International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Synthesis and Applications of Moringa Oleifera mediated Zinc Oxide Nanoparticles: A Systematic Review

G. Jayanthi[1], J. Indira[2]

[1]Assistant Professor, Department of Biotechnology, Kongu Arts and Science College (Autonomous), Erode-638107, Tamil Nadu, India
[2]Assistant Professor, Department of Chemistry, Vellalar College for Women (Autonomous), Erode-638012, Tamil Nadu, India

Abstract
Nanotechnology is one of the advancing tools that involves the applications in various areas of research. It plays a very important role in the field of medicine, science, engineering materials, cosmetics and food science. Nano materials often have unique properties that can be fabricated as a device for various applications such as controlling pollution, purification of water, disease management and energy sector. Zinc oxide nanoparticles possess numerous applications in various sectors like medicine, textile, rubber industry, cosmetics and food technology. Nowadays the green synthesis of nanoparticles is of keen interest among researchers due to its environmental sustainability. In this review article we have discussed the applications of Moringa Oleifera mediated green synthesis of Zinc oxide nanoparticles in medical and environmental domain.

Keywords: Nanoparticle, Zinc Oxide, Green Synthesis, Moringa Oleifera

1. Introduction

In this new era, nanotechnology has evolved as one of the important fields of research. The particle size, morphology and crystallinity of nanoparticles can immensely control their physical, mechanical, magnetic and optical properties [1, 2]. Among the metal oxide nanoparticles Zinc oxide nanoparticles (ZnO-NP) possess distinct physical and chemical properties. It is widely employed in the rubber industry as a waterproof material and also to increase the performance of the polymers. Due to its excellent UV absorption nature, ZnO-NP is widely applicable in cosmetic products [3].

Zinc is one micronutrient essential for our body metabolic functions such as protein and nucleic acid synthesis. Since it is readily absorbed by our body ZnO-NP is widely used as a food additive [4]. Zinc oxide nanoparticle is a less expensive, non toxic and possesses various properties such as antibacterial, anti inflammatory, anti diabetic and wound healing [5, 6]. ZnO-NP is widely employed in the textile industries due to UV resistance and antibacterial nature [7].

Moringa Oleifera is a tree belonging to the Moringaceae family known for its medicinal property and it originated in India. Almost all the parts of the tree such as leaves, flower, seed and fruit can be used as food. It possesses many medicinal properties such as anti-inflammatory, lipid profile control,

antioxidant, and anti-diabetic [8]. It is also known as the "Miracle tree" and Moringa Oleifera leaves are rich in calcium, protein, vitamins, low fat and fibre [8].

The flowers, seeds and leaves of Moringa Oleifera are rich in fatty acids and bioactive molecules, glucosinolates, phenolic acids and flavonoids [9]. In this review we have summarised the synthesis and applications of Zinc Oxide nanoparticles using Moringa Oleifera.

2. Green Synthesis of Moringa Oleifera mediated Zinc oxide Nanoparticles

The schematic representation for green synthesis of moringa oleifera mediated (ZnO-NP) is mentioned below [1, 10, 11].

Fig. 1 Green Synthesis of Moringa Oleifera mediated ZnO-NP

3. Applications of Moringa Oleifera mediated Zinc Oxide nanoparticles

3.1. Anti-bacterial Activity

Sukanta Pal [1,12,13] and his coworkers synthesised ZnO-NPs using Moringa Oleifera leaf extract and evaluated the antibacterial activity using the gram positive and gram negative bacterial strains such as Bacillus subtilis and Escherichia coli respectively. The inhibition zone against the bacterial strains was found to be 3.5 cm and 3.3 cm respectively.

Irfan et. al., [14] studied the antibacterial activity using Moringa Oleifera gum based ZnO-NPs against gram negative, gram positive and "super bug" bacteria such as Escherichia coli, Staphylococcus aureus and methicillin-resistant Staphylococcus aureus (MRSA) respectively and the zone of inhibition were measured with various concentrations of samples such as 30µg, 20µg and 10µg/disc. They found that ZnO-NP possesses good antibacterial activity against all bacterial strains.

3.2. Photocatalytic Activity

Sukanta Pal and his research team [1,15,16] evaluated the application of green synthesised ZnO-NPs for its photocatalytic degradation activity of titan yellow dye in the presence of sunlight. The UV-Visible spectrophotometer was employed for measuring the absorption spectrum of dye degradation. They concluded from their experiments that the degradation of titan yellow without the addition of Zno-NPs in the presence of sunlight was negligible but with the addition of Zno-NPs the degradation was increased by 96%.

3.3. Antioxidant Property

Nitesh Bhalla et. al., [17,18,19] studied the antioxidant efficacy of Moringa Oleifera mediated synthesis of ZnO-NP at different concentrations such as 10 to 100µg/ml using the free radical 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay. They also compared the antioxidant efficacy of green synthesised ZnO-NP with AR grade ZnO-NP. The colour change was observed by the addition of various concentrations of ZnO-NPs and the absorption spectrum was measured at 517 nm. The free radical scavenging efficacy was increased with increasing concentration of ZnO-NP using Moringa Oleifera leaves. The percentage of scavenging after 30 min was found to be 91%, 98.91% and 99.99% at concentrations of 50, 75 and 100µg/ml respectively. Further they also found that the percentage of scavenging for AR grade ZnO-NP after 30 min was only 14, 15 and 16.5% at concentrations of 50, 75 and 100µg/ml respectively.

3.4. Adsorption Experiments

Vartika and her co workers [20, 21] synthesised the ZnO-NPs and Cu doped ZnO-NPs using Moringa Oleifera leaf extract and evaluated its adsorption behaviour for the removal of congo red dye. They carried out the experiment for dye removal using ZnO-NP and also with Cu doped ZnO-NPs by varying the pH, adsorbent dose and concentration of congo red dye concentration. They concluded that dye removal efficiency was in the range between 90% to 93% for the pH between 2-10 for both the undoped and doped ZnO-NPs .

The ZnO-NPs was used as an adsorbent and its concentration was varied from 0.02g to 0.1g for 100 ml of 20 mg/L of Congo red dye solution. They found that dye removal efficiency was increased by increasing the concentration of the adsorbents.

They also carried out the experiment by varying the concentration of congo red dye concentration from 20 mg to 100 mg/L. The efficacy of dye removal decreases on increasing the concentration of dye due to the saturation of active sites on adsorbents.

They also carried out the kinetic studies for adsorption of dye using ZnO-NPs and Cu doped ZnO-NPs and they demonstrated that both follows the pseudo second order kinetics.

4. Conclusion

Nowadays green synthesis is found to be a keen interest in the research field due to the non toxic, eco-friendly and non-polluting nature. The Moringa Oleifera act as a reducing agent in the synthesis of ZnO-NPs. The addition of Moringa Oleifera plant extract influences the particle size, crystallinity and morphology of Zno-NPs. The Moringa Oleifera plant is easily available, abundant in nature, less expensive, possesses enormous amount of biomolecules and nutrient rich. Hence in this review article we have highlighted that the properties such as antibacterial, antioxidant, optical and adsorbance behaviour of ZnO-NPs are enhanced by the green synthesis using Moringa Oleifera plant extract. We have concluded that due to the presence of flavonoids, bioactive molecules and phenolic acids in Moringa Oleifera the antioxidant property of ZnO-NPs increases.

5. References

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