Nanoscale Reports

3(1) (2020) 10-14

RESEARCH ARTICLE

DOI:10.26524.nr.3.2

OPEN ACCESS

Biosynthesis of Magnesium Oxide Nanoparticles using the Extracts of Puniga Granatum Peels and Brassica Oleracea

M. Muthulakshmi[1]*, B. Naganandhini[2]

Abstract

Nanotechnology brings the enormous application in the field of medicine, agriculture and aquaculture technologies, which is shifted from the chemical based solutions. The current work concerned on green synthesis of Magnesium Oxide nanoparticle from the extracts of pomegranate peels and cauliflower, in which the Magnesium Sulphate Heptahydrate has been act as a precursor. Because of its high hardness property of Magnesium Oxide, it is used as fire retardant in plastic tubes and chemical fibre. The various analytical studies and morphological characteristics were taken for MgO nanoparticles such as XRD, SEM, FTIR, EDS, UV-Vis and Antibacterial activity. From the XRD, the crystallinity of MgO particles was found out. From the FTIR and UV-Vis spectrum, the powdered composition of the samples and their optical properties were determined. SEM predicts the morphological structure of MgO nanoparticlesand their elemental composition were determined in the EDS analysis. Antibacterial activity for MgO nanoparticles exhibited good results against gram positive and gram negative bacterial.

Keywords: Magnesium oxide, Antibacterial, Nanoparticles, Pomegranate, Cauliflower

Author Affiliation: [1]Department of Physics, Vellalar College for Women, Erode-12, Tamil Nadu, India.

Corresponding Author: M. Muthulakshmi. Department of Physics, Vellalar College for Women, Erode, Tamil Nadu, India, Email: sivaganesh0207@gmail.com

How to cite this article: M. Muthulakshmi, B. Naganandhini, Biosynthesis of Magnesium Oxide Nanoparticles using the Extracts of Puniga Granatum Peels and Brassica Oleracea. *Nanoscale Reports* 3(1), 10-14. Retrieved from https://nanoscalereports.com/index.php/nr/article/view/40

Source of support: Nil

Conflict of interest: None.

Received: 3 March 2020 **Revised:** 5 April 2020 **Accepted:** 8 April 2020

1. Introduction

Nanotechnology is a multidisciplinary scientific field undergoing explosive development.[1] Nanotechnology has a ability to produce new materials at the nanoscale and it has many application in the field of science like medicine, physics, cosmetics, environmental health, drug and gene delivery, chemical industries, electronics, space and biomedical science.[2] By the growth of the nanoscience and nanotechnology, the nanoparticles are used as a toxic gas absorbent.[3] Nanoparticles present in high surface area to volume ratio with decrease in the size, distribution and morphology of the particles.[4]

Different synthetic routes are used to prepare nanoparticles such as chemical and physical methods. The chemical methods includes combustion, microwave assisted synthesis, spinning disk reactor, wet chemical method, sol gel method, chemical synthesis, S precipitation method.(5) However these production methods are usually explosive, labour intensive and are potentially hazardous to the environmental and living organisms.[6] Biological approaches using micro organisms, plant or plant extracts for synthesis of metal nanoparticles and biological methods including yeast, fungi, bacteria have been used in synthesis of nanoparticles.[7] When compared to physical and chemical methods, green synthesis is simple and cost effective. It is performed at low temperatures and it is non -toxic to byproducts.[8]

Among all metal nanoparticles, Magnesium Oxide nanoparticles have the potential absorbent of toxic gas such as NO_2, SO_2, methanol, dimethylamine and trimethyl acetaldehyde.[9] Due to their hardness, high melting point, biocompatibility, biodegradability and versatile properties, they are widely used in the refactory materials, toxic waste remediation in industries.[10]. Some of the potential application of MgO is water purification, optoelectronics, bactericides, crucibles and insulators in industrial cables.[14-15] The plant extracts used for this synthesis are pomegranate peels (Punica granatum) and cauliflower (Brassica oleraceae).

