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REVIEW PAPER

Review on MgO nanoparticles multifunctional role in the biomedical field: Properties and applications

Heba Mohamed Fahmy [1], Mohamed Hamdy El-Hakim [1], Doaa Sayed Nady [2], Yomna Elkaramany [3], Fatima Adel Mohamed [4], Alaa Mohamed Yasien [1], Mariam Ahmed Moustafa [5], Bothaina Ezzat Elmsery [6], Hesham A Yousef [7]*

[1]Biophysics Department, Faculty of Science, Cairo University
[2]Chemistry Department, Faculty of Science, Cairo University
[3]Biotechnology Program, Faculty of Science, Cairo University
[4]Chemistry Department, Faculty of Science, Cairo University
[5]Zoology Department, Faculty of Science, Cairo University
[6]Department of Physics, Basic Science Center, Misr University for Science and Technology (MUST), Giza, Egypt.
[7]Entomology Department, Faculty of Science, Cairo University

ABSTRACT
Nanotechnology has introduced many useful uses to people's lifestyles in various fields such as health care, agriculture, the food industry, and separate industries during the previous few decades, and it is now available to the majority of the world's population. Among these applications, nanotechnology is critical in the realm of medical therapy. Many forms of studies indicate that nanoparticles, particularly metal oxide, can make a significant contribution to this field. In the current work, we examined one of them, MgO, a critical inorganic oxide used in a variety of applications. MgO is a multilateral oxide material with several properties, including great thermodynamic stability and a low refractive index and dielectric constant. The wide bandgap allows for a variety of uses in ceramics, catalysis, hazardous waste remediation, and antibacterial materials as a refractory additive paint and as a superconductor product. MgO NPs have been used in a variety of disciplines due to their extensive properties and functions, which we will discuss in this article.

Keywords: *Antibacterial activity, Cancer treatment, Catalysis, Nanoparticles cytotoxicity, Tissue engineering*

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INTRODUCTION
Nanotechnology has made significant development in terms of preparation, characterization, and application during the last several years. Nanomaterials are commonly used in scientific study due to their intriguing features and benefits over bulk materials. Many researchers with diverse interests and specialties have been drawn to nanomaterials in order to improve the quality of their study work while using nanomaterials. Many metal oxide Nanoparticles possess numerous advantages and are used in the medical research [1-4] such as Ag_2O [5, 6], CaO [7, 8], CuO [9-11], ZnO [12-14], SiO_2 [15-17], NiO [18, 19], CrO [20], Fe_3O_4 [21-23], Fe_2O_3 [24, 25], Al_2O_3 [26-29], CdO [30-32], and CeO_2 [33, 34]. Similarly, MgO nanoparticles have a high potential for use in nanomedical research [35], as well as numerous other applications in agriculture[36-38], chemical reaction catalysis [39-41], dye removal [42-44], and lithium batteries [45-47]. The interesting properties of MgO nanoparticles, such as stability, easy and inexpensive preparation methods, including green ones, magnetization, crystallinity, absorptivity, electrical and thermal conductivity, stoichiometry, large surface area, and reactivity, are attributed to their wide range of applications. All of these amazing capabilities propelled MgO nanoparticles to the forefront of nanomedical research. Our review will show the many preparation procedures that can produce MgO NPs with a uniform size distribution, various forms, and variable Dimensions.

* *Corresponding Author Email: heba_moh_fahmi@yahoo.com*
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The shape of MgO nanoparticles

Understanding shapes is fundamental to cognitive development; it is significant because it has practical applications in medicine, industry, agriculture, and scientific study.

MgO nanoparticles come in a variety of morphologies, including spherical nanocubes, nanocrystals, nanofibrous nanowires, nanotubes, and nanosheets. This variety of MgO NPs shapes has resulted in a wide range of applications that exploit each shape in a variety of fields. Table 1 depicts several shapes of MgO nanoparticles.

