

RESEARCH PAPER

Preparation and Characterization of Magnesium Oxide Nanoparticles and their Antibacterial Activity

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ABSTRACT

The precipitation process was used to prepare magnesium oxide (MgO) with magnesium nitrate hexahydrate $Mg(NO_3)_2 \cdot 6H_2O$, ammonia, and distilled water. The precursor is Mg Nitrate, the solvent is distilled water and ammonia is used to adjust the pH of the sample. The MgO was characterized by X-ray diffractometer microscopy. Through Scherrer equation and XRD spectroscopy, the mean size of the particle was observed to be 40 nm. The samples had good crystallinity and good orientation (222) direction. The main aim of the magnesium oxide synthesis in this paper is to explore its anti-bacterial quality. The size of the inhibition zone developed during disk diffusion tests and the minimum inhibitory and minimum bactericidal concentration of samples in media were used to test against antibacterial agents. The efficacy of magnesium oxide nanoparticles was evidenced by the fact that the results of bacterial sensitivity of nanoparticles vary according to the type of bacteria i.e. S. aureus and E. coli.

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INTRODUCTION

Nanoscience is the study of materials and technologies at the nanoscale; between one and one hundred nanometers. This field of research worries itself with the peculiar properties of the materials at this size at which their behavior is quite different at larger scales. Nanoscience has found application in many industries and one of such industries is medicine, which is used in development of more powerful medicines through targeting cancer cells [1]. It is useful in manufacture of smaller and faster parts in electronics such as microprocessors. It is also used

to make solar panels and energy storage systems more efficient in relation to increasing the amount of energy which is used in water purification and pollution treatment. These applications generate a new avenue of increasing standards in various industries. [2]. Magnesium oxide (MgO), which is a chemical compound consisting of magnesium and oxygen is considered to be a substance of great significance in various industrial and medical processes. Because of the special chemical and physical properties, magnesium oxide may be applied in a broad field of utilization [3,4].

There are many industries which utilize

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magnesium oxide (MgO) such as nutrition and medical. Magnesium oxide can inhibit other types of bacteria effectively indirectly [5,6]. One of its effects is its ability to alter the pH (level of acidity) of the surrounding environment. Alteration of the pH can inhibit the development of some forms of bacteria because they like acidic conditions [7]. Moreover, the MgO reaction with the acid present in the cell wall may have negative effects on the structure and the key processes in bacteria. This reaction is used to reduce the level of bacteria in a particular environment by avoiding their proliferation [8]. Bacterial inhibition can be defined as the process to prevent the growth and procreation of bacterial germs. This is important to the environment, food and health. This is achieved with the help of various techniques and resources. [9]. Laser preparation methods are considered among the most popular methods of producing nanoparticles due to their numerous advantages in numerous fields of scientific and industrial use. [10]. Method involves high-intensity beam of laser to create vast amount of heat in the target materials which causes the nanoparticles to fall and evaporate at the most accurate and uniform process. [11]. One of the most valuable opportunities of the technology is the ability to

closely monitor the size, shape, and chemical composition of the final nanoparticles. The nanoparticles that are made can be designed with some specific properties that can aid in achieving the goals of research and application through the manipulation of laser process conditions such as power, exposure time and the type of source material [12,11].

MATERIALS AND METHODS

Nanomaterial Synthesis MgO

This is the way the aqueous solution of magnesium nitrate hydroxide was prepared. Magnesium nitrate hydrate, $Mg(NO_3)_2 \cdot 6H_2O$, was dissolved in 100 milliliters of striped water to prepare the aqueous solution of magnesium nitrate hydroxide. The mixtures of distilled water and magnesium nitrate hydrate were agitated four hours in order to gain clarity. To achieve the pH of the magnesium nitrate hydrate solution of nine, ammonia was placed in the solution in drops whilst stirring. Right after that, the precipitate was obtained by thoroughly washing it numerous times with methanol and distilled water, filtering and drying the precipitate overnight at 100 degrees Celsius in the oven. Then the samples was ground and annealed at 500 degrees Celsius in a muffle

