

**Article**

**Green synthesis and characterization of silver nanoparticles using *Laurus nobilis* Leaves extract and degradation of methylene blue dye in polluted water**

**Rusul Sami Jabber\* and Zainab T. Y. Alabdullah**

Department of Chemistry, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq.

\*Corresponding Author. :Email: [Pgs.rusul.sami@uobasrah.edu.iq](mailto:Pgs.rusul.sami@uobasrah.edu.iq)

<https://orcid.org/0009-0004-9744-8852>, <https://orcid.org/0000-0003-1084-4939>

**Abstract**

In this work, extract from *Laurus nobilis* leaves was used as a capping and reducing agent during the manufacture of silver nanoparticles. The green-prepared silver nanoparticles were examined using UV-visible spectroscopy and scanning electron microscopy with energy dispersive X-ray (SEM-EDX). At 80 °C, the colour of the original solution changes to brown, signifying the creation of silver nanoparticles. The results indicate that the unique surface plasmon resonance peak of the silver nanoparticles is located at 435 nm. SEM data shows that the silver nanoparticles are spherical and have a particle size of less than 61.36 nm. 90% of the sample's surface was determined to contain silver, according to EDX approval. 55% of the methylene blue was degraded using synthesized silver nanoparticles.

**Keywords:** degradation, green synthesis, *Laurus nobilis* Leaves extract, silver nanoparticles.

**Introduction**

Because of its ability to modify materials at the nanoscale, nanotechnology has brought about changes in many scientific fields. Due to their robust antibacterial effect, distinct optical characteristics, and catalytic potential, silver nanoparticles—among the various varieties of nanoparticles—have garnered a significant of attention [1, 2]. Numerous techniques, such as chemical, physical, and biological ones, can be used to create silver nanoparticles; each has benefits and drawbacks of its own [3, 4].

evaporation-condensation or laser ablation, while chemical approaches typically involve the reduction of silver salts using different reducing agents [5, 6]. Utilising the reducing power of microbes or plant extracts, biological processes create nanoparticles in a way that is more eco-friendly [7, 8]. One biological method that has drawn interest is plant-mediated synthesis because of its economical and environmentally beneficial nature [9, 10]. Plants with natural proteins that function as stabilising and reducing agents have been employed to synthesise silver nanoparticles from leaves, stems, and roots [11, 12]. Green chemistry concepts can also be incorporated into the synthesis of nanoparticles to lessen their environmental impact and improve their biocompatibility, which makes them appropriate for use in pharmaceutical and medical applications [13, 14]. Plant-based synthesis has recently shown promise in generating nanoparticles with regulated size and shape, enhancing their usefulness in various applications [15, 18]. This work reviews the most popular synthesis procedures, emphasizing their mechanisms, benefits, and drawbacks. It also examines the characterization methods employed to evaluate the synthesized nanoparticles' characteristics.

Utilising plant components like leaves, stems, or roots, silver ions ( $\text{Ag}^+$ ) are converted to metallic silver ( $\text{AgO}$ ). Plant biomolecules, such as proteins, enzymes, and secondary metabolites, have dual functions as stabilising and reducing agents. Uses plant extracts rich in terpenoids, flavonoids, and polyphenols—natural reducing agents. Due to variations in extract content, both the biocompatible approach and this type of green synthesis have drawbacks. Moreover, numerous elements can impact the procedure, such as the type of plant used, the extraction technique, and environmental parameters like pH and temperature. However, the benefits include being affordable, safe for the environment, and able to create nanoparticles in a variety of sizes and forms. The methylene blue dye in contaminated water is broken down in this work using silver nanoparticles.

## **Experimental**

### **1. Prepare a solution of *Laurus nobilis* powder.**

Leaves of the *Laurus nobilis* tree were acquired from local markets. The leaves were then washed well with water several times. Then the leaves were left to dry for 10 days at 25 °C. After that, an electric grinder was used to crush the dried leaves into a very fine powder. 0.1 g of the ground and sieved powder with a size of 75 micrometres was taken, deionized with 100 ml of deionised water, and the extract was placed on a magnetic stirrer for an hour at a temperature of 90 °C, and then the extract was filtered.

