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Antioxidant, Antidiabetic, and Antimicrobial Potentials of Silver Nanoparticles Synthesized from *Viscum album*

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ABSTRACT
Substances smaller than 100 nm in size are called nanoparticles. In this study silver nanoparticle synthesis was carried out by using $AgNO_3$ from leaf, fruit, and branch aqueous extracts of the mistletoe (*Viscum album* ssp. *austriacum*) plant. It was determined whether silver nanoparticles were formed using the UV-Vis method. As a result of UV-Vis analysis of plant parts, peaks were observed at 425, 427, and 430 nm, indicating the surface plasmon resonance of AgNPs. Specific functional groups involved in the formation of AgNPs and reduction of Ag were determined using FT-IR spectroscopy. SEM and EDS analyses determined that the synthesized silver nanoparticle samples were nanosized, and the average size was 59.91. In addition to the crystallite size calculated from XRD diffraction, it was observed that the crystallite size of all silver nanoparticles obtained was in the nanometer range, and the nanoparticle peaks were the same as the peaks of pure silver. Considering the antioxidant results of the study, it was determined that the highest total phenolic and flavonoid amounts were in the leaf extract (35.57±1.39 mg GAE/g extract) and fruit extract (23.42±1.29 mg QE), respectively. Additionally, it was determined that the highest radical scavenging activity was in the fruit AgNPs sample (IC_{50} 129.24±1.38 µg/mL). Additionally, it was determined that the highest antidiabetic activity (α-amylase inhibition) was in the fruit AgNPs sample (IC_{50} 123.59±1.44 µg/mL). As a result, it was determined that silver nanoparticles obtained from these plant parts had superior antioxidant, antidiabetic, and antimicrobial properties.

Keywords: *Viscum album*, Green synthesis, Characterization, Antioxidant, Antidiabetic, Antimicrobial

1. Introduction

One of the most important fields of modern science is nanotechnology. Less than 100 nanometers in size, nanoparticles have properties that are considered to be much different and superior to those of bulky materials. Because of these features, they are used effectively in many fields today, such as medicine, cosmetology, biotechnology, and the chemistry sector (Nartop 2016). Recently, plant extracts and microorganisms have begun to be frequently used for metal nanoparticle synthesis. These biological methods have been proposed as an alternative to chemical methods. It is important to use plant extracts in the biosynthesis of nanoparticles (Kasthuri et al. 2009). The synthesis of nanoparticles from plant extracts is a highly preferred method because of its low cost, environmental friendliness, control of the reaction process, and high production rates (Ahmed et al. 2016; Nasrollahzadeh et al. 2015).

Metal nanoparticles have many important properties. Therefore, nowadays, they have wide usage areas, especially in developing new technologies such as silver nanomedicine, nanoparticles, materials science, and electronics. It especially attracts the attention of scientists (Bar et al. 2009). Silver is a good catalytic agent that will catalyze many reduction reactions very effectively (Suvith & Philip 2014; Navalon et al. 2016). But the chemical synthesis of silver nanoparticles also poses an environmental hazard. Therefore, in the last few years, the plant-derived green synthesis of silver nanoparticles has gained more importance due to its economic and environmental friendliness (Wesenberg et al. 2003; Khalilzadeh & Borzoo 2016). Among metal nanoparticles, silver nanoparticles are known to have inhibitory and bactericidal effects (Cho et al. 2005). In addition, silver nanoparticles with different chemical and physical properties have begun to be used more for industrial purposes, food, medicine, and health fields (Gurunathan et al. 2015). Due to their different and special structures, these nanoparticles are frequently used in the production of antibacterial and anticancer agents, the pharmaceutical industry, the field of orthopedics, the food industry, orthopaedics, drug release, anticancer agents, industrial, home, and health-related products, coatings of medical devices, the production of optical sensors, and the field of cosmetics. It is also used to increase the potency and performance of tumor-destroying drugs (Chernousova & Epple 2013). Silver shows great toxicity to a wide variety of microorganisms. In addition, silver nanoparticles show anti-viral, anti-inflammatory, anti-platelet, and anti-angiogenesis activity. Being effective

against cancer cells has made them very important (Stoimenov et al. 2002; Safaepour et al. 2009; Elumalai et al. 2010; Sotiriou & Pratsinis 2010; Huang & Zhan 2011; Kaviya et al. 2011; Vidhu et al. 2011).

Mistletoe has been used for medicinal purposes since ancient times reported to be used. The medicinal effects of mistletoe vary according to the type of plant it is used on (Ekhaise et al. 2010). Mistletoe (*V. album*) is a semi-parasitic plant that grows on trees such as fir, pine, spruce, pear, cherry, and pumpkin trees, belonging to the order Santalales, Loranthaceae family, and Viscum genus, which is green for four seasons. *V. album* ssp. *austriacum* species live on the trunk and branches of pines. It does not shed its leaves and is green in all seasons. Especially cardiovascular system diseases caused by this parasitic plant and has been reported to have positive effects on cancer. Additionally, this plant has antipsychotic, anti-diabetic, anti-inflammatory, and hypotensive properties (Hegde et al. 2011; Orhue et al. 2014). In addition, plant extracts, radiotherapy, and the harmful and mutagenic effects of chemotherapy reduction have been reported (Büssing et al. 1994; Kovacs 2002). Thus, these plant extracts increase the effectiveness of cancer treatment (Kienle et al. 2016). Pharmacological studies conducted with *Viscum* species have shown that the chemical structure of these plant species depends on the host tree. They especially contain active molecules such as phenolics and flavonoids, viscotoxins, lignans, phenylpropanoids, sterols, fatty acids, and terpenoids (Szurpnicka et al. 2019). A study examining the effects of *Viscum* species on the central nervous system in vivo showed that they have many properties, such as sedative and analgesic (Khatun et al. 2016), antiepileptic (Geetha et al. 2018), and antidepressant (Kumar et al. 2016). In addition, studies have shown that mistletoe has bioactive effects such as immunomodulatory and antifungal (Oei et al. 2019; Zhou et al. 2023), anti-inflammatory (Nicoletti 2023), antibacterial and antiradical (Çiftci et al. 2024), antioxidant (Nicoletti 2023). In addition, viscothionine found in mistletoe has a polypeptide structure and has been reported to increase insulin secretion. It has been stated in studies that especially mistletoe extract inhibits the α-glucosidase enzyme (Park et al. 2019).

Substances that contain unpaired electrons are called free radicals. Therefore, they are very active and easily react with biological molecules (Valko et al. 2007). These radicals are formed during the normal functioning of the cell and damage proteins, DNA, carbohydrates, enzymes, and lipids by disrupting their functioning (Shinde et al. 2012). It neutralizes and destroys these harmful radicals through metabolic antioxidant systems (Barber & Harris 1994). Antioxidant substances prevent many diseases, such as diabetes, cancer, cataracts, and cardiovascular diseases, which are thought to be caused by free radicals (Huang et al. 2005; Niki 2010). Oxidative stress has been reported to be a common pathway connecting mechanisms particularly involved in the pathogenesis of diabetic complications. Diabetes mellitus is a disorder in which there are complete or partial deficiencies in insulin secretion or function. This disorder is a chronic disease characterized by disorders in protein, carbohydrate, and fat metabolism. Oxidative stress parameters between oxidative stress and diabetes when measured it has been determined that there is a direct relationship.

Literature studies have shown that silver nanoparticles have many biological activities. Silver nanoparticles were synthesized from *Viscum orientale* plant leaf extract and it was reported that these nanoparticles have anthelmintic and antimicrobial activities. Additionally, this study reported the dose-dependent antiradical activity of silver nanoparticles (Kumar et al. 2023). It has also been reported that silver nanoparticles have antiviral, antifungal, antiparasitic, antibiofilm, and antitumor activities (Almatroudi 2020). Silver nanoparticles protect cells from this damage by preventing oxidative damage that occurs in metabolism. Therefore, they are used in the prevention and treatment of neurological diseases, diabetes, and cancer caused by oxidative stress. Because of these features, they have gained importance and hope (Bhakya et al. 2016).

In this study, it was aimed to investigate the in vitro antioxidant, antidiabetic, and antimicrobial potentials of nanoparticles by synthesizing silver nanoparticles (AgNPs) using the green synthesis method from three different aqueous extracts of *V. album* plant parts (leaf, fruit, and branch) for the first time. In addition, it was aimed to determine the use potential of the plant from the results obtained from the study and to contribute to silver nanoparticle studies.

2. Material and Methods

2.1. Materials

The pine mistletoe (*Viscum album* ssp. *austriacum*) plant was collected from Kirsehir, Turkey, in October (Figure 1). The fresh plant was first cleaned of its impurities by thoroughly washing it with tap water. It was then washed twice with distilled water and filtered. It was dried for two weeks in the shade and at room temperature without exposure to sunlight. The leaves, branches, and fruits of the dried mistletoe were pulverized with the help of a mechanical grinder (Fritsch P-15, Germany).

Figure 1- The appearance of mistletoe (*V. album*)

2.2. Methods

2.2.1. Preparation of plant part aqueous extracts

10 grams of powdered plant parts were weighed and placed in a 250 mL beaker, and 100 mL of bidistilled water was added. *V. album* plant part samples were boiled at 80 °C for 30 minutes. Then, the samples were filtered with filter paper and stored at 4 °C (Chung et al. 2017).

