A biomimetic approach towards synthesis of Zinc oxide Nanoparticles using Hybanthus enneaspermus (L.) F. Muell.

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Abstract: We report green approach for the synthesis of Zinc oxide (ZnO) nanoparticles from the aqueous extracts of leaves, stem and roots of Hybanthus enneaspermus (L.) F. Muell in present study. H. enneaspermus plant has been used in traditional system of medicines in India, but so far it has not been tested for synthesis of Zinc oxide nanoparticles. The nanoparticles were synthesized using Zinc Nitrate hexahydrate [Zn(NO3)2·6H2O] solution. The Zinc Nitrate solution was exposed to the herbal extracts, which was reduced and the nanoparticles were synthesized. The formation of nanoparticles was confirmed by the color change of the reaction mixture. The synthesized ZnO nanoparticles were characterized by UV-Vis spectrophotometric analysis. The reaction mixtures leaf extract showed absorption peak at 300 nm, stem extract at 290 nm and root extract at 288 nm.

Keywords: Green synthesis - Zinc oxide nanoparticles - Hybanthus enneaspermus.

INTRODUCTION

Nanoparticles are of great scientific interest, and they represent a bridge between the bulk materials and the molecules. Earlier, the nanoparticles were studied because of their size-dependent physical and chemical properties but now they have entered in commercial exploration with huge applications (Shearer et al. 2000). The intrinsic properties of metal nanoparticles are due to their size, composition and morphology (Dickson & Lyon 2000). These nano size metal oxides have been attracted researchers by their ability to withstand under harsh condition and safe to mankind (Fu et al. 2005).

Zinc oxide nanoparticles (ZnONPs) are versatile elements with various biomedical properties like, antimicrobial (Rajendran et al. 2010), antibacterial activities (Zhang et al. 2010) etc. ZnO nanoarticles are among the top most photocatalysts which are used in disinfecting waste water and to decompose pesticides, herbicides (Zhao et al. 2010) etc. Biosynthesis of ZnO nanoparticles and their use in various fields are reported by many authors (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, Kherarao & 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.

MATERIAL AND METHODS

Collection of plant material and preparation of broth solutions

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**Figure 1.** *Hybanthus enneaspermus* (L.) F. Muell. in natural habitat.

*Hybanthus enneaspermus* is an important ethno-medicinal herb (Fig. 1). The plant material for the present study was collected from the campus of K.M. Centre for Postgraduate Studies, Pondicherry, India. The leaf, stem and roots were collected from the healthy plants and washed thoroughly with distilled water, and finely cut into small pieces (Fig. 2,3 & 4A,B).

**Figure 2.** A, Mature leaves, B, Leaves in small pieces; C, Zinc Nitrate solution, aqueous extract of leaves and the mixture.

**Figure 3.** A–B, Stem cuttings; C, 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.

*Preparation of precursors and synthesis of Zinc oxide nanoparticles*
Zinc Nitrate hexahydrate [Zn(NO$_3$)$_2$.6H$_2$O] (Merck, Mumbai, India) was used as precursor to synthesize ZnO nanoparticles using *H. enneaspermus*. 1 mM Zinc nitrate solution was prepared using Zinc Nitrate hexahydrate with double distilled water and stored in refrigerator at 4°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.

**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 were confirmed and characterized by using UV-Visible spectrophotometer (Model 2202, Systronics Ltd. India). The UV-Vis absorption spectra of the zinc colloids from various parts of the plants were confirmed by using wave length scan between 200 nm and 700 nm.

**RESULTS AND DISCUSSION**

The ethnobotanical herb *Hybanthus enneaspermus* has been reported to have anti-inflammatory, antitussive, antiplasmodial, anticonvulsant, antibacterial, 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 (Fig. 2,3 & 4C) even after two hours. Color change from colorless to pale yellow was observed when the test solution was heated in the oven at 60°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 spectrophotometric analysis. The aqueous leaf extract showed absorption peak at 300 nm, stem extract at 290 nm and the root extract at 288 nm (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 on ZnO phosphor powders.

**Figures 5.** A, Spectrophotometric absorbance peak of leaf reaction mixture; B, Spectrophotometric absorbance peak of root reaction mixture; C, Spectrophotometric absorbance peak of stem reaction mixture.

**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 agriculture as nano-bio-fertilizers and in the field of medicine.

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**REFERENCES**