## **2. Preparation of silver nanoparticles by the wet method**

25 ml of laurel powder solution was taken with 25 ml of silver nitrate solution (1000 ppm was prepared by dissolving (0.1 g) of silver nitrate in 100 ml deionized water) and placed on a magnetic stirrer at 80 °C for 5 minutes until the colour changed to brown due to the form of silver nanoparticles.



**Figure (1) shows silver nanoparticles and laser beam pass through the solution**

## **3. preparation of a methylene blue solution**

A methylene blue solution with a concentration of 1000 ppm has been prepared by adding 0.1 g of methylene blue to 100 ml of deionised water, and the other solution was prepared by dilution.

## **4. Study of the maximum wavelength ( $\lambda_{max}$ ) of methylene blue**

The absorbance of the dye solution, which is a ketogenic dye and whose chemical formula symbol is ( $C_{16}H_{18}ClN_3S$ ), was measured using a single-beam UV-visible spectrometer of the type (Spectrophotometers 303-PD). The maximum measured wavelength (663 nm) was determined as shown in figure (2).

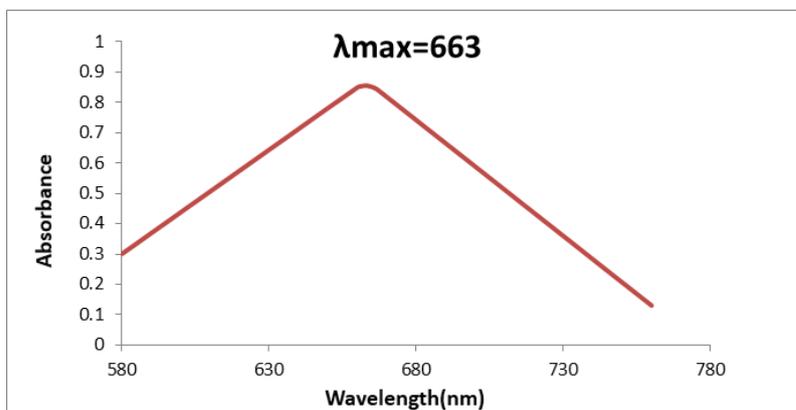


Figure (2) represents the UV-Vis spectrum of methylene blue dye.

## Results and discussion

### Investigation of surface plasmon resonance (SPR)

UV-Vis Spectroscopy, which uses the detection of the distinctive SPR peak to track the synthesis of silver nanoparticles.

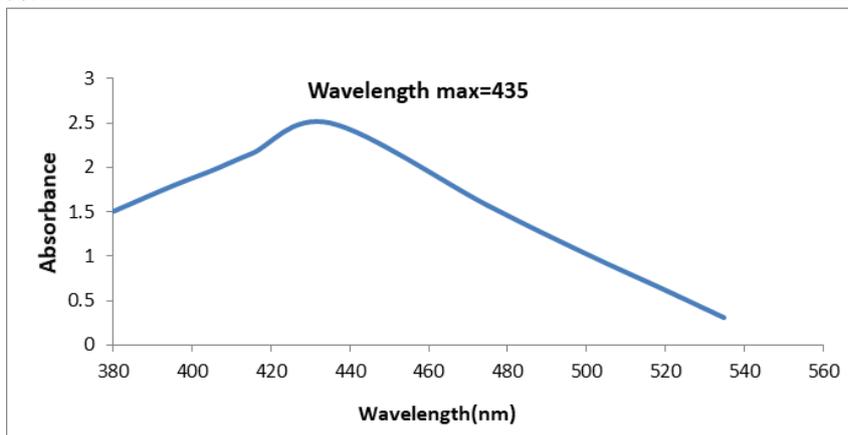
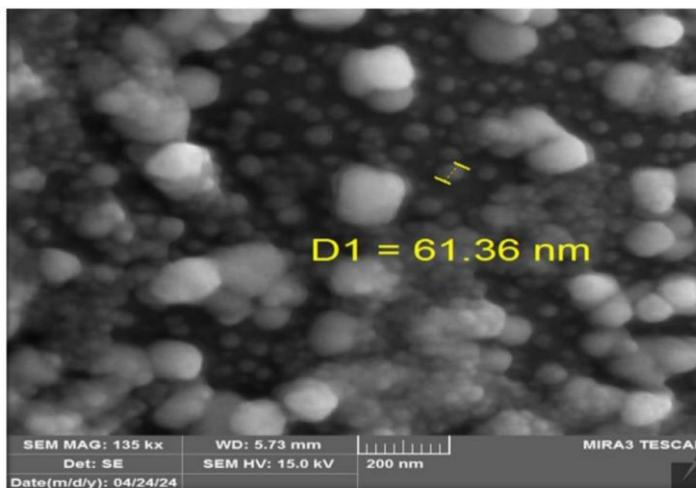


Figure (3) shows plasmon spectra for silver nanoparticles.

