Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 12 [8] July 2023 : 76-80
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Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

Evaluation of Antibacterial Activity of Mgo Nanoparticles Synthesized With *Syzygium aromaticum* And *Ficus carica* Leaves Extract

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ABSTRACT

The increasing incidences of antimicrobial resistance forced the scientific community to explore the alternative field to find the sustainable solution of the challenging problem. Nanotechnology is one of the developing fields which were explored to combat the antimicrobial resistance. The different types of plants provide different physical, chemical and antimicrobial properties due to capping of biomolecules on the surface of nanoparticles. In present, study, MgO nanoparticles were synthesized with two different plants Syzygiumaromaticum and Ficuscarica leaves extract. The synthesized MgO nanoparticles were characterized with the help of Uv-Vis spectrophotometer. The synthesized MgO nanoparticles show their absorption peak 309nm and 304 nm with Syzygiumaromaticum and Ficuscarica leaves extract, respectively. Synthesized MgO nanoparticles also evaluated for antibacterial properties against microorganism from gram +ve and gram –ve bacteria. MgO nanoparticles synthesized by clove leaves extract shows zone of inhibition of 19mm (E. coli), 17mm (P. aeruginosa),20mm (B. subtilis), 21mm (B. sphaericus) and MgO synthesized with fig plant shows zone of inhibition was E. coli (18mm), P. aeruginosa (18mm), B. subtilis (19mm) B. sphaericus (21mm). The difference in antibacterial activity by same metallic nanoparticles is due to the capping of biomolecules on the surface of MgO nanoparticles.

Keywords: *- Green nanotechnology, Nanoparticles, Fig, clove, zone of inhibition, plant extract.*

Received 04.05.2023 Revised 14.06.2023 Accepted 24.07.2023

INTRODUCTION

NPs synthesized by other than biological synthesis have limited uses in biomedical fields due to their toxicity. Biological materials are exponentially utilized for the biosynthesis of nanoparticles for application in biomedical and environment. Biological materials utilized for nanoparticles synthesis includes different types of micro-organisms and plant materials etc. Biosynthesis has several advantages over physical and chemical methods such as environment friendly, cost effective, time consuming and energy saving [1]. In biosynthesis, coating of biological molecules on the surface of nanoparticles makes the nanoparticles more biocompatible as compared to synthesis by physical and chemical methods [2-4]. Plant material based synthesized nanomaterials, provides advantages like biocompatibility and increased life-span of NPs that overcomes the limitations of physical and chemical methods. Plants have number of biomolecules and metabolites like vitamins, proteins, carbohydrates, phenolic compounds containing carbonyl, hydroxyl and amine as functional groups, which interact with metal ions and change the size into nano-range. Flavonoids contains functional groups which responsible for reduction of metal ions into NPs[5], and also act as capping agent on NPs which is responsible for stability and biocompatibility of NPs [6]. Magnesium nanoparticle (MgO NP) has gained more attention than other metal oxide due to various properties like non-toxic, increased stability to weight ratio, recyclable and hygroscopic in nature. Nanomaterials synthesized with different plant materials can have variation in their properties like change in absorbance spectra and antimicrobial activities etc [7-8].

*Syzygiumaromaticum*also known as clove tress belong to the Myrtaceous family. Clove tree is the rich source of phenolic compounds like hidroxicinamic acids, hidroxiphenylpropens, hidroxibenzoic acids. Clove tree leaves have various bioactive compounds like eugenol which is responsible for strong pungent smell and mainly utilized in products like toothpaste, soaps, pharmaceuticals and cosmetics.

Ficuscarica (Fig) earliest cultivated fruit trees belong to the family of Moraceae. The plant is small deciduous tree growing up to 7-10m (23-33ft) tall with white smooth white bark. *Ficuscarica* have three to five deep lobes leaves which contain milky latex composed of sugars, pectin, tannins, vitamins, flavonoids and trace elements. Numerous flavonoids were reported in fig leaves which is responsible for multiple types of pharmacological activities.

