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Short Communication

A BIOGENIC APPROACH FOR THE SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE NANOPARTICLES PRODUCED BY TINOSPORA CORDIFOLIA

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ABSTRACT

Objective: The study mainly focuses on the preparation and characterization of Zinc oxide nanoparticles using an aqueous stem extract of *Tinospora cordifolia.*

Methods: Zinc Oxide nanoparticles were synthesized by a biological method using the stem extract of *Tinospora cordifolia* using Zinc acetate dehydrate in the presence of Sodium hydroxide. The synthesized Zinc Oxide nanoparticles were characterized using Scanning Electron Microscope (SEM), Energy Dispersive X-ray analysis (EDX) and Fourier Transform Infrared Spectroscopy (FTIR).

Results: SEM results reveal that the shape of Zinc oxide nanoparticles was spherical and the average size ranges from 37-42 nm. EDX analysis provides the elemental composition of Zinc and oxygen present in the ZnO nanoparticles. The weight percentage of Zinc, oxygen and carbon was found to be 62.45, 28.82 and 7.51 respectively. Chemical bond formations were confirmed by using FTIR analysis.

Conclusion: Thus the study suggests that *Tinospora cordifolia* can be used for the synthesis of ZnO nanoparticles in a simple, cost effective and an eco friendly way. It can also serve as an alternative to conventional chemical method.

Keywords: Zinc Oxide, Nanoparticles, *Tinospora cordifolia*, Green synthesis, SEM.

Nanotechnology is a rapid, upcoming area in material science research which deals with controlling and manipulating of materials at the nano scale (10^{-9}) [1-3]. These materials behave differently from their bulk counterpart due to which they have increased applications in fields like biotechnology, biomedical sciences, physics, chemistry, etc [3,4]. It is also used in therapeutics and in medicines as drug delivery [2]. Much of the research focused on controlling their dimension and morphology since it has an impact on their applications [5]. Several methods such as chemical precipitation, solvothermal/hydrothermal reductions are available for the large scale production of nanoparticles [6]. However, these types of preparations were limited due to the involvement of toxic and hazardous chemicals, which led to biological risks [7, 8]. Several nanoparticles such as silver, palladium and Gold were found to have wide applications in optoelectronics, magnetic as information storage and also in medicine and textile industry [9, 10]. Nowadays, inorganic nanoparticles has been focused, due to their novel and improved physical, chemical and biological properties [11, 12].

In recent years, Zinc oxide (ZnO) nanoparticles gain more attention by the researchers because of its wide application in various fields such as pharmaceuticals, cosmetics, agro chemicals, ceramics, optical and piezoelectric field [13]. It is also used in preparing sun screen lotions as they are capable of absorbing UV rays. ZnO is an interesting semiconductor that is used in solar cells, ceramics and in cosmetics as sunscreen lotions since they can absorb UV rays [6, 14, 15]. It is used as a semiconductor, photo catalyst, antimicrobial agent, water disinfection, gas sensor and chemical sensor [16]. U. S. Food and Drug Administration has listed, zinc oxide nanoparticles as safe (GRAS). Conventional methods of synthesizing ZnO nanoparticles such as chemical precipitation, spray pyrolysis, sol-gel, thermal decomposition are commonly avoided as they involve critical temperature, pressure and also they give toxic end products and hence the plant mediated synthesis of the nanoparticles are more ecofriendly and gains more importance [11, 17].