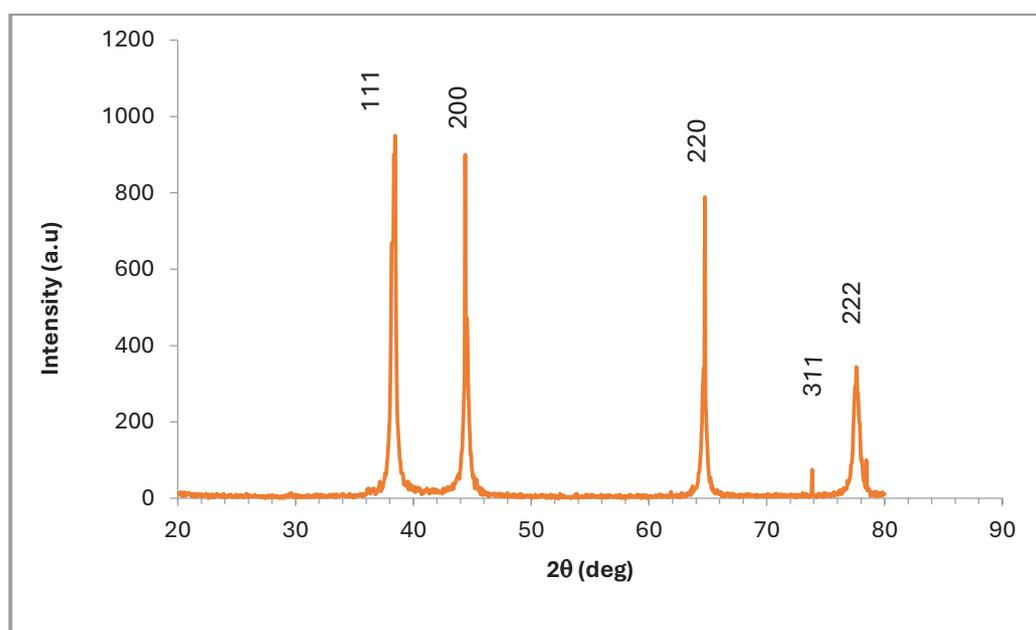


Fig. 1. X-ray diffraction of the MgO films.

furnace during a period of three hours. Finally, a white Nano-powder was obtained.

Sample accumulating

This investigation involved micrococcus luteus and Gram-positive and Gram-negative bacteria strains. All the micrococcus luteus, E. coli, and the Staphylococcus aureus were cultivated at 37°C in the nutrient agar plates. One colony was picked in a sterile loop and inoculated with 10 milliliters of nourishment and kept at 37°Celsius

throughout the night. After the completion, the S. aureus and E. coli at 108 cfu/mL, 106 cfu/mL, 104 cfu/mL, 103 cfu/mL, 100 cfu/mL and 10 cfu/mL in each medium were centrifuged at 6000 rpm of 5 minutes. The cells were centrifuged 3 times so as to eliminate the presence of medium and debris and then again after a second deferral in 500 l of phosphate-buffered saline (PBS). All the supernatants were discarded. Prior to adding them to the well cells were pipetted into PBS to be uniformly spread following the final wash that

