

RESEARCH PAPER

## Evaluation of Green Synthesis of Selenium Nanoparticles Using *Allium Cepa* Scaly Leaves Extract

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### ARTICLE INFO

#### Article History:

Received 26 December 2025

Accepted 14 March 2026

Published 01 April 2026

#### Keywords:

*Allium cepa*

EDS

Green Synthesis

Selenium

NPs

XRD

### ABSTRACT

Selenium is a crucial micronutrient needed for desirable growth and product related to fertility, disease opposition, and remediate of environmental issues. It exhibits a potential application in various fields of medicine, diagnostics, therapeutics, and toxicology due to unique structural properties and potential bioactivities. Whereas, it was abundant in two forms inorganic and organic compounds. selenium is easier to fabricate and combine with other biological or chemical agents to improve the biological characterization on compare to other metal Nps due to low toxicity, biocompatibility, and surface modification. Selenium/*Allium cepa* scaly leaves extract Nanoparticles were synthesized using 15 mM of sodium selenite as the precursor and 10 g *Allium cepa* scaly leaves extract as reducing and stabilizing agents. Selenium/*Allium cepa* scaly leaves extract (NPs) were characterized using Fourier-transform infrared spectroscopy (FT-IR) analysis, X-Ray Diffraction (XRD), and Energy Dispersive x-ray diffraction Spectroscopy (EDS). The aim of our study is to biosynthesized selenium, Selenium/*Allium cepa* scaly leaves extract (NPs).

### How to cite this article

AL-Abbasy M., Al-Mussawi K., Salman H. Evaluation of Green Synthesis of Selenium Nanoparticles Using *Allium Cepa* Scaly Leaves Extract. J Nanostruct, 2026; 16(2):2031-2040. DOI: 10.22052/JNS.2026.02.049

### INTRODUCTION

Nanotechnology has rapidly evolved, finding applications across diverse fields such as biology, chemistry, physics, and bioengineering. Nanoparticles, produced through various methods, have gained attention for their unique properties [1]. Among them, metal nanoparticles, like selenium nanoparticles (SeNPs), strontium nanoparticles (SrNPs), and zinc oxide nanoparticles (ZnONPs), have shown promise in biomedical applications due to their antioxidant capabilities and ability to transition between oxidation states [2]. In nanoparticle synthesis, the biological approach stands out for its environmental

friendliness and cost-effectiveness due to the utilization of microorganisms or medicinal plants, especially those with therapeutic properties, which have become preferred. Plant phytochemicals, known for their antioxidant and antibacterial properties, can be integrated into nanoparticles during production [3]. Selenium, a trace element in the human body, exhibits antioxidant, anti-inflammatory, and anti-diabetic properties. Selenium nanoparticles have been synthesized using medicinal plants to enhance their biomedical applications [4]. Due to its multiple uses in a variety of sectors, selenium has received a lot of interest from the scientific community

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lately [5]. Due to its special physical, chemical, and biological qualities, it plays a significant part in important life processes like fighting cancer, fighting bacteria, being an antioxidant, and getting rid of dangerous heavy metals [6]. High amounts, however, can have toxic consequences and negative health effects including fever, nausea, respiratory, cardiovascular, and gastrointestinal issues, as well as kidney failure [7]. In general, two methods are used to create nanomaterials. Top-down and bottom-up approaches are used. These approaches are further classified into three types based on how nanomaterials are synthesized (1) Physical methods, (2) Chemical methods, and (3) Biological methods [8]. The chemical process can happen spontaneously or be triggered by an external factor. Acidic-alkaline reducing agents or another chemical, such as sodium borohydride, nitric acid, ortho perchloro acid, or acidic acid for metal extraction, should be used to create nanomaterials through chemical synthesis [9]. The creation of nanomaterials can be accomplished reasonably easily and efficiently by reducing elemental Se to Se ions with the help of suitable reducers or stabilizers. The green synthesis technique uses a variety of biological agents and biomolecules that are involved in the production

of nanoparticles to fuse Nps both internally and externally [10]. The majority of the biological agents used in the creation of nanoparticles are bacteria, including pathogens, mold, seaweed, foam, and plants, each of which has a unique reaction with metal ions. On the basis of the different classes of algae like brown algae, red algae, green algae, cyanobacteria were utilized for the fabrication of biogenic Nps [11]. Biochemical techniques can be used to produce nanomaterials. Nevertheless, the biogenic synthetic approach is frequently employed because of its ease and simplicity. Additionally, there are no toxic or risky residual emissions into the environment. SeNPs made from biological materials have been shown to be less harmful than SeNPs made from chemicals [12].

