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Research Article

Synthesis, characterization and Study Bioactivity of Silver Nanocomposites

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ABSTRACT
The work include synthesis of nanocomposites (X / S / Ag) based on blend from Xanthan gum / sodium alginate polymers (X / S) with different loading of synthesized silver nanoparticales (0.01, 0.03 and 0.05 wt%) were added to the blend. The silver nanoparticles were prepared by reduction method and were characterized and analyzed using X-ray diffraction (XRD) and Atomic force microscope (AFM). XRD study showed the presence nanoparticle of silver with crystalline nature and face-centered cubic (FCC) structure and an average size of nanoparticles ranging from 32 to 37 nm. The surface study was performed using AFM which showed a fairly uniform shape to the nanocomposites and a spherical nature for the silver nanoparticles. The nanocomposite exhibited increase in the thermal stability and as well (X / S /0.05 Ag) nanocomposite film showed superior antimicrobial activity against Proteus, Basileus cyrus, Ecole, staph, pseudomonas, and Basilus subtilius.

Keywords: blend, nanocomposite, Xanthane gum, Sodium alginate, silver nanoparticles

INTRODUCTION

Polymer composites having metal nanoparticles had been paid huge attention as a consequence of their exceptional features. Their features extremely rely on the size, amount and dispersion quality of metal nanoparticles as well as type of it [1]. Polymer nanocomposite is one of advanced materials which have great importance among classes of nanocomposite materials.Where the properties of the polymer are improved by adding nanomaterials and showing unique characteristics that are not present in the materials individually due to of the high surface area to volume [2] Lately, nanoparticles have been requested with increasingly, In particular silver in nano size due to its have strategic characteristics in biocompatibility and antimicrobial [3] Besides this the multifunctional nature for the matrix polymeric [4-8] ,Therefore, the researchers focused on synthesizing polymeric nanocomposites containing silver nanoparticles [9-13] . Xanthan gum stands for the natural polysaccharide and it's a significant industrial biopolymer. [14]. The xanthan gum (polysaccharide B1459) was created by the bacterium Xanthomonas campestris (NRRL B-1459). Several tests were done on Xanthan gum due to its had unique features when it blending with other gum polymers natural or synthetic , water-soluble due to of its ability to form homogeneous aqueous dispersions and solutions with high viscosity, in addition particular significance is the insensitivity of solution viscosity to the heat and salt effects .It is worth noting that xanthine is polysaccharide systems has high molecular weight [15,16]. Sodium alginate ($NaC_6H_7O_6$) is a natural hydrophilic polysaccharide derived from a cell wall for the marine brown algae and have a linear form with backbone from (1–4) linked β-d-mannuronic acid (M) and α-l-guluronic acid (G).It has been widely investigated in the field of drug delivery due to it exhibited excellent biocompatible and biodegradable nature.[17] [18].

The object of this work was to manufacture antibacterial nanocomposite films from blend (xanthan gum / sodium alginate) with silver nanoparticles and study bioactivity of them

EXPERIMENTAL MATERIALS AND INSTRUMENTALS

Xanthan gum, Sodium alginate, Silver nitrate in addition to Tri-sodium citrate have purchased from Sigma–Aldrich Corporation. X-ray diffraction via (Shimadzu-XR-6000) device with Nickel -Copper filter for the x-ray radiation (Cu Kα, λ = 1.5406 Å). Scanning has continuously achieved under (2θ= 5-80) range and in average speed of 5 degree / mint. Fissure diameter for the entering X-ray of 0.3 mm. AFM analysis were carried out on a microscope model SPM AA3000 Angstrom Advanced Inc., USA origin, thermogravimetric analysis (TGA) was taken for by origin German instrument "STAPT-1000

LINSEIS" with a heating rate of 10 ° C / min under an inert atmosphere of nitrogen. Antimicrobial activity of samples was studied in Market Researches and Consumer Protection Center/ University of Baghdad.

Preparation of Silver Nanoparticles

Silver nanoparticles are formed using a chemical reduction method that included a 50 mL solution of 0.001M AgNO3 that was heated to boiling and then titrated against trisodiumcitrate (1%) with stirring and heating. Accordingly, the color was changed to pale yellow and the reaction continued until the silver nanoparticles were precipitate. After that, the precipitate was stirred to cool to room temperature, then filtered off by decantation and dried at 80°C [19].

