ISSN No:-2456-2165

Antimicrobial Properties and Characterization of Zinc Oxide Nanoparticles Synthesized from Terminalia Mentally Extract of Leaves

[1] Muhammad Waleed Ahmad, [1]Khalil Ullah, [2]Maymoona Shahbaz.
1: University of Education Lahore, Pakistan
1: University of Education Lahore, Pakistan
2: Government College University Faisalabad, Pakistan
Corresponding Author: [1]Khalil Ullah

Abstract:- Nanoparticles made from zinc oxide (ZnO) are finding their way into various consumer and commercial goods. Green production of ZnO nanoparticles from Terminalia, also manually extracted from leaves, is reported here. X-ray diffraction, a scanning electron microscope, and Fourier-transform infrared spectroscopy are used to determine the shape and size of the ZnO nanoparticles generated in this study. The size of the nanoparticles was measured to be between 23 and 216 nm. Zinc oxide nanoparticles were synthesized, and their antibacterial qualities were tested using the healthy diffusion technique against gram-negative Escherichia coli (E. coli) and gram-positive Balantidium. The antibacterial activity of the synthesized ZnO nanoparticle against Balantidium coli and Escherichia coli has been shown. The zone of protection against E-coil gram-negative bacteria expands when treated with ZnO nanoparticles. The current research verifies the green manufacturing of ZnO nanoparticles utilizing extract from Terminalia Mantaly Leaves.

Keywords:- *Nanoparticles, Antimicrobial properties, ZnO, E-coil.*

I. MATERIALS AND METHODS

➢ *Materials*

Department of Botany researchers at Kakatiya University in Warangal identified the Terminalia Mantaly leaves they collected at Venkatapur, Ghatkesar. As established by spectroscopic analysis, the zinc nitrate hexahydrate utilized in this study has a molecular weight of 297.48 g/mol and a purity of better than 90%.

➢ *Method for preparation of leaf extract*

Terminalia mental stems were gathered and cleaned twice in water that had been double-distilled to remove any dirt or dust. These leaves were dried in an oven at 300 k and ground into a fine powder. A 500 ml conical flask is filled halfway with water that has been distilled, and 10 g of powder is added to it [1]. The mixture is then heated to 80 °C and swirled on a magnetic stirrer for an hour. The filter paper from Whitman No. 1 was used to strain the liquid extract of the leaves before it was chilled to 4 degrees Celsius for later use [2].

➢ *Synthesis of Zinc oxide nanoparticles*

Two hours of stirring at 60 °C after adding 3 g of Zinc Nitrate to 30 ml of leaf extract. The resulting paste became yellowish after being cooked in a furnace for two hours at 400 degrees Celsius. In the end, a fine, white powder was produced. The characterization investigations and antibacterial activity necessitated the collection and storage of this [3].

➢ *Characterization techniques*

Scanning electron microscopy (SEM), elemental analysis (EDX), X-ray diffraction (XRD), and Fourier transform infrared spectroscopy (FTIR) were used to investigate the structural features of zinc oxide nanoparticles [4].

II. RESULTS AND DISCUSSION

➢ *Scanning electron microscope (SEM)*

The structure of the microstructure is studied with scanning electron microscopy (type Zeiss EV-18). The scanning electron micrograph revealed that ZnO nanoparticles take on various shapes. These spherical ZnO nanoparticles were also aggregated with other non-spherical ZnO particles. The current SEM also revealed non-spherical ZnO nanoparticles [5]. In the range of 23-216 nm, zinc oxide nanoparticles occupy.

➢ *Energy dispersive X-Ray*

Zeiss EV-18 EDX spectra often show peaks at the X-ray energy levels where the most significant data was collected. These peaks are characteristic of individual atoms and, as such, may be mapped to specific elements. When analyzing a spectrum, for instance, a greater peak intensity indicates a more significant concentration of that element in the sample [6].

ISSN No:-2456-2165

EDX users may determine the types of minerals present in a sample and their relative abundances within the material by using the technique [7].

The presence or absence of elements in a sample may be determined using EDX. Two EDX spectra only exhibit Zn and O peaks, confirming that the Nanoparticle sample comprises zinc oxide nanoparticles. This verifies the sample's purity, which was calculated to be 80.11 wt% Zn and 19.89 wt% O.

- *X Ray diffraction*

Synthesized ZnO NPs X-ray diffraction peak structures were consistent with baseline data (JCPDS card no. 00-036-1451) [8]. The XRD patterns of ZnO nanoparticles produced from Terminalia Mantely leaf extract. All pattern peaks agreed with previously known ZnO peaks. That ZnO has formed is shown here. Particle sizes, (hkl) values, and peak values are all included in Table 1. It can be seen from Table 2 that the particle sizes vary from 13 nm to 27 nm.