In the present research, we illustrate the novel reports concerning the application of bioactive nanomaterials based on techniques, surface morphology, crystal structure, and physiochemical properties that are elaborately discussed and compared with other metal nanoparticles with significant medicinal advantages.

## MATERIALS AND METHODS

The green synthesis of selenium nanoparticles

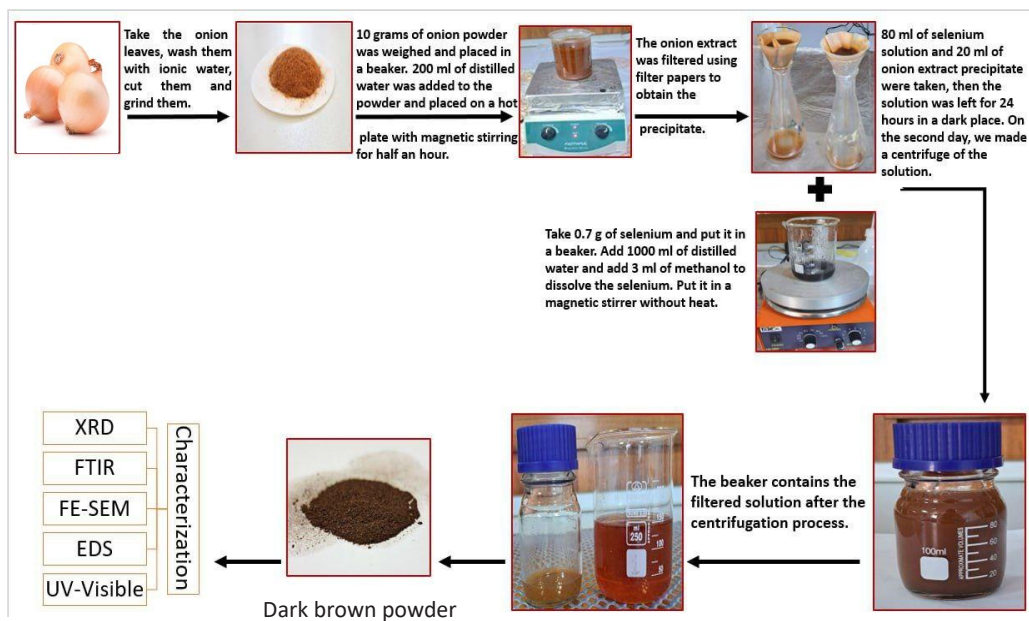


Fig. 1. Synthesis Se/*Allium* scaly leaves extract.

(Se-NPs) using onion peels (*Allium cepa*) scaly leaf extract and co-precipitation involves a two-step process: First, the extract acts as a reducing and stabilizing agent to form selenium nanoparticles, and then the co-precipitation method is used to enhance their formation and control the particle size and shape. This method is environmentally friendly and cost-effective, offering promising applications in various fields.

#### Synthesis of Selenium Nanoparticles [13]

Distilled water was used in this research as a solvent to dissolve the initial components. 0.7 grams of sodium selenate ( $\text{Na}_2\text{SeO}_3$ ) was added to 100 ml of distilled water to form a  $10^{-4}$  M  $\text{Na}_2\text{SeO}_3$  solution. Stirred for 30 minutes until the particles completely disappeared, then distilled water was added to bring the volume to 1 liter. The selenium was preserved from oxidation by storing it in a dark place.

#### Prepare *Allium cepa* scaly leaves extract solution [14]

1. The *Allium cepa* scaly leaves was chopped into small pieces and cleaned with distilled water and left to dry.
2. The onion scale leaves are ground in an electric grinder to a powder.
- 3-The appropriate amount of 100 milliliters of

distilled water was used to dissolve 10 grams of the powdered *Allium cepa* L.

4- After heating the mixture for 25 min to  $45^\circ\text{C}$  with stirring, it was filtered and stored at approximately  $7^\circ\text{C}$ .

To make Selenium nanoparticles, 20 milliliters of the *Allium cepa* scaly leaves extract solution and 80 milliliters of the  $\text{Na}_2\text{SeO}_3$  solution were mixed together. This solution was then agitated and allowed to stand at room temperature for 24 hours. The UV-Vis spectrometer was then used to record the solution's spectrum. To prepare for Selenium/*Allium cepa* scaly leaves extract (NPs) were characterized using Fourier-transform infrared spectroscopy (FT-IR) analysis, X-Ray Diffraction (XRD), and Energy Dispersive x-ray diffraction Spectroscopy (EDS), the solution was centrifuged at 4000 rpm for 30 minutes. The sample was then dried at  $75^\circ\text{C}$  [13], as seen in Fig. 1.

