



FTIR and XRD of Zinc Oxide Nano Particle from *Mangifera indica L. anacardiaceae*

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Zinc Oxide nanoparticle (ZnO) is broadly used in food packaging industry. Synthesis of ZnO includes different methods like using chemical, gas and sol gel. But it contains more toxins. Hence biosynthesis of zinc oxide nanoparticle is eco-friendly and non toxic. It acts as an anticancer, antidiabetic, antibacterial activity and so on. Trace metals like zinc, magnesium and chromium are involved in glucose metabolism and have a role in controlling blood glucose and hence in diabetic therapy. Zinc is also known to keep the structure of insulin and plays an important role in insulin synthesis, secretion and storage. Nano -ZnO is commonly utilized as additive in food. In this article we discussed about biosynthesis of zinc oxide nanoparticles from *Mangifera indica L. anacardiaceae* extract. Synthesized nanoparticles is subjected to its characterization such as Fourier Transform Infrared Spectroscopy (FTIR) in the range between 4000cm^{-1} to 400cm^{-1} and X-Ray Diffraction (XRD). Functional group was identified in FTIR and nature, size, composition and degree of crystallinity were determined by using X-ray Diffraction analytical technique.

Keywords: Zinc oxide; *Mangifera indica L. Anacardiaceae*; diabetes mellitus; FTIR and XRD.

1. INTRODUCTION

Nanoparticles, are particulated dispersion or solid particles in the size range of 10-1000nm. Nanotechnology, and its allied sciences, promises a step forward approach in manufacturing, materials, nanoelectronics, vitality, biotechnology, data innovation, medication, healthcare and national security [1].

Recently nanobiotechnologists are getting interested in Zinc Oxide nanoparticles (ZnONPs), due to its profound biomedical applications. ZnONPs acts as an antibacterial agent, by the generation of reactive free radicals as well as membrane rupture it causes both gram-positive and negative bacteria cell death. It has hypoglycemic effect diabetic animals by mediating pancreatic β -cells, increased insulin secretion [2].

Zinc is a trace element that is broadly present in all body tissues, including – brain, muscles, bone, skin and so on”. It is the most important factor of different enzyme systems, zinc takes part in body’s metabolism and acts a significant role in protein metabolism, nucleic acid synthesis, hematopoiesis and neurogenesis. In various field zinc oxide nanoparticles plays an important role as metal oxides with remarkable properties. “Compared with other metal oxides, ZnO – NPs are uncomplicated, economic, non – toxic, safe and biocompatible. Hence, it has been used as antibacterial, anticancer and antidiabetic, wound healing, anti- inflammation and bio imaging”. In biomedical field ZnO-NPs have many advantages [3].

Nano- zinc oxide (ZnO) as a small size particle can be absorbed readily by the body. Thus nano-ZnO is commonly utilized as additive in food. In addition, ZnO is evaluated as “GRAS” (generally recognized as safe) component by the US Food and Drug Administration (FDA) [4].

Diabetics with hyperglycemia exhibits symptoms like frequent urination, increased thirst and hungry. The innovations of various medicines with different modes of actions try to reduce high blood glucose level and its very important to manage diabetes and its complications. Trace metals like zinc, magnesium and chromium are involved in glucose metabolism and have a role in controlling blood glucose and hence in diabetic therapy. Over 300 enzymes are activated by zinc in the body, and it plays a crucial role in different metabolism. Zinc is also known to keep the

structure of insulin and plays an important role in insulin synthesis, secretion and storage. Some zinc transporters in pancreatic β -cells contain a potential role in insulin secretion. There is a very complex interlink among zinc, diabetes and diabetic complications and related diabetic symptoms [5].

Mango leaves have potential characteristics to control the diabetes. The extract of mango leaves contain bioactive components like benzophenones and flavonoids. Not only bioactive components it has potential minerals such as potassium, phosphorus, iron, sodium, zinc, calcium, magnesium and vitamins like A, B, E and C. Due to these properties mango leaves was chosen for synthesis of Zinc Oxide nanoparticles [6].

Mango leaves acts as an antidiabetic, antioxidant, antiviral, anti inflammatory, anticancer, antipyretic, hypolipidemic and gastro protective. Phytochemicals like tannins, flavonoids, gallic acid, taraxerol present in mango leaves reduce the hyperglycemia [7].

