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GREEN SYNTHESIS OF SeNPs FROM *AMARANTHUS VIRIDIS* AND *DATURA ALBA* AND THEIR BIOLOGICAL ACTIVITIES

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Abstract

This research focus on the eco-friendly production of Selenium Nanoparticles (SeNPs) using methanolic leaf extracts obtained from Amaranthus viridis L. and Datura alba L. The bio-synthesized Se-NPs have been analyzed by the UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and SEM (Scanning Electron Microscopy). The Ultraviolet-Visible Spectroscopy results displayed clear absorption peak of Selenium nanoparticles (SeNPs) at 280 nm for A. viridis and at 302 nm for D. alba. Both of the test plants displayed –OH and –CH_3 groups, in the FTIR spectra. SEM images revealed small, largely rounded SeNP's from A. viridis and D. alba, whereas XRD analysis demonstrated the crystalline character of the Selenium nanoparticles. According to the 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical assay, D. alba showed higher antiradical potential in comparison to A. viridis. The antimicrobial activity of SeNPs green synthesized from A. viridis and D. alba was checked using Penecillium verrucosum Dierckx. as test fungus. Different applied concentrations (0.5%, 1%, 1.5%, 2% and 2.5%) of green synthesized Selenium nanoparticles (SeNPs) significantly reduced fungal growth of P. verrucosum as compared to control treatment. 2.5% concentration of SeNPs from both A. viridis and D. alba showed maximum reduction in fungal biomass at 65%. SeNPs derived from D. alba showed slightly higher reduction as compared to A. viridis mediated SeNPs. From this study it can be concluded that Selenium nanoparticles synthesized from A. viridis and D. alba possess strong antioxidant and antimicrobial potential which can be utilize further in biomedicine, pharmacology, and sustainable agriculture. Using green synthesized SeNPs as bio fungicide can decrease the hazard of environmental pollution linked with chemical fungicide.

Introduction

Nano technology involves processing, consolidation, separation and deformation of constituents on a level of discrete atoms or molecules [1]. It has turned into an immediately developing area. Nanoparticles, immeasurably small particles that are 10-100 nanometers in diameter, can take any of several forms, including nanocrystals, nanopower, or nanoclusters. They were produced in great diversity of forms such as organic, carbon-based, inorganic and ceramic nanoparticles. They are readily prepared

nanoparticles through physical, chemical as well as biological techniques. The nanoparticles have immense chemical, catalytic, physical and biological properties which makes them extremely useful in the field of agriculture and medical science [2,3]. Metal nanoparticles are one of the widely research works in the field of green synthesis.

Selenium is an element whose atomic number is thirty-four and belongs to 4th period of the periodic table. It is non-metallic and it is regarded to be a chalcogen. In 1817, Berzelius discovered Selenium when he was conducting research in effort to produce an assay that would yield sulfuric acid [4]. Selenium (Se) is a crucial trace element which carries the title of a double-edged sword in its nature in that, it is vital in minute quantities and is toxic when it is in excess. It is significant in the field of human health, plant life, and industrial invention. The amount of Selenium in the soils of Punjab, Pakistan, is usually small (0.01 ppm -0.032 ppm) which is significantly lower than the recommended amount (0.5 ppm -1.0 ppm). This is a common deficiency mostly in semi-arid areas and the south-western parts and impacts negatively on the health of people and the animals. Studies have observed the importance of bio-fortification to deal with this issue [5].

Silver nanoparticles have been produced in various ways including physical, chemical and biological techniques. Nevertheless, the demand is rising to use environmentally friendly processes and biocompatible compounds and the biological method of nanoparticles production has become highly prospective in this respect. Today, there is a multitude of research works on the nature friendly synthesis of Selenium nanoparticles (SeNPs) which are likely to be applied in electronics, medicine and cleaning the environment sphere. The process of green synthesis involves the use of natural plant, bacterial, microalgal, and yeast compounds as substitutes of chemical acting agents, which makes it safer to the environment [6]. The green synthesis is particularly advantageous since methods that are not toxic, environmentally friendly and cost effective are in increasing demand [7]. The biological synthesis in the form of nanoparticles by organisms such as fungi, bacteria and plants presents a huge potential of medicines that can provide solutions to significant health problems [8,9].

Amaranthus viridis L. (Chowlai) is a plant of the family Amaranthaceae that is growing in Africa, Asia and Latin America. It is rich in different phytochemicals that include alkaloids, steroids, phenolics, flavonoids, saponins, tannins and cardiac glycosides that possess antioxidant and antimicrobial effects. The compounds can be applied in the pharmaceutical and food industry in the control of diseases [10]. *A. viridis* contains also much chrysin, sinapic acid quercetin and t-ferulic acid [11].

Solanaceae family is a family of plants that are useful in food, industry, ornamental, and medicinal value. One of the representatives of this family, Datura alba L., is abundant in flavonoids, withanolides, terpenoids, tannins, tropane atropane, and scopolamine alkaloid [12]. *D. alba* possesses good insecticidal, fungicidal, antioxidant, antimicrobial and hypoglycemic qualities [13].

This study aims at bio fabricating Selenium nanoparticles with the help of *A. viridis* and *D. alba*. These flora species have a number of phytochemicals especially alkaloids and phenols that make them have immense medicinal properties. The SeNPs that are synthesized green will be applied to the agricultural crops to improve their quality. They will also be tumor targeted, functionalized to enhance drug delivery and side effects minimization.

Material & methods

Collection of Plant Material

Amaranthus viridis and *Datura alba* were collected from Sargodha. The leaves from these experimental plants were rinsed using tap water, after which surface sterilization was carried out with a 1% sodium hypochlorite solution. After sterilization, test plants were oven-dried and crushed and ground carefully to form powder for further use. The pure culture of test fungus (*Penicillium verrucosum*) was procured from Fungal

Culture Bank, University of the Punjab, Lahore (Plate 4).

Plant Extract Preparation

The methanolic extracts of the test plants were made by following the procedure outlined in [14]. The material from the test plants was left to soak in methanol at room temperature for 7 days. This plant material underwent filtration through muslin cloth and then through filter paper. For subsequent analysis, the filtrate was kept in a refrigerator.

Synthesis and Characterization of Selenium Nanoparticles

For synthesis of Selenium nanoparticles, 20 mL of *A. viridis* and *D. alba* leaf extract were added to 180 mL of 10 mM Na_2SeO_3 [15]. This solution was kept on at 1200 rpm on magnetic stirrer for 40 min. Se-NPs were collected and dried to carry out different studies.

Characterization of Selenium Nanoparticles

Following techniques were used for Selenium nanoparticles characterization.