Pomegranate belongs to the family of lythraceae. It is a wide edible fruit cultivated throughout the meditterean region and its extracts are used to inhibit the growth of human breast cancer cells by inducing cell death.[11] Due to its antioxidant property, it may contain some tannin in pomegranate such as hydrolazable tannins, gallo tannins, ellagic tannins and condensed tannins.[12]

Cauliflower belongs to the family of brassicaceae which is cultivated around Europe. It has potent biological and immunological activities. They are very good source of electrolytes, minerals and vitamins.[13] It may also prevent the bone loss. It has high in dietary, fibre, folate, water content and vitamin C which possess high nutritional density. The present study synthesized the MgO nanoparticles using the extracts of pomegranate peels and cauliflower.

2. Experimental Procedure

2.1 Materials used

Pomegranate peels (Puniga granatum), Cauliflower (Brassica oleraceae), Magnesium sulphate heptahydrate.

2.2 Preparation of the Leaf Extract

Puniga granatum and Brassica oleracea were used to make the aqueous extract. About 240 g of fresh cauliflower and 12g dry powder of pomegranate peels were taken in a separate beaker and distilled water were added to make up to 125ml. Then the mixture was allowed to boil for 30 minutes. Then it is allowed to cool at room temperature and filtered using the whatmann filter paper. Finally the extracts were collected and stored for further use.

2.3 Synthesis of magnesium Oxide Nanoparticles

About 120 ml of Magnesium Sulphate Heptahydrate solution of 0.1M concentration was prepared using distilled water. Under constant stirring, the extracts of 125 ml of pomegranate peel and cauliflower were added drop by drop. The additions of extracts take up to 3hours. Then the solution was centrifuged, filtered and dried in a hot oven at 100°c. The dried samples were collected and grained well with the mortar. Finally the obtained MgO nanopowders were stored in the air tight container for further studies.

3. Results and Discussion

3.1 X-ray diffraction

The crystallographic analysis was carried out by X-ray diffraction method. The XRD patterns of MgO nanoparticles are produced using the extracts of pungi granatum and brassica oleracea. It was proved and confirmed by the characterized peaks observed in the XRD image. The graph is plotted between intensity and 2 theta values. The presence of sharp peaks at various positions and exhibited their spectrum of 2θ values ranging 27.71, 77.81, 19.80.

The average crystalline size was calculated using the Debye Scherrer formula,

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

Where, K is the proportionality constant approximately equal to unity, β is the FWHM of the peak in radians (theoretically corrected from the instrumental broadening), λ is the wavelength of X-rays (1.5406A), θ=Brrag's angle. The average crystalline size was measured from the calculated values given in the Table.1

From the below table, the average crystalline size was found to be 11 nm.

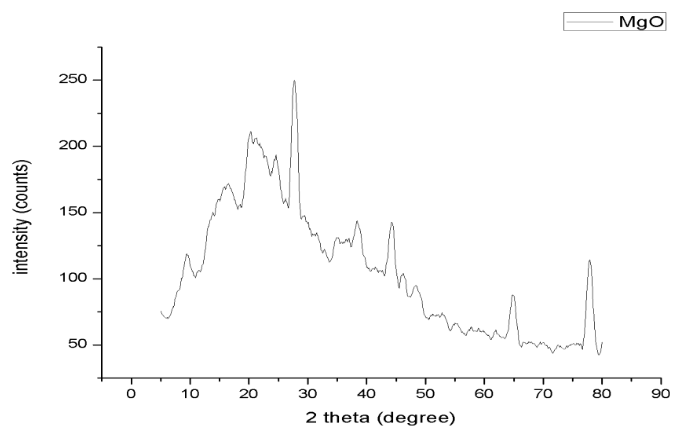

Fig. 1: XRD analysis of MgO nanoparticles

3.2 Fourier Transform Infrared Spectroscopy analysis

The presence of functional groups and biomolecules in the leaf extracts and within the MgO nanoparticles after synthesis are subjected to FTIR analysis.