2.2.2. Synthesis of silver nanoparticles by the green synthesis method

3 mM $AgNO_3$ (99.90%, Merck, Darmstadt, Germany), solution was prepared with distilled water (Ashraf et al. 2016). 10 mL of the *V. album* plant was taken from the aqueous extract solutions and 3 mM 90 mL $AgNO_3$ solution was added. Samples were mixed at room temperature for 45 minutes. The color changes observed in the samples indicate the emergence of silver nanoparticles (Asha et al. 2016). The samples turned a dark brown-black color after 24 hours. Thus, it was seen that silver nanoparticles were formed. Again, the formation of AgNPs was detected using the UV-Vis technique. The resulting solutions were centrifuged at 5.000 rpm for 60 min. The nanoparticles thus formed were precipitated and the supernatants were removed. The resulting nanoparticles were filtered by washing them three times with distilled water. Solid nanoparticles were placed in eppendorf tubes. After drying in an oven at 50 °C, it was weighed on a precision balance. The nanoparticles in these tubes were wrapped in aluminum foil.

2.2.3. Characterization of silver nanoparticles

2.2.3.1. UV-vis (Ultraviolet-visible spectrometry)

A reliable method for determining the surface plasmon resonance capabilities of nanoparticles is the UV-Vis spectrometry method (Bindhu & Umadevi 2013). Silver nanoparticle synthesis was carried out from different parts of the *V. album* plant. The formation of AgNPs by green synthesis was monitored by absorbance measurements at 250–600 nm in a Shimadzu UV-1800 model spectrophotometer. Distilled water was used for the blank sample.

2.2.3.2. FT-IR (Fourier transfrom infrared spectroscopy)

Determination of the functional groups of the plant extract using FT-IR spectroscopy was performed. FT-IR analyses of leaf, fruit, and branch extracts of the *V. album* plant and AgNPs obtained from these extracts were performed. Plant extracts and nanoparticles were analyzed in the range of 4000-500 cm^{-1} with the help of a Perkin Elmer Spectrum One brand device. FT-IR is a method used to determine the structure and structural properties of nanoparticles and related functional groups in biological extracts according to the wavelength of light (Shobha et al. 2014).

2.2.3.3. SEM (Scanning electron microscopy) and EDS (Energy dispersive X-ray spectroscopy)

SEM is a method that determines the shape, surface, and size of nanoparticles and reveals their images (Ali et al., 2016). The size, shape, and spatial organization of the purified AgNPs were examined by SEM. EDS is used for the analysis of the elemental composition of metal nanoparticles. It gives full information about the fundamentals of nanoparticles (Khandel & Shahi 2016). SEM-EDS (Jeol JSM 6390; scanning electron micrograph-energy dispersive x-ray spectroscopy) method was used to detect silver compounds in AgNPs.

2.2.3.4. XRD (X-ray diffraction analysis)

This method used to obtain information about the elemental composition or crystallographic structure of naturally and artificially synthesized nanoparticles (Wang 2000). The crystal structures of silver nanoparticles were studied using a RadBDMAX II computer-controlled X-ray diffractometer in the $3o \leq 2\theta \geq 80o$ range. The crystal sizes of the obtained silver nanoparticles were determined by the Debye-Scherrer equation.

2.2.4. In vitro biological activities

2.2.4.1. Antioxidant activity

2.2.4.1.1. Determination of total phenolic substance in plant samples

Total phenolic substance amounts of extracts of the *V. album* plant were determined (Slinkard & Singleton 1977). For this purpose, solutions of 1 mg/mL concentration were prepared with distilled water from plant part extracts. 0.1 mL was taken from the samples, and 4.5 mL of distilled water was added to them. Then, 0.1 mL of Folin-Ciocalteu reagent was added and vortexed. Then, 0.3 mL of 2% Na_2CO_3 was added to the samples and kept at room conditions for 2 hours. The absorbance of the samples was measured at wavelength 760 nm. For water extracts used as blanks, 0.1 mL distilled water instead of the extract was used. The same experimental procedure was used. Total phenolic substance amounts in plant samples were calculated using standard gallic acid substance. The results of the study were determined as gallic acid equivalent (mg GAE/g extract).

2.2.4.1.2. Determination of total flavonoid substances in plant samples

The total flavonoid substance amounts of *V. album* plant samples in the study were determined to be equivalent to quercetin by the modified aluminum nitrate method (Moreno et al. 2000). To evaluate the total flavonoid content, 0.5 mL of the plant extract at a concentration of 1 mg/mL was combined with 0.1 mL sodium acetate. After 1 minute, add 0.1 mL of 10% (w/v) $Al(NO_3)_3$ and shake. The volumes of the samples were completed to 5 mL using a 96% (v/v) ethanol solution. The absorbance of the samples, which were kept at room temperature for 40 minutes, was measured at a wavelength of 450 nm using a spectrophotometer device. The total flavonoid substance amounts of the samples in the study were expressed as mg quercetin equivalent (QE)/g extract. The solution prepared by adding ethanol was used as a blank instead of the sample. Analyses were performed in triplicate.

2.2.4.1.3. Determination of DPPH free radical scavenging activity of samples

This method is based on the detection of the DPPH (2,2-diphenylpicryl-1-hydrazyl, Merck) radical, which is a free radical, by the antioxidant substance and determining its purple color by measuring it in a spectrophotometer (Blois 1958). The lightening of the purple color of the radical indicates the presence of antioxidant activity. Samples of standard substances (BHT and ascorbic acid), plant extracts, and nanomolecules were prepared at concentrations of 25, 50, and 100 µg/mL. 4 mL of a 0.1 mM DPPH solution was added to 1 mL of these samples. Following the vortexing process, all samples were left for half an hour at room temperature in a dark location. At the end of the period, absorbance values of 517 nm were read in the spectrophotometer. The following formula was used to calculate the samples' DPPH radical scavenging abilities:

$$DPPH\ Radical\ scavenging\ activity\ (\%\ inhibition) = \frac{A\ control - A\ sample}{A\ control} x\ 100 \quad (1)$$

The IC_{50} value is the quantity of antioxidant material needed to scavenge 50% of the DPPH radical concentration in the samples (Deng et al. 2011; Scherer & Godoy 2009). The IC_{50} values of all samples were calculated. Inhibition-concentration graphs of the mixtures prepared at three different concentrations of 25, 50, and 100 µg/mL for each sample were drawn. IC_{50} values were calculated using the correct equation in the graphs.

2.2.4.2. Antidiabetic activities (α-amylase)

2.2.4.2.1. Determination of α-amylase enzyme inhibition of samples

In the presence and absence of *V. album* plant part extracts and silver nanoparticles, the activity of α-amylase enzyme (Merck), a carbohydrate digesting enzyme, was evaluated (Apostolidis et al. 2007). First of all, to evaluate the enzyme activity, 0.5 mL of starch and 0.5 mL of enzyme mixture were kept at 25 °C for 20 min. After that, the samples were added to 1 mL of DNS (3,5-dinitrosalicylic acid) solution and boiled for 5 minutes. The boiling samples were cooled in tap water before being mixed with 7.5 mL of distilled water. The absorbance of all samples was measured at $\lambda = 540$ nm. A control tube was created using a 0.5 mL buffer solution instead of the enzyme. To investigate the inhibitory effect of extracts and silver nanoparticles on the α-amylase enzyme, samples were prepared at concentrations of 25, 50, and 100 µg/mL. 0.5 mL of these samples were taken and placed in test tubes. 0.5 mL of enzyme was added to all tubes. The samples were kept at 37 °C for 15 minutes. 0.5 mL of starch solution was added to the samples. Then, DNS solution was added, and the boiling process was started. Sample blanks were

prepared for all the samples. A standard acarbose substance was used to compare the α-amylase enzyme inhibition of the samples. The same experimental procedure was applied to standard matter. The α-amylase enzyme inhibition values of all samples were determined using the formula below.

$$\%\ Inhibition) = \frac{[(Absorbance\ amylase - Absorbance\ Extract/Acarbose)}{Absorbance\ amylase} x\ 100 \quad (2)$$

Absorbance amylase; The absorbance of the tube is considered 100% active.
Absorbance extract; Sample absorbance-sample blank absorbance

2.2.4.3. Antimicrobial activity

2.2.4.3.1. Determination of antimicrobial activity of samples

In this study; In order to determine the antimicrobial activity of synthesized silver nanoparticles, antimicrobial activity was performed by agar well diffusion method using 11 pathogenic microorganisms for the application of AgNPs. The names of the microorganisms used are as follows: *Staphylococcus aureus* (ATCC 25923), *Bacillus cereus* (709 Roma), *Bacillus subtilis* (ATCC 6633), *Enterococcus faecalis* (ATCC 29212), *Escherichia coli* (ATCC 25922), *Aeromonas hydrophila* (ATCC7966), *Pseudomonas aeruginosa* (ATCC 27853), *Vibrio anguillarum* (ATCC 43312), *Klebsiella pneumoniae* (ATCC 13883), *Salmonella typhi* (ATCC 6539) and *Candida albicans* (ATCC 90028), Tryptic SoyAgar (TSA) medium was used in sterile petri dishes to provide growth media for microorganisms. 24-48 hour fresh cultures of pathogenic bacteria and yeast were spread on TSA Plates at a density of 10^6 cfu/mL. After sowing, the plates were opened with 6mm diameter wells, 3mM AgNP was added to 70 ml wells and after 24-48 hours of incubation, the zone diameters around the wells were measured in mm and the effect levels of AgNPs were determined. For the purposes of activity comparison, conventional antibacterial medication ampicillin was utilized (CLSI 2007).

