RESEARCH PAPER

Synthesis and Characterization of Silver Nanoparticles from *Triticum Aestivum* L. Extract

***Zainab Abas Abdul-Zahra* [1], *Ala'a H. Hussain* [1], *Inam Joudah Radhi* [1*], *and Radhiah Najm Abd* [2]**

[1] *Department of Chemistry, College of Education for pure Sciences, University of Karbala, Iraq*

[2] *Department of Biology, College of Education for pure Sciences, University of Karbala, Iraq*

ARTICLE INFO

Article History:
Received 22 May 2025
Accepted 09 August 2025
Published 01 October 2025

Keywords:
Ag nanoparticles
Antibacterial
Green approaches
Optimum condition
Zamioculcas Zamiifolia

ABSTRACT

The focus of this study has been the development of *Silver-Triticum aestivum L.* using the plant extract approach to create nanoparticles. This method deals with using the *Triticum aestivum L.* extract as a reducing agent, which converted silver ions to silver nanoparticles. This study utilized a *Triticum aestivum L.* extract as a capping agent to mitigate the aggregation of *Ag-Triticum aestivum L* nanoparticles. The formation of *Ag-Triticum aestivum L.* nanocrystals was confirmed by a color change from white to light yellow following a 24-hour incubation period. The dimensions and morphology of *Ag-Triticum aestivum L* nanoparticles were analyzed using field-emission scanning electron microscopy (FE-SEM). The FE-SEM images revealed that the prepared Ag-*Triticum aestivum L* nanoparticles have a diameter of 52.14–96.16 nm; our preparing particles have an average diameter of 77.16 nm, and they do not have uniform shape. While the cubic-like shapes are dominant. The characterization of the prepared Ag-*Triticum aestivum L* nanoparticles was conducted using Fourier transform infrared spectroscopy (FT-IR). To characterize the resulting Ag-*Triticum aestivum L* particles, an X-ray diffraction technique (XRD) and electrodispersive X-ray (EDX) were used.

How to cite this article
Abdul-Zahra Z., Hussain A., Radhi I., Abd R. Synthesis and Characterization of Silver Nanoparticles from Triticum Aestivum L. Extract. J Nanostruct, 2025; 15(4):1671-1677. DOI: 10.22052/JNS.2025.04.015

INTRODUCTION

Modern technology, or nanotechnology, has a broad range of applications involving the creation of particles or particles with a spectrum of nanoscales. The definition of nanotechnology is an advanced discipline that covers the manufacture, processing, and usage of multiple systems, installations, and devices made up of nano-modules [1,2]. Nanoparticles' small size, chemical makeup, and surface structure give them special qualities and characteristics. Because of the nanoparticles' huge surface area and tiny size, which are crucial for bridging the organic and inorganic phases of contaminants, this method is employed in the fabrication of nanomaterials to dispose of water pollutants [3, 4]. Due to its important uses in medical diagnosis and antibacterial coatings, silver nanoparticles have drawn the interest of numerous researchers in recent decades. Additionally, silver nanoparticles' antibacterial quality makes it possible to use them in a variety of products, including clothes and cosmetics. Silver nanoparticles, out of all the metal nanoparticles, have been examined

* *Corresponding Author Email: anaam,j@uokerbala.edu.iq*

in great detail due to their amazing mechanical, these characteristics make them suitable for a wide range of uses, including medical ones where they can be used to treat, diagnose, and probe cancer cells. Because of their surface-to-volume ratio and antibacterial properties, silver nanoparticles are useful ingredients in a variety of products, including textiles, household goods, and cosmetics. [5,6]. When compared to gold, copper, and other metals, silver metal has a high electrical conductivity, which makes it a great option for making conductive ink. Six Moreover, silver nanoparticle valence electrons show a robust surface SPR (plasmon resonance) at the surface of Ag-*Triticum aestivum L* NPs [Safe method for synthesizing silver nanoparticles using plant extract]. Under such conditions, a new substance that doesn't harm the ecosystem more and functions to return environmental conditions to their normal state using natural energy sources like sunlight must be found in order to address the challenge [7–9]. A substance is extracted from a matrix as part of the extraction process. Included are both liquid-liquid and solid-state extraction methods. The two-stage distribution of the solute is described by the partition theory as an equilibrium state. Extraction is determined by the manner in which the decomposer moves from water to the organic layer [10]. The extraction process is based on the spread or fragmentation of the solute between two solvents that are miscible with each other, and this process takes place in a special funnel extraction called a separation funnel. The extraction technique is used to separate one or more substances from each other, and it depends on solubility and miscessation. It is known that solvents dissolve their likenesses. [11–13[In this study, the active plant *Triticum aestivum L.*, which contains phenols and flavonoids among other bioactive components, was used. FTIR, FE-SEM, EDX spectroscopy, and the X-ray diffraction technique (XRD) were employed to analyze the resultant silver particles. We investigated our manufactured Ag-*Triticum aestivum L* nanoparticles' co-precipitation technique ability.

