



SYNTHESIS AND CHARACTERISATION OF HERB FABRICATED CHITOSAN-SILVEROXIDE NANOCOMPOSITES

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ABSTRACT

This research work explains the synthesis of chitosan-silver oxide nanocomposite and medicinal herb were loaded by swelling method. The synthesised nanocomposites were characterised by UV-VIS, FTIR spectroscopy. The scanning electron microscope (SEM) results showed that particles were spherical in the size range of 50-100 nm. The antibacterial activity of the nanocomposites was assessed by agar well diffusion method. Our studies proved that the chitosan as biomaterial based nanocomposites containing silver oxide has an excellent antibacterial activity.

Keywords: Chitosan, herbs, UV, FTIR, SEM, Agar well diffusion method

INTRODUCTION

Chitosan [β -(1,4)-2- amino-2 deoxy – D-glucose] is a second abundant natural polymer with unique features such as biocompatibility, biodegradability and antibacterial properties. Chitosan is obtained by deacetylation of chitin isolated from crustacean shells. Chitosan has great potential applications in areas such as biotechnology, biomedicine, agriculture, cosmetics and food technology [1]. It is a biopolymer that is known to accelerate the healing of wounds [2]. It has been reported as chitosan possesses a considerable antibacterial activity against a broad spectrum of bacteria [3,4].

Silver containing materials have been proved as effective antimicrobial agents. Both ionic and metal silver exhibit antimicrobial activities [5,6]. The antibacterial action of silver nanoparticles might be due to the release of Ag^+ [7,8]. Silver nanoparticles not only have antibacterial activity but also have wound healing property. It can restore burnt skin to normal skin[9]. By incorporating silver oxide nanoparticles, antibacterial activity of chitosan can be enhanced[10]. The antibacterial activity of chitosan-silver oxide is further increased by fabricating medicinal herb by swelling method.

Based on the medicinal importance three herbs were selected namely Naringicerunulata (mahavilvam in Tamil), Cyanodon dactylon (Arugampul in Tamil) and Cardiospermum halicababem (Mudakkathan in Tamil). The current work deals with the synthesis and characterisation of chitosan-silver oxide nanocomposites loaded with the above mentioned herbs. Synthesis of chitosan-silver oxide nanocomposites fabricated with herbs was confirmed by various characterisation technique i.e., UV, FTIR, SEM. The ultimate aim of the work was to study the antibacterial activity of the synthesised nanocomposites. The nanocomposites showed significant antibacterial activity against E.Coli and S.Aureus.

EXPERIMENTAL MATERIALS

Sodium hydroxide, acetic acid, polyvinyl alcohol, silver nitrate and polyethylene glycol were purchased from NICE Company and were in analytical grade.

Synthesis of chitosan

Chitosan was extracted from crab shells using HCl and NaOH [11]. Degree of deacetylation(DDA) of extracted chitosan was determined by UV spectroscopy method. In the current study, chitosan(60%DDA) was selected for the synthesis of nanocomposites.

Synthesis of silver oxide nanoparticles

Wet chemical method was employed for the synthesis of silver oxide nanoparticles using silver nitrate, polyethylene glycol and sodium hydroxide[12].

Collection, processing and extraction of herbs

Herbs namely NaringiCernulata (H_1), CyanodonDactylon(H_2) and Cardiospermumhalicababem(H_3) were selected for the synthesis nanocomposites. The selected herbs were collected in and around Chennai. To reduce the moisture, content the leaves were shade dried and then powdered and sieved. 20grams of herbal powder was suspended in 100ml of methanol and incubated for overnight. The supernatant liquid was filtered using whatman No.1 filter paper.

Synthesis of chitosan -silver oxide nanocomposites fabricated with herbs:

Step 1: Synthesis of chitosan- silver oxide nanocomposite

Silver oxide nanoparticle (100mg) prepared was added into 50ml of 1% chitosan solution and 50ml of PVA solution. The solution was stirred for 1 hour at 60°C to get homogeneous solutions. To this solution 1ml of 2% glutaraldehyde was added under stirring at room temperature. The solution was transferred immediately into glass plates. The formed film was washed with water and dried at room temperature.

Step 2: Fabrication of herbs over chitosan-silver oxide nanocomposite

Herbs(H_1, H_2, H_3) were loaded separately into chitosan-silver oxide nanocomposite by swelling method. For loading herbs, the film(50mg) was allowed to swell in 50ml of herbal solution for 24 hrs at 25°C.

The synthesised three different nanocomposites were designated as CAH₁, CAH₂and CAH₃, where C represent chitosan (60%DDA) and A represent silver oxide nanoparticles.

