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Research Article

Green Synthesis of *Datura stramonium* (Asaangira) Leaves Infusion for Antibacterial Activity through Magnesium Oxide (MgO) Nanoparticles

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The biosynthesized magnesium oxide nanoparticles were pigeon-holed with X-ray diffraction (XRD), ultraviolet-visible (UV-Vis) spectrophotometer, scanning electron microscope (SEM), and photoluminescence spectrometer (PLs) and antibacterial activity. *Datura stramonium* leaves extract has been used in the present work,; which has medicinal value, and we have synthesized magnesium oxide nanoparticles from both chemical and biosynthesis techniques. The XRD result indicates the realization of crystalline magnesium oxide nanoparticles, and again it is also inveterated with an ultraviolet-visible (UV-Vis) spectrophotometer. The superficial morphology expresses that magnesium oxide nanoparticles have a bulbous morphological shape for both biosynthesis and chemosynthesis. The antibacterial activity of magnesium oxide nanoparticles obtained from *Datura stramonium* leaves against *E. coli* and *S. aureus* was studied. The antibacterial activity also shows a good zone of inhibition. Both techniques are promising for the preparations of MgO nanoparticles in antibacterial activity and show the same result. This outcome demonstrates that the biosynthesized nanoparticles originate from having some medicinal uses and are biodegradable.

1. Introduction

Microbial infection endures enticement municipal consideration. It is predicted that almost 48 million gears of pathogenic ailments arise in the US [1]. Consequently, in demand to resolve this delinquency, it is essential to grow effective antimicrobial proxies to control the bacteriological populace [2]. Mostly, antibacterial proxies can be classified as carbon-based or mineral antibacterial proxies. Biological antibacterial proxies such as carbon-based acids, vital oils, bacteriocin, and enzymes have been extensively considered. Nevertheless, they have particular limitations, such as little confrontation to dispensation situations, which provides their solicitations. The foremost compensations of mineral antibacterial proxies, associated with carbon-based antibacterial proxies, are the enriched steadiness under exacting dispensation situations [3].

Nanotechnology is mostly apprehensive about the production of nanoparticles of flexible sizes, characters, chemical configurations, and controlled disproportion and possible use for human welfare [4]. The application of biological creatures such as microbes, plant extracts, or plant biomass could be a substitute for biochemical and physical techniques for the fabrication of nanoparticles in a sustainable way [5, 6]. The organic production technique of nanoparticles is easy, effective, and biodegradable in contrast to a chemical-mediated combination [7].

Metallic nanoparticles have been prepared using different approaches comprising physical, chemical, and biosynthesis techniques that involve the use of microbials like bacteria, yeast, and fungi [8] and plant extracts [9]. The physical and chemical techniques of metal nanoparticle synthesis use very large amounts of energy, toxic solvents, and dangerous chemicals [10]. The biological techniques of using microbials in the metallic nanoparticle approach are eco-friendly and cost-effective because of the intricate laboratory procedure of preparing and upholding the microbial cultures, complex extractions, and purification procedures [11].

It is important to pay special attention to metallic oxides such as NiO, zinc oxide, and CuO because not only are they reliable under harsh method conditions, but they are also widely perceived as safe materials [12]. However, several chemical approaches exist for metallic nanoparticle production; abundant reactants and raw materials are applicable in the reactions that are poisonous and theoretically dangerous. Nanostructured mesoporous zinc oxide is also of study interest due to its miscellaneous characteristics, which initiate from its structural appearances [13]. Nowadays, there have been some approaches for the production of nanostructured mesoporous zinc oxide, e.g., gel template method [14], modified citrate precursor method [15], microwave plasma torch method [16], and burning method [17]. Currently, certain mineral antibacterial constituents in specific mineral metallic oxides like titanium oxide (TiO_2), zinc oxide (ZnO), magnesium oxide (MgO), and calcium oxide (CaO) have been investigated [18].