MATERIALS AND METHODS

Synthesis of Silver Nanoparticles

Distilled water was utilized in this research as a solvent to dissolve the initial ingredients. Silver nitrate was added to 200 mL of distilled water to create a solution of AgNO3 (4 mL, 10-4 M), which was then stirred for 30 minutes until no particles were visible. The silver was kept from oxidizing by storing the solution in a dark place.

Prepare Triticum aestivum L extract solution

1. The extract from Triticum aestivum L was chopped into small pieces and cleaned with distilled water.

2. Let these tiny bits of wheat extract dry at 70 °C in the oven.

3-The appropriate amount of 100 milliliters of distilled water was used to dissolve ten grams of the powdered Triticum aestivum L extract.

4- After heating the combination for 10 minutes to 90 °C, it was filtered and stored at approximately 7 °C. To make silver nanoparticles, 20 milliliters of the *Triticum aestivum L* extract solution and 80 milliliters of the silver nitrate solution were mixed together. This solution was then agitated and allowed to stand at room temperature for six

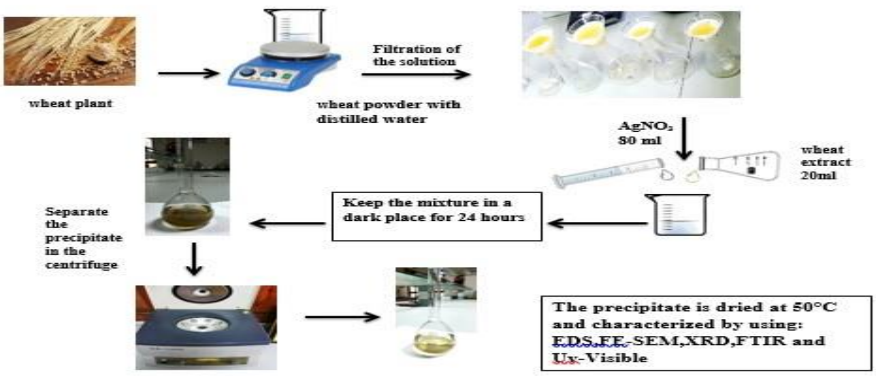


Fig. 1. Synthesis of Ag-*Triticum aestivum* NPs.

hours. The UV-Vis spectrometer was then used to record the solution's spectrum. To prepare for XRD, FTIR, FE-SEM, and EDX studies, the solution was centrifuged at 3000 rpm for 60 minutes. The sample was then dried at 75 °C [14], as seen in Fig. 1.

RESULTS AND DISCUSSIONS

When wheat extract is added to silver nitrate, the solution turns yellow. Fig. 1 illustrates how the solution changes to a brownish color after six hours at room temperature, signifying the synthesis of Ag-*Triticum aestivum* NPs. This alteration indicates that the *Triticum aestivum* extract reduces the silver ion, resulting in the formation of free Ag, which then expands to form clusters and nanoparticles. Utilizing the UV-1800 series Shimadzu spectrophotometer, the UV visible absorption spectrum was captured to offer additional insights into the Ag-*Triticum*

