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RESEARCH PAPER

Facile Green Synthesis of Silver Nanoparticle using Iraqi Wheat Leaf extract and study some of Characterization

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ABSTRACT

Green methods were effectively used in this study to produce silver nanoparticles. Green biosynthesis was used to create silver nanoparticles using plant extract (Iraqi wheat, Triticum aestivum L.). This study looked at how wheatgrass extract worked as a reducing agent. The as-synthesised silver nanoparticles were characterized and the existence of metallic silver ions confirmed using a range of physical methods, such as energy dispersive X-ray (EDX) detectors, field emission scanning electron microscopy (FE-SEM), and powder X-ray diffraction (XRD). Phenols were identified as the primary reducing agents in the plant extract by FT-IR analysis and UV-vis spectroscopy. Given that wheatgrass extract is a crucial capping agent, Its existence on silver nanoparticle surface was examined utilizing The FTIR study's findings verified that there were many functional groups on the nanoparticles' surface. In summary, this approach offers a straightforward, economical, and environmentally responsible method of creating nanoparticles without the use of dangerous chemicals.

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INTRODUCTION

The study of environmental engineering is crucial for improving human well-being. There are numerous uses for nanotechnology in environmental engineering. During the past few decades, a variety of nanostructures have been synthesized using an environmentally friendly and green approach. Numerous kinds of nanostructures, include metal nanostructures, metal oxide nanoparticles, magnetic nanoparticles, and nanocomposite [1,3], were synthesized using this method [4]. The most significant nanomaterials are silver nanoparticles (AgNPs), which are employed in roughly 24% of all nanotechnology applications. AgNPs have been utilized in the production of herbicides and insecticides, the breakdown of hazardous compounds, and as a disinfectant because of their catalytic activity [5]. Different fruit extracts, plants, microorganisms, and biodegradable polymers were used in the green synthesis of the nanomaterials. These organic substances have a significant impact on the stability, shape, and particle size of nanostructures. These days, a lot of researchers are interested in metal nanoparticles (MNPs) due to their physicochemical characteristics and their numerous applications. Nanoparticles, which range in size from (3 to 100) nm, are crucial to the characteristics and uses of this substance [6]. Due to its ability to thrive in arid environments, wheat plant, one of the three main cereals, is collected worldwide. Due to its numerous health benefits, eating whole wheat has recently been

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recommended, even though the majority of wheat used for human consumption has been refined during the past 200 years before being used as a meal or ingredient [7]. Due to their surface plasmonic resonance (SPR) characteristics, In the fields of nanotechnology and nanomedicine, noble metal nanostructures such as gold (Au), silver (Ag), and platinum (Pt) have been identified as essential nanoparticles. Due to its unique characteristics, Ag NP has been compared to other materials in recent years. Due to its substantial uses in antibacterial coatings and medical diagnosis, silver nanoparticles have drawn the interest of numerous researchers in recent decades [8]. Additionally, silver nanoparticles' antibacterial qualities make it possible to include them into a variety of goods, including apparel and cosmetics. Silver is a great choice for the production of conductive inks due to its high electrical conductivity when compared to other metals like copper and gold [9]. In order to convert silver ions into silver atoms, which then assemble into nanoparticles, we employed leaf extract from Iraqi wheat as a reducing agent in this investigation. XRD, FTIR,FE-SEM,EDS,and UV-visible were then used to characterize the produced silver nanoparticles.

MATERIALS AND METHODS

Silver Nanoparticle Synthesis

In this study, the basic materials were dissolved using distilled water as a solvent. A solution of $AgNO_3$ (4 mL, 10^{-4} M) was made 200 mL of distilled water was mixed with silver nitrate, and the mixture was stirred for 30 minutes until no particles were visible.. By keeping the solution in a dark location, the silver was prevented from oxidizing. To make wheat extract:

1- Five grams of dried and powdered wheat powder were dissolved in one hundred milliliters of distilled water.

2- Stir the mixture constantly while heating it for five minutes.

3- Using filter paper, the solution was filtered.