2.0 METHODOLOGY

2.1 Collection of Plant material and Plant extraction

Cloveand fig plants leave were collected from the herbal garden of Maharaja Agrasen University, Baddi, Solan region, Himachal Pradesh. The newly harvested leaves from the fig and clove trees were rinsed with distilled water to get rid of any dirt or other impurities that were present on the leaves' surface. The leaves were dried at room temperature for 5-7 days. Dried leaves were powdered with the help of mortar and pestle. A 250 mL beaker with 100 mL of distilled water and the prepared fine powder (5gm) was added before being heated on a heating mantle at 60°C for 10 minutes. Cool the solution and filter with the help of muslin cloth. Obtained plant extract centrifuged at 4500 RPM for 05 minutes to remove the solid plant debris. Collected both supernatant (plant extract) was stored at 4°C for further use.

2.2Synthesis of MgO NPs: -

Green synthesis of MgO NPs was done using by method of Sharma, *et al.,* (2023) [10]. In 50 mL of distilled water, magnesium nitrate hexahydrate ($Mg\ (NO_3)_2 \cdot 6H_2O$) was added and dissolved it. Equal volume of both plant extract was added to magnesium nitrate solution. Prepared solution was continuously heat and stirrer with the help of hot plate with magnetic stirrer at 60°C, till the colour was changed. Colour change indicates the formation of magnesium oxide nanoparticles (MgO NPs). The solution was centrifuged at 10000 rpm for 10 minutes. The pellet was collected and washed several times with distilled water and with ethanol then dried overnight at 60°C in hot air oven.

CHARACTERIZATION OF MGO NPS: -

To measure the optical parameters, MgO NPs were dispersed into double distilled water. The absorption spectrum of synthesized MgO NPs was measured using Labtronicsdouble beam UV-visible spectrophotometer (MODEL LT-2700) in the wavelength range of 200-800nm. Double distilled water used as a reference.

ANTIMICROBIAL ACTIVITY OF MGO NPS BY TWO DIFFERENT PLANTS: -

To determine antimicrobial activity of both green synthesized MgO NPs, assay was performed against gram negative bacteria (*Escherichia Coli, Pseudomonas aeruginosa*), gram positive bacteria (*Staphylococcus aureus, Bacillus subtilis*). The stock culture of four bacterial strains were revived in conical flask containing 100 mL of nutrient broth with 1mL of inoculum and incubated at 32-35°C. Revived bacterial culture (1mL) inoculum was added to 5ml of broth media followed by addition of green synthesized MgO NPs in concentration of 100 µl. The inoculated cultures were incubated at 32-35°C for 24 hrs. The turbidity due to bacterial growth was observed in liquid medium by measuring absorbance at 560 nm against control using UV-visible spectrophotometer. Antibiotics (Penicillin Streptomycin 0.2mg/ml and 200 unit/ml) used as a control.

RESULTS AND DISCUSSION-

Addition of magnesium nitrate hexahydrate in leaf extract of clove and fig plant leads to physio-chemical changes in the solution. Changes in the colour of reaction observed after one hour. Change in colour indicates as an initial sign to formation of MgO NPs. Change in colour from light brown to dark brown formation of MgO NPs from clove and fig leaves extract. Phenolic compounds and flavonoids are responsible for Mg ions to MgO NPs. After few hours, colour of the solution stopped changing due to complete reduction of MgO NPs.

Comparison the Optical analysis of two different for synthesis of MgO NPs: -

Synthesis of MgO NPs was evaluated by double beam UV-visible spectrophotometer. Absorption peak of clove based MgO NPs shows at 309nm show in Figure 1(a) while fig based MgO NPs shows peak at 304nm show in Figure 1(b).

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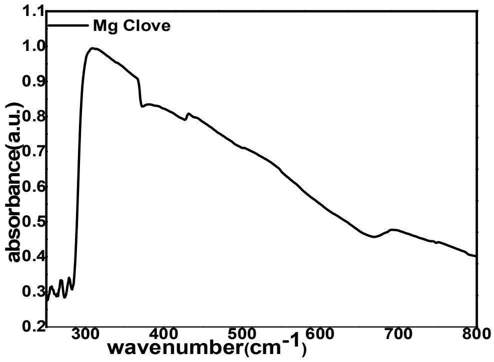

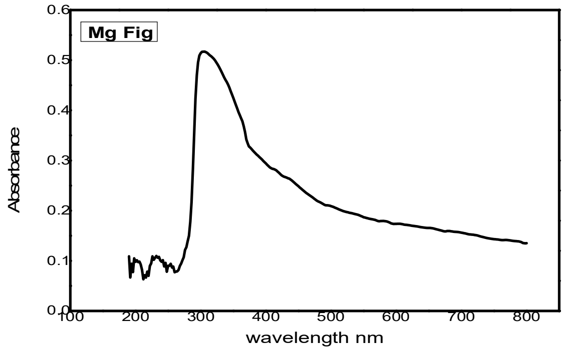

Figure 1, Optical absorbance of MgO nanoparticles (a) synthesized with clove leaves extract (b) synthesized with fig leaves extract.

