



Synthesis Of Silver Nanoparticles Using By Gum Arabic Based Hydrogel

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ABSTRACT

Different researchers have been working to synthesis silver nanoparticles by biological method because this method takes less time, low cost and one step method. Biodegradable material such as gum, bacteria, fungus etc. are used to synthesis silver nanoparticles and organic molecules which are present in biodegradable material, provides stability to silver nanoparticles. Biological method is used to synthesis of silver nanoparticles in this research. Gum Arabic Polyacrylamide Fumaric Acid (GAPAAFA) based hydrogel,used to synthesis silver nanoparticles. GAPAAFA hydrogel is taken into grey solution that contains silver particles that formed from silver nitrate and borax and after three hours, grey solution changes into brownish/yellow silver nanoparticles. GAPAAFA acts as stabilizing and capping agent. Synthesis of silver nanoparticles confirmed by the following method such as Ultra Violet-Visible Spectroscopy (UV-VIS),Thermo-Gravimetric Analysis(TGA),Dynamic Light Scattering(DLS), Zeta potential and effect on Escherichia coli and Bacillus subtilis.

Keywords: AgNp, GAPAAFA, antibacterial and DLS.

4.1Introduction

The Clusters of silver atoms with range of 1–100 nm at least in one dimension, known as Silver Nanoparticles (AgNps). Silver nanoparticles have antibacterial and antifungal property[1], so it is used in agriculture and medicine. AgNps provides nutrition, protection and improve the growth of some plants[2]. The other applications of silver nanoparticles in pest control, crop improvement, detection of plant diseases and food packaging has been carried out. The synthesis of silver nanoparticles by chemical and physical method is time taking, expensive and takes more steps in comparison to biological method. Stabilizing agent is also need by providing stability to silver nanoparticles. The Physical and chemical properties of AgNPs have unique, so, they are widely used in several filed of science and technology[3,4], such as surface-enhanced Raman spectroscopy [5], catalysts,[6]anti-bacterial materials [7,8], sensors , lubricating materials and so on, with exponentially increasing production. As the properties of AgNPs depend on their sizes,up to now, various methods, such as spray pyrolysis synthesis , microwave irradiation synthesis , chemical synthesis, UV irradiation synthesis, biological synthesis[9] and so forth, have been employed to prepare AgNPs with different sizes and shapes.

4.2. Synthesis:-

Silver nitrate and borax solution is prepared by mixing distilled water.Now,gum arabic based hydrogel (GAPAAFA) taken in silver nitrate and borax solution.The interaction started between silver particles and GAPAAFA.

4.3. Result and discussion:-

4.3.1. Silver Nitrate and Borax solution

The starting materials were silver nitrate solution, borax and GAPAAFA. The aqueous solution of silver nitrate is colorless (Fig.4.3.1 a) and its UV-VIS ,due to Ag⁺ ions is 306 nm(Fig. 4.3.1 b). When borax is mixed in colorless solution of AgNO₃,it first converts silver nitrate solution into light brown color solution (Fig.4.3.1 c), which is indication of unstable silver nanoparticle, because it immediately converts into grey/black solution(Fig.4.3.1 d) ,due to reduction of Ag⁺ ion into silver atoms as well as aggregation of silver atoms(Fig. 4.3.1 e). It can be confirmed, when UV-VIS curve of light grey/black solution(Fig.4.3.1 f) is compared with UV-VIS of AgNO₃ solution(Fig 4.1.3 a) , Absorbance of Ag⁺ ions is decreasing with same wavelength 307 nm(Fig.4.3.1 b, d, f), due to number of Ag⁺ ions decreasing because of aggregation..