Ultraviolet-Visible Spectroscopy

To verify the formation of Selenium nanoparticles, the Ultraviolet-Visible spectroscopic technique was employed. A small portion of the sample was transferred into a cuvette and subsequently analyzed across wavelengths from 200 to 600 nm, the range characteristic of Selenium. The most intense absorption peaks appeared at the wavelength corresponding to maximum absorption. At four distinct time period 2, 4, 10, and 24 hours the samples were examined in order to identify the wavelength exhibiting the maximum absorption. [16].

Scanning Electron Microscope (SEM)

SEM analysis was performed to examine the characteristic size and morphology of the selenium nanoparticles. For this analysis, a JSM-6480 scanning electron microscope was employed. A small quantity of the dried nanoparticles was deposited onto a copper grid covered with carbon.. Using blotting paper, any surplus liquid was gently removed. After the sample had dried, a thin film of nanoparticles was inspected, and images of the nanoparticles were recorded. [17].

Fourier Transform Infrared Spectroscopy (FT-IR)

A Spectrum IRTracer-100 FTIR Spectrophotometer was used to categorize diverse functional groups in Selenium nanoparticles. To get the sample ready for FTIR measurement, the mixture underwent centrifugation for 15 minutes at 10,000 rpm. The pellet was rinsed thrice using 20 mL of deionized water, in order to eliminate enzymes and proteins that not bound to pellet and were therefore unavailable for capping the Selenium nanoparticles.

Once the washing step was complete, the pellet was dried and ground into a powder. This powder was subsequently examined in diffuse reflectance mode, spanning a resolution range of 400 to 4000 cm^{-1} [18].

Powder X-ray diffraction (XRD)

An X'pert Pro MPD PAN analytical X-ray diffractometer, manufactured by Holland Limited, was employed to examine the nanoparticles. The instrument operated with a characteristic radiation wavelength of $\lambda = 1.54$ under a 2θ configuration. Readings were taken across the 2θ range spanning 20° to 80°. The resulting data were processed with dedicated XRD X'pert software. By applying the Debye-Scherrer formula to the width of the XRD peaks, the size of the nanoparticles was established using the formula:

$$D = 0.94\lambda / (\beta \cos \theta)$$

Here, λ denotes X-ray wavelength, D represents average size of the crystalline domain measured perpendicular to the reflecting planes, β stands for the full girth at half maximum (FWHM), and θ refers to the diffraction angle [19, 20].

Antioxidant Activity

Antioxidant potential of *A. viridis* and *D. alba* was analyzed by measuring their free radical scavenging activity against 2, 2-Diphenyl-1-picrylhydrazyl

(DPPH) by using the procedure of [21]. To do this, 10 grams of the powdered plant material under investigation was soaked in 50 mL of methanol and allowed to stand for 7 day. After a week the methanolic extract was filtered. Stock solutions of 10%, 20%, 30%, 40% and 50% were made by mixing 10, 20, 30, 40 and 50 µl of the sample extract with equal volume of 3 mL of a 0.004% DPPH respectively. Three milliliters of methanolic solution with 0.0004% DPPH were used as a control. The mixtures were thoroughly mixed and then left in the dark for half an hour. A Shimadzu Japan UV-1700 spectrophotometer was used to check absorbance at 517 nm and three duplicates of each sample were also tested. The following equation was applied to determine the percentage inhibition achieved through DPPH free-radical scavenging:

$$\text{Percentage inhibition}(\%) = \frac{\text{Absorbance in control} - \text{Absorbance in treatment}}{\text{Absorbance in control}} \times 100$$

Antimicrobial Activity

The antifungal properties of Selenium nanoparticles produced through green synthesis using A. viridis and *D. alba* were evaluated against the target fungus [22]. Five distinct concentrations: 0.5%, 0.1%, 1.5%, 2%, and 2.5% for each plant sample were prepared. In 250mL conical flasks containing 59.7, 59.4, 59.1, 58.8, 58.5, 58.2 and 57.9(mL) of distilled water were then filled with 1.2 g of malt extract (ME) and autoclaved the medium at 121°C and 15lb $inch^{-2}$ pressure for thirty minutes. Methanolic plant extract of 0.3, 0.6, 0.9, 1.2, 1.5, 1.8 and 2.1(mL) were added to bring the total volume up to 60 mL. Control flasks were without of any plant material. To avoid any bacterial production an antibiotic Amoxicillin (50 mg mL) was inserted in each flask. Each concentration was made in three replicas. Every flask was inoculated with a 5 mm mycelial disc obtained using a sterilized cork borer from a one-week-old culture of *Penicillium verrucosum*. After a week growth of fungus was checked by filtering it by pre weight filter paper (Whatman No. 1 filter paper). Dry weight of each filtrate was measured after drying it in an electric oven. The examined fungal biomass was calculated utilizing the equation below:

$$\text{Growth inhibition}(\%) = \frac{\text{Growth in control} - \text{Growth in treatment}}{\text{Growth in control}} \times 100$$

Statistical Analysis

To determine LSD (Least significant difference), the entire dataset underwent statistical analysis with the help of Statistix 8.1 software

RESULTS AND DISCUSSION

UV-Visible Absorption of *Amaranthus viridis*

The optical properties of Selenium nanoparticles (SeNPs) that were produced were examined by means of Ultraviolet–Visible spectroscopy. The appearance of a distinct absorption peak at 280 nm serves as evidence that Selenium nanoparticles were formed through green synthesis employing A. viridis leaves extract (Fig. 1).

