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# Eco-friendly synthesis of ZnONPs using *Ocimum tenuiflorum* leaf extract and its characterization

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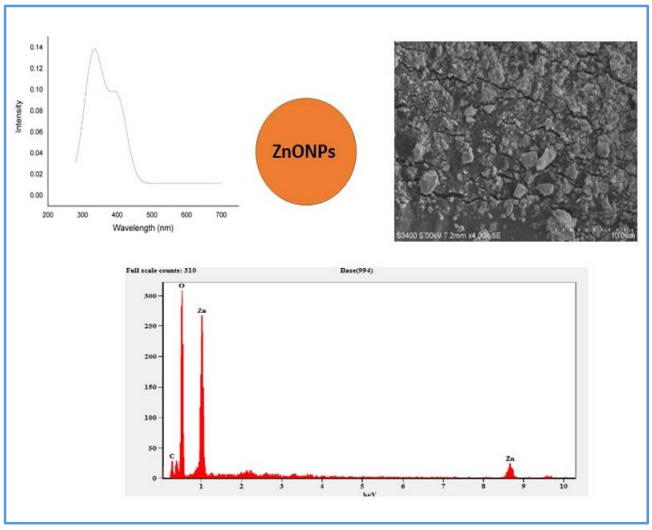
## ABSTRACT

*In this paper, an environmentally benign ZnONPs was prepared using Ocimum tenuiflorum leaf extract. Here we have used the leaves of Ocimum tenuiflorum plant. Green synthesis is an environmentally friendly method which reduces inert gases, toxic chemicals, radiations etc. when compared to other techniques of synthesis of nanoparticles. ZnO nanoparticles exhibit antibacterial, anti-corrosive, anti-fungal, and UV filtering properties. The prepared nanoparticles are characterized using X-ray diffraction (XRD), Scanning electron microscope (SEM), UV Absorption spectrum and emission spectrum. The average particle size is calculated to be in the range of 12-17 nm.*

## Graphical Abstract:




**Keywords:** ZnO nanoparticles, *Ocimum tenuiflorum*, X-ray diffraction studies.

## INTRODUCTION

Nanotechnology is the term given to those areas of science and engineering where phenomena that take place at dimensions in the nanometer scale are utilized in the design characterization, production and application of materials, structures, devices and systems. Nanotechnology can be very beneficial and has the potential to have a significant impact on society. It has already been embraced by the communication and information sectors. These particles have a dimension of 10–100 nm nanotechnology and involve new materials that have very different properties and new effects compared to the same materials made at larger sizes. Due to the very high surface-to-volume ratio of nanoparticles compared to larger particles [**1, 2**].

Zinc oxide (ZnO) nanoparticles are available as powders and dispersions. These nanoparticles exhibit antibacterial [**2**], anti-corrosive, anti-fungal, and UV filtering properties. Some other properties of ZnO nanoparticles are large binding energy, wide band gap, and high piezoelectric properties. ZnO nanoparticles have a wide range of applications like gas sensors [**3**], chemical sensors, lasers, diodes, solar cells [**4**], and drug delivery.

Conventional methods for synthesizing ZnO nanoparticles include chemical reduction, laser ablations, and the sol-gel method. These methods require toxic chemicals, high pressure, radiation, and inert gases. While green synthesis methods are environmentally friendly, minimize waste, plant leaf extracts have a high potential to reduce metal ions in a shorter time and act as stabilizing and reducing agents.

Here the synthesis of ZnO nanoparticles is carried out using the leaves of *Ocimum tenuiflorum* also known as Tulsi leaves which belong to the *Lamiacece* family. The chemical constituent of *Ocimum tenuiflorum* leaves include alkaloids, linalool, ursolic acid, aromatic compounds, flavons, and tannins.

## MATERIALS AND METHODS

All the materials such as Zinc nitrate, distilled water and the equipment's required for the synthesis was taken from the chemistry laboratory. The leaves of *Ocimum tenuiflorum* plant were collected from the Mysuru area.