After that, 20 milliliters of wheat extract and 80 milliliters of silver nitrate were combined, and the mixture was kept in a dark area for a full day.[10] Using a centrifuge, the precipitate was removed from the solution, and it was then dried in an oven set at 50 °C. As shown in Fig. 1, the precipitate was then powdered and examined using XRD , FTIR, FE-SEM, EDS, and UV-visible.

RESULTS AND DISCUSSION

Iraqi wheat plant extract was utilized as the capping agent and solvent in the procedure that produced Ag NPs from $AgNO_3$. Thus, in the first phase, the crystal structure of Ag NPs was ascertained using X-ray diffraction examinations; the analysis's findings are displayed in Fig. 2. The diffraction peaks are compatible with the face-

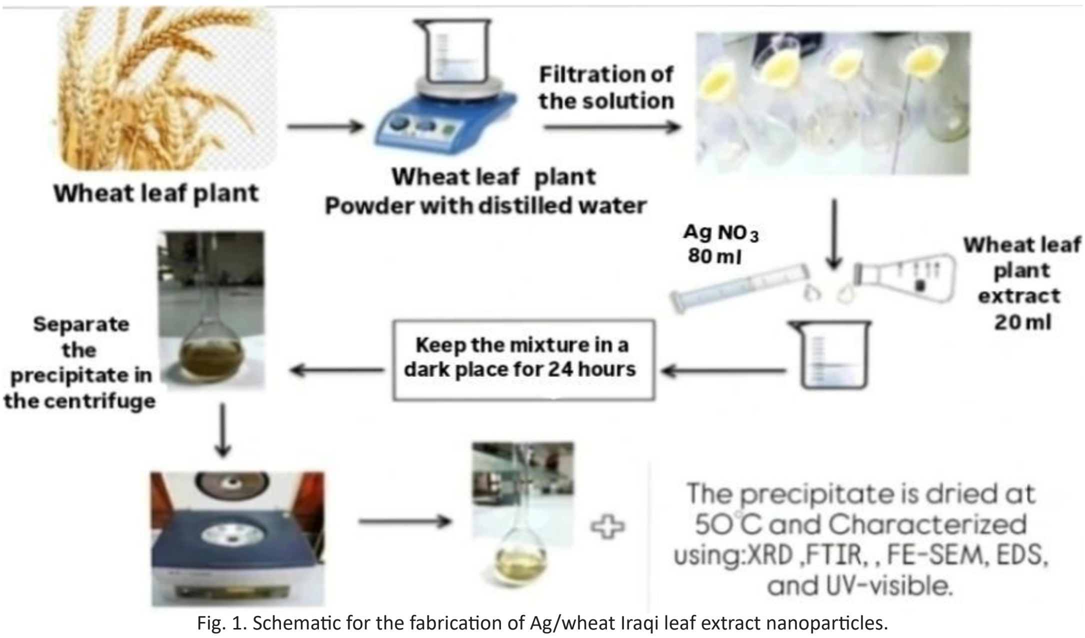

Fig. 1. Schematic for the fabrication of Ag/wheat Iraqi leaf extract nanoparticles.

centered cubic (FCC) phase that this list peals fits the reference file with JCPD= 7.01043 - 99.99460. The generated powder samples' crystal structure, phase identification, and crystallite size were examined using an XRD typical (PanalyticalX'pert) with CuKα radiation of λ=1.5405 A°. The XRD shows eight peaks at 12.89°, 16.95°, 27.71°, 29.40°, 32.23°, 46.26°, and 57.24°. The XRD data utilizing Scherrer's equation, the size of the silver-Wheat plant nanoparticles is determined.

$$\text{Crystalline Size (D)} = \frac{K\lambda}{\beta \cos\theta} \quad (1)$$

These values represent the wavelength (λ = 1.5406 Å), diffraction angle (θ), and full width at half maximum (β) of the Cu-Kα X-ray. The Debye Scherrer constant is denoted by K [11]. As the

