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GREEN SYNTHESIS OF MAGNESIUM OXIDE NANOPARTICLES BY USING *BUTEA MONOSPERMA* LEAF EXTRACT AND ITS ANTIBACTERIAL AND ANTIOXIDANT ACTIVITY

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Abstract

Green fabrication is an environmental friendly and innovative method and attractive research field for the production of Magnesium oxide nanoparticles (MgO NPs) in clinical and environmental applications. In this current study, a viable green synthetic approach to produce magnesium oxide nanoparticles by using *B .monosperma* leaf aqueous extract as a capping agent. The formation and physicochemical properties of MgO NPs were confirmed through stranded characterization methods. All the analytical data revealed that the formation of pure, rod shaped and crystalline MgO NPs with average size of 20 nm. This study reports that, the synthesized MgO NPs exhibiting good antioxidant activity and antibacterial activity it can be used for biomedical applications.

Keywords: *Butea monosperma* leaves, Antibacterial activity, antioxidant activity.

1.Introduction

A matter particle is referred to as a nanoparticle or ultrafine particle if its size is between one and one hundred nanometers (nm) [1]. The phrase is occasionally used to represent larger particles up to 500 nm, as well as fibres and tubes that are less than 100 nm in only two orientations, Smaller than 1 nm metal atoms are most referred to as atom clusters. Nanoparticles are often distinguished from microparticles (1-1000 m), "fine particles" (sized between 100 and 2500 nm), and "coarse particles" due to their smaller size (ranging from 2500 to 10,000 nm). These characteristics can be electric characteristics, ultrafast optical effects, or colloidal characteristics [2].

The properties of the bulk material may therefore be overshadowed by those of the surface layer. This impact is particularly strong for nanoparticles placed in media with different compositions because of the enhanced relevance of the interactions between the two materials at their interface. A platinum nanoparticle with a crystalline structure and a 2 nm diameter that can be seen to contain individual atoms. As nanoparticles are a common occurrence in nature, several fields, including chemistry, physics, geology, and biology, study them [3].

There are many chemical processes available to create MgO nanoparticles, however using chemicals, which are highly poisonous and dangerous, could cause environmental issues [4]. Building nanomaterials more sustainably is a goal. Nowadays, researchers view the biosynthesis of nanomaterials as a crucial topic of study. Potential uses for the green method of producing metal and semiconductor nanoparticles include the creation of new functional components.

As the starting material for the manufacture of metal oxide nanoparticles, numerous environmentally safe substances are used, including plant extract, bacteria, fungus, enzymes, etc. Magnesium oxide is an intriguing basic oxide that is used in the manufacture of refractory ceramics, adsorption processes, and many other processes [5].

Magnesium oxide is an intriguing basic oxide with a wide range of uses in the synthesis of refractory ceramics, adsorption, and catalysis [6]. It is a special solid with a high ionic character, a simple stoichiometry, a crystal structure, and the ability to be widely prepared with different particle sizes and shapes. According to reports, because to the large concentration of edge/corner sites and structural flaws on their surface, nanocrystalline MgO nanoparticles are particularly distinctive due to their exceptional characteristics, including strong chemical stability, high photocatalytic activity, high electrical permittivity, and non-toxic nature. Plant extracts contain biomolecules that function as reducing and capping agents to create stable nanoparticles. Hence, the obtained metal nanoparticles' characteristics, such as their biocompatibility.

