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Green Synthesis of Benevolent ZnO Nanorods Using *Emblica officinalis*

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A proficient protocol for the production of zinc oxide nanorods without calcinations was developed by green synthesis method using aqueous leaf extract of *Emblica officinalis*. This green synthesis approach shows that the environmentally benign and renewable aqueous leaf extract of *Emblica officinalis* can be used as a stabilizing agent for the synthesis of zinc oxide nanorods. The process involved the use of zinc acetate dihydrate and sodium hydroxide as a antecedent and aqueous extract of *Emblica officinalis* as a solvent with assorted roles as promoter, stabilizer and template for synthesis of zinc oxide nanorod. The fashioned nanorod ranged in dimension of about 100-200 nm. Scanning electron microscope, energy dispersive X-ray analysis, X-ray diffraction and Fourier transform infrared spectroscopy entrenched that the formed nanorods are zinc oxide nanorods. The results showed that as-prepared ZnO nanorods had Wurtzite structure.

Keywords: Nanorods, Emblica, Biotemplate, Phytochemicals.

INTRODUCTION

Zinc oxide nanoparticles are presently under intensive study for applications in the field of optical devices, sensors, catalysis, biotechnology, DNA labeling, drug delivery, medical, chemical and biological sensors and as catalyst. Increasing awareness towards green chemistry and biological processes has led to the development of an eco-friendly approach for the synthesis of nanoparticles. The plant phytochemical with antioxidant property is accountable for the preparation of zinc oxide nanoparticle. *Emblica* tree is one of the most celebrated herbs in the Indian traditional medicine system. *Emblica officinalis* tree is medium in height with spreading branches and crooked trunk belonging to the family Euphorbiaceae possesses antiviral, antibacterial, anticancer, antiallergy and antimutagenic properties. *Emblica* leaf ash contains zinc 4 ppm[1,2]. Plants produce wide array of bioactive molecules or phytochemicals which probably evolved as chemical defense against predation or infection but are now found to be useful for treatment of various ailments. This interest primarily stems from the belief that green medicine is safe and dependable compared with costly synthetic drugs that have adverse effects. The use of *Emblica* as an antioxidant has been examined by several authors[3,4]. The studies showed that *Emblica* preparations contained high levels of the free-radical scavenger, superoxide dimutase (SOD) in the experimental subjects[5,6]. Therefore, the present study was carried out with the aim of short course on how to synthesize zinc oxide nanorod in a natural scale.

EXPERIMENTAL

Leaves of *Emblica officinalis* were collected in the month of May 2013 from its natural habitat from nearby Seelapadi village, Dindigul district, Tamil Nadu. The plant was authenticated by Dr. D. Sarala Thambavani. The leaves were cleaned and washed with double distilled water, finely grinded and filtered. The different qualitative chemical tests were performed for establishing profile of given extract for its chemical composition. Qualitative phytochemical analysis was done using the standard procedures[7,8]. The qualitative examination of the aqueous extracts of the leaf sample of *Emblica officinalis* showed the presence of phytochemical constituents such as alkaloid, carbohydrate, glycoside, steroid, flavonoid, terpenoid, tannins and steroid (Table-1).

Zinc acetate dihydrate (99 % purity) and sodium hydroxide (pellet 99 %) was used as the preparatory material and was supplied by Sigma-Aldrich chemicals, India. Zinc oxide nanorods were primed by green synthesis method. 0.02 M aqueous zinc acetate dihydrate was added to distilled water under vigorous stirring. After vigorous stirring aqueous leaf extract of *Emblica officinalis* was introduced into the above solution followed by the addition of aqueous 2 M NaOH resulted in a white aqueous solution at pH 12. This was then

sited in a magnetic stirrer for 2 h. The precipitate was then taken out and washed continually with distilled water followed by ethanol to eliminate the impurities for the final product. Then a white powder of ZnO nanrods was obtained after drying at 60 °C in vacuum oven over night.

