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GREEN SYNTHESIS OF ZINC OXIDE NANOPARTICLES USING CARICA PAPAYA LEAVE EXTRACT AND THEIR CHARACTERIZATION

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Abstract

In this work, an environmental benign, Carica Papaya leaf extract was applied as an eco-friendly stabilizing agent to synthesize zinc oxide nanoparticles (ZnO NPs). To produce ZnO NPs,50 ml of leaf extract and 50 gm of ZnNO3 were added during the synthesis. The produced ZnO NPs were characterized using FTIR, which confirmed the transformation of functional groups through Zn–O. The XRD analysis confirmed the monoclinic crystalline structure and purity of the material. SEM images confirm the nanoparticles formation. The results revealed that the Carica leaf extract is a good stabilizing agent which reduces the size of particles significantly at higher concentrations and altered shapes to spherical. Hence, it Carica papaya leaf extract could be applied as a green stabilizing agent to fabricate the ZnO NPs.

Keywords: Carica papaya leaf extract, Green synthesis, ZnO, Characterization.

1 Introduction

Carica papaya L. (papaya) from family Caricaceae, a native to Mexico and northern South America, is now naturalized in many parts of the world including tropical and subtropical regions. Papaya also reported being a rich source of the digestive enzyme papain, which has applications in cosmetics, brewing industries in, tenderizing meat and pharmaceuticals. The raw fruit of papaya has laxative property and along with the fruit, the leaves are also use fulin pyrexia, diabetes, syphilis, and in the healing of wounds. Leaf and fruit extract of papaya exhibit antimicrobial and antioxidant activity due to the presence of phenols, vitamins, and enzymes.[1] The scattered reports (phytochemical/phytochemistry, pharmacological activities, nanoparticle fabrication from different plant parts, waste utilization, and some other miscellaneous uses of C. papaya) are collected and presented as taken together, we herein review those findings, which highlighted the isolated phytochemical compounds present in C. papaya plants, their pharmacological activities.[3] The biological approaches of papaya make it a promising candidate for the treatment of a variety of diseases and conditions. However, further research is needed to fully understand its potential benefits and to develop effective treatments based on its bioactive compounds.

Zinc oxide nanoparticles (ZnO NPs) are particles less than 100 nanometers in size. They have received significant attention in recent years due to their unique properties and potential applications in various fields. One of the main advantages of ZnO NPs is their high surface area to volume ratio, which allows for increased reactivity and catalytic activity.[4] They are also highly stable and have excellent biocompatibility, making them suitable for use in medical applications such as drug delivery and tissue engineering. [5] In addition, ZnO NPs have antimicrobial properties and have been shown to be effective against a wide range of microorganisms, including bacteria and fungi. This makes them a promising candidate for use in the development of antimicrobial coatings [6,7]. Zinc is an essential trace metal. Recent reports indicate that the NPs, including Zinc oxide nanoparticles (ZnO NPs) synthesized by the green technique, was non-toxic, bio-safe, bio-compatible, and had good inhibition against various microorganisms compared to chemically derived nanoparticles.[8]

Most of inorganic antibacterial agents are in the form of metal, which release its ions to retard prominently Gram-negative bacteria.[9] While organic antibacterial agents are susceptible to Gram-positive bacteria through organelle modification and disturbance of bio-chemical pathway. Therefore, in order to minimize the impact on the environment, green synthesis processes have been used to synthesize ZnO nanoparticles (ZnO NPs).[10,11] Green synthesis is a method to produce nanoparticles using microorganisms and plants with biomedical applications. This method has many advantages, such as environmental friendliness, cost effectiveness, biocompatibility, and safety.[12,13] Green synthesis of zinc oxide nanoparticles (ZnO NPs) involves the use of plant extracts, microorganisms, or other natural sources as reducing and stabilizing agents. This method is eco-friendly and sustainable, as it avoids the use of toxic

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chemicals and reduces energy consumption. [14,15]

2 Experimental

2.1. Materials and methods:

All glassware was rinsed with sterile distilled water and dried in a hot air oven set to 40 degrees Celsius. [16,17&18]. The fresh carica papaya leaves are taken. the leaves are washed with distilled water .The cleaned leaves are cut into small pieces and extract are collected.50 ml of carica papaya leaf extract are taken in the 250 ml beaker and 50 ml of $ZnNO_3$ solution are added along with 100 ml distilled water, after that the mixture is allowed to boiled for 60 minutes in magnetic stirrer. [19,20&21] The extract was cooled in the room temperature. Finally the extract was filtered with whattman filtered paper. [22,23] Finally, a brown colour powder was obtained, which was handled and packed with care for characterization.[24,25] extract was filtered with whattman filtered paper. [22,23] Finally, a brown colour powder was obtained, which was handled and packed with care for characterization.[24,25]

2.2 MATERIALS CHARACTERIZATION:

2.2.1.X-Ray Diffraction (XRD) Analysis

Crystalline property of the ZnO NPs was analyzed by using advanced diffractometer using Cu–Ka radiation. The operated voltage of the instrument was 40 kV and a current of 30 mA with the wavelength of 1.5406 A°. The diffracted peaks were recorded from 10° to 90° of 2θ angles. The samples for the XRD analysis were prepared in a similar way to that of FTIR analysis. The XRD spectra were obtained at Vellore Institute of technology, Vellore.