The solution obtained from a solution of silver nanoparticles prepared at a concentration of 1000 ppm showed a clearer surface plasmon resonance peak at 435 nm using a UV-Vis spectrometer and scanning at wavelengths from 380 to 500nm). This agrees with what others found [18] and the plasmon spectrum appeared as shown in Figure 3.

### Characterization by SEM

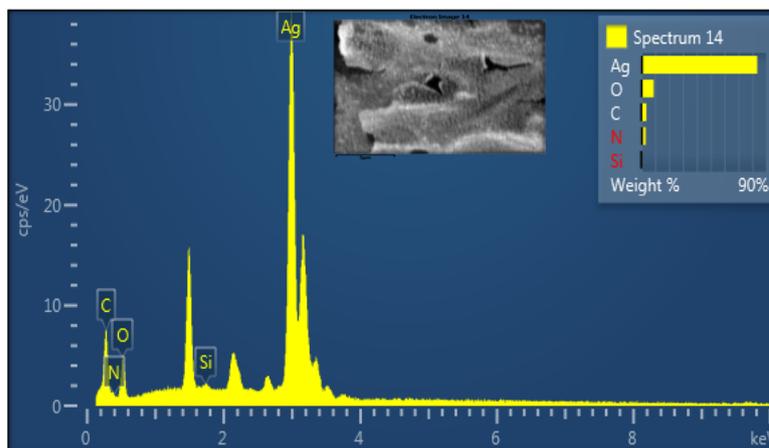
Study of the structure using a scanning electron device (SEM) of silver nanoparticles prepared by the wet chemistry method. The phenotypic characteristics of the silver nanoparticles prepared in this study were determined using scanning electron microscopy (SEM), as shown in Figure 4.



**Figure (4) Scanning electron microscope (SEM) images of the prepared silver nanoparticles**

SEM was used to study the nanoparticles outer surface, morphology, and size. The agglomerated particles appear in the image in the form of a small size due to the existing agglomeration, and the exact measurement for them cannot be calculated due to their morphological size. A clear image of the prepared silver nanoparticles appears, and they appear in spherical oval shapes. When EDX was done, it appeared at a size of 61.3 nm) as shown in Figure 5.

The presence of silver, oxygen, carbon, nitrogen and silicon atoms was shown through spectroscopy used for dispersed energy X-rays (EDX) to determine the components of the elements in the sample, as shown in figures 5 and 1. The EDX sample was detected and obtained sharp peaks from the Ag, O, C, and N components. The main output obtained shows the highest volume of silver (83.6%). As shown in figure 5, oxygen has a peak of 9%, carbon has a peak of 3.7%, nitrogen has a peak of 3.2%, and silicon has a peak of 0.3% [18].