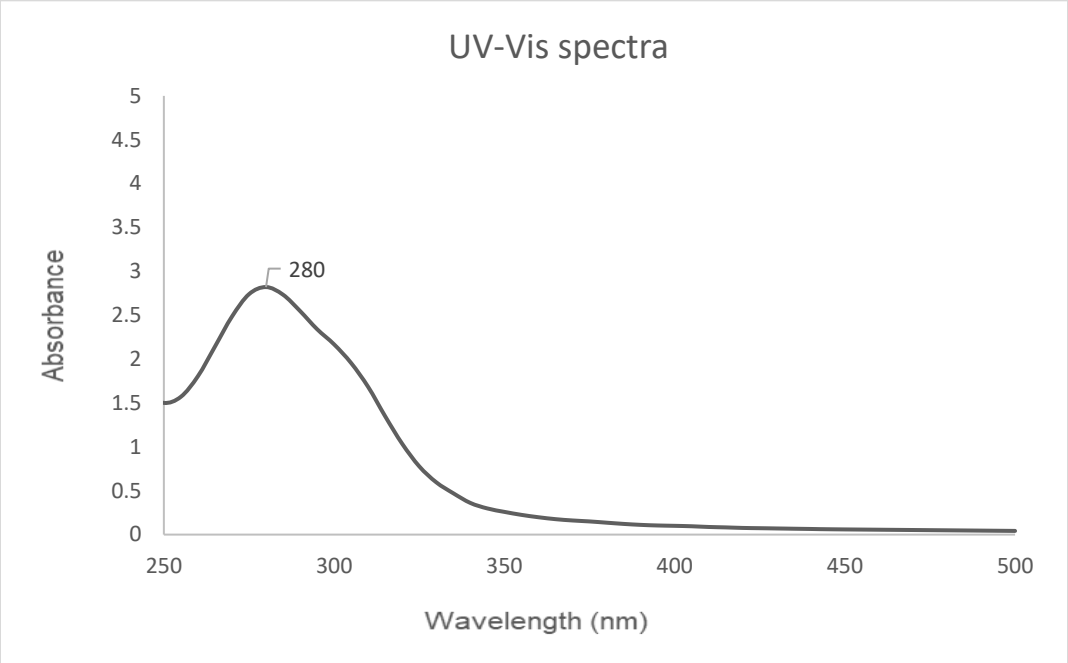


Fig 1 Ultraviolet–Visible absorption spectra of Selenium nanoparticles produced using the leaf extract of *Amaranthus viridis*

Ultraviolet–Visible Absorption of *Datura alba*

The Ultraviolet–Visible spectrum of Selenium nanoparticles as a result of green synthesis using *D. alba* plant extract showed a distinct absorption peak at 302 nm. This absorption band provides evidence for the formation of SeNPs during the synthesis process. The observed peak also reflects the optical characteristics of the prepared nanoparticles (Fig. 2).

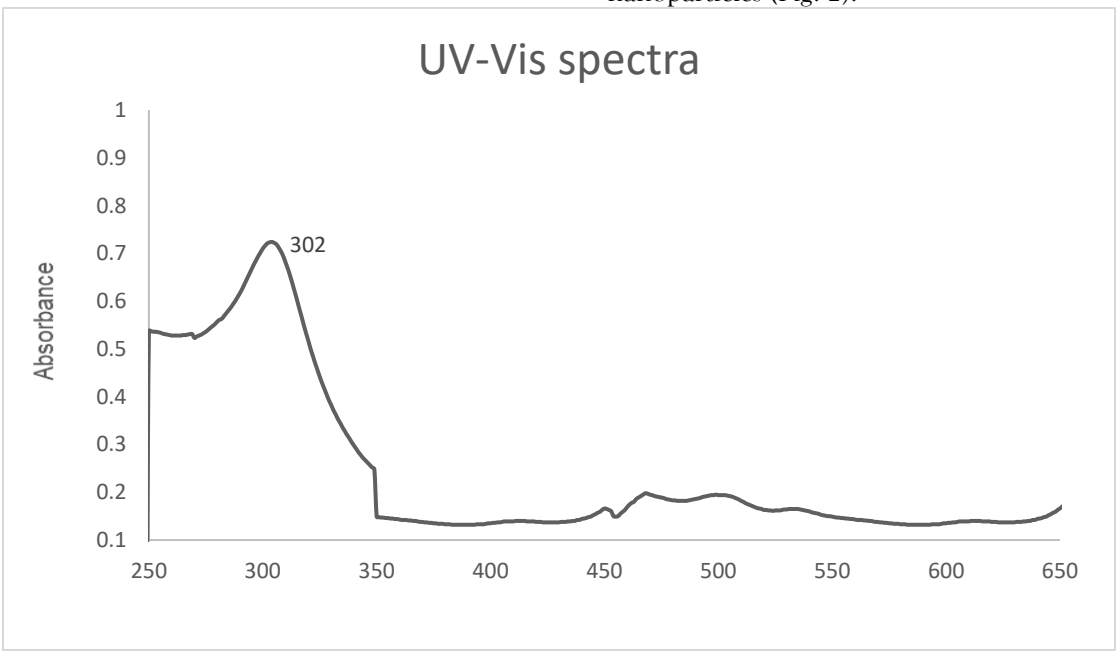


Fig. 2 UV-Visible Absorption Spectra of Se nanoparticles by green synthesis of *Datura alba*

Fourier Transform Infrared Spectroscopic (FTIR) Analysis of *Amaranthus viridis*:

The FTIR spectra revealed that the broad peak at 3200 cm-1 is due to O–H stretching, which suggests the existence of hydroxyl groups. The peak at 1630 cm^{-1} is associated with C=O/C=C vibrations, while the bands at 1349 and 1050 cm^{-1} are related to C–N and C–O stretching vibrations, respectively. The smaller peaks at 550, 675, and 775 cm^{-1} occur in the lower wavenumber region indicating the presence of additional molecular vibrations associated with the compounds present in the plant extract (Fig. 3).

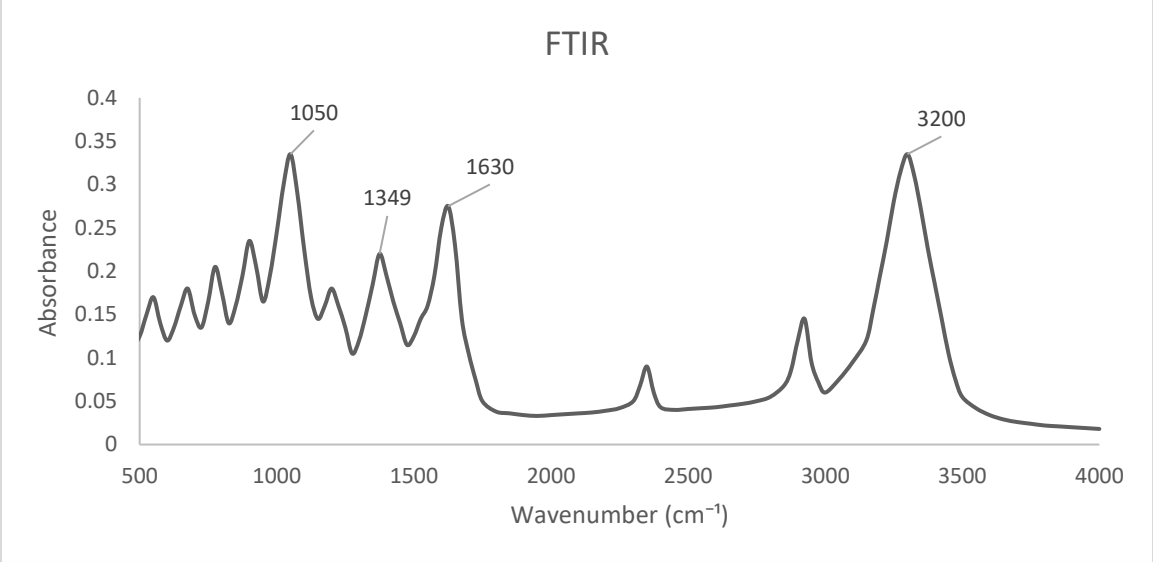


Fig.3 FTIR spectrum of synthesized Se nanoparticles synthesized from the leaf extract of *Amaranthus viridis*