2.2.4.3.2. Minimal inhibition concentration (MIC)

Minimum inhibition concentrations of AgNPs synthesized green by *V. album* were determined using sterile 96-well microplates. In order to carry out the study, the solutions taken from the cultures of 10 microorganisms in TSB were prepared with McFarland 0.5 turbidity test as 1x10 6 cells/ml. The concentrations determined for silver nanoparticles with green synthesis are; 512 µL/mL, 256 µL/mL, 128 µL/mL, 64 µL/mL, 32 µL/mL, 16 µL/mL, 8 µL/mL, 4 µL/mL and 2 µL/mL. The prepared microplates were incubated in an oven at 37 0 C for 24 hours. Plates taken after 24 hours were analyzed in a spectrophotometer at 600 nm (Petrus et al. 2011). In the study, the operations with AgNPs were carried out in triplicate.

2.2.4.3.3. Anti-quorum sensing analysis

In this study, Anti-quorum sensing (Anti-QS) analysis; carried out by macroscopic methods. The inhibition of violacein pigment by AgNPs indicates that nanocolloids have quorum quenching activity. In the macroscopic method, agar well diffusion method was used and *Chromobacterium violaceum* (ATCC 12472) was planted on the plates formed with TSA and the zone diameters formed by AgNPs were calculated (McLean et al. 1997).

2.2.5. Statistical analysis

The number of samples was determined to be three for the parameters examined, and The Microsoft Excel application was then used to compute the mean and standard deviations of the findings. Aqueous extracts of plant sections from the study showed significant differences in phenolic and flavonoid compounds (Kruskal-Wallis H, sig. $P<0.001$). One-sample Wilcoxon signed rank test was used to compare the antioxidant and antidiabetic results of the samples with their standards ($P<0.05$).

3. Results and Discussion

3.1. Evaluation of silver nanoparticles from V. album plant

It has been suggested that pharmacologically active compounds can pass from trees to parasitic host plants (Büssing & Schietzel 1999). The primary study was the preparation of aqueous extracts of leaf, fruit, and stem parts of *V. album* for the synthesis of AgNPs. When aqueous Ag^+ ions were subjected to *V. album* extract, they were reduced to Ag^0 state. In this study, green synthesis of AgNPs was carried out by using aqueous extracts of leaves, fruits, and stems of *V. album*. UV-Vis, FTIR, SEM, EDS, and XRD analyses were performed to characterize the synthesized AgNPs. In addition, total phenolic and flavonoid levels in plant sections were examined. The radical scavenging capabilities of plant component extracts and the AgNPs generated from them were then assessed.

The study was carried out together with samples containing silver nitrate and plant extract and control group samples without silver nitrate. Aqueous extracts of *V. album* plant parts were added to 3 mM aqueous $AgNO_3$ solution. After a short time, color

changes were observed in the silver nitrate added group samples compared to the control group samples. A brown black color change was observed over time in the extract samples to which 3 mM aqueous $AgNO_3$ solution was added (Figure 2). This color intensity increased over time. This color change is a sign that silver nanoparticles are formed. In addition, UV-Vis measurements of the samples also supported the formation of silver nanoparticles. No change was observed in the control group (plant samples without added silver nitrate).

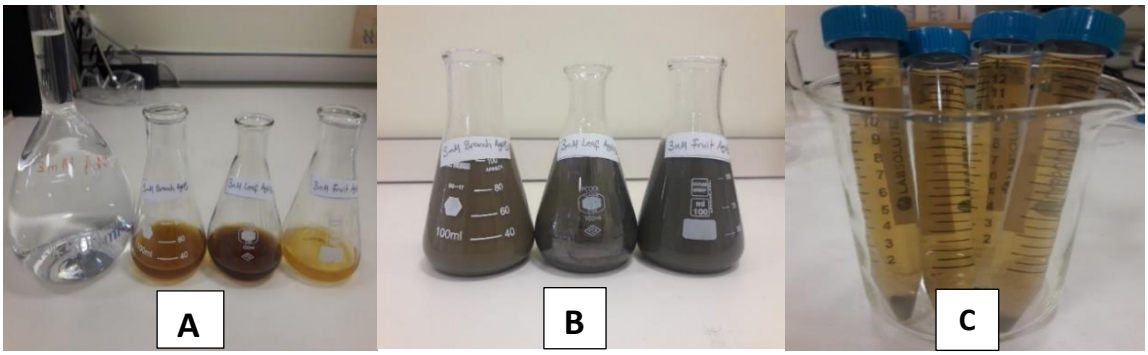


Figure 2- Aqueous solution of 3 mM $AgNO_3$ with *V. album* branch, leaf, fruit extract (A), Views of AgNPs after 24 hours of incubation (B), Appearance of AgNPs after centrifugation (C)

3.2. Characterization of silver nanoparticles (AgNPs)

3.2.1. UV-vis results

In silver nanoparticle synthesis from plant extracts, Ag^+ ions are reduced to Ag^0. Phytochemicals in the structures of plants take part in reduction reactions (Jha et al. 2009). Although the phytochemical contents of plants differ, the main mechanism is the reduction of silver ions. A color shift was noticed when silver nitrate solution was added to *V. album* extracts, suggesting the creation of silver nanoparticles. Additionally, the UV-Vis spectrophotometer method verified the creation of silver nanoparticles. UV-Vis spectroscopy method is frequently used in the characterization of the structure of nanoparticles. As a control, the absorbance values of both plant part extracts and silver nanoparticles obtained from these extracts were measured in the range of 250–600 nm on the spectrophotometer device. Silver nanoparticles were synthesized in this work utilizing extracts from *V. album* leaves, fruit, and branches. In literature studies, it has been observed that the surface plasmon resonance peaks of silver nanoparticles vary between 400 and 450 nm. As a result of the measurements made in this study, surface plasmon resonance peaks were detected in the leaf (345 nm), fruit (340 nm), and branch (345 nm) sections of the *V. album* plant. In addition, it was determined that leaf AgNPs (427 nm), fruit AgNPs (430 nm), and branch AgNPs (425 nm) obtained from these plant extracts had surface plasmon resonance peaks. The outcomes are displayed in (Figure 3).

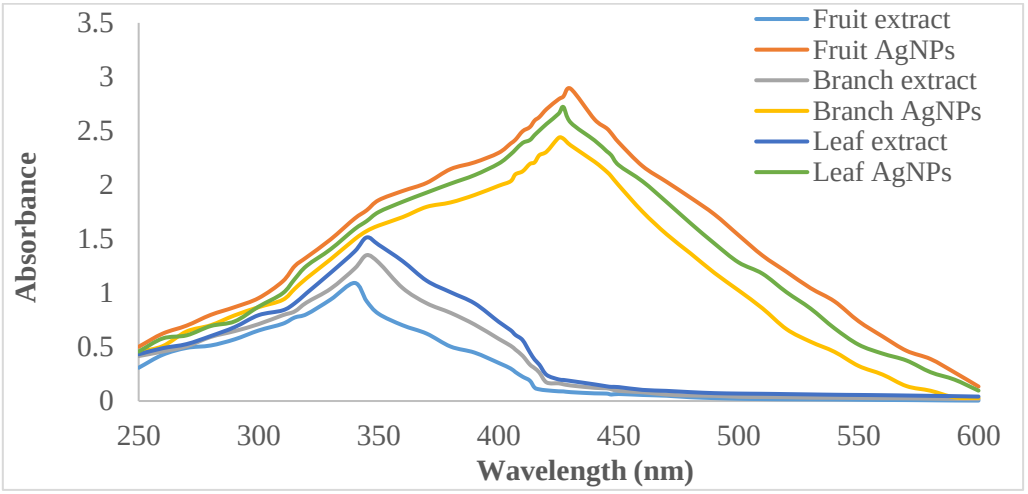


Figure 3- UV-Vis results of leaf, fruit, branch aqueous extract and silver nanoparticles

In a study, silver nanomolecules were synthesized with *V. album* fruit extract and silver nitrate solution. Surface plasmon resonance peaks were detected at 450 nm (Tahmasebi Zade Damirchi et al. 2020). In another study, the surface plasmon resonance peak wavelengths of round-shaped silver nanoparticles synthesized from different plant extracts were measured between 422 and 451nm (Akbal et al. 2016). It seems that our results are compatible with the literature.

3.2.2. FT-IR results

Fourier transform infrared (FT-IR) spectroscopy is an effective analytical technique utilized in a variety of scientific fields. It involves the measurement the plant extracts displayed a range of functional group vibrations throughout the spectral region of 4000-500 cm^{-1}. The FT-IR analysis approach was used to identify the biomolecules responsible for the reduction and stabilization of the AgNPs in this work. The FT-IR results of the study are shown in (Figure 4). FT-IR spectroscopy Plant extracts showed a variety of functional group stretching vibrations. Leaf, fruit and branch extracts of pine mistletoe showed characteristic absorption peaks corresponding to O–H stretching, C–H stretching, N–H of intramolecular hydrogen bonding. Although the peaks of the leaf extract have been observed at 3263.54 cm^{-1}, 2929.30 cm^{-1}, 1389.92 cm^{-1}, 1048.54 cm^{-1}, 1578.65 cm^{-1}, and 518.35 cm^{-1}, the peaks of the leaf AgNPs have been found at 3329.99 cm^{-1}, 1637.58 cm^{-1}, and 589.57 cm^{-1}. While the peaks of the fruit extract (3311.55 cm^{-1}, 2930.15 cm^{-1}, 1610.70 cm^{-1}, 1411.87 cm^{-1}, 1048.34 cm^{-1}, and 620.16 cm^{-1} were observed, the peaks of fruit AgNPs (3327.63 cm^{-1}, 1637.60 cm^{-1}, and 587.47 cm^{-1}) were determined. Additionally, peaks of branch extract (3301.36 cm^{-1}, 2930.97 cm^{-1}, 1589.50 cm^{-1}, 1392.43 cm^{-1}, 1047.73 cm^{-1}, 633.49 cm^{-1}) were observed, while branch AgNPs (3355.37 cm^{-1}, 2987.07 cm^{-1}, 2899.37 cm^{-1}, 2790.74 cm^{-1}, 2180.93 cm^{-1}, 2017.21 cm^{-1}, 1972.76 cm^{-1}, 1639.40 cm^{-1}, 1451.77 cm^{-1}, 1406.27 cm^{-1}, 1251.89 cm^{-1}, 1053.93 cm^{-1}, 867.83 cm^{-1}, and 656.33 cm^{-1}) peaks were determined. Our FTIR results were found to be compatible with the literature (Tahmasebi Zade Damirchi et al. 2020).

