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Eco-Friendly Green Synthesis of MgO Nanoparticles from Zingiber Officinale (Ginger) Root Extract and its Antibacterial Application

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Abstract: In this study preparation of MgO nanoparticles using Zingiber officinale (ginger) aqueous root extract by using green method. The green synthesis approaches are recognized by many scientists due to its cost effective, simple, eco-friendly. The stability and reduction of Mg^{+2} ions to MgO nanoparticles were characterized by UV-Visible spectroscopic analysis. From UV-Visible spectroscopy, higher band gap energy of 7.8 eV is obtained in the near visible region at the wavelength of 300 nm. The Zingiber officinale (ginger) root extract act as reducing agent for stabilization of particle size as well as medicinal value result showed a significant antibacterial activity against pathogenic bacteria, E.Coli.and S.aureus. The present investigation deals with the green synthesis of MgO nanoparticles and its antibacterial effect on selected bacteria.

Keywords: MgO nanoparticles; Zingiber officinale.; UV-Visible spectroscopy; Antibacterial activity; Green method.

I. INTRODUCTION

Currently the field of nanotechnology is one of the most active researche for scientist to attempt widespread research for the bio-synthesis of nanoparticles using the extract obtained from different plants and succeeded in the synthesis of inorganic metal oxide nanoparticles like MgO, CuO, ZnO and TiO_2 nanoparticles etc. An eco friendly green mediated synthesis of inorganic nanoparticle is a fast growing research in the limb of nanotechnology [1] than that of physical and chemical method. The biosynthesis method employing plant extracts have drawn attention as a simple and viable alternative to chemical procedures and physical methods [2]. MgO is picked for present study as it belongs to a group of metal oxides with photo-oxidizing and photocatalytic ability against chemical and biological species. Biological synthesis of MgONPs has not been widely exploited [3]. Magnesium oxide (MgO) nanoparticles have appropriate considerable attention due to their antimicrobial, UV blocking, high catalytic activities,imaging, sensing, drug delivery systems, cancer therapy, and diagnosis[4,5]. The MgO nanoparticles showed antibacterial and anticancer properties even at lower concentrations hence suitable for thin coating applications [6,7]. Antibacterial activity of the particles is analyzed using gram (+ve) positive and gram negative bacteria [8]. *Zingiber officinale (ginger)* belongs to the family *Zingibarace.*] and used as a traditional medicinal plant.

Its different parts are active in treating anemia, blindness, arthritis, hyperthyroidism, rheumatism, epilepsy, Chrohn's disease, antiherpessimplex virus, gout and sexually transmitted diseases [10, 11]. *Zingiber officinale (ginger)* is filled in nourishment due to the presence of essential phytochemicals. The phytochemical profile of its leaves exhibited the presence of essential minerals, vitamins, sterols, anthraquinones, alkaloids, terpenoids, flavonoids, tannins and saponins[12]. These phytoconstituents leads to the antiinflammatory, antiulcer, antidiabetic[13], anticancer [14], antimicrobial, antioxidant and antifungal properties[15]. Due to these evidences about the medicinal values and phytochemistry of this plant, the present study brought biomimetic approach for the green synthesis of eco-friendly MgO nanoparticles from *Zingiber officinale (ginger)* through bioreduction,UV-Visible spectroscopic characterization and antimicrobial studies.

II. MATERIAL AND METHODS

A. Materials

Magnesium nitrate hexahydrate ($MgNO_3.6H_2O$), deionised water was purchased from Sigma–Aldrich Chemicals. All glasswares are sterilized with nitric acid and further with deionised water and dried in oven before use *Zingiber officinale (ginger)* were collected from campus of Siddharth College, Jafrabad, Maharastra, India.

B. Preparations of Aqueous Extract Zingiber officinale (ginger)

Roots of *Zingiber officinale (ginger)* are show in figure 1. The roots were washed with tap water to remove dust particles and impurities. The Ginger roots dried under shade for 1 week, the dried roots were grinded using mortar and pestle until the roots are grinded finely powder form. The aqueous extract of *Zingiber officinale (ginger)* root was prepared using 20 g of powder of roots was added to 100 mL of deionized water at 70 °C to 80 °C for 20 minute. This extract was filtered through Whattmann filter paper No-1.The filtered extract was stored in refrigerator at 4°C for further studies.

