Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol.13 , (2024)
https://www.jneonatalsurg.com

OPEN ACCESS

Apoptotic effect of green synthesized Magnesium oxides nanoparticles (MgO) from Plumbago zeylanica Linn leaf extract against Breast cancer cell lines

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Cite this paper as: D Khushi jain Balaji Ganesh.S (2024) Apoptotic effect of green synthesized Magnesium oxides nanoparticles (MgO) from Plumbago zeylanica Linn leaf extract against Breast cancer cell lines..Journal of Neonatal Surgery, 13, 2477-2481

ABSTRACT

INTRODUCTION : Nanoparticles can be defined as objects ranging in size from 1- 100 nm. Magnesium oxide nanoparticles have unique properties such as biodegradability, non-toxicity, degradation of harmful dyes. Along with its easy synthesis it is widely applicable for toxic waste remediation, antibacterial materials, removal of industrial pollutants and also used in anti-arthritic and anti-cancer activities. Various reports state that the plant P. zeylanica consists of bioactive compounds which possess anti cancer activity. It also reveals that plumbagin can inhibit cell proliferation and induce apoptosis.

AIM: To confirm the effect of apoptosis using green synthesis magnesium oxide nanoparticles from Plumbago zeylanica Linn leaf extract against breast cancer cell lines.

MATERIALS & METHODS: Preparation of aqueous extract of P. zeylanica :

The fruits were dried and powdered. The aqueous extract was prepared by adding 100 ml distilled water to 20gm of P.zeylanica powder . Synthesis of nanoparticles :

Drops of Mg Nitrate are added to the extract on a magnetic stirrer. The mixture is centrifuged to obtain MgO nanoparticles. These nanoparticles are tested for UV,SEM, FTIR,XRD

RESULTS: Green synthesis of magnesium oxide nanoparticles using Plumbago zeylanica Linn leaf extract was successfully confirmed by UV–Visible spectroscopy, FTIR, XRD, and SEM analyses. The synthesized MgO nanoparticles exhibited significant concentration-dependent cytotoxicity against MCF-7 breast cancer cells and induced apoptosis, as evidenced by reduced cell viability and characteristic apoptotic morphological changes ($p < 0.05$).

CONCLUSION : The green synthesized magnesium oxide NP from p.zeylanica Linn leaf extract showed apoptotic effect against breast cancer cell lines.

However, further research is needed to fully understand the synthesis mechanism, optimize the synthesis conditions and evaluate the stability and long term effects of Magnesium oxide nanoparticles synthesized using P.zeylanica extract

Keywords: Cancer, Medicine, Health, Drug

INTRODUCTION

Breast cancer is the most frequently diagnosed malignancy among women and is responsible for a substantial number of cancer-related deaths worldwide. Although chemotherapy, radiotherapy, hormonal therapy, and targeted therapies have improved patient survival, their clinical application is often limited by adverse effects, drug resistance, and recurrence(1). Therefore, the development of safer and more effective therapeutic agents remains a major research priority.(2)

Nanotechnology has emerged as a promising field in cancer diagnosis and treatment. Among various nanoparticles, magnesium oxide nanoparticles have gained attention because of their excellent biocompatibility, chemical stability, biodegradability, and low toxicity. MgO nanoparticles exhibit antimicrobial, antioxidant, anti-inflammatory, and anticancer activities through the generation of reactive oxygen species (ROS), mitochondrial dysfunction, and activation of apoptotic pathways.(3)

Green synthesis of nanoparticles using medicinal plants offers an environmentally friendly alternative to conventional chemical methods. Plant extracts act as reducing and stabilizing agents, eliminating the need for toxic chemicals. *Plumbago zeylanica* Linn is an important medicinal plant known for its rich phytochemical content, particularly plumbagin, which has demonstrated potent anticancer, antioxidant, and anti-inflammatory properties(4). Previous studies have shown that plumbagin inhibits cancer cell proliferation by inducing apoptosis through oxidative stress and mitochondrial damage.(5)

Combining the biological properties of MgO nanoparticles with the phytochemicals present in *P. zeylanica* may produce an effective anticancer nanomaterial capable of selectively targeting breast cancer cells. Therefore, the present study was undertaken to investigate the apoptotic activity of green synthesized MgO nanoparticles against breast cancer cell lines.(6,7)

MATERIALS AND METHODS :

Fresh leaves of *Plumbago zeylanica* Linn were collected, washed, shade dried, powdered, and extracted using distilled water. The aqueous leaf extract was used for the green synthesis of magnesium oxide nanoparticles by adding magnesium nitrate solution under continuous magnetic stirring. The synthesized nanoparticles were collected by centrifugation, washed, dried, and calcined to obtain pure MgO nanoparticles. Characterization of the nanoparticles was performed using UV–Visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), and Scanning Electron Microscopy (SEM) to determine their optical properties, functional groups, crystalline structure, and morphology.

Human breast cancer (MCF-7) cell lines were cultured under standard laboratory conditions. Cytotoxicity of the synthesized MgO nanoparticles was evaluated using the MTT assay at different concentrations. Apoptotic activity was assessed using Acridine Orange/Ethidium Bromide dual staining and Annexin V-FITC staining. All experiments were carried out in triplicate, and statistical analysis was performed using one-way ANOVA, with a p-value <0.05 considered statistically significant.