The morphological structures of MgO nanoparticles were examined using a variety of analytical techniques. X-ray Diffraction is used to determine the crystallinity and size of the MgO nanoparticle (XRD). Transmission electron microscopy is used to determine the size and shape of the particles (TEM). Using Fourier transform infrared microscopy, the sample's infrared spectrum was acquired, revealing its powdered nature. UV-Visible spectroscopy was used to evaluate the optical properties of the NPs [48].

Table 1. shapes and sizes obtained from different preparation methods

Method of preparation	Size	Shape	Reference
Sonication method	15 nm	Nanocrystal	[60]
Sol-gel method	9.5 nm - 15.5 nm	Nanoplates	[61]
Hydrothermal method	10 nm in diameter 18-20 nm length	Nano wire	[62]
Co-precipitation method	21 nm	Nanocube	[63]
Green method	60-70 nm	spherical	[64]
Sol-gel method	200-300 nm	coralline	[65]
Wet chemical method	30-50 nm 50-80 nm 70-130	Dense flakes Irregular flakes Irregular porous	[66]
Green method	13 nm	spherical	[67]
Wet chemical method	25 nm	Nanocrystal	[68]
Quick precipitation method	50 nm length 20 nm thickness	Nanocrystal	[69]
Green method	Less than 10 nm	spherical	[70]
Green method	Less than 20 nm	spherical	[71]
Co-precipitation	28-64 nm	Nanocrystal	[72]
Green method	Less than 20 nm	spherical	[73]
Hydrothermal method	6 nm diameters 10 micro length	Nano wire	[74]
Cationic surfactant based microemulsion	8-10 nm	Anisotropic	[75]
Chemical precipitation	5-30 µm at 100 C Less than 1 µm at 960 °C Less than 500 nm at 1200 °C	Powders	[76]
The wet chemical reaction method	Average 16 nm. size distribution of 7-38 nm	spherical	[77]
Thermal decomposition of the hydroxide	1–100 nm	nanocrystal	[78]
hydrothermal calcination	40–60 nm in diameter thickness ~ 5 nm	nanoplates	[79]
Chemical precipitation	10-20nm thickness up to 100 nm length	nanoplates	[80]
The reaction of magnesium powder with water at a very low temperature	~ 40 nm width ~20 nm thickness up to 1 µm length.	nanoflakes	[81]
Preparation is done by torch flame of an oxygen microwave plasma	10–50 nm	Various shapes (hexahedrons, plates, and rectangles)	[82]

MgO nanoparticles size

MgO NPs have a long history of use in a variety of sectors for a variety of reasons [49]. Depending on the fabrication circumstances, different sizes have different properties: calcinations and temperature rate in the thermal decomposition method; conditions of gel preparation such as the heating rate for gel formation, pH, gelling agents, and temperature of gel calcination in the sol-gel method. The bactericidal characteristics of MgO fluctuate with particle size, with the bactericidal efficacy of MgO Nanoparticles increasing as particle size decreases [50]. The optical properties of MgO nanocubes, as measured by UV diffuse reflectance and photoluminescence spectroscopy, also reflect the change of the ratio between corner and edge ions [51]. The diameters of the MgO particles ranged from micro- to nano-sizes [52] or variable grain sizes [53]. Dynamic light scattering [54], disc centrifugation [55], nanoparticle tracking analysis [56], tunable resistive pulse sensing [57], atomic force microscopy [58], and electron microscopy are some of the techniques used to measure their size. The BET method can be used to calculate the surface areas of MgO particles, which have a high surface area of about 100 m^2/g [51]. The size of MgO nanoparticles measured by various preparation processes is shown in Table 1.