Table 1: Structural parameters of MgO nanoparticles

2θ (deg)	FWHM (deg)	Crystalline size D (nm)	Average crystalline size(nm)	Dislocation Density ($\delta \times 10^{15}$)	Micro strain ($\varepsilon \times 10^3$)
27.7179	0.75580	11.31377		7.81323	3.20017
77.8103	0.89350	11.93939	11	7.01512	3.03232
19.8000	0.84000	10.03221		9.93587	3.60878

The FTIR spectra of MgO nanoparticles are synthesized by green method are recorded in the range of 600 - 4000 cm-1. The results obtained from the studies are compared with the previous reported reprints and IR standards. The peaks at 1708.93cm^{-1} confirms the presence of C=O strong (aldehyde). The presence of medium O-H bending in carboxylic acid at 1444.68 cm^{-1}

The major peaks at 621.08 cm^{-1} which confirms the presence of MgO vibration.

The following Table 2 shows the wave number and their corresponding functional groups involved in MgO nanoparticles.

Table 2: Band assignments of MgO nanoparticles

S. No.	Wavenumber (cm^{-1})	Functional Group
1	1055.06	CO-O-CO Stretching
2	1111	C-O Stretching
3	2881.65	N-H Stretching
4	3726.47	O-H Stretching
5	3554.81	O-H Stretching

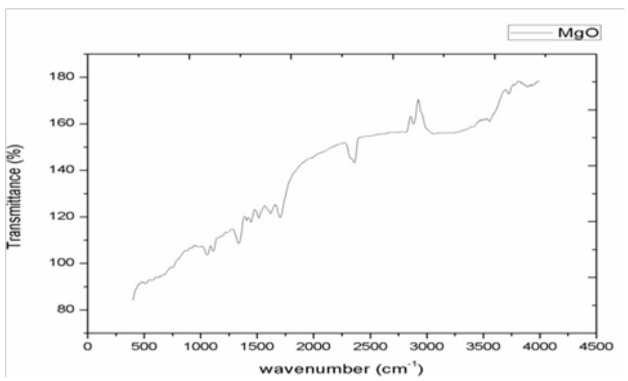

Fig. 2: FTIR Spectra of MgO nanoparticles

3.3 UV-Visible Spectroscopy Studies

The optical properties of MgO nanoparticles are characterized by UV-Vis spectroscopy. The UV absorption spectrum of MgO nanoparticles were recorded in the range of 300-1100 nm. The absorption spectrum reveals that prepared MgO nanoparticles absorbed the radiation in the UV range up to 338 nm. The band gap energy is measured from the maximum absorbance wavelength.

The optical band gap energy was calculated using the formula

$$Eg = h*c/\lambda \ max$$

Where,

h = planck's constant (6.626 x 10^{-34} J/S)

c = Speed of light (3 x 10^{8} m/s)

λ max = cut off wavelength (1086.00 x10^{-9} meters)

$$Eg = 1.14 \ eV$$

The conversion factor, 1eV = 1.602x10^{-19} Joules. From the absorption spectra of MgO nanoparticles, Bandgap energy is found to be 1.83 nm.

The following table shows the different wavelength of MgO nanoparticles and its corresponding absorbance in A.U.

Table 3: UV Spectrum of MgO nanoparticles

S.No.	Wavelength (nm)	Absorbance (A.U.)
1	1046.00	0.044
2	980.00	0.047
3	551.00	0.039
4	1086.00	0.041
5	926.00	0.038

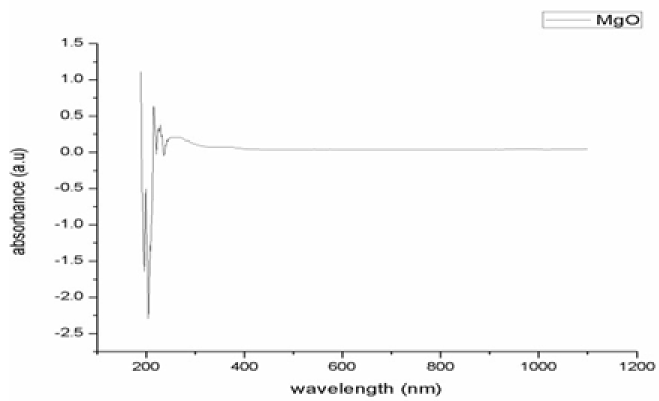

Fig. 3: Absorption spectra of MgO nanoparticles

3.4 Scanning Electron Microscope Analysis

SEM analysis is used to identify the surface morphology of the synthesized MgO nanoparticles. The SEM analysis of MgO nanoparticles were shown in Fig.4. The surface morphology of the sample was viewed through the high resolution scanning electron macroscopic analysis. The SEM images are scanned with a different magnification 10000, 15000, 20000, 30000. The SEM images of MgO nanoparticles show the agglomeration of spherical in shape.

