Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 1360 - 1364
Received 05 March 2021; Accepted 01 April 2021.

Biosynthesis Method and Characterization of MgO Nanoparticles by Using Local *Leuconostoc*spp. Isolate

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ABSTRACT

Background: Magnesium oxide nanoparticles (MgO NPs) were made using a biological method that included *Leuconostoc* isolate, magnesium nitrate, and NaOH as reducing agents. **Methodology:** This approach is both environmentally sustainable and non-toxic. In this experiment, 0.1 M (40 ml) magnesium nitrate $Mg(NO_3)_2.6H_2O$ was introduced and held at 37°C in a dark place with regular stirring at 1500 rpm. After 24 hours, the reaction mixture was dropped-wise with 2M NaOH solution to achieve a pH of 10-12. After adding the alkaline solution, a Mg $(OH)_2$ solution was formulated and left for 2 hours before the color changed to a brown color, then chaeacterization of MgO NPs by, UV-Visible spectroscopy, Fourier transforms infrared spectroscopy (FTIR), X-ray diffraction analysis (XRD), finally, scanning electron microscopy (FE-SEM).**Results:** FTIR spectra showed various functional groups in MgO NPs, which were also present in the bacterial extract. The MgO NPs were roughly with average in size, 43.88 nm, and spherical in shape when examined by SEM.The crystalline nature of MgO NPs was established using X ray diffraction (XRD) analysis. **Conclusion:** The current approach suggests that developing a biological process for mass-scale development of magnesium oxide nanoparticles may be possible.
Keywords: Magnesium oxide nanoparticle, Biosynthesis, Leuconostoc.

INTRODUCTION:

Nanosciences and nanotechnology have recently ushered in a global technological revolution centered on materials with dramatically improved physical, chemical, and biological properties [1,2]. Because of their scale, composition, and surface properties, nanoparticles have been known as antibacterial agents [3]. As a result, nanotechnology provides a means of improving the efficacy of inorganic antibacterial agents. Inorganic antibacterial agents have been studied using metal oxide nanoparticles such as ZnO, MgO, and CaO [4-6].Microelectronics, diagnostics, and biomolecular detection are all possible applications for MgO nanoparticles. MgO is a substance that is known to be suitable for both humans and animals. Microelectronics, diagnostics, and biomolecular detection are all possible uses for MgO nanoparticles. MgO is a material that is considered suitable for both humans and animals [7, 8]. Metal oxide nanoparticals' toxicity and antimicrobial activity are attracting a lot of attention. MgO is one of these oxides, with its low cost and environmentally friendly properties, although its toxicity is due to the processing of reactive oxygen species (ROS) [9]. MgO NPs have been shown to have antimicrobial properties against a variety of microbial species, especially bacteria [10], which needs to be investigated further at various levels. When microorganisms are exposed to higher metal salt concentrations, one of their defense mechanisms is thought to be the synthesis of nanoparticles (NPs) [11]. The aim of this study was to biosynthesize and characterize MgO nanoparticles formed by a biotechnological method in Hilla, Iraq, using *Leuconostoc* spp. as local isolates.

MATERIAL AND METHODS:

Bacterial isolate

*A Leuconostoc*spp. isolate was collected from the Microbiology Lab of the Biology Department of the College of Science at the University of Babylon in Iraq, and the bacteria were determined to be*Leuconostoc*spp. [12,13].

Solution and media

Merck Germany provided magnesium nitrate Mg(NO3)2.6H2O, brain heart infusion agar, brain heart infusion broth medium, and other chemical reagents.

Biosynthesis of MgO Nanoparticles

Two flasks were used for the biosynthesis of MgO NPs (magnesium oxide nanoparticles), one containing *Leuconostoc* spp. supernatant as a control and the other containing 0.1 M (40 ml) magnesium Nitrate Mg(NO3)2.6H2O and kept on stirring condition at 1500 rpm. After reaching the necessary temperature, 2M NaOH solution was lowered into the reaction mixture drop-by-drop to achieve the

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required pH and left for 2 hours until the color changed to a brown color. The pellet was dissolved in deionized water and dried after the supernatant was discarded. FTIR measurements, UV-Vis diffuse reflectance measurements, X-ray diffraction measurements, and field emission-scanning electron microscopes (FE- SEM) measurements were used to classify MgO nanoparticles [14].

