BIOSYNTHESIS OF SILVER NANOPARTICLES BY USING NOPAL EXTRACT AND THEIR POLYMERIC ELECTROSPUN

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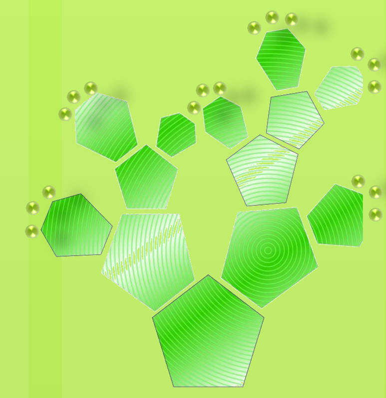


INTRODUCTION

Silver nanoparticles (AgNps) have played an important role because of their strong bactericidal and fungicidal activity. Within methods of synthesis for nanoparticles, the biological synthesis represents a clean alternative, presumably non-toxic and friendly environment for the formation of metal nanoparticles [1].

The incorporation AgNPps in polymeric matrices by process electrospinnig has generated materials with improved bactericidal, physical and mechanical properties[2] . Electrospinning is a low cost and continuous process to obtain polymeric nanofibers with different morphologies and ultrathin diameter, which can be applied in many fields.

The use of plants and their extracts to obtain metallic nanoparticles has been developed recently, in this work we present the results to synthesize AgNps by using the nopal extract (*Opuntia sp)* as a reducing agent in the presence of biocompatible water-soluble polymers such as poly(vinyl alcohol) (PVA), acting as stabilizing agents for the nanoparticles and then electrospun them to obtain nanofibers charged with AgNps.

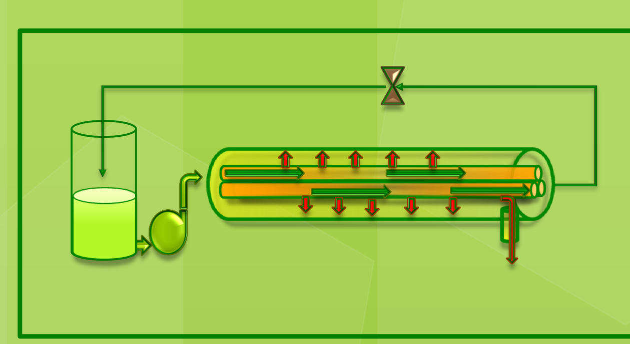
EXPERIMENTAL

Preparation and characterization of plant extract.

1.- Extraction

2.- Filtration

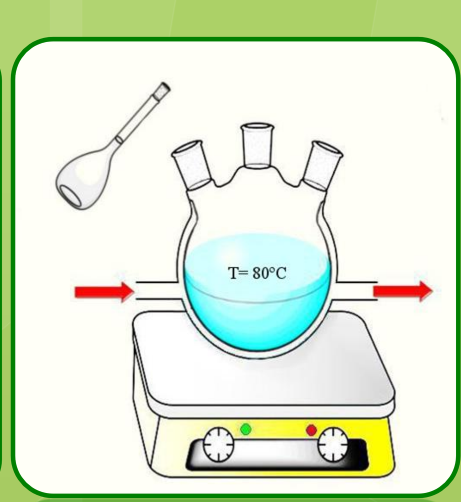
3.- Lyophilization



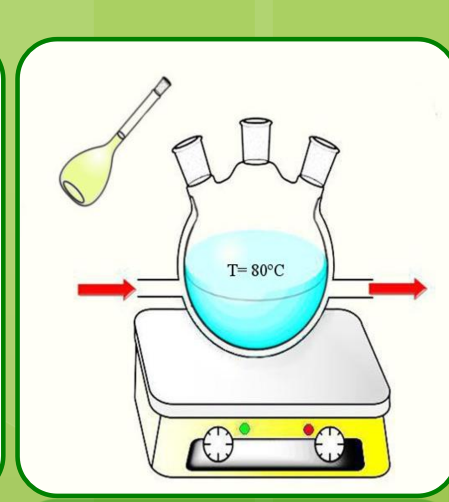
4.- Fractionation by ultrafiltration

Biosynthesis of metal nanoparticles.