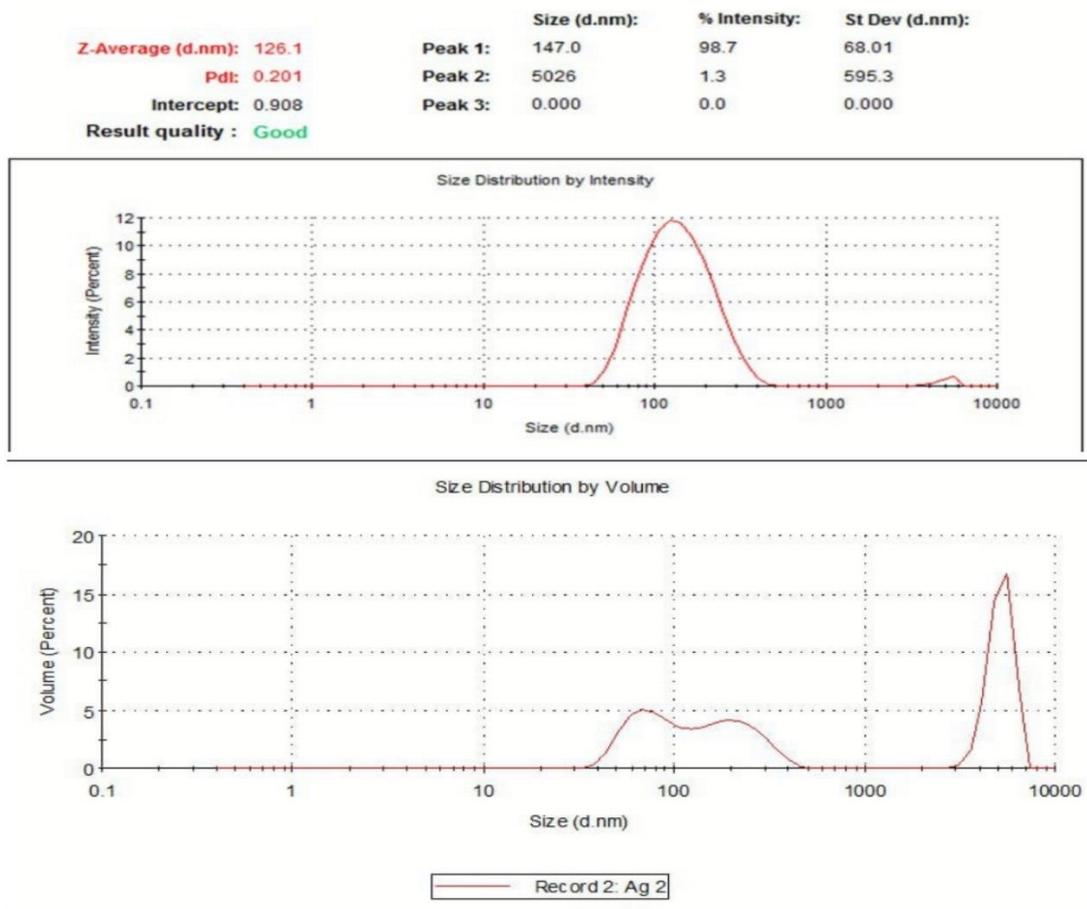
**Figure (5) X-ray diffraction (EDX) spectrum of silver nanoparticles**

Table (1) shows the percentages of elements composing the prepared silver nanoparticle sample.

Elements	Wt%
C	3.77
N	3.22
O	9.02
Si	0.37
Ag	83.62
Total:	100.00

**Dynamic light scattering of silver nanoparticles**

Figure (6) shows the range of sizes of silver nanoparticles prepared at a concentration of 1000 ppm. (a) represents the density of particle distribution. (b) represents the size distribution of particles.



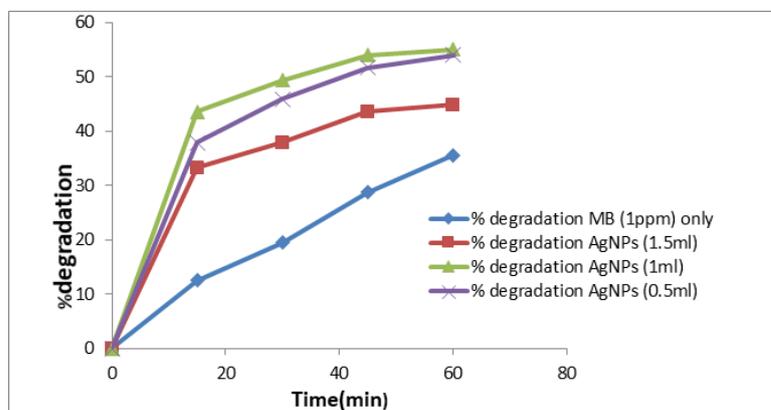
## Application of silver nanoparticles

### Investigating the impact of utilising varying silver nanoparticle sizes in a solution on the methylene blue dye's degradation.

Using three different sizes of silver nanoparticles (0.5 ml, 1 ml, and 1.5 ml), the degradation of methylene blue dye was investigated. Twenty millilitres of the methylene blue dye were mixed with these various sizes. Using visible light at a strength of 15 W, the dye's degradation was observed for one hour. Using a UV-Vis equipment, the absorbance was measured at the maximum wavelength of methylene blue dye (663 nm) at predetermined intervals (every 15 minutes). Over time, we observe a decline in the absorbance value and a progressive fading of the solution's hue. Table 2 and figure 7 displays the results.

