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PREPARATION OF ZINC OXIDE NANOPARTICLES FROM MORINGA OLEIFERA AND STUDY ON ITS CHARACTERS, ANTICANCER NATURE

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1. INTRODUCTION

The precise surface area and elevated fraction of surface atoms of metal nanoparticles gained enormous attention in the field of drug discovery, biotechnology and agriculture. The World Scientific News 55 (2016) 252-262 -253- metal NPs are reported to possess distinctive physicochemical uniqueness including catalytic activity, optical, electronic and antibacterial properties (Catauro et al., 2004). Green synthesis of nanoparticles and their applications in food processing, production of antimicrobials, cosmetics, health care products have been acknowledge by number of researchers (Begum et al., 2009). The utilization of plants in synthesis of zinc oxide nanoparticles (ZnO NPs) is quite novel technique and does not require consent with the preparation, which leads to eco-friendly green chemistry approach. The biological methods of nanoparticles synthesis were reported to have advancement over chemical and physical methods (Prasad and Elumalai, 2011). Recently the medicinal plant species exploited for the synthesis of zinc oxide nanoparticles are Hybanthus enneaspermus (Shekhawat et al., 2014), Camellia sinensis (Shah et al., 2015), Ficus benghalensis (Shekhawat et al., 2015), Zingiber officinale (Raj and Jayalakshmi, 2015), Hemidesmus indicus (Manokari and Shekhawat, 2015), Azadirachta indica (Bhuyan et al., 2015), Adhatoda vasica (Shekhawat, 2016) etc.. Moringa oleifera belongs to the family Moringaceae. It is a medium sized tree grows to the height of 5-12 m. Its leaves are bi- and tripinnate with entire oval shaped leaflets (Muhl et al., 2011). Stem is soft and the flowers are creamy white. The fruits (pods) are 20 to 30 cm long, green in color and change to brown when mature. Seeds are numerous, round or triangular in shape with three papery wings (Arbonnier, 2002). The plant is endowed with various life giving medicinal properties. Its different parts are employed in treating anemia, blindness, arthritis, hyperthyroidism, rheumatism, epilepsy, Chrohn's disease, antiherpessimplex virus, gout and sexually transmitted diseases (Mulh et al., 2011; Monera and Maponga, 2012; Dao and Kabore, 2015). M. oleifera is loaded in nourishment owing to the presence of essential phytochemicals. The phytochemical profile of its leaves showed the presence of essential minerals, vitamins,

sterols, anthraquinones, alkaloids, terpenoids, flavonoids, tannins and saponins (Kasolo et al., 2010). The immature pods and flowers are reported to contain linolenic, linoleic, palmitic and oleic acids (Mbikay, 2012; Berkovich et al., 2013). These phytoconstituents leads to the antiinflammatory, antiulcer, antidiabetic (Divi et al., 2012), anticancer (Nair and Varalakshmi, 2011), antimicrobial, antioxidant and antifungal properties (Ijarotimi et al., 2013). Due to these evidences about the medicinal values and phytochemistry of this plant, the present study applied biomimetic approach for the green synthesis of eco-friendly zinc oxide nanoparticles from panacea M. oleifera through bioreduction and UV-Visible spectroscopic characterization.

2. MATERIALS AND METHODS

2. 1. Collection of plant materials: Healthy Moringa oleifera trees were selected in the local provinces of Puducherry (Pondicherry, India) and its different parts namely fresh leaves, stem segments, flowers and fruit pods were collected during March-June 2014. These parts were initially washed under running water to remove dirt and other foreign particles and followed by rinsing in double distilled water and dried at room temperature. These materials were chopped into fine pieces Plant parts of M. oleifera used for the synthesis of ZnO nanoparticles. Five grams of plant materials chopped into fine pieces for the preparation of aqueous extracts.

2. 2. Preparation of aqueous extracts from various plant parts: Five (5) gm in each of leaf, stem, flowers and pod samples were challenged with 50 ml double distilled water and boiled for 15 min. After boiling period all the samples were filtered using Whatman filter paper (No.1) and the aqueous extracts were used for the synthesis of ZnO nanoparticles.

2. 3. Preparation of precursor: Zinc Nitrate hexahydrate [Zn (NO3)2·6H2O] (Merck, Mumbai) was used as a precursor for the synthesis of ZnO nanoparticles from M. oleifera plant parts. 1mM Zinc nitrate solution was prepared using double distilled water and stored in refrigerator at 4 °C for further use.

2. 4. Synthesis of ZnO nanoparticles : The plant extracts were used to reduction of metal ions in to metallic oxide nanoparticles. Three boiling tubes were used to synthesize ZnO nanoparticles, one containing 10 ml of 1mM Zinc nitrate solution as reference, and the second one containing 10 ml of aqueous plant extract and the third tube contained 5 ml of 1 mM Zinc nitrate solution and 5 ml of plant extracts as reaction medium and incubated at room temperature. To observe the visual color change, the reaction medium was boiled for 20 min at the temperature of 60 °C .The test solution from the third tube was centrifuged at 5000

rpm for 20 min to obtain the pellet. Supernatant is discarded and the pellet is dissolved in double distilled water. Color change in the reaction medium.