Fourier Transform Infrared Spectroscopic (FTIR) Analysis of *Datura alba*:

The FTIR spectra showed the broad peak at 3300 cm^{-1} matches to O–H stretching, indicating the existence of -OH groups. The absorption peak at 2925 cm^{-1} corresponds towards C–H stretching vibrations of aliphatic $-CH_3$ and $-CH_2$groups. This peak indicates occurrence of organic compounds from the *Datura* extract associated with the synthesized Selenium nanoparticles. The peak at 1625 cm^{-1} is associated with C=O/C=C vibrations, while the bands at 1375 and 1050 cm^{-1} are related towards C–N and C–O extending vibrations, respectively. The smaller peaks at 550, 675, and 775 cm^{-1} occur in the lower wavenumber region indicating the presence of additional molecular vibrations associated with the compounds present in the plant extract (Fig. 4).

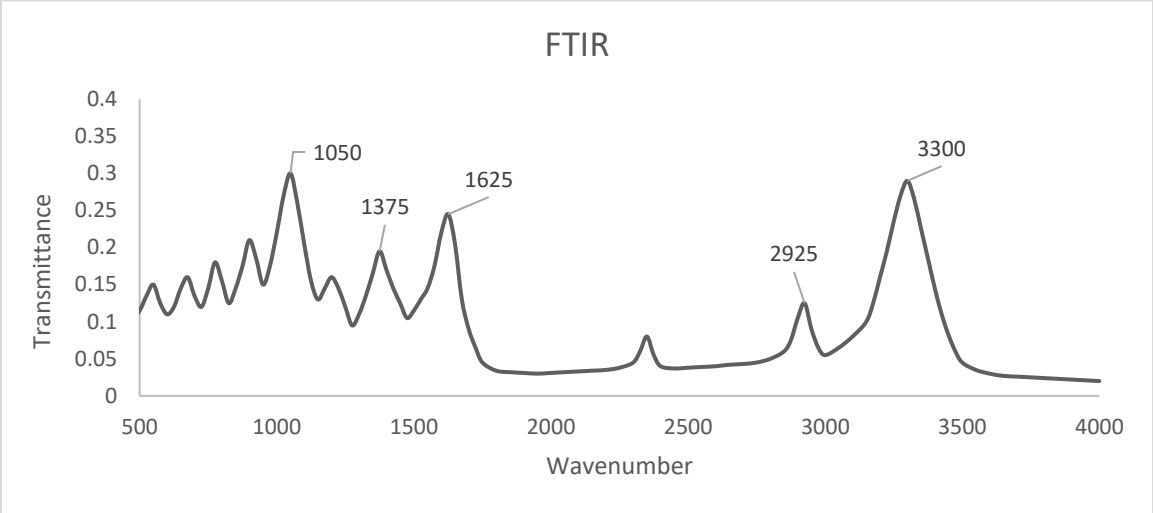


Fig.4 FTIR spectrum of synthesized Se nanoparticles synthesized from the leaf extract of *Datura alba*

X- Ray Diffraction Analysis of *Amaranthus viridis*

X-ray diffraction (XRD) analysis was performed to assess the crystalline properties of the Selenium nanoparticles obtained from A. viridis. XRD pattern showed a strong diffraction peak at approximately 24.31°, along with other peaks around 29.38°, 32.08°, and 47.56°. The presence of these diffraction peaks indicates the formation of a crystalline Selenium phase. Similar diffraction peaks in the range of approximately 23–33° and 55-56° have been reported for green synthesized Selenium nanoparticles (Fig. 5).

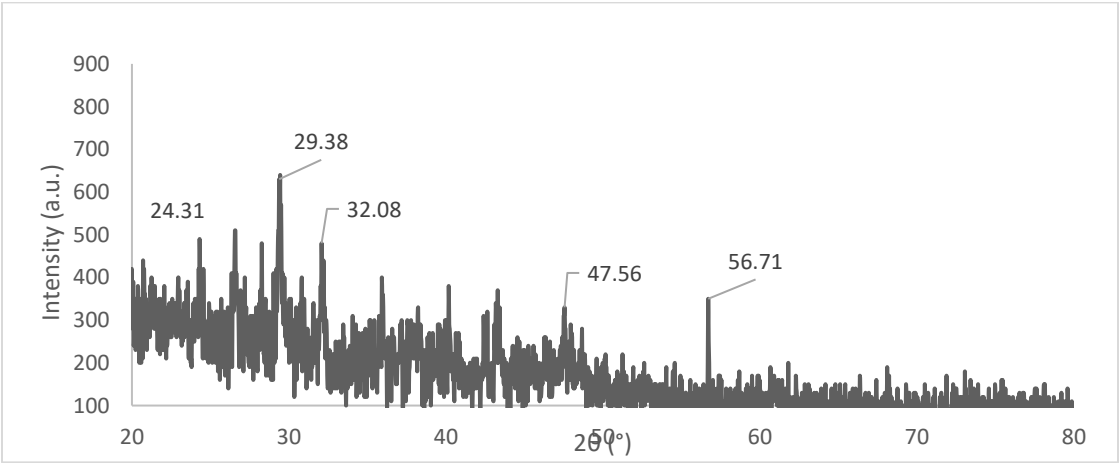


Fig 5 XRD pattern of green synthesized Se nanoparticles from *Amaranthus viridis* leaf extracts.

4. X- Ray Diffraction Analysis of *Datura alba*

The XRD pattern of Selenium nanoparticles synthesized using *D. alba* plant extract showed a prominent peak at approximately 29.35°. Additional diffraction features were observed around 26.59°, 43.36°, 52.48°, and 67.48°. These diffraction peaks indicate the crystalline nature of the synthesized Selenium nanoparticles. Recent studies on plant-mediated SeNPs have reported characteristic Selenium reflections near 23–27°, 29–30°, 41–43°, 51–56° and 63-67°, which are associated with crystalline Selenium (Fig. 6).

