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Medicinal Plant Leaf Extract-Assisted Synthesis of Zinc Oxide Nanoparticles for Antibacterial Study

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ABSTRACT

Pedalium Murex plant leaf extract-assisted synthesis, a quick and environmentally friendly microwave-heating approach to synthesis ZnO nanoparticles has been reported. X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission electron microscopy were used to examine the products (TEM). The sphere-like particles that make up the ZnO nanoparticles develop homo-centrically and used as antibacterial and bio-medical applications.

***Key words*:** Plant leaf extract, X-ray diffraction, Scanning electron microscopy, Antibacterial

Nanoparticles, nanowires and nanorods, which are one-dimensional nanometer-sized semiconductor materials, have attracted a lot of attention, because of their great potential for fundamental studies of the roles of dimensionality and size in their physical properties, as well as their use in optoelectronic nano-devices [1]. Zinc oxide (ZnO), a semiconductor with a relatively wide band gap (3.37 eV at ambient temperature) and a high exciton binding energy (60 meV), is one of the most promising materials for the manufacture of blue and ultraviolet (UV) optoelectronic devices, as well as gas sensing applications [2]. Various 1D ZnO nanostructures, such as rods, beltsns, rings, tetrapods, combs, sheets, and complicated structures [3-9] are currently the topic of significant investigation. The majority of synthetic techniques, on the other hand, involve high temperatures, extensive reaction times, and poisonous templates.

A new system, plant leaf extract-assisted synthesis, has recently been a hot topic in academia and industry [10]. Plant leaf extract-assisted synthesis are, low toxicity, nonflammability, a large electrochemical window, good solvents for many organic and inorganic materials, and high ionic conductively and thermal stability, making them appealing novel environmentally friendly solvents for organic chemical reactions [10], separations [11], and electrochemistry [12]. In contrast to their successful uses in organic and materials chemistry, plant leaf extract-assisted syntheses are still in their infancy in inorganic synthesis. Only a few publications utilising plant leaf extract-assisted synthesis as solvents have been published on the creation of hollow TiO_2 microspheres, mesoporous, nanosponges, super-microporous silica, palladium, platinum, iridium, and gold, single-crystalline tellurium nanorods and nanowires [13-20]. We recently used microwave heating to create ZnO nanosheet aggregates in a plant leaf extract-assisted synthesis [21]. By microwave heating in plant leaf extract-assisted synthesis, we expand this quick, seedless, template-free, and ecologically benign green method for the synthesis of ZnO nanostructures.

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MATERIALS AND METHODS

We employ plant leaf extract as solvents in a typical synthesis of ZnO nanostructure, which were prepared according to the literature [11]. Zn nitrate was dissolved in 50 mL of distilled water, and then plant leaf extract was slowly added to the solution and stirred for about 15 minutes to form a solution. After homogenization, the suspension was placed in an air-cooled household microwave oven (2.45 GHz, 750 W) and irradiated for 10 minutes. The products were washed twice with 100% ethanol and distilled water, and dried in vacuum at 60°C. Scanning electron microscopy (LEO1530), X-ray diffraction (Bruker D8 advance), and transmission electron microscopy (TEM) were used to describe and assess the morphology of the as-prepared products (JEOL, JEM- 200CX, at 200 kV).

RESULTS AND DISCUSSION

XRD analysis

Data in (Fig 1) shows a typical XRD pattern of the as-prepared ZnO sample. The hexagonal structure of ZnO (JCPDS card no. 36- 1451) with fine crystallinity may be indexed to all of the diffraction peaks. The intensity of the ZnO (002) peak is higher than the results of bulk ZnO when compared to typical diffraction patterns, indicating that the ZnO nanoparticles have a high growth orientation [22].