Among the researched mineral metallic oxides, zinc oxide, magnesium oxide, and calcium oxide are of specific attention due to harsh procedure circumstances and are largely observed as nontoxic resources to mortals [19]. Furthermore, they have antimicrobial action deprived of sunlight activation, associated with titanium oxide that needs sunlight [20]. Lately, nanosciences, as well as nanotechnology, have been foremost to a scientific rebellion in the biosphere, which is apprehensive with resources with meaningfully new as well as developed physical (somatic), chemical, and organic characteristics [21]. In this esteem, nanoparticles are renowned as antibacterial proxies because of their sizes, configuration, and superficial behaviours [22]. Therefore, nanotechnology compromises a way to upgrade the action of mineral antibacterial proxies. Metallic oxide nanoparticles like zinc oxide, magnesium oxide, and calcium oxide have been studied as mineral antibacterial proxies [23].

Magnesium oxide (MgO) is a significant mineral substantial with a widespread energy bandgap [24]. This metallic oxide has been applied in numerous ways such as catalysis, catalyst supports, poisonous wastes remediation, headstrong constituents as well as adsorbents, preservatives in weighty petroleum oils, shiny and antireflecting coverings, superconducting and ferroelectric thin films as the substrate, and superconductors and lithium-ion batteries [25]. In medical fields, magnesium oxide is used for the respite of indigestion, painful stomach, and bone renewal. Magnesium oxide nanoparticles also have an extensive perspective as an antibacterial proxy. So, in this work, the main preparation techniques, antibacterial action, and antibacterial types of using magnesium oxide nanoparticles are argued.

In this current work, we have used the *Datura stramonium* leaves extract which has therapeutic value and we have manufactured magnesium oxide nanoparticles from it by green deposition production technique. These green synthesized nanoparticles were tested by X-ray diffraction (XRD) characterization to calculate their magnitude and properties. The antibacterial activity of magnesium oxide nanoparticles obtained from *Datura stramonium* leaves is in contradiction to *E. coli*, *S. aureus*, and bacillus studied. The antibacterial activity also illustrates a good zone of inhibition.

2. Materials and Methods

2.1. Materials. All the reagents utilized in this research were of analytical grade. Magnesium nitrate (Mg $(NO_3).3H_2O$) and NaOH were obtained from Sigma-Aldrich. All solutions were prepared from double-distilled water.

2.2. Groundwork of Datura stramonium Foliage Extraction. *Datura stramonium* leaves of about 30–35 g were collected from East Wollega Zone, Gudaya Bila District, carefully washed away with double-distilled water, and cut into slight pieces; then, the foliage was heated in 250 ml cut-glass beaker with 150 ml of double-distilled water for 45 min at 300°C using a magnetic stirrer through the hot dish. After reheating, the pigment of the aqueous mixture was transformed from waterlogged to chocolate color and then the solution was allowed to refrigerate at 37°C.

The aqueous extract of *Datura stramonium* (Asaangira, Oromo) foliage was unglued by percolation with Whatman No. 50 filter paper. The deposits were cast off for the preparation of magnesium oxide (MgO) nanoparticles. *Datura stramonium* flowers, leaves, and fruit were taken from East Wollega Zone, Gudaya Bila District, Darbes Kebele, Oromia, Ethiopia, as illustrated in Figure 1.

2.3. Synthesis of Magnesium Oxide Nanoparticles. The sources utilized for the deposition of magnesium oxide nanoparticles are magnesium nitrate ($Mg(NO_3).3H_2O$) and NaOH. The magnesium oxide nanoparticles were produced by the chemosynthesis technique. 30 ml of $Mg(NO_3).3H_2O$ 0.2 M was dissolved with a volume of 30 ml of 0.2 M NaOH in a 150 ml beaker. Double-distilled water was added to fill the total volume required. The pH value of the solution was 2 (pH = 2), which is categorized under an acidic bath. Then, the solution was kept on the heater and stirred for 2 hr at a temperature of 50°C. Then, after it was allowed to cool down, the powder form of MgO nanoparticles was formed. Then, the powder was transferred to a plate and reserved for

Figure 1: *Datura stramonium* flowers, leaves, and fruit are taken from East Wollega Zone, Gudaya Bila District, Darbes Kebele, Oromia, Ethiopia.

application. The deliberation of ($Mg(NO_3).3H_2O$) 0.2 molarity, aqueous were dissolved with capacity (30 millilitres) of the *Datura stramonium*foliage except for the preparation. After some minutes, 30 ml of 0.2M sodium hydroxide (NaOH) was added drop by drop to the solution. Then, the mixture is maintained for a few hours. The pigment of the compound transformed from chocolate to yellow, representing the development of MgO nanoparticles.