Synthesis of silver nanocomposites films

A mixture from sodium alginate (1.5 g) and Xanthan gum (1 g) in100 ml distilled water was stirring for 12 h. then different weights from silver nanoparticle (0.01, 0.03 and 0.05 g) was added to (X/S) solution polymer blend under magnetic stirring. Ultrasonic water bath was used for 18 h. to avoid accumulation. Then the solution was poured in petridish [20].

RESULTS AND DISCUSSION

XRD Analysis: The crystal structures for silver nanoparticles (AgNPs), blend (X/S) and nanocomposite were investigated by X-ray diffraction (XRD) as shown in Fig.1.XRD had proven that pure AgNPs alone has four peaks, one at 2θ =38.08°and another's at 44.27°, 64.43° and 77.37 °, these peaks are correspond to reflections of crystalline standards 111, 200, 220 and 311 in the Face-centered cubic (FCC) structure for silver metal according to database on JCPDS with file no.04-0783 [21, 22]. Average size for the Ag NPs could be determined from XRD data by Debye–Scherrer formula:

$$D = \frac{K\lambda}{\beta \cos\theta} \quad \text{--------(5)}$$

Accordingly, K =0.89, it stands for the Scherrer constant, λ stands for the X-ray wavelength with a value of 0.15406, β stands for the peak width at half-maximum height (FWHM) and θ stands for Bragg diffraction angle[23]. The average size of AgNPs was recorded between 32 to 37 n. while the peaks for polymer blend (X/S) appeared at of 18.45°,33.24° and 64.44°.The silver nanocomposite exhibited the six main peaks correspond to the four peaks in the AgNPs and three peaks to blend (X/S) With lowering in an intensity of these peaks as compared with the pure AgNPs this was expected result to the existence of an amorphous structure was ascribed to polymers blend and interactions between the blend and AgNPs. [24].XRD spectrum of pure AgNPs, blend (X/S) and nanocomposite was shown for comparison in Fig.1.

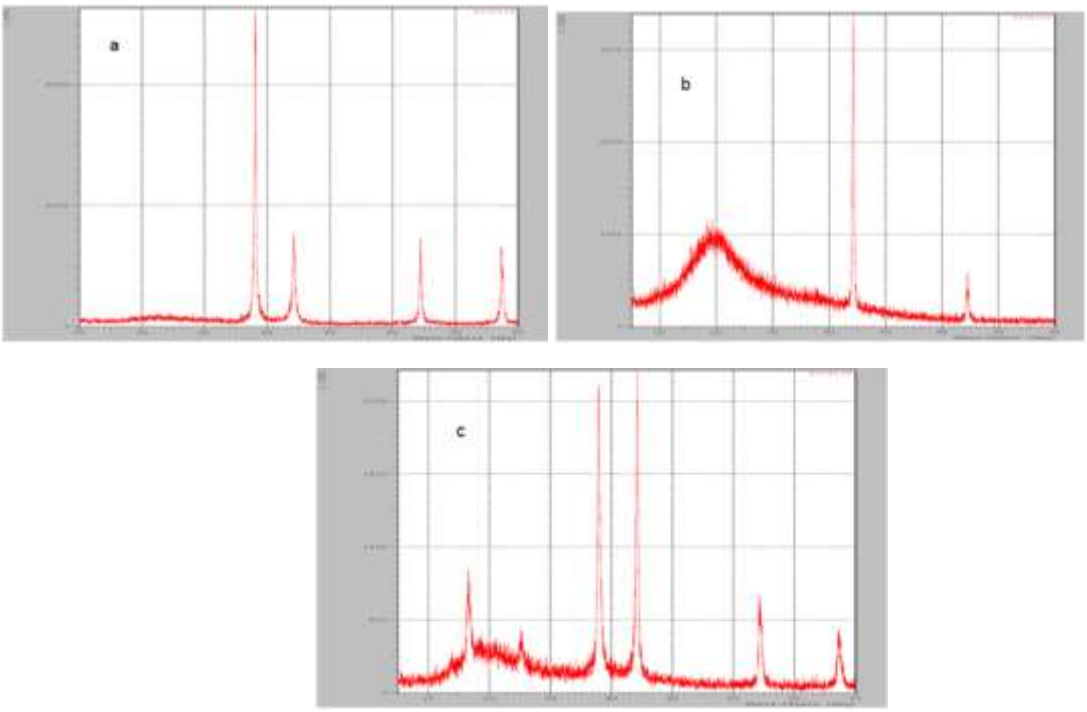

Fig1: XRD of (a)silver nanopaticles , (b)polymer blend (X/S), and (c) silver nanocomposite film.