MgO nanoparticles role in cancer therapy

Cancer is one of the top causes of death in all countries [83]. A cancer tumor develops when a person's cells begin to divide rapidly into surrounding tissues. Tumors can occur because of these excess cells. Cancer is a hereditary disease caused by genes that regulate cell processes, particularly growth and division. Because cancer cells can ignore signals telling them to stop proliferating, they can divide forever or initiate the process of programmed cell death, or apoptosis, which is a procedure used by the body to eliminate undesired or damaged cells. Because cancer is a lethal disease with over 100 different types of cancer for different tissues and organs, we need simple and inexpensive treatments. The utilization of oxide nanoparticles biogenic sources to substitute harmful compounds has become the current intriguing challenge. Nanoparticles less than 100 nm in size can interact with proteins, nucleic acids, and lipids both inside and outside the cell, which may aid in cancer diagnosis and treatment. MgO nanoparticles are one type of nanoparticle that uses *sargassum wighitii* (marine brown algae) as a capping and reducing agent. MgO NPs were tested against lung cancer cell lines in this study. MgO NPs produced lung cancer cytotoxicity, which might be attributed to elevated ROS levels as the mitochondrial membrane potential was altered, initiating the apoptotic process and ultimately leading to cell death [84]. The cytotoxicity test confirmed that the produced nanostructures are non-poisonous to normal healthy RBCs. MgO nanorods have potential applications such as a powerful chemotherapeutic agent for the rapid detection and identification of all cancer types [85]. The cytotoxic effects of MgO NPs on normal lung fibroblast cells and various malignant cells revealed that they had a magical power to destroy cancerous cells, including HeLa, AGS, and SNU-16 cells. In addition, MgO NPs were implied in hyperthermia and nano cryosurgery to cure cancer. These discoveries broaden the scope of MgO Nanoparticles' possible use in nanomedicine for a cancer cure as a viable alternative to chemotherapy because of their toxicity to cancer cells via apoptosis induced by ROS [86]. Measuring the heating efficiency of Fe/MgO magnetic shell nanoparticles and their *in vitro* application in hyperthermia was examined in human breast cancer cell lines. This study might be considered the first key principle for *in vitro* hyperthermia.

More research on the hyperthermal response is required before moving on to in vivo approaches [87]. MgO NPs have the potential to be exploited as a drug transporter and releaser. Furthermore, bimetal oxide nanoparticles with a multifunctional attitude will play a prominent role in DDS as a favourable drug vehicle [88]. *Penicillium* fungi were employed in the manufacture of MgO nanoparticles, which resulted in Stable Nanoparticles with outstanding anticancer properties and low influence on normal cells. Nanoparticles stimulated apoptotic activity and DNA damage, although more cytotoxicity experiments are needed to establish the Nanoparticles' potential toxicity [89]. Nanoparticles have a strong reciprocal effect with biomolecules, which can improve the way anticancer drugs are recognized. They can overpower cellular and noncellular strategies of blocking foreign bodies, making it easy for the drug to target the cancer cells and decreasing its dangerous effects on normal cells [90]. MgO nanoparticles could be used in the freezing method of nano cryosurgery, using their advantages as they are non-poisonous, biodegradable, and have a few bad consequences on humanity. According to experiments on animal and nucleation analysis, the bringing of MgO nanoparticles with their slight weight and good thermal features to the marked tissue would enhance the result of the cryosurgery as thermal features help shape the ice ball in the freezing method quickly and effectively [91]. The need to use nanomaterials in medications for humans is crucial to examine them clinically and study their interactions with plasma proteins as human serum albumin (HSA) and their cytotoxic effects on normal and cancer cell lines. It was found that MgO nanoparticles build an inactive, unplanned combination with HSA molecules by actions lacking attraction for water. Docking study dependent upon the size of the Nanoparticles showed that there are varying connections that can be constructed between MgO Nanoparticles and HSA. The circular dichroism spectroscopy Shows that MgO Nanoparticles did not change the secondary composition of HAS. They showed cytotoxicity instead of the K562 cell line, which made it an original anticancer, as their moderating of cell death begins with the production of ROS in the cancer cells [92].

