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GREEN SYNTHESIS OF ZINC NANOPARTICLES AND THEIR ANTIMICROBIAL ACTIVITY AGAINST PATHOGENIC MICROORGANISMS

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Abstract: *Zinc nanoparticles are considered to be very important nanoparticles having effective antibacterial and antifungal properties. Green synthesis of nanoparticles is considered to be more reliable and eco friendly as compared to other mode of synthesis. The main aim of the present study was to synthesize Zn nanoparticles using the aqueous extract of Bambusa tulda leaves and to test their antibacterial and antifungal activity. ZnO nanoparticles were synthesized following standard methods and were characterized by UV/VIS spectroscopy and Scanning Electron Microscopy. The antimicrobial activity was carried out against both Gram positive and Gram negative bacteria viz. Bacillus cereus (MTCC 1305), Escherichia coli (MTCC 10312), Proteus mirabilis (MTCC-3310) Pseudomonas aeruginosa (MTCC-3542) and Staphylococcus aureus (MTCC 87), as well as against the fungus Aspergillus niger (MTCC-9652). The synthesized Zn nanoparticles showed significant antimicrobial activity against both Gram positive and Gram negative bacteria as well as against the fungal strain tested for. Thus from this study it can be concluded that Bambusa tulda leaf extracts can be effectively used for synthesizing Zn nanoparticles which has effective antimicrobial activity. This study also suggests that green synthesized Zn nanoparticles can be used as an alternative to existing antimicrobial agents*

Keywords*: Green synthesis, Nanoparticles, Bambusa tulda and antimicrobial activity.*

Introduction: Nanotechnology is the science of production, manipulation and use of nanomaterials. There are numerous physical and chemical methods for synthesis of nanoparticles but most of these are expensive or use toxic substances due to which they are usually not favored [1]. Plant based production of nanoparticles are preferred over chemical synthesis due to its simplicity, eco-friendliness and extensive antimicrobial activity, non-toxic byproducts and large-scale synthesis [2, 3, 4, 5, 6, 7, 8 & 9]. Zinc oxide (ZnO) nanoparticles are of great importance due to their wide applications. They are known for their antimicrobial, UV blocking, high catalytic and photochemical activities and many more [10]. ZnO nanoparticles are reported to exhibit strong antibacterial activities on a broad spectrum of bacteria [11, 12, &13]. The present study was carried out to synthesize ZnO nanoparticles using the aqueous extract of *Bambusa tulda* leaves and to test their antimicrobial efficacy against some bacterial and fungal pathogens.

Method and Methodology

Fresh leaves of *Bambusa tulda* were collected and washed. Nearly 10 g leaves were boiled with 100ml of distilled water at 60^0 C for about 20 minutes, until the colour of the aqueous solution changes from watery to light yellow. Then the extract was cooled to room temperature and filtered. To this extract, zinc acetate was dissolved and the solution was stirred constantly using magnetic stirrer. Following complete dissolution, the solution was kept under vigorous stirring for about 4-5 hours at about 150^0C. The solution was then cooled at room temperature and the supernatant was discarded (Fig I). The pale white solid product obtained was washed and dried at 80 ^{0} C for 7–8 hours [14]. Characterization was carried out by taking the absorbance in the range of 300-500 nm using the UV/VIS spectrophotometer and finally by SEM analysis.

