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Antimicrobacterial Activity of Zinc Oxide Nanoparticles Produced by Chemical Method Against Human Pathogens

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Abstract: In the present research work, synthesis of zinc nanoparticles and its characterization was studied. Zinc nanoparticles were rapidly synthesized by chemical method. The synthesized zinc nanoparticles were characterized by various analytical techniques such as UV visible spectroscopy, XRD and FESEM. X ray diffraction and FESEM analysis confirmed the formation of well dispersed zinc nanoparticles with average particle size that range 10 nm as well as revealed their hexagonal structure. These chemically synthesized nanoparticles were found to exhibit antibacterial activity against different human pathogens. Therefore synthesized zinc nanoparticles were used to study the antimicrobial activity against *Enterococcus fecalis, Shigella dysentriae*, *Staphylococcus aureus, Salmonella paratyphi* by using disc diffusion methods.
Key words: Zinc nanoparticles, XRD, FESEM, *Staphylococcus aureus*, antibacterial activity.

Introduction

Zinc oxide appears as a white powder and is nearly insoluble in water. ZnO is nontoxic and is compatible with human skin making it a suitable additive for textiles and surfaces that come in contact with human body. The increase in surface area of nanoscale ZnO compared to bulk has the potential to improve the efficiency of the material function [1]. Zinc Oxide has proved to be a powerful antibacterial agent in the formulation of the micro scale and nanoscale systems for therapeutic applications. ZnO nanoparticles showed greater antibacterial activity than micro particles. ZnO particles have bactericidal against Gram-positive and Gram-negative bacteria but the exact mechanism of antibacterial activity have not been clearly identified. Antibacterial activity of ZnO nanoparticles depends on the surface area and concentration; if the concentration is higher and the surface area is larger ZnO nanoparticles possess satisfactory antibacterial activity [2]. In the present study ZnO nanoparticles was synthesized by chemical precipitation method and produce white powder nanoparticle was characterized by UV spectral analysis, SEM and X ray diffraction. Further its antimicrobial activity was determined against human pathogens to find out the efficacy of the synthesized nanoparticles.

Experimental Design

Synthesis of Zno Nanoparticles

The ZnO nanoparticles were prepared by wet chemical method using zinc acetate and Sodium hydroxides precursors and soluble starch as a stabilizing agent. Soluble starch (0.5%) was dissolved in 500 ml of distilled water and treated in microwave oven for complete solubilization. Zinc acetate, 0.1 mM was added in the above solution. Then the solution was kept under constant stirring at room temperature using magnetic stirrer for one hour. After complete dissolution of zinc acetate, 0.2 mM, of sodium hydroxide solution was added under constant stirring, drop by drop touching the walls of the vessel. The reaction was allowed to

proceed for 2 hr after complete addition of sodium hydroxide. After the completion of reaction, the solution was allowed to settle for overnight and the supernatant solution was then discarded carefully. The remaining solution was centrifuged at 10,000 rpm for 10 min and the supernatant was discarded. Thus produced nanoparticles were washed three times using distilled water. Washing was carried out to remove the by products and the excessive starch that were bound with the nanoparticles. After washing, the nanoparticles were dried at 80°C for overnight. During drying, complete conversion of Zn (OH) 2 into ZnO takes place [3].

Characterization of Nanoparticles

The nanoparticles synthesized was characterized by UV spectral analysis to find out the absorption range and the size was determined by FESEM analysis and the crystalline nature of the particle was done by X ray diffraction [4].

Antimicrobial activity of Zno Nanoparticles

The antimicrobial activity of Zinc oxide nanoparticles was done by disc diffusion method using Muller Hinton Agar. The pathogenic bacterial culture used were *Staphylococcus aureus, Enterococcus fecalis, Salmonella paratyphi A, Shigella dysentriae.*

Preparation of Inoculums

The above bacteria was inoculated in nutrient broth and kept for incubation at 37°c 2-3hrs and used as inoculum for antimicrobial activity.

Antimicrobial Activity

Muller hinton agar plates was prepared and a lawn culture was made on the sterilized solidified media and a well was made in which ZnO particles was added using micropipette at a concentration ranging from 10-25µl against the human pathogens *Staphylococcus aureus, Enterococcus fecalis, Salmonella paratyphi A, Shigella dysentriae* and kept for incubation at 37°c for 24 hrs and the result were observed along with control plates.