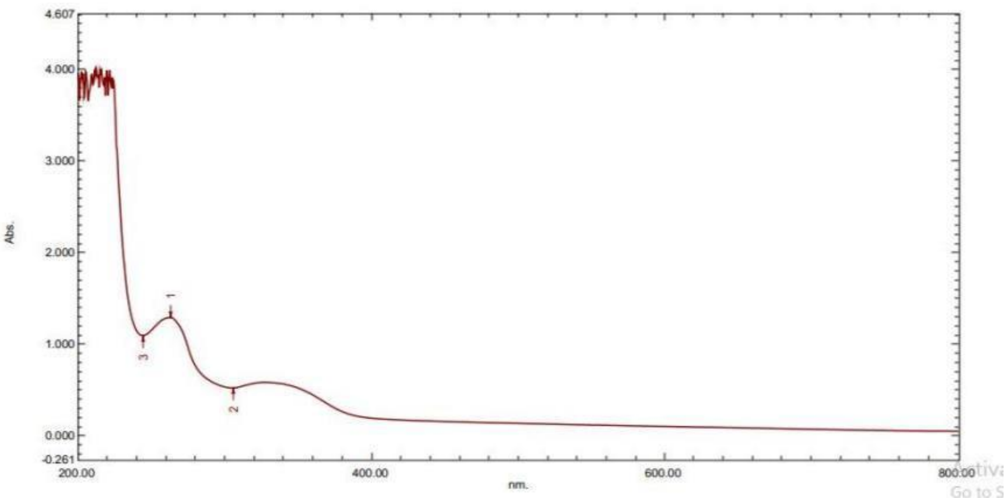


Fig. 2. Shows the violet ray spectrum of the surface of the nanomaterial.

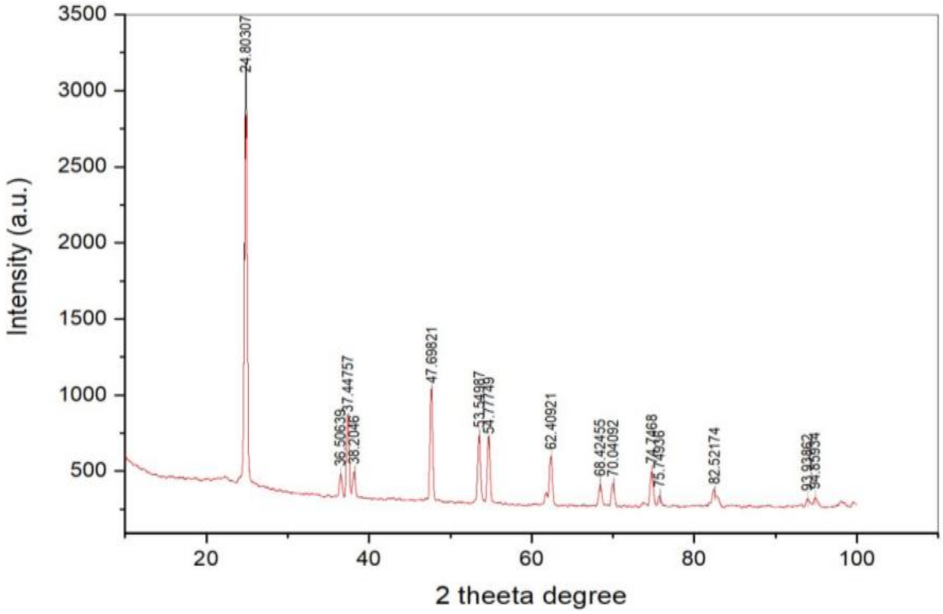


Fig. 3. XRD pattern for Ag-*Triticum aestivum L* NPs prepared using Litch Triticum aestivum L plant.

aestivum nanoparticle synthesis process.

When comparing the SPR band of the produced solution to that of bulk silver, Triticum aestivum L., it is evident from Fig. 2 that the latter shifted towards a longer wavelength (244,263,306) nm. As a result, the highest absorption wavelength utilized in all tests was 306 nm [15]. This transition can be explained by the way big silver particles develop. X-ray diffraction (XRD) analysis was performed to determine the crystalline nature [16] of the biosynthesized Silver-Triticum aestivum L nanoparticles. The XRD indicates the locations of the 14 peaks as follows: 24.80°, 36.50°, 37.44°, 38.20°, 47.69°, 53.54°, 54.77°, 62.40°, 62.42°, 70.04°, 74.74°, 75.74°, 82.52°, 93.93°, and 94.85°. Refer to Fig. 3. and proposing the Silver-Triticum aestivum L nanoparticles' FCC phase structure. The XRD data is used to calculate the size of the silver nanoparticles using Scherrer's equation.

$$\text{Crystalline size (D)} = \frac{K\lambda}{\beta \text{Cos}\theta} \text{ (nm)} \quad (1)$$

Crystalline size (D) = where β is the full width at half maximum (in radians), θ is the diffraction angle, and λ is the wavelength of the Cu-Kα X-ray (λ = 1.5406 Å). Debye-Scherrer constant is denoted by K. FT-IR analyses were carried out using Triticum aestivum L extraction to pinpoint the biomolecules in charge of the reduction process that converts Ag ions into Ag-Triticum aestivum L NPs [17].

