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DEVELOPMENT AND CHARACTERIZATION OF BIO-NANOCOMPOSITE HYDROGELS LOADED WITH SILVER NANOPARTICLE FOR ANTIBACTERIAL AND DRUG DELIVERY APPLICATIONS.

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Abstract : In this work, we present possible use of bionanocomposite hydrogels as templates to obtain metal nanostructures of different sizes. The hydrogels were synthesized via graft copolymerization of mixtures of acrylic acid (AA) and 2-hydroxyethyl methacrylate (HEMA) onto alginate backbones (Alg), in the presence of various loading levels of sodium montmorillonite (MMT).

The nanoparticles were synthesized in situ within the network hydrogel using chemical reducing method, with $AgNO_3$ as a silver precursor and $NaBH_4$ as reducing agent.

The bionanocomposite hydrogels were characterized by using UV–visible spectroscopy, thermo gravimetrical analysis and X-ray diffraction. Thermal and X-ray diffraction analysis confirmed the formation of nanoparticles in hydrogel. Effect of the presence of AgNPs on the drug release behavior of the obtained nanocomposites hydrogels using Amoxicillin (AMX) as a model antibiotic drug was also explored.

Keywords: PH-responsive hydrogels; Silver nanoparticles; Montmorillonite; Antibacterial activity; Drug delivery**.**

I- Introduction :

Recently, there has been a great interest to generate organic-inorganic nanocomposite hydrogels due to their superior biomedical performance. Hydrogels reinforced with silver nanoparticles (AgNPs) have shown excellent properties for antibacterial applications.

The aim of this study was to investigate the role of hydrogel networks on the stabilisation of metallic nanoparticles and their size reduction is also studied. Then, the effect of combining the silver nanoparticles with amoxicillin antibiotic on the release kinetics was also evaluated.

II- Materials and method :

The nanocomposites hydrogels networks were synthesized by employing free radical polymerization using N,N'-methylene bisacrylamide as crosslinker and potassium persulfate as redox-initiating, after the polymerization was over, the resulting hydrogels were cut into pieces of same thickness and then washed several times with distilled water.

Then, the in situ method was employed to prepared the metals nanoparticles (AgNPs) in the hydrogel networks.

The color of the disk indicated formation of nanoparticles in the hydrogel network

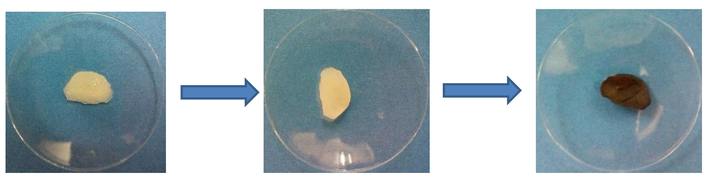


Figure 1: Photographs of the metal nanoparticle formation in the hydrogels.

III- Results and discussion :

FTIR spectroscopy

The success of the grafting reaction was confirmed by Fourier transform infrared spectroscopy (FTIR).

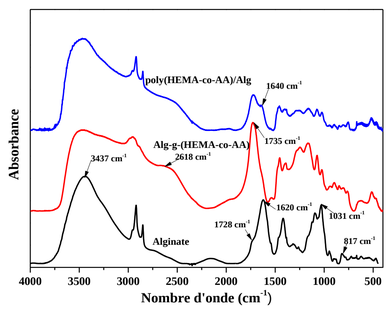


Figure 2. FTIR of the hydrogels.

UV–visible spectroscopy

The insertion of MMT in the hydrogels generated a shift in the absorption band characteristic of metallic nanoparticles towards the shorter wavelengths, which indicated the decrease in the size of NPs.

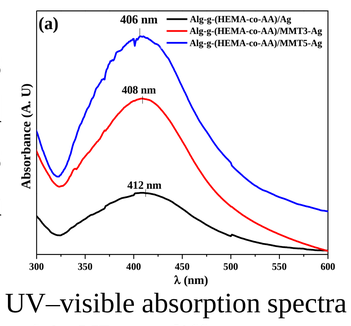
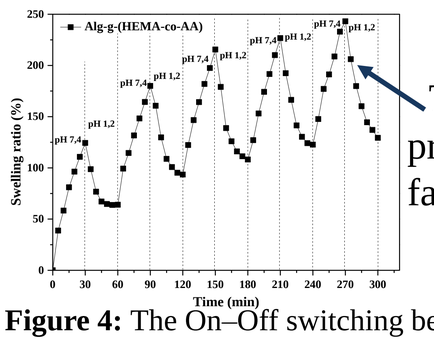


Figure 3. UV–visible absorption spectra for the production of AgNPs, at different percentages of MMT

Swelling studies



This phenomenon reveals that the process of swelling of the hydrogel is faster than that of deswelling.

Figure 4: The On–Off switching behavior of the hydrogel.

the network hydrogel showed an improved swelling after silver nanoparticles formation, this increase is due to the presence of nanoparticles which cause an expansion of the hydrogel network.