#### RESULTS AND DISCUSSION

One of the most fundamental and significant methods for identifying and characterizing nanomaterials is UV-visible spectroscopy. By measuring the UV-visible spectra of the reaction mixture over a range of 200–800 at various time intervals, the reduction of  $\text{Na}_2\text{SeO}_3$  metal precursors is kept track of [15].

When *Allium cepa* scaly leaves extract is added

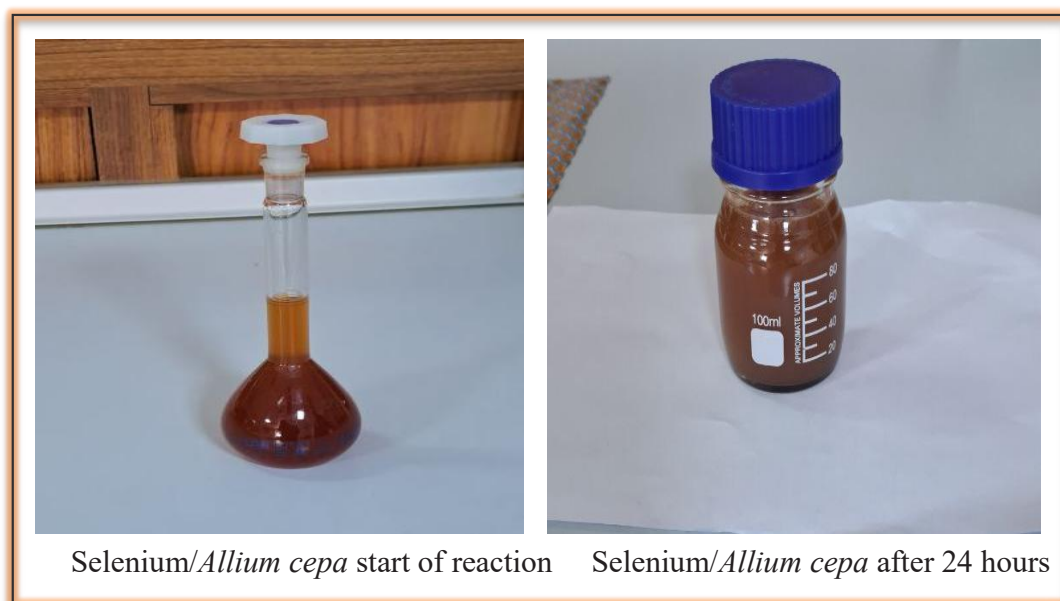


Fig. 2. *Allium cepa* before and after adding selenium.

to sodium selenate, the solution turns brown. Fig. 2 illustrates how the solution changes to a brownish color after 24 hours at room temperature, signifying the synthesis of *Se/Allium cepa L.* NPs. This alteration indicates that the *Allium cepa L.* NPs. extract reduces the sodium selenate, resulting in the formation of free Se, 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 *Se/Allium cepa L.* NPs. synthesis process. When comparing the SPR band of the produced solution to that of bulk *Se/Allium cepa L.* NPs. The highest absorption wavelength utilized in all tests was 354 nm [16]. This transition can be explained by the way big selenium particles develop. A Vis-UV device of the type, 8110SP spectrophotometer, Metertech Japan, was used. A pen procedure was carried out in the College of Education for Pure Science - University of Karbala-Iraq, and then it was discovered by studying the spectrum of the differential compound using the

violet and visible (UV) spectrophotometer, we notice the appearance of a peak at a wavelength of 354 nanometers (which confirms the presence of a nano material at the superconductivity (0.003).

FTIR analysis of selenium nanoparticles synthesized from *Allium cepa L.* was performed, and the FTIR spectra revealed distinct peaks at different wavenumbers in the selenium nanoparticles (Fig. 3). The observed peaks were observed at wavenumbers of 2919, 2851, 2289, 1612, 1318, 1160, 1064, 1012, 760, and 680  $\text{cm}^{-1}$ . The broad peak observed at 1816, 1612  $\text{cm}^{-1}$  was identified as a natural polymeric hydroxyl stretch of alcohol and hydroxy compound. The shorter peak at 760 and 680  $\text{cm}^{-1}$  indicates the presence of S-S stretched thiols, sulfides, and thio-substituted compounds, which describe different functional groups present in the plant extract that act on the reduction and stabilization process [15].