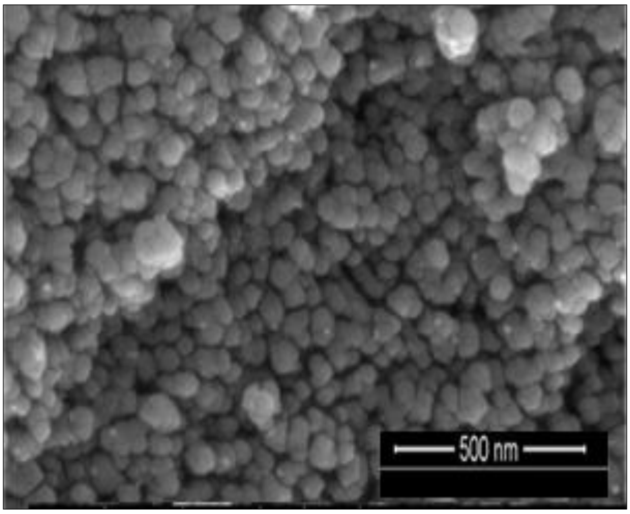

Fig 1 XRD pattern of ZnO sample

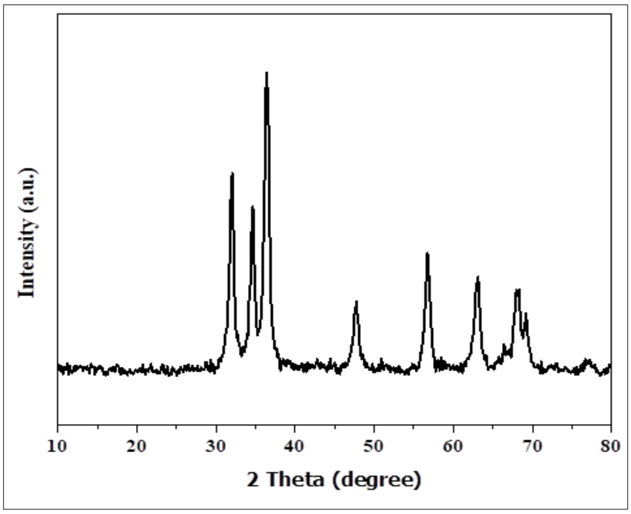

Fig 2 SEM image of ZnO sample

SEM analysis

(Fig 2) shows SEM morphologies of ZnO nanoparticles generated by microwave heating is shown in (Fig 2). The smooth surface with diameters of 10–15 nm was observed. Sphere like ZnO particles aggregates were obtained. The as-obtained ZnO spheres enlarged SEM image of the spherical ZnO nanostructure have many ZnO nanoparticles with diameters of 20–25 nm grew in the well distributed mode along the direction perpendicular to the centre of the sphere, and their morphologies are uneven [23-25]. Each particles out gradually, forming a hexagonal or near hexagonal shape with an outstanding layered structure.

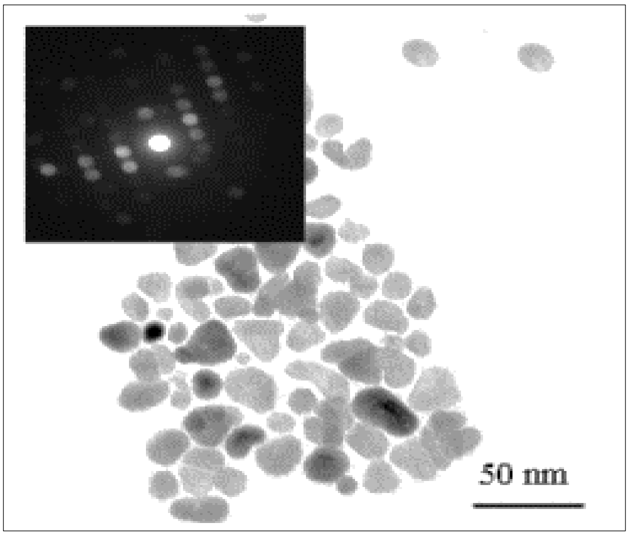

Fig 3 TEM image of ZnO sample

TEM analysis

TEM was used to further characterize the structural properties of the ZnO nanoparticles aggregates. The typical morphology of ZnO nanoparticles structure is shown in (Fig 3). It can be seen that nanoparticles ZnO is made up of ZnO growing homo centrically, rather than a simple collection of tiny crystallites [26-31]. (Fig 3) shows a TEM picture of a nanoparticle like ZnO hierarchical framework indicating good crystal quality.

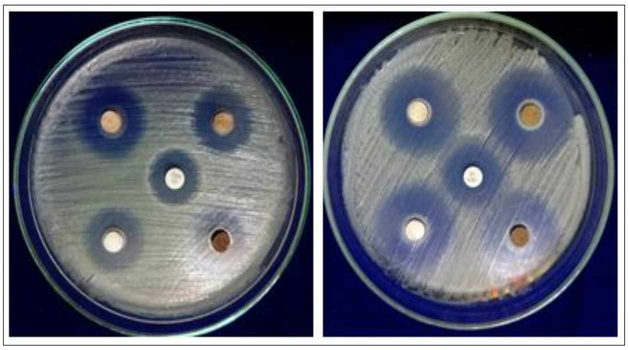

Fig 4 Antibacterial activity (a) *Klebsiellapneumonia*e and (b) *Staphylococcus aureus* of ZnO nanoparticles

Antibacterial activity

(Fig 4) shows the antibacterial activity of ZnO nanoparticles were investigated against gram negative (Klebsiellapneumoniae) and gram positive (Staphylococcus aureus) bacterial strains, respectively. From the images, it was found that there is no zone of inhibition over the control, which clearly shows that the zone of inhibition increases and influences higher antibacterial activity [32-35]. The particle size and surface area of the samples play a vital role in the antibacterial activity of synthesized samples.

CONCLUSION

Microwave-assisted heating in the *Pedalium Murex* plant extract-assisted synthesis has been used to successfully generate ZnO nanoparticles. This green technique is a quick, seedless, and template-free route that reduces reaction time and eliminates the need for costly synthetic methods. In the creation of different morphologies of ZnO, both plant leaf extract and microwave heating play a critical role. The current approach should be easily applied to similar nano/microstructures in other oxide materials, which is now being done.

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