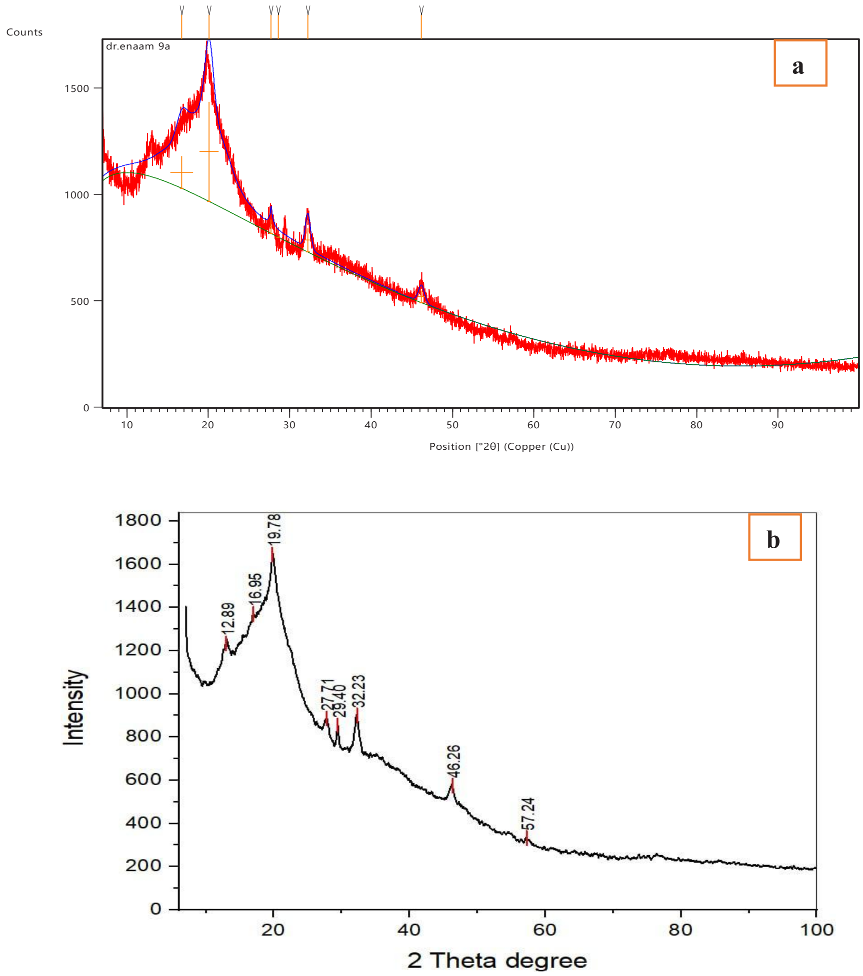

Fig. 2. XRD pattern for Ag/wheat leaf NPs (a-b).

Table 1. Crystallite sizes of Ag/*wheat leaf* NPs as obtained from XRD patterns.

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
16.7433	152.20	2.8365	5.29076	32.55
20.0891	467.53	2.3185	4.41649	100.00
27.7039	64.74	0.2642	3.21743	13.85
28.5719	0.00	0.0220	3.12164	0.00
32.2080	111.63	0.7588	2.77704	23.88
46.1466	56.23	0.8756	1.96551	12.03

concentration of Ag ions rises, the size of the crystallite decreases, which can be explained by metal doping inhibiting crystallite formation. The crystallite size is shown in Table 1 [12].

Additionally, the generation of Ag NPs in the 4000-500 cm-1 range was approved by FTIR analysis. Numerous peaks are shown in Fig. 3, and these peaks are associated with functional groups of wheat leaf extract on the surface of Ag nanoparticles. Fig. 3 indicates this band at (3275.24) cm^{-1} is caused by the O-H stretching of the pantothenic acid group. Also apparent is the very weak band of alkane C–H stretching vibrations of methyl, methylene, and methoxy groups at (2924.18 and 2954.74) cm^{-1}.

The C=O stretching vibrations of pantothenic acid are also responsible for the binary peak located at 1735.99 and 1670.41) cm^{-1} [13]. Furthermore, peaks at 1519.90, 1458.23, and 1304.94 cm^{-1} indicated C–H bending, while peaks at 1200.20, 1222.91, and 1091.75) cm^{-1} would indicate C–OH bond stretching. The aromatic ring vibration in wheat leaf extract is finally visible at (663.53, 621.10, 516.54, and 489.94) cm^{-1}. The extract's function as a capping agent in the synthesis of Ag NPs was validated by the FTIR analysis results [14] .

