Synthesis, Characterization and Biological activity of ZnONano particles

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Abstract : In this study, zinc Oxide nanoparticles were promptly synthesized from $Zn(NO_3)_2$solution,and formation of nanoparticles observed within chemical method. characterize zinc oxide nanoparticles using IR,scanning electron microscope (FeSEM),TEM and X-ray diffract meter. Additional its antimicrobial activity against Bacillussubtilisand Escherichia coliis studied.

Key words: Nanoparticles, Zinc oxide,Bacillus subtilis , Escherichia coli.

1. Introduction

The study have conducted with an aim of preparing Zinc Oxide nanoparticles in a short period by using standard laboratory technique.[1-7]Zinc oxide is an inorganic compound. It usually appears as a white powder, which is nearly insoluble in water. Most of ZnO which is used commercially is produced synthetically.[7-10] the chemical method was used followed by controlled and freezing drying processes.Nanomaterials find wide range of applications owing to their exciting physical, chemical and catalytic properties.[11-13]the effect of Zinc Oxide nanoparticles on antibiotics has been studied keeping in mind the fact that ZincOxide nanoparticles have an intrinsic bactericidal effect of their specific.Room temperature chemical method has been adopted for synthesis of ZnO nanoparticles.[14-18]This method has its own advantages such as

(i) Low processing cost

(ii) High yield

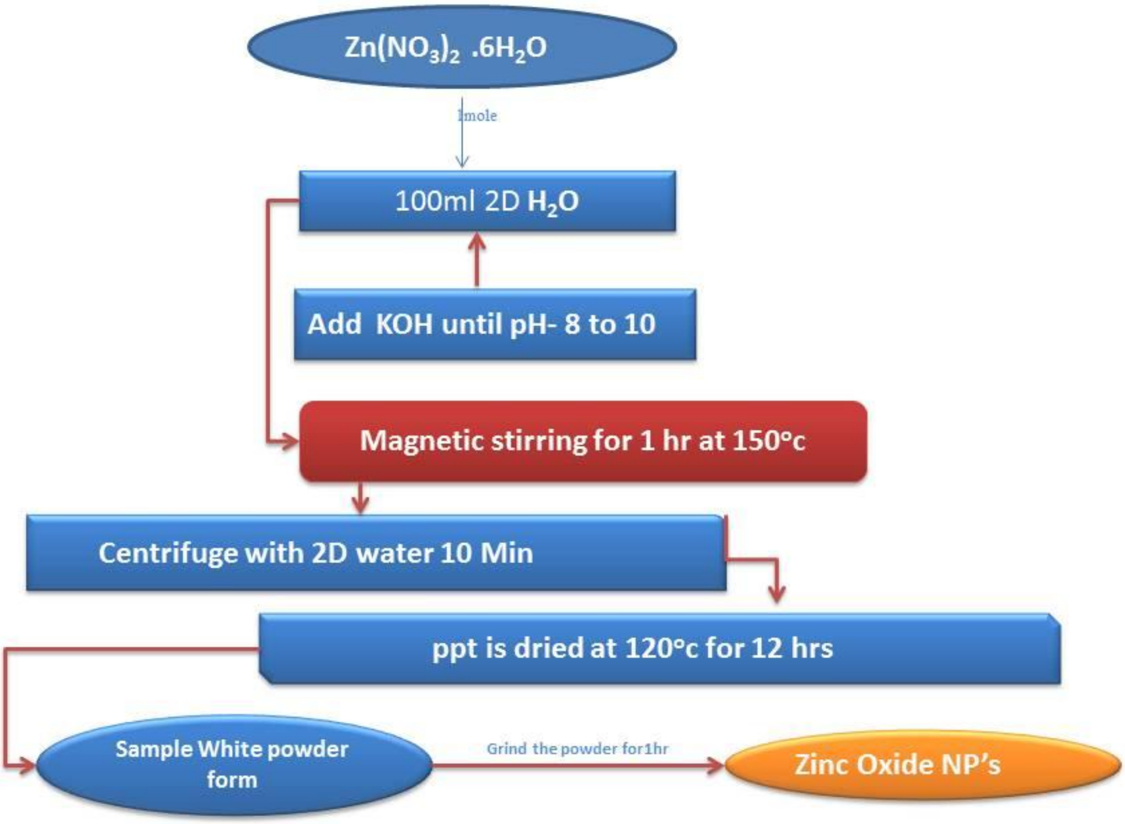
The influence of temperature on structural, materials studied by powder X-ray diffraction, infraredspectroscopy, scanning electron microscopy, TEManalysis. Certain chemicals can interfere directly with the proliferation of microorganisms at concentrations that can be tolerated by the host.[19-22]The antimicrobial activity of zinc oxide nanoparticles is well known.[23-26]Hence we make use of this property to inhibit growth of Bacillus subtitles Escherichia coli using disc diffusion method.ZnOnano NP's tureshave vast applications such, targeted drug delivery, anticancer agents, and antibacterial activity.[27]These two bacterial strains were selected as they are highly contagious; thence we can evaluate the potential antimicrobial activity of zinc oxide nanoparticles.

