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A Comparative Study of Chitosan-Zinc Oxide Nanocomposite and its Fabrication with Herb

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Abstract: ***The current study reports the synthesis of chitosan-zinc oxide nanocomposite and its fabrication with herb Cyanodon Dactylon. The synthesised nanocomposites were characterised by UV, FTIR and SEM studies. The antibacterial activity of the nanocomposites was determined by Agar well diffusion method. The synthesised composite showed enhanced activity against E. coli and S. aureus. The SEM studies proved the embedded zinc-oxide nanoparticle in composite and the size of the particles was found to be less than 100 nm.***

Keywords: chitosan,Cyanodon Dactylon, UV, FTIR, SEM, AgarWell diffusion method,*E. coli, S.* aureus

1. Introduction

The bionanocomposites are composite materials that contain biological origin and particles with at least one dimension in the range of 1-100 nm **[1]**. The present work involves the synthesis of a novel, ecofriendly, bioactive, antimicrobial bionanocomposite using chitosan, zinc oxide nanoparticles and herb *Cyanodon Dactylon*.

Chitin is the second abundant natural polysaccharide after cellulose. It is composed of (1-4) linked 2-acetamido-2-deoxy-β-D-glucose. It is found in exoskeleton of crustaceans, cuticles of insects and cell walls of fungi **[2]**. Chitosan is obtained by deacetylation of chitin **[3]**. It is a linear polymer consisting of (1-4) lined 2-amino-2-deoxy-D-glucose. Chitosan has unique properties such as biocompatibility, biodegradability and antibacterial activity **[4]**. Chitosan has considerable antibacterial activity against both Gram-negative and Gram-positive bacteria **[5]**. Low toxicity, biocompatibility and biodegradability make zinc oxide a material of interest for biomedicine and in pro-ecological systems. Nano zinc oxide due to its nano size, optical, chemical, biological and pharmaceutical properties, is used in biomedical applications**[6]**. The botanical name of Bermuda grass is *Cyanodon Dactylon*. In Tamil language, it is known as Arugumpul. *Cyanodon Dactylon* have been used in folk medicine as anti-inflammatory, ant cystitis, anti-hypertensive, anti-viral, anti-hysteria, anti-gonorrheal infections**[7].** Ethanol, methanol and acetone extracts of *Cyanodon Dactylon* showed wide range of antibacterial activity and can be used and administered in the ethnomedical practice **[8]**.

2. Experimental

2.1 Materials

Acetic acid, Polyvinyl Alcohol, Zinc nitrate, Glutaraldehyde and Sodium hydroxide were purchased from Nice Company and were in analytical grade.

2.2 Synthesis of chitosan

Chitosan was extracted from crab shells using HCl and NaOH**[9]**. Degree of deacetylation (DDA) of extracted chitosan was determined by UV Spectroscopy method. Chitosan (60% DDA), represented as C_2, in the present study, was selected for the synthesis of nanocomposites.

2.3 Synthesis of zinc oxide nanoparticles

Zinc oxide nanoparticles were prepared from zinc nitrate, sodium hydroxide using wet chemical method**[10].**

2.4 Collection, processing and extraction of herb

Cyanodon Dactylon, which is represented as H_2 in this study, was collected in and around Chennai. The leaves were shaded dried and then powdered and sieved. 20 grams of herbal powder was suspended 100 ml of methanol and incubated for overnight. The supernatant liquid was filtered using whatman No. 1 filter paper.

2.5 Synthesis of chitosan zinc oxide nanocomposite

Zinc oxide nanoparticle prepared was added into 50 ml of 1% chitosan solution and 50 ml of PVA solution. The obtained solution was stirred for one hour at 60^{o}C. To this solution 2% glutaraldehydewas added and transferred into glass plates. The synthesised nanocomposite is labelled as C_2Z

2.6 Fabrication of Cyanodon Dactylonover zinc oxide nanocomposite

Herb was loaded over chitosan zinc oxide nanocomposite film by swelling method. For loading of herbs, the film was allowed to swell in 50 ml of herbal solution for 24 hours at 25^{o}C.Zinc oxide nanocomposite loaded with *Cyanodon Dactylon*herb is labelled as C_2ZH_2.