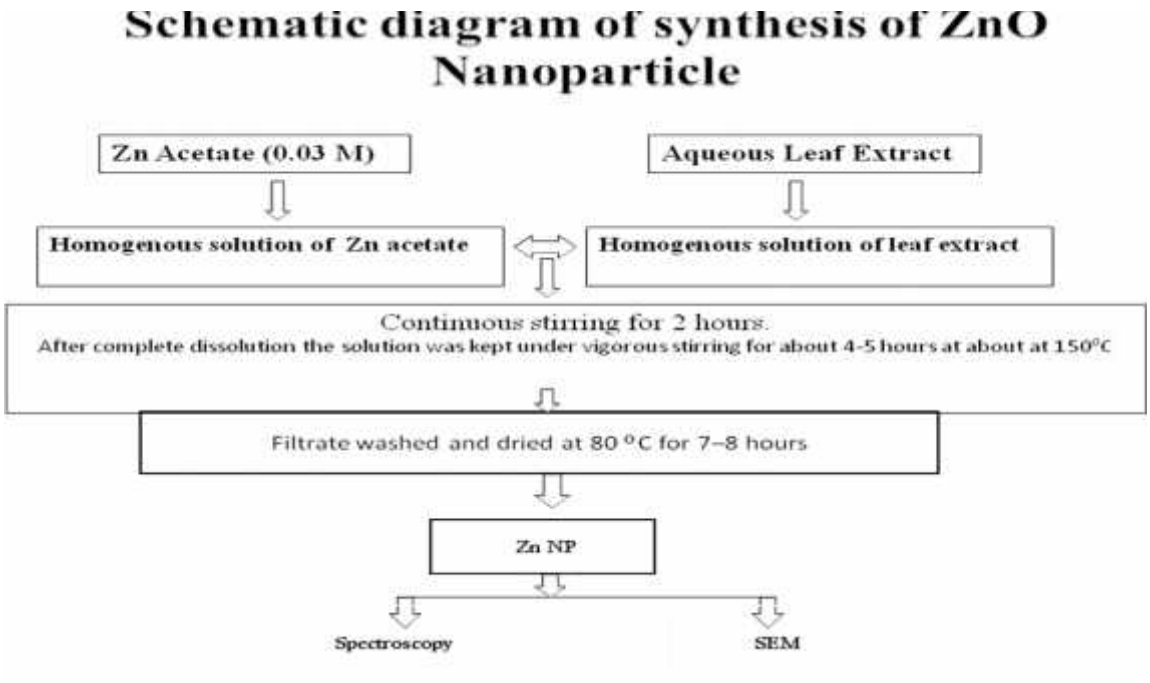

Fig I: Schematic diagram showing synthesis of ZnO Nanoparticles.

Antimicrobial activity was tested by Agar well Diffusion method [15] against some selected microbes. Test organisms were procured from Microbial Type Culture Collection and Gene bank (IMTECH, Chandigarh, India). The antimicrobial activity was carried out against both Gram positive and Gram negative bacteria viz. *Bacillus cereus* (MTCC 1305), *Escherichia coli* (MTCC 10312), *Proteus mirabilis* (MTCC-3310) *Pseudomonas aeruginosa* (MTCC-3542) and *Staphylococcus aureus* (MTCC 87), as well as against the fungus *Aspergillus niger* (MTCC-9652). Two antibiotics, Ampicillin and Cefotaxime were used as positive control and Zinc acetate solution was taken as negative control. Diameter of the zone of inhibition was measured in mm and expressed as Mean ± Standard Deviation.

Results and Discussion

UV spectroscopy and Scanning Electron Microscopic analysis confirmed the synthesis of nanoparticles. ZnO nanoparticle showed significant antimicrobial activity against both Gram positive and Gram negative bacteria as well as against the fungal strain tested for. The results were expressed in terms of zone of inhibition in mm ± Standard Deviation (Table I). The maximum zone of inhibition was found against *Pseudomonas aeruginosa* (31 ± 0.100) where as the minimum against *Bacillus cereus* (16 ± 0.231). The antimicrobial activity of Zn Nanoparticle was compared with the standard antibiotics ampicillin and cefotaxime (60 g/ml). ZnO nanoparticles were shown to have higher antimicrobial activity in comparison to the standard drugs against *Escherichia coli, Pseudomonas aeruginosa* and *Proteus mirabilis. Pseudomonas aeruginosa* and *Aspergillus niger* showed no zone of inhibition against Ampicillin (60 µg/ml). Several other studies have also confirmed the antimicrobial activity of ZnO nanoparticles against pathogens like *Bacillus subtilis, Escherichia coli Pseudomonas fluorescens Salmonella typhimurium, Salmonella enteritidis, Staphylococcus aureus* and *Listeria monocytogenes* [16&17]. Thus from this study it can be suggests that *Bambusa tulda* mediated synthesized ZnO nanoparticles can be effectively used as an alternative to existing antimicrobial agents.

Table I: Antimicrobial activity of the Zn nanoparticle against selected microbes.

S.N.	Name of the microorganism	Zone of inhibition in mm ± SD			
		ZnO Nanoparticle	Zn Acetate Solution	Ampicillin 60 µg/ml	Cefotaxime 60 µg/ml
1	*Staphylococcus aureus*	23 ± 0.312	-	25 ± 0.383	24 ± 0.231
2	*Escherichia coli*	30 ± 0.050	-	17 ± 0.058	11 ± 0.058
3	*Pseudomonas aeruginosa*	31 ± 0.100	-	-	21 ± 0.100
4	*Proteus mirabilis*	30 ± 0.100	-	20 ± 0.141	13 ± 0.071
5	*Bacillus cereus*	16 ± 0.231	0.9±0.050	26 ± 0.435	28 ± 0.289
6	*Aspergillus niger*	26 ± 0 .228	0.6 ±0.100	-	28 ± 0.354

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