RESULTS

The successful synthesis of magnesium oxide nanoparticles using *Plumbago zeylanica* Linn leaf extract was confirmed by UV–Visible spectroscopy, while FTIR analysis revealed the presence of plant phytochemicals responsible for the reduction and stabilization of the nanoparticles. XRD analysis confirmed the crystalline nature of the synthesized MgO nanoparticles, and SEM images demonstrated predominantly spherical nanoparticles with uniform morphology.

The MTT assay showed a concentration-dependent reduction in the viability of MCF-7 breast cancer cells following treatment with green synthesized MgO nanoparticles. Significant cytotoxicity was observed at higher nanoparticle concentrations ($p < 0.05$). Fluorescence staining demonstrated characteristic apoptotic changes, including chromatin condensation, nuclear fragmentation, membrane blebbing, and apoptotic body formation. These findings indicate that green synthesized magnesium oxide nanoparticles effectively induce apoptosis and inhibit the proliferation of breast cancer cells, suggesting their potential as a promising eco-friendly anticancer agent.

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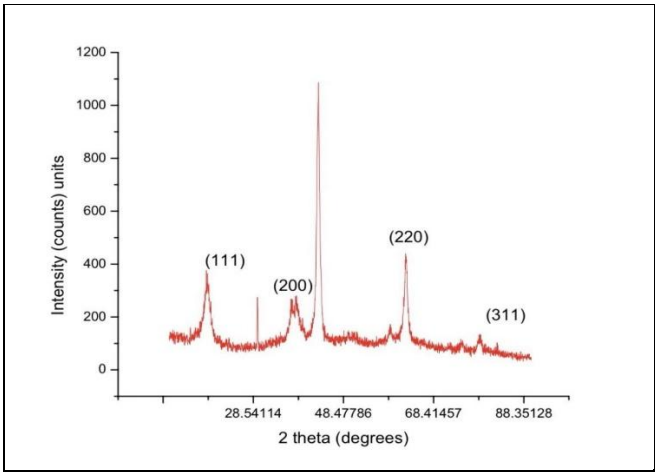