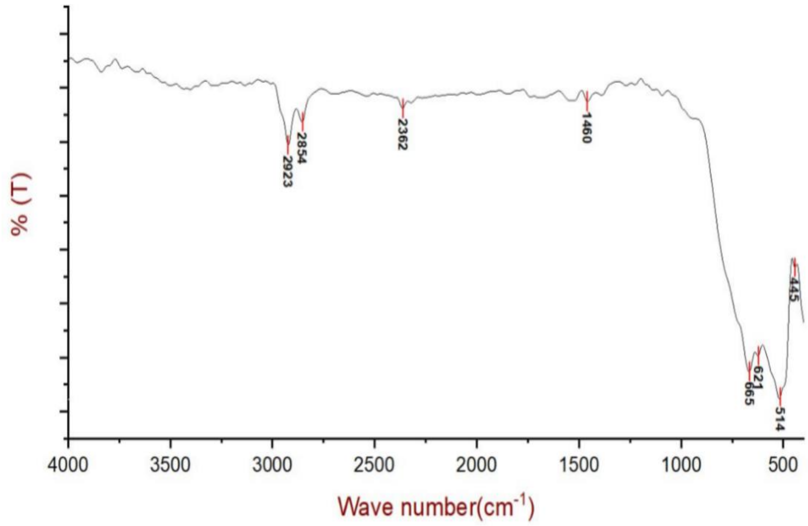


Fig. 4. FT-IR spectrum for Ag-*Triticum aestivum L* NPs.