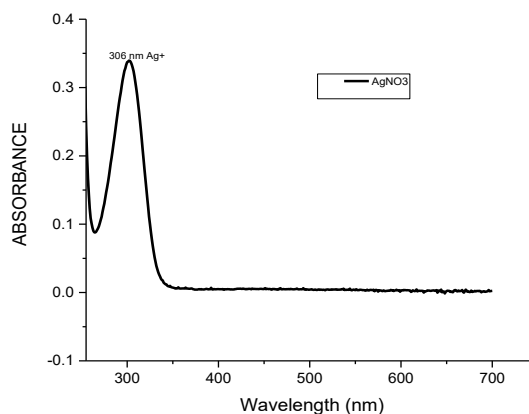

 Fig. 4.3.1 (a) AgNO_3 Solution

 Fig.4.3.1 (b) UV-VIS of AgNO_3 Solution


Fig.4.3.1 (c) Silver +Borax Mixture

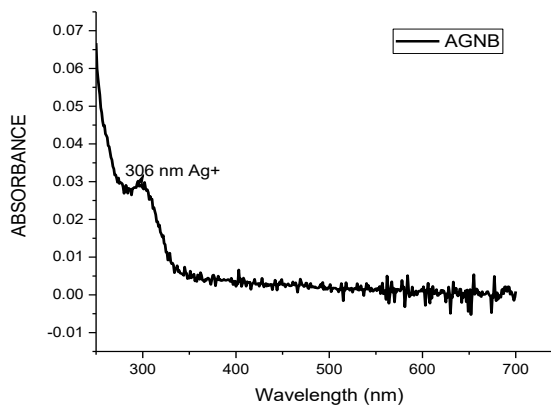
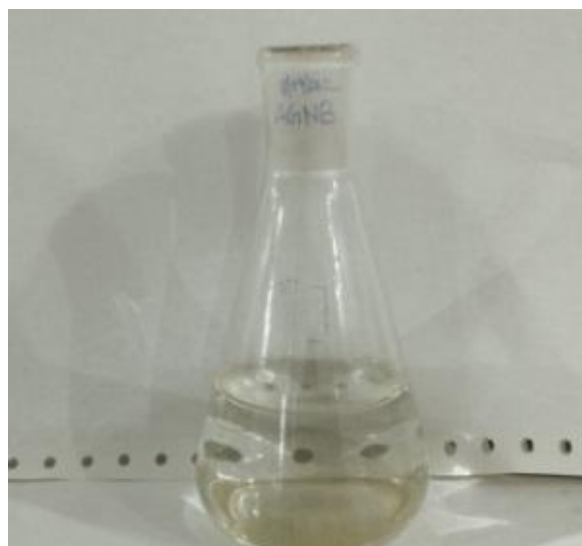
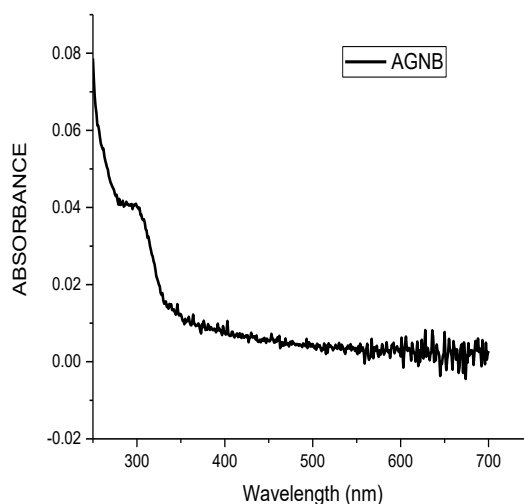

 Fig.4.3.1 (d) UV-VIS of AgNO_3 + Borax


Fig.4.3.1 (e) UV-VIS of silver +borax


 4.3.1 (f) UV -VIS of silver ions in AgNO_3 +borax

4.3.2. Silver Nanoparticles from silver nitrate + borax solution

When GAPAAFA hydrogel is mixed in the light grey/black solution, after 24 hour, grey solution become stable red brown colored silver nanoparticles solution (Fig.4.3.2.c,d), because GAPAAFA hydrogel absorbs, reduces, stabilizes and capping of the silver particles (Ag^+ ions and Ag atoms), confirmed with comparison of UV-VIS curves at the different interval of time. The absorbance and concentration is directly proportional to each other from Beer Lambert

law. It can be seen in UV-VIS curve (Fig.4.3.2.e), absorbance (concentration) is increasing with time but wavelength of silver nanoparticles is constant. Formation of silver nanoparticles is also confirmed by, DLS and Zeta potential.