X-ray diffraction (XRD) is a technique used to determine the crystalline structure of materials. It can be used to analyze nanomaterials extracted

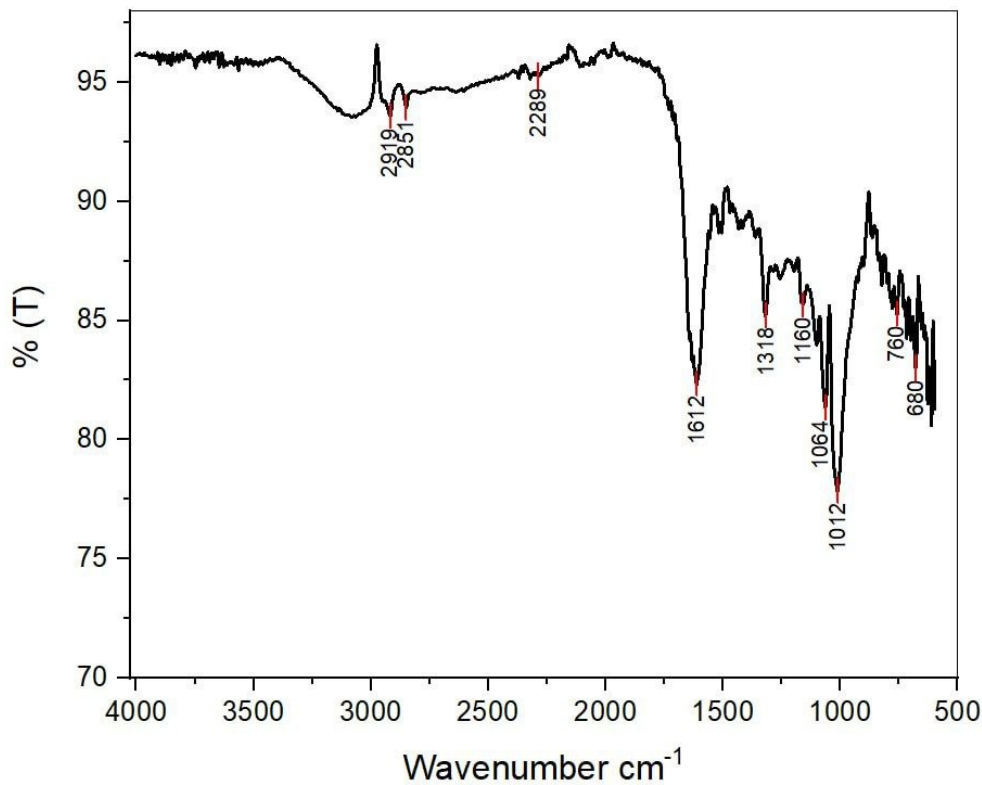


Fig. 3. FTIR - Fourier transform infrared; *Se/Allium cepa L* NPs

from plants, such as selenium-enriched onion extract. Simplified and suitable for this complex, the goal of using this technique is to identify crystalline properties and determine whether the formed particles are crystalline or amorphous [15]. In addition to determining the crystallite size of the materials, onion extract contains phenolic compounds and flavonoids that act as a reducing agent and catalyst for the formation of nanoparticles, Selenium nanoparticles (SeNPs) are biosynthesized using onion extract as a reducing agent [17].

The spectrum in Fig. 4 shows that the angles before 32.51° indicate selenium, which means that *Allium cepa* L. has reduced selenium to a nanocomplex, and its bands appeared clearly and sharply [18]. which are four sharp peaks appearing at angles (14.81°, 20.35°, 23°, 23.80°, 29.93°). These peaks correspond to the hexagonal or spinel crystal structure of selenium [19]. The crystallite size of the nanocomplex is calculated using the Scherrer's equation:[20]

$$D = K\lambda / \beta \cos\theta \quad (1)$$

Whereas, D: Crystal size (nm), K: Shape index (usually 0.9),  $\lambda$ : X-ray wavelength (usually Cu-K $\alpha$  = 1.5406 Å),  $\beta$ : Peak width at half height (FWHM) in

radians,  $2\theta$ : Reflection half angle ( $\theta/2$ ).