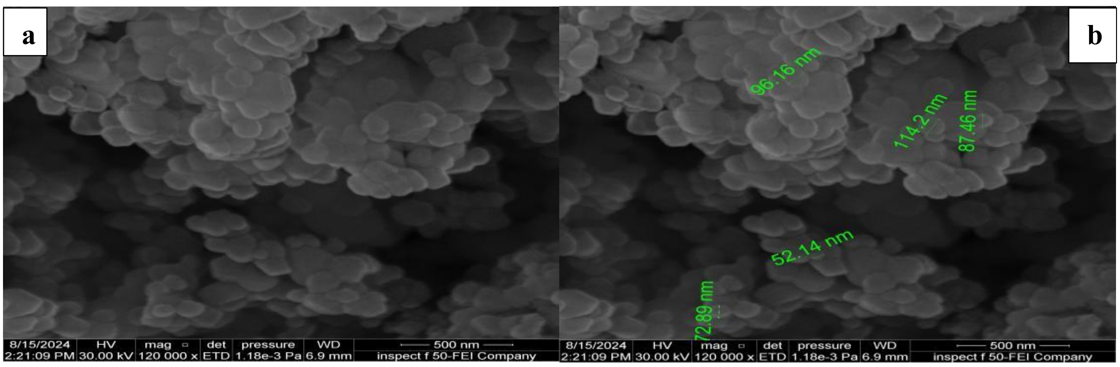


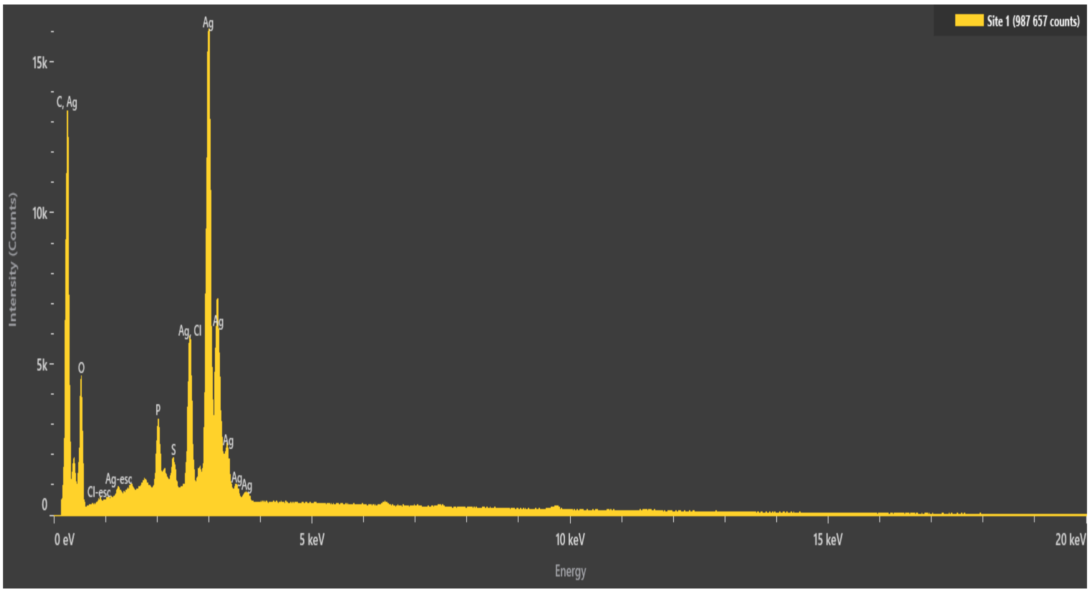
Fig. 5. FE-SEM spectrum (a,b) for Ag-*Triticum aestivum L* NPs without and with diameters respectively.

Fig. 4 shows peaks of 665,621,514,445) cm^{-1} for (-OH), 1460 cm^{-1} for (-C=O), 2362 cm^{-1} for (-C=N-), and 2923, 2854 cm^{-1} for (-C=C-).

The average size and surface morphology of the generated materials were determined by FE-SEM analysis, as shown in Fig. 5a, and b. The produced Ag-*Triticum aestivum L* nanoparticles had diameters of 52.14, 72.89, and 87.46.96.16 nm, according to the FE-SEM pictures. This is because Ag-*Triticum aestivum L* NPs are kept from aggregating by the Ag-*Triticum aestivum* extract, which functions as a capping agent [18]. Based on the FE-SEM images, the average diameter of Ag-*Triticum aestivum L* particles was determined to be approximately 77.16 nm.

The presence of the Ag-*Triticum aestivum L* NPs was confirmed by energy dispersive X-ray dispersive spectroscopy, or EDX. The Ag-*Triticum aestivum L* NPs nanocrystal line exhibits strong and precise diffraction peaks, indicating good crystallinities. The EDX spectra of the pure Ag-*Triticum aestivum L* NPs reveal the presence of only C, O, P, S, and Cland Ag. Table 1, provides a semi-quantitative assessment of the atomic concentration (atom%). It indicates that the products' Ag-*Triticum aestivum L* NPs element content is (33.0, 24.5, 1.5, 0.4, 3.8, 3.0, and 36.8) for Carbon (C), Oxygen (O), Phosphor (P), Sulphur (S), Chlorine (Cl), and Silver (Ag).

Fig. 6 displays the EDX data. It is clear from this that the weight ratios of Ag-*Triticum aestivum L* NPs were 32.0, 1.0, 0.3, 2.3, and 7.1%, in that order. The sample had all of the required phases of Ag, according to the EDX analysis, and the Ag-*Triticum aestivum L* NPs that were generated were extremely pure. The EDX results from this analysis



Map sum spectrum of TiO_2/AC NPs		
Elementa l	**Atomic %**	**Weight%Erroe**
C	57.3	0.2
O	32.0	0.3
P	1.0	0.0
S	0.3	0.0
Cl	2.3	0.0
Ag	7.1	0.2

Fig. 6. Pure Ag-*Triticum aestivum L* NPs elemental mapping and EDX analysis.

show similar C, O, P, S, Cl, and Ag ratios that are close to the theoretical values. Ag-Triticum aestivum L NPs samples' chemical composition is revealed by EDX analysis.