3. Characterization

The synthesisedchitosan-zinc oxide nanocomposites (C_2Z) and herb loaded chitosan-zinc oxide nanocomposites (C_2ZH_2)were characterised by UV visible spectrometer of the model SHIMADZU UV 1650 PC and FTIR spectroscopy using IR affinity 1 model of SHIMADZU IR 1650 PC.Morphology of the composites were observed by FESEM through DST nano emission model. The antibacterial activity against *E. coli* and *S. aureus*of the composites was determined by Agar Well diffusion method.

4. Results and Discussion

4.1 UV Visible Spectral Analysis

UV spectrum of chitosan-zinc oxide and chitosan zinc oxide nanocomposite fabricated with herb are shown in **Fig.1** and **Fig. 2**

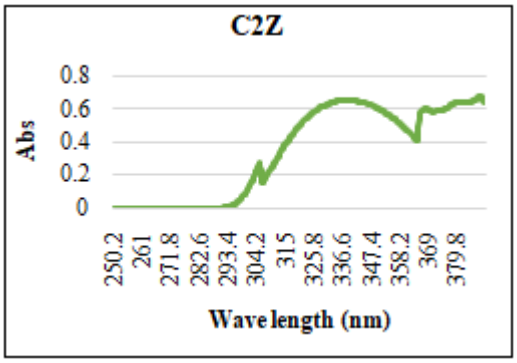

Figure 1: UV spectrum of C_2Z

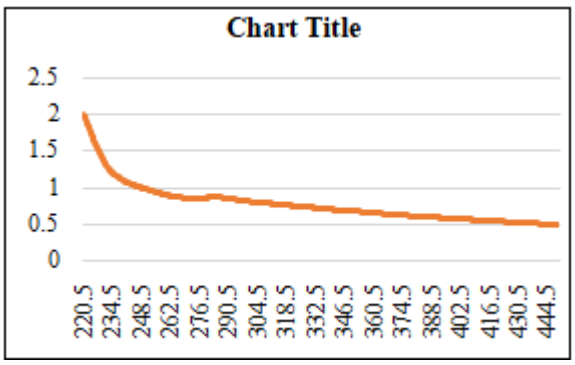

Figure 2: UV spectrum of C_2ZH_2

UV absorption spectrum of C_2Z and C_2ZH_2 are given in fig. 1 and 2. Nanocomposite C2Z showed absorption maximum at 340 nm and nanocomposite C_2ZH_2 showed maximum at 291 nm. The shifting of the peak clearly indicates the fabrication of herb on C_2Z.

4.2 FTIR Spectrum

Chitosan shows absorption peak at 3405$cm^{-1}$and 3280cm^{-1}. This is due to the OH and NH_2 group stretching vibration**.** In chitosan-zinc oxide nanocomposite(C_2Z), the peak due to OH and NH_2 group stretching vibration shifted to 3326 $cm^{-1}$and 2928 cm^{-1}which indicated the strong interaction between these groups and ZnO **[11]**. The C=O stretching band moved from 1672 cm^{-1} to 1644 cm^{-1}. New absorption peak at 650 $cm^{-1}$is due to the attachment of amide group with zinc oxide **[12].**

In chitosan zinc oxide nanocomposite fabricated with *Cyanodon Dactylon*(C_2ZH_2), the OH and NH stretching band of chitosan shifted to 3450 cm^{-1} and 2925cm^{-1}. The C=O stretching band of chitosan moved to 1654 cm^{-1}.New absorption peak is found at 441 cm^{-1}, 527 cm^{-1} for C_2ZH_2which are due to the attachment of amide group and stretching mode of ZnO.The shifting of peaks clearly indicates the fabrication of herb on chitosan zinc oxide nanocomposite. FTIR spectra of chitosan, chitosan-zinc oxide nanocomposite(C_2Z) and chitosan-zinc oxide nanocomposite fabricated with herb(C_2ZH_2) are shown in **Fig. 3, Fig. 4** and **Fig. 5** respectively.

