RESEARCH PAPER

Nd:YAG Laser Ablation Used to Preparation Silver Nanoparticles and Its Antibacterial activity Against Staphylococcus and Klebsiella Bacteria

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ABSTRACT

In this research, the silver nanoparticles were prepared using Nd: YAG laser ablation in liquid (PLAL). with five laser energies that (160, 300 ,460, 600 and 760) mJ.It is a physical method based work on the principle of dividing metal ions into metal atoms, the following tests were showed on the silver nanoparticles was XRD diffraction, UV- Visible spectroscopy, transmission electron microscope(TEM). XRD diffraction that observed the silver nanoparticles was face-centered cubic (fcc) , UV- Visible spectroscopy that observed the best silver nanoparticles in 600 Jm that have the highest absorbance. And it the best sample. TEM show that the particle size of sample 600 mJ (20)nm with spherical shape good dispersion of the prepared sample . For the antibacterial activity, applied of silver nanoparticles on two types of bacteria gram-positive bacteria *taphylococcu* and gram-negative bacteria *Klebsiella* , to study the extent of their effect on these bacteria, silver nanoparticles proved to be very effective in killing the two types of bacteria.

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INTRODUCTION

Silver nanoparticles " AG_{np} " that have many properties like optical and electrical; and thermal so are start combined into products the variety like photovoltaics, biological, sensor so; chemical [1]. Biomedical procedures today comprise, silver nanoparticles the that have incessantly release a little level of silver ions to bring protection in contradiction of bacteria [2]. The interaction strong of the AG_{np}, with electromagnetic (light) occurs for the (C.E conduction electrons) in metal outward suffer a collective oscillation in when excited to the upper state via light at exact wavelengths (Fig. 1, a). anywhere the metal nanoparticle that are determined free electrons into oscillation due to a strong connection with a exact wavelength of event light. Acknowledged as a (surface Plasmon resonance (SPR); this oscillation results in oddly very strong scatterings absorption properties [3]. Actually, silver nanoparticles can have effective extinction scattering with absorption cross sections up and doing to ten times, larger than ;their physical cross section [4]. The very strong scattering cross section agrees for sub 100 nm nanoparticles to be easily imagined with a conservative microscope. The light bright blue color is for SPR that is peaked on a (450 nm wavelength) [5]. The most exclusive property for spherical shape AG_{np} is that the(SPR) peak wavelength can be altered from 400 nm to 530 nm with varying on particle size so the limited

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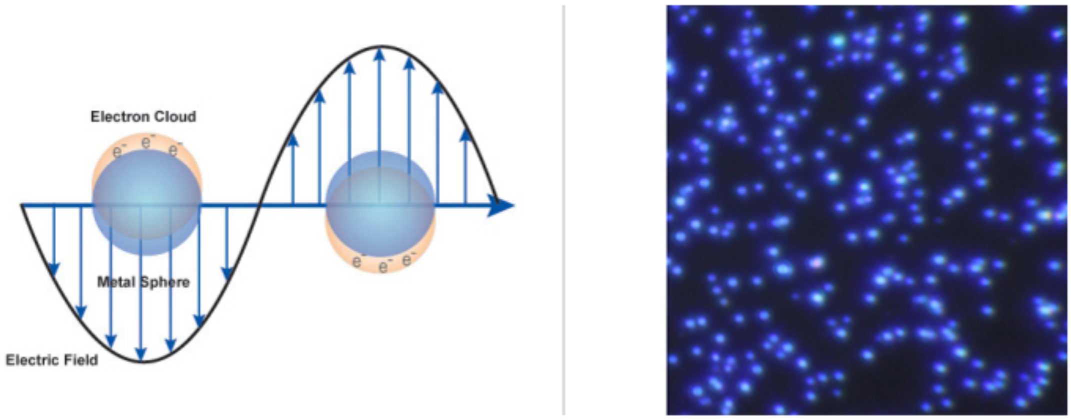

Fig. 1. (a) Surface Plasmon resonance (b) Dark field microscopy1 image of 60 nm AG_{np} [6].

refractive index close to the particle surface [6].

