IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Green Synthesis And Characterization Of Zinc Oxide Nanoparticles Using Kalanchoe Pinnate Leaf Extract.

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Abstract:

The interaction between zinc oxide (ZnO) nanoparticles and *Kalanchoe pinnate*, a medicinal plant with various therapeutic properties, was investigation in this study. ZnO nanoparticles were synthesized and characterized through UV, FTIR, and FE-SEM. It examined, revealing size-dependent effects on plant growth and enhanced the accumulation of secondary metabolites, while higher concentrations induced cytotoxicity and oxidative stress. These finding suggested potential applications in enhancing therapeutic properties of k. pinnate extracts, emphasizing the importance of dosage control. Further studies are elucidating underlying mechanisms and optimize nanoparticle use in plant- based therapies.

Key words: Zinc oxide (ZnO), Kalanchoe pinnate.

1. Introduction:

The National Nanotechnology initiative defines nanotechnology as the manipulation of matter having a minimum dimension ranging from 1 to 100 nanometers. The terms "nanotechnologies" and "nanoscale technologies" are frequently used to refer to the large category of studies and application that have size in common. These nanoparticles are synthesized using physical, chemical, or biological methods. Color, density, hardness, and melting and boiling points are examples of physical attributes. A substance's capacity to go through a particular chemical change is described be its chemical property. The green synthesis method is found to be cost-effective, non-toxic, and biodegradable in nature. ZnO is the formula for the inorganic compound zinc oxide. It is an insoluble white powder in water. Batteries, semiconductors, ferrites, foo just a few of the materials and products that use zinc oxide as an additive. Zinc oxide is mostly created synthetically, despite the fact it is found naturally as the mineral zincite. These days, noble metal nanoparticles like silver, zinc oxide, gold, lead, etc. are created. However, zinc oxide nanoparticles are superior to other nanoparticles in the biological and pharmaceutical industries. There are two kinds of method used to create nanoparticles: Top-down method and bottom-up method. This study explores the green synthesis of zinc oxide nanoparticles using plant extracts, highlighting its cost-effectiveness, environmental friendliness, and potential biomedicine applications. It provides an in-depth understanding to the techniques used in this environmentally friendly synthesis. The paper reports the green synthesis of ZnO nanoparticles from a leaf extract of *kalanchoe pinnate.* The purpose of this work is to assess the characteristics of the resultant nanoparticles for possible uses and investigate the possibility of manufacturing ZnO nanoparticles using Kalanchoe pinnate extract. We want to create a sustainable and ecologically friendly method of producing zinc oxide nanoparticles by utilizing the phytochemical content of kalanchoe pinnate in nanoparticle synthesis. The Kalanchoe pinnata, a medicinal plant known for its diverse pharmacological properties, presents an intriguing candidate for green synthesis of ZnO nanoparticles.

2. Materials and methods:

Fig:1 Kalanchoe pinnate

The kalanchoe leaves of the plant are washed thoroughly with distilled water to remove dust and other particles. Take 50gm of leaves were weighted and sliced into small pieces and are crushed using a mortar and pestle by adding a sufficient amount of water. The extract was then pretreated by boiling it for 15min, which softens the cell membrane. Then filtering using Whatman No. 1 filter paper. In order to remove the debris, it is then centrifuged at 2400rpm for 5 min. Taken 100ml of distilled water and added 14g of Zn $(NO_3)_2.6H_2O$. Stirred for few minutes until the salt dissolved and added the centrifuged leaf extract. The mixture is stirred at 65°C for 20 min. The white colour was turned into pinkish red colour were then collected allowed to calcinate. The sample was calcinate at 400°C for 4hrs. At the same temperature until a thick yellow paste. The calcination removes the impurities present in the sample, and you get a purified form of the nanoparticles.