The compacted manufactured goods were cleaned, and then, the separate precipitate was bare to return to the situationby placing it in the furnace at 50°C for about 60 min; then, it was allowed to cool at room temperature, and we obtained the crushed powder using a motor and pestle, before adding Mg $(NO_3).3H_2O$, and after adding Mg $(NO_3).3H_2O$, respectively.

3. Results and Discussion

3.1. X-Ray Diffraction. The XRD pattern of MgO nanoparticles derived from the sol-gel technique is illustrated in Figure 2. For biosynthesis or *Datura stramonium* extract MgO nanoparticle, few peaks but the longest peaks were observed; the presence of prominent and sharp diffraction peaks positioned at the 2θ values of 30, 32, 35, 37, 48, 56, 64, and 69 corresponding to (211), (110), (111), (200), (100), (210), (220), and (320) planes, respectively, indicated the formation of MgO with bulbous crystalline shape. For chemosynthesis MgO nanoparticles, many peaks were the same except no peak formed at 2theta values of less than 30 and some crystalline impurities were detected that fluctuated the intensities of peaks; this result shows the prepared nanoparticle formation with a spherical (bulbuls) shape. The findings demonstrated that the structure resembled cubic shape in nature. These results agreed with reported works [26, 27]. Debye–Scherrer's formula was used to compute the crystalline size of zinc oxide, as shown in Table 1:

$$D = \frac{0.94\lambda}{\beta \cos \theta}, \quad (1)$$

where D = crystalline size (nm), K = 0.9 (Scherrer constant), λ = 0.15406 nm (wavelength of the X-ray sources), β = FWHM (radians), and θ = peak position (radians).

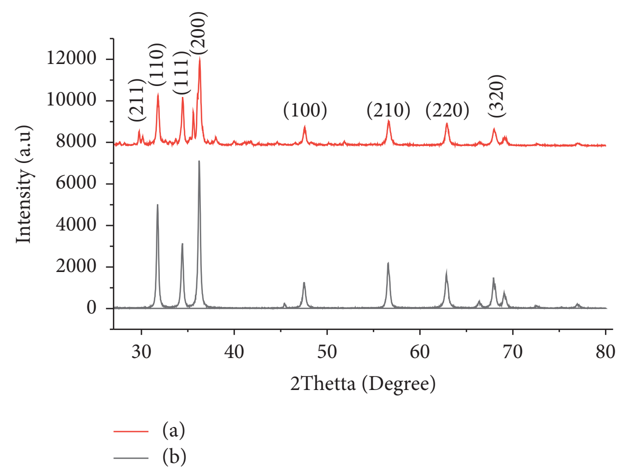


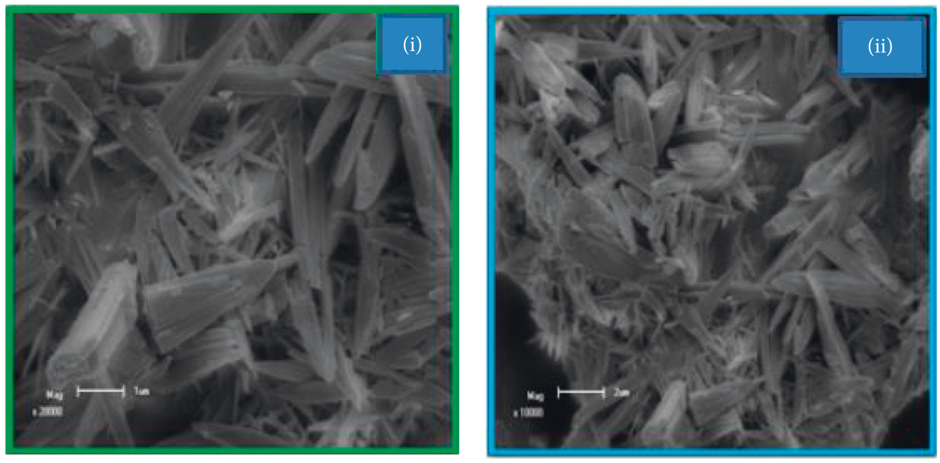
Figure 2: X-ray diffraction pattern of (a) biosynthesized magnesium oxide (MgO) from *Datura stramonium* leaves extract and (b) chemosynthesized nanoparticles.