**Preparation of leaf extract of *Ocimum tenuiflorum*:** To prepare the leaf extract of the *Ocimum tenuiflorum* plant the leaves are washed thoroughly with water and dried. 2 gm of dried leaves are taken in a 250 mL borosil beaker with 100 mL of distilled water. This solution is boiled for 30mins until the solution turns reddish in colour. The solution is cooled at room temperature. The leaves extract is filtered using filter paper. Figure 1 shows the leaves extract of the *Ocimum tenuiflorum* plant.

**Figure 1.** Leaf extraction of *Ocimum tenuiflorum* plant.

**Green synthesis of ZnO nanoparticles using of leaf extract of *Ocimum tenuiflorum*:** For the synthesis of ZnO nanoparticles 10 mL of *Ocimum tenuiflorum* leaf extract was taken boiled to 70"C using magnetic stirrer heater. Then 5gm of zinc nitrate was added to the leaf extract of *Ocimum tenuiflorum*, the mixture was heated to reduce to a deep red paste. The paste is dried in the dryer at temperature 100-120"C for 2 to 3 days. Zinc oxide nanoparticles obtained is in the form of light-yellow coloured powder. This powder is mashed in ceramic mortar pestle to get finer nature for characterization [5].

## RESULTS AND DISCUSSION

**X-ray diffraction studies:** The XRD pattern of the prepared Zinc oxide nanoparticles is shown in figure 2. The observed diffraction peaks of ZnO nanoparticles is $2\theta$=36.20°. The Full width half maximum value ranges is 0.6012. The average crystalline size is 14.53 nm [5, 6].

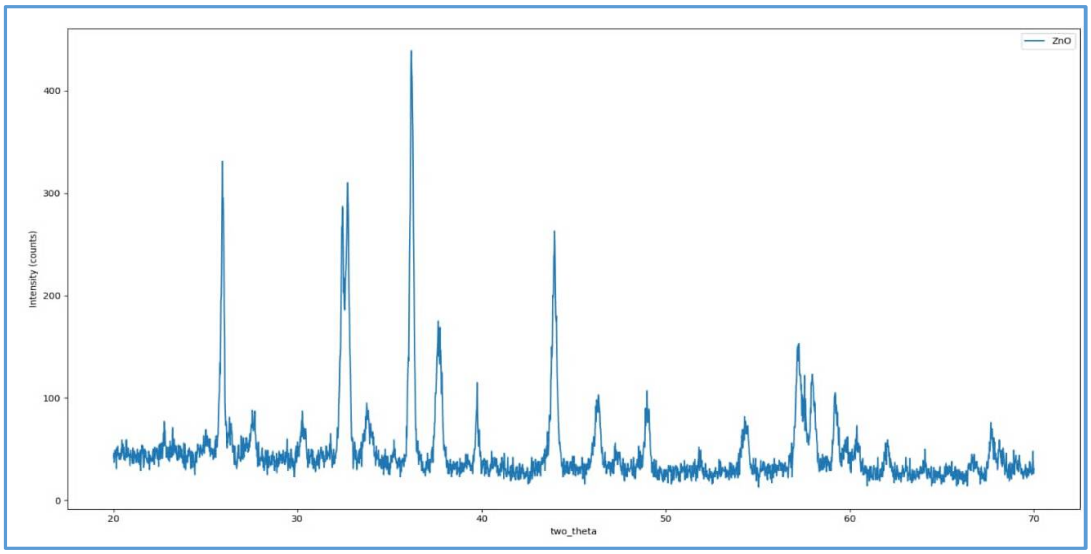
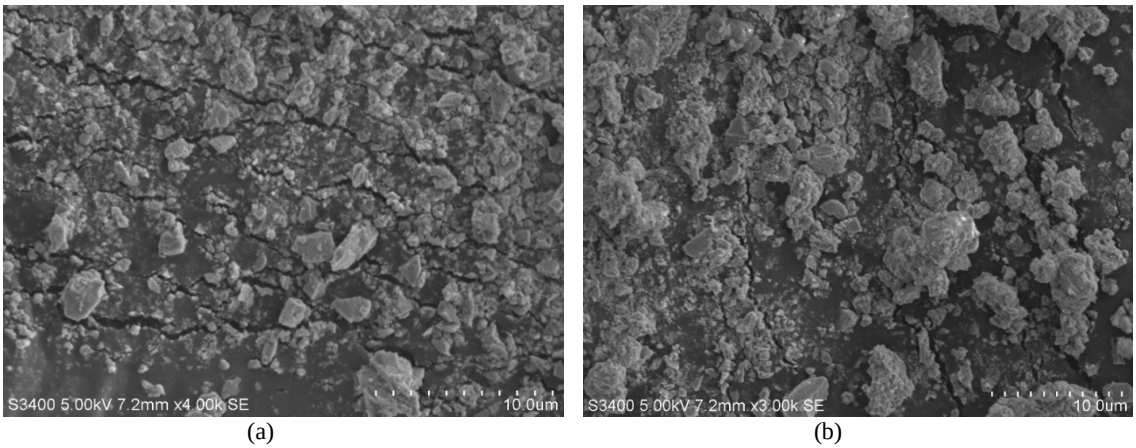