3. Results and discussion:

3.1 UV-visible spectroscopy:

The presence of secondary metabolites in plants reduces zinc ions in the solution to zinc oxide. The plant extract not only acts as reducing agents but as stabilizing agents as well. Ultraviolet visible spectroscopy was also used in order to determine the optical absorption spectra of ZnO nanoparticles. This was confirmed by taking the UV-visible spectrum analysis in the range of 200 nm – 2500 nm. The spectrum showed a peak at 2390 nm which is specific for ZnO nanoparticles. The bandgap energy was calculated using the formula

$$Eg = 1240/\lambda eV$$

$$= 1240/2390 eV$$

$$Eg = 0.5 \text{ eV}$$

and found in be 0.5 eV which is analysis to reported values of energy bandgap for ZnO nanoparticles. The absorbance (A) or transmittance (%T) or reflectance (%R), and change with time.

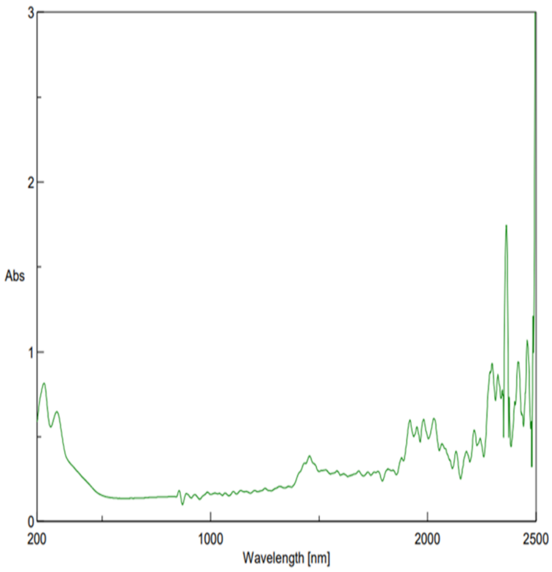

Fig:2 UV-visible absorbance spectra

The ZnO nanoparticles is tested for UV-Visible reflectance analysis. The spectrum confirms range wavelength in x-axis from 200nm to 2500nm. The spectrum showed peak of Zinc oxide (ZnO) nanoparticle is above 949nm. It provides information about the structure and composition of the medium.

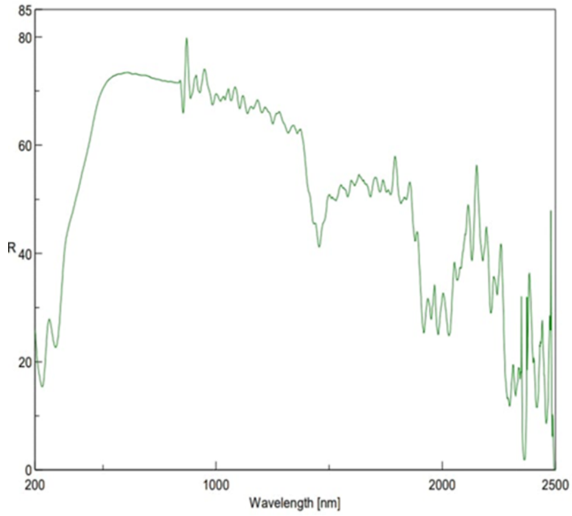

Fig:3 UV-visible reflectance spectra

3.2 FT-IR analysis:

FT-IR gives the composition and formation of functional groups of the synthesized ZnO nanoparticles. It also suggests that the formations of ZnO nanoparticles nanoparticles is due to the interaction of phenolic compounds, alkynes, terpenoids, and flavonoids. Fig. 5.2 represents FT-IR spectra of the synthesized ZnO in the range 400-4000 cm^{-1}. The functional groups were responsible for reducing zinc ions to ZnO, which was observed as bands. Each of the bands corresponds to various stretching modes.

The broad band observed at 3225 cm^{-1} corresponds to O–H bending. The C=C band range at 1643cm^{-1}. The band at 1313 cm^{-1} corresponds to C–N. The C–O stretching and the bands between 1000 and 1300 corresponds, and the multiple sharp bands at 492 cm^{-1} and 420 cm^{-1} are attributed to the presence of Zn–O stretching bands.