3.5 Energy Dispersive Spectrum studies

The elemental composition of the MgO nanoparticles is characterized by EDAX analysis. The EDS examine the X-ray emitted from the synthesized sample, when electrons bombarded on the surface of the sample. By measuring the intensity and energy of the signal, the data about the chemical composition was detected. The figure shows the elemental composition of MgO nanoparticles as Mg (10.07%) O (89.93%)

3.6 Antibacterial Assays

The antibacterial activity of MgO nanoparticles were tested by well diffusion method through the zone of

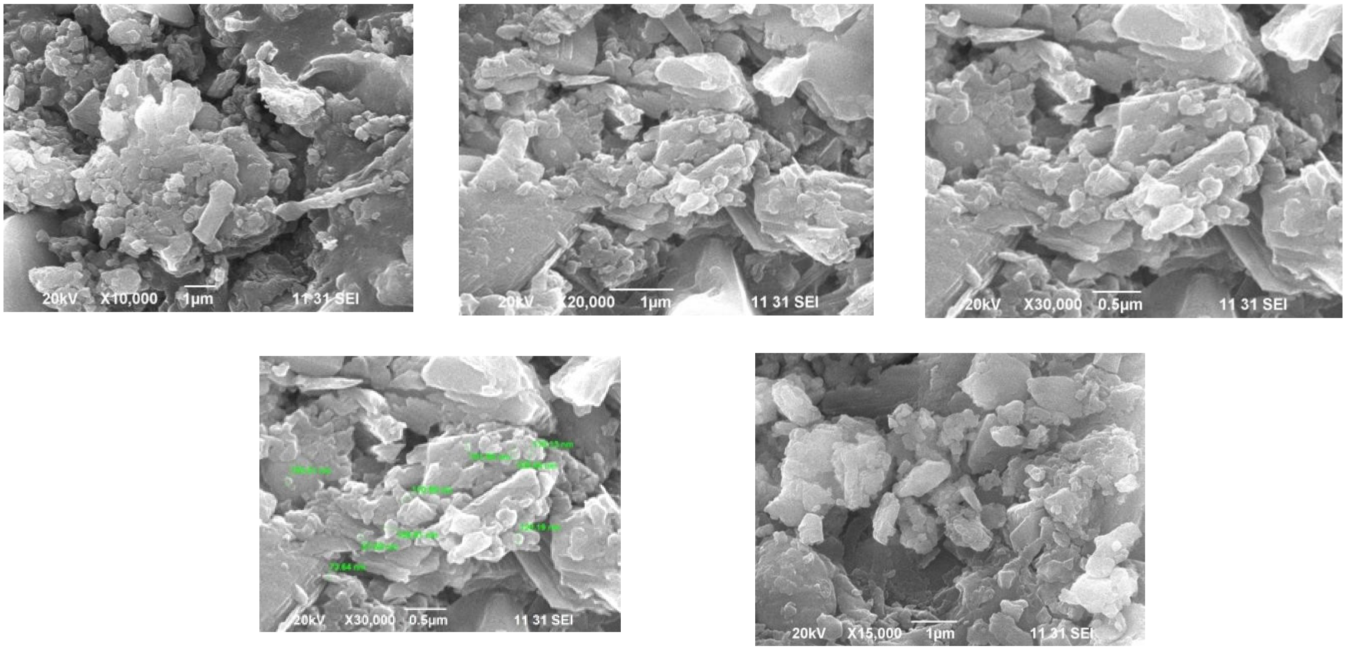

Fig. 4: SEM analysis of MgO nanoparticles

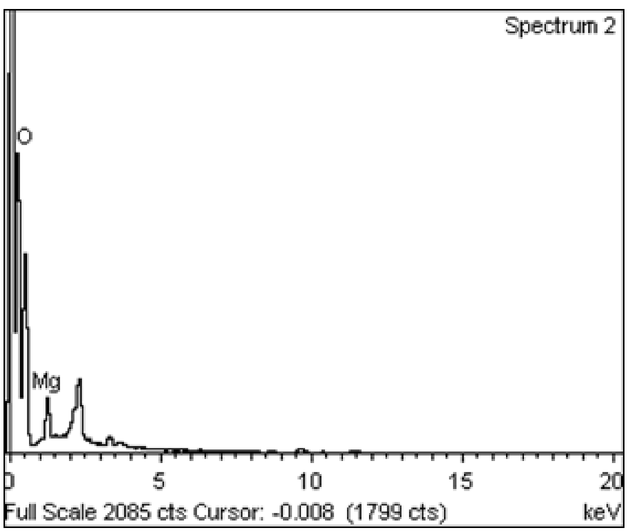

Fig. 5: EDAX analysis of MgO nanoparticles

inhibition. Liquid Mueller Hinton agar media and the Petri plates were sterilized by autoclaving at 121°C for about 30 minutes at 15 lbs pressure. Under aseptic conditions in the laminar airflow chamber, about 20 ml of the agar medium was dispensed into each Petri plate to yield a uniform depth of 4mm. After solidification of the media, 18 hrs culture of