Fig. 4 shows the average size and surface

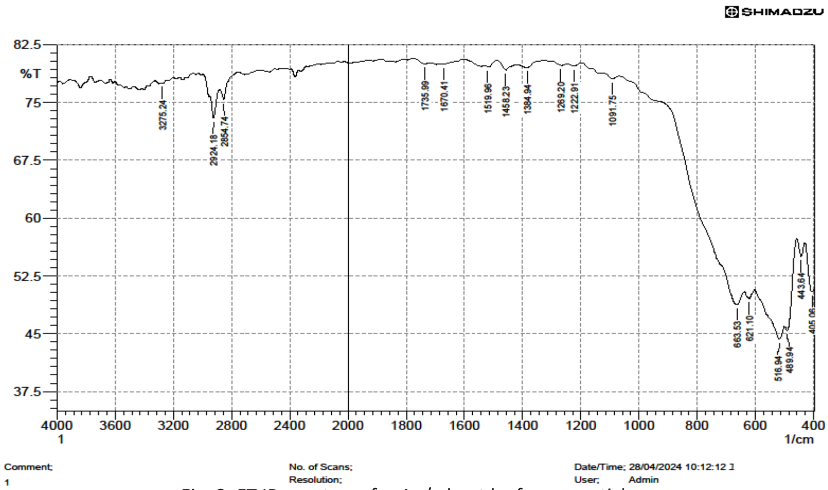

Fig. 3. FT-IR spectrum for Ag/wheat leaf nanoparticles.

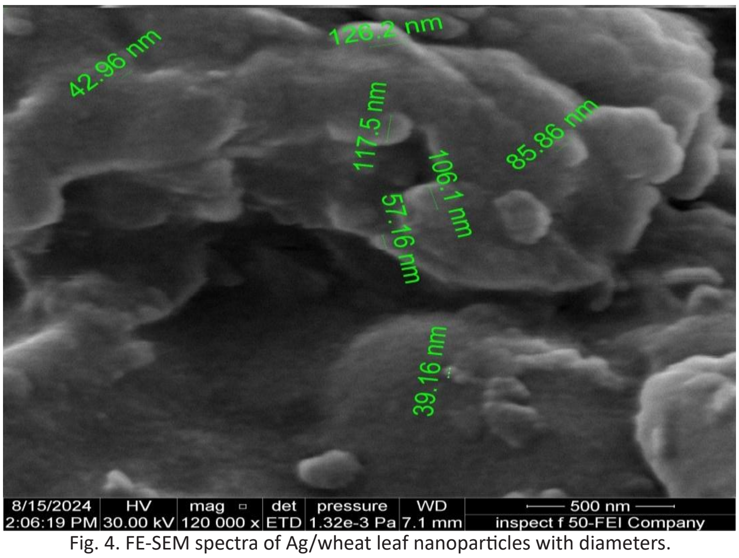

Fig. 4. FE-SEM spectra of Ag/wheat leaf nanoparticles with diameters.

morphology of the generated materials as assessed by FE-SEM analysis [15]. The synthesized Ag/wheat leaf nanoparticles' diameters, as shown by the FE-SEM pictures, are 39.16, 42.96, 57.16, 85.86, 106.1, 117.5, and 126.2 nm. This occurs as a result of the Ag/wheat leaf extract's capping action, which stops the Ag/wheat leaf NPs from clumping together. Based on the FE-SEM images, the average diameter of the Ag/wheat leaf particles was calculated to be around 95.82 nm.

Energy dispersive spectroscopy, or EDS, was used to confirm the presence of the Ag/wheat leaf NPs in Fig. 5a and b [16]. Strong and accurate diffraction peaks are seen in the Ag/wheat leaf