Butea monosperma (Lam) Fabaceae family member Taub (Butea frondosa), also called Palas in Sanskrit, is a traditionally utilised medicinal plant. Bark, seeds, leaves, and flowers are all medicinal properties. Moreover, it is said to have antibacterial properties. The fluid bark concentrate of B. monosperma was used in the current study to combine magnesium oxide nanoparticles and reduce the

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magnesium ions found in the arrangement of magnesium nitrate. Additional investigation was done into the ability of these green magnesium particles to fight certain harmful bacteria. In order to maintain a healthy physiologic state and promote wellness, the body possesses a sophisticated antioxidant defence system made up of enzymatic and nonenzymatic mechanisms [7] the enzymatic antioxidants are catalase, glutathione peroxidase, and superoxide dismutase. Contrarily, the body also makes use of nonenzymatic antioxidants such uric acid, bilirubin, and lactoferrin. However, under illness settings, the endogenous antioxidant mechanisms get overworked, leading to an excess buildup of free radicals that cause oxidative stress and are associated with a number of ailments [8]. Antimicrobial drugs' primary purpose is to minimise the burden of infectious diseases on the planet [9]. However, the introduction and spread of multidrug resistant (MDR) strains in pathogenic bacteria have grown to be a serious public health threat because there are fewer, or occasionally no, effective antimicrobial treatments available for the illness caused by pathogenic bacteria [10].

2. Materials and method

2.1 Collection of plant sample

Butea monosperma leaves were collected fromnariyur village. Tirupattur district, Tamil Nādu, India. The leaves were washed with running tap water and cut into small pieces. The extract of *B. monosperma* was prepared using 100 ml distilled water and it allow for boiling at 100 C at 30 min. The obtained extract was filtered using Whatmann No1 filter paper and it stored at 4°C for further use.

2.2 Synthesis of MgO nanoparticles

10g of Magnesium nitrate was dissolved in 100 ml distilled water and it was allowed to boil at 60°C for 20 min. Then, the 50 ml of *P. nigrum* extract was added to 100 ml of Magnesium nitrate solution and it was kept at 60°C for 30 min. Then the solution was incubated for 24 hours and dark greenish precipitate was obtained after the incubation period. Next, the obtained precipitate was annealed at 400°C-500°C for 3 hours. After the annealing process fine powder was obtained & stored at 4°C for further studies.

2.3 Characterization studies of magnesium oxide nano particles

2.3.1 UV- Visible spectrum for synthesized nano particles

The sample was measured for its maximum absorbance using UV -Visible spectrometer. The optical property of MgO nanoparticles was analysed via ultraviolet and visible absorption spectroscopy in the range of 200 – 800nm**.**

2.3.2 FTIR analysis for synthesized nano particles

The FTIR spectrum was taken in the mid -IR region of 400 – 4000cm. The spectrum was recorded using ATR (Attenuated total reflectance) technique. The dried sample was mixed with the KBr (1:200) crystal, and the spectrum was recorded in the transmittance mode

2.4 2,2 -Diphenyl -1- picrylhydrazyl free radical scavenging activity assay by brand Williams

The extracts were prepared in concentrations of 20,40,60,80 and 100µg/mL for this assay. First, 3 mL of extract of each concentration was mixed with 1 mL of the 0.1 mmol/L DPPH solution prepared in methanol. Next, the tubes were incubated in the dark at room temperature for 30 min and then read at 517 nm using a UV-VIS spectrophotometer. Solvent without extract was used as a negative control and AA was used as a positive control. The effect of antioxidant capacity was observed as the colour change of purple DPPH to yellow/light-yellow and % inhibition values of each extract were calculated using the following equation:

Inhibition (%)= [(Acontrol — Ablank) — (Asample — Ablank)]×100/(Acontrol — Ablank),

Where A control is the absorbance of the negative control and A sample is the absorbance of AA or extracts. Inhibitory concentration (IC50) values were calculated with inhibition rates using a four parameter logistic regression model after sigmoidal curves were plotted. Each of the standards and the samples were measured in triplicate and mean values were used for the calculations.