Gram positive microorganisms such as Bacillus cereus(MTCC 430), Staphylococcus aureus (MTCC 3160), Gram negative microorganisms such as E.coli (MTCC 1698) and Klebsiella pneumoniae (MTCC10309) obtained from IMTECH, Chandigarh were swabbed on the surface of the agar plates. Well was prepared by using cork borer followed with loading of 50 *µl* and 100µl of each sample to the distinct well with sterile distilled water as negative control and gentamycin(30mcg/disc) as positive control. The sample loaded plates were then incubated at 37°C for 24 hours to observe the zone of inhibition.

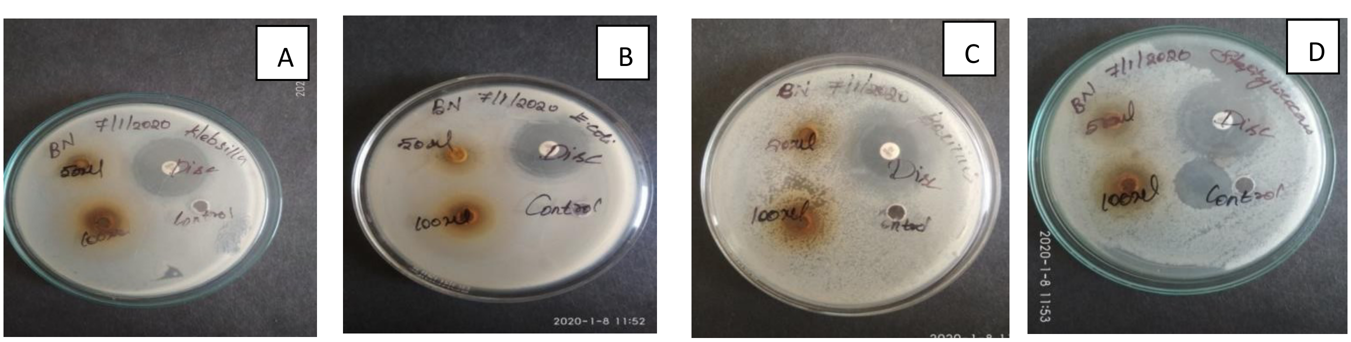

Fig. 6: Zone of inhibition of MgO nanoparticles against A) Klebsiella pneumonia B) Eschericha coli C) Bacillus cereus D) Staphylococcus aureus

The MgO nanoparticles are easily enter the nucleus of the bacteria and provides a surface area for interactions that hinders growth mechanism.

B) Eschericha coli C) Bacillus cereus D) Staphylococcus aureus

The following Table 4 shows that the zone of inhibition of MgO nanoparticles for both gram positive and gram negative.