When the FT-IR spectra of the nanoparticles were examined, it was observed that there was a shift in the peaks. These shifts observed in the peaks revealed the role of functional groups in the plant in bioreduction and stabilization. In addition, FT-IR spectra of leaf and fruit extracts showed that the 1048 cm^{-1} peak disappeared, indicating that the functional group complex was good enough to form metallic oxide nanoparticles.

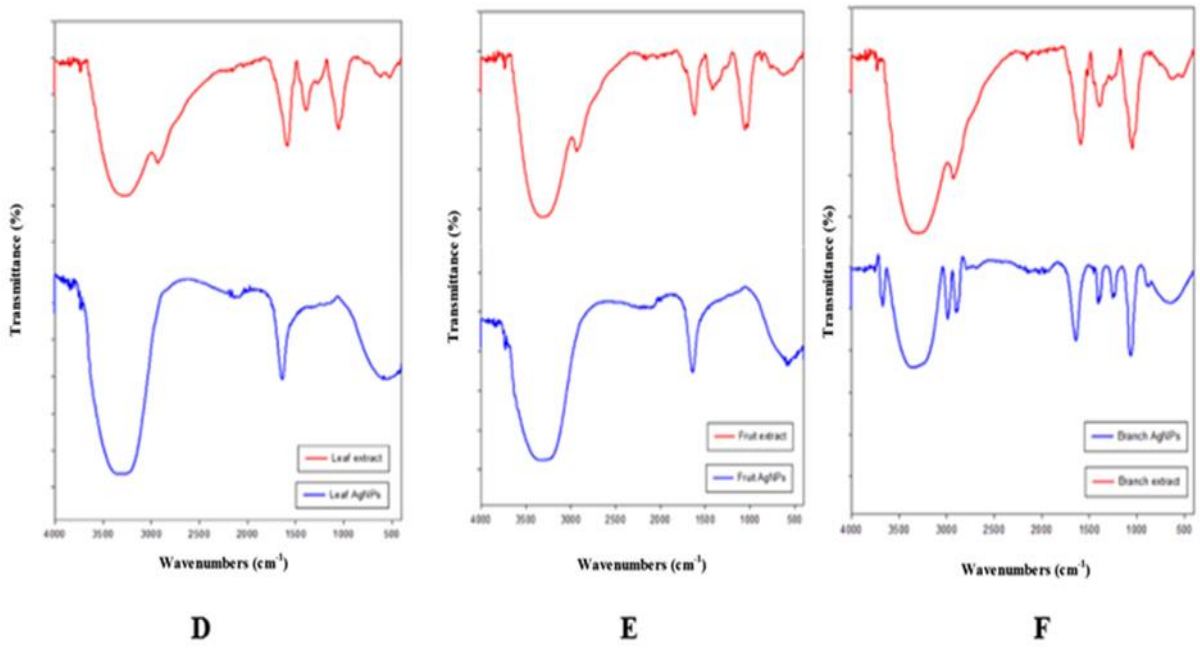


Figure- FT-IR results of leaf extract and silver nanoparticle (D), fruit extract and silver nanoparticle nanoparticle (E), branch extract and silver nanoparticle (F)

3.2.3. SEM and EDS results

AgNPs in the study were visualized by SEM analysis. The images obtained are shown in (Figures 5-7). AgNPs formation and morphological properties were determined in SEM analysis. It was noted that silver nanoparticles created from *V. album* plant parts had a spherical form. The silver nanoparticles obtained from the leaf extract are spherical in shape, and their sizes vary between 30.16 to 70.82 nm. In addition, 77% of the silver nanoparticles obtained from the leaf extract were found, and in addition to the intense silver peaks, 16% C and 7% O peaks were also observed (Figure 5).

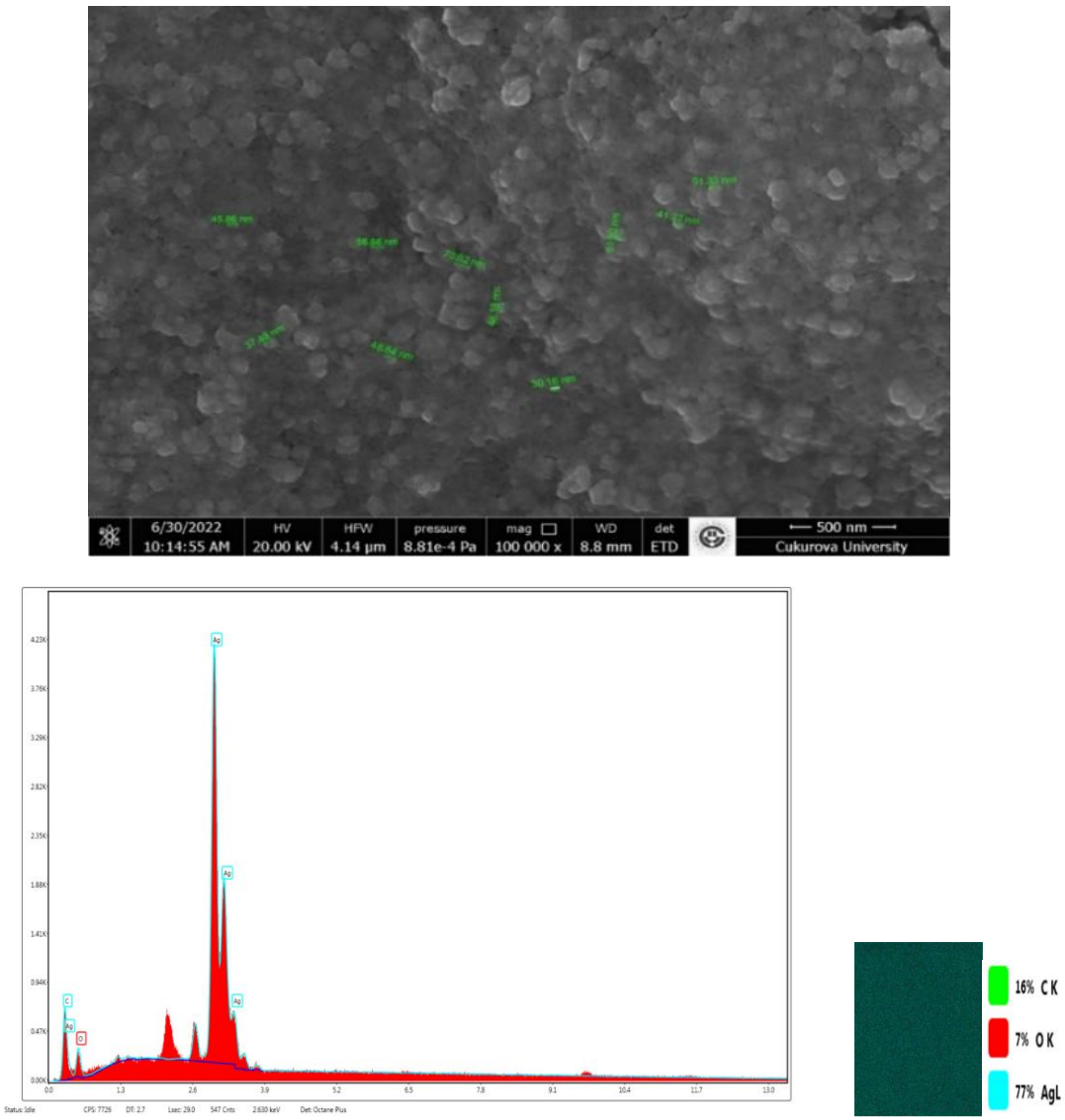


Figure 5- SEM and EDS analysis results of leaf AgNPs

In particular, it was discovered that the nanoparticles generated from the plant fruit extract were both abundant and reduced in size. Fruit silver nanoparticles range in size from 20.55 to 63.21 nm and have a spherical form. In addition, silver nanoparticles were formed at a rate of 83%, and in addition to intense silver peaks, 12% C and 6% O peaks were also observed (Figure 6).