The green synthesis of selenium nanoparticles (Se-NPs) using onion peels (*Allium cepa* scaly leaf extract and co-precipitation involves a two-step process: First, the extract acts as a reducing and stabilizing agent to form selenium nanoparticles, and then the co-precipitation method is used to enhance their formation and control the particle size and shape. This method is environmentally friendly and cost-effective, offering promising applications in various fields [21], [22]. In Fig. 5, the layers of reduced precipitated selenium are shown in the form of clear crystals. These layers are superimposed on top of each other, and above the layers are grains or balls of crystalline selenium in the form of aggregates in the form of particles (usually spherical). Then he took several balls and calculated the crystal dimension of the nanomaterial and the measurements were (42.96, 48.20, 70.42, 77.29) nanometers. The average crystal dimension was (59.72) nanometers, indicating that the reduction is not homogeneous and shows sizes between (1 $\mu$ m - 500 nm). This indicates that the reduction is either in the form of selenium metal or selenium oxide.

Energy dispersive spectroscopy (EDS) confirmed the presence of *Allium Cepa*.L-Se NPs. The strong and fine diffraction peaks show that the nanocrystalline lines in the *Allium Cepa*.L-Se NPs nanocomposites

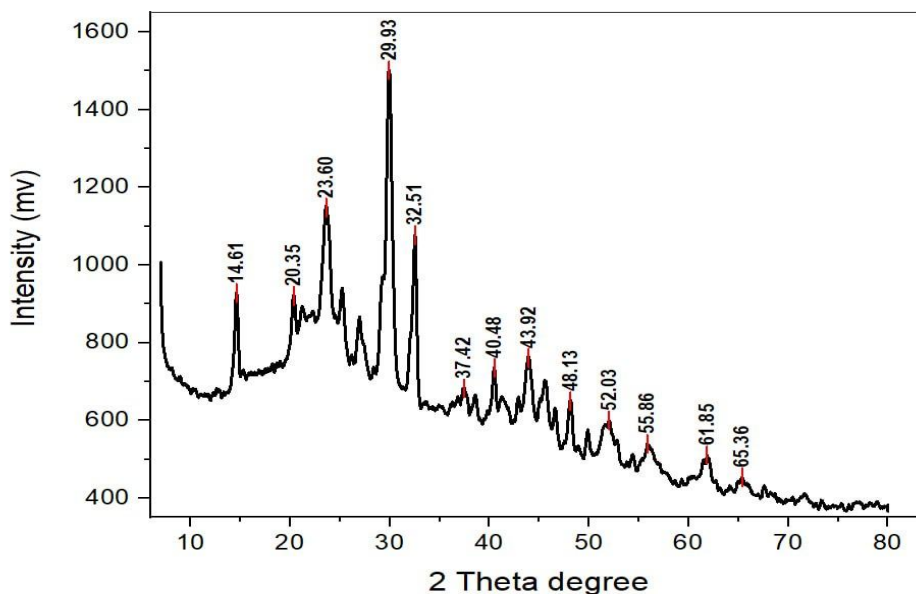


Fig. 4. XRD spectrum of Se nanoparticles formed by *Allium cepa* L.

have good crystallinity. The EDS spectra show that the pure compounds contain only Se, O, Ca, In, Na, Si, S, K, Cl, and Fe (Figs. 6 and 7).

Table 1 shows a semi-quantitative assessment

of the atomic concentration (atom%), which shows that the content of the elements oxygen (O), sodium (Na), silicon (Si), sulfur (S), chlorine (Cl), potassium (K), calcium (Ca), iron (Fe), selenium (Se),

