International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Antioxidant & Anti Inflammatory Activity Of Magnesium Oxide Nanoparticles - An In vitro study

Research Article

Kalyani Behera[1], Iffat Nasim[2*], Rajesh Kumar S[3]

[1] Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai- 600077, India.
[2] Professor and Head, Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University - Chennai - 600077, India.
[3] Associate Professor, Department of Pharmacology, Saveetha Dental college, Saveetha Institute of Medical and Technical Sciences, Saveetha University Chennai- 600077, India.

Abstract

Introduction: Magnesium oxide (MgO) is an important inorganic material & has shown a promising role for applications in medicine. MgONPs have unique properties like high chemical stability, high photo catalytic activity and non-toxic nature.
Aim: The aim of the study was to evaluate the antioxidant and anti inflammatory activity of magnesium oxide nanoparticles (MgONps) using Phyllanthus emblica fruit extract.
Materials and Methods: MgONPs were synthesised using Phyllanthus emblica fruit seed extract, and antioxidant & anti inflammatory activity of synthesized MgONPs were assessed using DPPH radical assay & by Albumin denaturation assay.
Result and Discussion: The plant extract color was green and when it reacted with magnesium nitrate solution it changed to brown color which indicated the synthesis of MgONPs. The MgONPs have a characteristic band in the ultraviolet visible (UV) region due to their surface plasmon resonance. The peak was at a wavelength of 385.0 nm. DPPH assay was used to evaluate the antioxidant activity of newly synthesized nanoparticles and it showed good antioxidant activity.Albumin Denaturation assay was used to evaluate the anti inflammatory activity of newly synthesized nanoparticles and the results showed excellent anti inflammatory activity.
Conclusion: Biosynthesised MgONPs showed promising results for biomedical applications. Hence, it may be employed in large scale production and may be used in many medicinal applications.

Keywords: Antioxidant activity, Anti inflammatory, Magnesium oxide, Nanoparticles, Phyllanthus emblica.

Introduction

Magnesium oxide is an important inorganic material and has shown a promising role for application in tumor treatment in medicine. MgO nanoparticles are promising antibacterial agents due to their high resistance to harsh processing conditions [1]. Three main antibacterial mechanisms have been proposed, such as the formation of ROS, the interaction of nanoparticles with bacteria, subsequently damaging the bacterial cell and an alkaline effect. An important aspect of nanoscience is mainly the synthesis of nanoparticles (NPs) of different chemical composition, size, shape and properties [2]. Recently, researchers have found the biological methods for the synthesis of nanoparticles which is an alternative to chemical or physical methods. Biological methods for the production of nanoparticles are considered safe and environmentally friendly, cost- effective and it ensures the complete elimination of toxic chemicals [3]. The synthesis of NPs using biological means, especially plants, is biocompatible, as they secrete functional biomolecules which actively reduce metal ions [4]. Nanoscale magnesium oxide possess unique optical, electronic, magnetic, thermal, mechanical and chemical properties due to its unique properties [5]. Nano magnesium oxide has an advantage of being prepared from readily available and economical precursor and solvents and therefore it is considered as potent

***Corresponding Author**:
Iffat Nasim,
Professor and Head, Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Saveetha University - Chennai - 600077, India.
Tel: +91 940063567
Email ID: iffatnasim@saveetha.com

Received: May 05, 2021
Accepted: June 20, 2021
Published: June 30, 2021

Citation: Kalyani Behera, Iffat Nasim, Rajesh Kumar S. Antioxidant & Anti Inflammatory Activity Of Magnesium Oxide Nanoparticles - An In Vitro Study. *Int J Dentistry Oral Sci.* 2021;08(5):2913-2917. doi: http://dx.doi.org/10.19070/2377-8075-21000568

solid bactericidal material under simple condition .Magnesium Oxide Nanoparticles have unique properties when compared to bulk materials and have excellent properties like high chemical stability, high photocatalytic activity, high electrical properties, non-toxic nature etc. [6]. In the present work, the synthesis of magnesium oxide was performed using an extract of Phyllanthus emblica. The fruit extract of the Phyllanthus emblica, commonly referred to as indian gooseberries (amla), has potent anticancer properties. The bioactivity in this extract is principally mediated by polyphenols, especially tannins and flavonoids.The Phyllanthus emblica can incorporate both cancer- prevention and anticancer properties [7]. Magnesium oxide Nps are highly ionic nanoparticle metal oxide with extremely high surface areas and crystal morphologies. Nanotechnology has developed in such a way that it has a huge horizon of applications such as drug delivery, gene transfection, tissue regeneration, and antibacterial as well as anti-inflammatory applications. The high biocompatibility of noble metals made them attain more importance among researchers on nanotechnology. One of the major challenges for the production of nanoparticles is the use of environmental-friendly materials that come under green chemistry, to avoid the production of hazardous substances.Magnesium oxide Nps are highly ionic nanoparticle metal oxide with extremely high surface areas and crystal morphologies [8, 9].