**Table (2) represents the percentage of degradation of methylene blue dye using different volumes of silver nanoparticles and using of light source at (15W).**

Time(min)	degradation% of Methylene blue (0.5ml)	degradation% of Methylene blue with AgNPs (1ml)	degradation% of Methylene blue with AgNPs (1.5ml)	degradation % of MB only
0	0	0	0	0
15	37.9	43.6	33.3	12.6
30	45.9	49.4	37.9	19.5
45	51.7	54.0	43.6	28.7
60	54.0	55.0	44.8	35.6



**Figure (7) shows the degradation of methylene blue dye, using different volumes of nanosilver solution, and using a light source with a power of (15W)**

From the table, we note that the highest degradation of methylene blue dye is when using a volume of 1 ml of nano-silver solution, where the percentage was 55%, followed by using a volume of 0.5 ml of nano-silver solution, where the degradation was 54%. As for using a volume (1.5 ml) of nano-silver solution (44.8%).

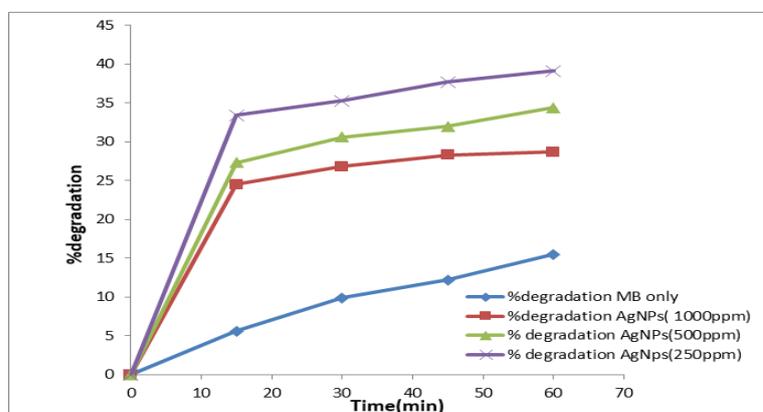
**2. investigating how applying solutions containing varying amounts of silver nanoparticles affects the methylene blue dye's breakdown**

Using three different concentrations of a wet-prepared solution of silver nanoparticles (250 ppm, 500 ppm, and 1000 ppm), the degradation of methylene blue dye was investigated.

These concentrations were taken in fixed volumes of 1 ml each, then applied to 20 ml of methylene blue dye. Visible light was used to study the degradation. The outcomes at a 15W power were displayed in Table 3 and Figure 8.

**Table 3 represents the percentage of degradation of methylene blue dye using different concentrations of nanosilver solution and a light source with a capacity of 15 W.**

Time(min)	degradation% of Methylene blue with AgNPs (1000ppm)	degradation% of Methylene blue with AgNPs (500ppm)	degradation% of Methylene blue with AgNPs (250ppm)	% of MB only
0	0	0	0	0
15	24.4	27.3	33.4	5.6
30	26.8	30.6	35.3	9.9
45	28.3	32.0	37.7	12.2
60	28.7	34.4	39.1	15.5



**Figure 8 shows the degradation of methylene blue dye using different concentrations of nanosilver solution and a light source with a power of 15 W.**

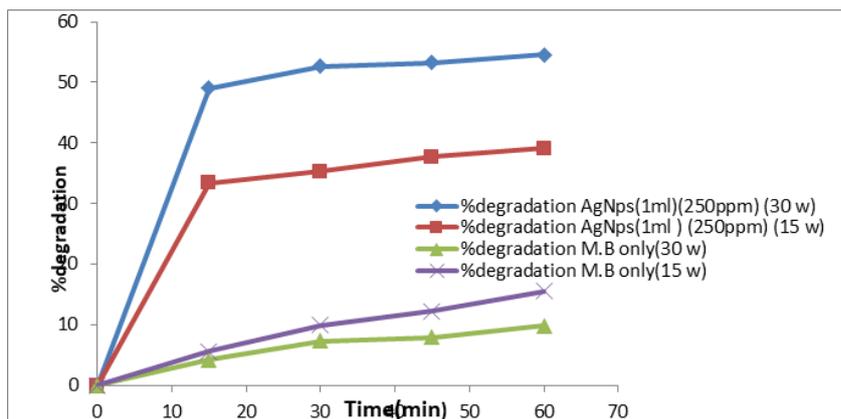
From table (3), we note that the highest degradation of methylene blue dye is using a nano-silver solution with a concentration of 250 ppm, where 39.1% of the dye was broken after an hour and using light, followed by the degradation of methylene blue dye using a nano-silver solution with a concentration of 500 ppm, where 34.4% was broken. % of the dye for the same time, followed by breaking the methylene blue dye using a nanosilver solution at a concentration of 1000 ppm, which broke 28.7% of the dye. (The higher the concentration, the greater the absorption, and thus the less cracking.)[18]