Tinospora cordifolia (Gudichi) is a deciduous climbing shrub which belongs to the family Menispermacea and has been categorized in Ayurveda as 'Rasayana' [18]. The stem of *Tinospora cordifolia* is one of the most important constituents of several Ayurvedic preparations because it has anti-inflammatory, anti-cancer, anti-malarial, antioxidant and anti-diabetic properties [19, 20]. The plant is rich in bioactive components such as alkaloids, phenolics, steroids such as tinosporine, tinosporide, columbin etc., that are responsible for its medicinal activities [20, 21]. It is also rich in protein, calcium and phosphorous [22]. In this current study, an attempt has been made in synthesizing ZnO nanoparticles by using the stem extracts of the *Tinospora cordifolia* and was characterized using SEM, FTIR and EDX. To the best of our knowledge, it is the first time to report the synthesis of Zinc Oxide nanoparticle using *Tinospora cordifolia.* All chemicals needed for the synthesis of ZnO nanoparticles were brought from Fischer Scientific (zinc acetate dihydrate and sodium hydroxide).

Tinospora cordifolia plant was collected from our college campus and was confirmed. The stem of the plant was separated and was washed thoroughly to remove the dust particles present on its surface. The stem parts were dried in the oven for about 1 hour at 50 °C and were finely cut into pieces using a sterilized knife. The dried stem pieces were boiled in de ionized water at 80 °C for 10 minutes and extract obtained was brought to room temperature and was filtered using Whatmann No1 filter paper. This extract was stored in 4 °C for future use.

Zinc acetate dihydrate, is used as a precursor for the synthesis of ZnO nanoparticles. 0.01 M of Zinc acetate dihydrate was prepared using 50 ml of deionized water and stirred in magnetic stirrer for 10 minutes. To this Zinc acetate dihydrate solution, 500 µl of stem extract was slowly added and allowed to stirrer continuously. 1 M NaOH was taken in the burette and added carefully to the mixture of Zinc acetate dihydrate and stem extract until it reaches pH 12. Once the pH is attained, then the mixture was allowed on the stirring condition for 2 hours until a white precipitate was formed. This mixture was then centrifuged at 10000 rpm for 10 minutes. The supernatant was discarded. The pellet was dried at 80 °C and the resulting white powder was carefully collected and used for characterization. The characterization was performed using SEM, Energy dispersive X-ray diffractive spectroscopy(Carl Zeiss, Germany) and Perkin Elmer1 Spectrum FT-IR at a scanning range of 450-400 cm^{-1}.

The shape, structure and size of the Zinc Oxide nanoparticles synthesized using stem extracts of *Tinospora cordifolia* was determined by the SEM analysis (fig. 1 & fig. 2) and an average size of about 37 nm was seen in the ZnO nanoparticles. The previous studies showed that the ZnO nanoparticles were in the range between 25-55 nm and these were in accordance to our present study [6]. The shape of the Zinc Oxide nanoparticles is found to be spherical in shape which also matched with the earlier studies.

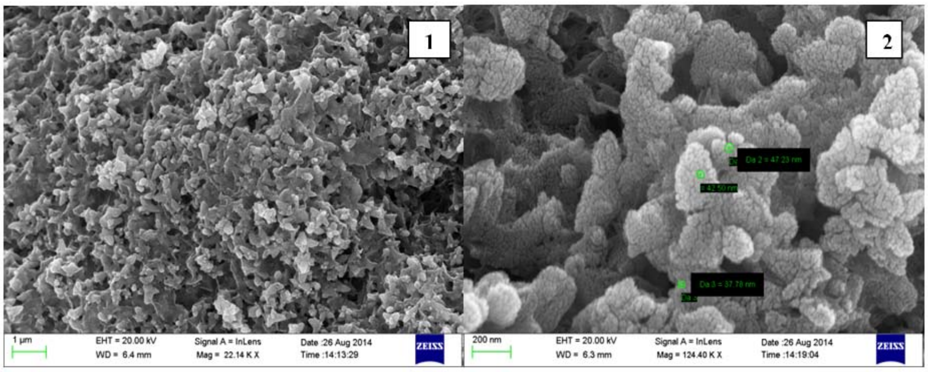

Fig. 1-2: SEM images of ZnO nanoparticles using stem extracts of *Tinospora cordifolia*

The energy dispersive X-ray analysis was performed to know the elemental composition of Zinc and oxygen present in the ZnO nanoparticles (fig. 3). 62.45 weight percentage of Zinc, 28.82 weight percentage of oxygen and a 7.51 weight percentage of carbon were obtained in the analysis. A 76.32 weight percentage of Zinc and 23.68 weight percentage of oxygen was reported from the previous studies and a similar pattern was obtained, but the presence of carbon was observed in our study which was due to the use of Zinc acetate dehydrate, as a precursor for the synthesis of Zinc Oxide nanoparticles [25].