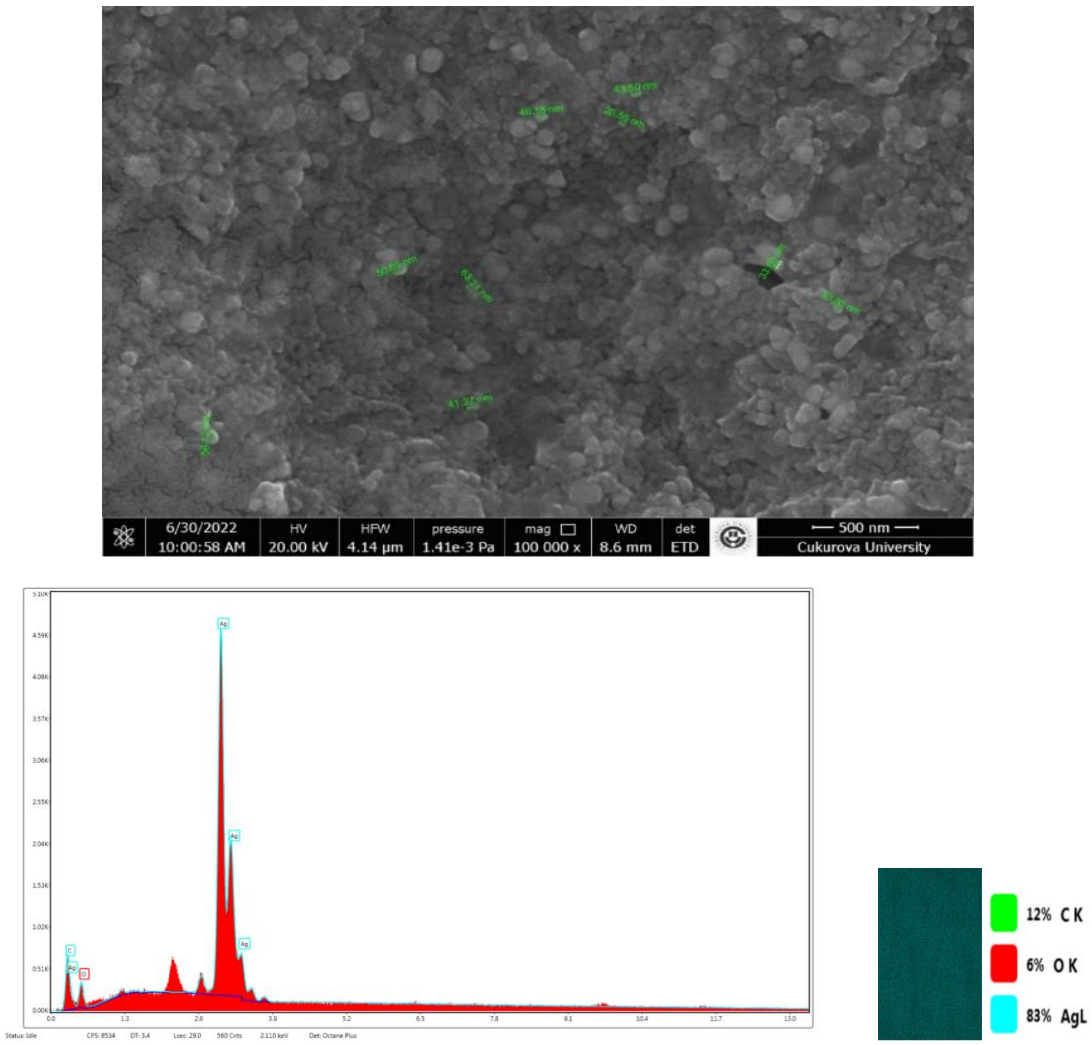


Figure 6- SEM and EDS analysis results of silver nanoparticles synthesized from fruit extract

The silver nanoparticles generated from the branch extract ranged in size from 30.16 to 99.27 nm and had a spherical shape. In particular, it was determined that 74% of the silver nanoparticles produced by the branch extract were formed. In addition to the intense silver peaks, 18% C and 8% O peaks were also observed (Figure 7).

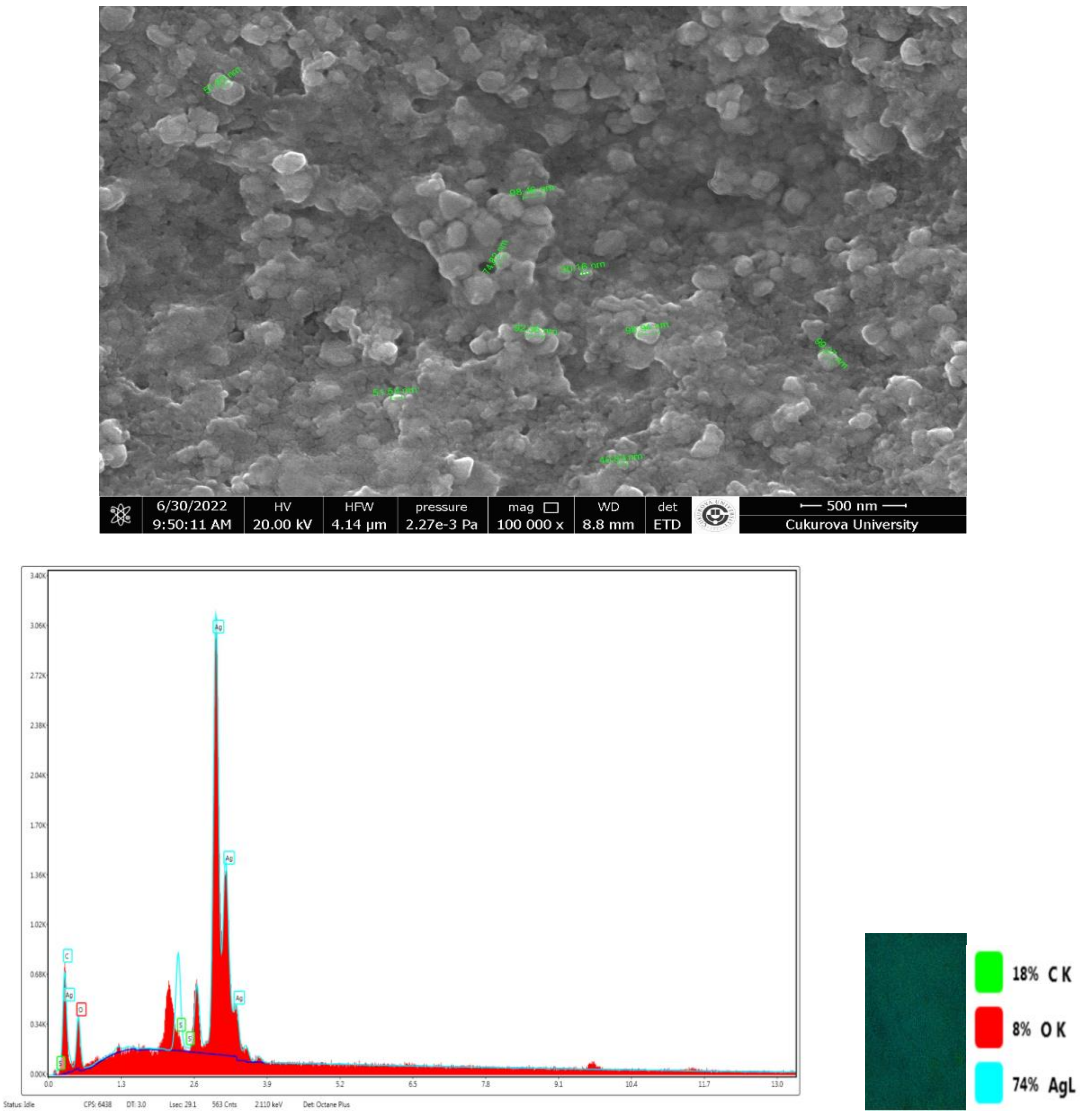
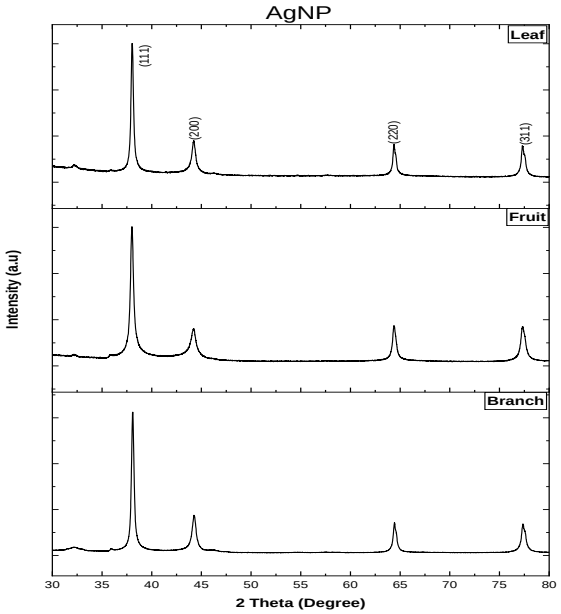


Figure 7- SEM and EDS analysis results of silver nanoparticles synthesized from branch extract

It is observed that silver nanoparticle synthesis occurs efficiently from the leaves, fruits, and branches of the *V. album* plant. SEM and EDS tests revealed that silver nanoparticles generated from *V. album* fruit aqueous extract were abundant and smaller in size. In a research, silver nanoparticles were generated from an aqueous extract of *V. album* fruit, and the silver nanoparticles obtained were spherical in form with diameters ranging from 40 to 70 nm (Tahmasebi Zade Damirchi et al. 2020). In this research, the size of silver nanoparticles produced from fruit extract was between 20.55 and 63.21 nm. Silver nanoparticles of smaller sizes were obtained compared to the literature. Additionally, it was determined that the fruit AgNPs sizes obtained from this study were smaller than the nanoparticle sizes obtained from the leaf and stem extracts.