Morphology study

The Atomic force microscope AFM was used to investigate the surface morphology of silver nanoparticales and (X/S) Blend. Fig 2 and 3 illustrate the AFM images of nanoparticles Ag NPs, (X/S) Blend film and nanocomposites. It is clearly seen that the nanoparticle had spherical morphology with the average size of 60-80 nm with some accumulation as shown in table 1. Comparing the AFM images between nanocomposite and pure blend, it is noted that the presence of nanoparticles makes the shape more homogeneous.

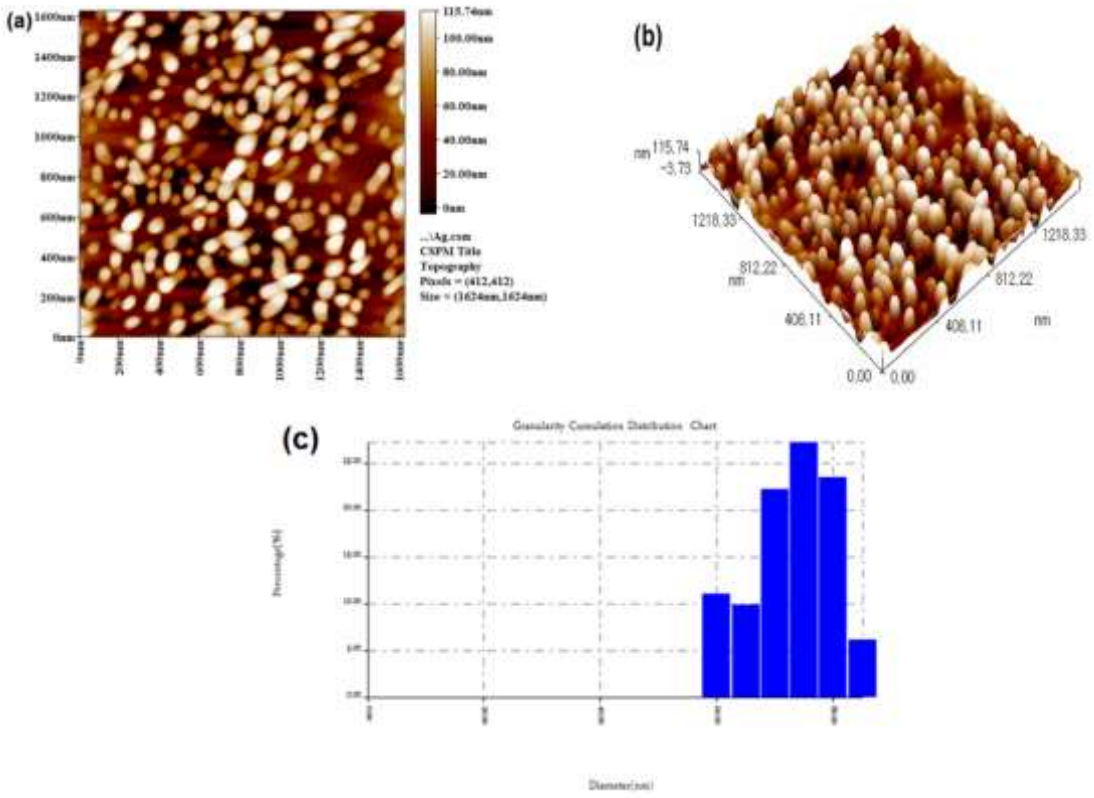

Fig.2: The AFM images (a) and (b) of the AgNPs and (c) granularity accumulation distribution for AgNPs

Table 1: Average diameter and accumulation percentage for AgNPs

Diameter(nm)<	Cumulation(%)	Diameter(nm)<	Cumulation(%)	Diameter(nm)<	Cumulation(%)
60.00 65.00	11.11 20.99	70.00 75.00	43.21 70.37	80.00 85.00	33.83 10.00