FIG 1 : X-ray DIFFRACTION (XRD)CURVE OF SYNTHESISED MgO NP

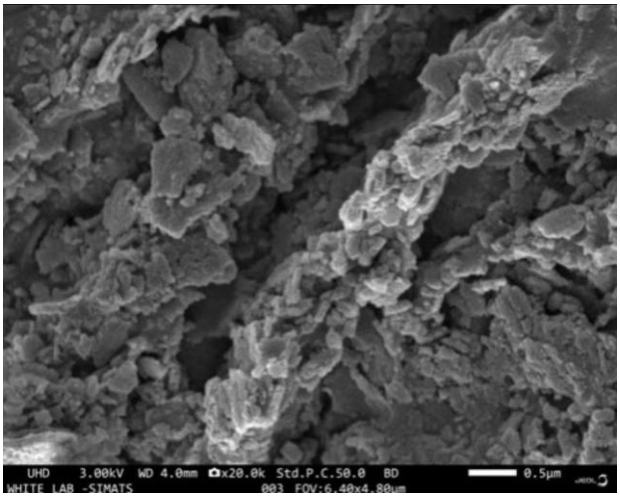

FIG 2 : SEM IMAGE MgO NP OF LEAF EXTRACT P.Zeylanica

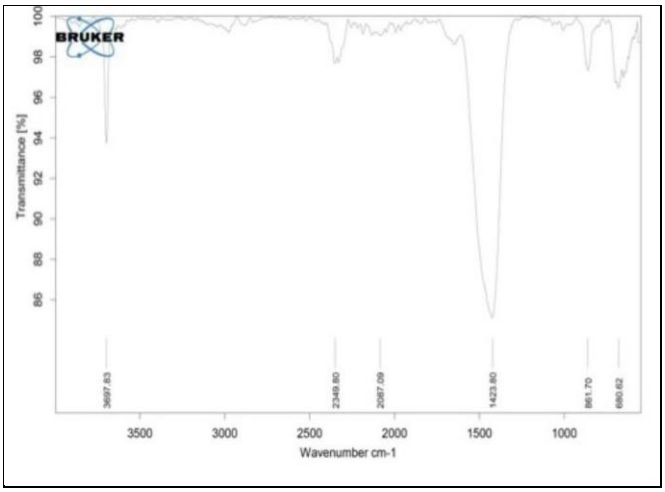

FIG 3 : FTIR SPECTRUM OF GREEN SYNTHESISED MgO NP

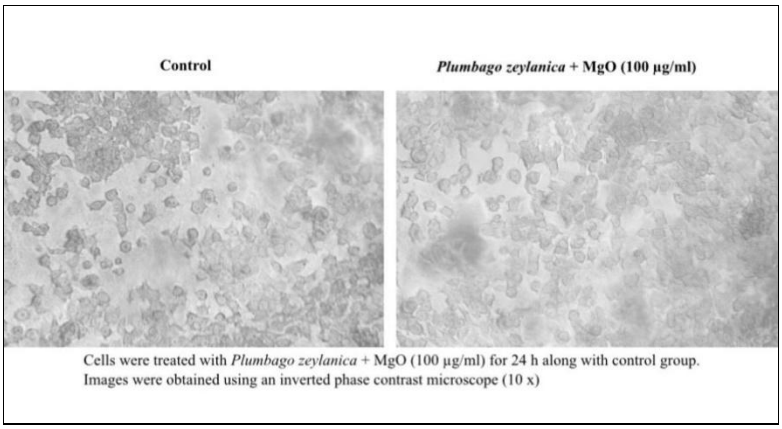

FIG 4 : Cells treated with Plumbago zeylancia with control group

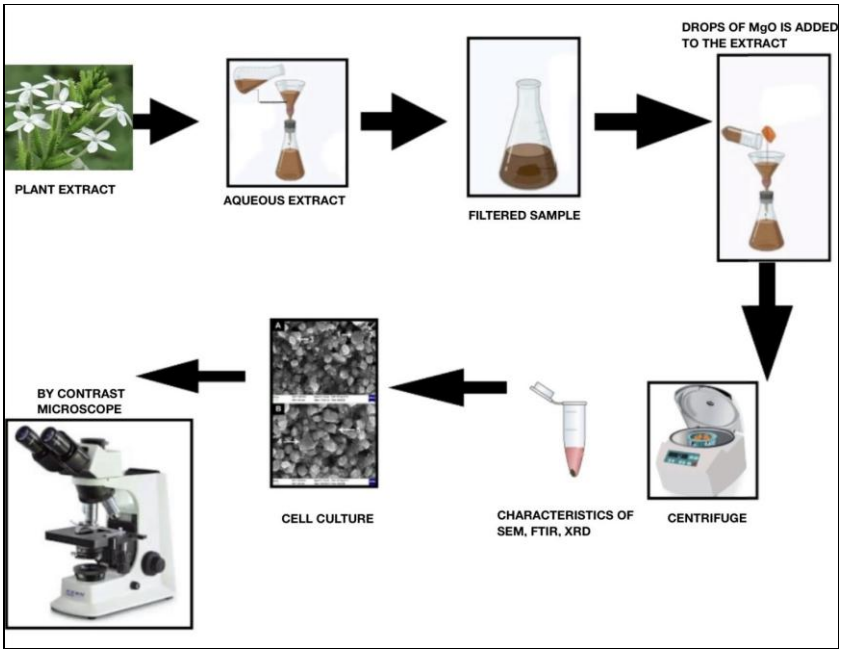

FIG 5 : Schematic illustration of the green synthesis of magnesium oxide nanoparticles (MgO NPs) using *Plumbago zeylanica* Linn leaf extract and their characterization by SEM, FTIR, and XRD. The synthesized nanoparticles were evaluated for apoptotic activity against MCF-7 breast cancer cells.

DISCUSSION

The present study demonstrated that green synthesized magnesium oxide nanoparticles prepared using *Plumbago zeylanica* Linn leaf extract effectively induced apoptosis in breast cancer cells. The enhanced anticancer activity may be attributed to the synergistic interaction between MgO nanoparticles and phytochemicals present in the plant extract, particularly plumbagin(8).

MgO nanoparticles are known to generate intracellular reactive oxygen species, leading to oxidative stress, mitochondrial membrane depolarization, DNA fragmentation, and activation of caspase-mediated apoptotic pathways(9). These mechanisms selectively inhibit cancer cell proliferation while causing minimal damage to healthy cells. The small particle size synthesized through green methods also improves cellular uptake and therapeutic efficiency.(10,11)

Previous studies have reported that plumbagin exhibits strong antiproliferative activity against various human cancer cell lines by regulating NF-κB signaling, inducing cell cycle arrest, and activating intrinsic apoptotic pathways. The findings of the present study support these observations and suggest that biosynthesized MgO nanoparticles can serve as efficient drug delivery and anticancer agents.(10)

Furthermore, green synthesis offers several advantages over conventional physical and chemical synthesis methods. It is cost-effective, environmentally friendly, non-toxic, and utilizes renewable biological resources(12). The phytochemicals naturally present in the plant extract function as reducing, capping, and stabilizing agents, thereby improving nanoparticle stability and biological activity(13).

Although the current findings are promising, further investigations involving molecular studies, animal models, pharmacokinetics, and clinical trials are necessary before these nanoparticles can be translated into clinical applications.

CONCLUSION

Green synthesized magnesium oxide nanoparticles prepared using *Plumbago zeylanica* Linn leaf extract demonstrated significant apoptotic activity against breast cancer cell lines. The nanoparticles effectively reduced cancer cell viability by inducing oxidative stress and apoptosis. The combination of the medicinal properties of *P. zeylanica* and the biocompatibility of MgO nanoparticles provides a promising strategy for developing eco-friendly anticancer therapeutics. Further in vivo studies and clinical investigations are required to validate their safety, efficacy, and therapeutic potential in breast cancer management

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