Previously our team has a rich experience in working on various research projects across multiple disciplines [10-24] Now the growing trend in this area motivated us to pursue this project.

In the present study, we have used Phyllanthus emblica. fruit extract for the green synthesis of MgONPs and the synthesized nanoparticles were characterized using ultraviolet visible (UV-Vis) spectroscopy. Hence, the aim of the study was to evaluate the antioxidant and anti inflammatory activity of magnesium oxide nanoparticles (MgONps) using Phyllanthus emblica fruit extract.

Materials And Methods

Preparation of extract

To prepare the Phyllanthus emblica (amla) extract; 5 g of amla fruit were washed thoroughly with distilled water and dried for 15-20 minutes at room temperature. The extract solution was prepared by boiling dried fruit in a 500ml beaker consisting 200 ml of distilled water for one hour at 100 degree celsius. Freshly prepared amla extract was used for the synthesis of MgONPs .

Synthesis of magnesium oxide nanoparticles

5 ml of fresh Phyllanthus emblica extract and 20ml of distilled water was added to a 250ml beaker and heated at 600 C. 5 gram of Magnesium Nitrate is added to the solution and heated at 800 C with continuous stirring for 4 hours. The Magnesium nitrate ions were reduced to Magnesia or Magnesium Oxide nanoparticles by using Phyllanthus emblica (amla) extract. The formation of Magnesium oxide nanoparticles (MgONPs) have been observed by color change of the solution from yellow to yellowish-brown color.

Optimization of synthesis of magnesium oxide nanoparticles

The green synthesis of MgONPs was mediated by using different concentrations of Phyllanthus emblica (amla) extracts. Different concentration viz. 5ml, 10ml, 25ml, 50ml of freshly prepared aqueous extracts have been used as a reducing agent. Among 5ml, 10ml, 25ml, 50ml concentrations used 5ml of extract was found to be good for the synthesis of MgONPs.

Effect of stirrer temperature

The influence of stirring temperature for the green synthesis of MgONPs were studied by exposing the precursors in range of temperature from 350 C to 1500 C. Among 350 C, 500 C, 800C, 1000 C and 1500 C Stirring temperatures used 800 C of Stirring temperature was found to be good for the synthesis of MgONPs.

Antioxidant Activity by DPPH assay

Hydrogen donating capacity or free radical scavenging by the nanoparticles was evaluated by the DPPH measure, which depends on the reduction of the methanolic coloured radical type of the DPPH to the non-coloured solution. Different concentrations (10-50 µg/ml) of the nanoparticle was taken in the ELISA plate. To each ELISA plate a measured quantity of 0.2 mM of DPPH (2,2- diphenyl-1-picryl hydrazyl) was added. 1 ml of DPPH was added to 2 ml of methanol solution to act as a control group. Ascorbic acid was used as the standard, which was employed to compare with test nanoparticles. The ELISA plate was incubated in a dark condition for 30 minutes. After incubation, reduction in the number of DPPH free radicals measured by UV Spectrophotometer at 517 nm absorbance.

% Inhibition was calculated using the following formula [%Radical scavenging activity]:-

% of inhibition = (Control Absorbance - Sample Absorbance/ Control Absorbance) × 100

Anti inflammatory Activity by Albumin Denaturation Assay:

Albumin denaturation assay was done by using Bovine Serum albumin. 2 ml of 1% Bovine albumin fraction was mixed with 400 ml of plant extract in different concentrations. The pH of the mixture was adjusted to 6.8 by adding hydrochloric acid. The reaction mixture was incubated at room temperature for 20 mins in a water bath. The mixture was cooled to room temperature & the absorbance value was recorded at 660 nm. DMSO (Dimethyl Sulfoxide) was used as control. Diclofenac sodium in different concentrations was used as standard.

% Inhibition was calculated using the following formula:

% of inhibition = (Control OD − Sample OD)/ Control OD × 100

Results And Discussion

Visual Observation

Magnesium oxide was synthesized by a green synthesis method from magnesium nitrate, NaOH using amla extract. The influence

of various parameters viz., Stirring temperature, Concentration of Amla extract, Color change of MgONPs were also checked and conditions were optimized for the synthesis of MgONPs [Figure 1].

