Materials and its Characterization

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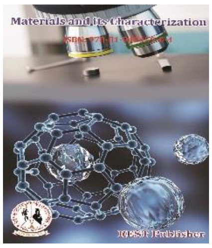

Green Synthesis of Zinc Oxide Nanoparticles Using Plant Extract as Natural Reducing Agent and Their Characterization

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Abstract: *In this paper, Zinc oxide nanoparticles (ZnO NPs) were synthesized using Curry leaves, Moringa oleifera leaves and Psidium guajava leaves extract. Thr structure of the green synthesized ZnO nanoparticles were characterized by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction pattern (XRD), Scanning electron microscope (SEM) coupled with energy dispersive X-ray diffraction study. Further, the above analysis methods confirmed the formation of ZnO nanoparticles. In conclusions, it is suggested that crystalline ZnO nanoparticles can be produced commercially using these plant extract as stabilizing agent.*

Keywords: *Curry leaves, Moringa oleifera, Psidium guajava, ZnO nanoparticles.*

1. INTRODUCTION

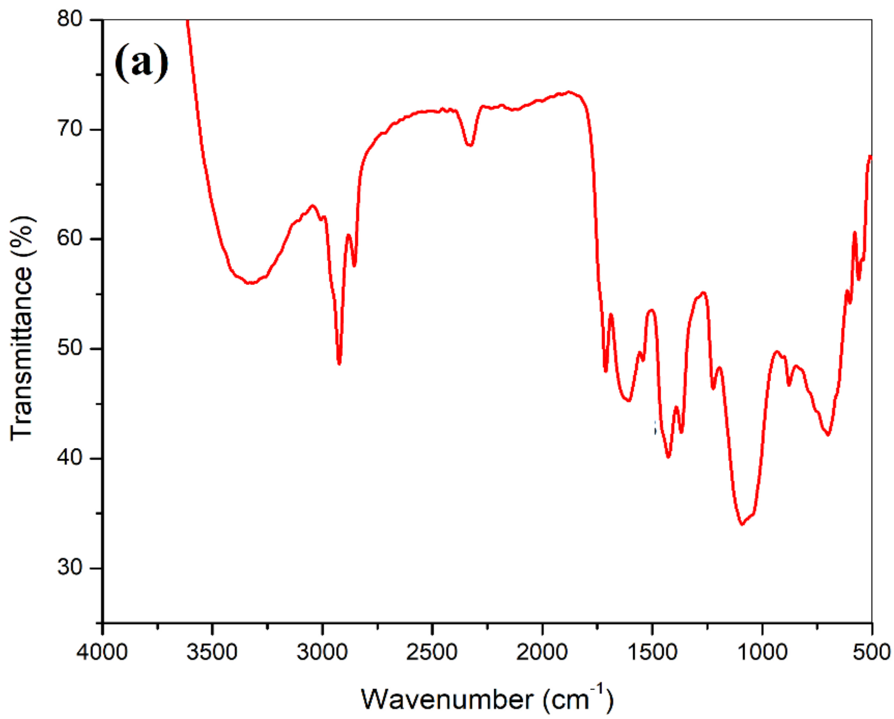
Zinc oxide nanoparticles (ZnO-NPs) attracted exciting research interest due to their vast horizon of applications such as smart UV sensors [Sosna-Głębska et al. 2019], targeted drug delivery [Fahimmunisha et al. 2020], antioxidant activity [Lingaraju *et al.*, 2016], biosensors [Hwa and Subramani, 2014], environmental remediation [Singh et al. 2018] and even as agent enhancing drought tolerance and nutrient source of crops [Pokhrel and Dubey, 2013]. One of the unique features of nanoparticles biosynthesis is the selectivity of different morphology of the formed nanoparticles according to the biological source used with enhanced stability. Classic chemical and physical methods used for nanosynthesis can be generally classified in (i) top-down and (ii) bottom-up approach. The "top-down synthetic approach" of nanomaterials employs mechanical energy, high energy lasers, thermal, and lithographic methods for producing nanoscale materials. atomization, annealing, arc discharge, laser ablation, electron beam evaporation, radiofrequency, sputtering, and focused ion beam lithography. Some examples for the "bottom-up approach" are chemical vapour deposition and atomic layer deposition, which belong to the gas-phase methods, while the reduction of metal salts, sol-gel processes, template synthesis, and electrodeposition correspond to the liquid phase. There are various types of environment-friendly approaches reported for the synthesis of ZnO-NPs (ultrasonic assisted synthesis and microwave-assisted synthesis [Bayrami et al. 2019]. Biological synthesis methods use either plant extract or microbes for facilitating the formation of nanoparticles. Several characteristics can be attributed to green practices, which make them significant than chemical processes [Jeevanandam et al. 2016]. The major advantage is the potential application of biosynthesized nanoparticles for biomedical purposes or directly in living systems. This is due to the reduced level of toxicity associated with these nanoparticles compared to that prepared through physicochemical methods. Other advantages may be the stabilizing effects of biocomponents used in synthesis procedure and the corona formation by surface modification of the nanoparticles, which makes them more suitable in living systems [Singh et al. 2016].