2. EXPERIMENTAL

2.1Reagents

Chemicals are procured from renowned companies like sigma Aldrich, molychem and used without further purification. Experimental Zinc Nitrate ($Zn(No_3)_2 \cdot 6H_2O$), potassium hydroxide and Double distilled water was used as the solvent throughout the experiment.

2.2 Synthesis of Zinc oxide NP,s



1mole of Zinc Nitrate $Zn(NO_3)_2$was dissolved into 50ml deionized water, and KOH (PH - 3) was dissolved into 50ml deionized water in a 250ml glass beaker with constantly stirring until the solution becomes transparent, respectively. Then, KOH solution was added drop wise into the above solution under ceaselessly magnetic stirring for 1 hr at 150^{o}c. A milky white precipitate appeared at the end of the reaction indicating the formation of Metal Oxide Nano Particles. The precipitate obtained was centrifuged, separated and washed with ethanol several times by a repeated sonication centrifugation process. Finally, the precipitate was dried in a vacuum-air oven at 120^{o}c for 12 hrs.

fig:1 ZnO NP's preparation images

3. Characterization

X-ray diffraction analyses are performed on analytical X"Pert PRO X-ray diffractometer, with a Cu X-ray tube, operating at 40 kV and 40 mA.The specimens are mounted on SEM mounts with carbon tape and sputter-coated with a thin layer of gold.The infrared emission spectroscopy (IES) is carried out on a Nicolet Nexus 870 FTIR spectrometer. The emission spectra are collected at an interval of 50 ºC, over the range 100 ºC – 850 ºC. Further details have been published.the TEM micrograph of ZnO nanoparticles. ZnO particles are composed of randomly oriented spherical grains with an average size of 33nm.[28]Antibiotic susceptibility tests are performed againstB.subtilisE.coli and A.nigerfollowing the protocol for the Agar-well diffusion method[29-31]according to Performance Standards for antimicrobial susceptibility testing.

4. Results and discussion

4.1 Infrared Spectroscopy(FTIR)

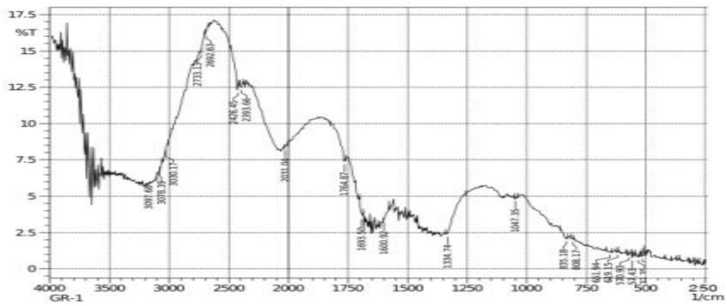


fig:2 Infrared Spectroscopy pattern of ZnO NP’s

4.1 Infrared emission spectroscopy(FTIR)

The solid-state FT-IR spectrum of the complex is fully consistent with their structural data as revealed from the peak appeared at 3230cm indicates the presence of stretching vibration of the O–H group. The absorption peaks observed around 2397cm are assigned to the Co2 mode. The Co2 mode are present in the FTIR spectra due to atmospheric Co2 in the sample. Sample might had been trapped some CO2 from the atmosphere during FTIR characterization which might had given such mode. The strong absorption band at 1764cm is assigned to the C=O stretching. The strong absorption bending of the hydroxyl group at 1334.The absorption band at 570 cm-1 is assigned to the stretching mode of ZnO the peak at 873cm are assigned to the c-o bending vibration**.**