Results and Discussion

Synthesis of ZnO By Wet Chemical Method

Zinc oxide nanoparticles was synthesised by using 0.1mM zinc acetate, 0.1%starch solution and 0.2 mM sodium hydroxide by wet chemical method. The synthesized was white powdery in nature and a satisfactory yield was produced which were in accordance with the Padmavathy, and Vijayaraghavan [3].

Fig. 1 Dried zinc oxide nanoparticles.

Characterization of ZnO Nanoparticles

The dried ZnO nanoparticles (Fig.1) was subjected to various analytical techniques such as UV-Visible spectral analysis, FESEM and XRD. In spectral analysis the distilled water was used as blank and the absorbance of the blank was adjusted to zero further the ZnO nanoparticles were analysed for absorption range. The absorption range was found around 220 nm (Fig.2).

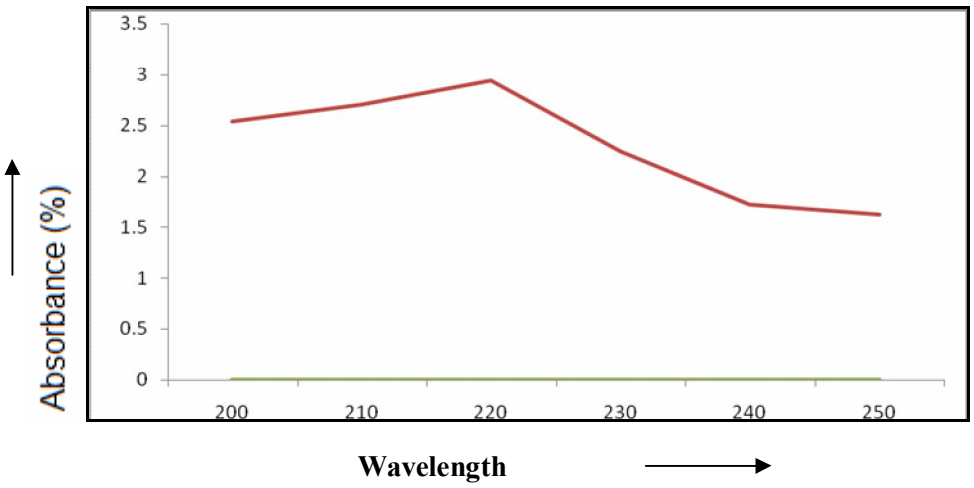


Fig. 2 UV-Vis spectra of the ZnO Nanoparticles

The SEM study of ZnO nanoparticles was done to find out the study of synthesized nanoparticles which was around 10 nm (Fig.3). Further X ray diffraction was done to determine the crystalline nature of ZnO nanoparticle. All the peaks were hexagonal in shape and the peaks were obtained at 32°, 34°, 47°, 57°, 63°, 66°, 73°.indicating the crystalline nature of ZnO Nanoparticles (Fig.4). This was in correlation with work of Shah and Shahry [4].

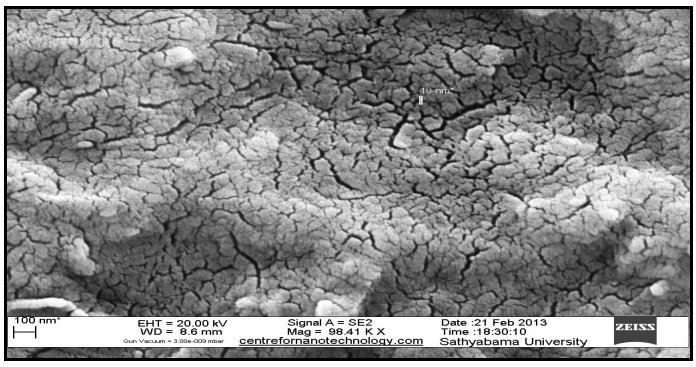


Fig. 3 FESEM image for ZnO Nanoparticles of scale 100nm.