3.2.4. XRD results

Figure 8 shows the x-ray diffractograms of silver nano particles produced by green synthesis method from the leaf, fruit and branch of *V. album* plant at room temperature. The results of X-ray measurements were indexed according to JCPDS card no: 98-042-691 and according to the literature. All silver nanoparticles exhibit a surface-centred cubic crystal structure (Awwad et al. 2013; Vigneshwaran et al. 2006; Venkatesham et al. 2012). Here, it is obvious that Ag nanoparticles were produced from three parts of the plant *V. album* (leaf, fruit, branch) with high purity, because all of them have high intensity of the peaks in the xrd graphs. The peaks (111), (200), (220), and (311) observed in the XRD results indicate the presence of pure silver nanocrystals.



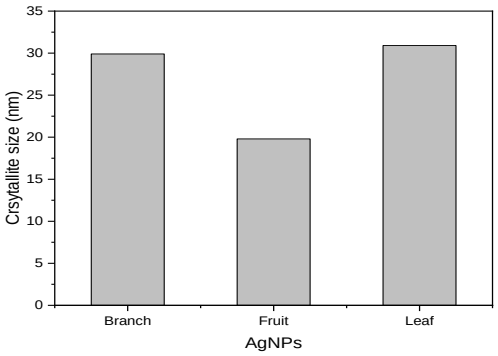


Figure 8- XRD diffractograms of AgNPs **Figure 9- Crystallite size of AgNPs**

In addition, the crystallite size of Ag nanoparticles obtained from X-ray curves was determined using the Debye-Scherrer method (Awwad et al. 2013; Qader et al. 2022).

$$D = k\lambda/\beta\cos\theta \quad (3)$$

Where; D is the crystallite size of AgNP, λ is the wavelength of the x-ray source, β is the full width at half maximum of the diffraction peak, K is the Scherrer constant with a value from 0.9 to 1, and θ is angel of maximum peak (in a radians). For this study, CuK_α X-ray is used and the wavelength value is 1.5406 A. According to these calculations, the crystallite size of the silver nanoparticles obtained from the branch and leaf was the same (~30 nm), while the crystallite size of AgNPs obtained from the fruit (19.8 nm) decreased (Figure 9).

3.3. In vitro antioxidant potential research

3.3.1. Total phenolic and flavonoid analysis results of samples

The phytochemical composition and medicinal effect of the mistletoe plant, which has been used for medicinal purposes since ancient times, vary depending on the type of plant it grows on (Jäger et al. 2021; Dash et al. 2017; Vicaş et al. 2011).

Research shows that phenolic acids and flavonoids found in the structure of plants are natural antioxidants. In particular, the antioxidant capacity of plant extracts is related to the phenolic compounds in their structure (Roman et al. 2009; Miliauskas et al. 2004). The most curious and researched chemical property of as leaves, fruits, and branches were determined as mg gallic acid equivalent (GAE)/g extract. Again, the phenolic compounds are their antioxidant activity (Materska 2008). The total phenolic substance amount (TPC) results in different parts of this plant such total flavonoid substance amount (TFC) of the plant parts was expressed as mg Quercetin equivalent (QAE)/g extract. The results of the study are shown in Table 1.

Table 1- Total phenolic and flavonoid substance amounts of *V. album* plant part extracts

Samples	***TPC (mg of GAE/g extract)***	***TFC (mg of QE/g extract)***	***sig. (p)***
Leaf-water extract (LW)	35.57±1.39	20.57±1.16	< 0.001
Fruit-water extract (FW)	34.31±1.20	23.42±1.29	< 0.001
Branch-water extract (BW)	32.24±1.44	18.95±1.04	< 0.001

(n=3, X ±SD mean of three measurements± Standard Deviation), (Kruskal-Wallis H, sig. $p < 0.001$).

Viscum album subsp. *album* growing on *Malus domestica Borkh*. total phenolic and flavonoid amounts of the plant were examined at various time intervals. The reported total phenolic amounts ranged from 33.78±1.60 to 48.62±1.31 mg GA per g of dry extract). It was also determined that total flavonoid amounts varied between 11.72±0.23 and 13.78±0.25 mg Q per g of dry extract (Pietrzak & Nowak 2021). Again, the total phenolic and flavonoid amounts of the methanol extracts of the leaves, fruits, and branches of the *Viscum album* L. plant grown on twelve different plants were calculated. Phenolic amounts of the leaves

vary between 10.18±0.58 and 16.59±0.49 mg GAE/g, and flavonoid amounts vary between 13.32±0.67 and 97.92±0.51 mg QE/g. While fruit phenolic amounts vary between 11.2±0.68 and 22.76±0.38 mg GAE/g, flavonoid amounts vary between 2.22±0.53 and 38.52±0.44 mg QE/g. Branch phenolics ranged from 9.81±0.62 to 12.83±0.51 mg GAE/g, and flavonoids from 8.52±0.48 to 74.52±0.44 mg QE/g (Korcan et al. 2023). The total phenolic results of this study are LW>FW>BW, while the total flavonoid results are FW>LW>BW (Figure 10). It has been observed that our findings are compatible with previous literature studies.

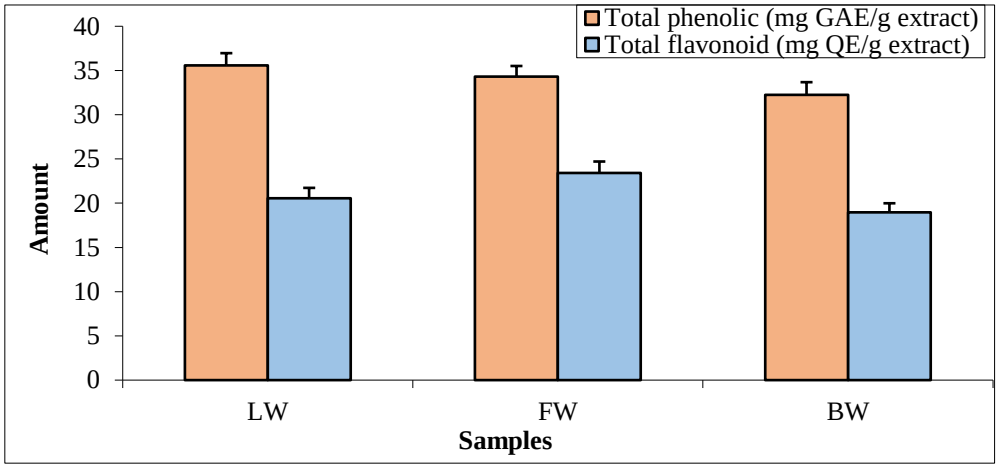


Figure 10- The total phenolic and flavonoid content of *V. album* plant extracts

3.3.2. DPPH radical scavenging activities of samples

The DPPH radical is a radical that can react with all antioxidants, including hydrophilic, lipophilic, and the weakest antioxidants. For this reason, the DPPH method is the most commonly used method in antioxidant capacity determination studies (Kedare & Singh 2011). The results of the study are shown in (Figure 11). Firstly, the inhibition percentages of the DPPH radical were calculated. The inhibition values of the samples in this study at 100 µg/mL concentration were determined as follows: Ascorbic acid (84.46)>BHT (75.63)>fruit AgNPs (42.37)> fruit extract (38.05)>leaf AgNPs (37.14)>leaf extract (35.94)>branch AgNPs (31.39)>branch extract (30.76) ($P<0.05$).

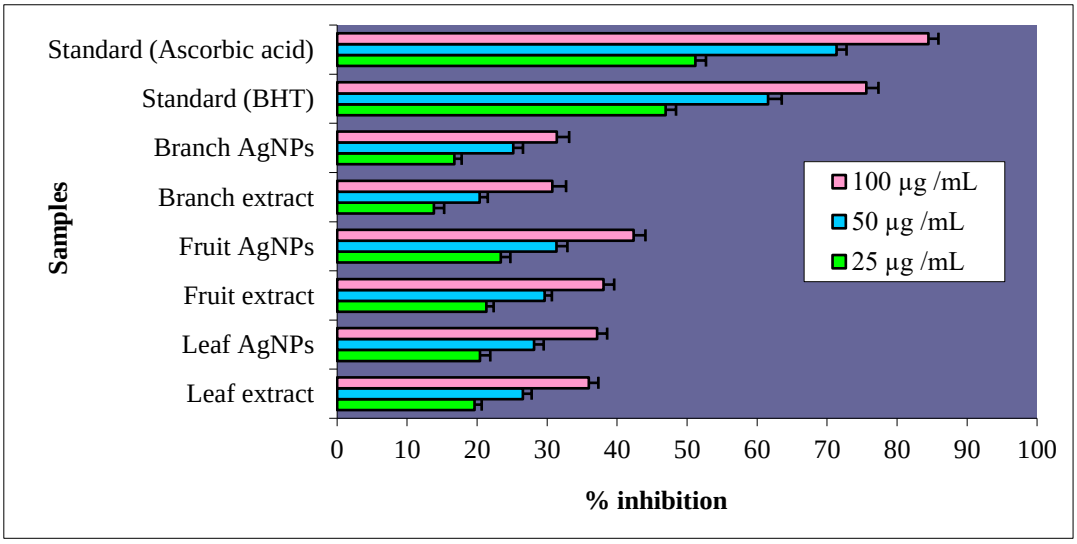


Figure 11- DPPH analysis of *V. album* plant part extracts and silver nanoparticles

In addition, in this study, the IC_{50} values of *V. album* plant part extracts (leaf, fruit, and branch) and silver nanoparticles synthesized from these extracts were also calculated. The antioxidant results of the study are expressed as both inhibition percentages and IC_{50} values. A lower IC_{50} value indicates greater antioxidant activity. For this reason, the IC_{50} values of *V. album* plant part extracts, silver nanoparticles synthesized from these extracts, and standard (BHT and Ascorbic acid) substances were calculated ($P<0.05$). The IC_{50} values for the samples in the study are shown in Table 2.