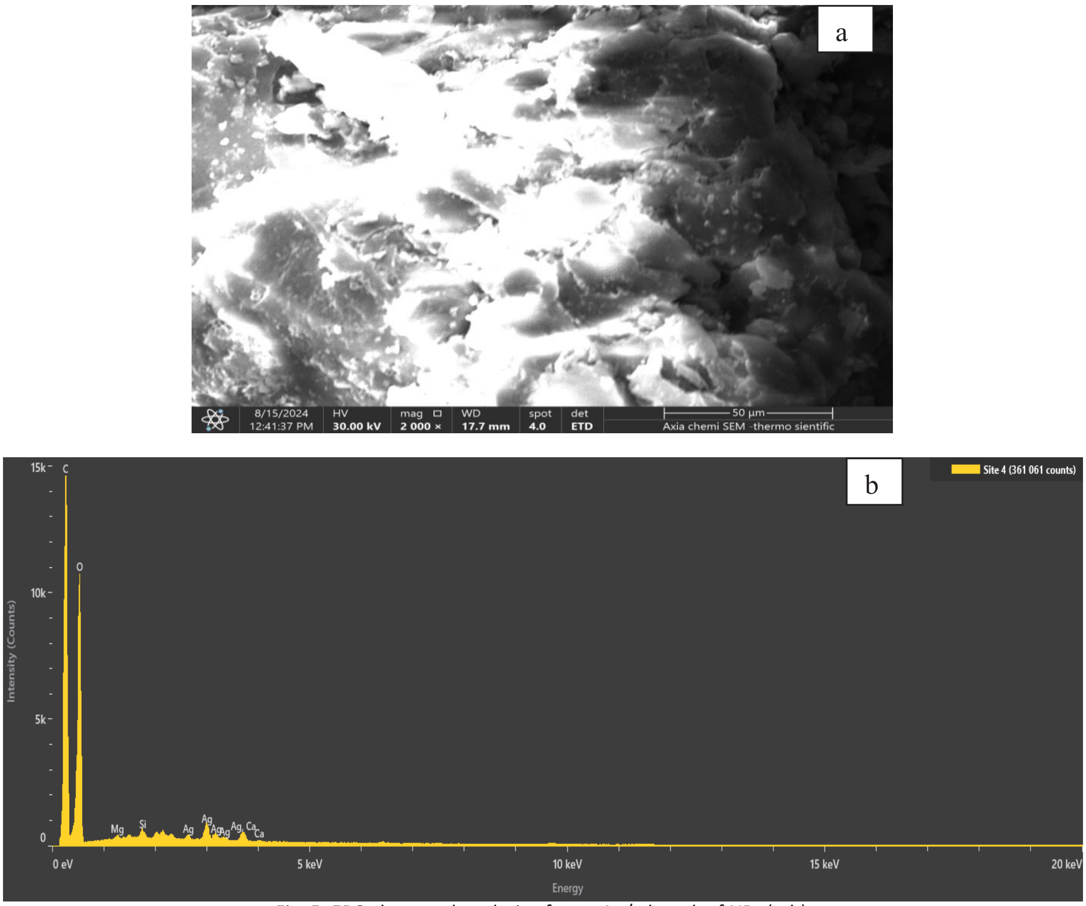

Fig. 5. EDS elemental analysis of pure Ag/wheat leaf NPs (a-b).

Table 2. Ag/wheat leaf NPs composition was examined using EDS

Element	Atomic%	Atomic % Error	Weight%	Weight % Error
C	46.8	0.3	38.8	0.3
O	52.4	0.3	57.9	0.4
Mg	0.1	0.0	0.2	0.0
Si	0.2	0.0	0.4	0.0
Ca	0.2	0.0	0.6	0.0
Ag	0.3	0.0	2.1	0.1

NPs line, suggesting good crystallinities. The pure Ag/wheat leaf NPs' EDS spectra show that only (C, O, Mg, Si, Ca, and Ag) are present [17]. Table 2 provides a semi-quantitative assessment of the atomic concentration (atom%). As evidenced by the elements of Ag/wheat leaf NPs in the products are (46.8, 52.4, 0.1, 0.4, 0.2, 0.2 and 0.3) for Magnesium (Mg), Calcium (Ca), Silicon (Si), Carbon (C), Oxygen (O), and Silver (Ag).

EDS analysis reveals the chemical composition of Ag/wheat leaf NPs samples. As seen in the image, the generated samples are primarily composed of O, C, Na, Ti, Al, and Ag, with very little Mg, Si, or Ca. 6(a-b) [18].