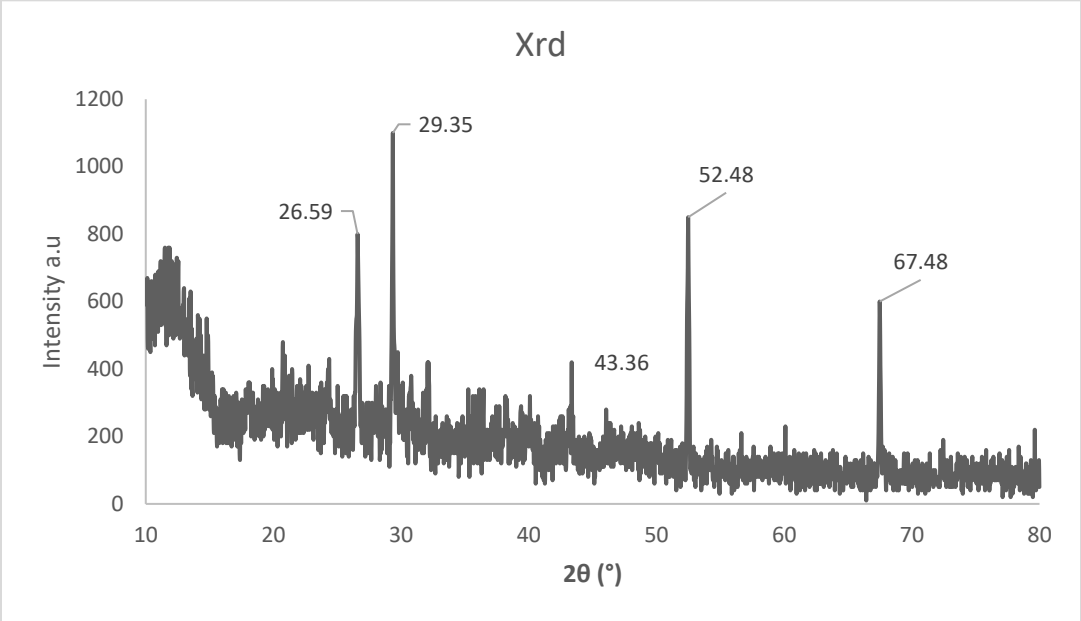


Fig. 6 XRD pattern of green synthesized Se nanoparticles from *Datura* leaf extracts.

Scanning Electron Microscopy (SEM) Analysis of *Amaranthus virdis*

The technique of Scanning Electron Microscopy was applied to observe the surface morphologies and approximate sizes of the Selenium nanoparticles synthesized by using *A. virdis*. The SEM images showed small, mostly rounded and irregular particles, with some particles occurring close together and showing slight agglomeration. The particle size was approximately 30–130 nm based on the observed particles. The variation in size may be related to the different compounds present in the test plant extract, which can affect the formation and stabilization of nanoparticles (Fig. 7).

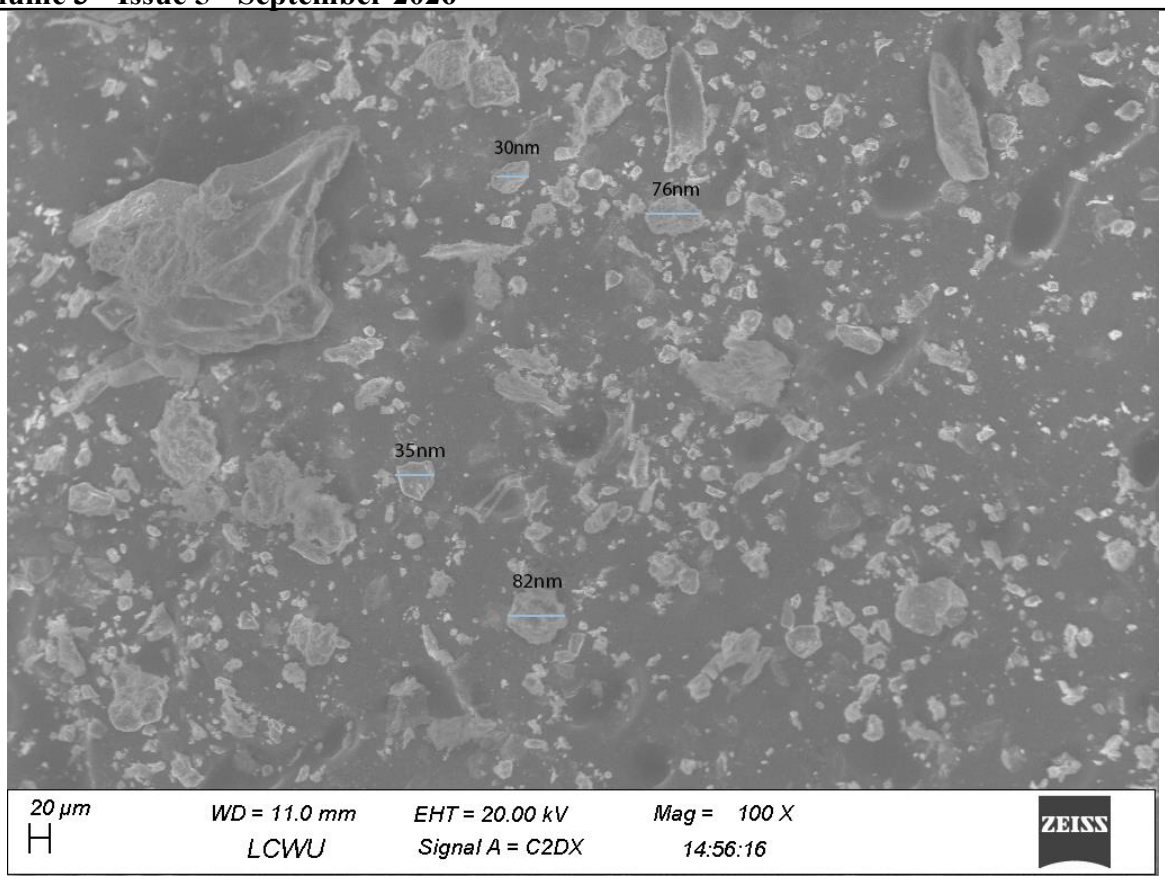


Fig. 7 SEM image of Selenium nanoparticles synthesized from leaf extract of *Amaranthus viridis*

Scanning Electron Microscopy (SEM) Analysis of *Datura alba*

The SEM images of Selenium nanoparticles synthesized using *D. alba* plant extract showed small rounded to irregular particles with some degree of aggregation. The particle size that was observed measured roughly 50–150 nm. Variations in particle size and morphology may be affected by the phytochemicals found in the extract of *Datura*, since composition of plant and synthesis conditions can influence nanoparticle nucleation and growth (Fig. 8).