2.5 Antimicrobial activity by Agar Well Diffusion:

Agar well diffusion method is widely used to evaluate the antimicrobial activity of plants or microbial extracts. Similar to the procedure used in disk-diffusion method, the agar plate surface is inoculated by spreading a volume of the microbial inoculum over the entire agar surface. Then a hole with a diameter of 6mm is punched aseptically with a sterile cork borer or a tip, and a volume (50–150 µl) of the ethanolic extracts of KKE and NVE, MgO nanoparticles and mixture at desired concentration is introduced into the well. And the positive control Gentamycin disc kept in the agar surface. Then agar plates are incubated under suitable conditions depending upon the test microorganism. The antimicrobial agent diffuses in the agar medium and inhibits the growth of the microbial strain tested.

3. Result and discussion

3.1 UV – Vis Spectroscopy

Figure 1 below depicts how MgO nanoparticles respond to absorption (MgO NPS). At 262 nm, which is between 260 and 280 nm . The magnesium oxide nanoparticles range between 260 nm – 330 nm

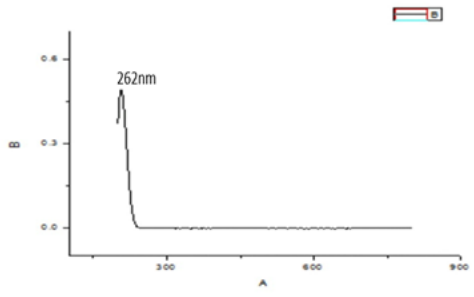

Figure 1

Moreover, the precursor ion Mg2+, MgCl2 salt does not exhibit a spectrum at the designated wavelength. After the addition of plant extracts and NaOH solution, a peak with a wavelength of between 260 and 270 nm was observed [4]. This peak can be attributed to the creation of metal oxide nanoparticles. This phenomenon is connected to the creation of MgO nanoparticles from their aqueous solution precursor.

3.2 FTIR analysis

Figure 2 shows the measured peaks to be at 3680cm-1, 3480cm-1, 2912cm-1, 2360cm-1, 1659cm-1, 1425cm-1, and 1024cm-1, and 455 cm-1. The Mg0 region of the spectrum for MgO nanoparticles was measured in the range of 3300 cm-1 to 3600 cm-1.The peak region of the MgO Nanoparticles between 450 to 600 cm-1Peaks at 3680 cm-1 indicate the presence of a (O-H) bond; peak at 3480 cm-1 indicates the presence of a primary amine (N-H); peak at 2912 cm-1 indicates the presence of a carboxylic acid (O-H); peak at 1024 cm-1 was observed (C-N); and peak at 455 cm-1 was observed as MgO due to the reduction and stabilisation of the metal group MgO [sivaraj *et al* ., (2014)].

Table 1: FTIR analysis

Abs cm-1	Appearance	Group	Compound
3680	Medium, sharp	O-H stretching	alcohol
3480	Medium	N-H stretching	Primary amine
2912	Week, broad	O-H stretching	Carboxylic acid
2360	Strong	O=C=O stretching	carbon dioxide
1425	Medium	O-H bending	Carboxylic acid
1024	Medium	C-N stretching	–
455	-	C-Br stretching	–