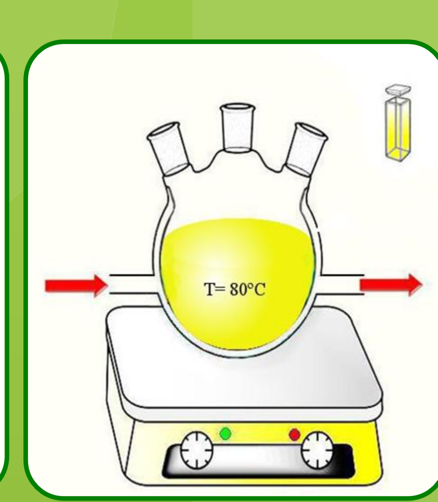
1º Addition NH_4OH + SDS



2º At 80ºC addition $AgNO_3$ solution

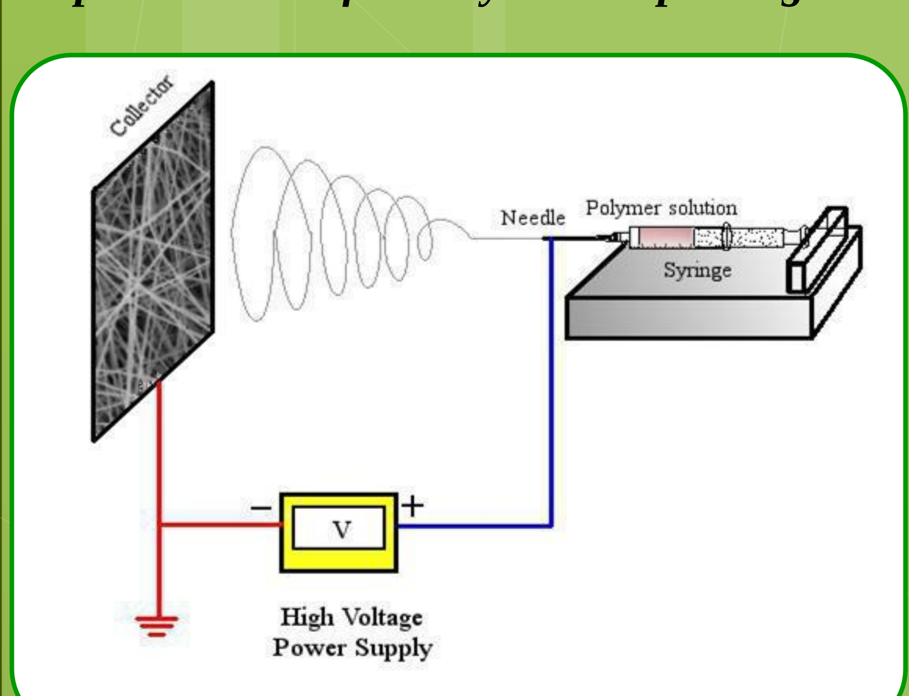


3º Beginning of reaction with nopal extract



4º Monitored reaction by UV-vis

Preparation nanofibers by electrospinning.



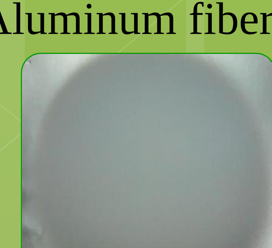
Electrospinnig conditions:

Voltage: 20 kV

Distance from the needle tip-to-collector: 15 cm

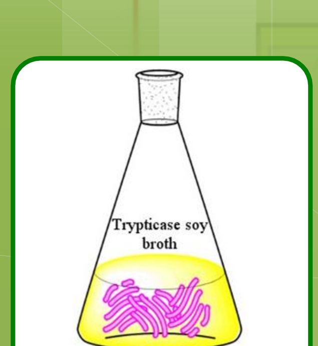
Flow rate: 0.3 mL/h.

Aluminum fibers collector



PVA fibers

Antibacterial activity of the synthesized AgNps.



I. Dilution method in trypticase soy broth

II. Plating dilution

III. Viable count

IV. Solution different concentration AgNPs Challenge against E.Coli y S. Aureus

RESULTS AND DISCUSSION

Characterization of plant extract.

Processed cladodes (g)	Nopal extract freeze dried (g)
3,003	60.94

Table 1.- Main chemical composition of nopal extract (Opuntia sp).

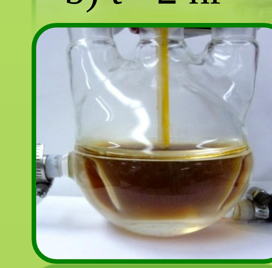
Parameter	Extract without filtration	Permeate 3000 NMWC
Insoluble solids	4 %	
Total protein	11.16 %	6.61 %
Soluble protein	0.53 %	0.15 %
Total sugars	11.62 %	12.11 %
Total phenols	23.55 %	19.94 %

Biosynthesis of AgNPs.

a) t= 0

b) t= 2 hr

c) t= 3 hr



d) t= 5 hr

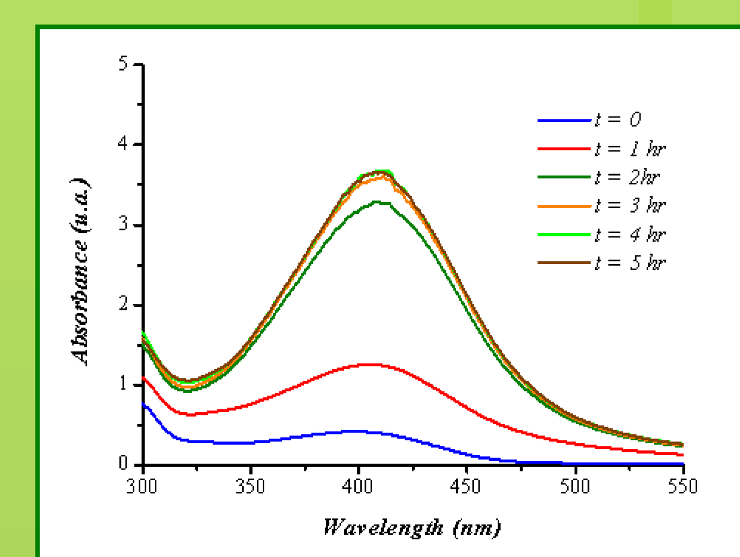


Figure 1.- UV-vis spectra recorded as a function of reaction time using nopal extract as reduction agent.