Table 1: XRD data and calculation of peaks parameters: 2theta, FWMH, and crystalline size (nm).

Sl. no.	2theta (degree)	FWMH (radians)	D (nm)
1	30	6.86465	0.337219
2	32	8.93974	0.295582
3	35	0.87978	0.285169
4	37	1.01812	0.173284
5	48	0.69772	0.148195
6	56	0.62852	0.134706
7	64	0.00513	0.136776
8	69	0.00513	0.13690

The average crystalline size of magnesium oxide nanoparticles was revealed to be 0.17 nm.

3.2. Scanning Electron Microscopy (SEM). An instrument used for the analysis of surface morphology was scanning electron microscope (SEM). A well-established method for investigating the topography, texture, and surface



(a) (b)

Figure 3: Scanning electron microscopy of (a) biosynthesized magnesium oxide (MgO) from *Datura stramonium* leaves extract at 20000 magnification and (b) chemosynthesized nanoparticles at 10000 magnification.

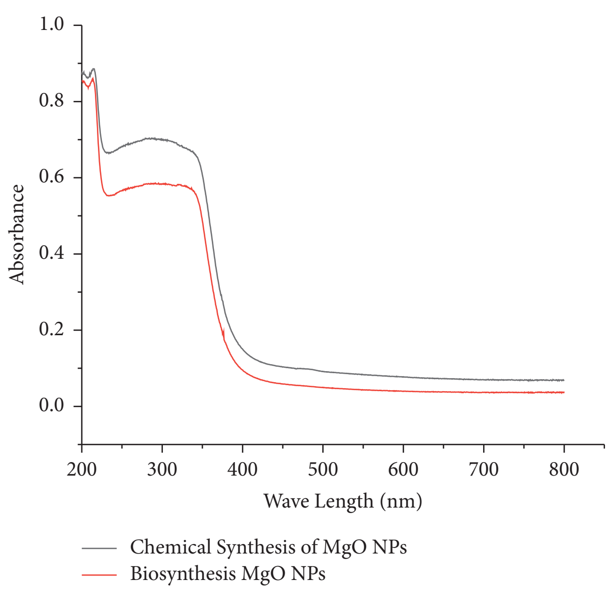


Figure 4: Absorbance measured by UV-Vis of biosynthesized magnesium oxide (MgO) nanoparticles derived from *Datura stramonium* leaves extract.

characteristics of powders has been developed. The scanning electron microscope (SEM) generates a three-dimensional picture of the specimen, which is extremely useful when evaluating the shape and structure of a sample. The SEM images were analyzed, and a topographical analysis was carried out on the basis of the surface study results. The morphology of both biosynthesized and chemosynthesized magnesium oxide nanoparticles was determined by scanning electron microscopy. As shown in Figures 3(a) and 3(b), the SEM micrographs of these materials at different magnification designate a wood cracked-like structure and no agglomeration was found. This shape is relatively spherical or bulbuls; this result is in good agreement with reported works [28–30].