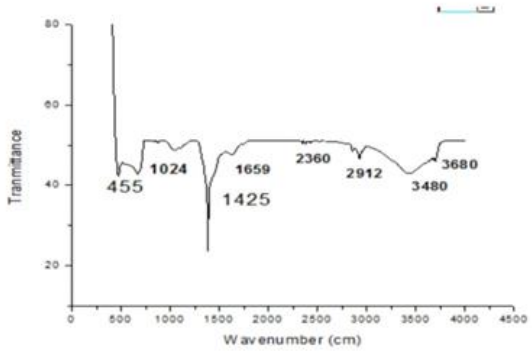

Figure2: FTIR

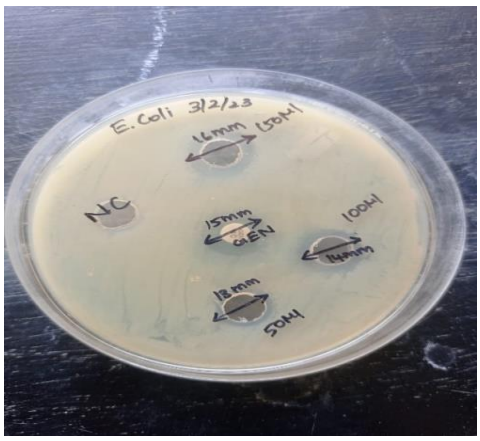

Figure 4: *Escherichiacholi*

3.3 Antibacterial activity

Antibacterial activity MgO Nanoparticles

Figure 3: *Bacillus subtilis*

The impregnation method was used to assess the relative antibacterial activity of MgO nanoparticles against the pathogenic bacteria *Bacillus subtilis* (gram-positive) figure 3 and *E. coli* (gram-negative) figure 4. The zone of inhibition (mm) from antibacterial tests of MgO nanoparticle samples. MgO nanoparticles show antibacterial action against bacillus subtilis and E. coli, and their zone of inhibition for gram-positive bacteria is wider than that for gram-negative Both gram-positive and gram-negative bacteria were susceptible to the antibacterial activity of the green synthesised magnesium oxide nanoparticles, but it was discovered that the antibacterial effect of MgO nanoparticles was higher against gram-positive (*bacillus*) bacteria than that against gram-negative (*E. coli*), with the inhibition zones of 16 mm and 14 mm, respectively.

3.4. Antioxidant activity

Figure 5 depict power. The antioxidant potential of bioact-

ive compounds can be examined using the stable radical DPPH.

By measuring the absorbance of the DPPH radical in the sample at 517 nm, butea monosperma leaf extract antioxidant activity was determined using ascorbic acid as a control. In terms of DPPH antioxidant activity, butea monosperma leaf extract at 50 µg/ ml has a scavenging capacity of about 90% compared to conventional ascorbic acid's 100%.

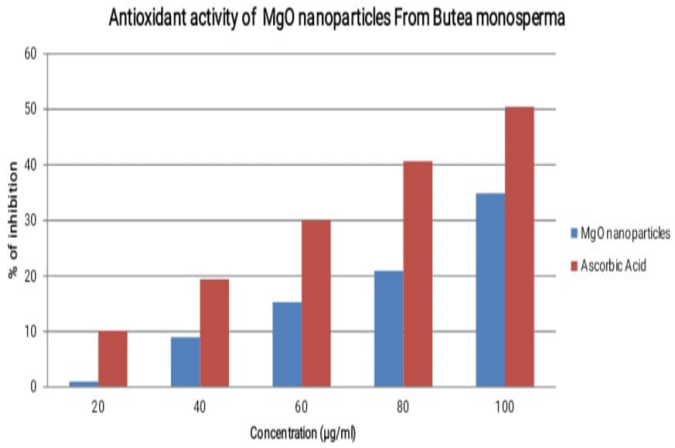

Figure 5

4. Conclusion

In this current study, we present green synthesis of magnesium oxide nanoparticles utilising *butea monosperma* leaf extract. The leaf extract contains organic compounds that act as reducing agent and stablising agent. many methods , including UV-Vis and FTIR responses ,were used to characterise the produced MgO NPs. Based on the FTIR response , it was determined that plant extract contains functional group that serve as both a stablising agent and a reducing agent. The prepared MgO Nanoparticles has good antibacterial activity, and has a good antioxidant property which is proved by DPPH

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Reference

[1] Zhu, L.; Zeng, W. Room-temperature gas sensing of ZnO-based gas sensor: A review. Sens. Actuators, A Phys. 2017, 267, 242–261.

[2] Jin, H.; Zhao, X.; Wu, Z.; Cao, C.; Guo, L. Supercritical water synthesis of nano-particle catalyst on TiO2 and its application in supercritical water gasification of biomass. J. Exp. Nanosci. 2017, 12, 72–82.