2.2.2. FTIR SPECTROSCOPY:

Functional group and the metal-oxygen bond formation in synthesized ZnO NPs was assessed by Fourier transform infrared spectrascopy. The IR spectra of the samples were measured by KBr pellets. Synthesized ZnO NPs powder samples were measured using Jasco 6300 FT-IR spectrophotometer in the range of 4000-400 cm^{-1}. The FTIR spectra were obtained at Government Engineering College, Bargur, Krishnagiri.

2.2.3. UV - VISIBLE SPECTROSCOPY:

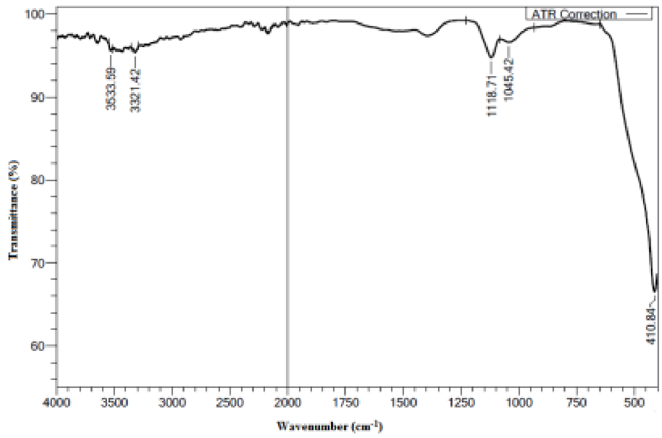

Fig 2 FTIR spectrum of ZnO nanoparticles

The formation of ZnO NPs was assessed by UV–Visible spectroscopy. The absorption spectra of the samples were recorded using UV–Visible spectrophotometer operated at a resolution of 1 nm in the range 200-800 nm. The UV-Vis spectra was obtained at Government Engineering College, Bargur, Krishnagiri.

2.2.4.SEM - EDAX SPECTROSCOPY:

Formation of the ZnO NPs was identified by scanning electron microscope with the resolution of 15 nm. The magnification of the instrument was 5×3, 00,000 (both in high and low vacuum modes). The SEM-EDS (JEOL Model JSM-6390LV) was obtained from VIT, Vellore.

3 Results and Discussion

3.1. X-Ray Diffraction (XRD) Analysis

X-ray diffraction (XRD) is a versatile technique that can be applied to a wide variety of sample types. The optimal sample for XRD analysis is a smooth-surfaced crystalline powder that has been properly mounted in the sample holder at a 45 degree angle.

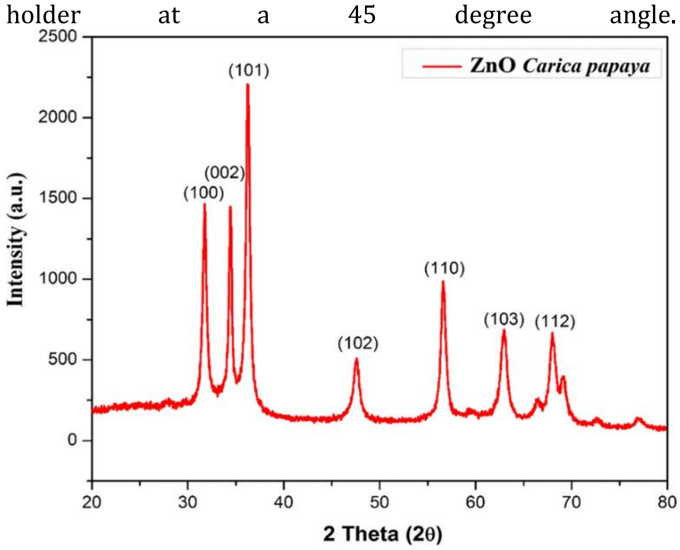

Fig 1 XRD spectrum of zinc oxide nanoparticles

ZnO nanoparticles were confirmed by the spectrum. For the ZnO nanoparticle, 2θ value in the peak appears in the spectrum in the following ranging values, 31.75 ˚, 34.40 ˚, 36.23 ˚, 47.53˚,56.59 ˚,62.85 ˚,66.39 ˚,67.94 ˚, and 69.07 ˚.

3.2 FTIR ANALYSIS:

The FT-IR spectrum observed the different characteristic functional group correlate with synthesized nanoparticles. The information about vibrational and rotational modes of motion of a molecule is given by the FTIR spectrum. The characteristic functional group present in synthesized zinc oxide can be confirmed by peaks in graph.

The absorption peak for the sample in the range of 3533.59,3321.42,1178.71,1045.42 and 410.84. The absorption peak for the zinc oxide nanoparticles is in the range of 410 to 575.9 cm^{-1}. The stretching vibration of hydroxyl compounds at 3321.42 cm^{-1} and 3533.59 cm^{-1}. The C-O stretching vibrational at 1045.42 cm^{-1}. The peak at 1178.71 cm^{-1} is corresponds to the primary alcohol . Therefore, FTIR spectrum confirms the formation of ZnO nanoparticles.