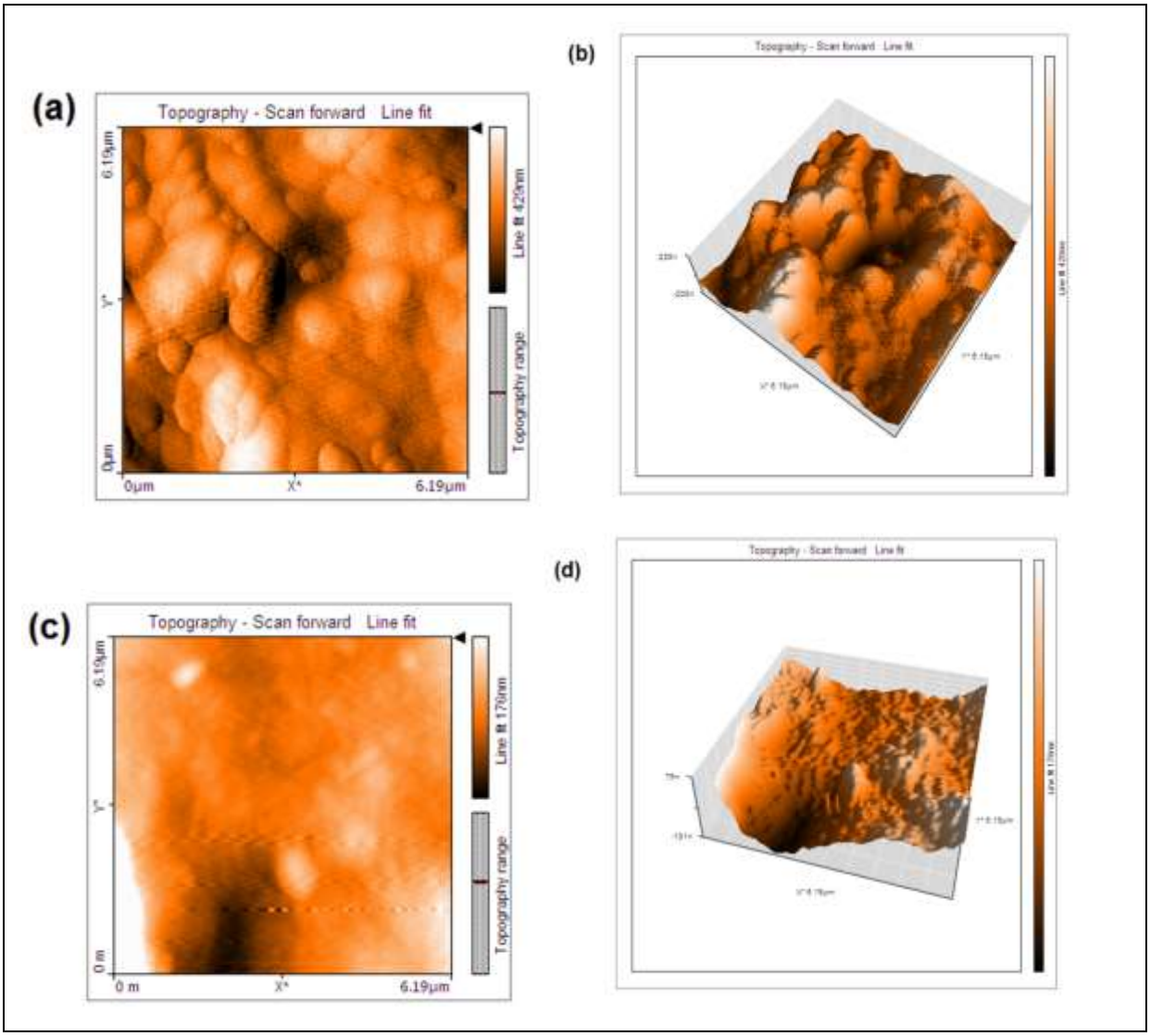

Fig 3: Atomic force microscope (AFM) images of a, b for blend (X/S) and c, d for silver nanocomposite with 0.05Wt% AgNPs.

TG Analysis

The thermo gravimetric analysis curves of the blend and nanocomposites with0.05 wt% of Ag nanoparticles are shown in the Fig.4. the nanocomposites with 0.05 wt % Ag exhibited the higher thermal stability, this enhancement in thermal stability was attributed to the presence of the Ag nanoparticales and the strong interaction between the Ag and polymers blend.

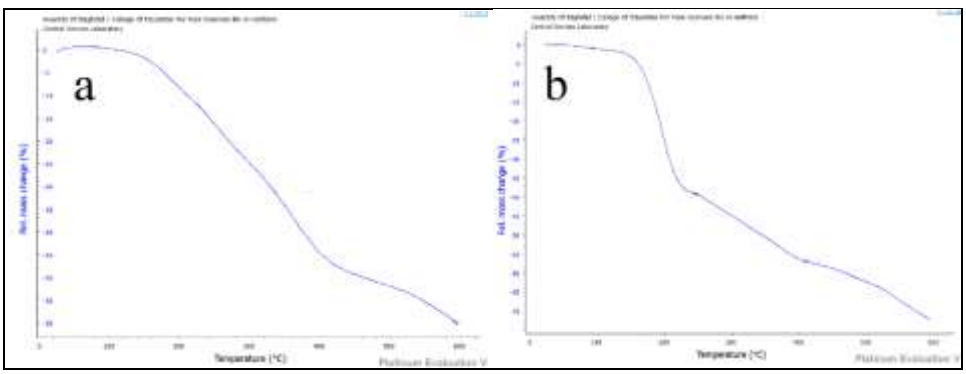

Fig. 4. Thermal gravimetric analysis (TGA) curves of (a) blend (X/S); (b) nanocomposite (X/S/Ag)