MgO nanoparticles as an antibacterial

There are two types of bacteria depending on their impact on humans; Commensal bacteria[93], which are beneficial and essential for our survival, and harmful bacteria[94], which threaten our health. We used to get rid of the harmful bacteria by using antibiotics. However, due to the unselective use of antibiotics, bacteria are progressively resistant to several antibiotics at a very large rate over time [95-97], leading to the rapid development of antibiotic-resistant strains due to their potential antibacterial activity against Gram-positive and Gram-negative bacteria [98]. They are proposed to slow the growth rate of more resistant bacteria because they target multiple biomolecules simultaneously [99]. MgO is a metal oxide nanoparticle with antibacterial properties. Its properties depend on shape and size. Where small-sized MgO NPs had better antibacterial activities towards gram-negative (*E. coli*) bacteria and gram-positive (*S. aureus*) [100]. MgO nanoparticles have dosage-dependent antibacterial activity [101]. Frequency affects the activity too, where increasing shaking rate increased the death of bacteria in the slurry, suggesting that the active oxygen generated from the MgO powder slurry was one of the main factors in its activity [102]. MgO nanoparticles can be metabolized properly inside the body compared to heavy metal oxide nanoparticles (silver and zinc), where it is easy for the degraded ions to be removed [103]. MgO nanoparticles showed unique antibacterial properties against several common foodborne pathogens. Their contact with bacterial cells leads to leakage from the cellular membrane and oxidative stress induction, causing cell death [104]. MgO nanoparticles were prepared at various temperatures for thermal decomposition, resulting in various sizes and surface areas. The antibacterial effect was studied by diffusion method using *E. coli*, then introducing MgO nanoparticle suspensions. The MgO nanoparticles showed remarkable bactericidal activity producing a large inhibitory zone surrounding the nanoparticles, and stronger activity against gram-positive bacteria than gram-negative ones was noticed. The antibacterial activity was more related to the surface area than the resulting nanoparticle size [105].

