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BIOSYNTHESIS OF SILVER NANOPARTICLES USING DIANTHUS CARYOPHYLLUS LEAF EXTRACT WITH UV-VISIBLE SPECTRAL ANALYSIS

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ABSTRACT

This research shows that silver nanoparticles (AgNPs) may be made using aqueous Dianthus caryophyllus leaf extract and a 1mM solution of silver nitrate ($AgNO_3$). The plant broth solution, which was used for the bioreduction of Ag+ ions, was extracted from a variety of leaves, including young, mature, and green varieties. The presence of AgNPs was verified by a shift in hue from yellowish-green to dark brown, which signifies the completion of the synthesis. After a 12-hour incubation period, the nanoparticles were extracted by centrifugation. Using UV-Visible spectrophotometry, the AgNPs were characterized. The results showed absorption peaks between 400 and 450 nm, indicating that there were nanoparticles smaller than 25 nm.

Keywords: Leaf, Dianthus caryophyllus, Reduction, Nanoparticles

I. INTRODUCTION

There are a number of benefits to biosynthesis of nanoparticles, especially when plants are used instead of traditional chemical synthesis methods. The use of potentially harmful reagents and by-products is now unnecessary in this one-step method. The bioactive components found in plant extracts play an important role in nanoparticle formation, serving as reducing and stabilizing agents. These substances include alkaloids, phenolics, flavonoids, proteins, and enzymes. These chemicals have the ability to stabilize nanoparticles of metal ions, reducing their size and shape while also inhibiting aggregation. An appealing alternative for industrial applications is the use of plants in nanoparticle synthesis due to its low cost, ease of scaling, and compatibility with large-scale manufacturing. Dianthus caryophyllus, more often known as carnation, is one of the plants utilized to synthesize nanoparticles. Its phytochemical profile is particularly promising.

One member of the Caryophyllaceae family that is often used as an attractive plant is Dianthus caryophyllus. Although it originated in the Mediterranean, its lovely blossoms have made it a popular plant for cultivation all around the globe. Although the plant is mostly recognized for its aesthetic qualities, new research has shown that it has bioactive chemicals in its leaves that might be used in nanotechnology. Dianthus caryophyllus leaves are ideal for nanoparticle production due to their abundance of phenolic chemicals, flavonoids, saponins, and terpenoids, all of which have significant reducing and stabilizing characteristics. In addition to aiding in the reduction of Ag+ ions to Ag0 nanoparticles, these phytochemicals affect the final nanoparticles' size, shape, and stability.

A promising and environmentally friendly method for synthesizing nanoparticles is the production of silver nanoparticles using leaf extract of the Dianthus caryophyllus plant. The procedure calls for a precise pH, temperature, and reaction time for the silver nitrate ($AgNO3$) to interact with the plant extract. While the biomolecules in the plant extract stabilize the nanoparticles and prevent them from agglomerating, the plant extract lowers the $Ag+$ ions in silver nitrate into AgNPs. Without the requirement for external energy inputs, the synthesis process may be carried out at ambient settings and is both simple and efficient, making it ecologically benign. Because of their improved physicochemical qualities, the resultant silver nanoparticles might be used in many different ways.

II. REVIEW OF LITERATURE

Ma, Zhanqiang et al., (2023) Among ornamental plants, tree peonies (Paeonia suffruticosa Andr.) are highly prized for their cut flowers. But the production and use of cut tree peony blooms are greatly limited by their short vase life. Applying silver nanoparticles (Ag-NPs) to cut tree peony flowers reduced bacterial growth and xylem blockage in vitro and in vivo, which extended the postharvest lifetime and improved the horticultural value. The synthesis and characterization of Ag-NPs were carried out using the leaf extract of Eucommia ulmoides.

Zia, Muhammad et al., (2020) At 6 mg/L, the regenerated plants' fresh and dry weights rose considerably ($P < 0.05$). The reducing power potential, total antioxidant activity, and DPPH-based free radical scavenging activity of regenerated plants were shown to vary with the content of AgNPs in the medium. The total phenolics and flavonoids in the regenerated plants were also measured in an effort to identify antioxidants that do not need enzymes and may thus fight oxidative damage. The results show that, concentration dependently, metallic nanoparticles significantly impact the in vitro development of carnation cultivars. Additionally, nanoparticles may be used to enhance floriculture plant regeneration and in vitro shoot multiplication.