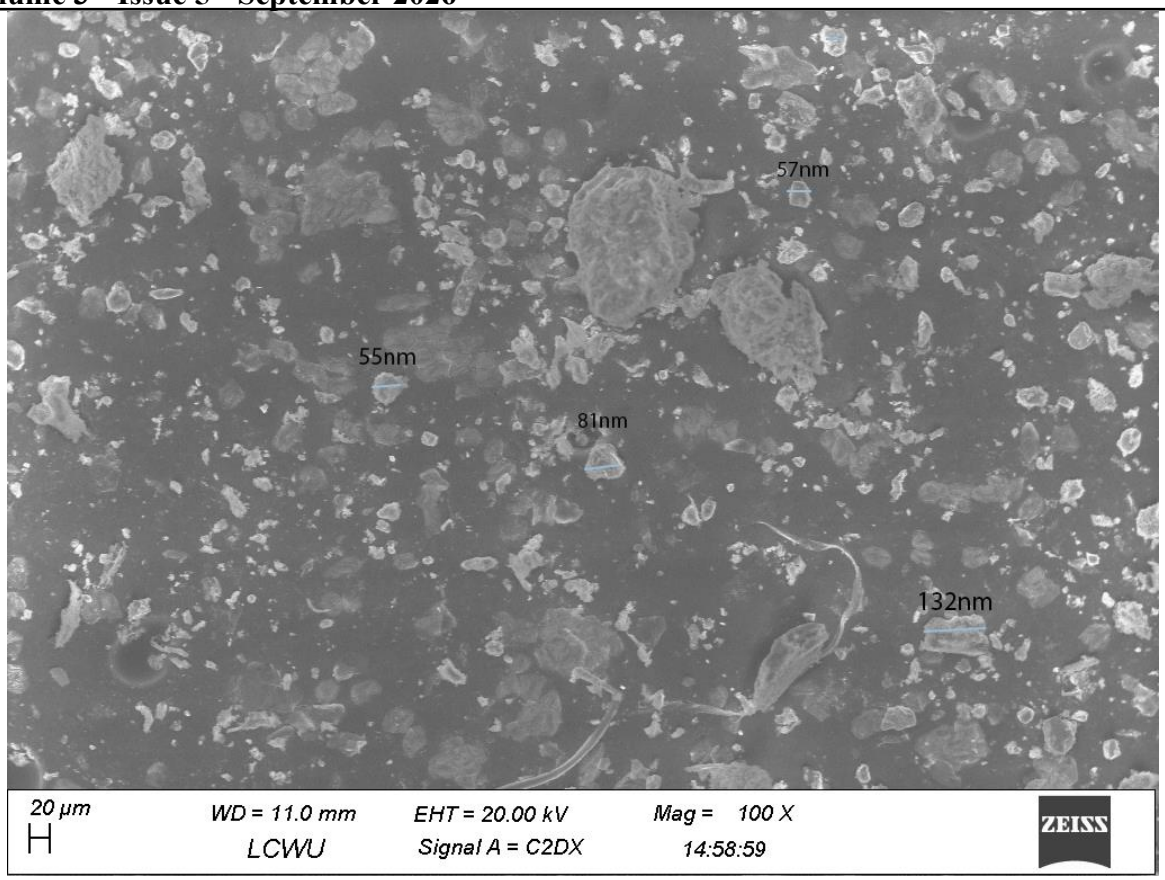


Fig. 8 SEM image of Selenium nanoparticles synthesized from leaf extract of *Datura alba*

Antioxidant Activity

To evaluate the antioxidant activity of SeNPs synthesized via *A. viridis* and *D. alba*, a 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical assay was carried out using spectrophotometry. Of the two plants tested, *D. alba* exhibited greater antiradical potential than *A. viridis*, which likewise demonstrated antioxidant activity. In both of the test plants, the greatest percentage of inhibition was determined at a concentration of 50%, whereas the lowest potential was seen at a concentration of 10%. In the case of *D. alba*, the highest inhibition was documented at 62%, while the lowest activity was noted at 29%. Conversely, in the case of *A. viridis*, the strongest antiradical activity reached 59%, whereas the lowest efficacy recorded was 26%; by contrast, the standards displayed radical scavenging efficacy of 79%, with a weaker activity of 51%. This showed that, for both green synthesized SeNPs, the antioxidant potential continued to rise as the concentrations increased. (Fig. 9).

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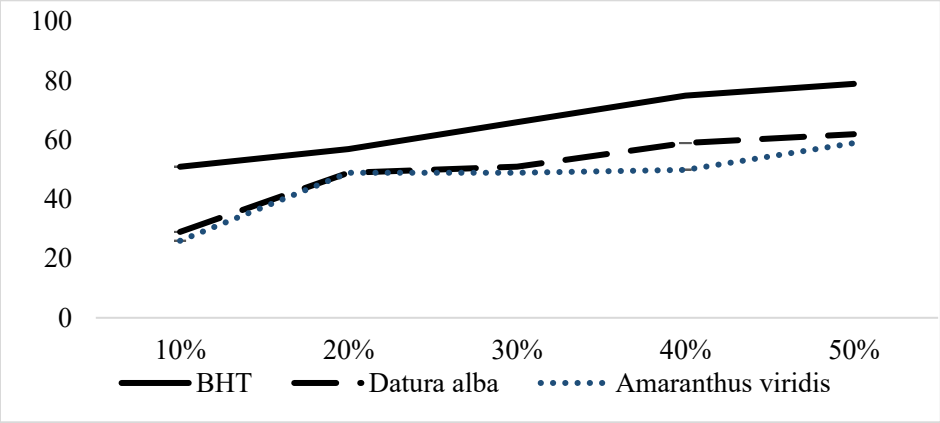


Fig. 9: Antioxidant activity of different concentrations of Green Synthesized SeNPs from *D. alba* and *A. viridis* at P ≤ 0.05.

