

NANOPARTICLE COATED BANDAGE CLOTH - ANTIMICROBIAL ACTIVITY

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ABSTRACT

Nanoparticles are multifunctional inorganic compounds which are used in several applications. The interaction of biomaterials with metal ions leads to formation of metal nanoparticles with controlled size, shape and surface chemistry. Biosynthesized nanoparticles are safe and possessing more antimicrobial activity. Today post operation infections are most common. Infections after surgery are caused by microorganisms. The most common of these include *Staphylococcus aureus*, *Streptococcus* and *Pseudomonas aeruginosa*. Nanoparticle coated bandage cloths may reduce the causes and risk factors of surgical site infections. Here we report a method using Green Nanotechnology for the preparation, characterization and antimicrobial activity of nanoparticle coated bandage cloths. We synthesized zinc oxide nanoparticles using a shrub, *Nyctanthes arbor-tristis* flower extract which belongs to Oleaceae family and distributed throughout India in most places.

KEYWORDS: Bandage cloth, Post-operative infections, *Staphylococcus*, *Streptococcus*, *Pseudomonas*.

INTRODUCTION

Nanotechnology is a multidisciplinary scientific field which is growing rapidly and so called as “a wonder of modern medicine” (R. Sharmila Devi and R. Gayathri, 2014; Sangeetha Gunalan et al., 2012). Bionanotechnology is the combination of biotechnology and nanotechnology which deals with developing biosynthetic and ecofriendly synthesis of nanomaterials (Patil Rajesh, Talekar Dhanashree, 2012). Zinc oxide is a wide band gap (3.37eV) II-VI semiconductor which possessing natural n-type electrical conductivity and is non-toxic (K. Chitra and G. Annadurai, 2013; Wellings et al., 2007).

Zinc oxide is one of the most important functional materials as it has unique properties like UV emission is near, optical transparency, electric conductivity (M. G. Ma et al., 2008). Zinc oxide nanoparticles have large volume to ratio of area and high UV absorption (Brajesh Kumar et al., 2014) which can be utilized in industries like cosmetics and pharmaceuticals (J. W. Rasmussen et al., 2010), UV emitting devices (S. J. Yang and C. R. Park, 2008), solar cells (W. J. E. Beek et al., 2004), gas sensors (E. R. Waclawik et al., 2012; P. Rai and Y. T. Yu, 2012) etc.

In the present study ZnO nanoparticles were synthesized and stabilized by *Nyctanthes arbor-tristis* flower and the

characterization of nanoparticles were done by UV-Visible Spectroscopy, Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), Fourier Transmission Infrared Spectroscopy (FTIR) and Transmission Electron Microscopy (TEM). Synthesized nanoparticles were coated on Bandage (gauge) cloth using dip and dry method and antimicrobial assays were performed on nanoparticle coated bandage cloth.

EXPERIMENTAL METHODS

Plant Material

Nyctanthes arbor-tristis flower extract which belongs to Oleaceae family was prepared by thoroughly washed 250 gms of flowers, grinded with 500 ml of distilled water and filtered the extract using muslin cloth. The aqueous orange color flower extract was stored in the refrigerator and used for synthesis of nanoparticles.

Synthesis of ZnO nanoparticles

ZnO nanoparticles were prepared using 1 mM ZnSO₄.7H₂O aqueous solution. In the preparation, 3 ml of flower extract of *Nyctanthes arbor-tristis* was added to 10 ml of 1 mM ZnSO₄.7H₂O aqueous solution. The mixture was stirred for 2 hours at 80°C and kept for observation up to occurrence of color change; the color change from orange to reddish brown was the identification for the formation of ZnO nanoparticles. The resulting ZnO nanoparticles were separated by

centrifugation at 6000 rpm for 15 minutes and washed with distilled water for 4 times. The resulting particles were dried in a hot air oven at 120°C for 1 hour. The dried nanoparticles were stored for further characterization and antimicrobial assays.

