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ANTIBACTERIAL PROPERTY OF MgO NANOPARTICLES PREPARED THROUGH GREEN SYNTHESIS ROUTE FROM ORANGE PEEL EXTRACT

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Abstract

The present review is to synthesize metal oxide nanoparticles by Green Route Method from citrus peel powder under Sun dried and Oven dried form. Hence the current focus is to synthesize Magnesium Oxide nano powder from the citrus plant extract such as citrus fruit peels. Green route method is an alternative as well as Non-Toxic method to Synthesis MgO nanoparticles biologically. The various characterization studies were carried out for synthesized MgO Nanoparticles such as X-ray Diffractometer (XRD), Fourier Transform Infrared (FTIR), UV-Vis Spectroscopy, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analyzers (EDAX), Photo Luminescence (PL) and Anti-Bacterial activity.

Keywords: Magnesium Oxide; Green route method; Sun dried and Oven dried.

1. Introduction

The vast number of papers and reviews in this field during the last ten years indicates that nanoscience and nanotechnology are expanding at an extremely rapid rate. Due of its enormous applications, everyone is concentrating on this. MGO nanoparticles show great promise in a variety of applications, including toxic waste cleanup, superconducting goods, catalysis, and antibacterial activity against food-borne pathogens [1,2]. The development of experimental procedures for the production of nanoparticles (NPs) with varying chemical compositions, sizes, shapes, and characteristics is a key component of nanoscience. As an alternative to chemical or physical procedures, researchers have recently attempted to discover biological ways for synthesizing nanoparticles. When it comes to producing NPs, biological approaches are thought to be safe, environmentally friendly, economical, and guarantee that all harmful substances are completely removed [2]. It is poisonous and dangerous for the environment due to the various processes utilized in chemical synthesis, including pyrolysis, micelle, hydrothermal, and sol-gel processes. Green synthesis emerges as a rescuer in order to reduce this detrimental impact on the environment. Microorganisms, algae, and plants can serve as the biological building blocks for green synthesis [3]. In addition to biological applications, green synthesis-derived nanoparticles are utilized in transistors, magnetic devices, photocatalysts, microelectronic devices, anticorrosive coatings, electrocatalysts, and powder metallurgy. Other applications for these nanoparticles include anti-inflammatory, antimicrobial, effective drug delivery, bioactivity, tumor targeting, anti-cancer, and bio-absorption [4,5].

The utilization of environmentally benign, low-cost, and straightforward green technologies for the synthesis of ZnO NPs has garnered a lot of interest lately. In order to scale up and produce NPs industrially, these approaches entail the use of plant, fruit, and vegetable extracts that are utilized as reductant agents and stabilizers to control the formation of the crystals [3,5]. Magnesium oxide nanoparticles are white, odorless, nontoxic powders with exceptional hardness and melting points. Because of these nanoparticles' biocompatibility, biodegradability, and affordability, they are utilized extensively in several sectors. Magnesium oxide is used in medicine as an antibiotic, anticancer, and to treat heartburn and indigestion. It also helps to promote bone regrowth [6].

These traditional or more cutting-edge extraction methods could either degrade the targeted chemicals because of high temperatures and lengthy extraction times, as in solvent extractions, or they could offer health hazards because they don't know about safety precautions to take during radiation exposure. Plasma discharges in a variety of configurations are the newest technique for processing homogeneous and heterogeneous systems, including plant material [7]. From the perspective of practical applications, the contact nonequilibrium low-temperature plasma (CNP) is a viable alternative among plasmochemical discharges. Between the gaseous electrode and the liquid surface, where another electrode is situated, plasma discharge is produced [8]. Because of its broad-spectrum antibacterial activity and antioxidant properties, the application of biosynthesized silver nanoparticles (AgNPs) in agriculture is gaining significant attention. AgNPs that are biosynthesized are

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biocompatible, economical, and environmentally benign. The nanoparticles show many antibacterial processes in addition to their ability to benefit plants [9]. Therefore, it is very important to examine how biosynthesized AgNPs inhibit Acidovorax, as this is a safe, affordable, and environmentally friendly approach that can be effectively used to the field of nanotechnology. Thus, our goal was to create AgNPs using fresh pomelo fruit extract and assess their antibacterial efficacy against the BBS pathogen, Ao strain RS-2 [9,10,11].