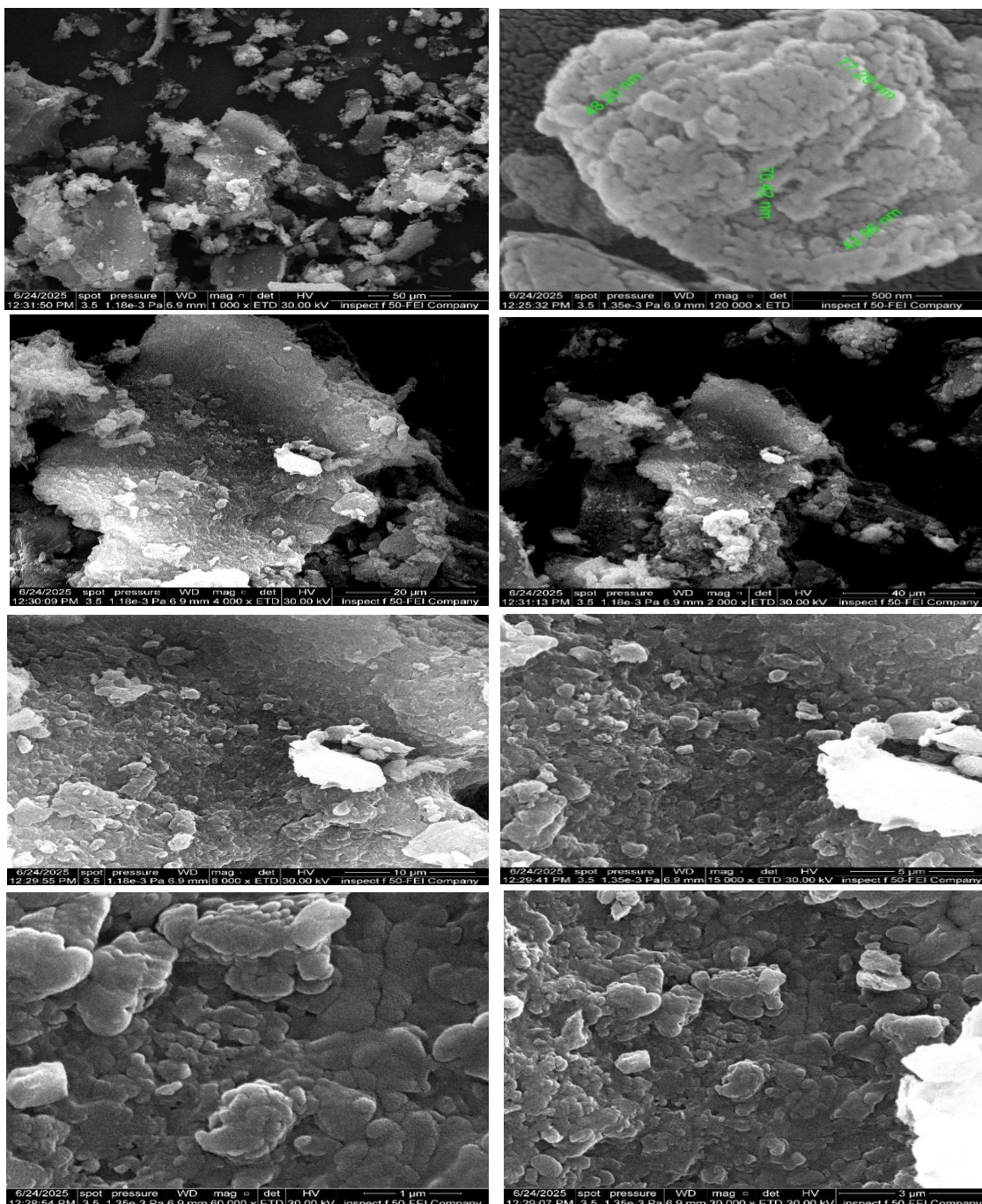


Fig. 5. *Allium cepa*-Se NPs nanocomposite under scanning electron microscope (SEM). Sizes range from (1μm - 500 nm).