3.3. UV-Visible Spectrophotometer Analysis. UV-visible spectroscopy shows the preoccupation spectroscopy in the ultraviolet-visible phantom area [31]. It customs sunny in the noticeable region and head-to-head near-infrared (NIR) arrays. In this section of the electromagnetic spectrum, molecules experience electronic changeovers. Nanoparticles have convinced optical assets such as sizes, shapes, concentrations, and accumulation state, as well as a refractive index which can be acknowledged with a UV-vis spectrometer. Nanoparticles prepared from certain metals powerfully interrelate with a convinced wavelength of light as well, as their sole optical characters indicate a singularity known as surface plasmon timbre [32, 33]. In the current research, UV-vis is used for both biosynthesized and chemosynthesized magnesium oxide nanoparticles prepared from *Datura stramonium* leaf extracts. Figures 4 and 5 show the absorbance and transmittance spectra of biosynthesized MgO nanoparticles and chemosynthesized MgO nanoparticles between wavelengths of 250 nm to 800 nm, respectively.

Broad peaks were perceived at 325 nm, as shown in Figure 5, for biosynthesized and chemosynthesized ones. As it can be seen, a black line shift occurs because of leaf extracts and chemical grounded variation. Broadening and shift are attributed to agglomeration or an upsurge in the size of the particles [34].

The transmittance spectra which are shown in Figure 5 were evaluated from the absorbance. The outcomes show that the optical transmittance of the MgO nanoparticles prepared by biosynthesis MgO nanoparticle with blue colour is greater than that of chemically prepared MgO nanoparticle with red colour, for wavelength greater than 450 nm. The higher transmittance also indicates a lower defect density of the MgO nanoparticle since absorption of light in the longer wavelength region (>500 nm) is frequently caused by crystalline faults such as grain boundaries and dislocations [35, 36].

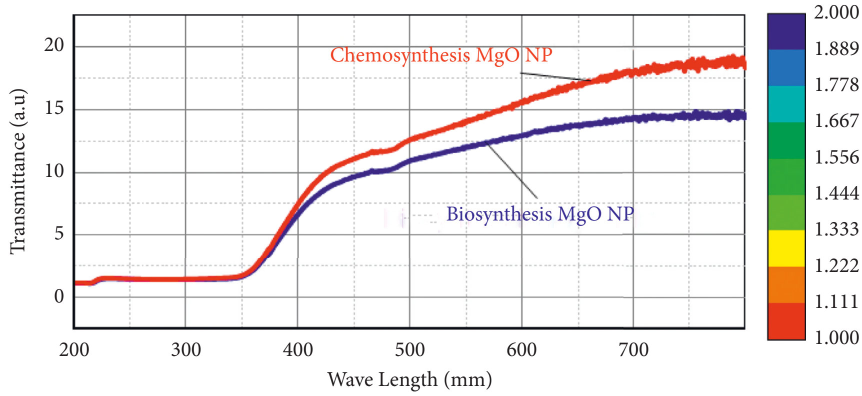


FIGURE 5: Transmittance measured by UV-Vis of biosynthesized and chemosynthesized magnesium oxide (MgO) nanoparticles derived from *Datura stramonium* leaves extract.

3.4. Photoluminescence (PL) Analysis. The PL continuum of magnesium oxide nanoparticles was chronicled at 37°C through a Xe spotlight as an excitation sunlit foundation at an excitation wavelength of 450 nanometers. Photo-luminescence emanation continuums are portrayed in Figure 6. Fleabags from the valence posse and electrons (e-) from the electronic states composite with each other, and this is accountable for the emanation properties of conversion metals [37]. The recombination of photo-excited electron (e-) and hole (h) sets at the energy situations would persuade the photo-emission [38]. The natural surroundings of the imperfections cause light emanation. Photo-luminescence stretches the evidence around the froths and imperfections in nanoparticles. The defect middles create changed electronic states in the widespread bandgap. The emanation variety shows emission at different techniques because of their different colour centres on the magnesium oxide nanoparticles shown in Figure 6. It is evident from the highest emission spectrum that the magnesium oxide nanoparticles emit at several wavelengths due to the presence of multiple colour centres on the particles. It has risen to the UV-visible region. PL spectra revealed UV (389 nm), violet (390 nm, 391 nm), blue (451 nm), green (455 nm), and orange (462 nm) emissions. The presence of oxygen vacancies in MgO nanoparticles causes them to glow in the ultraviolet (389 nm) area (surface defects). If there is a lot of imperfection, there will also be a lot of strength. Because of the F centres, there has been an increase in green emissions [39, 40].