2. MATERIALS AND METHODS

Curry leaves, Moringa oleifera and Psidium juajava leaves were collected from Tiruvannamalai. The leaves were washed several times with distilled water to removes the dust particles, cut in to small pieces, dried at shade and ground to powder. Powdered plant material, 25 g boiled with distilled water for 30 minutes. The water soluble extract was filtered using Whatman filter paper and preserved at refrigerator for further study. Zinc acetate was as a precursor which was purchase from Merck Ltd, Mumbai, India. Zinc acetate 0.02 M solution was prepared using distilled water. The Curry leaves, Moringa oleifera and Psidium juajava leaves extract were taken in burette. This solution in 100 ml beaker was placed in magnetic stirrer with heating. Temperature of the magnetic stirrer was set to 80ºC. The solution was heated 30 min with continuous stirring. At this stage, extract was slowly added drop wise to zinc acetate solution. A turbid precipitate was produced in the beaker was thoroughly washed with distilled water and the water molecules was completely removed. Then the powder was dried at 80ºC in hot air oven for 4 hours. The precipitate was then collected in a ceramic crucible and heated in an air heated furnace at 500°C for 3 h. A light white coloured powder was obtained and this powder was carefully collected and sent for characterization. Crystalline nature of Zinx oxide nanoparticles was analysed using X-ray diffraction studies. Functional groups present in the ZnO nanoparticles were characterized by Fourier Transform Infrared spectra (FTIR) the 400–4000 cm^{-1}. The morphology and size distribution were characterized using FE-SEM (JEOL JSM 6701-F) coupled with EDAX analysis.

3. RESULTS AND DISCUSSION

Among the most important reducing agent plant extracts, which are relatively easy to handle, readily available, low cost, and have been well explored for the green synthesis of other nonmaterial. Thus, the phytochemicals such as hydroxyl, carboxyl, and amino functional groups, which can serve both as effective metal-reducing agents and as well as capping agents to coating on the metal nanoparticles in a single step. ZnO nanoparticles were synthesized by green method using Curry leaves, Moringa oleifera and Psidium juajava leaves extract. The phytochemicals present in the extract responsible for the reduction of metal salt in to metal nanoparticles. Curry leaves, Moringa oleifera and Psidium juajava are well known for its biological and medicinal properties. Various significant pharmacological activities such as antioxidant, immunomodulatory, anti-inflammatory, antitumor, antidiabetic and antimicrobial have been reported. All parts of Curry leaves, Moringa oleifera and Psidium juajava such as such leaves, flowers, root barks and stem barks explored for various biological studies. Hence, we aimed to apply this twig extract for the synthesis of Zinc oxide nanoparticles. The precipitate was then collected in a ceramic crucible and heated in an air oven at 100°C for one day, the dried sample material was mashed in a mortar-pestle to form a light-yellow coloured powder was obtained. Curry leaves, Moringa oleifera and Psidium juajava was used as a reducing material as well as surface stabilizing agent for the synthesis of ZnO nanoparticles. FT-IR spectroscopy is used to identify the functional groups present in the ZnO. The interpretation of the IR spectrum involves the correlation of the absorption bands with the chemical compounds in the sample. The FTIR spectrum ZnO NPs are shown in Figure 1 FTIR spectra of green synthesis ZnO NPs (Fig. 8) have shown absorption band at 3329, 2918, 1613, 1436, 1081 and 703 cm^{-1}, respectively. The peaks in the region between 600 and 400 cm^{-1} are allotted to MO (ZnO). The band at 703 cm^{-1} confirms stretching vibrations of zinc oxide NPs.