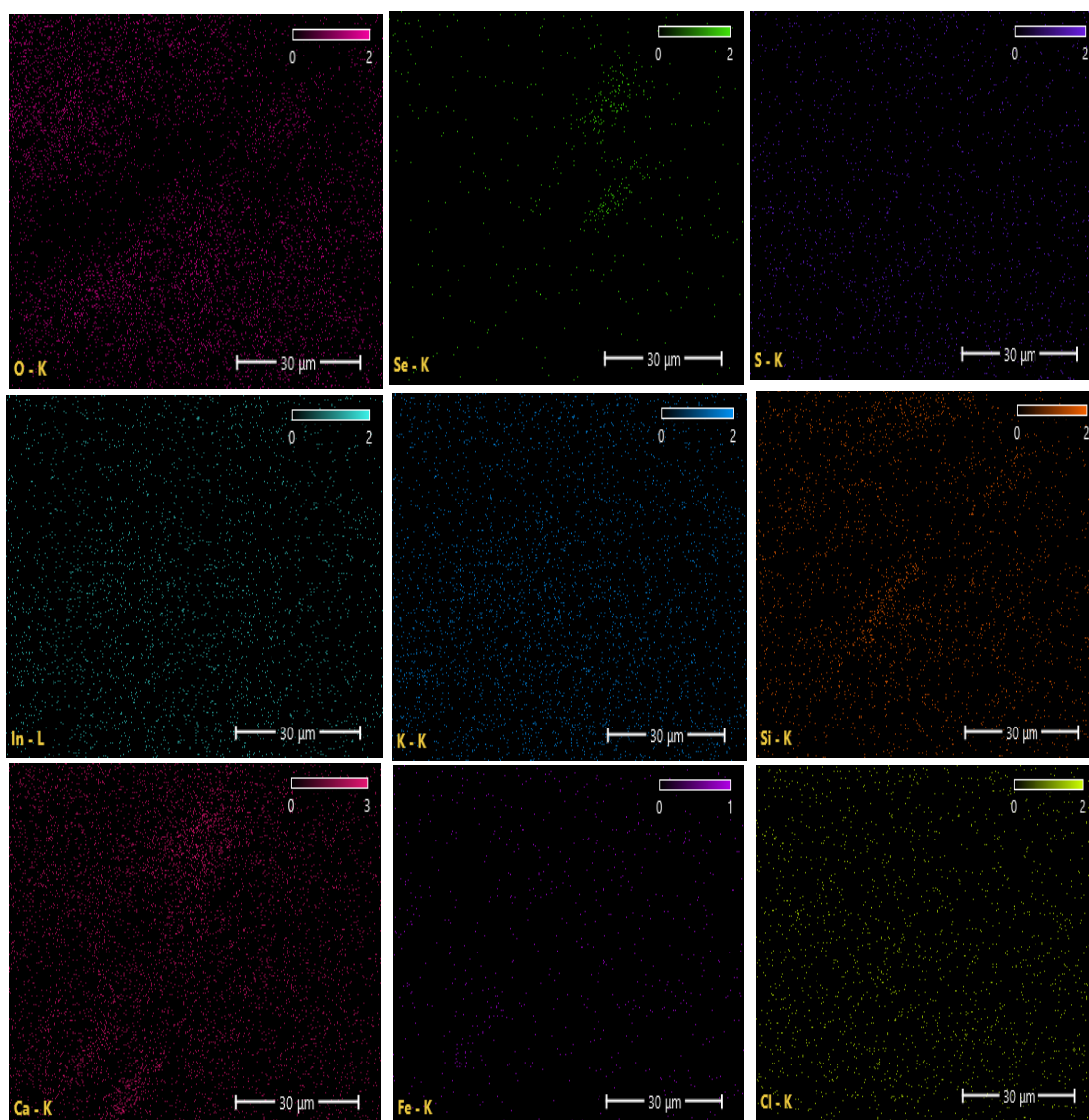


Fig. 6. Real image of *Se-Allium Cepa.L* NPs EDS analysis.

Table 1. EDS analysis of total Number of Counts is 81 423 and average count rate is 1. 663 cps.

Weight % Error	Weight %	Atomic % Error	Atomic %	Element
0.8	69.2	0.9	84.7	O
0.2	0.8	0.2	0.7	Na
0.1	3.9	0.1	2.7	Si
0.1	2.1	0.0	1.3	S
0.1	2.1	0.1	1.1	Cl
0.3	5.0	0.2	2.5	K
0.3	11.2	0.1	5.5	Ca
0.1	1.4	0.0	0.5	Fe
0.6	3.7	0.1	0.9	Se
0.6	0.6	0.1	0.1	In