Table 1. Shows the size, interplanar spacing, and lattice parameters of zno nanoparticles of the xrd data

No. of Peaks	Planes	Pos. [°2Th.]	FWHM [°2Th.]	Particle Size(nm)	Interplaner spacing (Aº)	Lattice parameter(a) (Aº)	Lattice parameter(c) (Aº)
1	(1 0 1)	31.5887	0.4656	17.88	2.876	3.88	
2	(0 0 1)	34.2887	0.4656	17.66	2.688		5.87
3	(1 0 2)	36.0887	0.4888	17.66	2.487	3.88	5.88
4	(1 0 1)	47.3665	0.8878	17.88	1.776	3.98	5.87
5	(1 01)	56.3776	0.4887	19.66	1.687	3.55	
6	(1 0 2)	62.6787	0.7768	16.88	1.4776	3.87	5.88
7	(2 0 1)	66.0565	0.7766	23.77	1.487	3.98	
8	(1 1 3)	67.6987	0.9776	15.6	1.377	3.87	5.98
9	(2 0 2)	68.9387	0.4887	13.77	1.87	3.44	5.87
10	(0 0 5)	72.4665	0.4776	13.77	1.398		5.98
11	(2 0 1)	76.7895	0.4887	21.77	1.277	3.76	5.87
		Particle average size	15.77 nm				

Table 2. It represents the wave numbers, presence of type of bond and functional group.

S.NO	WAVE NUMBERS		BOND TYPE	FUNCTIONAL GROUP
	Theoretical	practical		
1	3701–3643	3644, 3666,3666,3677, 3688	O H Stretching	ALCOHOLS AND PHENOLS
2	3201–3502	3477,3477	O H STRETCH, H-BOUNDED	ALCOHOLS AND PHENOLS
3	3366–3555	3477	N H stretch	AMINES
4	3366	3266	O H Stretch	CARBOXYLIC ACID

S.NO	WAVE NUMBERS		BOND TYPE	FUNCTIONAL GROUP
	Theoretical	practical		
5	2877–3055	2866	C H Stretch	ALKANES
6	1766–1677	1777	C O stretch	CARBOXYLIC ACID
7	1777–1788	1777	C O stretch,	ESTERS, SATURATED ALIPHATICS
8	1677–1666	1666,1677,1666	C stretch	ALKENES
9	1466–1466	1466	C H BEND	ALKENES
10	1277–1388	1377	N O Symmetric stretch	NITRO COMPOUNDS
11	1077–1277	1077,1166	C N stretch	ALIPHATIC AMINES
12	566–876	888,877	C Cl stretch	ALKYL HALIDES
13	403–677	466,477	C-Halogen	HALOGEN COMPOUND

The Debye-Scherrer formula is used to determine particle size, and the result is given by $D = K\lambda/\beta\cos\theta$ D is the particle's diameter, K is the Debye Scherrer constant (0.98), X-ray intensity (1.54Ao), and scattered angle [9].

Parameters like interplanar distance and the lattice parameters may be calculated from an X-ray diffraction pattern using the formulas n = 2dsin and $\frac{1}{d^2} = \frac{4}{3}\left[\frac{h^2+k^2+hl}{a^2}\right] + \frac{l^2}{c^2}$. Table 1 summarizes these findings.

➢ *Fourier transform infrared spectroscopy* ***(FTIR)***

The functional groups in the sample were analyzed using a model of the FTIR Nicolet 50X microscope. Presented in Fig. 8 is an FTIR spectrum covering the wavelengths 173–4075 cm1 for the ZnO nanoparticles synthesized from the leaves of Terminalia mentally. After comparing the obtained spectral peaks to the documented literature, the various bond modes have been assigned to the peaks [9].

Peaks between 400 and 600 cm1 may verify the existence of metal oxides. The 470 cm1 and 436 cm1 peaks in this FTIR prove that ZnO nanoparticles are present.

III. ANTI-BACTERIAL ACTIVITY

This bactericidal is tested using the healthy diffusion technique on B- coli (gram +) and E-coli (gram -). The first step was to make the culture broth and let it sit at 37 degrees Celsius for the night. You may make nutrient broth and agar using distilled water and an autoclave for 1 hour. The agar medium was mixed with the previously created culture broth and then placed onto the sterilized plates to set [10]. A healthy 6 mm in diameter is drilled onto each plate using a gel puncher. These wells contain a mixture of gram-positive and gram-negative bacteria ranging from 200 g/ml to 800 g/ml, with a 200 g/ml step in between. The plates were incubated for two days at 37 degrees Celsius. Terminalia mantel leaves showed an inhibitory zone for producing ZnO nanoparticles after two days [11].