They are silver nanoparticles ranging in size from 1-100 nanometers. While it is described

Although they are often referred to as “silver”, some of them consist of a significant portion of silver oxide. Silver nanoparticles can be used in many applications and the commonly used silver nanoparticles are spherical.

The use of silver nanoparticles in catalysis has a great deal of interest in recent years. It is the most common use for medicinal purposes and bacterial inhibition.

MATERIALS AND METHODS

Preparation Ag NPs

The experimental setup castoff for the preparation of AG_{np} with pulsed Nd: YAG laser wave length (1064 nm) in altered energy (160,300,460,600,700) mJ appears in Fig. 2. The target was used a (10 × 10 ×2) mm in thickness silver foil piece99% pure from Sigma–Aldrich. AG_{np} were preparation in a glass tube filled with 10 mL of distilled water, the target must be moved in rotary surface plane parallel to the reduction the number of laser pulses irradiating in the similar spot area.

Preparation powder of silver nanoparticle AG_n

After preparing the liquid samples by pulsed laser ablation, the sample was inserted into an oven at 70 °C for two hours until the sample was dry and silver nanoparticles were obtained. One of the disadvantages of this technique is to obtain a small amount of powder, so the same experiment

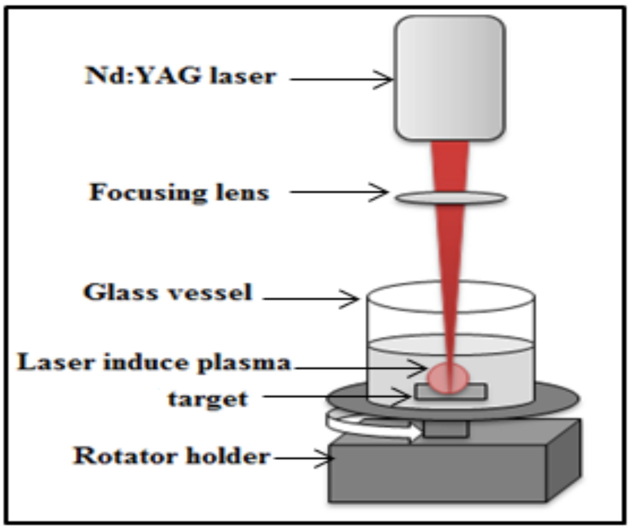

Fig. 2. experimental setup for laser ablation.

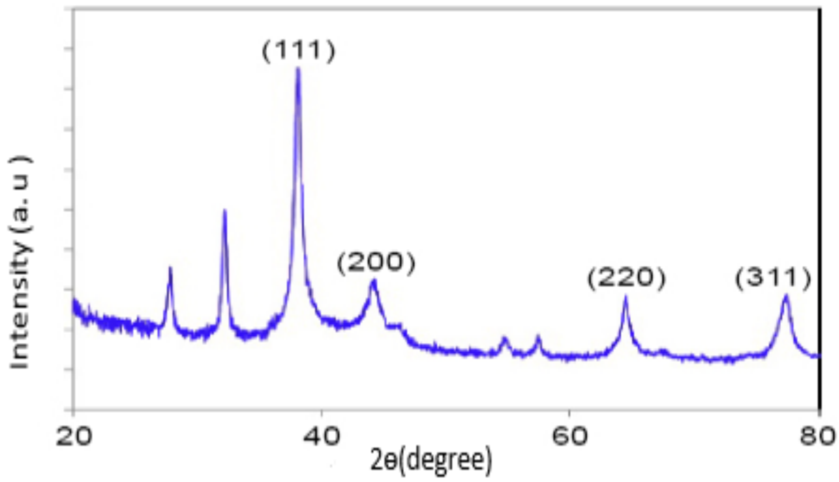

Fig. 3. XRD diffraction of AG_{np} preparation by laser ablation in 600 mJ.

is performed more than once to obtain a good amount for measurement XRD diffraction.