Size impact was also noticed when using Gram-positive (*S. aureus*) and gram-negative (*E. coli*) bacteria. The antibacterial efficacy of nanoparticles has been examined. Smaller MgO nanoparticles are discovered to have both gram-positive and gram-negative adverse antimicrobial activity, while larger MgO nanoparticles have a gram-negative adverse impact only [66]. Decreasing the size of the nanoparticles will lead to an increasing in the surface area. Consequently, a larger number of surface hydroxyl groups will help destroy the bacterial protein contributing to the antibacterial effect of the MgO nanoparticles [106]. In another experiment, different concentrations of MgO nanoparticles were inoculated with cultures of *Escherichia coli* overnight. MgO nanoparticles were found to have potent antibacterial properties against foodborne pathogens (*E. coli*). The MgO NPs application injures the cell membrane, resulting in intracellular contents leakage consequently; bacterial cell death [107]. The same activity toward (*E. coli)* was shown when a simple green chemistry procedure was used to synthesize MgO NPs, coat them with cotton fabric, and test them with the agar diffusion method [108]. The antibacterial property of MgO NPs was evaluated as the Inhibitory zones appear around the MgO powder slurry when there is direct contact with nutrient agar plates inoculated with (*E. coli)* or (*S. aureus*). However, no zone appeared when they were isolated from each other by a penicillin cup [109]. The direct interaction between NPs and (*E. coli)* was prone to attack the cell membrane. MgO nanoparticles prepared by sol-gel and calcination techniques had a high tendency to inactivate (*E. coli*) and remove heavy metal ions. When the cell membrane was damaged, heavy metal ions entered easily into a bacterial cell and thus induced bacterial inactivation [110]. Increasing the shaking rate resulted in increasing the death rate of (*E. coli)* in the slurry, showing that the contact frequency between bacterial cells and MgO powders affected the antibacterial activity. Chemiluminescence research revealed that active oxygen produced from the MgO powder slurry and that changes in antibiotic sensitivity in *E. coli* treated with MgO powder matched those seen in *E. coli* treated with active oxygen. So, it was suggested that the active oxygen generated from the MgO powder slurry was a primary factor aiding in its antibacterial activity [109]. Reactive oxygen species generation was also noticed when using MgO antibacterial against gram-negative bacteria *Escherichia coli* and *Pseudomonas aeruginosa* as well as the gram-positive bacterium *Staphylococcus aureus with* resazurin as an indicator of cell growth. The minimal inhibitory concentration of 1,000 µg/mL for *P. aeruginosa* & *S. aureus and* 500 µg/mL against *E. coli* was observed*.* MgO NPs increased ultrasound-induced lipid peroxidation in the liposomal membrane [111]. Natural synthesis is a new method used to eliminate the chances of toxins contaminating; the MgO NPs were prepared using extracts from the three different leaves: *Amaranthus tricolour*, *Amaranthus blitum*, and *Andrographis paniculata*, then inoculating in *E. coli* culture. The nanoparticles made from *A. blitum* had the strongest antibacterial activity and the largest inhibition zone [112]. MgO nanoparticles prepared with microwaves and hydrothermal methods showed a noticeable antibacterial activity towards the A. *hydrophila* [113]. The *Vibrio Cholerae* bacterial system was used for antibacterial properties investigation of the nanoparticles where significant inhibition of bacterial growth is noticed, and insignificant cytotoxicity was found in Human intestinal or tumor cells [114]. Different MgO nanoparticles were synthesized using different methods and compared its bactericidal activity to the TiO_2 nanoparticles on *Bacillus subtilis*. The results showed that the bactericidal ability of MgO was inversely related to the particle size. Magnesium oxide nanoparticles have better bactericidal effects than TiO_2 nanoparticles in both the absence and presence of light. The activity was related to the high concentrations of O_2 found, which is highly active and can react with the peptide linkages in the surrounding walls of the spores. The spores are destroyed by the resulting damage to their structure [115]. Magnesium oxide showed great efficiency against *P. aeruginosa* bacteria isolated from Urine tract infection; it showed an inhibition zone diameter of 24 mm [116]. Study of antibacterial activity of MgO against water found bacteria *(Pseudomonas aeruginosa and Staphylococcus aureus)* revealed the effectiveness of MgO nanoparticle is greater against gram-positive than the gram-negative pathogens; this is attributed to the absence of outer membrane within the cell wall, unlike the gram-negative bacteria, which have a complex wall [117]. Apart from the antibacterial resistance, MgO NPs also aid in disease prevention in some veggies. In tomatoes, MgO was used to prevent the infection with *Ralstonia solanacearum*. inducing systemic resistance [118]. MgO also conducted antifungal activity in *Saccharomyces cerevisiae*, *Aspergillus niger, Candida albicans,* and *Rhizopus stolonifer*. Evaluation of antifungal activity was done via measuring the electrical conductivity changes resulted from the fungal metabolism. MgO nanoparticles show a noticeable effect against all fungi used in this study [119]. MgO nanoparticles doped with silver were tested for their antibacterial effect. This doping process led to a MgO nanoparticles size decrease. Also, the bactericidal effect of the MgO NPs was improved greatly due to increased ROS production and the probability of interactions between the nanoparticles and Bacteria [120].

MgO nanoparticles as a biosensor

Because of its vast surface area, electrochemical processes at the nano-scale level play a vital role in generating various biosensors to detect very low concentrations of chemicals. It exemplifies high activity reactions, catalysis, and has a high absorption capacity in enzyme immobilization [121]. MgO NPs are electrodes that detect hydrogen peroxide (H_2O_2) via catalase enzyme coupling (CAT). H_2O_2 is decomposed using CAT enzyme, while MgO NPs are utilized as an electrochemical transducer to assist and expedite electron transfer [122]. Another method of using nano MgO to detect H_2O_2 is by immobilizing Horseradish peroxidase (HRP) and preserving biological activity to a considerable extent, in which nano MgO is inoculated in a chitosan solution to form a nanocomposite as a stage in the manufacturing of an H_2O_2 biosensor [123]. Another biosensor used to detect H_2O_2 in hydroquinone as a mediator is prepared by adding MgO NPs prepared by the thermal evaporation method to the gold electrode. This biosensor is characterized by high sensitivity and rapid response [124]. Another one is the nonenzymatic sensor used to solve the problems of poor reproducibility and long-term operation. One of the nonenzymatic sensors is MgO nanoporous, which is eco-friendly and exhibits excellent electro-oxidation activity toward hydrogen peroxide. It can also be applied to detect H_2O_2 in the food as it has no potential risks to human health [125]. Another Biosensor depends on MgO nanobelts, which are highly sensitive towards ascorbic acid [126]. In the last years, Graphene was utilized to analyze ascorbic acid, dopamine, and uric acid, but this works well due to the overlapping of the oxidation peaks of these three acids. Recently, MgO nanobelts have been synthesized because of peak separation between analytes; therefore, the three acids can be detected by graphene-modified tantalum pelt with MgO NPs. [127,128]. The polyhedral nanocages and nanocrystals structures of MgO nanoparticles are used to produce high sensitive biosensors in a short time, glucose biosensors [121]. The biomolecule of MgO NPs, due to their biocompatibility, excessive sensitivity, and effective surface area, could be utilized as a good electrochemical biosensor material for detecting nucleic acid molecules [129]. Chitosan-modified nano MgO configure nanosensor for sensitive detection of *V. cholera* instead of conventional methods and costs a long time [130]. MgO nanoflowers are used to produce easy and low-cost biosensors for efficient detection of micro-RNA [131-132].