Table 2- IC_{50} values (DPPH radical scavenging activities) of *V. album* plant part extracts, silver nanoparticles and standards

Samples	*IC_{50} (µg/mL)*	*95% Confidence Interval for Mean*	
		Lower Bound	*Upper Bound*
Leaf extract	163.42±1.61	160.59	166.25
Leaf AgNPs	157.09±1.41	154.61	159.57
Fruit extract	152.88±1.85	149.63	156.13
Fruit AgNPs	129.24±1.38	126.83	131.66
Branch extract	185.29±1.27	183.06	187.51
Branch AgNPs	176.28±1.47	173.70	178.86
Standard (BHT)	27.44±1.39	25.01	29.87
Standard (Ascorbic acid)	12.83±1.26	10.62	15.04

In a study, it was found that the DPPH radical removal % inhibition values of methanol extracts of mistletoe growing on different trees were between 59.52 and 95.12 (Uçar et al. 2006). Again, DPPH radical inhibition percentages of the leaf and root parts of *V. album* growing on various trees were calculated. According to this study, the leaf parts ranged from 31.25 to 68.93, and the root parts ranged from 30.13 to 67.28 (Tahirović & Bašić 2017). The results of this study were found to be compatible with the literature. The results obtained show that AgNPs synthesized from *V. album* plant parts have significant antioxidant activity. The antioxidant capacity of the fruit aqueous extract and the silver nanoparticles produced from this extract were found to be greater than in other portions of the plant. The difference between the results may be due to the type of tree on which this plant is grown, the time of collection, the different extraction environments, and the different phytochemical contents of the plant parts (Jäger et al. 2021). Silver nanoparticles were synthesized using the leaves of *Tagetes erecta* L., one of the plants used for health purposes, and the antioxidant capacity (DPPH radical removal) of these nanoparticles was investigated. While the IC_{50} value of the plant extract was 40.0 µg/mL, the IC_{50} value of silver nanoparticles synthesized from this extract was reported to be 23.8 µg/mL. It was determined that the antioxidant capacity of silver nanoparticles was greater than that of the extract (Erenler et al. 2021). It can be concluded that these silver nanoparticles have therapeutic potential in the treatment of free radical caused illnesses.

3.4. In vitro antidiabetic potential research

3.4.1. α-amylase enzyme inhibition of samples

One of the enzymes that enables the breakdown of starch into glucose is α-amylase (Kim et al. 2014; Shim et al. 2003). Therefore, finding these enzyme inhibitors is important in the treatment of diabetes (Ibrahim et al. 2019). The α-amylase enzyme inhibition percentages values of *V. album* plant part extracts and silver nanoparticles synthesized from these extracts and standard acarbose are shown in (Figure 12).

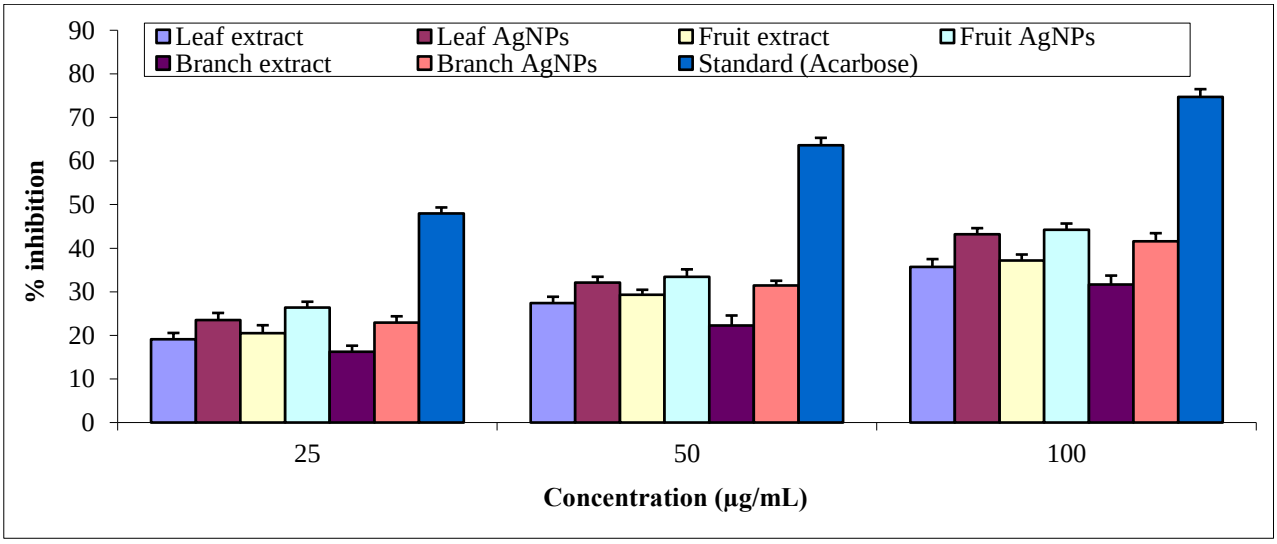


Figure 12- α-amylase enzyme inhibition percentages of the samples

The α-amylase enzyme inhibition percentages of samples at 100 µg/mL concentration are as follows: standard Acarbose (74.67±1.82), fruit AgNPs (44.21±1.45), leaf AgNPs (43.17± 1.43), branch AgNPs (41.59±1.85), fruit extract (37.16±1.39), leaf

extract (35.72±1.78) and branch extract (31.70±2.01) (P<0.05). Additionally, IC_{50} values were calculated using three different concentrations of all samples. The results are shown in Table 3.

Table 3- IC_{50} values (antidiabetic activity) of *V. album* plant part extracts, silver nanoparticles, and standard

Samples	*IC_{50} (µg/mL)*	*95% Confidence Interval for Mean*	
		Lower Bound	*Upper Bound*
Leaf extract	164.21±1.29	161.95	166.47
Leaf AgNPs	125.01±1.40	122.55	127.47
Fruit extract	156.94±1.48	154.33	159.55
Fruit AgNPs	123.59±1.44	121.06	126.12
Branch extract	189.17±2.01	185.64	192.70
Branch AgNPs	132.71±1.34	130.35	135.07
Standard (Acarbose)	22.55±1.63	19.69	25.41

Studies have shown that oxidative stress is responsible for the progression and pathogenesis of diabetes (Simmons 2006; Kaneto et al. 2007). The increase in free radicals and the weakness of the intracellular antioxidant defense system lead to an increase in diabetes complications (Gupta & Chari 2005). In a study conducted on in vivo rats, *V. album* extract was given to rats for 20 days. As a result of the study, it was determined that these extracts had radical scavenging, antioxidant, and antidiabetic activities (Ahmed et al. 2019). Studies have reported that mistletoe leaves are effective in relieving diabetes (Gray & Flatt 1999). In a study that synthesized silver nanoparticles from *Tribulus terrestris* seed extracts, which are widely used in traditional medicine, the in vitro antidiabetic activities of these nanoparticles were investigated. As a result, it was reported that silver nanoparticles at a concentration of 100 µg/mL showed high α-amylase enzyme inhibition of 75.68 ± 0.11% (Rahman et al. 2023). In this study, the α-amylase enzyme inhibition percentages of leaf, fruit, and branch silver nanoparticles at 100 µg/mL concentration were determined as leaf AgNPs (43.17± 1.43), fruit AgNPs (44.21±1.45), and branch AgNPs (41.59±1.85), respectively. It was determined that our results were lower than the *Tribulus terrestris* silver nanoparticle results. As a result of this in vitro study, it was determined that *V. album* plant parts and silver nanoparticles synthesized from these parts had antidiabetic properties.

3.5. In vitro antimicrobial potential research

Within the scope of the study, the antimicrobial activities of AgNPs (3mM) synthesized from *V. album* on pathogenic microorganisms were investigated. Zone diameters related to the antimicrobial activities of synthesized AgNPs are given in Table 4 in millimeters.

Table 4- Antimicrobial activity zone diameters of *V. album* plant extracts and silver nanoparticles

Microorganisms	*Leaf AgNPs (mm)*	*Fruit AgNPs (mm)*	*Branch AgNPs (mm)*	*V.album extract (mm)*			*Control*			
				Leaf	*Fruit*	*Branch*	*Ampicillin 10 (µL/mL)*	*Nystatin*	*$AgNO_3$ (3mM)*	*Distilled water*
S. aureus (ATCC 25923)	18	20	16	12	14	10	18	_	5	_
B. cereus (709 Roma)	12	18	17	_	13	15	17	_	4	_
E. faecalis (ATCC 29212)	12	10	15	13	12	13	15	_	5	_
B. subtilis (ATCC 6633)	_	12	_	_	_	_	_	_	4	_
E. coli (ATCC 25922)	20	10	_	12	14	_	15	_	5	_
A. hydrophila (ATCC 7966)	12	_	_	13	_	_	_	_	7	_
P. aeruginosa (ATCC 27853)	16	8	14	_	_	13	_	_	7	_
K. pneumoniae (ATCC 13883)	16	10	_	14	_	_	_	_	6	_
V. anguillarum (ATCC 43312)	12	10	_	_	13	_	15	_	5	_
S. typhi (ATCC 6539)	12	21	_	10	12	_	20		6	_
C. albicans (ATCC 90028)	_	_	_	_	_	_	_	18	_	_