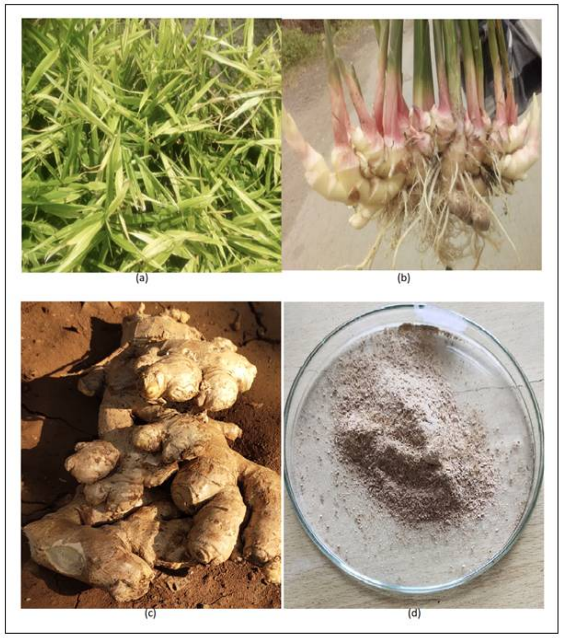

Figure 1 Plant of Ginger, Ginger roots and Root powder

C. Green Synthesis of MgO Nanoparticles

An aqueous solution of 0.1M magnesium nitrate [Mg $(NO_3)_2.6H_2O$] was prepared for the synthesis of magnesium oxide nanoparticles. 25.6 gm of magnesium nitrate [Mg $(NO_3)_2.6H_2O$] was dissolved in 1000 mL of double distilled water to obtain 0.1M of magnesium nitrate precursor solution. 10 mL of *Zingiber officinale (ginger)* root extract was added to 50 mL of 0.1M magnesium nitrate solution in an Erlenmeyer flask and stirred at about 70°C for 2 hours. The particles formed after an adequate time of stirring were collected by centrifugation at 10000 rpm for 10 minutes. Then the centrifuged particles were washed with distilled water and again subjected to centrifugation at 5000 rpm for 10 minutes. The separated white precipitate was dried in an oven at 70°C for 2 hours and ground well with mortar. The powdered Mg $(OH)_2$ sample was calcined in a muffle furnace at 350-450°C to get MgO nanoparticles. The synthesis, characterization, and application of of MgO is summarized in figure 2.

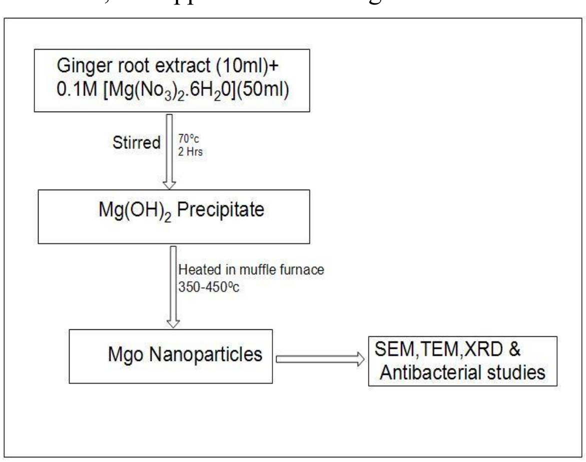

Figure 2. Flow chart for synthesis, characterization, and application of MgO NPs.

D. Antibacterial Test

An antibacterial activity of *Zingiber officinale (ginger)* root extract-mediated MgO nanoparticles was performed and their antimicrobial efficacy was compared against two bacterial strains, *E.coli, S.aureus* were evaluated using standard well-diffusion method. Pure culture of the test bacteria was inoculated on NA plates by spread plate technique. 100µl of the test solutions containing the MgO nanoparticle of 200 µl were poured in the agar wells at different concentrations of 0.5 mg/ml, 1 mg/ml, 1.5 mg/ml, 2 mg/ml, 2.5 mg/ml, 3 mg/ml and 4 mg/ml and were incubated at 37°C for 24 hours. The Zone of inhibition of the MgO nanoparticle at varying concentration towards each microorganism was measured, and their size of the zones were investigated and observations were recorded.

E. Characterization of MgO Nanoparticles

UV-Visible spectra analysis

The bio-reduction of Magnesium nitrate into MgO nanoparticles using the aqueus extract of *Zingiber officinale (ginger)* root was subjected to record UV-Visible spectroscopy. The UV-Visible absorption spectra of the reaction media were noted at room temperature in a quartz cuvette (1 cm path length) and at the wavelength ranging from 200 to 700 nm using a Equip-tronics Dual Beam Spectrophotometer. The absorption peaks is obtained at the wavelength 300 nm.