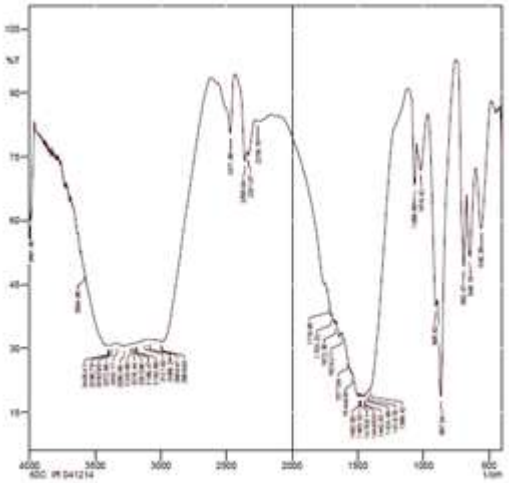

Figure 3: FTIR spectrum of chitosan

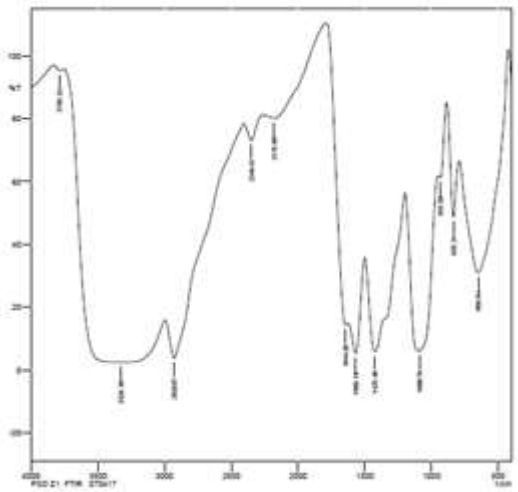

Figure 4: FTIR spectrum of C_2Z

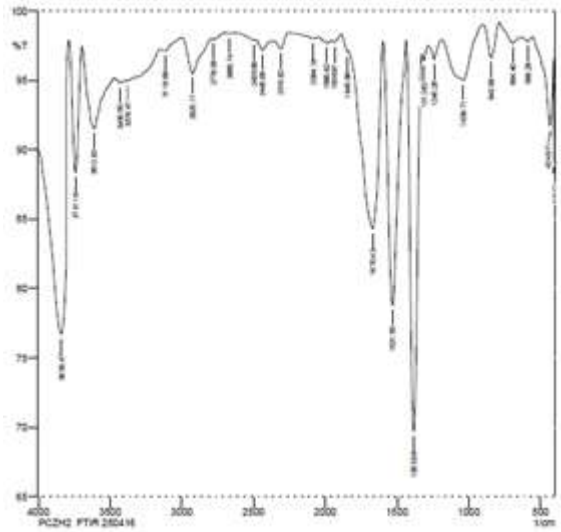

Figure 5: FTIR spectrum of C_2ZH_2

4.3 SEM Analysis

Morphological study of synthesized chitosan zinc oxide nanocomposite(C_2Z) and chitosan zinc oxide nanocomposite fabricated with herb(C_2ZH_2)were carried out with field emission scanning electron microscope (FESEM). **Fig. 6 and Fig. 7**shows the SEM images of the composites C_2Z and C_2ZH_2respectively. It was observed that the size of the zinc oxide nanoparticles was less than 100 nm. SEM image of C_2ZH_2(**Fig. 7**) clearly shows the fabrication of herb into C_2Z.