The produced samples are mostly made up of O, C, Cl, and Ag with very little P and S present, as

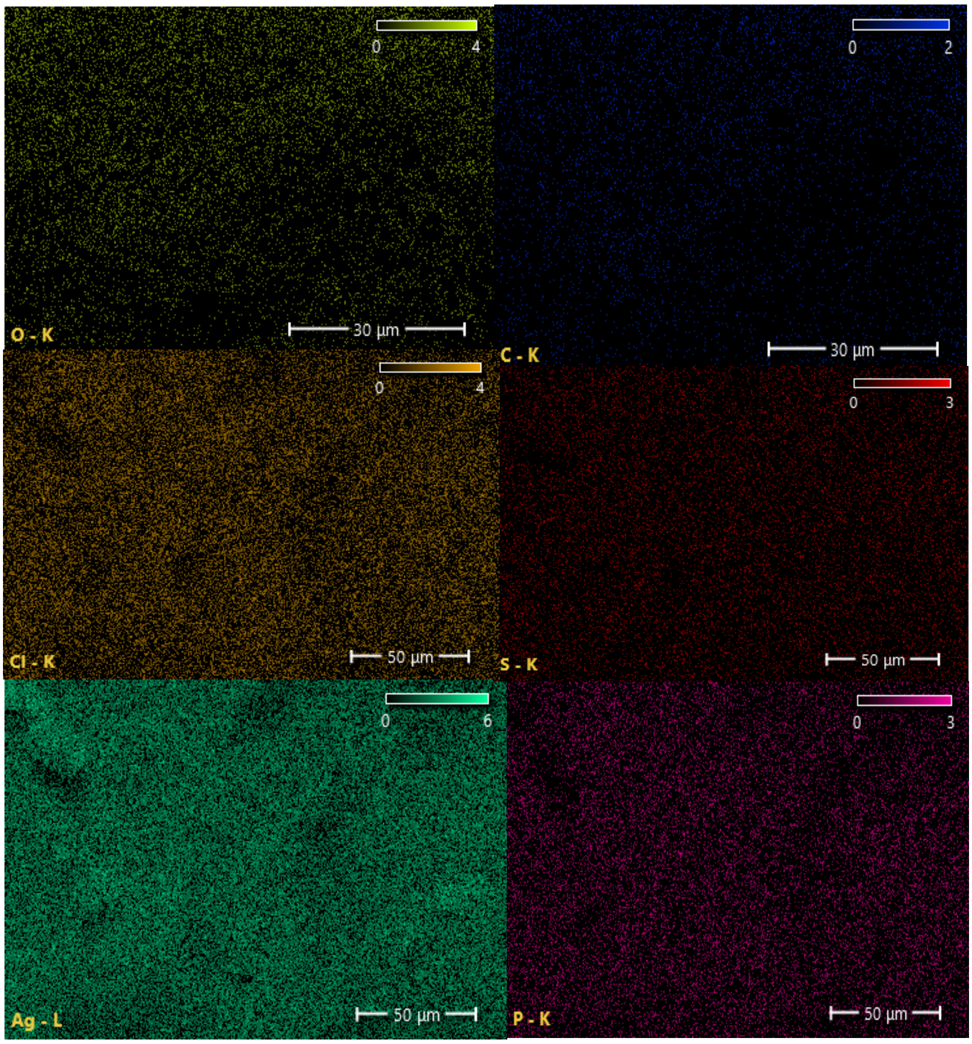


Fig. 7. EDX analysis for Ag-*Triticum aestivum L* NPs.

Table 1. Ag-*Triticum aestivum L* NPs composition was examined using EDX.

Elements	Atomic %	Atomic % Error	Weight %	Weight % Error
C	57.3	0.3	33.0	0.2
O	32.0	0.4	24.5	0.3
P	1.0	0.0	1.5	0.0
S	0.3	0.0	0.4	0.0
Cl	2.3	0.0	3.8	0.0
Ag	7.1	0.0	36.8	0.2

shown in Fig. 7.

CONCLUSION

This work involves putting Ag metal onto nano-plant extracts. Ag-Triticum aestivum L nanocomposite preparation using chemical precipitation technique. Identification and investigation of a few uses for Ag-Triticum aestivum L nano extract. Because the extract acts as a capping agent, our produced particles, which have a diameter of (~77.16) nm and a non-uniform shape, do not form huge lamps. Ultimately, Ag-Triticum aestivum LNPs' XRD, FTIR, FESEM, and EDX data demonstrated that they are crystalline and have an FCC structure.