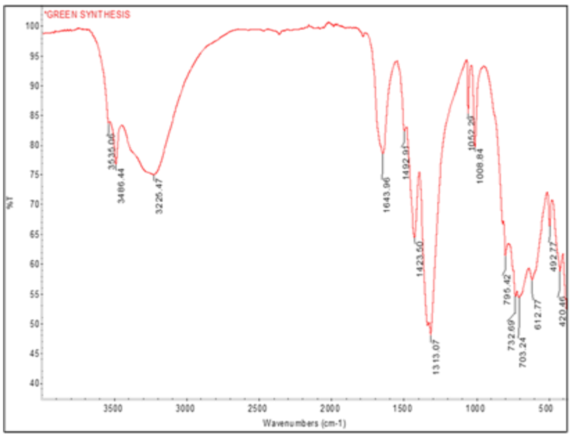

Fig:4 FTIR Spectrum

3.3 FESEM analysis:

FESEM images were taken in different magnifications to examine the shape and size of the nanoparticles synthesized, as shown in Fig.5.3. The surface morphology confirms the formation of nanoparticles in their agglomerated form. Various literature reports the effect of surface morphology ZnO. The particles were found to be rod shape and micron size which was further confirmed using below image.

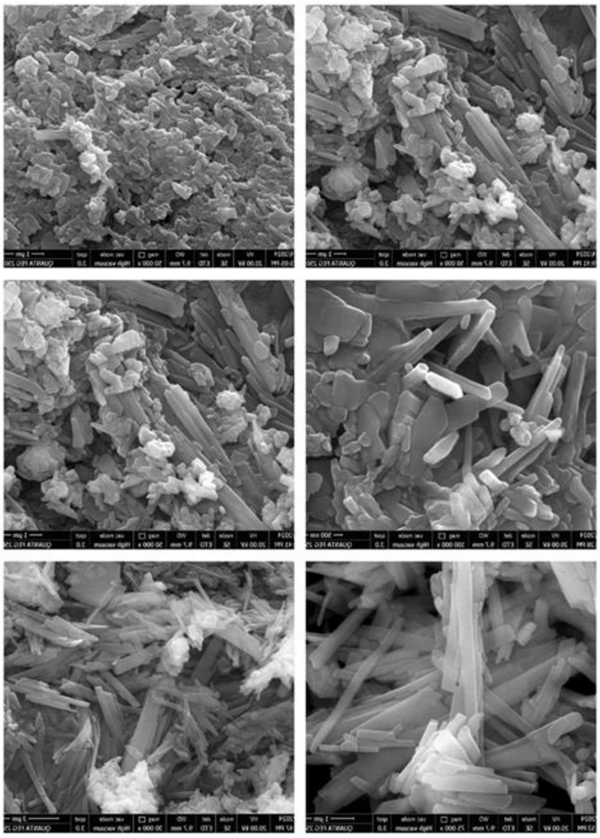

Fig:5 FESEM image

Table:1 Results of FT-IR analysis:

Wave number cm^{-1}	Nature of bond	Vibration assignment
$3225cm^{-1}$	O-H	Bending
$1643cm^{-1}$	C=C	Stretching
$1313cm^{-1}$	C-N	Stretching
$1052cm^{-1}$	C-O	Stretching
$732cm^{-1}$	=C-O	Asymmetric stretching
$420cm^{-1}$	Zn-O	Stretching

4. CONCLUSION:

The nanoparticles were successfully synthesized using the Nitrate derivative of Zinc and plant extract of the indigenous medicinal plant Kalanchoe Pinnate. The study reports a simple, cost-efficient, and greener method for synthesizing Zinc oxide from the leaves extract of the plant. Unlike the conventional techniques used to produce the nanoparticles, the green synthesis method was found to be ecofriendly. In UV visible spectrometer absorption peak was observed at 2390nm, and UV-Visible reflectance peak was observed at 949nm which is specific for Zinc oxide nanoparticles. The characterization carried out using Field emission scanning electron microscope (FESEM) reveals the presence of Zinc oxide nanoparticles in its agglomerated form. It is rod shape and micron size. The Fourier Transform-

Infra-red (FTIR) spectroscopic analysis shows absorption peak of Zn-O bonding between 492cm^{-1} and 420cm^{-1}. The various characterization methods carried out confirm the formation of nano zinc oxide.

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