The UV-visible absorption spectroscopic diagram of pure Ag/wheat leaf NPs extract is shown in Fig. 7. To further support the synthesis of silver-Wheat leaf particles, The Shimadzu spectrophotometer of the UV-1800 series was used to record the UV-Vis absorption spectrum

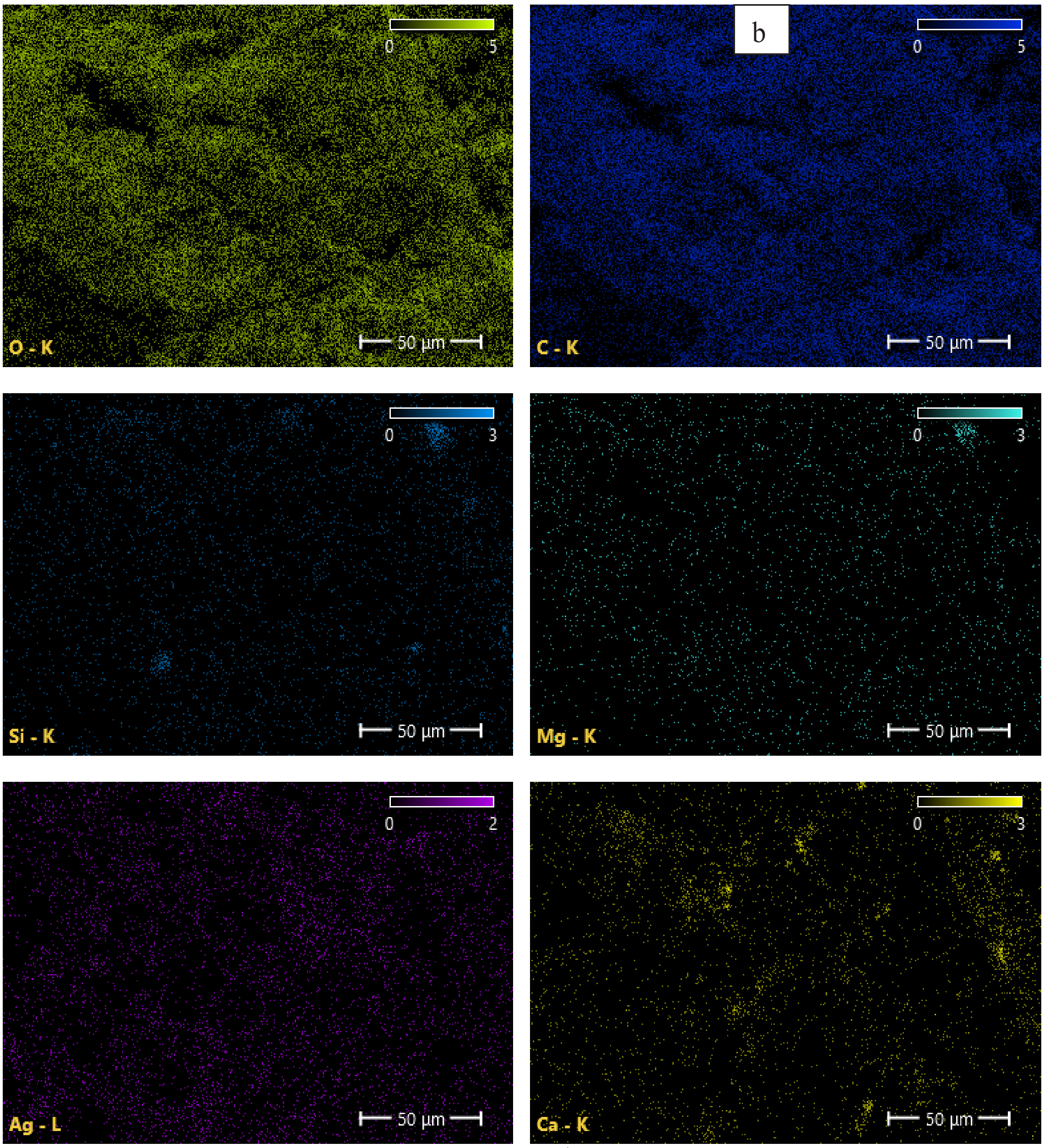

Fig. 6. Real EDS analysis image of pure Ag/wheat leaf nanoparticles (a-b).