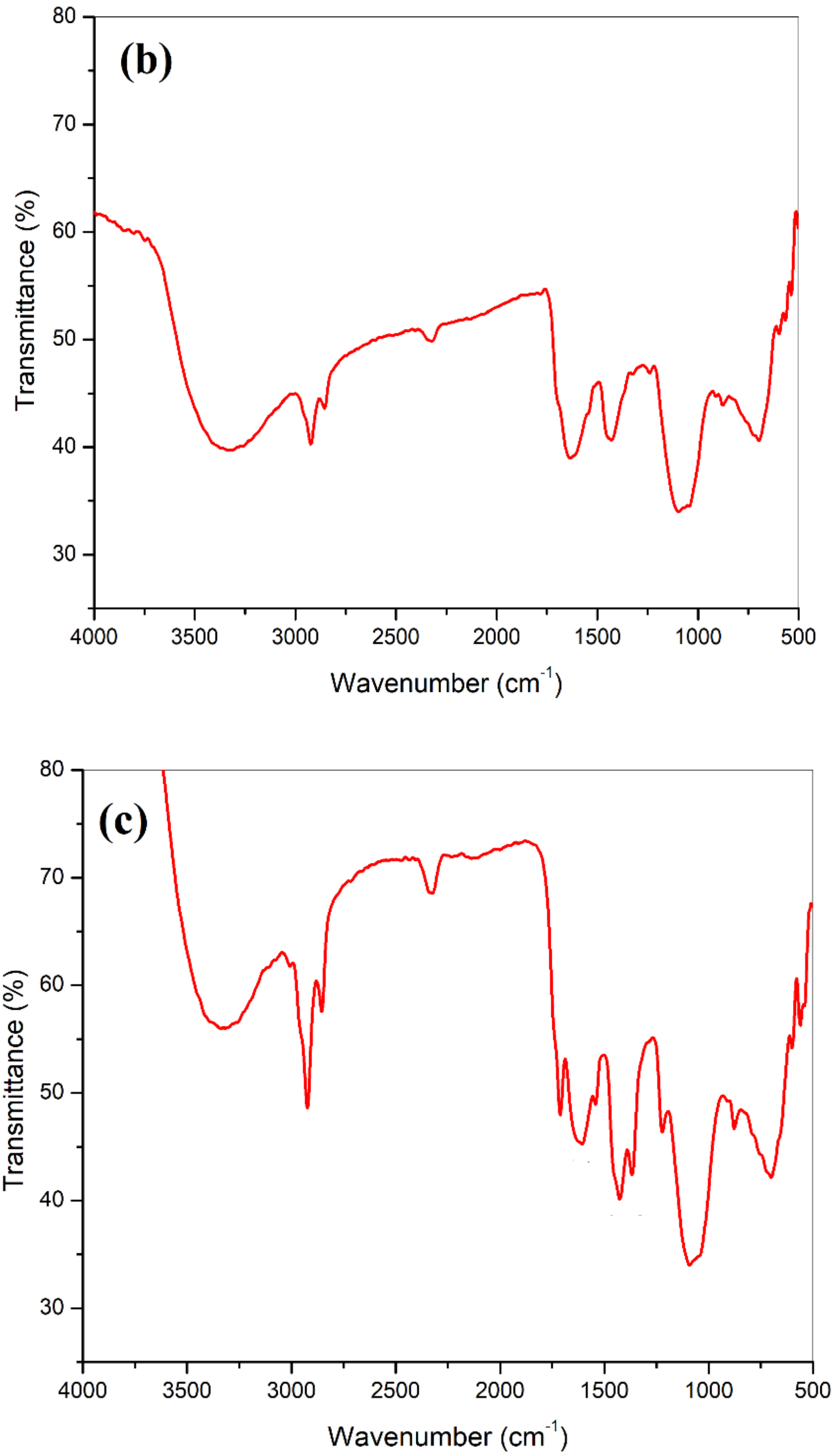


FIGURE 1. FTIR spectra of green synthesis

X-ray diffraction studies Zinc hydroxide was synthesized using Curry leaves, Moringa oleifera and Psidium juajava extracts are shown in Figure 2 (a-c). X-ray diffraction was taken for confirmation of zinc oxide phase of the nanoparticles. The XRD peaks were identified as (100), (002), (101), (102), (110), (112) and (202) reflections, respectively. The broad and strong diffraction peaks indicate amorphous crystalline nature of zinc oxide nanoparticles. The zinc hydroxide was incinerated at 400ºC for 3 h in muffle furnace. Hydroxide present in the compound was removed and converted in to Zinc oxide nanoparticles which was characterized by XRD.