Table 2: Thermal properties of pure blend (X/S) and its nanocomposites (X/S/Ag)

Compound	$CDT_{max}(^0C)$	FCDT(^{0}C)	$T_{10}(^0C)$	T_{25} (^{0}C)	$T_{50}(^0C)$
Blend (X/S)	140	595.155	80	229.859	336.352
Composite (X/S/Ag)	155	595.386	97	245.925	409.81

CDTmax: maximum compound degradation temperature; FCDT: final compound degradation temperature; T_{10}, T_{25} and T_{50}: The temperature to weight loss 10% , 25% and 50% respectively

Antibacterial behavior of polymer blend and silver nanocomposites

Antibacterial activity of the silver nanocomposites (X / S / Ag) and mixture (X / S) against Proteus, Basileus cyrus, Ecole, staph, pseudomonas, and Basilus subtilius was examined using zone of bacterial inhibition method. (Disc spread). The solutions were prepared from combined nano (X / S / Ag) and blend (X / S) using distilled water as a solvent and the plates were examined after incubation at 37 ° C for 24 hours. In the plates of silver nanocomposites (X / S / 0.05Ag), the inhibitory region around the disc was the most obvious after incubation for approximately one day .Fig. 5 illustrates the inhibition areas formed by silver nanocomposites (X / S / 0.05Ag) and blend films. Results in Table 3 showed that the silver nanocomposites (X / S / 0.05Ag) were highly antibacterial while no antibacterial activity was exhibited by a blend, which was used as a control matrix.

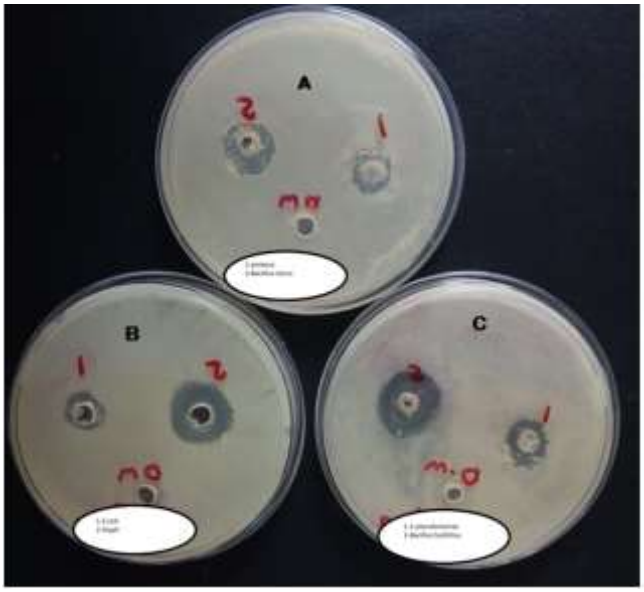

Fig.5: Antimicrobial activity of (X/S+0.05 Ag) againstA: (Proteus and Basileus cerus), B : (E.coli and Staph) and C: (pseudomonas and Bacillus Subtillus)

Table 3: Result of bacterial activity test

Compound	Proteus	Basileus Cerus	E.coli	Staph	pseudomonas	Bacillus Subtillus
Nanocomposite(X/S/Ag)	13	16	15	21	12	20
Blend (X/S)	0	0	0	0	0	0

CONCLUSION

silver nanoparticles(AgNPs) was prepared by reduction method and the nanocomposite films consisting of blend (xanthan gum - sodium alginate) with different weights of AgNPs were synthesized by solution casting method. XRD and AFM results suggest that the strong interactions are formed between AgNPs and blend matrix. Where a study of morphology for silver nanocomposite film showed homogeneous spread in the blend matrix and DSC study was exhibited the improvement in thermal properties this were due to compatibility and interactions between AgNPs and blend matrix. In addition, the antibacterial activity of nanocomposite (X/S/ 0.05Ag) was shown to be enhanced for Staph

Bacillus Subtillus. Bacillus Cerus, pseudomonas, E. coli and proteus compared to the pure blend. (X/S).

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