RESULTS AND DISCUSSION:

After adding the alkaline solution, a solution of Mg (OH)2 was created, which was left for 2 hours until the color changed to brown, as shown in Figure (1). This result was confirmed by Ali et al., (2020), who synthesized MgO NPs from *Persimmon* extract. [15].

UV-visible Analysis

The optical absorption spectrum is described as UV–VIS [21]. The absorption spectra of MgO were measured at wavelengths ranging from 200 to 800 nm. It can be seen from Figure 2 that, After treatment with the ultrasonic processor, there were changes towards the larger wavelength at absorbances of 240 nm and 310 nm, resulting in a decrease in the energy gap from 5.16 eV to 4.0 eV. This result agrees withthat of Moorthy et al. (2015) and Sivalingam et al. (2012) [5, 22].

The energy band gaps of MgO NPs were calculed by the following formula

$E= hc/\lambda$

The energy gap in MgO NPs synthesized by the biosynthesis method decreases as the wavelength changes from 7.8 eV in bulk MgO to 5.16 eV in MgO NPs synthesized from bacteria. This may be linked to the increased aggregation of MgO NPs. This is due to defects that arise during the preparation of MgO NPs [9, 22].

X-Ray Diffraction

Figure 3 provides an example of X-ray diffraction for magnesium oxide nanoparticles. The particle size of magnesium oxide NPs was estimated to be 25.94 nm, and the increase in the sharpness of XRD peaks represents the particles' crystalline state. XRD verified that the synthesized MgO has a cubic crystal system. The following criteria were used to assess crystalline size: Debye Scherrer's formula $D= 0.94\lambda/\beta \cos\theta$.

Table 1 shows the crystalline size values and structural parameters of MgO NPs synthesized by bacteria (1). No characteristic peaks of impurities were observed in the MgO NPs sample synthesised by *Leuconostoc*spp test, indicating that high purity MgO was obtained. The peaks at 2Θ = 36.154, 42.42, 58.112and 74.702 were assigned to (111), (200), (220) and (311) planes of cubic MgO nanoparticles respectively. The average size of the MgO NPs sample that synthesis by *Leuconostoc* spp. was (25.94 nm).

Field Emission Scanning Electron microscopy (FE-SEM)

Figure 4 shows the surface morphology of MgO nanoparticles as seen from a FE-SEM picture The image analysis showed that the MgO NPs synthesized by *Leuconostoc*spp. were roughly spherical, with an average diameter of 43.88 nm of MgO NPS synthesized by *Leuconostoc* spp.

Fourier Transform Infrared (FTIR)

Using Fourier transform infrared spectroscopy (FTIR), the functional groups of MgO NPs samples synthesized by isolate (*Leuconostoc* spp.) samples were identified. The findings of both samples' FTIR analysis were shown in figure 5 and their functional groups were listed in table(2) .Analysis of the results of FTIR depending on [16,17].

The absorbance peaks 3851.98, 3747.24, 3270.36, 2952, 2922.88, 2853.70, 1648.70, 1456.71, 1376.95, 1073.73, 722.31and 562.77were present in the MgO NPs sample that synthesis by *Leuconostoc* spp . The absorbance peak at 3851.98 and 3747.24 corresponds to the O–H stretching mode of hydroxyl groups and hydrogen bonding, indicating the presence of alcohol at 2952relates to the methylene C-H stretch, the absorbance peak at2922.88, 2853.70, 1648.70, 1456.71, 1376.95, 1073.73, 722.31and 562.77 relate to alkenyl C=C stretch, aromatic nitro compounds, the methylene C-H bend, ammonium ion, aryl –O stretch, C-O stretch and Mg–Ostretching bond respectively.

The absorbance peak at 562.77 is The vibration of the MgO stretching bond, which suggests the presence of MgO in the system, is due to it. Calcinated sample [18]. After that, the formation of MgO crystallite is cubic since the absorbance peak is between 1000 and 500 cm^{-1}. [19].