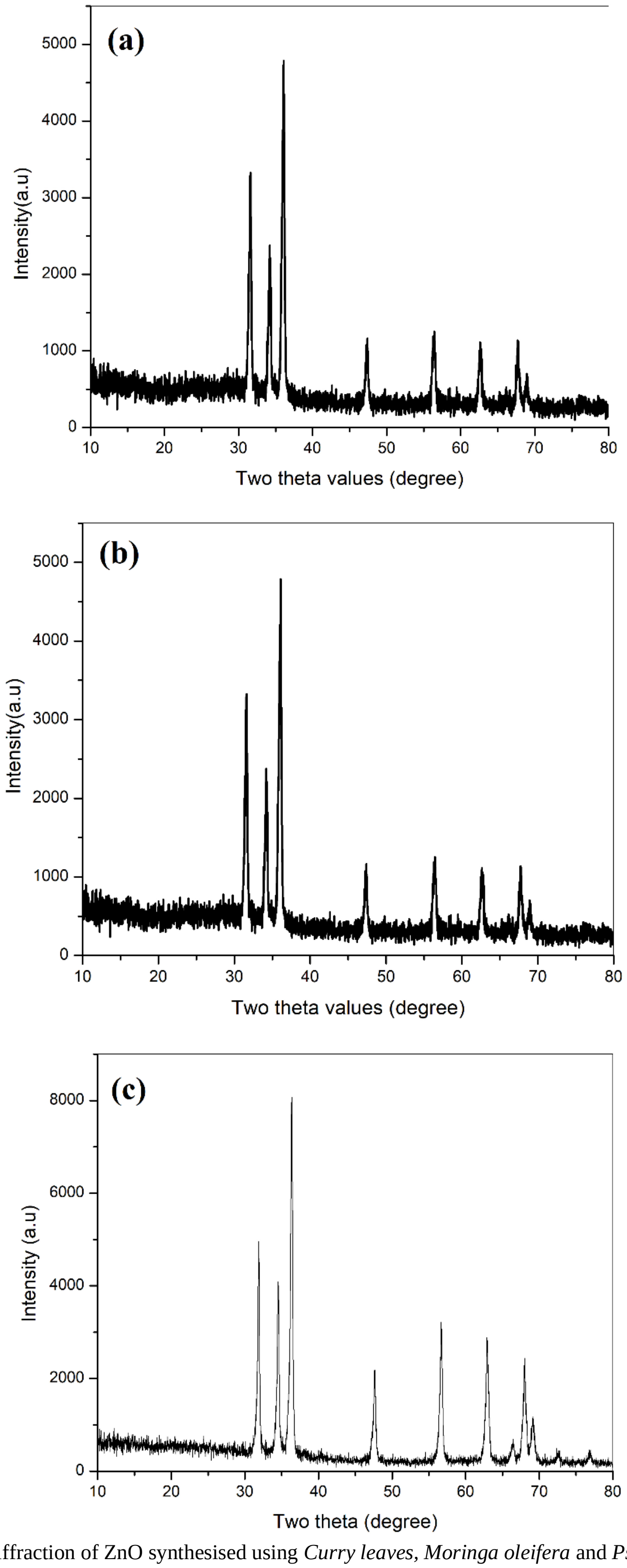


FIGURE 2. X-ray diffraction of ZnO synthesised using *Curry leaves*, *Moringa oleifera* and *Psidium juajava* extracts

SEM is one of the techniques to find out the surface morphology the synthesised ZnO nanoparticles. The FE-SEM image of prepared ZnO NPs was presented in Figure 3 (a-c). The diameter of the cluster ZnO NPs found to be in the range of micro to nanoparticles and is nearly spherical in shape with rough surface with average size of 500 nm.