Antimicrobial Activity of Green Synthesized Selenium Nanoparticles From *A. viridis* and *D. alba*

Different concentrations (0.5%, 1%, 1.5%, 2% and 2.5%) of green synthesized Selenium nanoparticles (SeNPs) from *A. viridis* and *D. alba* significantly reduced fungal growth of *Penicillium verrucosum* as compared to control treatment. 2.5% concentration of SeNPs from both *A. viridis* and *D. alba* showed maximum reduction in fungal biomass at 65%. *D. alba* mediated SeNPs showed reduction in fungal biomass by 54%, 58% 57% and 64% at 0.5%, 1%, 1.5% and 2% concentrations, respectively. Similarly, *A. viridis* mediated SeNPs showed reduction in fungal biomass by 45%, 48% 55% and 61% at 0.5%, 1%, 1.5% and 2% concentrations, respectively. Synthetic fungicide exhibited a comparatively higher reduction than both plants with fungal biomass reduction of 60%, 63%,71%, 76% and 85% at 0.5%, 1%, 1.5%, 2% and 2.5% concentration, respectively. Fungal growth inhibition increased with increasing SeNPs concentration. SeNPs derived from *D. alba* showed slightly higher reduction as compared to *A. viridis* mediated SeNPs (Fig. 10 & 11).

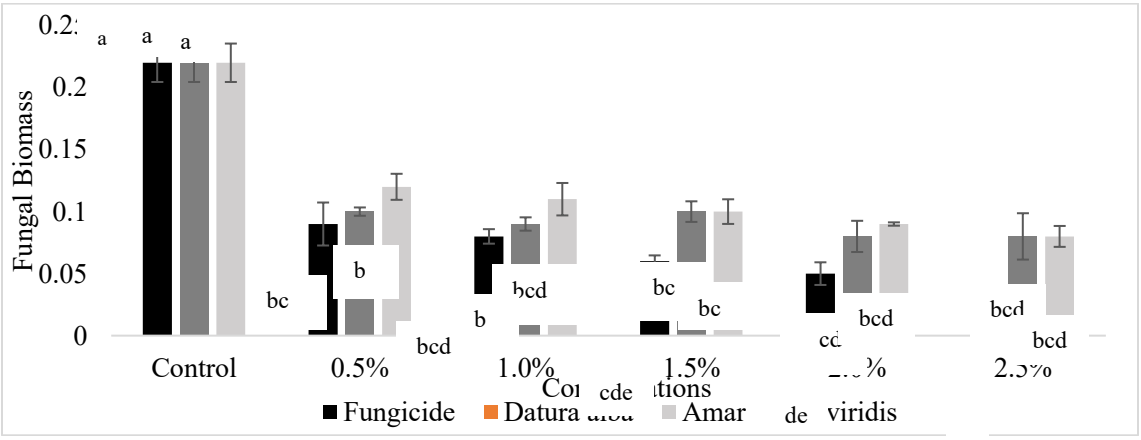


Fig 10: Effect of various concentrations of Green Synthesized SeNPs using *D. alba* and *A. viridis* on the *in vitro* growth of *P. verrucosum*. The standard error of the means across three replicates is represented by vertical bars. Values marked with different letters indicate significant differences as established according to LSD test (P ≤ 0.05).

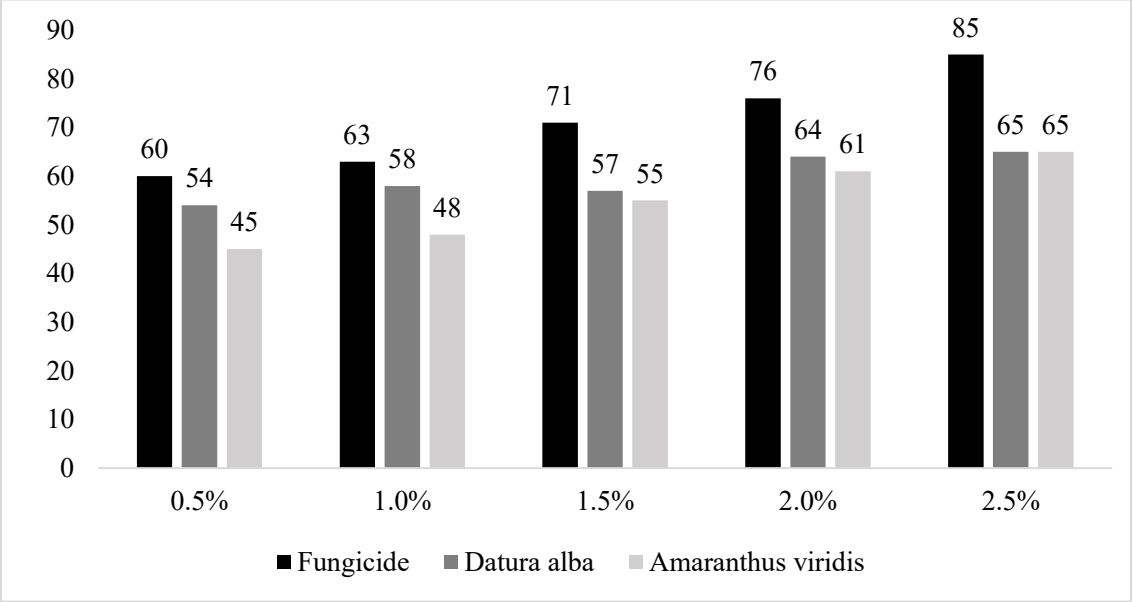


Fig 11: Percentage decrease on growth of *P. verrucosum* by different concentration of green synthesized nanoparticles of *D. alba* and *A. viridis*

In this study, plant extracts of *Amaranthus viridis and Datura alba* were used to make the Se nanoparticles by green synthesis. The green synthesis (plant mediated) of nanoparticles is a very simple approach that is environmental friendly because it contains natural compounds that participate in Se ions reduction and newly formed nanoparticle's stabilization. Different studies have demonstrated that the substances like phenolics, flavonoids, proteins, and other plant metabolites influence the formation and stabilization of nanoparticles [23]. There is some difference in characterization of Se nanoparticles, because we use two different kinds of plant extracts. This is obvious that every plant extract has its own chemical composition. As aresult the quantity and type of phytochemicals present at the time of nanoparticles synthesis effect the properties of nanoparticles like size, formation and morphology [24].

UV visible spectroscopy provided the first confirmation of Se nanoparticles' formation. SeNPs made with *Datura alba* extract displayed a peak at 302 nm, while the *Amaranthus viridis* mediated SeNPs displayed a maximum absorption peak at 280 nm. The difference noted in both plants wavelengths, because of different optical properties. The difference in particle size, form is due to different plants ectract's phytochemical properties [25].

The *Amaranthus viridis* sample's peak at 280 nm is also consistent with a previous work that found a UV–visible absorption peak at 280 nm in plant-mediated SeNPs [26]. SeNPs made with Clerodendron phlomoides extract demonstrated an absorption band at 325 nm in a different recent work, indicating that the absorption position can change depending on the plant source and synthesis conditions. Therefore, the current study's peaks at 280 and 302 nm support the creation of SeNPs; nevertheless, the two samples' differences could be attributed to the various biological materials used in their synthesis [27].