MgO role in tissue engineering

Tissue engineering is a field of research that employs living cells in a variety of ways to improve tissue and organs by growing and assembling three-dimensional tissues from cultivated removing cells on bioactive degradable scaffolds [134]. Recently, tissue engineering has helped in orthopedic disorders treatment because it uses engineering principles, biology, and chemistry, so it is more effective than traditional methods [135]. Bones are characterized by pore interconnectivity and highly porous structure. To achieve that, we use the first 3D printing scaffolds of tricalcium phosphate (TCP) doped with SrO-MgO to improve bioactivity, bone formation, leading to early healing, increasing density, and reducing of the pore size of the bone. Also, doping improves bone modeling and mechanical strength of the TCP scaffolds [136-137]. Bioactive samples are used for bone regeneration applications because the hydroxyapatite layerable stimulates biological fluids. Researchers have been drawn to glass and glass-ceramics based on Ca, Mg, Si2, and O6 in recent years due to their exceptional properties, which include a low degradation rate, high mechanical strength, and low toxicity. It also attaches to the tissues of live organisms faster than the hydroxyapatite layer [138]. MgO nanoparticles are used in conjunction with poly (L-lactic acid) (PLLA) and hydroxyapatite (HA) nanoparticles to treat damaged bone; MgO NPs are used in orthopedic treatment by enhancing osteoblast union and spreading on HA–PLLA nanocomposites and making mechanical properties suitable for cancellous bone applications. Furthermore, MgO nanoparticles promote osteoblast growth and can be exploited to modify the mechanical properties of additive biomaterials [139].

MgO role in dental implantation

The dental implant is paramount to manage teeth loss [140]. It should be biocompatible, strong, inert, and tough [141]. Recently most modification has been designed to reduce time and improve dental implantation [142]. Nanotechnology is regarded as one of the most promising future tools in implant dentistry. Nano surface modification technologies are commonly utilized to improve the surface material properties of dental implants, resulting in faster osseointegration and bone healing [143]. Many experiments have been conducted in order to promote osseointegration and establish a thermal expansive coffined match between two phases in bioactive glasses covered titanium implants. Magnesium oxide improved the bioactivity, thermal characteristics, and structural qualities of glass by inhibiting crystallization, lowering the thermal expansion coefficient, and softening the glass temperature [144].