Hashemabadi, Davood. (2014) The treated flowers blossomed at a slower rate than the control flowers. Treatment of cut flowers with 15 mg l(-1) of SNP and 0.3 mM STS resulted in the highest peroxidase activity and the lowest lipid peroxidation. In summary, the research found that cut carnation 'Tempo' flowers lasted longer after being treated with SNP and STS. This was due to a decrease in oxidative stress, an improvement in the anti-oxidant system, a reduction in bacterial populations, and a delay in blooming.

Suica-Bunghez, Ioana-Raluca et al., (2011) The researchers set out to document an environmentally friendly method of producing antioxidant silver nanosystems by repurposing two ornamental plants with potential medicinal uses: Hyacinthus orientalis L. and Dianthus caryophyllus L. Spectral approaches (UV-VIS absorption, FTIR, DLS) were used to evaluate these plants' prospective abilities for bioreduction of Ag^+ to Ag^0. The antioxidant characteristics of the herbal silver nanoparticles were ascertained using the chemiluminescence technique, and their stability was verified by ξ-potential measurements.

Suica-Bunghez, Ioana-Raluca et al., (2011) From this vantage point, metallic nanoparticles are the most beneficial nanomaterial because of their antibacterial capabilities. There is an ongoing effort to harness the biosynthesis of nanoparticles using plant extracts. One viable and cost-effective option for the industrial-scale production of nanoparticles is the use of plant extracts, which are both inexpensive and environmentally safe. The current study details the straightforward method for synthesizing silver nanoparticles.

III. MATERIALS AND METHODS

Collection of plant materials and extract preparation

The carnation, or Dianthus caryophyllus, is a well-liked species of flowering plant in the family Caryophyllaceae. The plants used in this study originated in India. The leaves were collected at various stages of maturity and cleaned extensively with distilled water. Each leaf was sliced into a tiny fragment. In a 250 ml Erlenmeyer flask with 50 ml of sterile distilled water, 5 gram of washed and chopped leaves were boiled for 5 minutes to make the plant leaf broth solution. After obtaining the herbal aqueous extract using the normal filtering process, it was kept at 4oC in separate conical flasks.

Preparation of 1mm aqueous solution of silver nitrate

The 100 ml of distilled water was mixed with 0.017g of silver nitrate ($AgNO_3$) and swirled well until the nitrate was fully dissolved. To be used later in the process of making silver nanoparticles from the water extract of Dianthus caryophyllus leaves, this 1 millimolar solution of silver nitrate is kept in a brown container at 4 degrees Celsius.

Synthesis of silver nanoparticles

In order to create silver nanoparticles, a 1mM aqueous solution of silver nitrate was used. In order to create AgNPs, two tubes were heated: one with a control solution of 10 ml of 1 mM $AgNO_3$, and the other with a test solution of 9.0 ml of 1 mM Silver nitrate and 1.0 ml of plant leaf extracts. The incubation period was 12 hours at room temperature. The gradual transformation of the leaf extracts' color from a pale green to a deep brown was monitored on a regular basis. The pellet used for further research was obtained by centrifuging the reaction mixtures at 5000 rpm for 15 minutes. Once the particle has been dissolved in deionized water, the supernatant is discarded.

Characterization of silver nanoparticles

Silver nanoparticles have exceptional optical characteristics, which allow one to learn a lot about their physical condition by studying their spectral properties in solution. Because of this, describing them is essential. The development of Ag nanoparticles was seen qualitatively using a UV-Visible spectrophotometer and visually by seeing a shift in hue from greenish yellow to dark brown.

UV- Vis spectral analysis

The occurrence of nanoparticle aggregation may be detected by sensitively tracking the UV-visible spectra of the silver nanoparticles over time. Using a UV-VIS Spectrophotometer, we were able to track the decrease of Ag^+ ions in metallic form. A tiny portion of the reaction mixture was extracted and analyzed using a spectrophotometer operating between the 300 nm to 700 nm wavelength range. How long it takes for a plant's color to change is plant-specific. In order to establish a correlation between the results, the experiment was performed three times at regular intervals.

IV. RESULTS AND DISCUSSION

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A medicinal plant is D. caryophyllus. Everywhere you look, people are finding practical uses for this plant. This work demonstrated the considerable green production of silver nanoparticles utilizing an aqueous extract of D. caryophyllus leaf and 1 mM AgNO3. D. caryophyllus, in its new suspension, had a yellowish-green hue. Nevertheless, the emulsion took on a dark brown hue with the addition of AgNO3 and a 25-minute period of shaking at room temperature (Fig. 1). This proved that AgNPs were synthesized in the mixed solution. The activation of surface Plasmon vibrations in silver nanoparticles is known to cause them to show a dark brown hue in aqueous solutions.