III. RESULTS AND DISCUSSION

The present investigation involves root extract of medicinal plant species *Zingiber officinale (ginger)* for the synthesis of MgO nanoparticles. The all different parts of the plants have already been exploited for the synthesis of various metal nanoparticles with precious bioactive mechanisms. This report proposed on bio-synthesis of MgO nanoparticles leaf extracts of *Zingiber officinale (ginger)*. The AgNPs from Ginger root have been investigated to possess significant antifungal activity against Candida albicans [16]. The silver nanoparticles reduced by the gum of *Zingiber officinale (ginger)* were reported to showed antibacterial activity against *Staphylococcus aureus, E. coli* and Pseudomonas aeruginosa [17]. The synthesized MgO nanoparticles from the root of *Zingiber officinale (ginger)*, and these nanoparticles at the concentration of 200 µg/ml exhibits antibacterial activity against gram positive and gram negative bacteria such as *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Proteus mirabilis, Escherichia coli* and antifungal activity against *Candida albicans* and *Candida tropicalis*.[16].

A. UV-Vis-Spectrum

The MgO nanoparticles were synthesized by using root extract of *Ginger* as detailed above. The reduction of Magnesium metal ions to MgO nanoparticles in the reaction medium was initially analyzed using UV-Vis Spectrophotometer between 200 to 700 nm. The UV-Vis spectrum of MgO Nps is shown in Figure 3. Confirmation of the synthesized MgO product in nano-scale was exhibited by the highly blue shifted absorption maximum occurring around 300 nm.

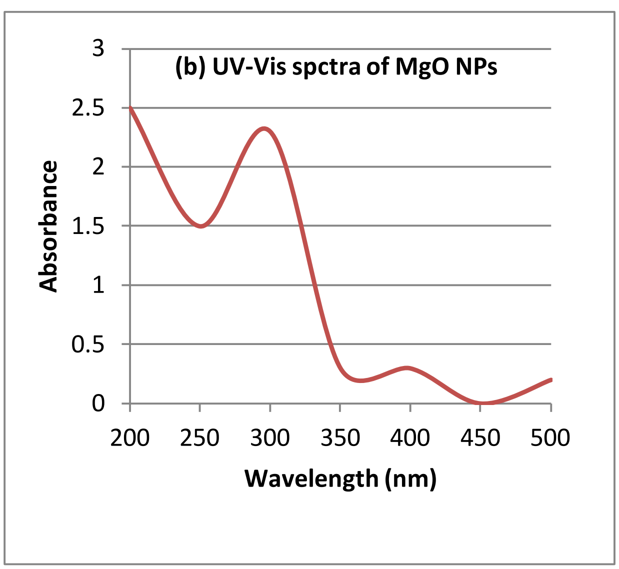

Figure3.UV-vis spectra of MgO NPs synthesized using *M.Oleifera* leaves extract

B. Antibacterial Activities of ZnO Nanoparticles against E. coli ans S.aureus

The characteristic features of nanoparticles namely the larger aspect ratio deliver greater surface area of contact with the microbial pathogens and provides enhanced reactivity. The MgO nanoparticles synthesized using the root extracts of *Zingiber officinale (ginger)* exhibited antibacterial activity against gram negative, *E. coli,* gram positive bacteria, *S. aureus*. The antibacterial activity was performed with varying concentrations of MgO nanoparticle, such as 0.5 mg/ml, 1 mg/ml, 1.5 mg/ml, 2 mg/ml, 2.5 mg/ml, 3 mg/ml and 4 mg/ml. It was found that the zone of inhibition increased with increase in concentration of the MgO nanoparticle. The zone of inhibition was found for *E.coli* as 1 mm at 0.5 mg/ml, 2.5 mm at 1 mg/ml, 2 mm at 1.5 mg/ml, 5 mm at 2 mg/ml, 3 mm at 2.5 mg/ml, 2.5 mm at 3 mg/ml and 2.4 mm at 4 mg/ml. show in Figure 4. While the zone of inhibition was found for *S.aureus* as 1 mm at 0.5 mg/ml, 2.5 mm at 1 mg/ml, 3 mm at 1.5 mg/ml, 4 mm at 2 mg/ml, 2.5 mm at 2.5 mg/ml, 2 mm at 3 mg/ml and 1.8 mm at 4 mg/ml. In case of *E. coli* the zone of inhibition was found to be increases from 0.5 mg/ml concentration to 2.0 mg/ml concentration and after continuously decreases from 2.0mg/ml concentration to 4 mg/ml concentration. Same trend were observed in case of *S.aureus.*The zone of inhibition was found higher of *E.coli* than *S.aureus* except at 1.5 mg/ml concentration.