4.2 X-ray diffraction (XRD)

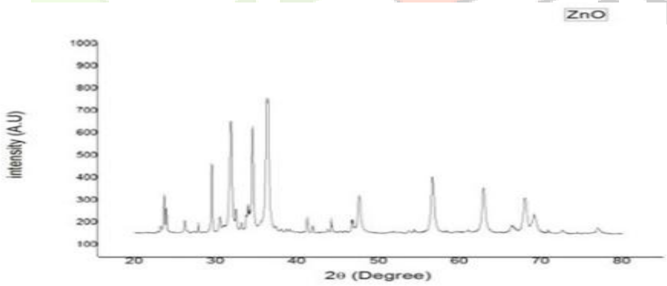


fig:3 X-ray diffraction pattern of ZnO NP’s

Figure3 shows XRD diffraction pattern of ZnO nanoparticles. The peaks are indexed as 23.7º(1188), 30.7º(1342), 33.00º(4680),49.99º(500),55.10º(840) and 65.10º(620), respectively.All diffraction peaks of sample correspond to the characteristic structure of zinc oxide nanoparticles (a=0.315nm and c=0.529nm).This is in agreement with reported literature and the standard pattern of ZnO. Similar, X-ray diffraction pattern are reported by C. Average particle size of ZnO nanoparticles is found to be 76 nm using Scherrer equation37. Diffraction pattern corresponding to impurities are found to be absent. This proves that pure ZnO nanoparticles are synthesized.

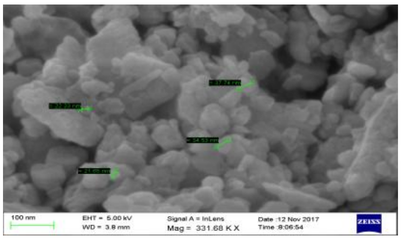


Fig:4 SEM image of ZnO NP'sfig:5 EDS pattern of ZnO NP's

Figure 4 shows the SEM image of ZnO nanoparticles. freshly prepared ZnO chemical was coated and dried at 80℃. The particle size of ZnO nanoparticles prepared via this method was about20-50 nm. We can clearly conclude that ZnO nanoparticles continue to grow after synthesis, even when stored at room temperature.

The SEM image was taken at X331.68 magnification. The image shows ZnO particles are spherical in shape with smooth surface and the size of the particles around 100 nm.