ACKNOWLEDGMENT

Authors are grateful to the University of Karbala, College Eduction for Pure Science for supporting this work through the project: "Synthesis and characterization of silver nanoparticles from *Triticum aestivum L.* Extract".

CONFLICT OF INTEREST

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

REFERENCES

1. Malik S, Muhammad K, Waheed Y. Nanotechnology: A Revolution in Modern Industry. Molecules. 2023;28(2):661.
2. Gupta SRN. Advances in Molecular Nanotechnology from Premodern to Modern Era. International Journal of Materials Science and Engineering. 2014.
3. Aslan N. Synthesis and Characterization of ZnO@Fe_3O_4 Composite Nanostructures by Using Hydrothermal Synthesis Method. Türk Doğa ve Fen Dergisi. 2022;11(1):95-101.
4. Kansal SK, Ali AH, Kapoor S, Bahnemann DW. Synthesis of flower like zinc oxide nanostructure and its application as a photocatalyst. Sep Purif Technol. 2011;80(1):125-130.
5. Hanafy M. Green Synthesis and Characterization of TiO2 Nanoparticles Using Aloe Vera Extract at Different pH Value. Basic and Applied Sciences - Scientific Journal of King Faisal University. 2020.
6. Fabrication and Characterization of Silver Nanoparticles Using Plant Extract. International Journal of Pharmaceutical Research. 2020;12(02).
7. Lachheb H, Puzenat E, Houas A, Ksibi M, Elaloui E, Guillard C, et al. Photocatalytic degradation of various types of dyes (Alizarin S, Crocein Orange G, Methyl Red, Congo Red, Methylene Blue) in water by UV-irradiated titania. Applied Catalysis B: Environmental. 2002;39(1):75-90.
8. Kh. Utilization from Cement Kiln Dust in Removal of Acid Dyes. Am J Environ Sci. 2012;8(1):16-24.
9. Saiqa Ikram SA. Silver Nanoparticles: One Pot Green Synthesis Using Terminalia arjuna Extract for Biological Application. Journal of Nanomedicine and Nanotechnology. 2015;06(04).
10. Mittal M, Sharma M, Pandey OP. UV–Visible light induced photocatalytic studies of Cu doped ZnO nanoparticles prepared by co-precipitation method. Solar Energy. 2014;110:386-397.
11. Sakkas D. The use of two density gradient centrifugation techniques and the swim-up method to separate spermatozoa with chromatin and nuclear DNA anomalies. Hum Reprod. 2000;15(5):1112-1116.
12. Yamaji A. The multiple inverse method: a new technique to separate stresses from heterogeneous fault-slip data. Journal of Structural Geology. 2000;22(4):441-452.
13. Amsterdam A, Jamieson JD. Studies on Dispersed Pancreatic Exocrine Cells. The Journal of Cell Biology. 1974;63(3):1037-1056.
14. Mashkour MS, Kahlol MK, Al-Hasnawi SW. Colorimetric Determination of Metoclopramide Hydrochloride and Glutathione by using 1,2 Naphthaquinolinc-4-Sulphonate Sodium Reagents. Research Journal of Pharmacy and Technology. 2018;11(8):3290.
15. Wdaah AH, Idan Salman H, Balakit AA. Synthesis and characterization of selenium-polyvinyl alcohol nanoparticles as eco-friendly corrosion inhibitor for carbon steel in 1.0 M H_2SO_4. Inorg Chem Commun. 2024;165:112505.
16. Abdel-Megeed A, Abdel-Rheim KHM, Kordy AMA, El-Ghannam SA, Salem MZM, Adel MM. Duckweed (Lemna minor) biomass aqueous extract-mediated synthesis of silver nanoparticles as a novel formulation era for long-term efficacy against Tribolium castaneum and Sitophilus oryzae adults on wheat seeds. Biomass Conversion and Biorefinery. 2024;15(4):5429-5446.
17. Al Hindawi AM, Joudah I, Hamzah S, Tarek Z. Plant extract: safe way for fabrication silver nanoparticles. IOP Conference Series: Materials Science and Engineering. 2019;571(1):012069.