Characterisation:\

The synthesised three different nanocomposites namely CAH₁, CAH₂,and CAH₃, were characterised by UV-Vis spectrometer of the model SHIMADZU UV 1650 PC and FTIR spectroscopy using IR affinity 1 model of SHIMADZU IR 1650 PC. Morphology of the synthesised nanocomposites were analysed by FESEM through DSD nano emission model. The antibacterial activity of the nanocomposites was determined by agar well diffusion method.

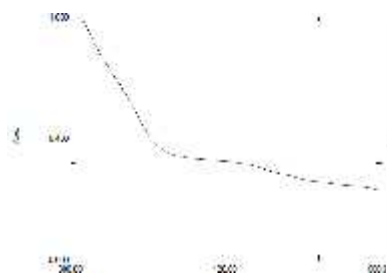
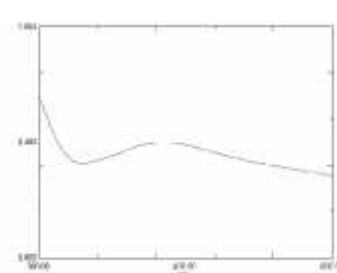
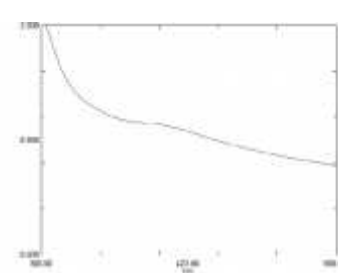
RESULTS AND DISCUSSION

UV-Vis spectral analysis

Chitosan-silver oxide nanocomposites fabricated with herbs CAH₁, CAH₂and CAH₃, were analysed using UV-Vis spectrometer. The UV-Vis spectrum of herb fabricated nanocomposites was shown in fig(1a, 1b and 1c.)

Absorption peaks were observed at 421nm, 414nm and 420nm respectively for nanocomposites CAH₁, CAH₂and CAH₃. A single peak at the range of 420nm in the UV-Vis

spectrum of the nanocomposites was due to the excitation of surface plasmon vibration of silver atoms [13].

Fig 1a- CAH₁Fig 1b- CAH₂Fig 1c- CAH₃

FTIR Spectral Analysis

FTIR spectra of chitosan and nanocomposites are shown in **fig. 2** and **fig. 3** respectively. All characteristic peaks of chitosan were observed in the spectra of chitosan nanocomposites. The OH and NH stretching band of chitosan shifted from 3651cm^{-1} to 3439cm^{-1} (CAH₁), 3651cm^{-1} to 3464cm^{-1} (CAH₂), 3651cm^{-1} to 3444cm^{-1} (CAH₃). The CO stretching band of chitosan moved from 1668cm^{-1} to 1662cm^{-1} (CAH₁), 1668cm^{-1} to 1652cm^{-1} (CAH₂), 1668cm^{-1} to 1656cm^{-1} (CAH₃). New peaks are found at 434cm^{-1} , 592cm^{-1} (CAH₁), 450cm^{-1} , 590cm^{-1} (CAH₂), 405cm^{-1} , 592cm^{-1} (CAH₃). These peaks are due to intrinsic stretching vibrations of metal oxygen bond [13]. The shifting of the peaks was due to the formation of inter molecular bonds between chitosan and herb. The shifting of OH and NH peaks were due to the formation of co-ordination bond between silver atom and electron rich group (Oxygen/Nitrogen) present in chitosan. Hence IR spectrum confirms the presence of silver oxide nanoparticles in chitosan [14].

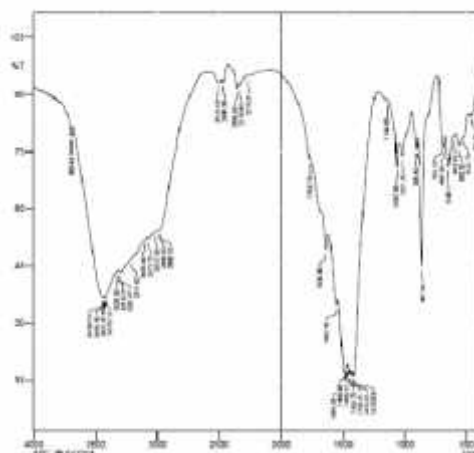
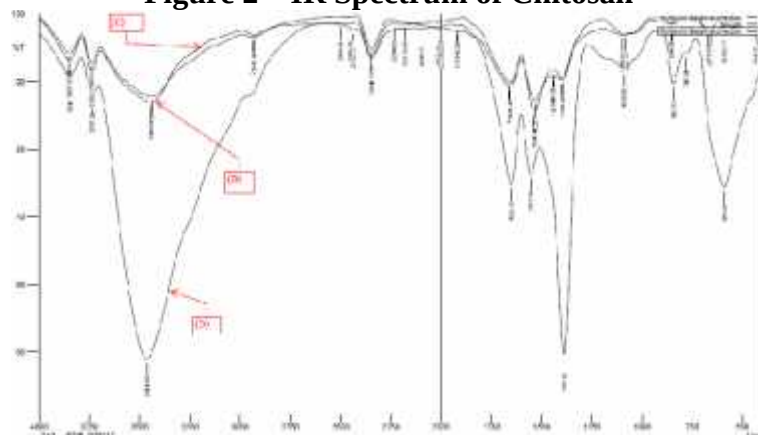