**3. Study of the degradation of methylene blue dye in the occurrence of different power light sources (15W and 30W) and prepared silver nanoparticles.**

In this study, a fixed size (1 ml) of prepared silver nanoparticles with a concentration of 250 ppm, which acts as a catalyst, methylene blue dye prepared with a size of 20 ml and a concentration of 1 ppm, and a different light source with a power of 15 and 30 watts were used, and the results appeared as shown in the table (4) and figure (9).

**Table 4 displays the percentage of methylene blue dye degradation using produced silver nanoparticles under various light conditions and with the size of the nanoparticles maintained.**

Time (min)	degradation% of Methylene blue (15W)	degradation% of Methylene blue with AgNPs (15W )	degradation% of Methylene blue (30W)	degradation% of Methylene blue with AgNPs (30W)
0	0	0	0	0
15	5.6	33.4	4.2	49.0
30	9.9	35.3	7.3	52.7
45	12.2	37.7	7.9	53.3
60	15.5	39.1	9.8	54.6



**Figure 9 shows the degradation of methylene blue dye in the presence of different light sources using prepared silver nanoparticles catalysts.**

Table 4 shows that the percentage of degradation of the methylene blue dye without using the prepared silver nanoparticles is very low, the percentage of degradation was low when using a 15-watt source, and the percentage of degradation of the organic dye methylene blue dye with the prepared silver nanoparticles was higher when using a light source (30-watt). The percentage of degradation was 54.6% higher than the percentage of degradation of methylene blue dye with silver nanoparticles prepared when using a light source with a power of 15 W, whose percentage of degradation was 39.1%. That is, the greater the intensity of the source, the greater the crushing.

### Acknowledgment

The author states their truthful appreciations to Chemistry Department, College of Education for Pure Sciences, University in Basrah, Iraq for the support of this study.

### Conclusion

Studies amply demonstrated the synthesis of AgO nanoparticles and revealed the presence of several phytochemicals in the plant extract, which serve as a capping and stabilizing agent for the generated AgO nanoparticles. From the analyses of results, it is obvious that the precursors have played a vital role in surface shape and structure of AgO nanoparticles. Our results confirm the potential of *Laurus nobilis* Leaves .

for the synthesis of AgO nanoparticles in a simple, quick and ecofriendly approach. AgO nanoparticles can be used for degradation of methylene blue dye in polluted water using visible light (tungsten lamp). With a degradation rate of 54.6% at a concentration of the dye of 1 ppm, the photodegradation experiments of these nanoparticles prove very excellent photocatalytic activity on methylene blue dye.