**Figure 2.** XRD pattern of as-prepared ZnONPs.

**SEM- Scanning electron microscope:** The prepared nanoparticles are subjected to Scanning Electron Microscopy and the high resolved images are shown in figures 3 (a and b). The average particle size was found to be in the range of 12-17 nm which well matches with XRD results [7].




(a) (b)

**Figure 3.** SEM images of as-prepared ZnONPs in two different magnifications.

**Energy-dispersive x-ray spectroscopy (EDS):** The composition of the prepared sample was determined by Energy Dispersive X-ray Spectroscopic analysis, where the mass percentage of Zinc obtained is 37.16% and that of oxygen is 46.49%. is shown in figure 4 and table 1. The presence of carbon shows that it is absorbed on the surface of the metal from the leaves during the process of boiling. The energy Dispersive X-ray spectroscopy analysis also determines the presence of Zn isotopes [8].

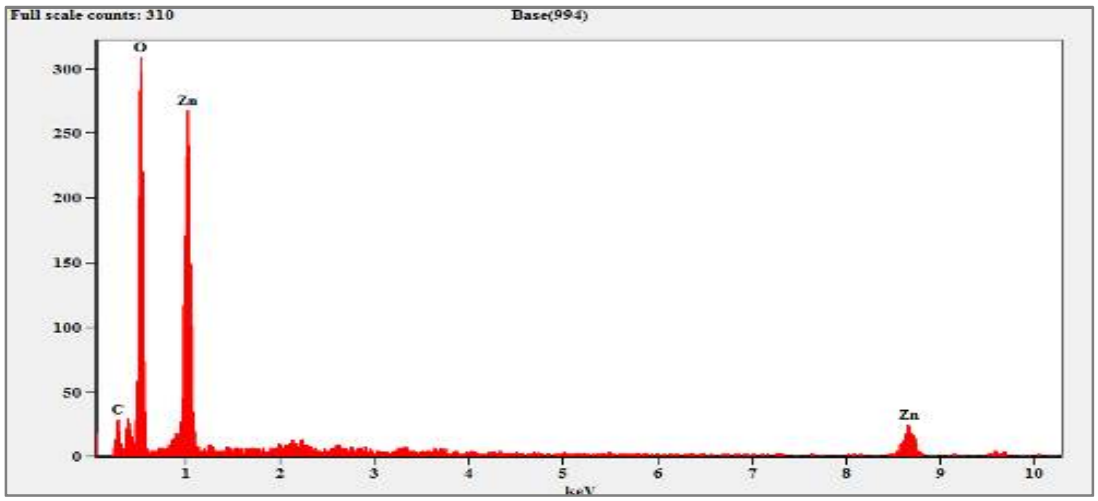



**Figure 4. EDS analysis of as-prepared ZnONPs.**

**Table 1.** Composition of ZnO nanoparticles

| Element Line | Weight % | Weight % Error | Atom % |
|---|---|---|---|
| C K | 16.35 | ±1.92 | 28.14 |
| O K | 46.49 | ±1.33 | 60.10 |
| Zn K | 37.16 | ±.73 | 11.75 |
| Zn L | -- | -- | -- |
| Total | 100.00 | -- | 100.00 |

**UV-Visible absorption spectrum:** The Absorption Spectrum of the prepared ZnO nanoparticles is shown in the figure 5. The plot shows the measurement of Absorbance as a function of wavelength which ranges from 200-700 nm. The absorbance of the prepared NP's ranges from 330-420 nm and the major absorption coefficient was observed at 342 nm [8].