Table 4: Antibacterial activity of MgO nanoparticles

S. No	Micro Organisms	Zone of inhibition in Diameter (mm)		Std. Antibiotic (Gentamycin) 30 mcg/disc
		50 µl	100 µl	
1	Bacillius cereus	15	20	28
2	Staphylococcus aureus	21	22	29
3	Escherichia coli	20	22	27
4	Klebisella pneumonia	25	30	27

4. Conclusion

The growing need of environmentally ecofriendly nanoparticles, researchers are using the green method for Pharmaceutical application. Thus, the water extracts of cauliflower and pomegranate peels are suitable for synthesizing MgO nanoparticles from the Magnesium Sulphate heptahydrate solution. The particle size of the MgO nanoparticles is found to be around 11nm. The wave numbers and their corresponding frequencies are determined using FTIR analysis. The MgO nanoparticles are spherical in structure and it exhibited antibacterial activity against gram positive and gram negative bacterial. The synthesized MgO nanoparticle has many medical applications and it helps to the society.

References

1. R. Sharmila, Green synthesis of Zinc oxide Nanoparticles using Hibiscu rosa sinesis, International journal of current engineering of technology, AIP Conference Proceedings xx (2019) 2444-2446.
2. M. Vijayalakshmi, S. Richa, Green synthesis of Zinc oxitde nanoparticles using fresh peels extract of puniga granatum and its Antibacterial activity, International journal of Pharma research and health science, 3(3) (2015) 694-699.
3. G. Faridesh, M. Seyyed, The nanoparticles will be in the form of polymer nanocomposites, Asian journal of chemistry, 24 (2012) 8.
4. A.K.M.I. Awwad M. Nida, S. Amany, O. Adbeen, Biosynthesis of Silver nanoparticles using Oleoeuropea leaves extract and its antibacterial activity, Nanoscience and Nanotech, 2(6) (2012) 164-170.
5. S.Balamurugan, L. Ashna, P. Parthiban, Synthesis of Nanocrystalline MgO particles by Combustion followed by Annealing Method using Hexane asa fuel, Journal of Nanotechnology, 2014 (2014)6.
6. V. Snehal, M. Chandra, M.Prakash, Biosynthesis of Zinc oxide Nanoparticles using Ixora Coccinea Leaf extract – A green approach, Open Journal of Synthesis Theory and Applications, 5 (2016) 1-14.
7. G. Alagummuthu, R. Kirubha, Green synthesis of Silver Nanoparticles using Cissus quadrangularis plant extract and their antibacterial activity, International journal of Nano. Mat Bio., 2(3) (2012) 30-33.
8. S.S. Harini, T. Sobha Rani, Plant Mediated green synthesis of catalytic activity and Antibacterial activity of Silver nanoparticles, Asian journal of chemistry, 31 (2019) 2037-2041.
9. P. Than-dong , V.N. Nguyen, S. Ajit Kumar, D. Van-Duong, Advanced Nanomaterials for Green Growth, Journal of chemistry, 2019 (2020).
10. S.M. Dizaj, K. Adibkia, Antimicrobial activity of the metals and metal oxide nanoparticles, Material science and engineering: C, 44 (2014) 278-284.
11. Rehab M. Amin, Abuelmagd M. Abdelmonem, Rapid green synthesis of Metal nanoparticles using pomegrante polyphenols, International journal of science: Basic and Applied Research, 15 (2014)1.
12. P. Sugirtha, R. Divya, Green synthesis of Magnesium oxide nanoparticles using Brassica oleracea and puniga granatum peels and their anticancer and photocatalytic Activity, Asian journal of chemistry, 27(2015) 2513-2517.
13. R. Tamileswari, M. Haniff Nisha, Sr.S. Jesurani, Green synthesis of silver nanoparticles using Brassica Oleracea and Brassica Oleracea Capitata and their analysis of Antimicrobial activity, International journal of Engineering research and Technology, 4 (2015).
14. V. Sridhara, K. Pratima, G. Krishnamurthy, B. Sreekanth, Vegetables assisted synthesis of silver nanoparticles and its Antibacterial activity against two human pathogens, Asian journal of Pharmaceutial and Clinical Research, 6 (2013) 53-57.
15. K. Maheswari, R. Sathyamoorthy, Flower-shaped CuO nanostructures: synthesis, characterization and antimicrobial activity, Journal of Materials Science & Technology, (2013) 29 909–914.