Preparation of Mueller Hinton Agar (MHA)

Dissolve 38 mg of (Mueller Hinton Agar) in one liter of distilled water. and then heat in stirrer (100CO) temperature and boil for one minute to totally liquefy of Mueller Hinton agar. We were put in an autoclave at (121 °C for 15 minutes). then cool to room temperature. Decant cooled Mueller Hinton Agar into sterile petri dishes on a side by side, horizontal surface to give identical depth. A consent cooling to room temperature [7,8].

RESULT AND DISCUSSION

Structure and Characterization for a silver nanoparticle AG_{np}

X-Ray Diffraction for silver nanoparticle

The crystalline property of the AG_{np} silver nanoparticles were studied using a technique XRD as additional certain by XRD analysis for the sample that prepare by laser ablation in energy 600 mJ due to that have the highest absorbance. The sample(600mJ) that significant specific peaks at 2θ values (38°, 46°, 64°, and 77°) correspond to (111), (200), (220), and (311) planes in face-centered cubic (fcc) silver crystal singly. The

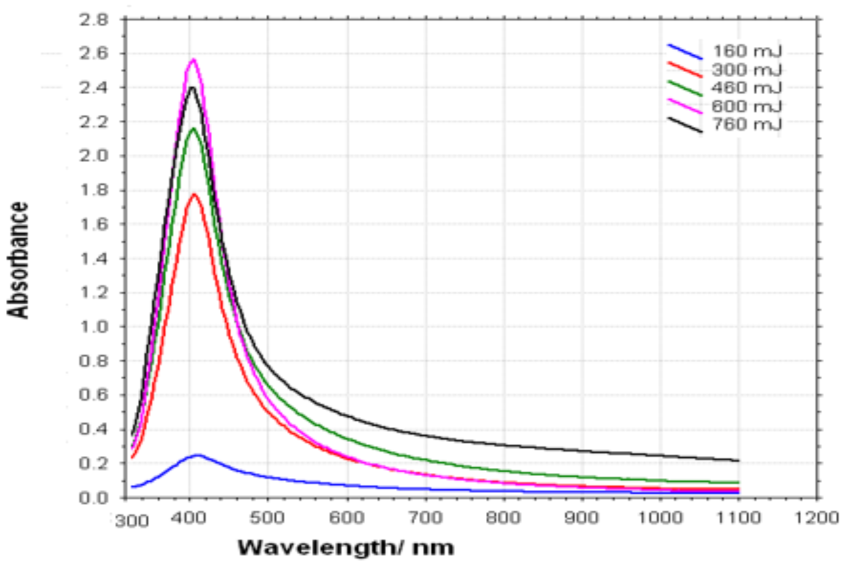

Fig. 4. UV-visible spectroscopy of AG_{np} preparation by laser ablation for different laser energy.

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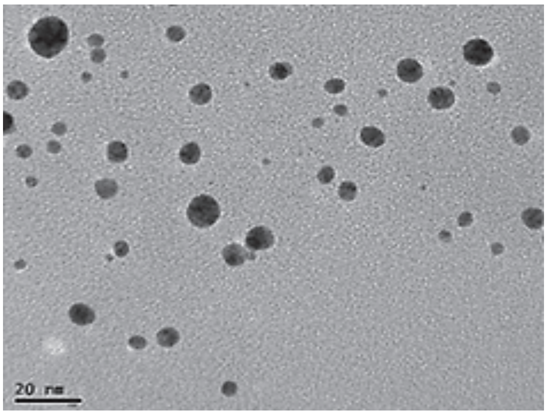

Fig. 5. TEM of AG_{np} preparation by laser ablation for in 600 mJ.

XRD results are in arrangement with various described values, authorizing the cubic structure of preparation AG_{np} [9,10] .The peak of plan (111), observed to be only wide, due to the size of silver nanoparticles as they expand as the size of silver nanoparticles decreases (Fig. 3) [11].