UV- Vis Spectroscopy

UV-Vis absorption spectroscopy is the most widely used method for characterizing the optical properties and electronic structure of nanoparticles, as the absorption bands are related to the diameter and aspect ratio of metal nanoparticles [25]. In this study, the prepared MgONPs were confirmed by UV-Vis spectroscopy. The absorption spectra response of MgONPs was observed at 385.0nm. [Figure 2]. This proves the reduction of magnesium nitrate and the emergence of MgO.

Antioxidant activity

The mechanism behind the antioxidant property is attributed to the inhibition of chain reaction, decomposition of peroxides, binding of transition metal ion catalysts, radical scavenging activity and inhibition of continued hydrogen abstraction. The free radicals present are unstable which cause cellular damage due to the generation of ROS that interact with other molecules in the biochemical reactions. The properties of absorbing, neutralizing these free radicals or quenching singlet and triplet oxygen are few crucial factors that are responsible for the antioxidant activity. The highest antioxidant activity is attributed due to the presence of various bio-reductive groups of the phytochemicals present on the surface of the MgONPs. According to Figure 3, the radical scavenging property of the MgONPs, when compared with the standard ascorbic acid shows that the plant mediated MgONPs have the potential to used as an antioxidant as it shows mild comparable effect to that of the standard antioxidants.During the experiment the presence of MgONPs dissolved in DPPH, the color changed from deep violet to pale yellow solution, which indicated the scavenging of free radicals is complete.

Anti inflammatory activity

Bovine serum albumin (BSA) makes up around 60% of all the proteins in animal serum. It is commonly used in cell culture, particularly when protein supplementation is necessary and the other components of the serum are unwanted. BSA undergoes denaturation upon heating and starts expressing antigens associated with Type III hypersensitivity reaction which are related to diseases such as rheumatoid arthritis, glomerulonephritis, serum sickness and systemic lupus erythematosus. Denaturation of tissue proteins is one of the causes of inflammatory and arthritis. Formation of auto antigens in certain diseases may be due to denaturation of proteins [18, 19]. Agents that can prevent protein denaturation, would be useful for anti-inflammatory drug development. The ability of a substance to inhibit the denaturation of protein signifies apparent potential for anti-inflammatory activity. The Phyllanthus emblica mediated magnesium oxide nanoparticles showed a dose-dependent anti-inflammatory activity in this study. When compared with the standard diclofenac sodium, the Phyllanthus emblica mediated MgONPs gave almost equal anti inflammatory activity at 50 µl concentration [Figure 4]. From the present study it can be concluded that *Phyllanthus emblica* mediated MgONPs have excellent anti inflammatory effect.

Our institution is passionate about high quality evidence based research and has excelled in various fields [15, 26-35].

Figure 1. Demonstrating Visual Observation of MgONPs reduced by Phyllanthus emblica.

Figure 2. Demonstrating the absorption spectra response of MgONPs synthesized using Phyllanthus emblica extract . The peak was observed at 385.0nm at 48 hour confirmed the presence of MgONPs.

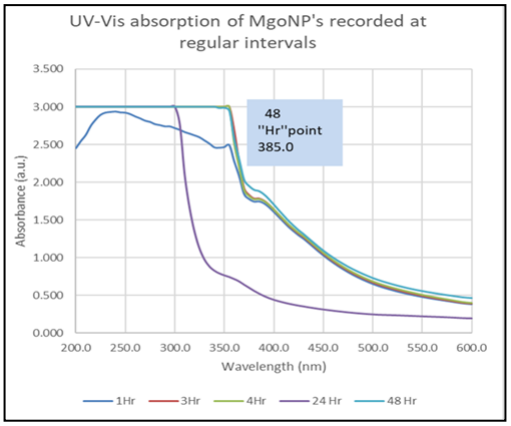


Figure 3. Bar graph representing the Antioxidant property of Phyllanthus emblica mediated Magnesium oxide nanoparticles.