Overall, the findings showed that the produced ZnO NPs had a substantial impact on the growth, biofilm formation, swimming motility, and cell membrane of Xoo strain GZ 0003. Additionally, Awwad et al. discovered that ZnO NPs had extremely effective antibacterial activity against S. aureus and E. coli after synthesizing the particles using fruit extracts from Ailanthus altissima. The aforementioned research demonstrates how easy, economical, and environmentally benign the green synthesis of ZnO NPs is—by avoiding the usage of hazardous chemicals. The produced ZnO NPs also have exceptional chemical and physical characteristics and a broad range of applications [12,13], citrus fruits are used in the bottom-up process of biosynthesizing silver nanoparticles, which involves the reduction of silver ions. Citrus peels, such as Citruslimetta and Citrus Sinesis, are rich in polyethoxylated flavones and flavones, which are extremely uncommon in plant extracts. The extract from citrus fruits functions as a reducing agent to initiate the creation of nanoparticles. Therefore, this synthesis technique is safe, nontoxic, and environmentally friendly. Since toxic chemical substances are not used in the synthesis of nanoparticles, using environmentally benign materials for nanoparticle synthesis offers many advantages in pharmaceutical and biomedical applications, according to International Journal of Pharmacy and Biological Sciences Riddhi Rajesh Gada and Unnati Padlia [14,15,16]. investigated the potential of using Nephelium lappaceum L. peel as a natural, nontoxic reducing agent for creating MgONPs; the resulting nanoparticles ranged in size from 60 to 70 nm. When silver nanoparticles were previously produced from plant materials and tested for antibacterial activity, it was discovered that they had remarkable inhibitory action against bacterial strains [18,19].

The process of skin aging is dynamic and involves unpredictable sequences of structural changes to the collagen-rich extracellular matrix (ECM). The primary marker of premature aging associated with the ongoing degradation of hyaluronic acid is the significant disintegration of long-lived proteins like fibronectin, collagen, and elastin [20,21,22].

Perennial chamomile plants are members of the Compositae family. It has long been used in traditional medicine as a sedative, to aid with digestion, and to relieve headaches and toothaches. There have been reports of the plant's anti-inflammatory, antibacterial, antioxidant, and anti-arthritic qualities [23,24,25,26].

Citrus peels contain more Antimicrobial, Anti-oxidant Property hence these found less when compared with pulp and juices of citrus fruits. Hence Low cost, Easy availability of fruit peel residues from lemons, limes, orange, and other citrus fruits inhibit the growth of Bacteria, Viruses Etc. Dried Citrus peels contains addition of D-Limonene, Vitamins, Polymethoxyl Flavones, Hesperidin which increases immune system, digestions, insulin resistance and mainly help to manage blood glucose levels etc. Many Research Established the citrus peel (By product) has multiple applications for living beings. The citrus fruit residues regarded as wastes alleviate pollution problems in environment which is rich in Nutraceutical resources, Bio active Compounds, Dietary supplements and also these wastes added more value in manufacturing of food supplements.

2. Method

The Existing work to Synthesis MgO Nanoparticle by beneficial method from Rutaceae Family Fruits Peel Citrus Sinensis [21].

The Synthesis procedure of MgO-NPs was followed by simple four steps

1. Preparation of Citrus Fruit Peel Powder [1,2]
2. Preparation of Peel powder Extract [1,2]
3. Preparation of Magnesium Nitrate with Extract Solution
4. Conglomeration of MgO Nanoparticle [22]

2.1 Preparation of Citrus Fruit Peel Extract

Citrus Sinensis commonly known as oranges were brought from market and the peels were removed by hand. The removed peels were washed with Tap water and Double distilled water [23] and were dried under two different conditions such as, Sun Dried Form and Oven Dried Form. The photographic image of the dried peels is shown in fig.1.

Fig. 1. Shows Peels of Citrus Sinensis a) sun dried and Oven dried

Citrus Sinensis were dried under Sun light for (3-4) days then its grinded into fine powder. Citrus Sinensis Sun dried peel powder mentioned as (A1) whereas the peels dried in oven at 80^{0}C for 10 hours, and its grinded into fine powder were termed as (A2).

2.2 Preparation of Peel Powder Extract

Citrus Peel Powder Extract were Prepared by mixing 2% Peel Powder with 98% Double Distilled Water through continuous stirring and heating the mixture at 80^{0}C for 40 minutes. The obtained Citrus Peel Extract were filtered by Whatman Filter Paper.