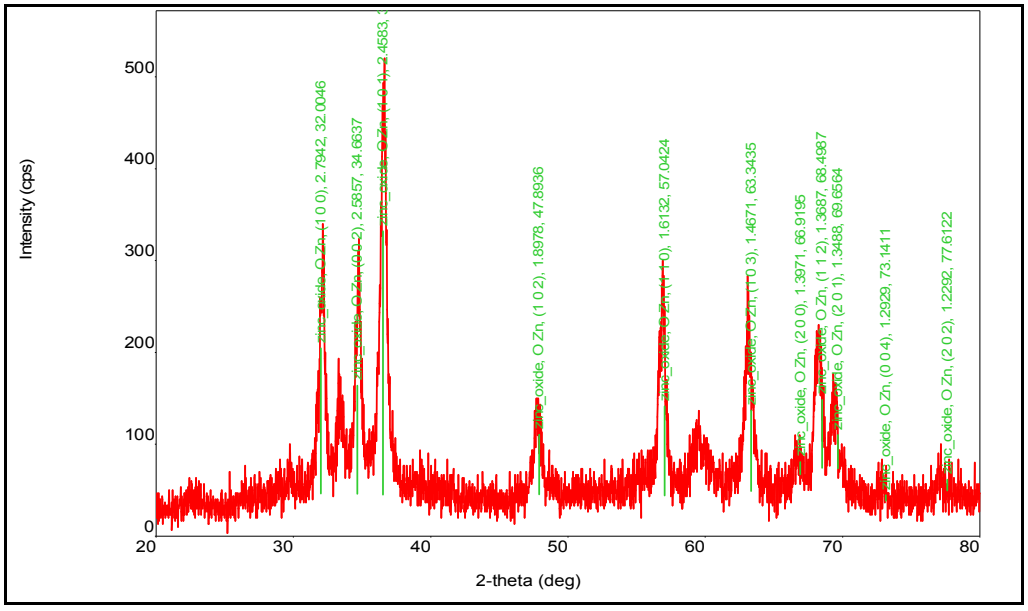
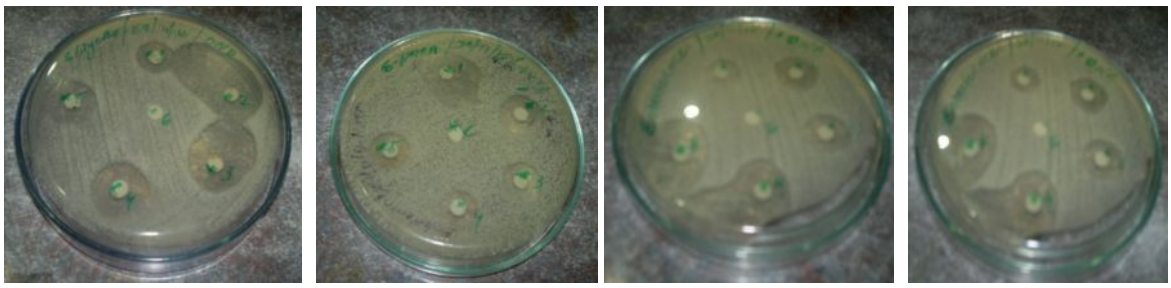


Fig. 4 XRD patterns of ZnO nanoparticles

Antibacterial activity

Zinc oxide nanoparticles bactericidal effect was studied against four different pathogenic bacteria *Staphylococcus aureus, Salmolnella.paratyphi. A, Enterococcus fecalis,* and *Shigella dysentriae* (Fig.5). The synthesized ZnO Nanoparticles shows effective antibacterial activity by disc diffusion method which has inhibited the growth of pathogenic gram positive gram negative bacteria [5].



S. aureus **S.paratyphi. A** **E. fecalis** **S. dysentriae**

Fig. 5 Antibacterial activities of ZnO nanoparticles against test organism.

Table 1. Antibacterial activity of zinc oxide nanoparticles

Test Organism	5µl ZnO	10 µl ZnO	15 µl ZnO	20 µl ZnO	25 µl ZnO	Control
S.aureus	10mm	10mm	11mm	11mm	15mm	0
S. dysentriae	12mm	10mm	10mm	10mm	11mm	0
E. fecalis	9mm	10mm	10mm	10mm	11mm	0
S. paratyphi-A	11mm	11mm	12mm	11mm	12mm	0

Conclusion

From the results it can be summarized that the synthesized zinc nanoparticles shows effective antibacterial activity and it can be used as substitute for antibacterial agents.

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