3.3. UV – VISIBLE ANALYSIS:

The most widely used technique for the structural characterization of synthesized nanoparticles is UV–Visible spectroscopy. The entire properties of the materials can be changed by the size of the nanoparticles. The green synthesis of zinc oxide nanoparticles using carcia papaya leaves was studied. The absorption peak for the zinc oxide nanoparticles has observed in the range of 250 to 300 nm. The UV-visible spectroscopy confirmed the formation of zinc oxide nanoparticles.

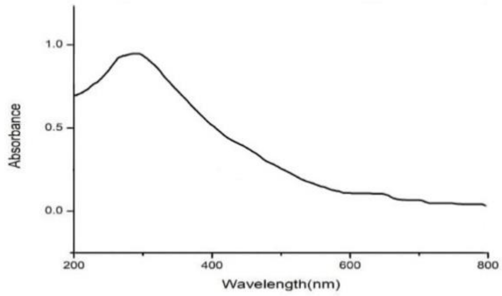

Fig 3 UV spectrum of ZnO nanoparticles

3.4 SEM – EDAX ANALYSIS:

SEM analysis is done to visible the shape and size of nanoparticles. Scanning electron microscope was used to determine the shape of carica leave extract of ZnO nanoparticles. SEM image were seen in different magnification ranges like 2μm – 20kV which clearly demonstrated the presence of spherical shaped nanoparticle with mean the average diameter. The presence of metallic Zinc oxide in the synthesis of ZnO nanoparticles was confirmed by EDAX analysis. The SEM images exhibit agglomerated particles as seen in the figure. Though there are no specific shapes of the particles are observed from the SEM images, it confirmed the formation of ZnO NPs. As seen in the figure, SEM images exhibit agglomerated spherical shape particles with few lengthy particles.

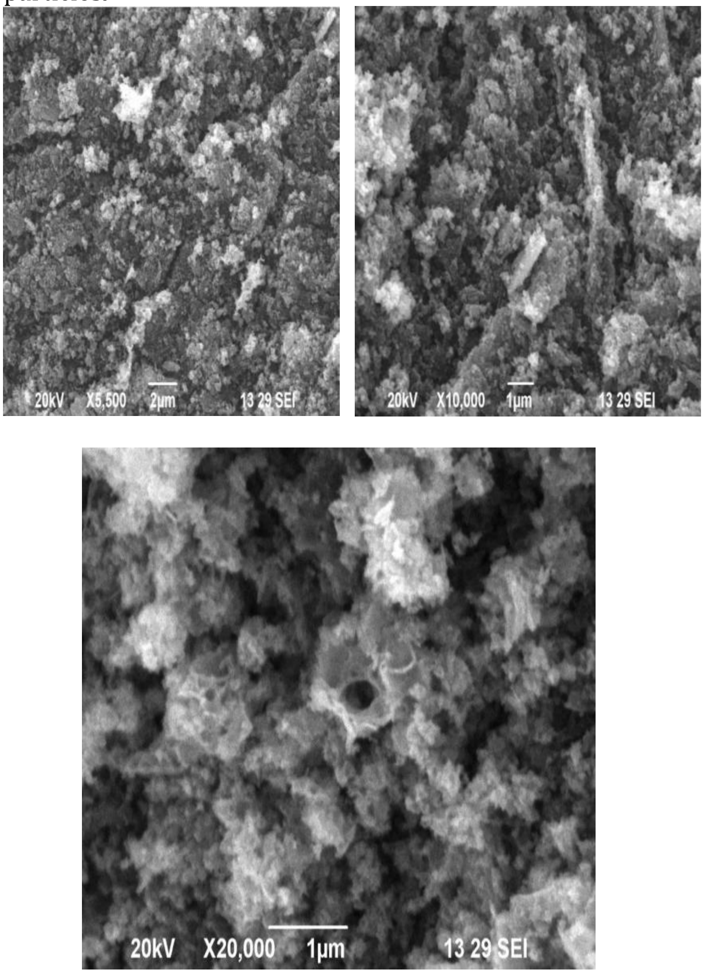

Figure 4. SEM – EDAX image of Zinc oxide nanoparticles.

4 Conclusions

Green synthesis of zinc oxide nanoparticles using carcia papaya leaf extract were successfully synthesized. The XRD, UV-Vis and FT-IR spectrum are used to study about crystal structure, impurities and size of the zinc oxide nanoparticles. In XRD purities of the sample can be determined and the 2Ɵ values are confirmed the presence of zinc oxide nanoparticles. UV-visible studies gives absorption peak for the zinc oxide nanoparticles from the range 250 to 300 nm and it also confirmed the formation of zinc oxide nanoparticles. In FT-IR spectrum zinc oxide nanoparticles gives stretching vibrational and the absorption peak for the zinc oxide nanoparticles is in the range of 410 to 575.9 cm^{-1}. The advantage of uses of plant extract is to reduce the toxicity and eco-friendly.

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