2.3 Preparation of Magnesium Nitrate with Extract Solution

Magnesium Nitrate solution was prepared by adding 10 ml of Mg(No3) with 90 ml of Citrus peel Extract Solution.

2.4 Preparation of MgO Nanoparticles

Magnesium Nitrate with Peel Extract were heated and Stirred Continuously for 3 hours at 100 ^{0}Celsius, from the observations the colour changes from brighter tone orange to dull tone. Hence it implies Magnesium Nitrate reduced to Magnesium Oxide the Obtained Extract kept as dried for 24 hours over night. In this period the nanoparticles were settled down in the bottom of flask then its calcinated at 500^{0}C for 5 hours. Pure White Magnesium Oxide Nanoparticle formed.

3. Results and discussion

3.1 XRD Analysis

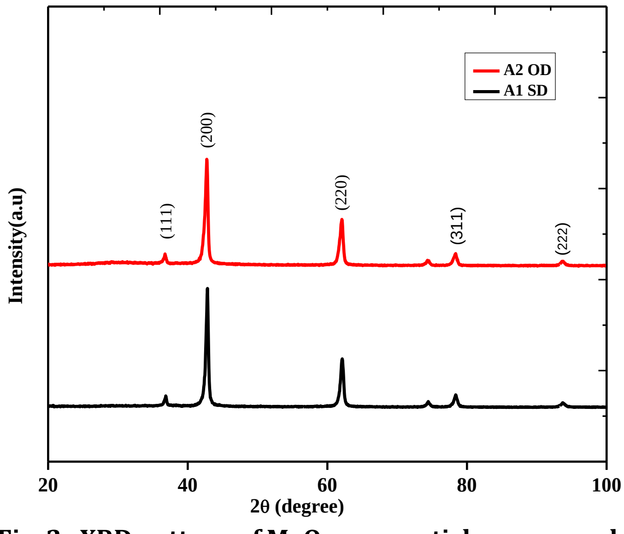


Fig. 2. XRD pattern of MgO nanoparticles prepared in the presence of Orange Peel powder (A1) Sun Dried (SD) and (A2) Oven Dried (OD)

The MgO Nanoparticle synthesized in the presence of Citrus Peel Powder were analyzed by X-Ray Diffractometer as Shown in fig.2. The MgO Peaks were absorbed at 36°, 42°, 62°, 74°, and 78° along with crystallographic planes of Miller indices values are (1 1 1), (2 0 0), (2 2 0), (3 1 1) and (2 2 2) were absorbed for Citrus peel powders for both Sun dried and oven dried form. The XRD Pattern of Pure MgO Nanoparticle matches the JCPDS Card No 45-0946 revealing the formation of Face Centered Cubic (FCC) structure and the peaks shows Sharp intensity. No impurity peaks were detected from sample. As the peak width increases the size of particle decreases, which indicates the formation of nanoparticle [12]. The Lattice parameter of the synthesized MgO nanoparticle were obtained by a=b=c=4.211nm. The crystallite size was calculated using the Debye-Scherer Formula,

$$D = k\lambda/\beta \cos\theta$$

Where,

D is the average crystallite size of Debye Scherer

K is the constant (0.9)

λ is the wavelength of X- rays used

β is the half width at full maximum (FWHM)

The calculated Crystallite sizes were found to be 23.6 and 24.8 nm for the MgO nanoparticles synthesized with the Orange Peel powder dried in sun and oven respectively.