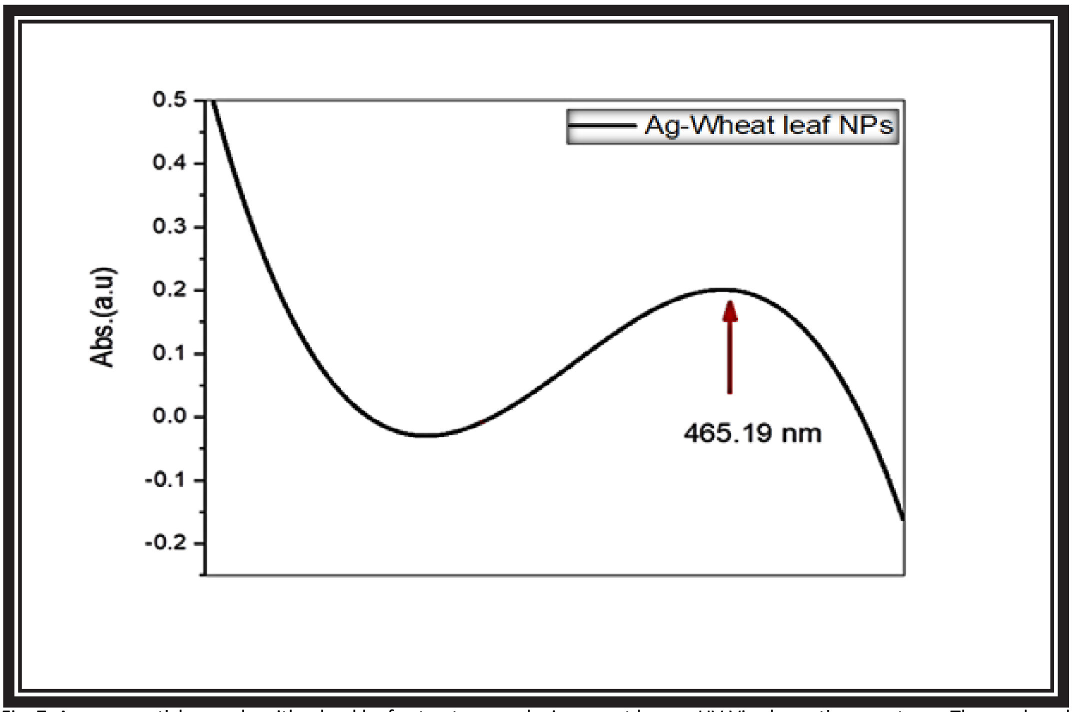

Fig. 7. Ag nanoparticles made with wheal leaf extract as a reducing agent have a UV-Vis absorption spectrum. The produced Ag nanoparticles' SPR absorption band is indicated by the red arrow at about 465.19 nm.

[19]. According to Fig. 7, the produced solution's Surface Plasmon Resonance (SPR) absorption band is around (465.24) nm. The production of silver nanoparticles in the presence of pure wheat leaf NPs extract is responsible for this shift to red, in contrast to the silver metal's SPR band at 420 nm. Our findings align with the UV-Vis absorption band of Ag nanoparticles extracted from banana peels by Alvakonda Narayanamma (λ = 454.07 nm) [10,21].

CONCLUSION

One of most intriguing subjects in the realm of nanotechnology is the green production of nanomaterials. In this context, recent years have seen advancements in biosynthesis employing the plant and plant extract. Iraqi wheat leaf extract was used in this investigation as Ag^+ cation in $AgNO_3$ solution is converted to Ag^0 by a reducing agent. Silver NPs were thus produced as a result of the reaction of the $AgNO_3$ solution with the wheat leaf extract. several characterisation techniques, including UV-vis spectroscopy, FTIR, FE-SEM, EDS, and XRD. Furthermore, the FTIR results showed that Ag/wheat leaf extract was utilized as the capping agent and surfactant to regulate the shape and size of these nanoparticles. Lastly, this technique can be used to eliminate a variety of hazardous chemical reagents used in the manufacture of nanomaterials and to synthesize any kind of metal nanoparticle on a big scale.

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CONFLICT OF INTEREST

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

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