TABLE-1
PHYTOCHEMICAL CONSTITUENTS OF *Emblica officinalis* AQUEOUS LEAF EXTRACT

S. No.	Phytoconsitituents	Reagents	Aqueous
1	Alkaloids	Mayer's	+
		Wagner's	+
2	Carbohydrates	Molisch's	+
		Benedict's	+
3	Glycosides	Legal's	+
		Borntrager's	+
4	Steroid	Libermann burchard's	+
5	Fixed oils	Spot test	+
6	Saponins	Gelatin	+
		Lead acetate	+
7	Tannins	Ferric chloride	+
		Wagner's	+
8	Protein	Millon's	+
		Biuret	+
9	Flavonoids	Alkaline reagent	+
		Shinoda's	+
10	Terpenoids	Thionyl chloride	+

+ Presence; –Absence

Fourier transform infrared (FT-IR) spectra was recorded on Jasco FT-IR5300 model spectrophotometer in KBr pellets. The particle size and external morphology of the sample were characterized by scanning electron microscope (SEM) (LEO 1530FEGSEM). The X-ray powder diffraction pattern of the as-synthesized sample was recorded on an X-ray diffractometer (XRD, PW 3040/60 Philips X'Pert, Holland) using CuK_α radiation (λ = 1.5416 Å) operating at 40 kv and 30 mA with 2θ ranging from 10-90°.

RESULTS AND DISCUSSION

FT-IR study of dry powdered test drug in KBR pellet was investigated to identify the presence of functional groups (Fig. 1). A clear ZnO stretching mode was observed at 557-417 cm^{-1}[9]. The pattern of absorptions at 665 cm^{-1} match up aromatic C-H. Absorption peak at 930 cm^{-1} point out the aromatic stretching (out of plane bending). Primary amine ($R\text{-}NH_2$) show two N-H stretching bands in the range 3550-3300 cm^{-1}. Bands at 1015 cm^{-1} symbolize the aromatic skeletal vibration. The corresponding CH_2 out of plane bending vibration characteristic of group R CH_2 SR' and RCH_2Cl group appears at 1213 and 1325 cm^{-1} specify the presence of alkane. Absorption at 1617 cm^{-1} is due to C=C stretching vibration. Absorption at 2916 cm^{-1} are assigned to aromatic symmetric CH_3 stretching band. Band absorption near 2373 cm^{-1} corresponds to acid because of the overlapping of C-H. From FTIR results can be inferred that the bio-organics[9] like triterpenoids, sterols, alcohols, hydrocarbons, Phenolic compounds flavonoids, lignans, coumarins, tannins, quercetin, alkaloids, cynogenic glycosides from leaves formed a strong capping on the nanoparticles.

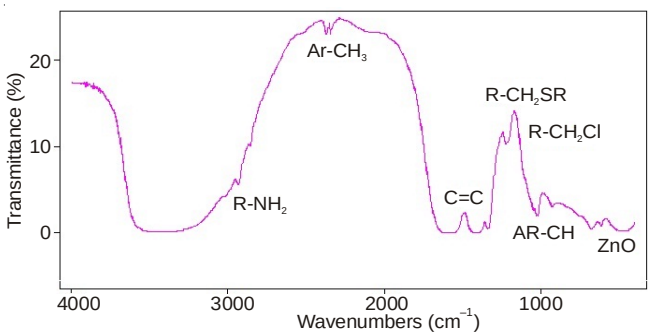

Fig. 1. Spectra of aqueous leaf extract of *Emblica officinals*

Fig. 2 exemplify the X-ray powder diffraction patterns of zinc oxide nanorods synthesized by reaction of aqueous leaf extract of *Emblica officinalis* with zinc acetate dihydrate and sodium hydroxide. All peaks can be well indexed to hexagonal wurtzite phase of zinc oxide (JCPDS CARD NO:36-1451) with peak at (100), (002), (101), (102), (110), (103), (200), (112) and (201)[10-12]. Tremendously broad peak at about 36° is indicative of nano crystalline nature of ZnO wurtzite phase. The average particle size was about 16 nm which was probable by Debye Scherrer's equation ($d = k\lambda/\beta\cos\theta$). The results confirmed that aqueous leaf extract of *Emblica officinalis* is a suitable green template to prepare homogeneous ZnO nanorods.