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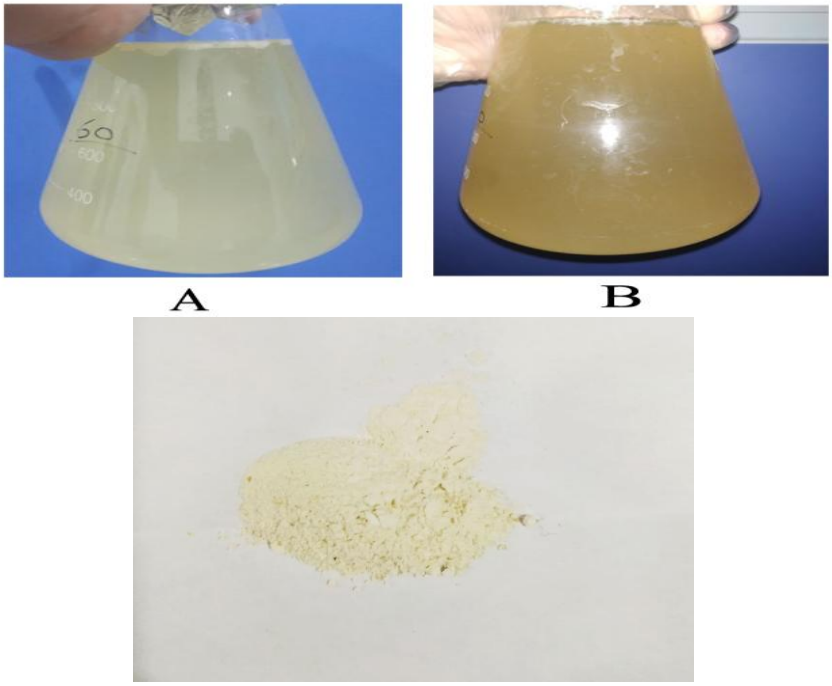

Figure 1:MgO NPs by biosynthesis by bacteria method.(A) before adding NaOH (B) after adding NaOH. (C) MgO NPs powder

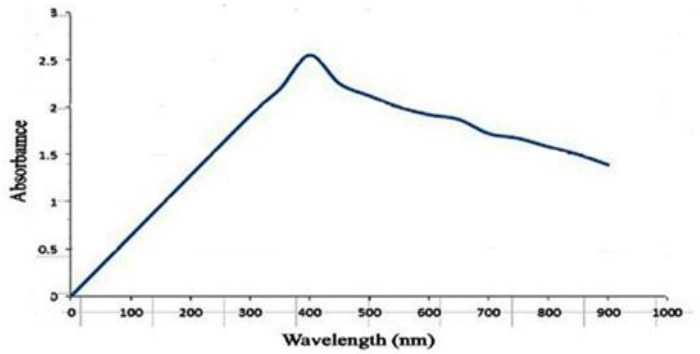

Figure 2: Absorbency of UV spectrophotometer of MgO NPs produced from *Leuconostoc*spp

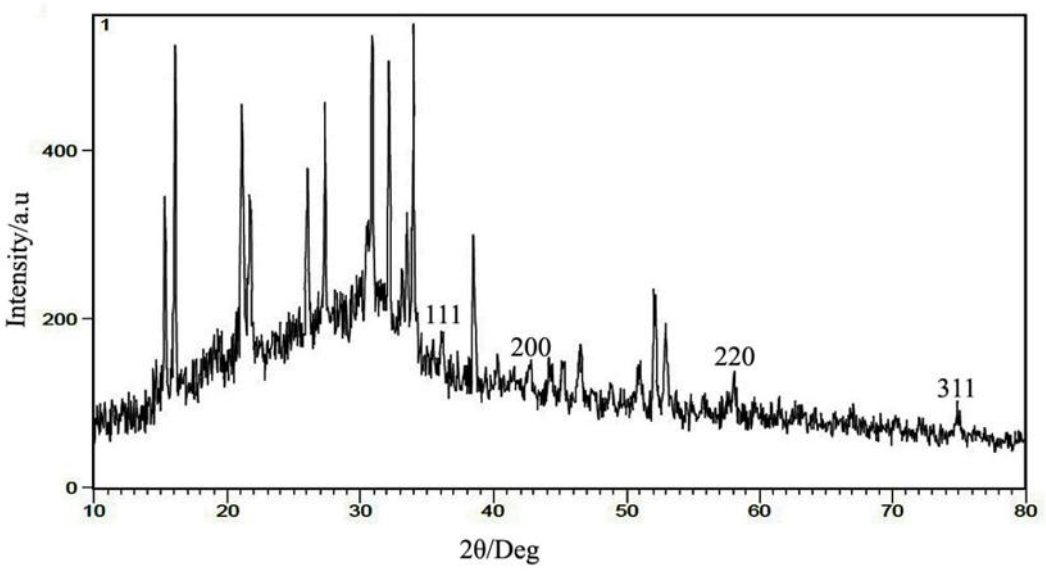

Figure 3:XRD patterns of MgO NPS powder synthesis by *Leuconostoc*spp.