Optical band gap energy (E_g) of the MgO nanoparticles can be estimated using the model proposed by Tauc. The following relation is given by Tauc's model

$$\alpha h\nu = B\ (h\nu - E_g)^n$$

Where hν is the incident energy, B is energy independent constant, factor n is representing nature of electronic transition causing optical absorption. For direct allowed transitions value of n is ½. In case of direct allowed transitions variation of $(\alpha h\nu)^2$ with hν yields a good straight line fit to the absorption edge. The extrapolation of the linear portion at $(\alpha h\nu)^2 = 0$ gives the estimation of E_g. By the use of Tauc's plot method the estimated bandgap value for green synthesized MgO NPs for clove plant is 2.5 eV and 2.99 eV for fig plant. Some studies reported band gap at 2.91 eV [13]. Different research studies show MgO NPs absorption peak at 300nm, 309.6nm [11-12].

Compare the Antimicrobial activity of MgO NPs by two different plants: -

Green synthesized MgO NPs by two different plant materials shows antibacterial activity against gram +ve bacteria and gram -ve bacteria. Zone of inhibition measured as *E. coli* (19mm), *P. aeruginosa* (17mm), *B. subtilis* (20mm) *B. sphaericus*(21mm) for clove leave and fig plant zone of inhibition was *E. coli* (18mm), *P. aeruginosa* (18mm), *B. subtilis* (19mm) *B. sphaericus*(21mm) and control shows 30mm shows in Figure 2.

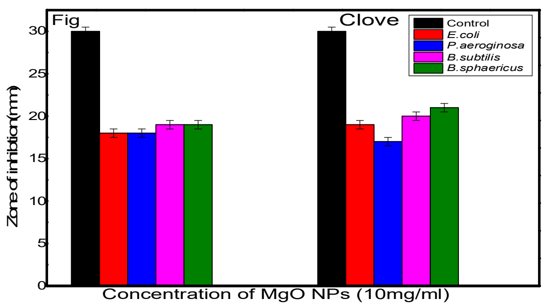

Figure 2, Comparison of antimicrobial activity of MgO synthesized with Clove and Fig leaves extract

Synthesized MgO NPs can interact with cell membrane of bacteria in different pathways like release of ROS (Reactive oxygen Species), direct contact with cell membrane and release of Mg^{2+}. These processes damage the cell through DNA disruption, cell membrane damage, cellular respiratory disorder, protein denaturation etc. Similarly, MgO NP antibacterial properties were reported by various researcher, they report, zone of inhibition of various size in the range of 9.6mm-36 mm [14-16] againstgram -ve bacteria and gram +ve bacteria.

CONCLUSION

Magnesium nanoparticles were successfully synthesized by two different plant materials which is easily available. Identification of Green synthesized MgO NPs done by double beam UV-visible spectrophotometer. Antibacterial potential of MgO NPs as a function of nanoparticles concentration was tested against gram +ve bacteria (*B. subtilis, B. sphaericus)*and gram -ve bacteria *(E. coli*, *P. aeruginosa)*. From the study, MgO NPs were observed to have strong antibacterial potential when compared with control. Growth study of gram +ve and gram -ve bacteria were strongly affected by MgO NPs. It was also observed that the growth rate of bacteria was strongly inhibited by small amount of MgO NPs. Magnesium oxide nanoparticles can be used as antibacterial agents in biomedical and biomedical engineering.

DECLARATION OF INTEREST: -

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENTS

Authors acknowledge the Maharaja Agrasen University for providing necessary facility.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

DATA AVAILABILITY:-Data available on request.

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CITATION OF THIS ARTICLE

Rajni Sharma, Shiv Kumar Giri, Anil Kumar, Kanupriya, Gulab Singh.Evaluation of Antibacterial Activity Of Mgo Nanoparticles Synthesized With *Syzygium aromaticum a*nd Ficus Carica Leaves Extract. Bull. Env. Pharmacol. Life Sci., Vol 12[8] July 2023: 76-80.