After 48 hours, the inhibition zone around each well was measured in millimeters to assess the susceptibility of the test microorganisms. Antibiotic use as a control allowed for comparison of antimicrobial activity outcomes. In addition, we employed the 3 mM $AgNO_3$ solution's antibacterial activity as a control, which obscures the viewable region. The greatest inhibitory effect of the silver nanoparticle synthesized from the leaf extract was in *E. coli* with a 20 mm diameter inhibition zone, followed by *S. aureus* with an 18 mm diameter inhibition zone, and then *P. aeruginosa* and *K. pneumoniae* with a 16 mm diameter inhibition zone. Good efficacy against pneumoniae has been observed. The most inhibitory effect of the silver nanoparticle synthesized from the fruit extract was determined in *S. typhi* with a 21 mm diameter inhibition zone, followed by *S. aureus* with a 20 mm diameter inhibition zone and then *B. cereus* with an 18 mm diameter inhibition zone. The most inhibitory effect of the silver nanoparticle synthesized from the sap extract was determined in *B. cereus* with a 17 mm diameter inhibition zone, followed by *S. aureus* with a 16 mm diameter inhibition zone and then against *E. feacalis* with a 15 mm diameter inhibition zone. As can be seen in Table 4, silver nanoparticles synthesized from *V. album* leaf, fruit and branch extracts were comparable to some antibiotics in *S. aureus* and *E. coli*, *P. aeruginosa*, *K. pneumoniae*, *S. typhi*, *E. feacalis* and *B. cereus*. It has good antibacterial activity against *C. albicans* showed no antimicrobial effect with the silver nanoparticle synthesized from *V. album* (leaf, fruit and branch). Table 4 shows the widths of the inhibition zones of aqueous extracts of *V. album* leaves, fruits, and branches. Compared to ampicillin, leaf extracts of *V. album* had decreased antibacterial activity against *K. pneumoniae* (14 mm), *E. feacalis* and *A. hydrophila* (13 mm), and *E. coli* (12 mm). In contrast, compared to ampicillin and $AgNO_3$, the majority of the produced AgNPs had a better antibacterial effect on the test microorganisms. The inhibition zone diameter of 21 mm (*S. typhi*) offered the best level of antibacterial activity for AgNPs produced from *V. album* (fruit). Comparing this number to ampicillin and $AgNO_3$, it is substantially greater. The results of the antibacterial activity tests were compared to those of the control experiment. There were no zones of inhibition observed in the control, indicating that the antibacterial effect is caused by silver nanoparticles.

Nanoparticles have been used in the pharmaceutical industry as an alternative to antibiotics in recent years. As a result, it is possible that it could be a solution to the antibiotic resistance developed by pathogenic bacteria. According to reports, silver nanoparticles are being used to treat a wide range of diseases caused by both gram-negative and gram-positive bacteria. The degradation and eventual death of bacteria are brought on by AgNPs' interactions with cellular components or biomolecules. Translation and protein synthesis are impeded by denaturation, which is specifically brought on by AgNPs contact with ribosomes. Additionally, AgNPs may interact with the carboxyl and thiol groups on galactosidase, obstruct intracellular biological processes, and result in cell death (You et al. 2012). AgNPs are used in implantable technology, the treatment of wounds, medical equipment, antibacterial medications to prevent bacterial infections, and immunizations (Wang et al. 2017).

3.5.1. Minimal inhibition concentrations (MIC) of samples

Table 5 shows the minimal inhibition concentrations (MIC) of AgNPs with antimicrobial activity within the scope of the study. AgNPs derived from the leaf extract of *V. album* have a significantly higher minimum inhibitory concentration against *E. coli* and *S. aureus* than against *S. typhi* and *A. hydrophila*. The extracts MIC values against *B. cereus*, *E. faecalis*, *P. aeruginosa*, *K. pneumoniae*, and *V. anguillarum* were not significantly different.

Table 5- MIC table of *V. album* plant extracts and silver nanoparticles

Microorganisms	*Leaf (AgNPs) (µL/mL)*	*Fruit (AgNPs) (µL/mL)*	*Branch (AgNPs) (µL/mL)*	*V.album extract (µL/mL)*			*Control*			
				Leaf	*Fruit*	*Branch*	*Ampicillin 10 (µL/mL)*	*Nystatin*	*$AgNO_3$ (3mM)*	*Distilled water*
***S. aureus* (ATCC 25923)**	16	16	_	_	32	_	16	_	64	_
***B. cereus* (709 Roma)**	32	16	16	_	16	8	16	_	128	_
***E. faecalis* (ATCC29212)**	32	256	16	32	64	16	32	_	128	_
***B. subtilis* (ATCC 6633)**	_	32	_	_	--	_	_	_	256	_
***E. coli* (ATCC 25922)**	16	256	_	64	32	_	32	_	128	_
***A. hydrophila* (ATCC 7966)**	64	_	_	32	32	_	_	_	32	_
***P. aeruginosa* (ATCC 27853)**	32	256	32	_	16	16	_	_	64	_
***K. pneumoniae* (ATCC 13883)**	32	64	_	16	_	_	_	_	256	_
***V. anguillarum* (ATCC 43312)**	32	64	_	_	_	_	32	_	128	_
***S. typhi* (ATCC 6539)**	64	16	_	256	16	_	16	_	256	_
***C. albicans* (ATCC 90028)**	_	_	_	_	_	_	_	**16**	_	_

3.5.2. Anti-Quorum sensing analysis of samples

Zone diameters of AgNPs made with anti-majority detection activity (Anti-QS) agar well diffusion method was calculated in mm Table 6.

Table 6- Zone diameters of anti-quorum sensing activities of AgNPs synthesized by *V. album*

Concentration (µL/mL)	*Leaf AgNPs (mm)*	*Fruit AgNPs (mm)*	*Branch AgNPs (mm)*	*V.album extract (µL/mL)*		
				Leaf (mm)	*Fruit (mm)*	*Branch (mm)*
	3mM	3mM	3mM			
5	20	18	12	13	12	11
2.5	19	17	11	12	12	11
1.25	18	16	10	11	11	10
0.625	15	12	9	10	11	10

The loss of pigment in *C. violaceum* bacteria is an indication that the applied material (AgNPs) causes Quorum-Sensing (QS) inhibition. As stated in Table 6; it was determined that all AgNPs synthesized were effective in the agar diffusion method for anti-QS. The inhibition zones formed were determined as the regions where *C. violaceum* bacteria could not produce pigment. AgNPs are inhibit the production of acyl homoserine lactone (AHL) by *C. violaceum*, which prevent the bacteria from coming together and therefore have Anti-QS activity. AgNPs were produced from *V. album* through disc diffusion using the bioreporter strain CV12472, and varied concentrations (5, 2, 5, 1.25, and 0.625 µL/mL) were used in the *C. violaceum* experiment. In CV 12472 cultures containing exogenous AHL, the loss of purple pigment is a sign that *V. album* has inhibited quorum sensing. The amount of silver nanocolloids injected had a direct correlation with the inhibition effect on quorum sensing, as shown by the distinct halo zone of inhibition surrounding the wells of different diameter. This research establishes for the first time the quorum quenching activity of silver nanoparticles created by aqueous extracts of *V. album* (Arunkumar et al. 2022).

4. Conclusions

In traditional medicine, aqueous extracts of *V. album* have been used in cancer treatment for years. For this reason, the leaf, fruit, and branch parts of the *V. album* plant were discussed. It was determined whether silver nanoparticles could be synthesized from plant part extracts by the green method. In addition, this is the first study in which the characterization and biological activities (antioxidant, antidiabetic and antimicrobial capacities) of these plant parts and silver nanoparticles synthesized from these parts were investigated using UV-Vis, FTIR, SEM, EDS, and XRD analysis methods. The UV-Vis examination of silver nanoparticles revealed that Ag^+ ions were converted to Ag^0. Furthermore, surface plasmon resonance peaks at 427, 430, and 425 nm were observed in UV-Vis analyses, indicating the synthesis of leaf, fruit, and branch silver nanoparticles, respectively. Comparing the FTIR results of plant extracts and silver nanoparticles showed that some functional groups were involved in silver nanoparticle synthesis. When the SEM images of the plant part silver nanoparticles were examined, it was observed that the silver nanoparticles obtained from all three parts were spherical in shape. It was determined that the silver nanoparticles obtained from the fruit part extract were smaller and nanosized than the nanoparticles obtained from other parts of the plant. In addition, when the EDS results of the nanoparticles were examined, it was determined that silver nanoparticles consisting of three parts of the plant were formed in a high and pure form of 74% to 83%. XRD results of plant-part silver nanoparticles showed that the nanoparticles were formed in a pure and crystalline structure. In particular, it was determined that the crystal size of all three leaf, fruit, and branch parts was in the nanometer range. It was observed that the crystal size of the AgNPs obtained from the fruit extract was smaller. Antioxidant, antidiabetic and antimicrobial activity determinations were made to determine the biological activities of plant parts and silver nanoparticles synthesized from these parts. It has been concluded that different parts of this plant are valuable in terms of antioxidant, antidiabetic, and antimicrobial parameters. It was concluded that silver nanoparticles synthesized from the fruit extract of this plant are strong in terms of antioxidant and antidiabetic activity. It is known that the leaf and branch parts of the *V. album* plant, which is a medicinal aromatic plant, are consumed mostly, and the fruit parts are not consumed. This study showed that fruit parts thought to be poisonous are rich in both antioxidants and antidiabetics. Therefore, it was concluded that the unused fruit parts of this plant can be used in silver nanoparticle synthesis. As a result, it was concluded that leaf, fruit, and branch extracts of the *V. album* plant and silver nanoparticles synthesized from these extracts can be used as synthetic antioxidant, antidiabetic, and antimicrobial natural drug raw materials.

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