3.2 FTIR Spectral Analysis

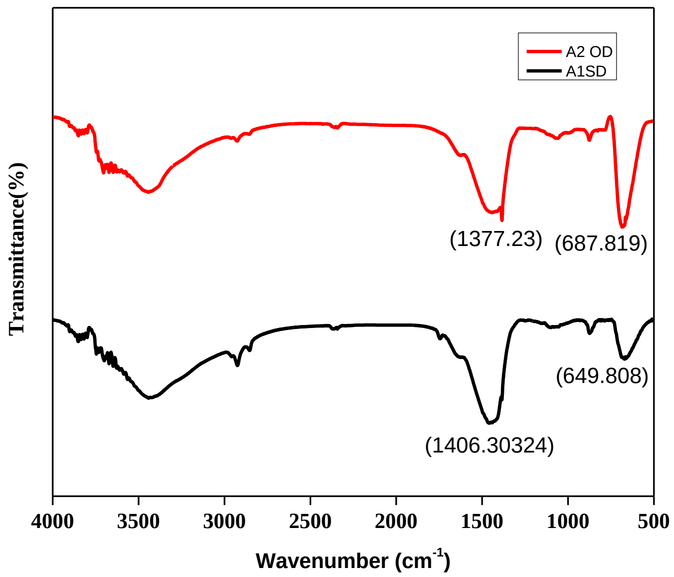


Fig 3. FTIR Spectra of MgO nanoparticles prepared in the presence of Orange Peel powder (A1) Sun Dried (SD) and (A2) Oven Dried (OD)

The chemical reactions in Citrus Peel Powder were analyzed by vibrational stretching of bonds and the bending bodes of molecules from the FTIR spectra of Synthesized MgO Nanoparticle. The spectra of MgO nanoparticles represents in the figure at the range of 1000-4000cm-1 (fig. 3) Sun Dried and Oven Dried of Orange [2] these stretching modes of vibrations belongs to Mg-O Molecules. The characteristics peak of 1377.23 cm^{-1} and 1406.30 cm^{-1} represents the stretching modes of C-O and C-O-C bend hence these peaks imply presence of Carboxylic acid functional group. Therefore, the FTIR spectra confirms the presence of MgO [l]. The presence of small peaks in C-O stretching due to dried Peel of Citrus fruits because the peel contains the carboxylic acids.

3.3 UV – Vis Spectroscopic Analysis

The UV-Vis absorption spectrum is used to analysis the absorption properties of the prepared MgO nanoparticles in the wavelength ranges from 200 nm to

900 nm. The UV-Vis absorption pattern of the prepared MgO nanoparticles were presented in fig.4. The Cut-off wavelength was found to be 225 nm, 232 nm for both sundried and oven dried Citrus Peel Powders. In order to calculate the bandgap of the prepared MgO nanoparticles, tauc plot was used as shown in fig.5.

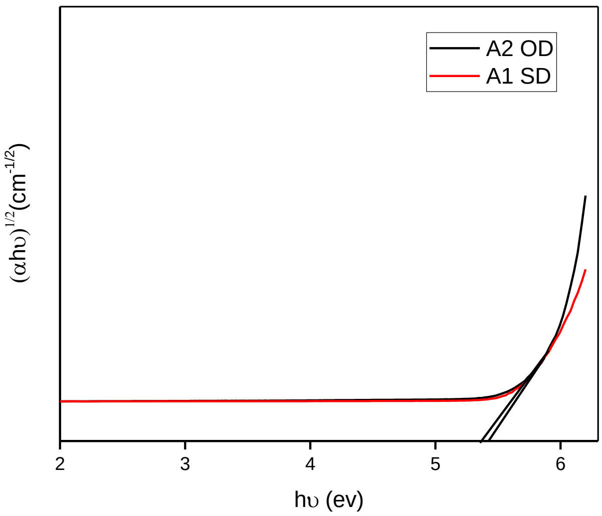


Fig. 5. Tauc Plot of of MgO nanoparticles prepared in the presence of Orange Peel powder (A1) Sun Dried (SD) and (A2) Oven Dried (OD)

From the tauc plot the band gap energy can be calculated by using the following relation

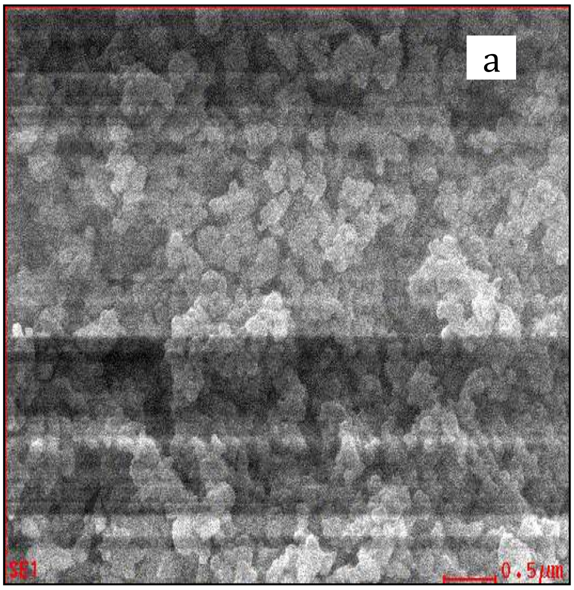
$$(\alpha h\nu) = A (h\nu - Eg)$$

Where,

A = Absorption Co-efficient
h = Planck's constant
eV = Photon Energy
Eg = Band gap Energy
n = constant its equal to ½ for the direct band gap

The Band gap energy (Eg) of MgO nanoparticles prepared using the Orange Peel Powder dried in Sun and Oven were 5.36 eV, 5.43 eV respectively.