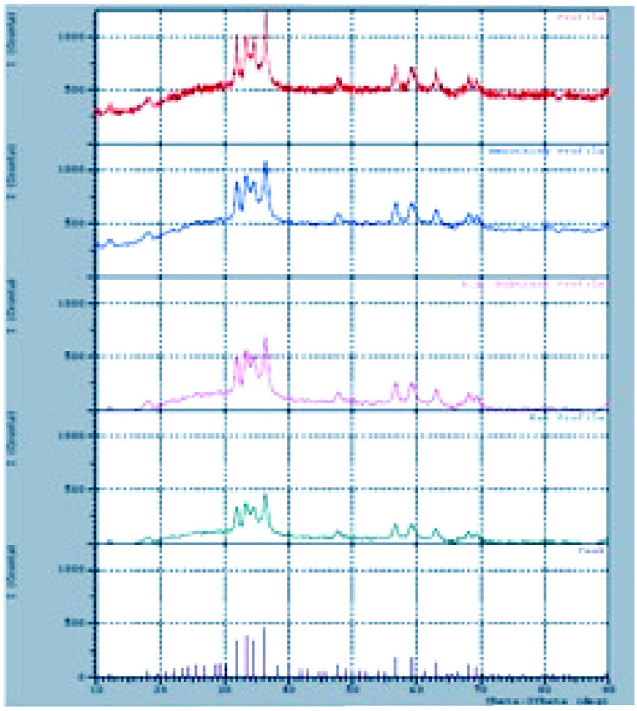

Fig. 2. XRD spectra of ZnO nano rods of aqueous leaf extract of *Embilica officinals*

The morphology and structure of the samples were determined using a scanning electron microscope. Fig. 3 shows the scanning electron microscope micrograph of ZnO nanorod synthesized using aqueous leaf extract of emblica officinalis.

The elemental distribution of ZnO nanorods was determined with EDX analysis. From the EDX spectrum reveals the (Fig. 4) only presence of zinc and oxygen with 49.31 and 50.69 % composition which is in good agreement with the

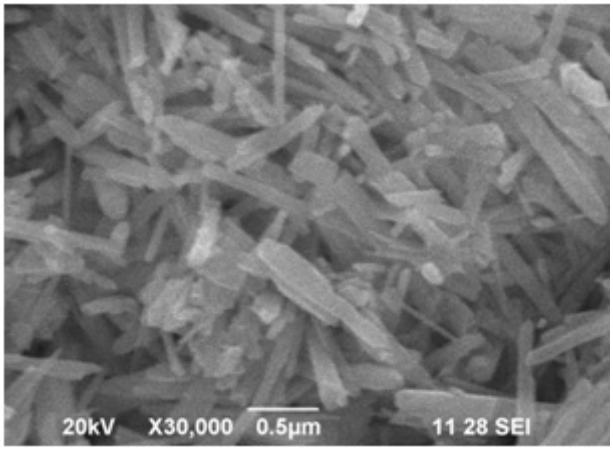

Fig. 3. Representative SEM image of the synthesized ZnO nano rods

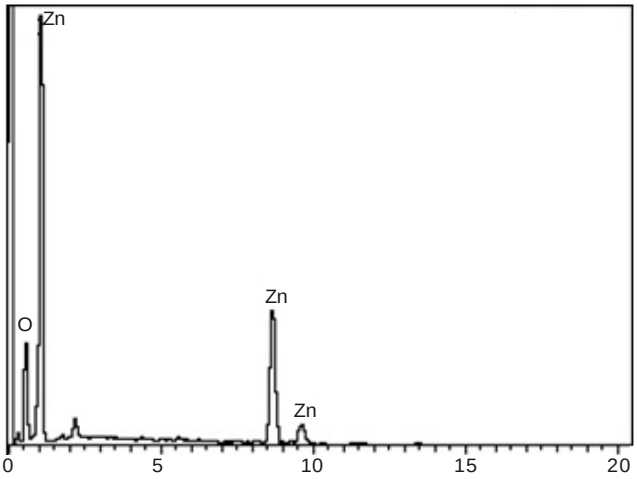

Fig. 4. Elemental spectra of ZnO nano rods revealed by EDX analysis

results of FT-IR and XRD. Owing to this reason the progress of green chemistry with the use of plants in the synthesis of nanorods has engrossed a great attention.

Conclusion

In this research, a green method that is friendly to environment has been developed in preparation of ZnO nanorods using aqueous leaf extract of *Emblica officinalis* as a biotemplating agent for the pattern of zinc oxide nanorod with zinc acetate and sodium hydroxide as a surrogate. Also the present exploration confirms for the first time synthesis and characterization of ZnO nanorods prepared by green technique (XRD, SEM, FTIR and EDAX). The size of the primary rod calculated using powder XRD pattern is 16 nm. FT-IR results confirmed that aqueous leaf extract of *Emblica officinalis* is a suitable green template to prepare homogeneous nanorods. The synthesized nanorods rods are highly stable. Zinc oxide nanoparticles have found fabulous application in biomolecular detection, diagnostics, micro electronics and water remediation.

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