Fig.4.3.2 (a) Silver particles at zero hour



Fig.4.3.2 (b) Silver particles at first hour

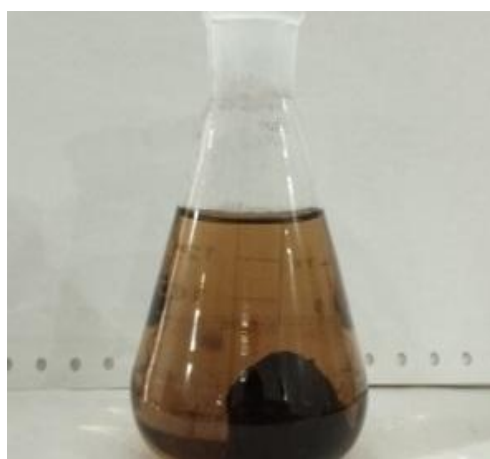


Fig.4.3.2 (c) Silver particles at second hour

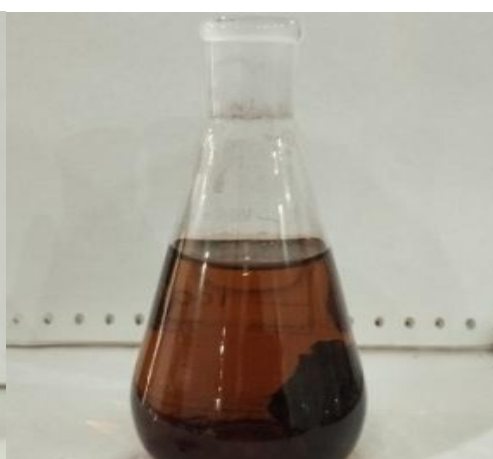


Fig.4.3.2 (d) Silver particles at third hour

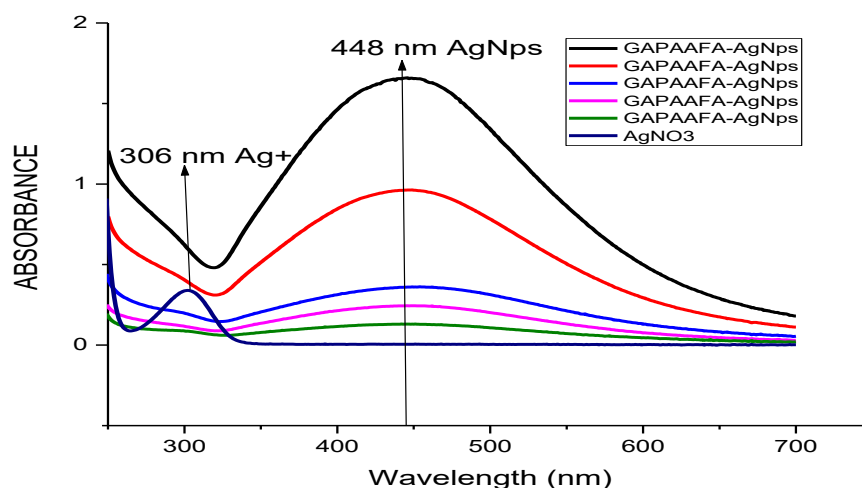


Fig.4.3.2(e) UV-VIS curve

4.3.3.Zeta potential

Nanoparticles with a zeta potential between -10 and $+10$ mV are considered approximately neutral, while nanoparticles with zeta potentials of greater than $+30$ mV or less than -30 mV are considered strongly cationic and strongly anionic, respectively. Since most cellular membranes are negatively charged, zeta potential can affect a nanoparticle's tendency to permeate membranes, with cationic particles generally displaying more toxicity associated with cell wall disruption

