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Preparation of silver nanoparticles using Hyssop plant extract

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Abstract
In the production of silver nanoparticles, Ag-NPs, we relied on green chemistry, and the method included the use of an extract from the wild hyssop plant, which has great medicinal value according to modern medical studies. To prepare the necessary extract, a plant sample was collected from the highlands of the Syrian coast. To find the ideal concentration for the preparation, multiple concentrations of plant extracts were used to create silver nanoparticles. The study used an X-ray diffraction device (XRD), a visible light absorptiometry (UV-VIS), a scanning electron microscope (SEM), and then the resulting silver nanoparticles were measured and their nanosized range was determined. The highest wavelength that the silver nanoparticles could reach was also determined. It absorbs light within the wavelength range of 400-450 nanometers.
Key words: Silver nanoparticles, biological preparation, wild hyssop plant, X-rays diffraction, scanning electron microscope.

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I. Introduction:

Green chemistry aims to carry out chemical production processes in ways that preserve the environment and prevent harmful effects on public health, and it is one of the most important research trends within the field of chemistry at the present time. In the field of green chemistry, the technology of preparing nano-sized metal elements is crucial because it helps reduce hazardous waste and contributes to saving energy and resources [1].

Silver nanoparticles are very small particles of silver, ranging in size from 1 to 100 nanometers. These particles are of great importance due to their unique properties when they are nano-sized. It shows broad antimicrobial activity against a wide range of bacteria, germs, viruses and fungi. Its mechanism of antimicrobial action works through the release of silver ions that interfere with the metabolic processes of microbes and cause their death. These particles also have anti-inflammatory properties and reduce the production of inflammatory cytokines, which are molecules that trigger inflammation [2, 3].

On the other hand, some recent studies have shown that Ag-NPs have the ability to inhibit the growth of cancer cells, and this anti-cancer effect is attributed to the ability of these particles to generate reactive oxygen molecules, which can harm cancer cells, as has been applied in some studies. Which is currently being worked on by targeting the cancer cell only without causing harm to healthy neighboring cells [4].

In addition, Ag-NPs have important thermal and electrical properties, as they have high thermal transmittance, and they can also be incorporated into medical materials to improve thermal conductivity. It has high electrical conductivity properties and is used in electronic applications, such as fuel cells and transistors [5].

The biological preparation of nano-metallic silver is an important application of using green chemistry instead of using traditional chemicals, which may be dangerous and have a negative impact on the environment. This method uses biological materials, such as plant extracts, to accelerate silver production reactions. There are many advantages to using the biological method to produce nanosilver, including increased production process efficiency, reduced energy and resources required for conventional preparation, and greater environmental health through reduced use of chemicals and reliance on environmental resources [6, 7].

Hyssop, also known as David's Tooth, is an evergreen perennial that belongs to the Lamiaceae family. This plant has a lifespan of ten years or more. Hyssop - which some refer to as a weed - belongs to the family of perennial herbaceous plants. It grows to a length ranging

from 60 to 90 cm and has thin, pointed leaves (Figure 1) [8].

Hyssop contains extracts that act as antioxidants and also help the body break down complex carbohydrates, reducing the risk of high blood sugar. It can also be used as a nutritional supplement to prevent high blood sugar, as studies have shown that the oils found in the hyssop herb can help fight fungi, in addition to that these oils can prevent the growth of about 13 strains of fungi [9]. This plant also contains biologically important plant components, including tannins and phlegm that treat asthma and respiratory infections [10].

The preparation method in this study is based on specific biological reactions that stimulate the formation of silver at the nanoscale level, by using the plant extract as a source of compounds and materials that contribute to the extraction reaction and the formation of nanosilver. Ag-NPs have unique properties that make them ideal for diverse applications, such as pharmaceuticals, medical materials, and biotechnologies [11].

Figure (1): Wild hyssop plant

II. The importance of the research and its objectives

Silver nanoparticles are a subject of interest in nanomaterials research due to their special and distinctive properties in various fields, especially medical ones. Obtaining nanoparticles in a sustainable manner by using plants to benefit from them also contributes to preserving the environment, which makes this study one of the most important studies currently being conducted in many fields. In addition, the importance of this study is to focus on the economic and environmental aspect of obtaining nanoparticles by taking into account reducing production costs and achieving sustainability.