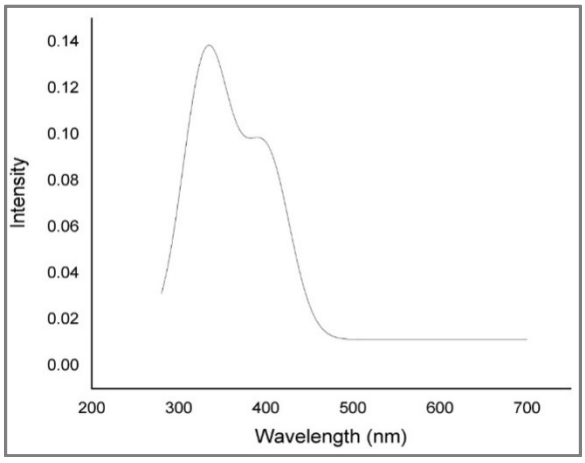



**Figure 5.** Absorption spectrum of as-prepared ZnONPs.

**Emission spectrum:** The figure 6 shows the emission spectrum of the prepared ZnO nanoparticles maintained at 350 nm excitation wavelength. Two major peaks were observed at 352 and 702 nm. Two other minor peaks were observed near to 400 nm [**8**].

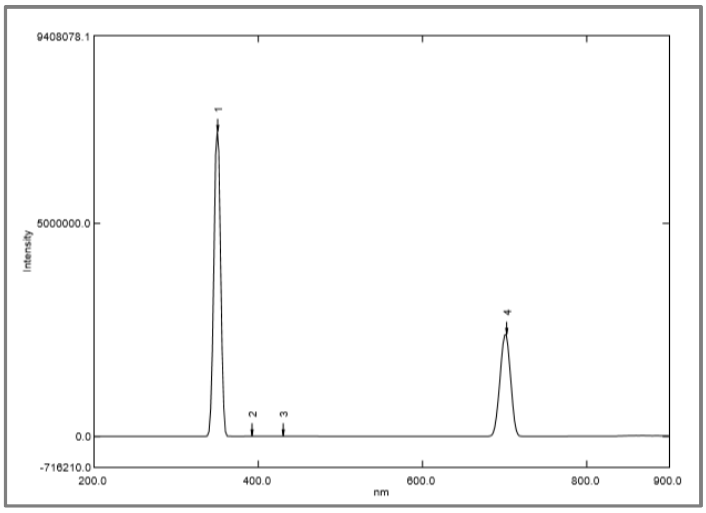



**Figure 6. Emission spectrum of as-prepared ZnONPs.**

## APPLICATION

This is one of the facile and easy methods for the synthesis of nanomaterials through green approach.

## CONCLUSION

To sum up, we have synthesized ZnONPs through a green approach using *Ocimum tenuiflorum* leaf extract. Green synthesis is an eco-friendly method which reduces the use of chemicals and radiations while synthesizing nanoparticles. The as-prepared ZnONPs were subjected to different characterization techniques like XRD, SEM and EDS for crystallinity, morphology and elemental analysis. The average crystalline size was found to be 14.53 nm. The same was confirmed with the average particle size which ranges from 12-17 nm. The absorption spectrum of the prepared sample was studied and found to be in the range of 330-420 nm. In which the major peak was observed at 342 nm. The emission spectrum of the same sample was studied and found that it emits at 352 nm and 702 nm. The prepared nanoparticles can be used in various industrial applications, low-cost LED's and various fluorescent applications.

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