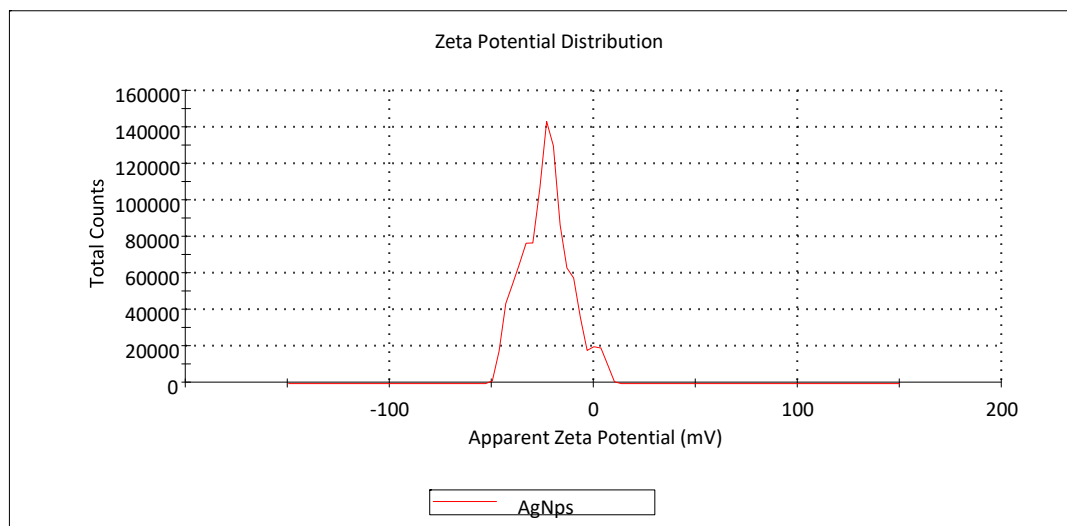


Fig 4.3.3. Zeta potential

4.3.4. SIZE DISTRIBUTION REPORT BY INTENSITY

Results

Size (d.nm):

Z-Average (d.nm): 73.22

PdI: 0.485

Intercept: 0.875

	% Intensity:	St Dev (d.n...	
Peak 1:	98.63	100.0	52.99
Peak 2:	0.000	0.0	0.000
Peak 3:	0.000	0.0	0.000

The above result, confirmed the syntheses of silver nanoparticles from GAPAAFA, because average size of aggregated particles are 73.22 nm by size distribution report by intensity.