1.1 Fourier Transformed Infrared Spectroscopy (FTIR)

Infrared absorption spectroscopy is utilized to determine the shape of molecules with its characteristic absorption of infrared radiation. Infrared spectrum is molecular vibrational spectrum. When exposed to infrared radiation, sample molecules selectively absorb radiation of specific wavelengths which causes the change of dipole moment of sample molecules. The concentration of absorption peaks is related to the change of dipole moment and the possibility of the changeover of energy levels”. Infrared spectrum of absorption, emission and photoconductivity of solid, liquid and gas will be obtained using Fourier Transform Infrared spectroscopy technique. Different kinds of functional groups are detected by using this technique [8]. This spectrum has been recorded between the range $4000-400\text{cm}^{-1}$

1.2 X-ray Powder Diffraction (XRD)

“X-ray Powder Diffraction (XRD) is an efficient analytical technique used for the determination of grain size, composition of solid solution, lattice constants and degree of crystallinity in a mixture of amorphous and crystalline substances. It is the method commonly used for the study of crystal structures, atomic spacing, crystalline

sizes, stress analysis, lattice parameters and quantitative phase analysis that can give provide information on unit cell dimensions. This information is essential for the creation of a material to its structure and hence its properties”.

In the present article, simple, eco-friendly, economically effective method was used to synthesize Zinc Oxide nanoparticles using mango leaves extract. The synthesized Zinc Oxide nanoparticles were characterized by FTIR and XRD.

2. MATERIALS AND METHODS

2.1 Plant Material

Mangifera indica L. Anacardiaceae leaves were collected from Virudhunagar and the plant authentication was confirmed by Botanical Survey of India, Coimbatore “(Authentication No: BSI/SRC/5/23/2019/Tech./188)”.

2.2 Preparation of Plant Extract

2.2.1 Aqueous extract

Aqueous extract of *Mangifera Indica L. Anacardiaceae* leaves -10 g of collected plant leaves were washed and shade dried at room

temperature until constant weight. The leaves were pulverized and stored.

In 100ml of 60°C distilled H₂O, powdered leaves were allowed to dissolve for 15 minutes. The supernatant was strained using Whatman filter paper and stored at 4°C for further use.

2.3 Biosynthesis and Characterization of Zinc Oxide Nanoparticles

The method proposed by [9] was used for the separation of zinc oxide nanoparticles in the *Mangifera indica L. Anacardiaceae* leaves and the detailed procedure is given in Fig 1.

2.4 Characterization of Zinc Oxide Nanoparticles (ZnOnps)

Chemical structure of *Mangifera indica L. Anacardiaceae* zinc oxide nanoparticles was characterized using Fourier Transform Infrared (FTIR) Spectroscopy. It shows the intensity of the absorbance corresponding to the functional groups of *Mangifera indica L. Anacardiaceae* zinc oxide nanoparticles and the nature, size, composition and degree of crystallinity were determined by using X-ray Diffraction analytical technique.

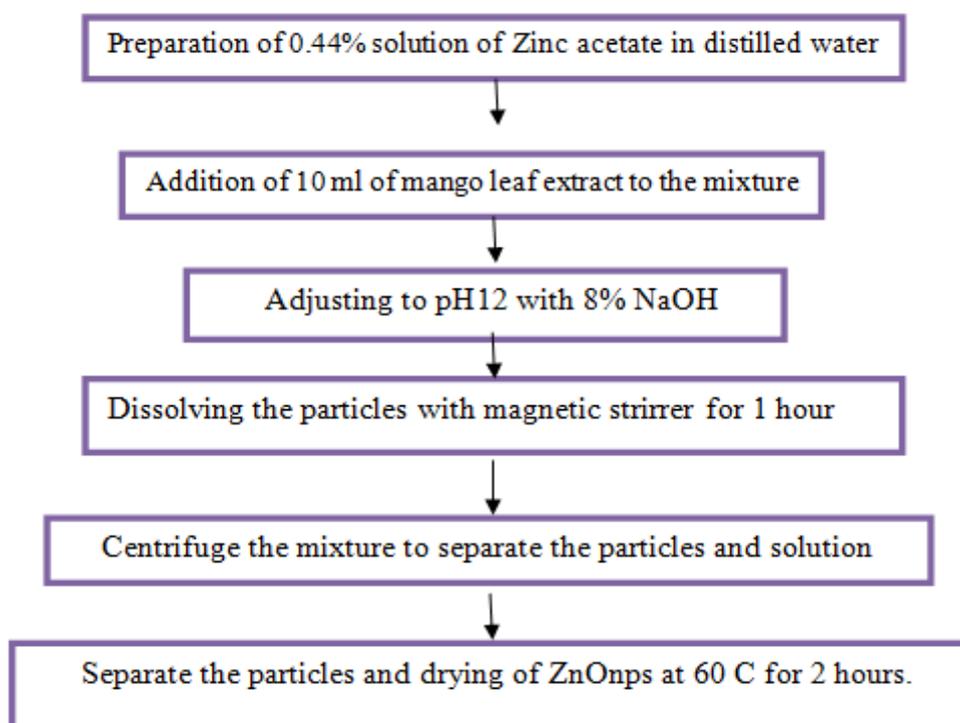


Fig. 1. Biosynthesis of *Mangifera indica L. Anacardiaceae* zinc oxide nanoparticles

2.5 Fourier Transformed Infrared Spectroscopy (FTIR)

The functional groups of nanoparticle from *Mangifera indica L. Anacardiaceae* were recorded using Fourier Transform Infrared Spectroscopy using SHIMADZU Miracle spectrophotometer (FTIR 820IPC) KBr techniques. Infrared spectra were recorded between ranges 4000 and 400 cm^{-1} .