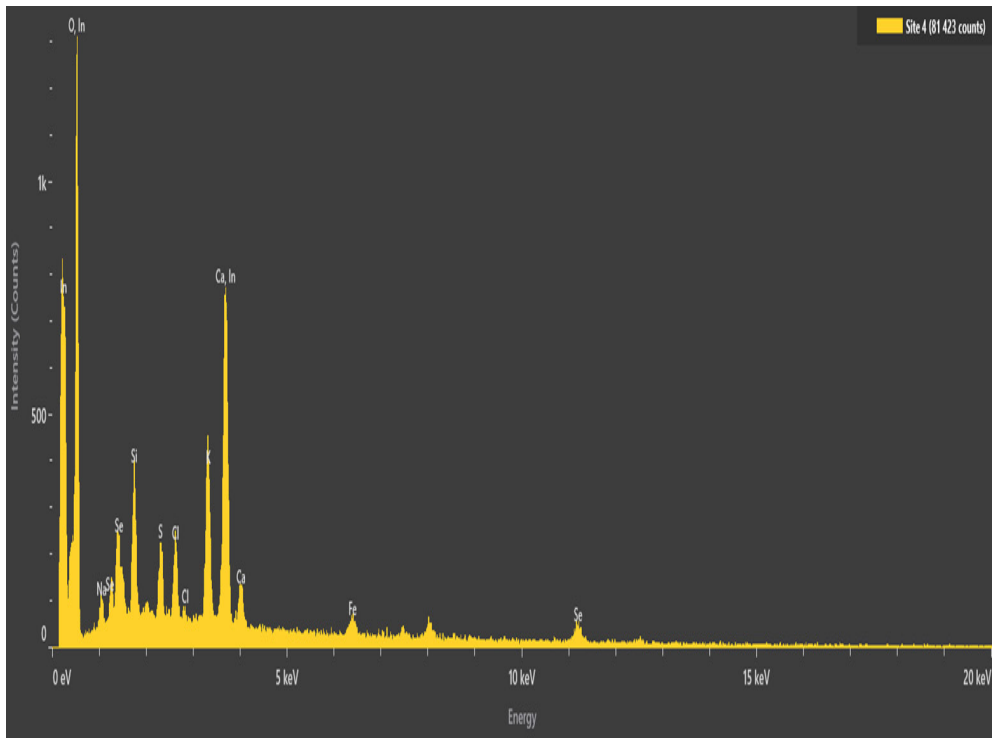


Fig. 7. EDX Spectrum of Se-*Allium Cepa* NPs.

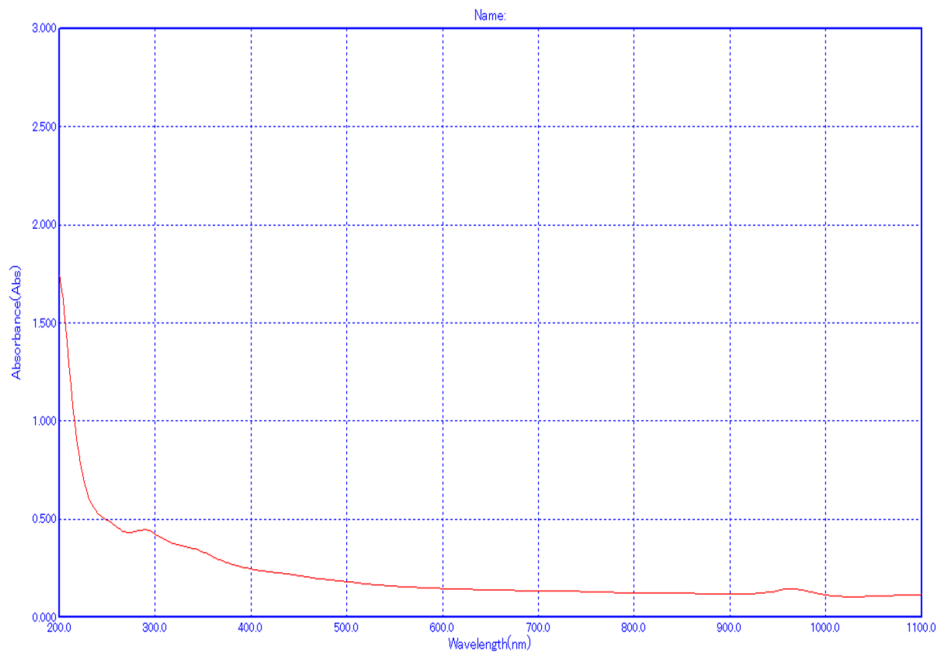


Fig. 8. UV-Vis absorption spectrum of Se- NPs in the presence of *Allium Cepa.L* extract.

and indium (In) in the products are (84.7%, 0.7%, 2.6%, 1.3%, 1.1, 2.5, 5.5, 0.5, 0.9, 0.1) respectively.

To provide more evidence for the formation of *Se-Allium Cepa.L NPs*, UV-Vis absorption spectrum was recorded Utilizing the (UV-Vis: 190-1100nm/ BIOBASE- China) spectrophotometer. The surface plasmon resonance (SPR) absorption band of the prepared solution is found to be ~310 nm as shown in Fig. 8. This red shift (compared to the SPR band of Se- metal at 350 nm) is attributed to the fabrication of *Se- NPs* in the presence of *Allium Cepa.L* extract.

## CONCLUSION

In conclusion, the selenium nanoparticles synthesized through *Allium Cepa scaly leaves Allium cepa* (onion) contains phenolic compounds, flavonoids, and antioxidants. Selenium (Se) is a trace element with antioxidant properties and is important in many biological functions. Preparation of selenium nanoparticles (SeNPs) using plant extracts (such as onion) is a green and environmentally safe method. The results of the evaluation of the green synthesis of selenium nanoparticles using onion (*Allium cepa L.*) scaly leaf extract by the co-precipitation method indicate the successful preparation of stable and environmentally friendly nanoparticles with distinctive physical and chemical properties. This approach demonstrates the effective ability to reduce selenium to its nanoscale form via the bioactive compounds in onion leaves.

## ACKNOWLEDGMENTS

We would like to thank College of Education for Pure Science - University of Karbala, Iraq for providing all facilities throughout the research work.

## CONFLICT OF INTEREST

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

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