3.4 SEM Analysis



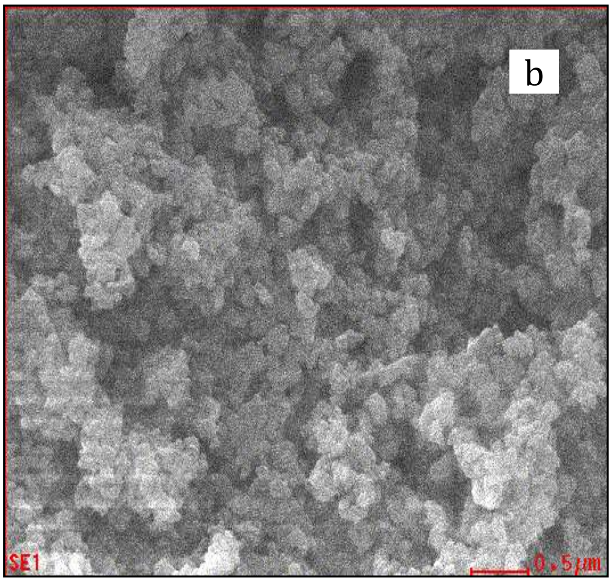
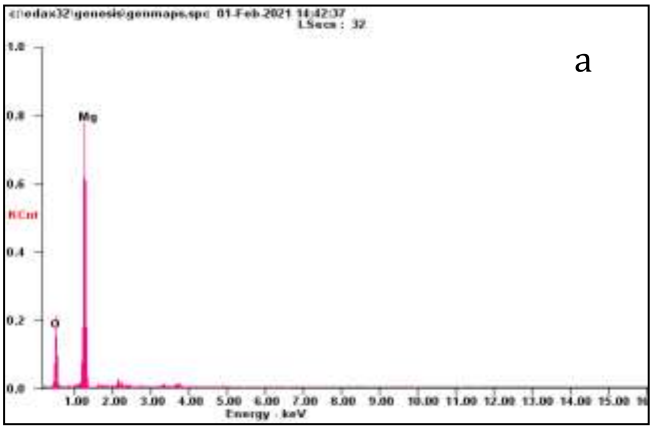


Fig. 6. SEM image of MgO nanoparticles prepared in the presence of Orange Peel powder dried in a) Sun and b) Oven

The morphology of the prepared MgO nanoparticle was studied from the SEM micrographs shown in the Fig.6 (a & b). From the SEM image it can be clearly seen that the prepared MgO nanoparticles were spherical in shape and also homogenous i.e., equally distributed and dense in nature. However, a few agglomerations were seen here and there.

3.5 EDAX Analysis

The Elements presents along with the sample can be confirmed from EDAX Analysis. The EDX spectrum of the prepared MgO nanoparticles are presented in fig. 7. The presence of Mg and O is confirmed and the absence of peaks pertaining to other elements shows the purity of the prepared samples. The weight percentage and atomic percentage of the elements present in the sample prepared in the prescence of orange peel powder dried in sun and oven are presented in table 1.



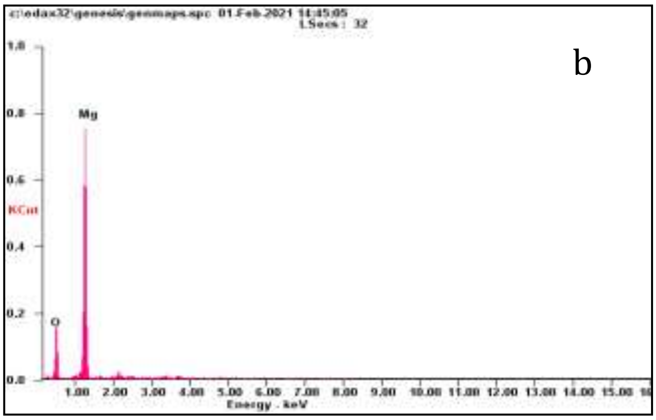


Fig. 7. EDX pattern of MgO nanoparticles prepared in the presence of Orange Peel powder dried in a) Sun and b) Oven