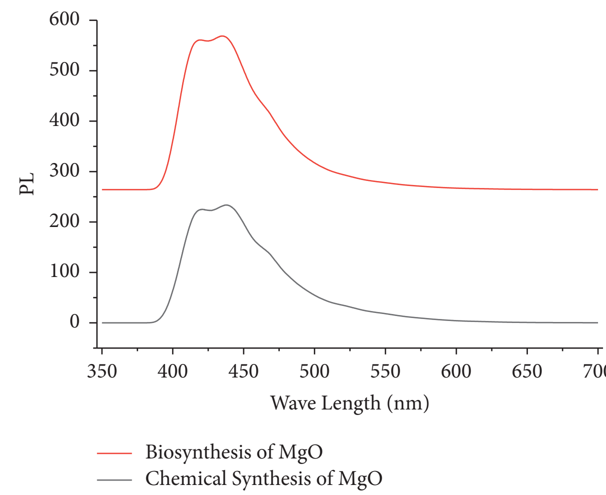


FIGURE 6: Photoluminescence (PL) spectrum of biosynthesized and chemosynthesized magnesium oxide (MgO) nanoparticles derived from *Datura stramonium* leaves extract.

3.5. Antibacterial Activity Analysis. The antibacterial commotion of biosynthesis and chemosynthesis MgO nanoparticles resulting from *Datura stramonium* (Asaangira) leaves extracts was applied for Gram-negative(G−) *Escherichia coli* and Gram-positive (G+) bacteria *Staphylococcus aureus* and bacillus by tabloid discuss dispersal procedure [41]. Nutrient agar cultures were cast off to develop bacteria.

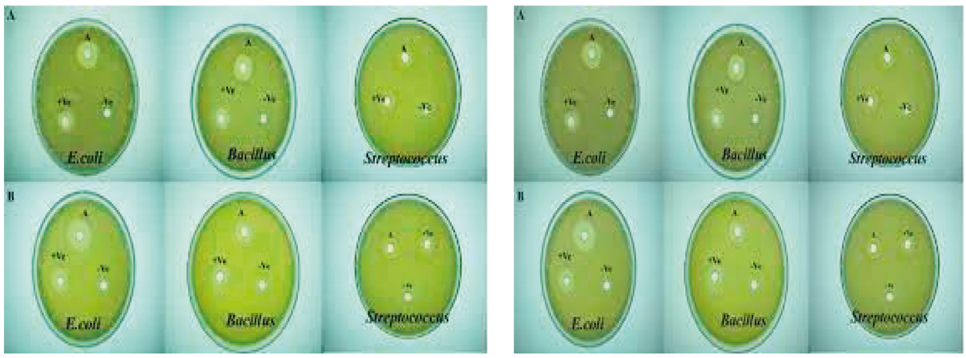
3.6. Preparation of Inoculums. The bacterial investigation concerns were shifted away from the conventional beliefs represented by the nutrient culture (NC) dishes and also hatched for a period of forty-eight hours. After that, more discrete bacteriological groups that were not connected were used as inoculums [42]. The bacteriological ring was used to transfer the microorganisms to the autoclaved nutrient culture, which was then moderately whirled while being heated to approximately 500 degrees Celsius in a distilled water bath with a variety of other miscellaneous ingredients. After that, the culture was transferred to sterile Petri plates, where it was given time to coagulate and was also subjected to a biological evaluation.

A new instance was created by marking inoculums from each of the existing media on nutrient agar means in a Petri dish. Aliquots of magnesium oxide were freshly synthesized in the following volumes: 25 μL, 45 μL, 65 μL, 85 μL, and 100 μL. On tabloid discusses, with a radius of 2.5 millimetres, nanoparticles were saturated with the help of a micropipette [39].

3.7. Development Sketch of Bacteria. After that, new groups began occupying the incubation space and were used to research the development of inoculations using

Table 2: Bacterial activities of biosynthesized MgO nanoparticles.