[3] Ezhilarasi, A.A.; Vijaya, J.J.; Kaviyarasu, K.; Maaza, M.; Ayeshamariam, A.; Kennedy, L.J. Green synthesis of NiO nanoparticles using Moringa oleifera extract and their biomedical applications: Cytotoxicity effect of nanoparticles against HT-29 cancer cells. J. Photochem. Photobiol. B Biol. 2016, 164, 352–360.

[4] Das, B.; Moumita, S.; Ghosh, S.; Khan, M.I.; Indira, D.; Jayabalan, R.; Tripathy, S.K.; Mishra, A.; Balasubramanian, P. Biosynthesis of magnesium oxide (MgO) nanoflakes by using leaf extract of Bauhinia purpurea and evaluation of its antibacterial property against Staphylococcus aureus. Mater. Sci. Eng. C 2018, 91, 436–444.

[5] Amrulloh, H.; Fatiqin, A. Sintesis Nanopartikel MgO Menggunakan Ekstrak Daun Kelor (Moringa oleifera) dan Uji Aktivitas Antibakteri Terhadap Escherchia coli dan Staphylococcus aureus, 1st ed., Pustaka Learning Center: Malang, Indonesia; 2020; p 145.

[6] Leung, Y.H.; Ng, A.M.C.; Xu, X.; Shen, Z.; Gethings, L.A.; Wong, M.T.; Chan, C.M.N.; Guo, M.Y.; Ng, Y.H.; Djurišić, A.B.; Lee, P.K.H., Chan, W.K.; Yu, L.H.; Phillips, D.L.; Ma, A.P.Y.; Leung, F.C.C. Mechanisms of antibacterial activity of MgO: Non-ros mediated toxicity of MgO nanoparticles towards Escherichia coli. Small. 2014, 10, 1171–1183.

[7] Patil, A.B.; Bhanage, B.M. Novel and green approach for the nanocrystalline magnesium oxide synthesis and its catalytic performance in Claisen-Schmidt condensation. Catal. Commun. 2013, 36, 79–83.

[8] Pilarska, A.A.; Klapiszewski, Ł.; Jesionowski, T. Recent development in the synthesis, modification and application of Mg(OH)2 and MgO: A review Powder Technol. 2017, 319, 373–407.

[9] Park,J.-W.; Lee, W.-K.; Lee, C.-H. Preparation of nano-magnesium oxide from seawater bittern using decarboxylation/precipitation method. Mol. Cryst. Liq. Cryst.2016, 636, 142– 148.

[10] Choudhary VR, Rane VH, Gadre RV. Influence of Precursors Used in Preparation of MgO on Its Surface Properties and Catalytic Activity in Oxidative Coupling of Methane J Catal. 1994; 145:300-311. 11. Rajagopalan S, Koper S, Decker S, Klabunde KJ. Nanocrystalline metal oxides as destructive adsorbents for organophosphorous compounds at ambient temperatures. Eur. J Chem. 2002; 8 (11):2602-2607.

[11] Sayyed, M.I.; Elmahroug, Y.; Elbashir, B.O.; Issa, S. Gamma-ray shielding properties of zinc oxide soda lime silica glasses. J. Mater. Sci. Mater. Electron. 2016, 28, 4064–4074.

[12] El-Nahal, M.A.; Elsafi, M.; Sayyed, M.I.; Khandaker, M.U.; Osman, H.; Elesawy, B.H.; Saleh, I.H.; Abbas, M.I. Understanding the Effect of Introducing Micro- and Nanoparticle Bismuth Oxide (Bi2O3) on the Gamma Ray Shielding Performance of Novel Concrete. Materials 2021, 14, 6487.

[13] R. He, X. Qian, J. Yin, Z. Zhu, Preparation of Bi_2S_3 nanowhiskers and their morphologies, J. Cryst. Growth., 252 (2003) 505-510.