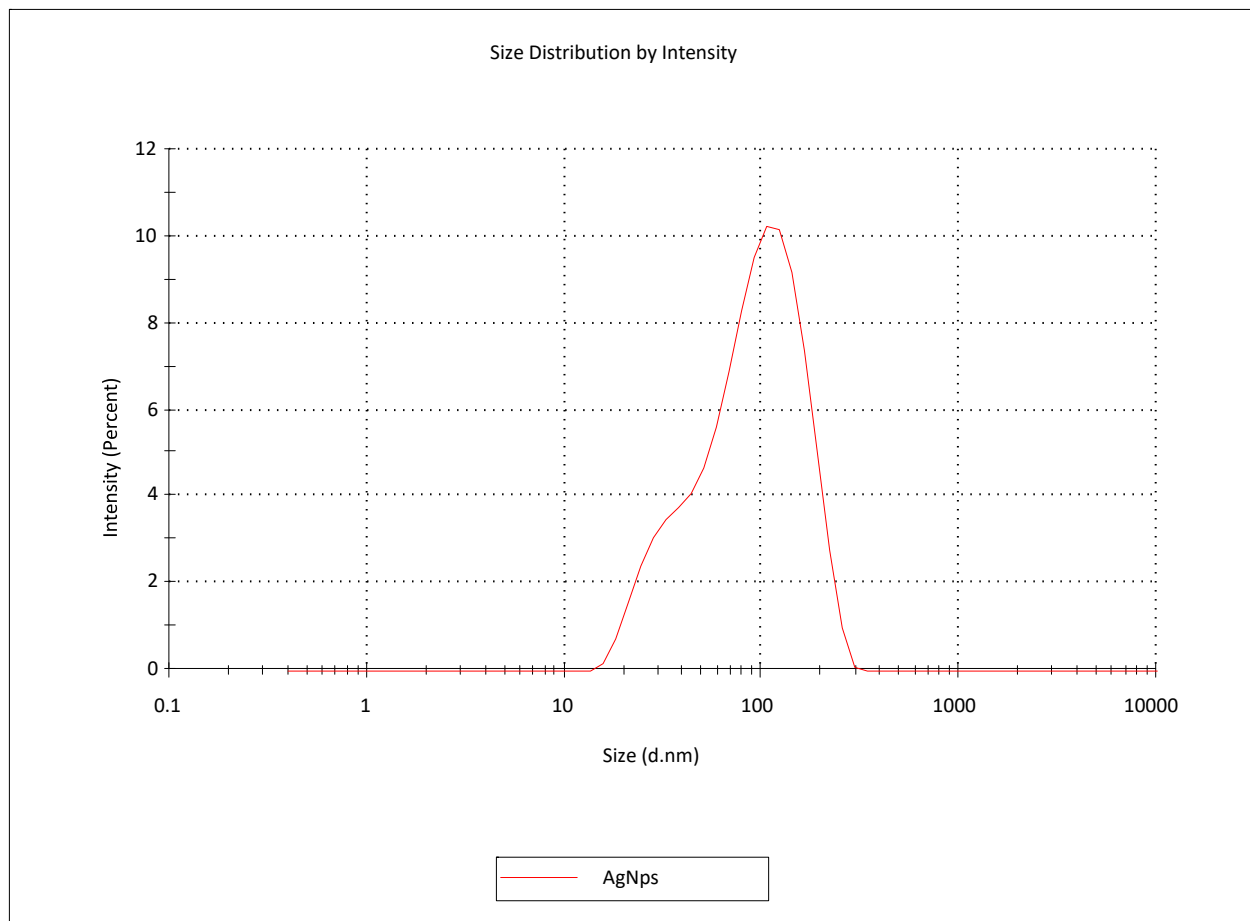


Fig 4.3.4. Size distribution report by intensity

4.3.5 AgNps applied on E.coli and B.Subtilis

Silver nanoparticles applied on E.coli[10] and B.subtilis and as a result , it stop the growth of E.coli and B.subtilis,can be seen in the fig.4.3.5.

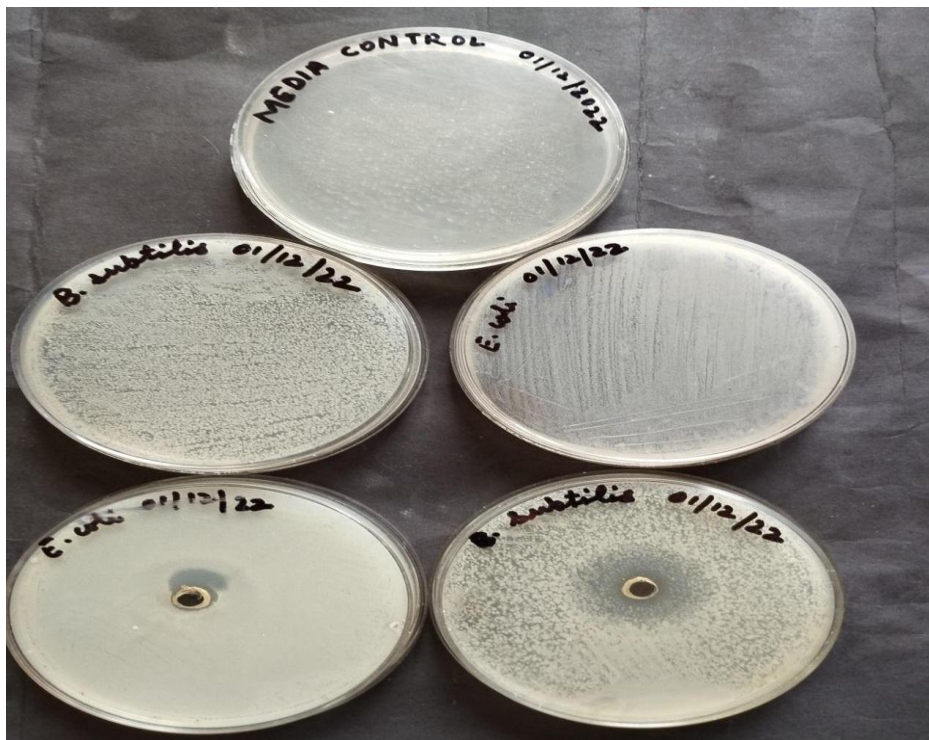


Fig.4.3.5 Effect of AgNps on E.coli and B.subtilis

4.4.Conclusion.

GAPAAFA acts as a reducing agent ,stabilizing agent and capping agent. It can observed without GAPAAFA hydrogel ,light grey solution due to aggregated silver atoms (fig.4.3.1b,d,f), can not be converted into stable silver nanoparticles, with time, light grey color become more dark, which is the sign of more aggregation of silver atoms and after some time blackish aggregated silver atoms settled down due to gravity. But, it can be observed ,adsorbed silver atoms by GAPAAFA from silver nitrate and borax solution ,can release silver atoms and make brownish/yellow silver nanoparticles which has confirmed by UV-VIS, DLS AND zeta potential..It can conclude on the basis of experiment , GAPAAFA act as stabilizing and capping agent.

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