2.6 X-Ray Diffraction (XRD) Analysis

X-ray diffraction is based on constructive interference of monochromatic X-rays and a crystalline sample. These X-rays are generated by a cathode ray tube, filtered to produce monochromatic radiation, collimated to contemplate and directed towards the sample. The interaction of the incident rays with the sample produces constructive interference (and a diffracted ray) when conditions satisfy Bragg's Law ($n\lambda = 2d \sin\theta$). These diffracted X-rays are then detected, processed and counted. By scanning the sample through a range of 2θ angles, all feasible diffraction orders of the pattern have to be attained because of the random direction of the crushed material. Alteration of the diffraction peaks to d-spacing lets in detection of the mineral since each mineral has a set of particular d-spacing. Commonly, this is reached by evaluation of d-spacing with standard position [10].

3. RESULTS AND DISCUSSION

3.1 Fourier Transformed Infrared Spectroscopy (FTIR) Analysis

FTIR analysis was done for the characterization of functional group present in zinc oxide

nanoparticles synthesized *Mangifera indica L. anacardiaceae*. The interpretation of IR spectra helps to determine the functional groups present within organic compounds. This can be determined by examining each spectrum for common IR stretches that are characteristics of organic functional groups.

Table 1 and Fig. 2 show the absorbance spectra recorded for *Mangifera indica L. Anacardiaceae* zinc oxide nano particles.

The peak frequency observed for *Mangifera indica L. anacardiaceae* zinc oxide nanoparticles 1411.89 cm^{-1} same to C=C extending and is between the standard frequencies (1400 – 1600 cm^{-1}). The peak frequency observed at 1033.85 cm^{-1} corresponds to the C-F extending and the standard frequency is 1000-1350 cm^{-1} . The peak frequency observed at 910.40 cm^{-1} corresponds to the =C-H bend and the standard frequency is 910+990 cm^{-1} . The peak frequency observed at 756.16 cm^{-1} corresponds to the C-Cl extending and the standard frequency is 750-850 cm^{-1} . The peak frequency observed at 694.37 cm^{-1} corresponds to the C-H extending and the standard frequency is 690-710 cm^{-1} . The peak frequency observed at 617.22 cm^{-1} corresponds to the C-Br extending and the standard frequency is 500-680 cm^{-1} . The peak frequency observed at 540.07 cm^{-1} corresponds to the C-Br extending and the standard frequency is 500-680 cm^{-1} . The peak frequency observed at 478.35 cm^{-1} corresponds to the C-I lengthen and the standard frequency is 200-500 cm^{-1} . The peak frequency observed at 455.20 cm^{-1} corresponds to the C-I elongation and the standard frequency is 200-500 cm^{-1} .

Table 1. FTIR spectra values of the *Mangifera indica L. Anacardiaceae* zinc oxide nano particles

Frequency standard (cm^{-1})	Frequency Obtained (cm^{-1})	Intensity	Functional Group
1400 - 1600	1411.89	Small and very week	Aromatic compound Ring C=C stretch
1000 -1350	1033.85	Small and very strong	Alkyl halides C-F stretch
910+990	910.40	Medium + strong	Alkenes =C-H bend
750 - 850	756.16	Small and very week	Alkyl halides C-Cl stretch
690-710	694.37	Small and very week	Aromatic compound C-H stretch
500-680	617.22	Small and very week	Alkyl halides C-Br stretch
500-680	540.07	very strong	Alkyl halides C-Br stretch
200-500	478.35	Strong	Alkyl halides C-I stretch
200-500	455.20	very strong	Alkyl halides C-I stretch