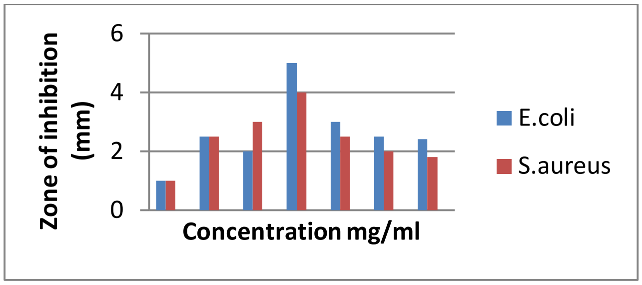

Figure.4 Bar graph showing the zone of inhibition (mm) of *E.coli* and *S.aureus*

IV. CONCLUSION

The biosynthesis of MgO nanoparticles were successfully produced by the leaf extract of *M.Oleifera* .The green method used is simple,easily eco-friendly and very fast. The characteristic color changes to yellow indicate the synthesis of MgO nanoparticles.Which is further confirmed the reduction of Mg^{+2} ions in to MgO nanoparticles by using UV-Visible spectroscopy. The UV-Vis absorption peak at 300 nm.The antibacterial investigate revealed that the gram-negative and gram-positive bacteria are sensitive to the MgO nanoparticles.

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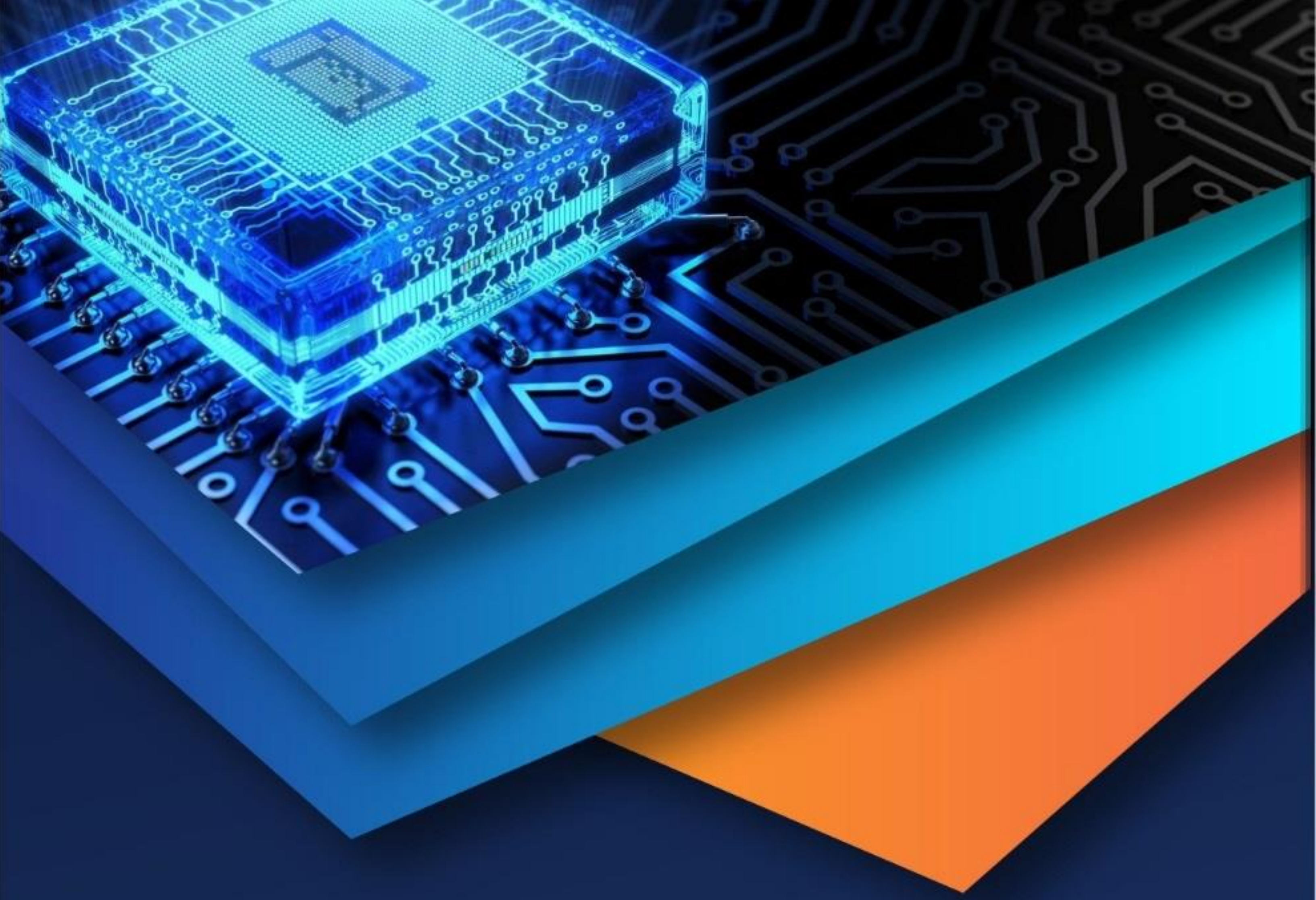

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