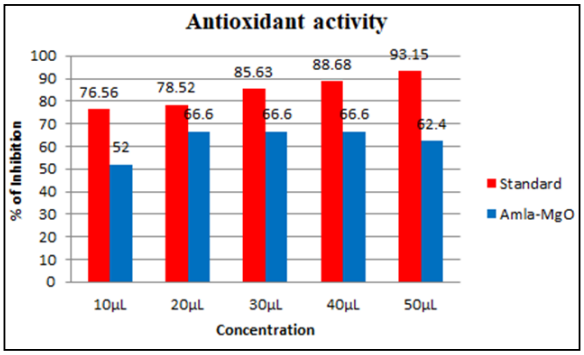
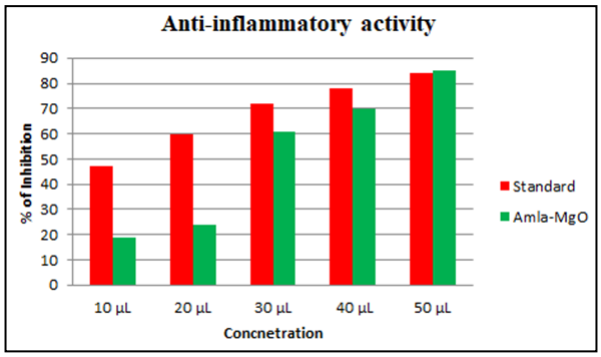


Figure 4. Demonstrating Anti inflammatory property of Phyllanthus emblica mediated Magnesium oxide nanoparticles.



Conclusion

Within the limitations of the study, it can be seen that *Phyllanthus emblica* mediated MgONPs have a potential to be used as an antioxidant and anti-inflammatory agent in dentistry and can be used as an alternative to commercially available products. Hence, MgONPs can be a potent therapeutic agent against many biomedical applications, which could be a potential area that can be explored in future.

Acknowledgement And Declarations

The authors would like to acknowledge the institution and all the staff members of the Department of Conservative Dentistry and Endodontics for their support towards completion of this research. The authors deny any conflicts of interest associated with this paper.

References

[1]. Reda M, Ashames A, Edis Z, Bloukh S, Bhandare R, Sara HA (2019) Green Synthesis of Potent Antimicrobial Silver Nanoparticles Using Different Plant Extracts and Their Mixtures. Processes 7:510

[2]. El-Nour KMMA, Abou El-Nour KM, Eftaiha A, Al-Warthan A, Ammar RAA (2010) Synthesis and applications of silver nanoparticles. Arabian Journal of Chemistry 3:135–140

[3]. Agarwal H, Venkat Kumar S, Rajeshkumar S (2017) A review on green synthesis of zinc oxide nanoparticles – An eco-friendly approach. Resource-Efficient Technologies 3:406–413

[4]. Rajeshkumar S, Bharath LV (2017) Mechanism of plant-mediated synthesis of silver nanoparticles – A review on biomolecules involved, characterisation and antibacterial activity. Chemico-Biological Interactions 273:219–227

[5]. Shukla AK, Iravani S (2018) Green Synthesis, Characterization and Applications of Nanoparticles. Elsevier

[6]. Menon S, S. R, S. VK (2017) A review on biogenic synthesis of gold nanoparticles, characterization, and its applications. Resource-Efficient Technologies 3:516–527

[7]. Rajeshkumar S, Naik P (2018) Synthesis and biomedical applications of Cerium oxide nanoparticles - A Review. Biotechnol Rep (Amst) 17:1–5

[8]. Kumar P, Senthamil Selvi S, Lakshmi Prabha A, Prem Kumar K, Ganeshkumar RS, Govindaraju M (2012) Synthesis of Silver Nanoparticles from Sargassum Tenerrimum and Screening Phytochemicals for Its Antibacterial Activity. Nano Biomedicine and Engineering. https://doi.org/10.5101/nbe.v4i1.p12-16

[9]. Go EC, Pandey AS, MacRae TH (1990) Effect of inorganic mercury on the emergence and hatching of the brine shrimpArtemia franciscana. Marine Biology 107:93–102

[10]. Govindaraju L, Gurunathan D (2017) Effectiveness of Chewable Tooth Brush in Children-A Prospective Clinical Study. J Clin Diagn Res 11:ZC31–ZC34

[11]. Christabel A, Anantanarayanan P, Subash P, Soh CL, Ramanathan M, Muthusekhar MR, Narayanan V (2016) Comparison of pterygomaxillary dysjunction with tuberosity separation in isolated Le Fort I osteotomies: a prospective, multi-centre, triple-blind, randomized controlled trial. Int J Oral Maxillofac Surg 45:180–185

[12]. Soh CL, Narayanan V (2013) Quality of life assessment in patients with dentofacial deformity undergoing orthognathic surgery--a systematic review. Int J Oral Maxillofac Surg 42:974–980

[13]. Mehta M, Deeksha, Tewari D, et al (2019) Oligonucleotide therapy: An emerging focus area for drug delivery in chronic inflammatory respiratory diseases. Chem Biol Interact 308:206–215