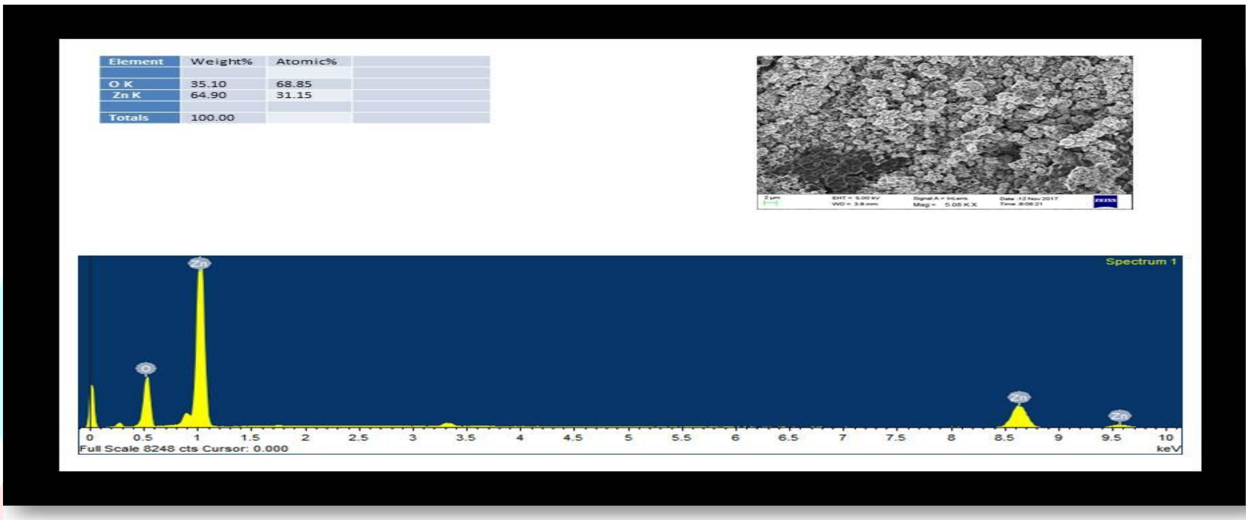


Fig:5 the EDAX image of ZnO NP's

Chemical purity of the samples was tested by EDX. The corresponding EDX spectrum (Figure 5) shows that the ZnO nanoparticles were composed with only Zinc and Oxygen elements, which indicates that the product is high-pure ZnO[17].

4.3 Transmission Electron Microscopy (TEM) Analysis

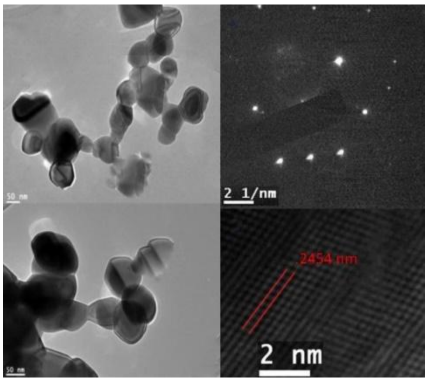


Fig.6TEM analysis of ZnO nanoparticles.

Figure displays TEM micrographs of ZnO NPs obtained from the annealing of Z_1 at 350°C (Z_4,), 600°C (Z_7) for 2 h. TEM images show that the ZnO NPs are spherical shape. It is worth mentioned that the increase in the annealing temperatures *generally* led to the increase of the NPs size. For the sample annealed at 350°C,the average diameter is

24.54 nm. It is worth mentioning that the average crystal diameter obtained from the Scherer's formula (28.33 nm) in good agreement with the value obtained from analysis of transmission electron microscope images. However,for the sample annealed at 600°C,ZnO crystals aggregated into clusters of several hundred nanometers in size, showing large differences from theXRD results. It was reported that the application of Scherer's formula is restricted to small particles (usually smaller than 100 nm) and the above observed large differences reflect the inapplicability of Scherer's equation to large ZnO crystallites.

4.4 Antibacterial activity

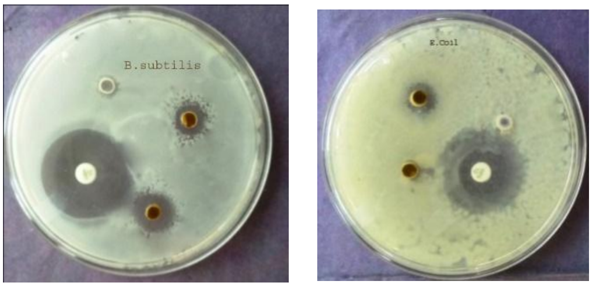


Fig.7 Inhibition zones for complex against.B.subtilisE.coli.

Bacteria	*Inhibition zone (mm)*
E.coli	10
B.subtilis	13

Table. 1 antimicrobial activities of ZnO NP's

The antibacterial activity of ZnO nanoparticles was evaluated by measuring the zone of inhibition against the test organisms. The sizes of the zones of growth inhibition are presented in Table 1.croorganisms used for antimicrobial activity are Bacillus subtilisandEscherichia coli.The antibacterial activity performance of Metal Oxide nanoparticles was done by using disc diffusion methodThe zone of inhibition increases with the increase in Metal oxide nanoparticle concentration and decrease in particle size.

5. Conclusions

The analysis of the experimental data result in the following conclusion:

ZnO nanoparticles have been successfully synthesized by simple chemical method. The preparedZnOnano particles s showed enhanced and synergistic antibacterial activities.ZnO nanoparticles were spherical in shape and characterized using XRD, FT-IR ,SEMand FESEM techniques. The average particle size was found to be 50 nm usingScherrer's equation and 100 nm obtained from SEM measurement for ZnOnano particles dried at120°C.The method has a high yield and can be used for large scale synthesis of ZnOnano particles.[20-25]

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