MgO Nanoparticle for bioactive glass

Bioactive glasses are reactive materials that may connect to mineralized bone tissue in a physiological environment and are used to restore damaged body parts in particular [145]. They accelerate tissue healing by inducing bone cell renewal and self-repair [146]. It has a wide range of applications in the biomedical field. It was first developed for middle ear surgery; it is now commonly utilized in the dentistry sector and is being researched for use in regenerative medicine and tissue engineering. The biocompatibility and bioactivity features of Bioactive glass are enhanced in nano-sized Biomaterials [147]. Many other composites have been created, but the most reactive materials inside the human body have significant CaO and Na2O content [148]. The glass transition, melting commencement, endpoints, and temperature at which fusion occurs were all lowered when CaO was replaced with MgO. The activation energies for crystallization and glass transition were similarly reduced, indicating decreased bond length and enhanced strength. The thickness increased in direct proportion to the MgO content. The bioactivity test demonstrated that the greater the MgO concentration, the slower the reaction between the glass and bodily fluid [149]. The addition of MgO to a glass composite improves the bioactive glass's ability to behave as thermoseeds during hyperthermia [150]. The sol-gel process was used to create bioactive glasses containing MgO. This addition aided in the acceleration of the production of the hydroxyapatite layer [152]. Nanoparticles films with different formulations of chitosan blend with bioactive glass, including MgO NPs, were produced for system development have applicability in guided tissue regeneration. The inclusion of the inorganic component in the chitosan matrix improves the biological response of the membranes [153-155]. Bioactive Glass containing MgO nanoparticles exhibits potent antibacterial properties. Furthermore, they can aid in the repair of broken bones [156]. Using powder components allows for consistent precipitation, resulting in crack-free bioactive glass, as opposed to bulk materials [158]. Bioactive Glasses infused with MgO have various advantages when used for orthopedic and dental coatings [159]. Bioactive glasses and ceramics have recently been discovered to have major uses in biomedicine, notably bone repair and substitution. Recent advances in tissue engineering have made it possible to improve the physical and biological efficiency of bioactive lenses and glass ceramics by including certain components into their compositions. These ingredients can improve the physiological, biological, and therapeutic qualities of bioactive glass [160].

MgO nanoparticles in medical imaging

Medical imaging plays n Significant part in providing useful information to medical sciences and drugs. Imaging is frequently utilized to detect the presence of cancer and develop the cure plan by studying human tissues without entering any equipment into the body [161, 162]. Magnetic nanoparticles have piqued the interest of nanomedicine researchers due to their advantageous properties that can greatly facilitate their application in the medical field [163-165]. Magnetic nanoparticles can improve image contrast and provide higher-resolution scans, allowing for more precise diagnosis and therapy [166, 167]. The magnetic properties of MgO nanoparticles, as well as their ability to stay in the bloodstream for a long time, made them an ideal contrast agent for MRI [168]. Using MgO nanoparticles is overwhelming due to being Non-toxic, free of side effects, biocompatible, and quickly introduced into the human body [169]. Numerous medical applications for MgO Nanoparticles can be summarized through the Diagram as follows:

MgO cytotoxicity

In the preceding sections, we can obviously notice that Magnesium oxide nanoparticles are used in a wide range of applications and are widely manufactured around the world. However, concerns about its safety remain.

MgO Nanoparticles displayed a hemolytic activity, releasing their hemoglobin content [170]. Being of a high positive charge, MgO nanoparticles produces an increment of the blood level of K+ as progression for their hemolytic effect [171]. Using alcohols such as ethanol during MgO nanoparticles preparation can radically eliminate risks of MgO nanoparticles in terms of being

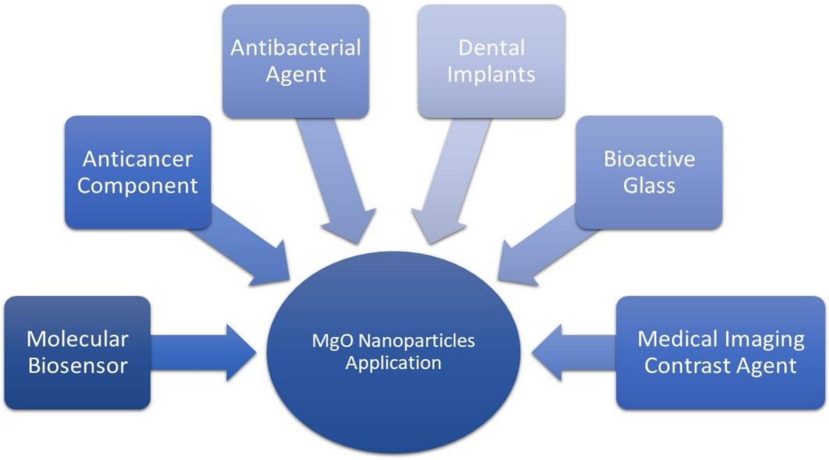

Fig 1. Diagram Represents the Different Medical applications of MgO nanoparticles