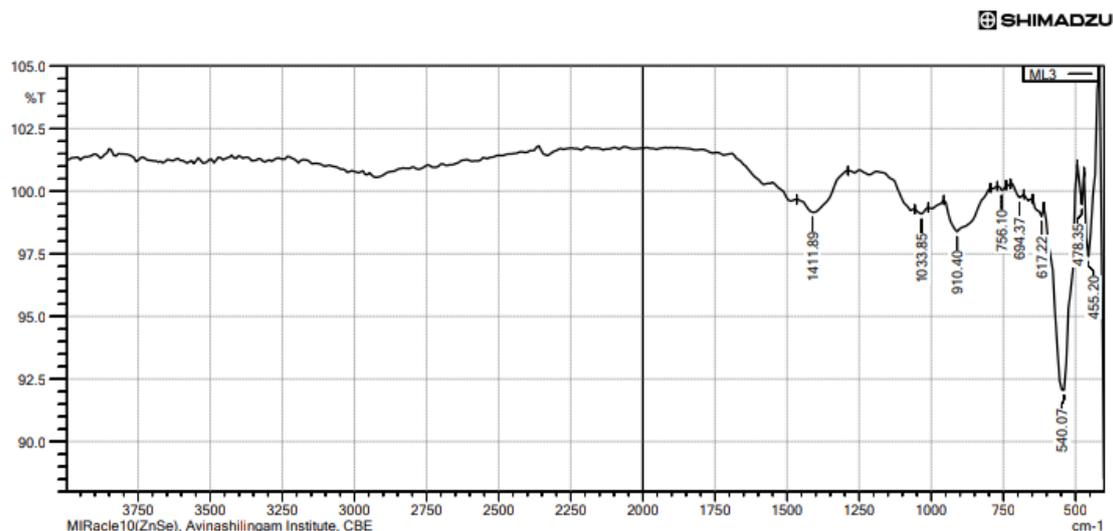


Fig. 2. FTIR Spectra of Zinc oxide nano particle from *mangifera indica L.-Anacardiaceae*

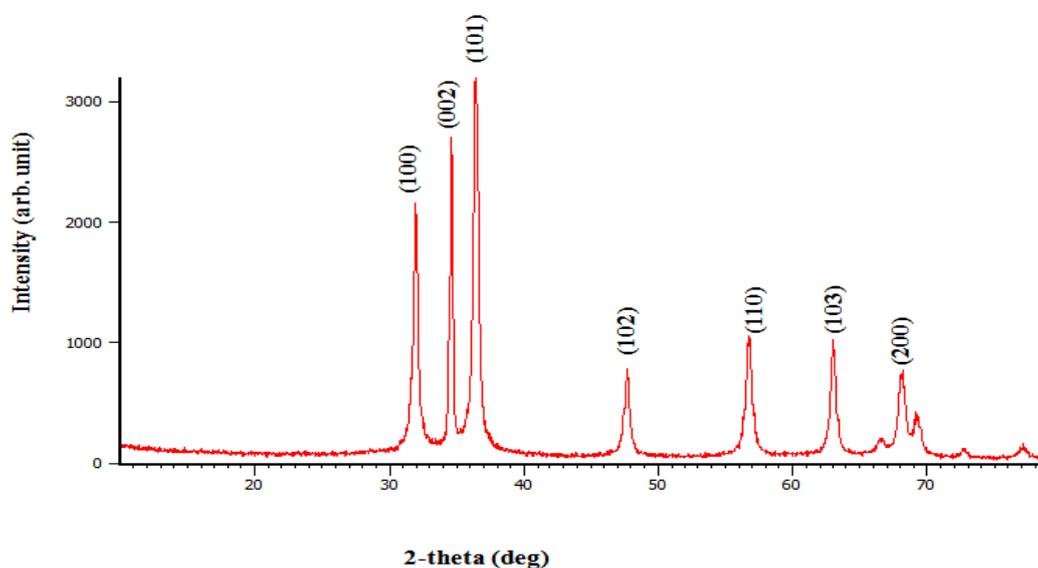


Fig. 3. X-Ray Diffraction of Zinc Oxide Nanoparticles from *Mangifera Indica L. Anacardiaceae*

3.2 X-Ray Diffraction Analysis

The X-Ray Diffraction (XRD) pattern of the synthesized ZnO nanoparticles obtained was shown in Fig. 3. The peaks were obtained at 2θ values of 31.750° , 34.407° , 36.232° , 47.523° and 56.565° are associated with (100), (002), (101), (110), and (102) respectively and all the peaks of diffraction are well indexed to the Zincite structure of hexagonal ZnO. The average particle size calculated using XRD pattern by applying Scherer formula was 26 nm". These results

coincidence with the study by Narayana et al. [11] studied in *mangifera indica*.

$$D = 0.9\lambda / (\beta \cos \theta) \quad (1)$$

4. CONCLUSION

Zinc oxide nanoparticles have been synthesized from *Mangifera indica L. anacardiaceae* was studied in this article. "Green synthesis is highly economical and non - toxic method for synthesis of zinc oxide nanoparticles." Functional group

present in zinc oxide nanoparticles was done by FTIR analysis for the characterization. Analysis of XRD proved that the crystalline nature of the zinc oxide nano particles.

CONSENT

Not applicable.

ETHICAL APPROVALS

We conducted our research after obtaining proper IEC approval.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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