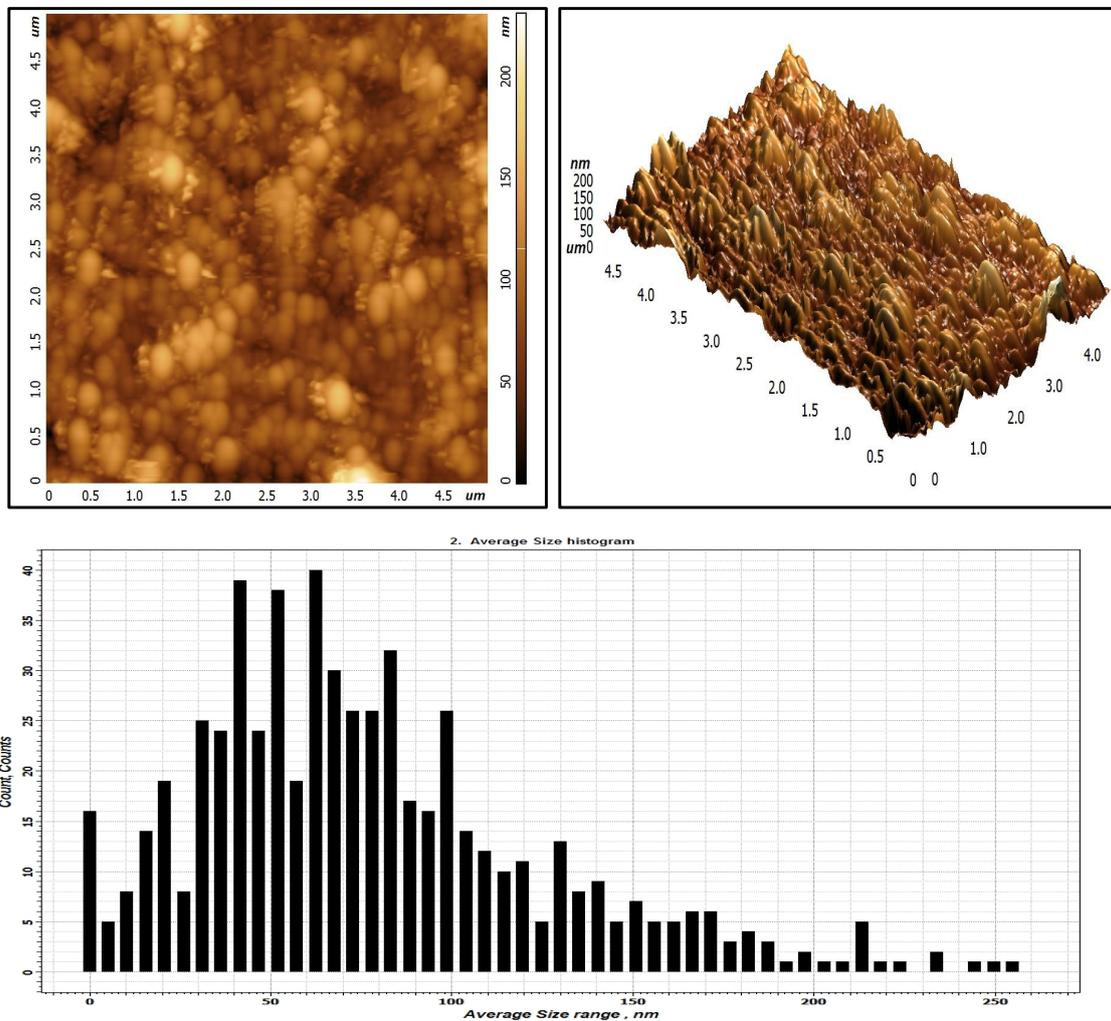


Fig. 2. Atomic force microscope images of MgO.

cleaning up all the supernatant.

RESULTS AND DISCUSSION

Characterization of MgO materials

The crystal phase of MgO nano-particles was identified with the help of powder XRD method with the use of Philips diffractometer with the X-ray as the source of Cuka radiation with the wave length of 0.15406 nm. Fig. 1 shows that magnesium oxide is found at phase-cubic. The peaks of impurities could not be detected. Fig. 1 indicated the presence of characteristic peaks of reflections at five MgO three and the peaks were indexed to (111), (200), (220), (3 1 1) and (222) planes of diffraction. A cubic unit cell is $a=b=c$ 4.130. The average crystallite size was calculated by using the highest peak (200) by Debye-Scherrer formula, which is having measured values as a Gaussian curve at the peak (200). Even, it can be imagined that the average size of the particles of magnesium oxide is approximately 40 nm. [13].

Results of Atomic force microscope (AFM)

Atomic force microscopy is one of the ways of

analyzing the size and the shape of particles. It gives 2D and 3D topography images of the scanned surface of the ready sample. The topographic pictures in Fig. 2 are 2D and 3D. The 3D topography image indicates that the MgO nanoparticles have the maximum height of 45 nm. MgO nanoparticles were also found to contain an average size of 40 nm. The shape of the nanoparticles is very acicular [14]. The acicular form is a crystal habit composed of a radiating mass of fine crystals in the shape.

Scanning Electric Microscopy (SEM)

The pictures of SEM of the generated nanomaterial are presented in Fig. 3. This accumulation of the aggregate particles on many layers is of crystalline and non-homogenous nature [15]. The results of the microscope analysis showed that the shape of the particles is normally non-specific, elongated, and spheric. [16].

Biological tests

Fig. 4 indicates the effectiveness of magnesium oxide nanoparticles in preventing the growth of certain bacteria. The zone of inhibition had a

