ... & York, D. W. (2010). Mechanistic investigation into antibacterial behaviour of suspensions of ZnO nanoparticles against E. coli. *Journal of Nanoparticle Research*, *12*(5), 1625-1636.

[16] Zhao, L., Lu, P. F., Yu, Z. Y., Guo, X. T., Shen, Y., Ye, H., ... & Zhang, L. (2010). The electronic and magnetic properties of (Mn, N)-codoped ZnO from first principles. *Journal of Applied Physics*, *108*(11), 113924.

[17] Cassandra D, N.N., Jodi H, Linfeng G, Tan, Li, et al. , *"Green synthesis of gold and Zinc oxide nanoparticles from plant extracts."*.

[18] Kaviya S, S.J., Viswanathan B., *"Green Synthesis of Zinc oxide nanoparticles using Polyalthia longifolia Leaf extract along with D-Sorbitol."*. Journal of nanotechnology, 2011: p. 1-5.

[19] Catauro M, R.M., De Gaaetano FD, Marotta A, *"Sol–gel processing of drug delivery materials and release kinetics."*. J Mater Sci Mater Med, 2005. **16(3)**: p. 261-265.

[20] Crabtree JH, B.R., Siddiqi Ra, Huen IT, Handott LL, Fishman A, *"The efficacy of Zinc oxide-ion implanted catheters in reducing peritoneal dialysis-related infections."*. Perit Dial Int, 2003. **23(4)**: p. 368-374.