UV-visible spectroscopy of silver nanoparticle

One of the most commonly used tests is to identify different substances such as the biological molecule, mineral transitional ion, organic compounds The first indication of the good preparation of silver nanoparticles is the change of color of the colloidal solution from transparent to yellow and then to darker with increased laser energies. The laser energy is the main factor affecting the properties, size and concentration of the prepared silver nanoparticles. Fig. 4 shows the surface Plasmon resonance(SPR) absorption spectra of the colloidal silver nanoparticles solutions prepared with different energies (160,300,460,600 and 760) mJ, the shape appears to occur at about (400-405) nm, which is evidence of the formation of colloidal silver nanoparticles.

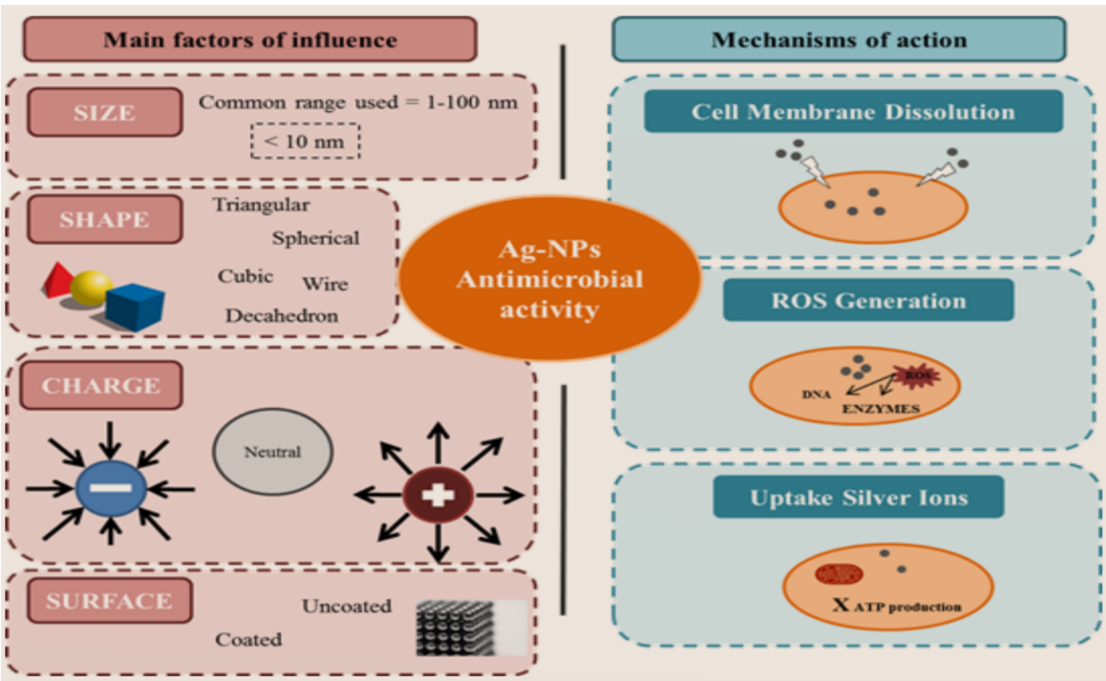

Fig. 6. Main important silver nano- activity mechanism

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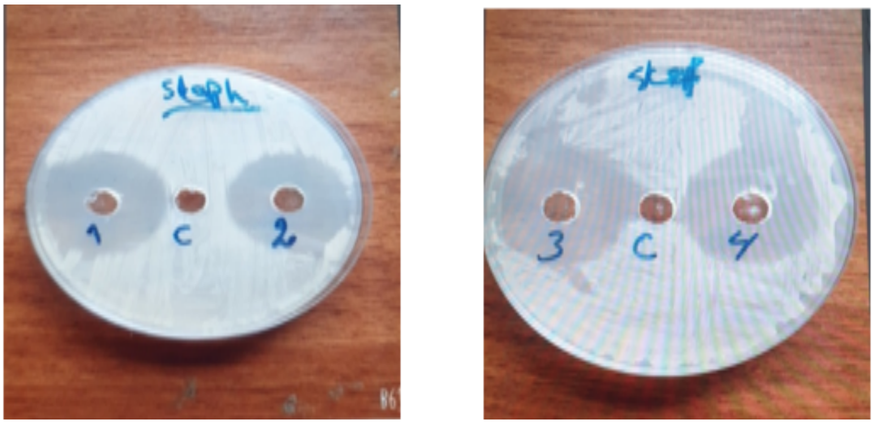

Fig. 7. Inhibition zone of Streptococci bacteria by silver nanoparticles (AG_n)in 600 Jm in different concentrations.