Characterization of the AgNPs and nanofibers obtained.

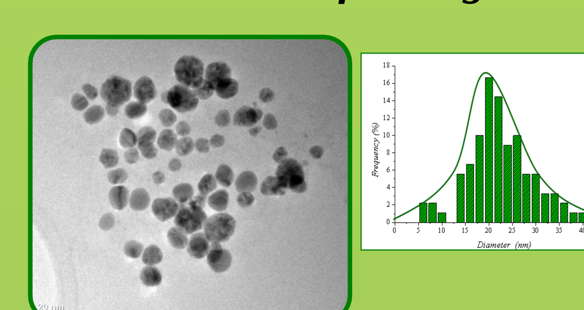


Figure 2.- TEM image of AgNPs synthesized using nopal extract. (Scale bar 20 nm).

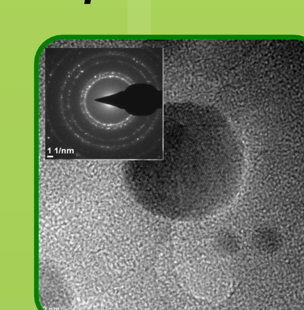


Figure 3 .- HR-TEM micrograph (Scale bar 2nm).

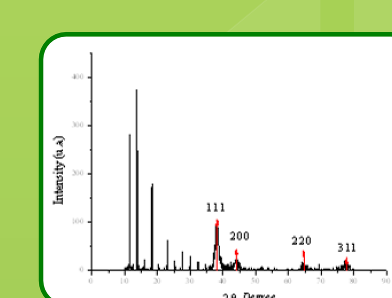


Figure 4.- XRD pattern of the obtained AgNPs

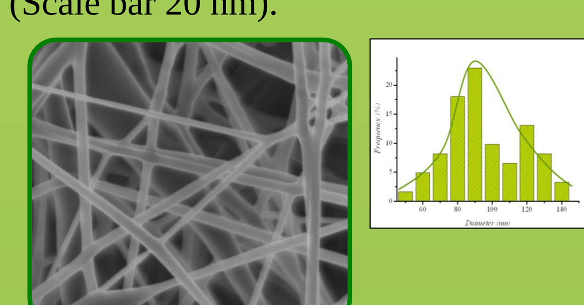


Figure 5.- SEM image at 50000 X of nanofibers with a 100 ppm AgNps

Figure 6.- TEM image at 56000X of AgNPs synthesized using nopal extract (scale bar 0.2 μm).

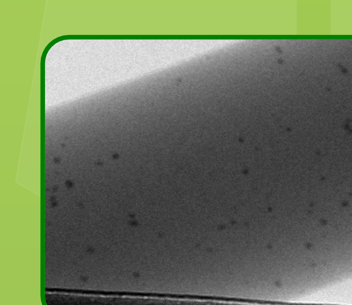
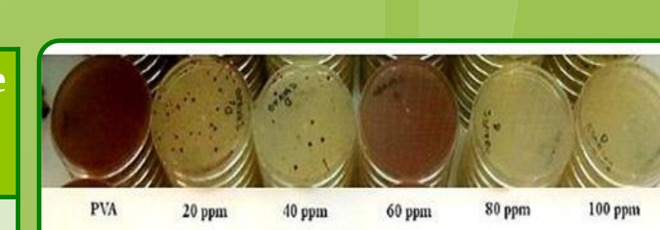


Figure 7.- TEM image of nanoparticles incorporated into nanofibers "in situ" (scale bar 20 nm).

Antibacterial activity of AgNps.

Bacteria	Minimal Inhibitory Concentration (MIC) (mg/L)	Minimal Bactericide Concentration (MBC) (mg/(L)
Escherichia coli ATCC-25922	185	185
Staphylococcus aureus ATCC-25213	40	67



CONCLUSIONS

An eco-friendly and low cost protocol for biosynthesis of silver nanoparticles using nopal extracts has been demonstrated, where apparently the main components of the nopal extract (sugar and phenols) participated as reducing and possible capping agents. The synthesized AgNps mainly showed spherical shape, in the range 2-20 nm with average size of 10 nm. The silver nanoparticles showed a *d* spacing typical of 2.02 Å of crystaline structure of elemental silver nanostructure. UV-Vis spectroscopy showed the characteristic plasmon absorption peak for the AgNps ranging from 430-450 nm. Both bacterial strains tested showed good MIC and MBC activity. It was possible to incorporate the AgNPs and directly electrospun them without any other process in between.

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