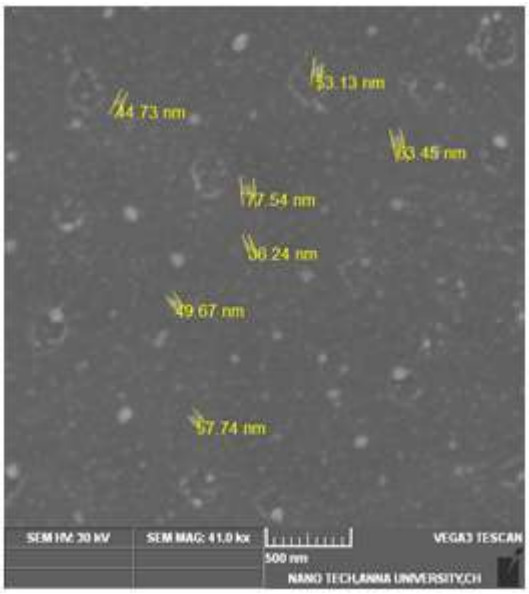

Figure 6: SEM image of C_2Z

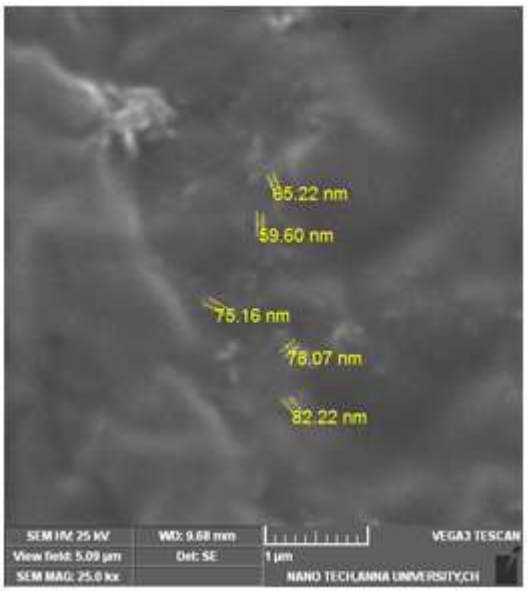

Figure 7: SEM image of C_2ZH_2

4.4 Antibacterial activity

The antibacterial activity of chitosan zinc oxide nanocomposite(C_2Z) and chitosan zinc oxide nanocomposite fabricated with herb(C_2ZH_2) wasdetermined by Agar Well diffusion method. The antibacterial activity of the nanocomposites was tested against *E. coli* and *S. aureus*. The antibacterial activity was measured based on the diameter of zone of inhibition in mm and the values are given in **Table 1**.It was observed that fabrication of herb into chitosan zinc oxide nanocomposite influences the antibacterial efficiency and showed enormous growth inhibition against *E. coli* and *S. aureus.* Hence, to improve the therapeutic efficacy of chitosan zinc oxide nanocomposite as antimicrobial agent, herb was fabricated into chitosan zinc oxide nanocomposite. The enhanced activity is due to the synergistic effect of chitosan, zinc oxide nanoparticles and herb.

Table 1: Antibacterial activity of CZ and CZH

S. No.	Sample	Zone of inhibition (mm)	
		E. coli	*S. aureus*
1	Standard (Methicillin)	11	16
2	C_2Z	13	14
3	C_2ZH_2	24	33

5. Conclusion

In the current work chitosan zinc oxide nanocomposite was synthesised (C_2Z). To improve the antibacterial activity of the nanocomposite, *Cyanodon Dactylon*was fabricated into the nanocomposite (C_2ZH_2). The synthesised nanocomposites C_2Z, C_2ZH_2 were characterised by UV, FTIR and SEM studies. SEM studies prove the presence of zinc oxide nanoparticles in the chitosan matrix. The size of the zinc oxide nanoparticles in C_2Z and C_2ZH_2 was found to be 50-100 nm. Antibacterial activity of these nanocomposites was determined by Agar well diffusion method. The antibacterial activity was enhanced by adding *Cyanodon Dactylon*to chitosan zinc oxide nanocomposite

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