III. Materials and research methods

3.1. Preparation of plant extract

The sample of the fresh hyssop plant used in this research was collected from the countryside of the Syrian coast, and it was prepared according to specific stages, as it was washed well with distilled water several times to purify it of impurities if they were present. Work was done to determine the appropriate amount of plant in order to prepare nanoparticles.

The extraction process was carried out in the first stage by weighing 10 grams of the plant and mixing it with 100 ml of distilled deionized water in a glass beaker. The mixture was then heated on an electric heater at a temperature of oC90 degrees Celsius before reaching the boiling point for an hour, stirring occasionally. Then the mixture was left to cool at laboratory temperature. After that, the plant extract was separated using filter papers first, then using centrifugation second, and the plant extract was kept in the shade for 24 hours to monitor stability and color change.

In the second stage, after observing the color stability and homogeneity of the resulting solution, 100 grams of the studied plant were weighed with 1000 ml of distilled water, and the same previous preparation process was performed to prepare the required plant extract, where the plant extract was separated and preserved after obtaining it at a temperature of oC0 degrees Celsius. To later produce silver nanoparticles, Ag-NPs.

3.2. Preparation of silver nanoparticles (Ag-NPs)

Depending on the molecular weight, solid silver nitrate compound (100% purity, SIGMA-ALDRICH) was used to prepare a 100 ml solution at a concentration of 1 M. Bioformation reactions of silver nanoparticles were carried out depending on the amount of plant extract, according to specific proportions in several stages, in each of which 10 ml of a 1 molar silver nitrate solution was mixed with different volumes of aqueous plant extract, ranging from (0.5, 1, 1.5, 2).) ml in a glass beaker, then the glass beaker for all the prepared proportions was covered with aluminum foil in order to preserve the samples and avoid external contamination. After that, the solutions were heated according to the preparation proportions on an

electric heater at a temperature of 50°C for an hour with magnetic stirring at a speed of 150 revolutions per hour. minute.

The prepared solutions were then left to cool in a dark area and at laboratory temperature for 24 hours, to determine the appropriate amount of aqueous extract suitable for the preparation of silver nanoparticles. Observing the color change of the mixture was adopted as preliminary evidence of the formation of silver nanoparticles, as the color changed from yellow to brown. The degree of color and precipitation was also relied upon, and it became clear, from the color and the more stable precipitate, that a volume of 2 ml of plant extract is the appropriate volume for returning silver ions. Therefore, 50 ml of silver nitrate solution was mixed with 10 ml of aqueous extract at a temperature of 50oC for 1 hour with magnetic stirring at a speed of 150 rpm. The reaction was monitored using a UV-VIS visible light absorption meter during different time periods ranging from (10, 20, 30, 40, 50, 60) minutes.

The nanoparticles were re-prepared according to the same addition ratios in order to obtain a sufficient amount of nanoparticles by separating and drying the obtained particles to perform the required measurements.

3.3. Study samples

The prepared silver Ag-NPs were characterized using X-ray diffraction device, using radiation from copper metal [λ Kα1] = 1.54060 Å, scanning electron microscope (SEM), visible light absorptiometry (UV-VIS).

IV. Results and discussion

4.1. XRD diffraction

The resulting Ag-NPs were studied using an XRD device, and processing was performed using the Rietveld method based on the The results of the analysis showed the presence of particles in regular aggregates with few impurities and high purity, with a difference in the intensity of the peaks due to a difference in structure when the crystal size decreases towards the nano size, according to the reference crystalline silver spectrum, according to the X-ray diffraction database ICDD file JCPDS NO:04. -0783 for silver particles, as shown in (Figure 2).