Fig. 8. Inhibition zone of Klebsiella bacteria by silver nanoparticles (AG_n) in 600 Jm in different concentrations.

Silver nanoparticles increase in absorbance and shift to the larger wavelength region, and this is evidence of the formation of particles with a larger size or vice versa for silver nanoparticles.

In Fig. 4, noticed the spectra maximum peek around (400-405) nm, which is a specific of spherical AG_{np} [11,12]. Absorption rate increased are experimental identical (160, 300, 460 and 600 mJ) when the laser pulses energy is increased, then absorption value is decreased in (760mJ). It can be credited to the detail that upper laser pulse energy products greater AG_{np} concentration [13].

Transmission electron Microscope (TEM) of silver nanoparticle

A transmission electron microscope is used to photograph liquid or soft samples, through which electrons can fall on the sample to form the image. In the Fig. 5. is a clear picture of the electronic microscope(TEM) carrier where it shows a picture of silver nanoparticles and theparticel size 20 nm, all of which appear in spherical form and this applies with the examination of the veal. The image also shows the good dispersion of the prepared sample, which is very suitable for medical applications [14].

Silver Nano activity mechanism

There are two important hypotheses for silver Nano activity mechanism:

The first is the direct interaction of silver particles with the bacterial cell wall. detailing this hypothesis, where the adhesion occurs between the positive charges of silver nanoparticles and the negative charges of cells through the force of electrostatic attraction between the charges and thus interact with sulfur and proton in the cell wall, which leads to its molecular dissolution

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followed by cell death. The second hypothesis is the release of silver ions and their breakdown after the entry of the nanoparticles into the cell leads to an increase in the reaction of oxygen, which will destroy the enzymes of the cell that are responsible in the process of respiration and thus the death of the cell. Inside some types of resistant bacteria may appear, but not for a long time, and this can be seen in the formed inhibition zone as the larger the area, the greater the effect of the prepared silver nanoparticles.

One of the killing mechanisms is penetration. due to Silver nanoparticles show interaction with bacteria and cause the possibility of silver nanoparticles penetrating the cell membrane, thus losing DNA's ability to reproduce, weakening the cell. Bacteria enzymes that transport cells and weaken cell cytoplasm are killed. In the Figs.7 and 8, the inhibition zone of nanoparticles is observed, which is clearly measured as found for Streptococci bacteria (15mm),and Klebsiella bacteria (13mm) [15,16].

Antibacterial activity of silver nano particle (AG_n)

Silver nanoparticles have biological activity for the is investigated against Gram negative bacteria Klebsiella, Gram positive Bacteria Streptococci by (well diffusion method) with different concentrations which is colloidal in the (distilled water) for solvent to be suitable flow into the Agar. Each sample solution put in the (Well) in the dishes. Then put in incubated at 37 ºC for 24 hours. After one-day was observed inhibition zone. The bacterial examine was completed by a good expansion method against AG-np_s. The(cultures) were swabbed on the sterile (MH) agar dishes with four wells complete by sterile stopper borer. The dishes ware incubated to detected the clear zone of inhibition around the wells for 24 hours [17,18].

CONCLUSION

In the present study, AG_n was prepared by Nd:YAG laser with a wavelength 1064 nm at an energy of 600 mJ for different concentration. The XRD and Uv-Visible analyses and TEM were used to investigate the crystallinity and absorption and size. The result of the analysis confirms the natural materials is Ag Nanoparticles. After preparation, we study the antibacterial activity against Gram Negative Bacteria Klebsiella, Gram-positive Bacteria Streptococci. Illustrate the inhibition zone of AG_n against Streptococci is more than Klebsiella, this behavior returns to the multi-reason including the sensitivity of Streptococci and the nature of the outer wall of bacteria Streptococci.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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