2. 5. Characterization of ZnO nanoparticles (UV-VIS spectra analysis): The bioreduction of ZnO nanoparticles using M. oleifera aqueous extracts were monitored by measuring the UV-Visible spectroscopy. The UV-Visible absorption spectra of the reaction media were recorded at room temperature in a quartz cuvette (1 cm path length) and at the wavelength ranging from 200 to 700 nm using a Systronics Double Beam Spectrophotometer (Model 2202, Systronics Ltd.) in diffuse reflectance mode using Zinc nitrate as reference.

3. RESULTS AND DISCUSSION: The present study involves various parts of medicinal plant species M. oleifera for the synthesis of ZnO nanoparticles. The plant is endowed with immense secondary metabolites and astonishing nutritive properties. The different parts of the plants have already been exploited for the synthesis of various metal nanoparticles with valuable bioactive mechanisms. This report aimed on synthesis of ZnO nanoparticles using extracts of various parts of M. oleifera. Prasad and Elumalai (2011) reported the synthesis of silver nanoparticles (AgNPs) from aqueous leaf extracts of M. oleifera. Sathyavathi et al. (2011) proposed that the leaf mediated Ag nanoparticles from M. oleifera are used in optical limiting. The AgNPs from M. oleifera leaves have been reported to possess significant antifungal activity against Candida albicans (Vibhute et al., 2014). Silver nanoparticles from M. oleifera have been reported to induce apoptosis of human cervical carcinoma cells (Vasanth et al., 2014). The silver nanoparticles reduced by the gum of M. oleifera was reported to exhibit antibacterial activity against Staphylococcus aureus, E. coli and Pseudomonas aeruginosa (Kudle et al., 2013). Silver nanopaticles from the seeds of M. oleifera are reported to control major dengue vector Aedes aegypti and against dengue serotype DEN-2 (Sujitha et al., 2015). Gold nanoparticles synthesized from the pods of M. oleifera was reported to possess antibacterial activity against gram positive and gram negative bacteria such as Bacillus subtilis, Escherichia coli, Klebsiella pneumonia and Staphylococcus aureus (Belliraj et al., 2015). The porous activated carbons derived fruit shells were employed in the synthesis of highly dispersed and stable ruthenium nanoparticles (RuNPs) and exploited for supercapacitor applications (Lou et al., 2016). Elumalai et al. (2015) synthesized ZnO nanoparticles from the leaves of M. oleifera, and these nanoparticles at the concentration of 200 µg/ml exhibits antibacterial activity against gram positive and gram negative bacteria such as Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Proteus mirabilis, Escherichia coli and antifungal activity against Candida albicans and

Candida tropicalis. The reduction of zinc metal ions to zinc oxide nanoparticles in the reaction medium was preliminarily analyzed using UV-Vis Spectrophotometer between 200 to 700 nm. The UVVisible spectroscopic analysis of ZnO nanoparticles from leaf and flower reaction medium was confirmed by the strong absorption spectra at 308 nm. The maximum absorption of stem and fruit pods reaction medium was observed at 293 nm Plant extracts at the concentration of 5 ml was found to mediate the ZnO nanoparticles synthesis in less time, whereas the increased and decreased concentrations were less effective when challenged with the precursor. The color change of reaction mediums was observed at different time duration. The pale yellow color development in the leaf reaction medium was observed immediately when the leaf extract is challenged with zinc nitrate solution. Deep yellow color formation was recorded n the stem and fruit pod by heating the respective reaction medium in water-bath for 20 min at 60 °C. Flower extract and precursor changed the color after 12 minutes of incubation at room temperature. The higher surface to volume ratio of nanoparticles are mainly due to exitonic transitions and deep-trap transitions (Shekhawat et al., 2013; Firdhouse et al., 2015). This size dependent property of ZnO nanoparticles were appeared as a clear broad absorption peak through UV-Visible spectral analysis. The spectra from various parts of M. oleifera confer the difference in the excitation wavelength. This may be due to presence of secondary metabolites at various fractions in leaves, stem, flowers and fruit pods.

4. CONCLUSION: The biomimetic approach on synthesis of ZnO nanoparticles using various parts of M. oleifera is simple, easily scaled up, eco-friendly and quick. The characteristic color changes to yellow in the reaction medium indicate the synthesis of ZnO nanoparticles. The absorption spectral analysis using UV-Visible spectroscopy confirms the reduction of zinc ions in to zinc oxide nanoparticles from herbal extracts of M. oleifera. The formation of ZnO nanoparticles from leaves and flowers exhibit absorption peak at 308 nm. The stem and fruit pods showed absorption peak at 293 nm.

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