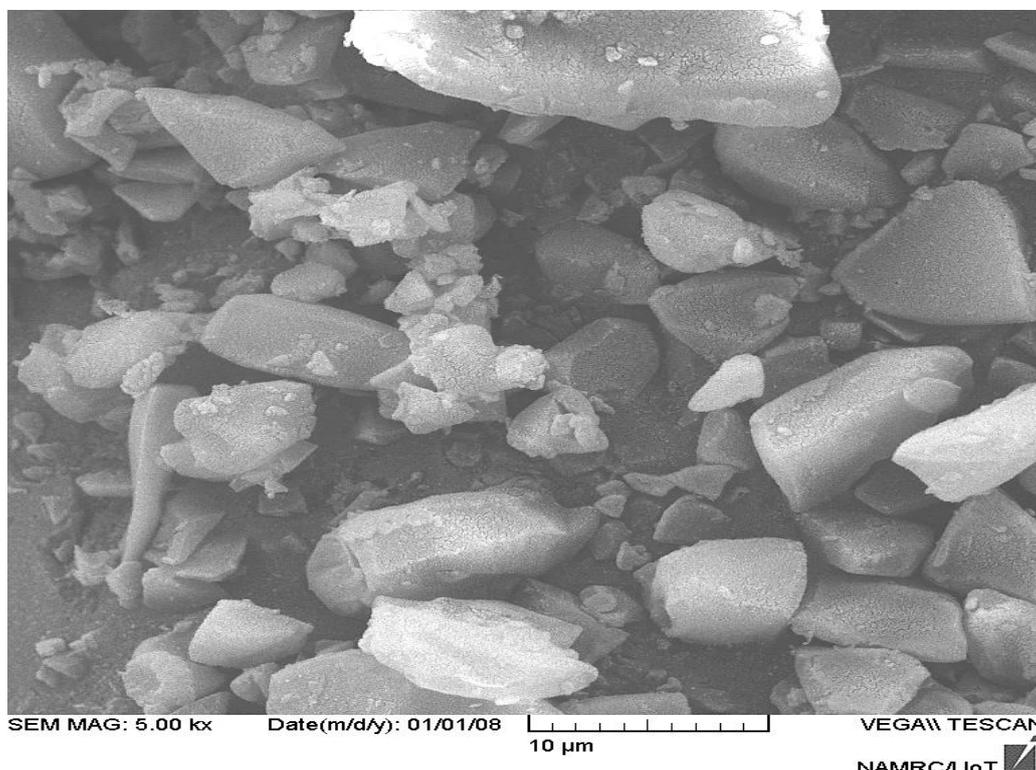


Fig. 3. SEM under microscope MgO.

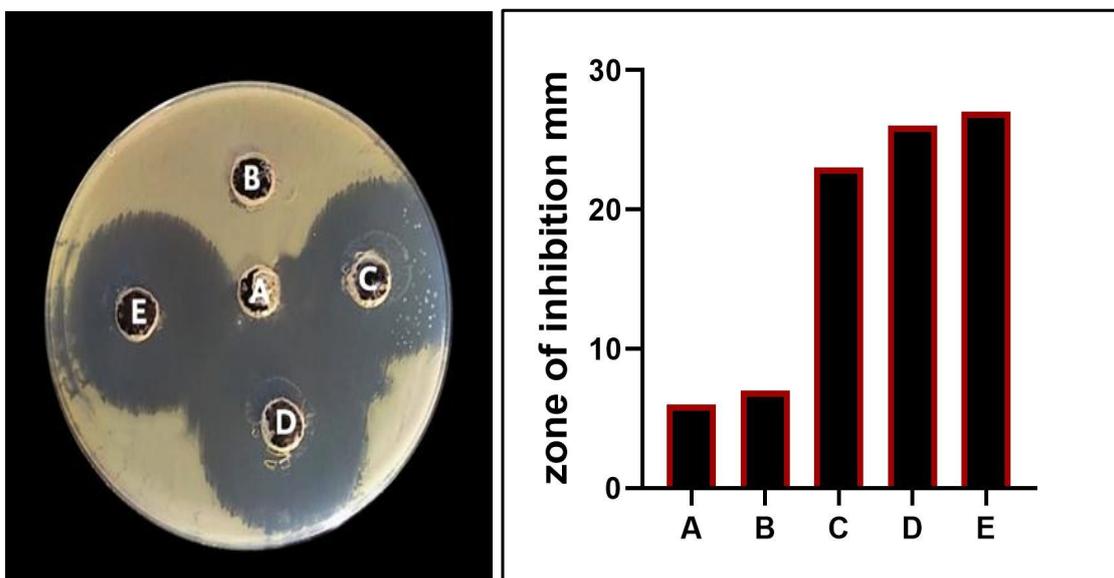


Fig. 4. Antibacterial activity of (sample 1) on S.aureus. A, Control. B, 62.5 ug/mL. C, 125 ug/mL. D, 250 ug/mL. E, 500 ug/mL.

Table 1. Explain the antibacterial activity of nanoparticles.

		Antibacterial analysis(Zone of inhibition (mm))				
Sample		A	B	C	D	E
<i>S.aureus</i>	MgO	6	7	23	26	27
<i>E.coli</i>		6	9	29	32	33

diameter of 33 nm and the positive bacteria such as Staphylococcus aureus and Staphylococcus epidermidis reacted with the substance with negative reactions being seen with gram-negative bacteria such as Escherichia coli. [17].

CONCLUSION

The XRD finding confirmed that magnesium oxide was present. The fine powders of MgO were produced successfully and the pH maintained through a precipitation process of magnesium nitrate, distilled water and Superior purity the Nano- powder indicates that an increase in MgO concentration inhibits bacterial growth. MgO nanoparticles at the concentration of 30mg/ml were found to inhibit S. aureus.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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