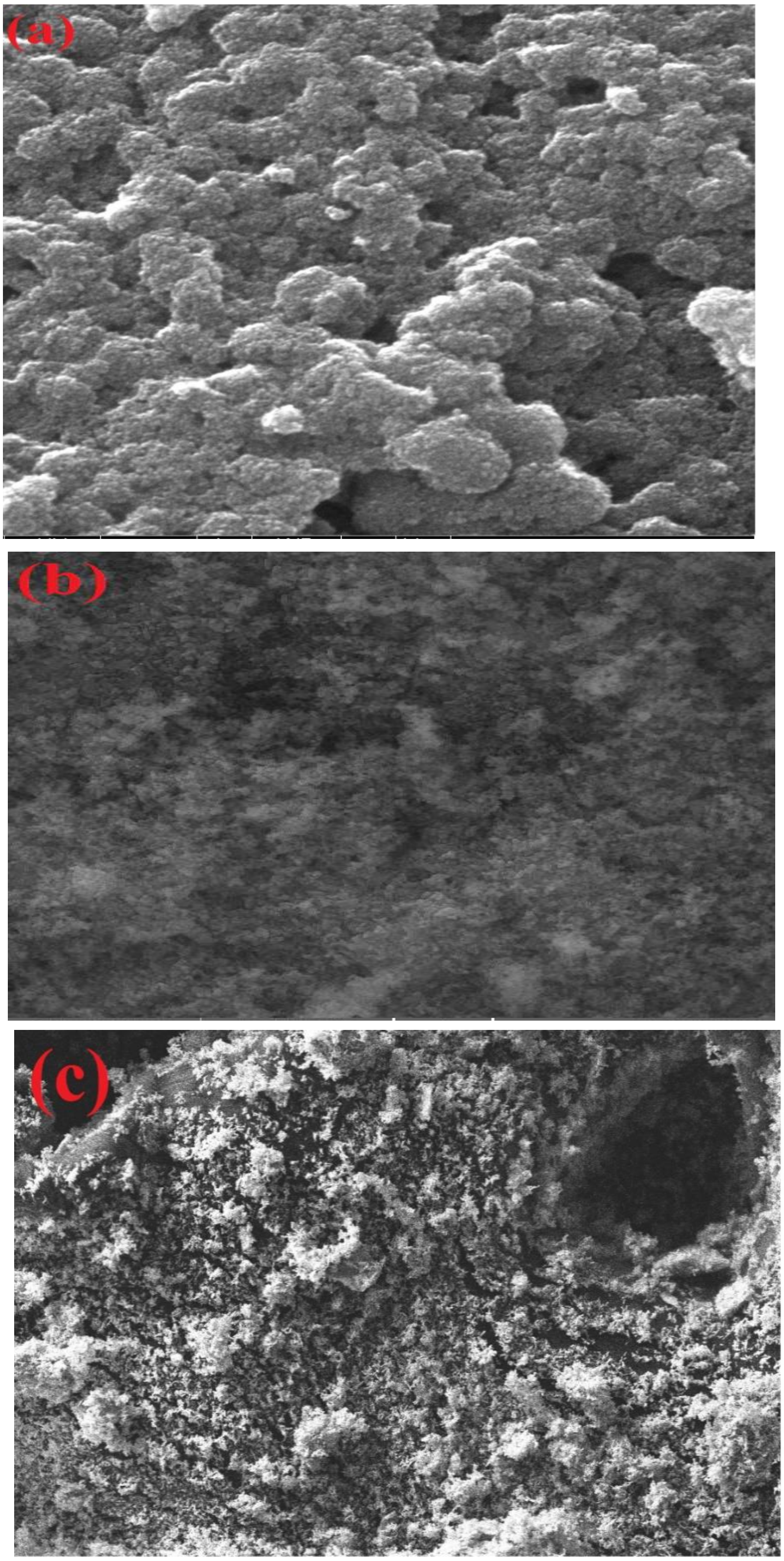


Figure 3. SEM image of ZnO synthesized using Curry leaves, Moringa oleifera and Psidium guajava extracts

The SEM images of ZnO synthesized using *Curry leaves*, *Moringa oleifera* and *Psidium juajava* extracts found to be irregular. It is difficult to find the exact morphology of the particles.

4. CONCLUSIONS

Zinc oxide nanoparticles have been successfully synthesized using a simple and efficient method. Furthermore, we have demonstrated that the use of a natural, low cost biological reducing agent, *Curry leaves*, *Moringa oleifera* and *Psidium juajava* extracts can produce Zinc oxide nanoparticles in aqueous solution at room temperature. Based on the kinetic studies, together with evidence obtained from UV-Visible, IR, XRD and SEM it is assumed that the phytochemicals which are present in *Curry leaves*, *Moringa oleifera* and *Psidium juajava* extracts leaves extract is responsible for the formation of Zinc hydroxide which produces Zinc oxide on annealing at 400°C for 3 h in Muffle furnace. The process for the synthesis of zinc oxide nanoparticles in large scale using *Curry leaves, Moringa oleifera* and *Psidium juajava* extracts leaves extract may have commercial viability and to develop studies in the surface between biology and material science.

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