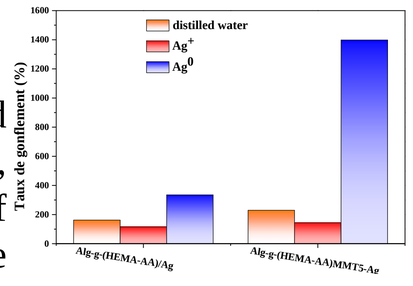
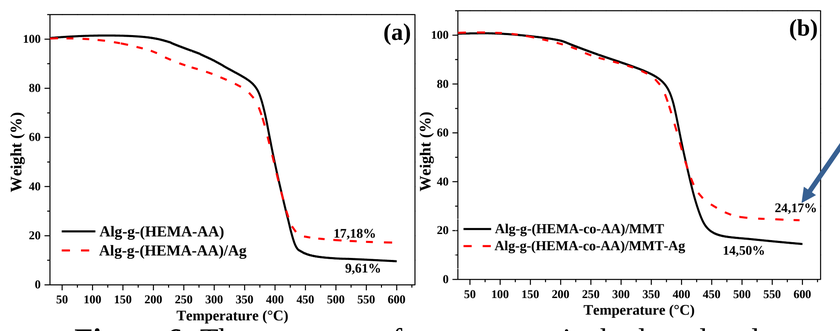


Figure 5: hydrogel swelling property (a) Effect of pH on Swelling of Hydrogel Nanocomposite

Thermal gravimetrical analysis

The thermal decomposition of the hydrogels with and without metallic NPs, show that the residual masses increased after introducing the silver nanoparticles into the hydrogel. This increase is due to the presence of metallic nanoparticles.



The presence of MMT in the hydrogel network increases the trapping of NPs.

Figure 6: Thermograms of nanocomposite hydrogel and nanocomposite hydrogels loaded with silver nanoparticles.

X-ray diffraction

The introduction of MMT into the hydrogel network caused an increase in the peak intensity of the Ag nanoparticles. This suggests that MMT promotes the trapping and / or reduction of NPs.

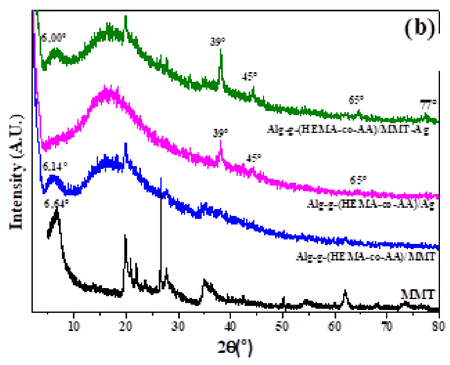


Figure 7: The XRD pattern of nanocomposite hydrogel-nanoparticle and nanocomposite hydrogels-NPs incorporated with MMT.

Antibacterial properties

The study of the antibacterial effect of NPs-Ag, at different percentages of MMT (0, 3, 5)%, showed an inhibitory effect against the two bacteria E. coli (gram negative), and S. aureus (gram positive).

It should be noted that the zones of inhibitions obtained were maintained even after one week of incubation.

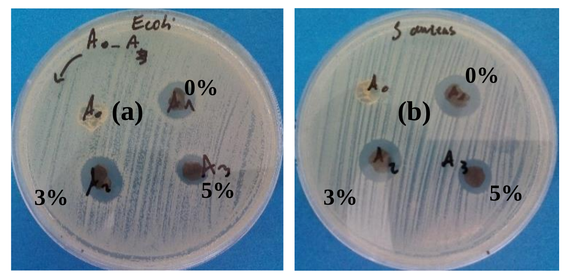
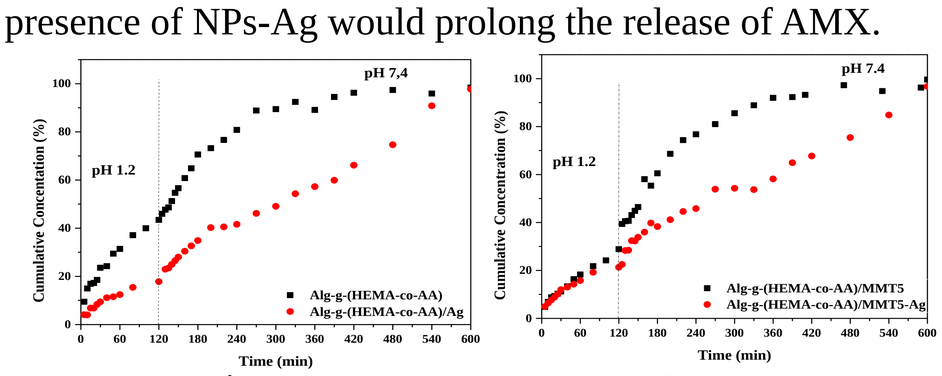


Figure 8. Photographs of the inhibition zones of hydrogel/Ag nanocomposite hydrogel against S. aureus and E. coli.

Drug release behaviour

The presence of NPs-Ag would prolong the release of AMX.



the rate of AMX released from Alg-g-(HEMA-co-AA) is 43% in SGF, this rate is reduced to 17% in the hydrogel Alg-g-(HEMA- co-AA)/Ag.

Figure 9: In vitro release profile of AMX from different hydrogels.

Conclusion:

In summary, we report the preparation and evaluation of a pH-responsive hydrogel integrating silver nanoparticles as drug reseal systems, the result show that the presence of the MMT in the network allowed to reduce the size of the metallic nanoparticles, which represents a promising result for the control of the size of the nanoparticles.

Moreover, the results of the swelling and the release showed that the prepared nanocomposite hydrogels exhibited good proprieties which make them promising material to deliver the anti-bacterial agent.