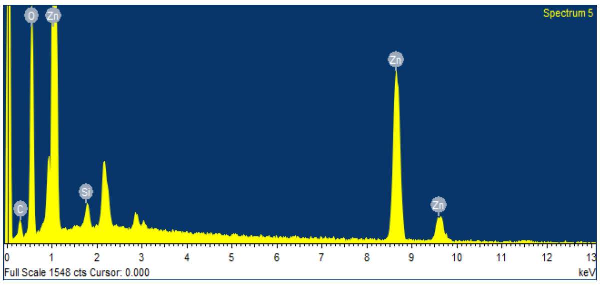

Fig. 3: EDX Pattern of ZnO nanoparticles using stem extracts of *Tinospora cordifolia*

For the chemical bond confirmations of the Zinc Oxide nanoparticle the FTIR analysis (fig. 4) was carried out and was found to have a strong absorption at 3411, 1639, 1555,1410 and 538 cm^{-1}. The absorption peak at 3411 cm^{-1} confirmed the O-H bond stretching, which indicated the presence of carboxylic acids, C=C bond stretching was seen at 2415 cm^{-1} which indicates the presence of aromatic ring. The absorption peak at 1555 cm^{-1} indicated the N-H bond stretching, which showed the presence of amines and the 1410 cm^{-1} absorption peak corresponded to C-H bond stretching indicates the presence of poly phenolics, water and alcohol. The absorption band that was seen at 538 $cm^{-1}$is a clear indication of ZnO and similar peaks were reported in earlier studies. [6, 17]. On comparing with the results obtained in this study, there is a slight deviation in peak ranges and this may be due to the variation in the extracts that was used for the synthesis of the Zinc Oxide nanoparticles.

Synthesis of Zinc oxide nanoparticles by chemical methods are generally avoided as it involves the usage of toxic chemicals and hence the plant mediated synthesis is gaining importance which can serve as a better alternative. In this context, the present study was undertaken in which Zinc Oxide nanoparticles is synthesized with the help of a medicinal plant *Tinospora cordifolia*. The average size of ZnO nanoparticle was found to be 37 nm having a spherical shape which was confirmed by SEM analysis. EDX results confirm the presence of Zinc and Oxygen in the synthesized ZnO nanoparticle. FTIR studies clearly indicate the presence of reducing and capping biomolecules that are responsible for the production of ZnO nanoparticle. Thus, our present study confirms the potential of *Tinospora cordifolia* for the synthesis of ZnO nanoparticle in a simple, cost effective and an eco friendly way.

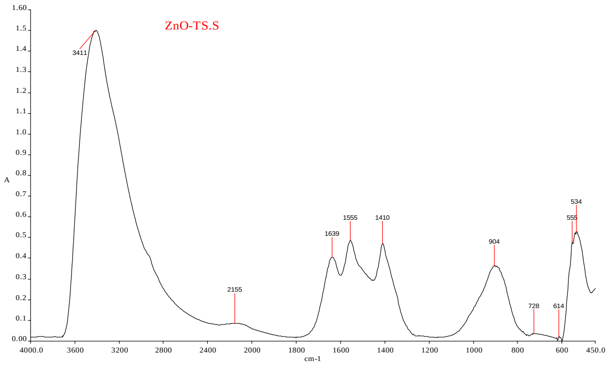

Fig. 4: FTIR Pattern of ZnO nanoparticles using stem extracts of *Tinospora cordifolia*

CONFLICT OF INTERESTS

Declared None.

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