The findings showed that the suppression zone expands at ever lower concentrations for B-coil gram-positive bacteria. The zone of inhibition against E-coil gram-negative bacteria caused by the produced ZnO nanoparticles ranges from 2 mm to 7 mm for varied doses [12][13].

IV. CONCLUSIONS

For the first time, ZnO nanoparticles were effectively produced utilizing an extract from the leaves of the Terminalia belly mentally plant. Leaf extract from Terminalia was mentally on par with other reported leaf meditative syntheses. The Terminalia mental leaf extract effectively synthesized ZnO particles of the size. This was found using XRD, SEM, EDX, and FTIR characterization examinations of the produced ZnO particles. Nanoparticles made from Terminalia mentally leaf extract were found to have a size distribution (within the margin of error) of between 23 nm and 218 nm. Terminalia mentally leaf extract shows promise as a green alternative for the large-scale production of ZnO nanoparticles. Antibacterial activity against E-coil and B-coil is high in the produced ZnO nanoparticles. In light of the findings and the published literature, Terminalia mentally leaf extract may also be utilized to reduce ZnO particles since this technology is environmentally safe, stable, and requires the least amount of time for manufacturing. Terminalia Mantaly is being used in large-scale ZnO nanoparticle and nanostructure synthesis, and the influence of leaf extract concentration on ZnO nanoparticle size and shape is being studied for future reporting.

REFERENCES

[1]. M. A. Vélez, M. C. Perotti, L. Santiago, A. M. Gennaro, and E. Hynes, "Bioactive compounds delivery using nanotechnology: design and applications in dairy food," in *Nutrient delivery*, Elsevier, 2017, pp. 221–250.

[2]. L. J. Frewer, N. Gupta, S. George, A. R. H. Fischer, E. L. Giles, and D. Coles, "Consumer attitudes towards nanotechnologies applied to food production," *Trends food Sci. Technol.*, vol. 40, no. 2, pp. 211–225, 2014.

[3]. A. K. Hussein, "Applications of nanotechnology to improve the performance of solar collectors–Recent advances and overview," *Renew. Sustain. Energy Rev.*, vol. 62, pp. 767–792, 2016.

[4]. L. Zhang *et al.*, "Preparation and properties of mixed metal oxides based layered double hydroxide as anode materials for dye-sensitized solar cell," *Chem. Eng. J.*, vol. 250, pp. 1–5, 2014.

[5]. M. Rani and S. K. Tripathi, "Fabrication, characterization and photoconducting behaviour of mesoporous ZnO, TiO2 and TiO2/ZnO bilayer system: comparative study," *Energy Environ. Focus*, vol. 2, no. 3, pp. 227–234, 2013.

[6]. S. Iravani, "Green synthesis of metal nanoparticles using plants," *Green Chem.*, vol. 13, no. 10, pp. 2638–2650, 2011.

[7]. N. Bala *et al.*, "Green synthesis of zinc oxide nanoparticles using Hibiscus subdariffa leaf extract: effect of temperature on synthesis, anti-bacterial activity and anti-diabetic activity," *RSC Adv.*, vol. 5, no. 7, pp. 4993–5003, 2015.

[8]. A. Król, P. Pomastowski, K. Rafińska, V. Railean-Plugaru, and B. Buszewski, "Zinc oxide nanoparticles: Synthesis, antiseptic activity and toxicity mechanism," *Adv. Colloid Interface Sci.*, vol. 249, pp. 37–52, 2017.

[9]. X. Wang, J. Lu, M. Xu, and B. Xing, "Sorption of pyrene by regular and nanoscaled metal oxide particles: influence of adsorbed organic matter," *Environ. Sci. Technol.*, vol. 42, no. 19, pp. 7267–7272, 2008.

[10]. A. Kolodziejczak-Radzimska and T. Jesionowski, "Zinc oxide-from synthesis to application: a review. Materials (Basel) 7: 2833–2881." 2014.

[11]. A. C. Janaki, E. Sailatha, and S. Gunasekaran, "Synthesis, characteristics and antimicrobial activity of ZnO nanoparticles," *Spectrochim. Acta Part A Mol. Biomol. Spectrosc.*, vol. 144, pp. 17–22, 2015.

[12]. M. Vaseem, A. Umar, and Y.-B. Hahn, "ZnO nanoparticles: growth, properties, and applications," *Met. oxide nanostructures their Appl.*, vol. 5, no. 1, pp. 10–20, 2010.

[13]. H. Mirzaei and M. Darroudi, "Zinc oxide nanoparticles: Biological synthesis and biomedical applications," *Ceram. Int.*, vol. 43, no. 1, pp. 907–914, 2017.