Figure 2 – IR Spectrum of Chitosan

Figure 3 – IR Spectrum of (a) CAH₁ (b) CAH₂ (c) CAH₃

MORPHOLOGICAL STUDIES

Morphological study of synthesised chitosan- silver oxide nanocomposites fabricated with herbs are carried out using field emission scanning microscope(FESEM). The SEM images of the nanocomposites are shown in **Fig. (4a, 4b & 4c)**. The chitosan-silver oxide nanocomposites fabricated with herbs have aggregated structures. The particles in nanocomposite film are found with almost spherical morphology. The size of the Silver oxide nanoparticles was found to be in the range of 50-100 nm

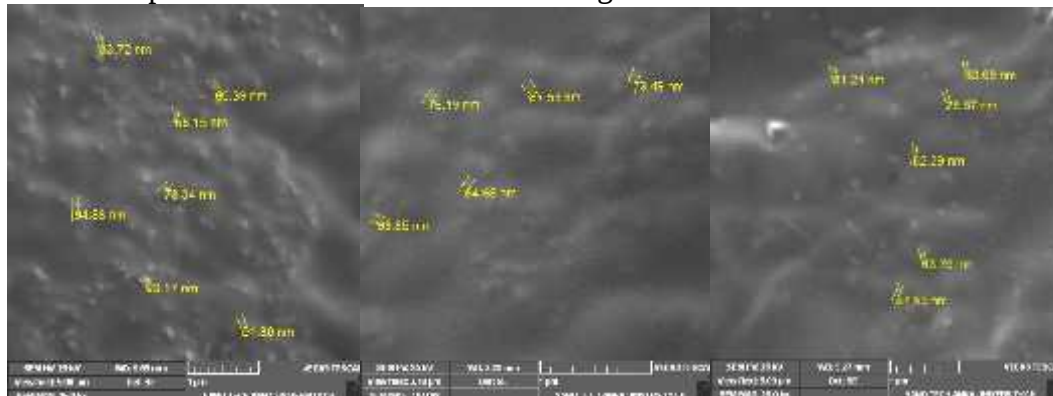


Fig 4a

Fig 4b

Fig 4c

SEM images of CAH₁–(Fig 4a), CAH₂–(Fig 4b) and CAH₃–(Fig 4c).

Antibacterial Activity

Chitosan-silver oxide nanocomposites fabricated with herbs have been evaluated for their antibacterial activity against pathogenic bacteria such as *E. Coli* and *S. Aureus* by agar well diffusion method. The diameter of zone of inhibition values of the nanocomposites against the growth of microorganisms are summarised in **Table-1** and the zone of inhibition images is illustrated in **fig. (5)**. The results revealed that Chitosan-silver oxide nanocomposites fabricated with herbs showed enormous growth inhibition against *E.Coli* and *S.Aureus* compared to other combinations.

Table 1 – Antibacterial activity of chitosan Silver Oxide nanocomposite loaded with herbs

S.No	Samples	Zone of inhibition (mm)	
		<i>E. Coli</i>	<i>S. Aureus</i>
1	CAH ₁	21	19
2	CAH ₂	26	21
3	CAH ₃	25	19

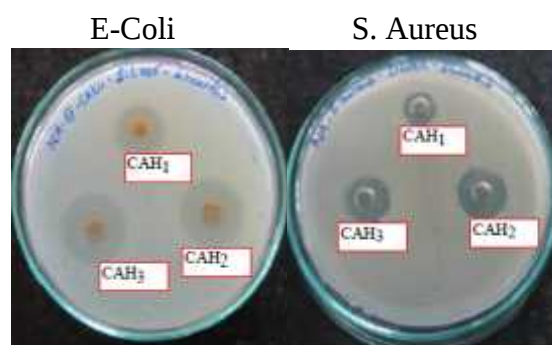


Fig 5 – Inhibitory effect of Chitosan-Silver Oxide Nanocomposite loaded with herbs

CONCLUSION

The chitosan silver oxide nanocomposites fabricated with herbs were synthesised. UV-VIS and FTIR Spectroscopy confirmed the formation of nanocomposites. The morphology of the nanocomposites was studied by SEM. The antibacterial activity of the synthesised nanocomposites against E.Coli and S.Aureus were determined by agar well diffusion method. It was proved that chitosan-silver oxide nanocomposites fabricated with herbs have an excellent antibacterial activity.

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