## **References**

- [1] S. K. Srikar et al., "A review on synthesis of nanoparticles and their applications," *Research Journal of Engineering Sciences*, vol. 2, no. 4, pp. 43-47, 2013. DOI: 10.5281/zenodo.1079258
- [2] N. Durán et al., "Mechanistic aspects in the biogenic synthesis of extracellular metal nanoparticles by peptides, bacteria, fungi, and plants," *Applied Microbiology and Biotechnology*, vol. 90, no. 5, pp. 1609-1624, 2011. DOI: 10.1007/s00253-011-3241-5
- [3] P. V. Kamat, "Photophysical, photochemical and photocatalytic aspects of metal nanoparticles," *Journal of Physical Chemistry B*, vol. 106, no. 32, pp. 7729-7744, 2002. DOI: 10.1021/jp0209289
- [4] A. K. Jha et al., "Plant extract mediated synthesis of silver and gold nanoparticles and their applications," *Journal of Nanoscience and Nanotechnology*, vol. 9, no. 12, pp. 1-20, 2009. DOI: 10.1166/jnn.2009.206
- [5] D. Philip, "Green synthesis of gold and silver nanoparticles using *Hibiscus rosa sinensis*," *Physica E: Low-Dimensional Systems and Nanostructures*, vol. 42, no. 5, pp. 1417-1424, 2010. DOI: 10.1016/j.physe.2009.11.118
- [6] P. Mohanpuria, N. K. Rana, and S. K. Yadav, "Biosynthesis of nanoparticles: technological concepts and future applications," *Journal of Nanoparticle Research*, vol. 10, no. 3, pp. 507-517, 2008. DOI: 10.1007/s11051-007-9275-x
- [7] J. Huang et al., "Biosynthesis of silver and gold nanoparticles by novel sundried *Cinnamomum camphora* leaf," *Nanotechnology*, vol. 18, no. 10, p. 105104, 2007. DOI: 10.1088/0957-4484/18/10/105104
- [8] G. Singaravelu et al., "A novel extracellular synthesis of monodisperse gold nanoparticles using marine alga, *Sargassum wightii* Greville," *Colloids and Surfaces B: Biointerfaces*, vol. 57, no. 1, pp. 97-101, 2007. DOI: 10.1016/j.colsurfb.2007.01.010
- [9] S. Shiv Shankar et al., "Biological synthesis of triangular gold nanoprisms," *Nature Materials*, vol. 3, no. 7, pp. 482-488, 2004. DOI: 10.1038/nmat1152

- [10] A. Ahmad et al., "Extracellular biosynthesis of silver nanoparticles using the fungus *Fusarium oxysporum*," *Colloids and Surfaces B: Biointerfaces*, vol. 28, no. 4, pp. 313-318, 2003. DOI: 10.1016/S0927-7765(02)00174-1
- [11] S. Iravani, "Green synthesis of metal nanoparticles using plants," *Green Chemistry*, vol. 13, no. 10, pp. 2638-2650, 2011. DOI: 10.1039/C1GC15386B
- [12] A. R. Shankar et al., "Synthesis and characterization of silver nanoparticles by using green chemistry," *International Journal of Green Nanotechnology: Physics and Chemistry*, vol. 1, no. 4, pp. 299-313, 2009. DOI: 10.1080/19430840903214666
- [13] N. V. Yallappa et al., "Green synthesis of silver nanoparticles using *Capsicum frutescens* and their bactericidal activity," *Research Journal of Biotechnology*, vol. 9, no. 2, pp. 83-90, 2014. DOI: 10.1016/j.jbiotec.2013.10.011
- [14] S. Jain et al., "Plant-mediated green synthesis of silver nanoparticles using *Daucus carota* seed extract," *Materials Letters*, vol. 147, pp. 73-76, 2015. DOI: 10.1016/j.matlet.2015.01.149
- [15] M. Sathishkumar et al., "Cinnamon zeylanicum bark extract and powder mediated green synthesis of nano-crystalline silver particles and its bactericidal activity," *Colloids and Surfaces B: Biointerfaces*, vol. 73, no. 2, pp. 332-338, 2009. DOI: 10.1016/j.colsurfb.2009.06.005
- [16] M. Veerasamy et al., "Biosynthesis of silver nanoparticles using *Mangifera indica* leaf extract and evaluation of their antimicrobial activity," *Journal of Saudi Chemical Society*, vol. 15, no. 2, pp. 113-120, 2011. DOI: 10.1016/j.jscs.2010.06.004
- [17] Z.TY Alabdullah and A.Saad, "Green Synthesis of Nickel Nanoparticles and their Application of Removal of Aliphatic Hydrocarbons from Crude Oil" *Iraqi Journal of Science*, 2021, Vol.62, No.11(Special Issue), pp: 4333-4341 DOI: 10.24996/ijcs.2021.62.11(SI).14
- [18] Z.TY AlAbdullah, I. Altameemi and A. Sadda, "A New Comparison between Ag-Nano Adsorbent and Walnut Shell Adsorbent" *Egypt. J. Chem.* Vol. 64, No. 8 pp. 4017 - 4026 (2021) DOI: 10.21608/EJCHEM.2021.63737.3388