[14]. Ezhilarasan D, Apoorva VS, Ashok Vardhan N (2019) Syzygium cumini extract induced reactive oxygen species-mediated apoptosis in human oral squamous carcinoma cells. J Oral Pathol Med 48:115–121

[15]. Campeau PM, Kasperaviciute D, Lu JT, et al (2014) The genetic basis of DOORS syndrome: an exome-sequencing study. Lancet Neurol 13:44–58

[16]. Kumar S, S S (2016) Knowledge and awareness regarding antibiotic prophylaxis for infective endocarditis among undergraduate dental students. Asian J Pharm Clin Res 154

[17]. Christabel SL (2015) Prevalence of type of Frenal Attachment and morphology of frenum in children, Chennai, Tamil Nadu. World J Dent 6:203–207

[18]. Kumar S, Rahman R (2017) Knowledge, awareness, and practices regarding biomedical waste management among undergraduate dental students. Asian J Pharm Clin Res 10:341

[19]. Sridharan G, Ramani P, Patankar S (2017) Serum metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Cancer Res Ther 13:556–561

[20]. Ramesh A, Varghese SS, Doraiswamy JN, Malaiappan S (2016) Herbs as an antioxidant arsenal for periodontal diseases. J Intercult Ethnopharmacol 5:92–96

[21]. Thamaraiselvan M, Elavarasu S, Thangakumaran S, Gadagi JS, Arthie T (2015) Comparative clinical evaluation of coronally advanced flap with or without platelet rich fibrin membrane in the treatment of isolated gingival recession. J Indian Soc Periodontol 19:66–71

[22]. Thangaraj SV, Shyamsundar V, Krishnamurthy A, Ramani P, Ganesan K, Muthuswami M, Ramshankar V (2016) Molecular Portrait of Oral Tongue Squamous Cell Carcinoma Shown by Integrative Meta-Analysis of Expression Profiles with Validations. PLoS One 11:e0156582

[23]. Ponnulakshmi R, Shyamaladevi B, Vijayalakshmi P, Selvaraj J (2019) In silico and in vivo analysis to identify the antidiabetic activity of beta sitosterol in adipose tissue of high fat diet and sucrose induced type-2 diabetic experimental rats. Toxicol Mech Methods 29:276–290

[24]. (2018) Fluoride, fluoridated toothpaste efficacy and its safety in children - review. Int J Pharm Res. https://doi.org/10.31838/ijpr/2018.10.04.017

[25]. Montes-Burgos I, Walczyk D, Hole P, Smith J, Lynch I, Dawson K (2010) Characterisation of nanoparticle size and state prior to nanotoxicological studies. Journal of Nanoparticle Research 12:47–53

[26]. Vijayashree Priyadharsini J (2019) In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. J Periodontol 90:1441–1448

[27]. Pc J, Marimuthu T, Devadoss P (2018) Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. Clin. Implant Dent. Relat. Res.

[28]. Ramesh A, Varghese S, Jayakumar ND, Malaiappan S (2018) Comparative estimation of sulfiredoxin levels between chronic periodontitis and healthy patients - A case-control study. J Periodontol 89:1241–1248

[29]. Ramadurai N, Gurunathan D, Samuel AV, Subramanian E, Rodrigues SJL (2019) Effectiveness of 2% Articaine as an anesthetic agent in children: randomized controlled trial. Clin Oral Investig 23:3543–3550

[30]. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R (2019) Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. J Oral Pathol Med 48:299–306

[31]. Mathew MG, Samuel SR, Soni AJ, Roopa KB (2020) Evaluation of adhesion of Streptococcus mutans, plaque accumulation on zirconia and stainless steel crowns, and surrounding gingival inflammation in primary molars: Randomized controlled trial. Clin Oral Investig 1–6

[32]. Samuel SR (2021) Can 5-year-olds sensibly self-report the impact of developmental enamel defects on their quality of life? Int J Paediatr Dent 31:285–286

[33]. R H, Hannah R, Ramani P, Ramanathan A, R JM, Gheena S, Ramasubramanian A, Monika K (2020) CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology 130:306–312

[34]. Chandrasekar R, Chandrasekhar S, Sundari KKS, Ravi P (2020) Development and validation of a formula for objective assessment of cervical vertebral bone age. Prog Orthod 21:38

[35]. Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A (2018) In silico analysis of virulence genes in an emerging dental pathogen A. baumannii and related species. Arch Oral Biol 94:93–98