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Table 1. Crystalline size and structural parameters of the MgO NPs sample that synthesis by *Leuconostoc* spp.

MgO NPs synthesis by*Leuconostocs*pp.				
2θ (Deg.)	**FWHM (Deg.)**	**Crystalline size D(nm)**	**Hkl**	**Avarege of size(nm)**
36.154	0.2952	28.29	111	25.94
42.42	0.3936	21.64	200	
58.112	0.246	36.92	220	
74.702	0.5904	16.92	311	

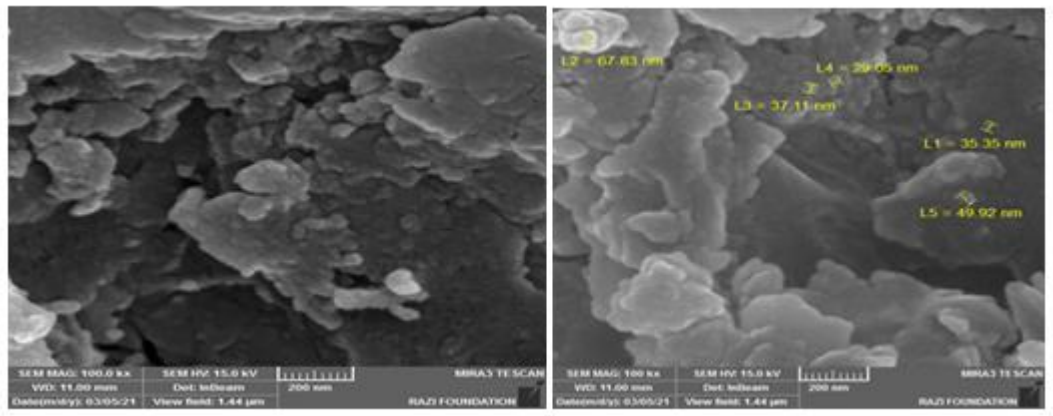

Figure 4. The surface morphology of MgO NPs synthesized by *Leuconostoc*spp by FE-SEM .

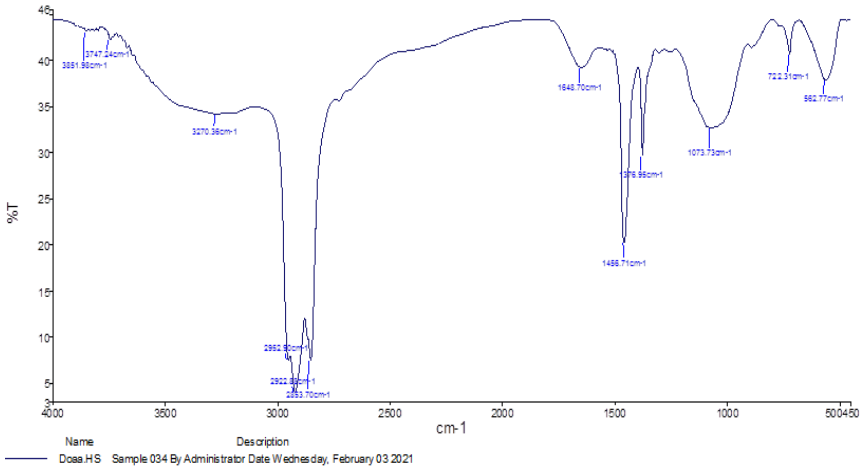

Figure 5: FTIR spectrum of the MgO NPs sample that synthesis by isolate: *Leuconostoc*spp.

CONCLUSION

Gram-positive bacteria *Leuconostoc* spp. were used in a biological process to produce magnesium oxide nanoparticles. It has been confirmed. Compared to current chemical processes, this process is likely to be less expensive, easier, and require less energy and raw materials. The development of an environmentally friendly method for the synthesis of metallic nanoparticles is a significant step forward in nanotechnology.

ACKNOWLEDGEMENT:
This project was made possible thanks to the financial help of College of Science, Babylon University, Hilla , Iraq.

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