Characterization

UV-VIS spectra analysis: UV-Vis spectroscopy was used to characterize the optical absorption properties of ZnO. The UV-Vis absorption spectra of the samples were recorded in the wavelength range of 200 to 800nm using a UV-2400PC Series UV-Vis spectrophotometer.

Scanning Electron Microscopy (SEM): SEM analysis was done using JSM-6610 SEM machine. Thin films of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the samples on the grid and then the film on the SEM grid were allowed to dry by putting it under a mercury lamp for 5 minutes.

Energy Dispersive Spectroscopy (EDS): EDS analysis was done using JSM-6610 SEM instrument equipped with a Thermo EDS attachment. The plant extracts reduced zinc oxide nanoparticles were dried and small amount of sample coated on to carbon film and performed.

Fourier Transform Infrared Spectroscopy (FTIR): FTIR analysis was performed to identify the possible functional groups involved in the synthesis of ZnO nanoparticles. Infrared spectra were measured at the wavelength in the range of 1000-4000.

Transmission Electron Microscopy (TEM): TEM analysis was done using TEM instrument JEOL 1200 EX operating at 120kv voltage. Thin film of the sample were prepared on a carbon coated grid by dropping a very small amount of the sample on the grid, extra solution was removed using a blotting paper. Later on, film on the TEM grid was allowed to dry by placing it under a mercury lamp for 5 minutes for the characterization of size and shape of synthesized silver nanoparticles (D Sarvamangala et al., 2014).

Antibacterial Assays: The antibacterial assays were done on human pathogenic bacteria like *Staphylococcus aureus* (gram +ve), *Streptococcus* (gram +ve) and *Pseudomonas aeruginosa* (gram -ve) by the Mueller Hinton (MH) agar plate – method, fresh overnight cultures are used for inoculating ZnO nanoparticles.

1 µl and 2 µl of the content were inoculated on the MH agar plates. To check the antibacterial activity of the fabrics, the bandage cloths (fabrics treated with ZnO nanoparticles) were gently pressed in the center of the cultures. The absence of growth on the plates confirmed antibacterial activity. The minimum inhibitory concentration (MIC) of ZnONPs was determined and the zone of inhibition was measured after 24-28h.

RESULTS AND DISCUSSION

UV-VIS Spectral analysis confirms the formation of ZnO nanoparticles in the reaction mixture. The prepared ZnO nanoparticles exhibit an absorbance peak at 258 nm. Figure 1 shows the morphology of ZnO nanoparticles synthesized by *Nyctanthes arbor-tristis* flower extract by SEM analysis. The larger ZnO nanoparticles may be due to the aggregation of smaller ones. The EDS confirms the presence of elemental zinc and oxygen in the Figure 2. FTIR spectra provide information about the possible functional groups and local molecular environment. Different peaks were observed at different stretches of bonds in the Figure 3. Peaks at 3424.97 and 2906.21 are may be due to OH stretching and aldehydic C-H stretching. 1632.71 and 1024.17 peaks are due to C-C stretching and C-O stretching. TEM photographs confirm the shape as round and size in the range between 17.74 nm to 22.78 nm (Figure 4). Zinc Oxide nanoparticles exhibited antibacterial properties against bacterial pathogens such as *Staphylococcus aureus* with 32 mm zone of inhibition, *Streptococcus aeruginosa* with 35 mm zone of inhibition and *Pseudomonas aeruginosa* with 29 mm zone of inhibition (Figure 5) by close attachment of the nanoparticles with the microbial cells (D Sarvamangala et al., 2013).

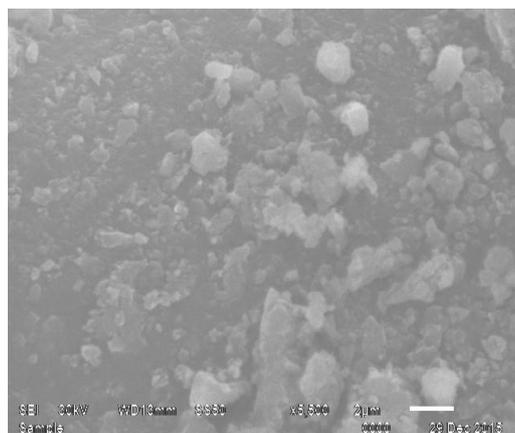


Fig. 1: Sem Analysis.