biocompatible with the components of the human blood [172]. Several histological and structural changes in Endothelial cells can occur following an exposure to MgO nanoparticles [173]. Vascular endothelial cells suffer from dysfunctional on treatment with MgO Nanoparticles which may contribute the formation of arteriosclerosis [174]. MgO Nanoparticles can do a severe damage to the respiratory system in the picture of triggering Lung Inflammation [175]. Pulmonary effect of MgO nanoparticles is strongly related to diminishing of cell viability accompanied by the elevation of the reactive oxygen Species [176]. MgO nanoparticles can generate oxidative stress inside the liver cells which is associated with hepatocytotoxicity that can wholly affect all the liver functions [177]. The preceding toxic effect can be impressively eliminated when having the MgO nanoparticles conjugated with some natural proteins like Zein [178]. Glomerulus deformation is also observed after treatment with MgO nanoparticles which can lead to a renal function failure [179]. Toxic effects of MgO nanoparticles can be minimized to a low extent when low dosage is being used as per study carried out on the intestinal cells [180]. The following Figure is spotting the divergent cytotoxic effects of the MgO Nanoparticles.

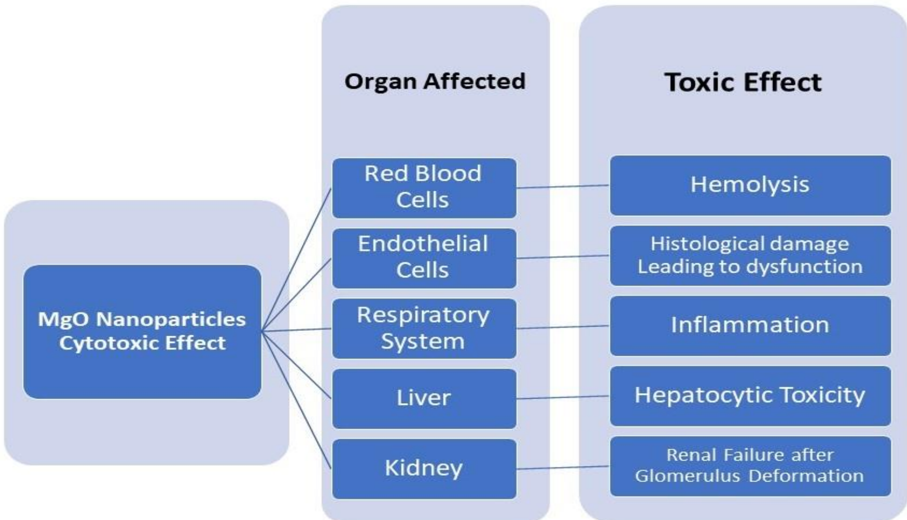

Fig 2. Systematic Representation for the toxic effects of MgO nanoparticles on different human body organs

CONCLUSION

Nanomaterials, particularly metal oxides, are useful in scientific research in a variety of domains because of their appealing features. In the medical field, for example, magnesium oxide is used. It comes in a variety of forms and sizes (varying from 6nm to 130nm), each with its own set of features. It's antimicrobial as well as anticancer. MgO nanoparticles are utilised in the creation of biosensors, the diagnosis of cancer, and the mentorship of the cure plan through medical imaging because of their active catalysis property, high reaction activity, and high absorption capability in enzyme immobilisation. Bioactive glass is being developed for application in surgery, dentistry, bacteria inhibition, bone mending, and tissue engineering. Because of its many properties, such as antibacterial, anticancer, biocompatibility, nontoxicity, biodegradability, and low cost, research findings justify adding MgO nanoparticles to a variety of medically useful compounds. In addition, MgO appears to be beneficial and safe in numerous medical uses. Considering the potential for harmful effects as a result of the exposure to MgO nanoparticles, we have to have the most proper way the get benefit of MgO nanoparticles and avoid its potential harmful effect simultaneously.

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