Treatment	Concentration (μg/mL)	Percentage of inhibition
Magnesium oxide nanoparticles	25	17.16 ± 1.02
	45	25.12 ± 1.30
	65	26.43 ± 1.23
	85	38.46 ± 1.32
	100	58.67 ± 1.09



(a) (b)

Figure 7: (a, b) Antibacterial activity of biosynthesized and chemosynthesized MgO nanoparticles derived from *Datura stramonium* (Asaangira), respectively.

Table 3: Bacterial activities of chemosynthesized MgO nanoparticles.

Treatment	Concentration (μg/mL)	Percentage of inhibition
Magnesium oxide nanoparticles	25	14.23 ± 1.12
	45	18.14 ± 1.25
	65	19.43 ± 1.00
	85	28.24 ± 1.14
	100	38.54 ± 1.05

microorganisms. We made sure the media potage solution was checked for turbidity, and we kept the OD (optical density) at 500 nm between 0.08% and 0.10% throughout the process.

3.8. Preparation of Media Culture. Both nutrient culture agar, as well as nutrient potage, was used as components of the development media that were investigated in this study. The nutrient agar was sterilised for the purpose of pasteurisation by being subjected to 15 Ibs pressure at 120°C for 20 minutes and then maintaining at 37°C.

3.9. Evaluation of Antibacterial Properties. Before the investigation, the plates were sterilised in an autoclave and dehydrated in a dry furnace overall. Kirby–Bauer's discussion of a dissemination method that uses the postponement of microorganisms feasting on nutrient culture agar provides evidence that antibacterial negotiator has the potential to estrange the microbial cell [43]. Bacterial activities of biosynthesized MgO nanoparticles are listed in Table 2. The examinations were done for both biosynthesized MgO and chemosynthesized MgO NPs set for an outstanding result. Utilizing two different methods produces the same outcome for all of the bacterial types that were tested. So, under the right conditions and in the right environment, eco-friendly biosynthesis is safe and promises antibacterial activity. After vaccination, the plates were kept in an incubator at a temperature of 30 degrees Celsius for a period of 48 hours. The antibacterial action was achieved by measuring the embarrassment zone. The antibacterial bustle of genuine MgO Nanoparticles was powerful by the Kirby–Bauer disc dispersal methodology, which is demonstrated in Figures 7(a) and 7(b). Bacterial activities of chemosynthesized MgO nanoparticles are listed in Table 3.

As it is seen from Tables 2 and 3 concerning Figures 7(a) and 7(b), the antibacterial activities (*E. coli*, bacillus, and *Streptococcus*) are analyzed. The biosynthesized MgO nanoparticle shows a high inhibition zone, which is promising for antibacterial applications. The result also agrees with reports [44, 45].

4. Conclusion

The biosynthesis and chemosynthesis of MgO nanoparticles were studied in an aqueous medium using *Datura stramonium* leaves extract for biosynthesis. The prepared biosynthesized nanoparticles of magnesium oxide are established by colour variations, and it has been tested by XRD, SEM, PL, UV-Vis, and antibacterial activity. Its size, approximately 0.17 nm, was definitely by X-ray diffraction analysis. The different peaks confirm the presence of different functional groups and bonding. SEM shows that the biosynthesized nanoparticles had rod-like structure, PL analysis reveals that the prepared material was crystalline, and it has strong peaks at a higher wavelength for the biosynthesis of MgO nanoparticles derived from *Datura stramonium* , and UV-Vis also confirmed this output. The antibacterial activity shows that the biosynthesized nanoparticles show the bacterial activity against Gram-negative *Escherichia coli* and Gram-positive bacteria *Staphylococcus aureus* and bacillus by the paper disc diffusion method and show a good zone of inhibition. Both techniques are promising for the preparations of MgO nanoparticles in antibacterial activity and show the same result. This outcome demonstrates that the biosynthesized nanoparticles originate from having some medicinal uses and are biodegradable.

Data Availability

The data used to support the findings of this study are included within the article.

Disclosure

This study was performed as a part of the employment of the authors (Dambi Dollo University, Ethiopia).

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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