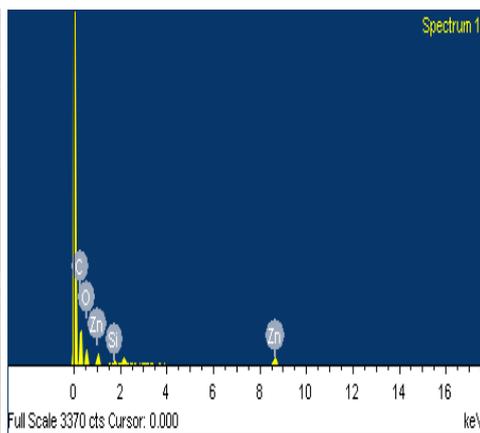
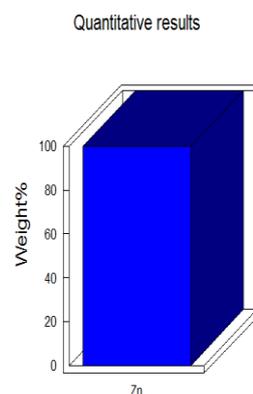


Fig. 2. Eds Analysis.



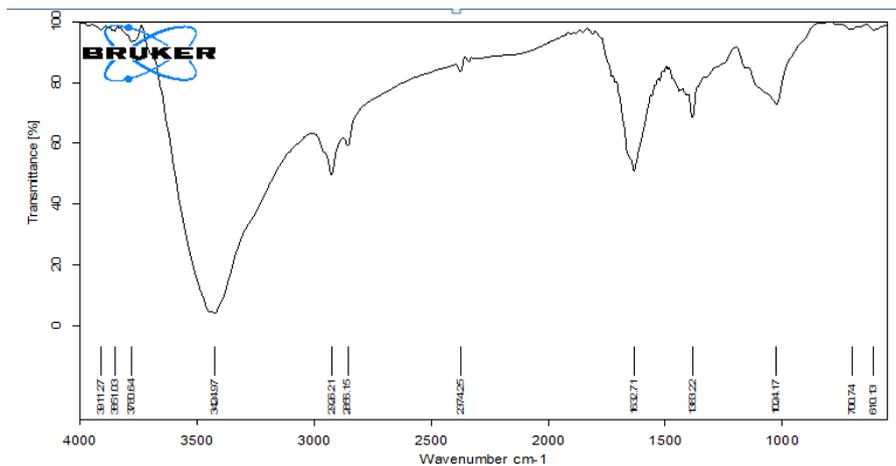


Fig. 4: Ftir Analysis for *Nyctanthes Arbor Tristis* flower zinc oxide nanoparticles.

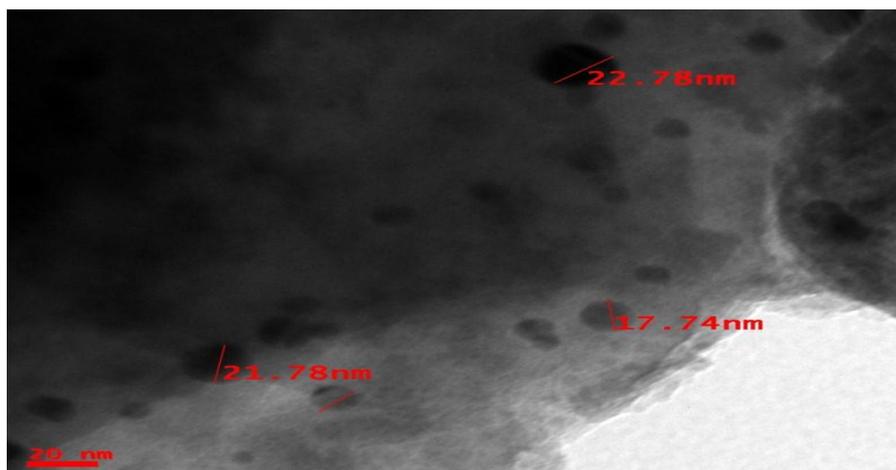


Fig. 4: Tem Analysis.