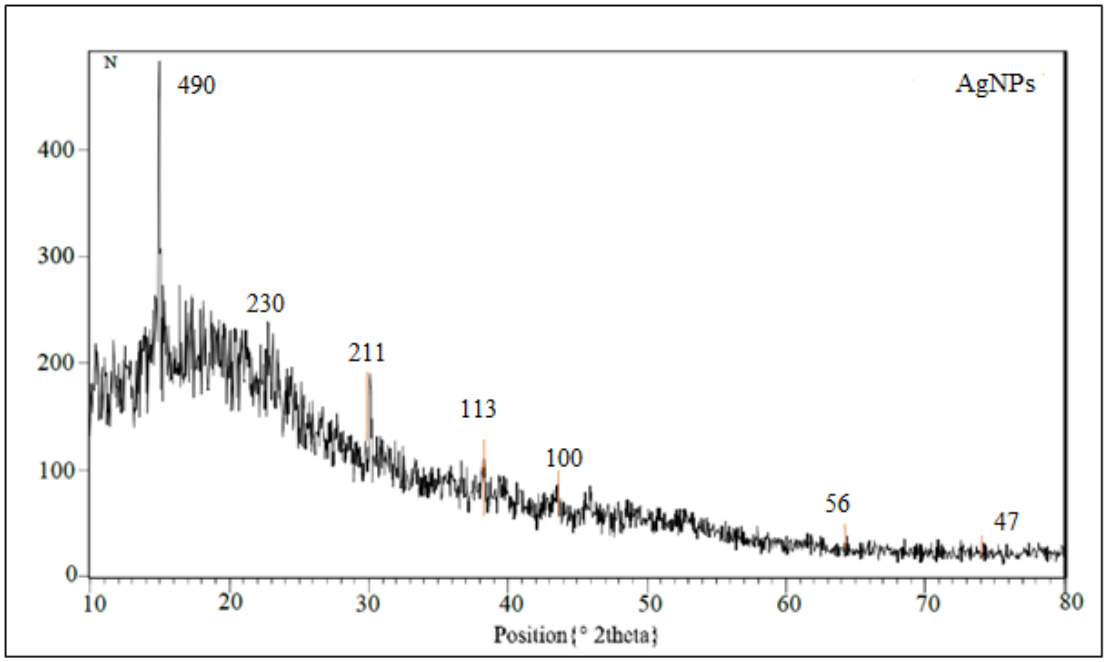

Figure 2: XRD spectrum of silver nanoparticles

4.2. Scanning electron microscope SEM

The structural morphology and size of the biologically produced Ag-NPs nanoparticles were examined using a scanning electron microscope. The results showed that, on average, the nanoparticles were regular aggregates with a spherical shape. The diameters of the nanoparticles ranged from 45.29 to 69.75 nm, and the sizes of silver nanoparticles typically ranged between 1 and 100 nm [12], indicating that the resulting Ag-NPs were formed at nanoscale size (Figure 3).