The functional groups connected to the chemicals that derived from plant produced SeNPs were identified using FTIR analysis. In addition to lesser bands at 550, 675, and 775 cm^{-1}, the SeNPs made by *Amaranthus viridis* had large peaks at 1050, 1349, 1630, and 3200 cm^{-1}. O-H stretching is linked to the broad band around 3200 cm^{-1}, while aliphatic group C-H stretching is linked to the band around 2925 cm^{-1}. The bands in the

1050 and 1349 cm^{-1} regions indicate various C–O / C–N related vibrations, the band at 1630 cm^{-1} may be connected to carbonyl or related unsaturated group vibrations. The results tells that the *Amaranthus viridis* plant extract's organic components continued to be linked to the surface of the NPs. Because they can take part in the reduction and stabilization of nanoparticles, these surface bound plant chemicals are essential to green synthesis. Phytochemicals from the plant extract were linked to the synthesis and stabilization of the SeNPs [28].

FTIR analysis of Selenium nanoparticles made with *Datura alba* plant extract indicated main peaks at points 1050, 1375, 1625, 2925 and 3300 cm^{-1}. The O-H streching was shown by a peak at 3300 cm^{-1}, and a peak at 2925 shows the C-H streching of aliphatic elements. The band present at 1625 cm^{-1} is connected with C-O / C-C vibrations, and the peaks at 1375 and 1050 cm^{-1} are linked to C–N and C–O stretchings. The above peaks show that several chemicals made from plant extract are present on the surface of the Seleniumnanoparticles. During green synthesis, these substances may be crucial to the creation and stability of the nanoparticles [29].

SEM analysis showed that *A. viridis* mediated SeNPs were mostly round and in irregular form with some degree of aggregation. The exact particle size ranging from 30-130 nm. While, *D. alba* mediated SeNPs were also rounded and irregular in pattern with slight aggregations and its size was ranging from 50-150nm. The difference in particle size of both samples were mostly because of difference in the phytochemical composition of *D. alba* and *A. viridis* extract. Phytochemical compounds may be responsible for the change in nucleation and nanoparticles sizes. Earlier it was reported that green synthesized nanoparticles from *Sarcocorina fruticosa* presnted spherical morphology with size ranging from 50 to 100 nm. *Cassia javanica* showed spherical and irregular particle size ranging from 35-100nm. The particle-size ranges observed in the present study therefore fall within the broad range reported for plant-mediated SeNPs. However, the SEM images used in this study provide an approximate size estimation rather than a complete statistical particle-size distribution. Higher-magnification SEM or TEM images would provide more accurate individual particle measurements [30].

XRD analysis was employed to examine the crystalline properties of the synthesized SeNP. The *Amaranthus viridis*-mediated sample showed prominent diffraction features around 26.59°, 29.41°, 32.14°, and 43.36°, while the *Datura alba*-mediated sample showed major features around 26.56°, 28.27°, 29.44°, 32.08°, and 35.92°. The presence of distinct diffraction peaks indicates that the synthesized material contains an ordered crystalline component. The XRD pattern of green-synthesized SeNPs can vary depending on the plant extract and synthesis conditions. Recent work with Catharanthus roseus reported characteristic Selenium reflections at 23.90°, 29.37°, and 31.65°, which were assigned to the (100), (101), and (111) planes of trigonal Selenium (2026). Similarly, SeNP diffraction peaks at 23.77°, 29.90°, 41.31°, 43.85°, 45.63°, 51.87°, 55.79°, 61.77°, and 65.67°, confirming a crystalline Selenium phase [31,32].

The XRD results of the present study therefore support the formation of a crystalline Selenium-containing nanomaterial. The differences in peak positions and intensities between the *Amaranthus viridis* and *Datura alba* samples may result from differences in crystallite formation, particle growth, and the organic compounds associated with the nanoparticle surface [29,30].

Overall, the results from characterization showed the evidence that green synthesis of Selenium nanoparticles done susseccfully with the use of both plants extracts of *A. viridis* & *D. alba*. The peaks at 280 nm and 302 nm of UV showed primary evidence of formation of NPs. Several functional groups linked to chemicals produced from plants were found by FTIR analysis, confirming their function in the synthesis and stability of the nanoparticles. SEM showednanoscale particles with some accumulation, whereas the XRay Diffraction displayed distinct diffraction features representing a crystalline component. The plant extracts made nanoparticles with some differences in the optical

properties, form, and size of particle. These differences reveal that the selection of plant extract can effect the characteristics of green synthesized SeNPs.

All the applied concentrations 0.5%, 1%, 1.5%, 2% and 2.5% of green synthesized Selenium nanoparticles (SeNPs) from *A. viridis* significantly reduced fungal growth of *Penicillium verrucosum* as compared to control treatment. 2.5% concentration of SeNPs. The experimental plant *A. viridis* is able to inhibit the conidial germination of various harmful fungal specimens [33]. The findings show that nanoparticles derived from *A. viridis* could serve as a promising antifungal agent against diverse pathogenic fungal strains [34]. The test plant *D. alba* also significantly reduced fungal growth of *P. verrucosum* as compared to control treatment. 2.5% concentration of SeNPs from both *A. viridis* and *D. alba* showed maximum reduction in fungal biomass at 65%. *D. alba* mediated SeNPs showed reduction in fungal biomass by 54%, 58% 57% and 64% at 0.5%, 1%, 1.5% and 2% concentrations, respectively. Fungal growth inhibition increased with increasing SeNPs concentration. Earlier report suggested that *D. alba* possess strong antimicrobial antimicrobial potential [35].

To assess the antioxidant activity of SeNPs mediated by *A. viridis* and *D. alba*, the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical assay was performed using spectrophotometry. Of the two test plants, *D. alba* exhibited greater antiradical potential than *A. viridis*, although the latter also demonstrated antioxidant activity. For both test plants, the greatest percentage inhibition was determined at a concentration of 50%, whereas the lowest potential was recorded at a concentration of 10%. Because bioactive molecules are present on their surface, the synthesized metal nanoparticles exhibit strong antioxidant activity. When their radical scavenging activity is examined, these antioxidants serve as stabilizing and capping agents for the nanoparticles that have just formed [36, 37].

Conclusion

This study concluded that synthesis of SeNPs using plants is a convenient, inexpensive and eco-friendly way to overcome the hazardous effects of synthetic chemicals. In present study the green synthesized SeNPs from both the test plants *A. viridis* and *D. alba* showed great antioxidant and antimicrobial potential, which can be further utilized in the drug discovery and crop management practices.

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