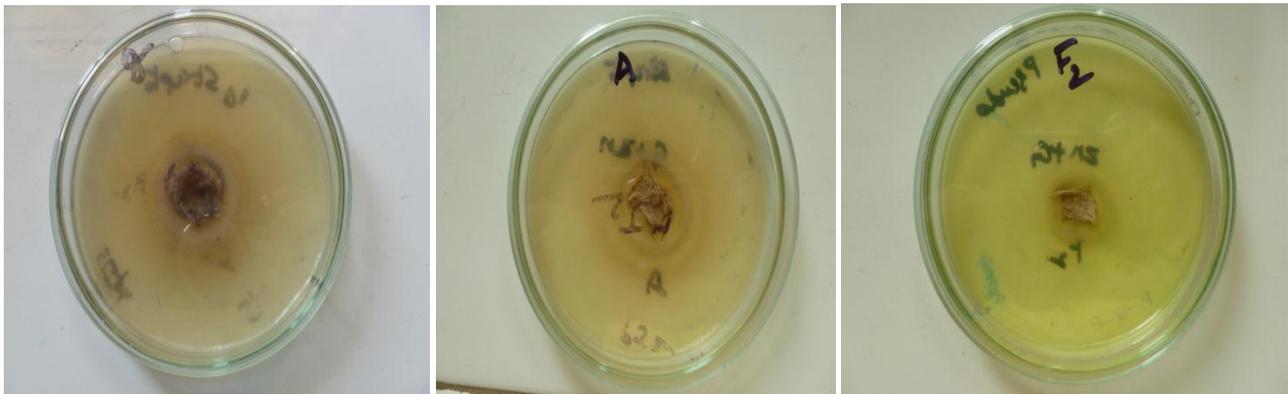


Fig. 5: *Staphylococcus aureus*, *Streptococcus aeruginosa*, *Pseudomonas aeruginosa* disc inserted with ZnO nanoparticle coated bandage cloth.

CONCLUSION

Our investigation reveals, the bio reduction of aqueous Zn ions by the flower extract of a shrub *NYCTANTHES ARBOR TRISTIS* flower has been demonstrated. The reduction of the metal ions through the flower extracts leading to the formation of ZnO nanoparticles of fairly well – defined dimensions. This green chemistry approach toward the synthesis of zinc nanoparticles has many advantages. Applications of such eco- friendly nanoparticles in bactericidal, wound healing and other

medical and electronic applications make this method potentially exciting for the large- scale synthesis of other inorganic materials (nanoparticles).

The characterizations from UV-Vis support the stability of the biosynthesized nanoparticles. The SEM analysis reveals the morphology, crystalline shape and surface area. The EDS analysis strongly suggests the formation of ZnO nanoparticles. TEM images of ZnO nanoparticles exhibit Round shape, image of ZnO nanoparticles

average size in the range of 17.74 nm - 22.78 nm (Harish Kumar and Renu Rani, 2013). The Zinc Oxide nanoparticles using plant flower extract proved excellent antimicrobial activity. The ZnO nanoparticles have been synthesized using this *Nyctanthes arbor-tristis* flower extract shown great zone of inhibition.

✓ ZnO nanoparticles coated bandage cloth may help for burnt people in Re-Epithelization, reduces inflammation, and increases antimicrobial and antiviral activity.

✓ According to the *American Cancer Society*, UV rays can weaken the immune system, making it harder for the body to fend off wound infections.

✓ Basic wound dressings such as gauze can also be effective at covering the affected area and protecting it from UVA and UVB rays.

✓ Nanoparticle (ZnO) coated gauze or bandage cloth will be more effective in all ways for the burnt, injured, bedridden people in wound healing.

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