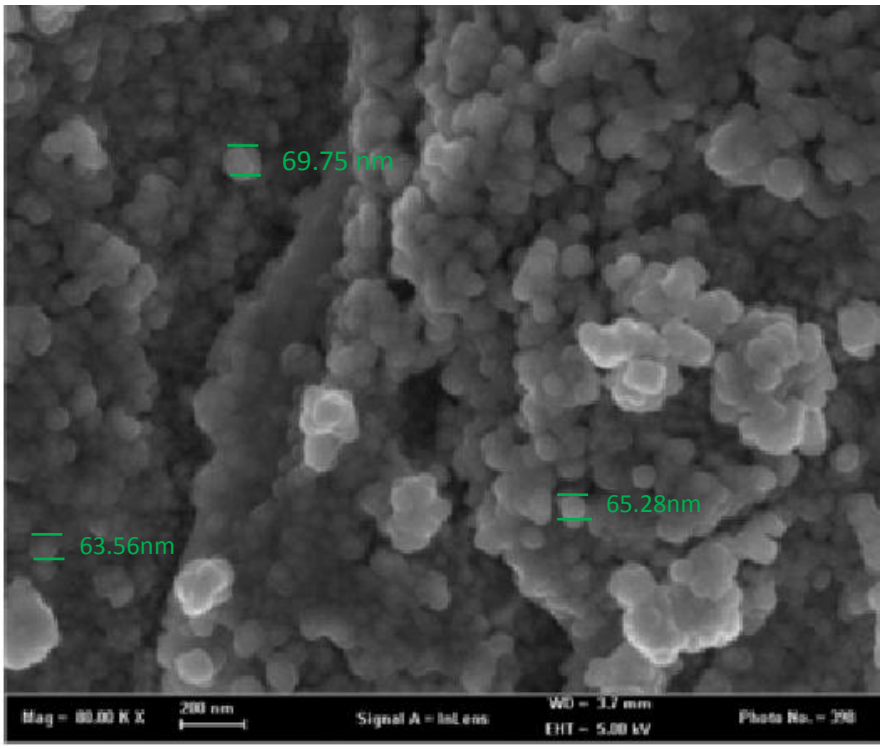

Figure 3: SEM image of silver nanoparticles

3.4. UV-VIS visible light absorptiometry

The bio-prepared silver nanoparticles were measured using visible spectroscopy in each sample to confirm the maximum absorption wavelength based on the concentration of the plant extract solutions (0.5-1-1.5-2) ml and the concentration of silver nanoparticles in the solution (Figure 4).

The typical wavelength range for the properties of silver nanoparticles is 400-600 nm. As the concentration of the resulting silver nanoparticles in the samples increases, the visible light spectra of nanoparticles prepared using aqueous extract of hyssop show a shift in the visible light absorption field, with the wavelength absorption peak in the field centered around 438–420 nm (as shown in Table 1).

The results showed that the return of silver ions Ag^{+} from silver nitrate solution to silver element Ag^{0} led to the formation of silver nanoparticles in the plant extract.

Table (1): Values of the maximum wavelength of absorption of silver nanoparticles in the prepared samples.

Concentration (mM)	Wave length (nm)	Absorption
0.5	420	0.925
1	428	1.244
1.5	434	2.233
2	438	2.658

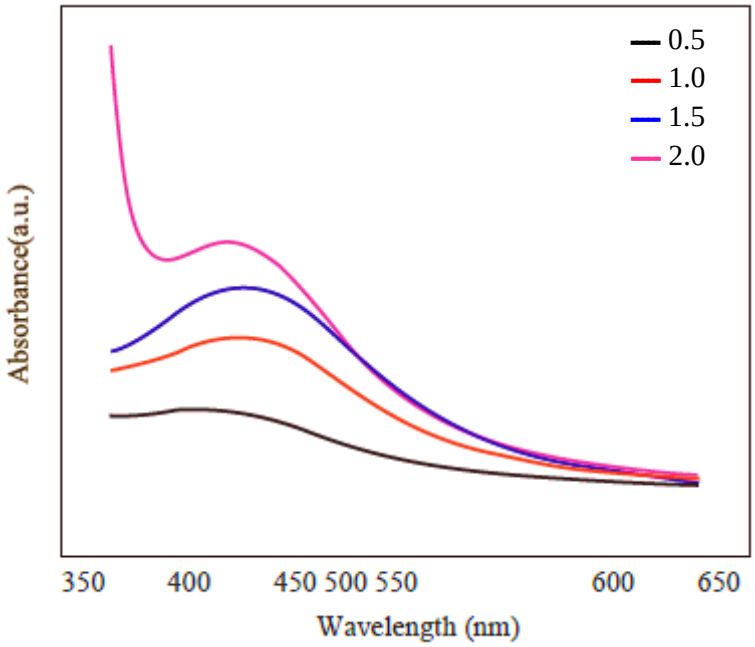

Figure: (4) Visible absorption spectrum of silver nanoparticles as a function of the concentration of aqueous plant extracts in the prepared samples

V. Conclusion

Silver nanoparticles were obtained within the wavelength range of 438–420 nm.The sizes of the resulting silver nanoparticles ranged between (45.29 - 69.75) nm.The best concentration of plant extract for nanosilver preparation was determined in 2ml samples. It is recommended to conduct biological study on fungi and bacteriocins of silver nanoparticles prepared from hyssop extract. In addition to preparing silver nanoparticles from hyssop extract at other concentrations and making a comparison between them.

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