Table 1. Weight percentage and atomic percentage of the Elements present in the prepared sample

S.NO.	Element	Weight%	At%
A1 SD	Mg K	67.74	58.02
	OK	33.29	43.13
A2 OD	Mg K	61.85	51.61
	OK	38.15	48.39

3.6 Photoluminescence Studies

The Photoluminescence analysis used to record the emission spectra of the sample. The PL spectrum of MgO nanoparticles prepared with the extract of citrus peel powder dried in sun (A1) and oven (A2) in fig.8, show emission peaks are 460 and 465nm respectively. The emission peaks at the range of 460 may be due to the recombination of the electron with oxygen vacancy [13]. The emissions from 460 to 465 nm ranges are possible due to Mg vacancies at interstitials which might have occurred due to unbalanced exegeted and subsequential crystallizations.

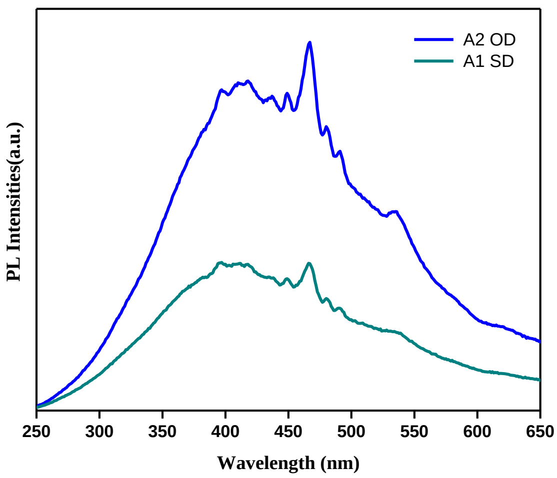


Fig. 8. Photoluminescence analysis emission spectra of MgO nanoparticles

3.7 Antibacterial Activity

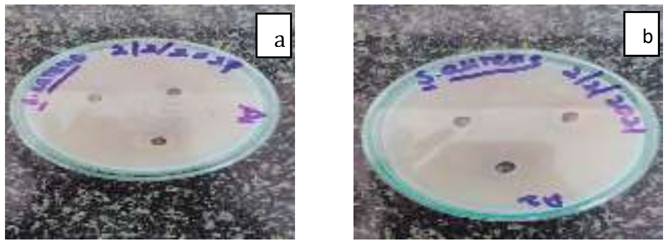


Fig. 9. Antibacterial effect of MgO nanoparticles prepared in the presence of Orange Peel powder dried in a) Sun and b) Oven

To analysis the Antibacterial effect towards the Gram-Positive Bacteria such as Staphylococcus i.e (s.aureus) and also the Gram Negative Bacteria such as Escherichia Coli i.e (E.coli) of the MgO nanoparticle synthesized with the citrus peel powder dried under sun and in oven are presented in fig.9. Petriplates were prepared by pouring 20 ml of Muller Hinton and drying it. After the Plates were dried, 0.1 ml inoculums suspensions were poured and spread uniformly. These inoculums were kept to dried. After drying for 5 minutes, bacterial plates were incubated at 37 deg/cel. The inhibition was observed in the plates are shown in the fig. 9. The synthesized MgO Nanoparticle sample does not show any effects on such Gram-Positive and Gram-Negative Bacteria. Thus, the prepared samples don't possess antibacterial property.

4. Conclusion

MgO Nanoparticle were synthesized successfully by a cost effective and non -toxic Green Route. The formation of MgO nanoparticle with high purity were confirmed from XRD results obtained. The bond vibrational analysis was studied from FTIR spectra. Optical properties were analyzed by UV -vis Spectra and PL emission studies. The band gap was caulated using tauc plot as 5.36 eV and 5.43eV for the prepared samples. The PL emission obtained at the range of 460 nm confirms the formation of MgO nanoparticles and their optical emission properties. The anitibacterial tests conducted with Staphylococcus i.e (s. aureus) and also the Gram-Negative Bacteria such as Escherichia Coli revealed that the prepared nanoparticles did not have antibacterial property.

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