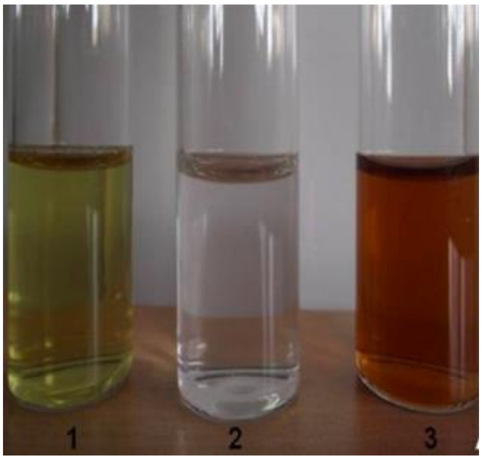

Figure 1: Experimental solutions

After being exposed to 1 mM AgNO3, the cell free extract's color changed from light yellow to dark brown. The change in color reached its peak after 10 to 12 hours of incubation, and it continued to intensify throughout the incubation time, suggesting the creation of silver nanoparticles (Fig. 2). When incubated under the identical circumstances, the cell filtrates of the control group (which did not include silver ions) did not change color.

Figure 2: Experimental solutions after 12 hrs

What makes AgNPs unique is that their optical characteristics are shape- and size-dependent. The contact with electromagnetic radiation causes conduction electrons to collectively oscillate, which in turn dominates these optical features. Aside from that, AgNPs were also synthesized at ambient temperature using extracts from lower-level plants, such as algae, fungus, etc. Extract proteins serve a dual purpose in

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nanoparticle synthesis: reducing Ag+ and controlling their form. It was postulated that the reduction of Ag+ ions was caused by the carboxyl groups in aspartic and glutamine residues as well as the hydroxyl groups in tyrosine residues of the proteins.

Surface plasmon resonance (SPR) measurements were taken at wavelengths ranging from 300 to 700 nm in the Dianthus caryophyllus and Silver Nitrate + Dianthus caryophyllus emulsions to track the production of silver nanoparticles. At wavelengths between 400 and 450 nm, the distinctive silver SPR bands were seen (Fig. 3-8). We presumptively found these absorption bands in silver nanoparticles that were very tiny, less than 25 nm. The UV-Vis absorption spectra revealed that there were two peaks within the wide SPR band. It is clear from these two peaks that there are two distinct distributions of hydrosol silver nanoparticles.

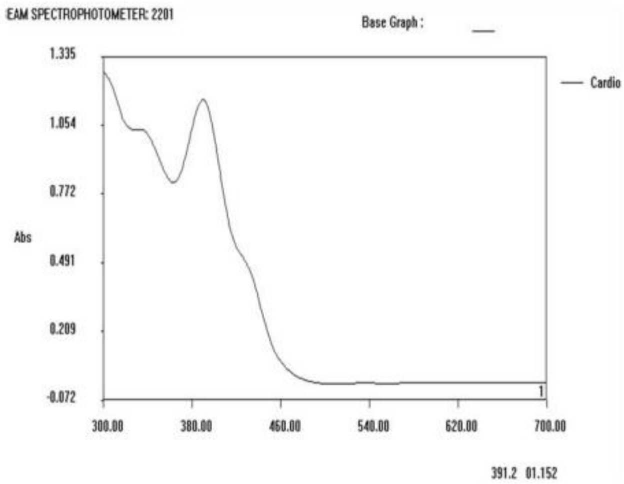

Figure 3: First observation of UV-Vis spectrum of silver nanoparticles synthesized

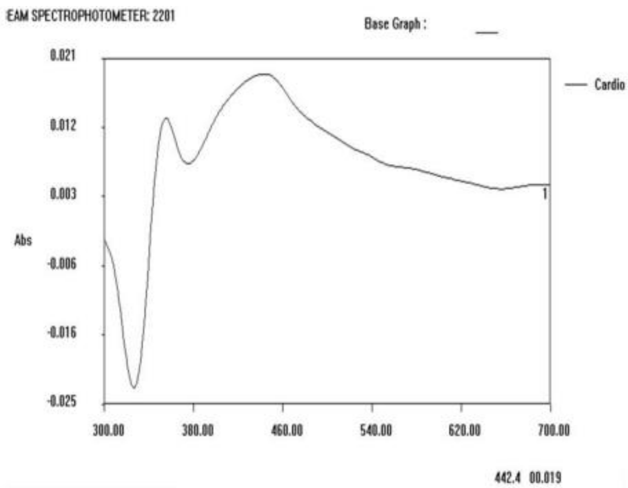

Figure 4: Second observation of UV-Vis spectrum of silver nanoparticles synthesized

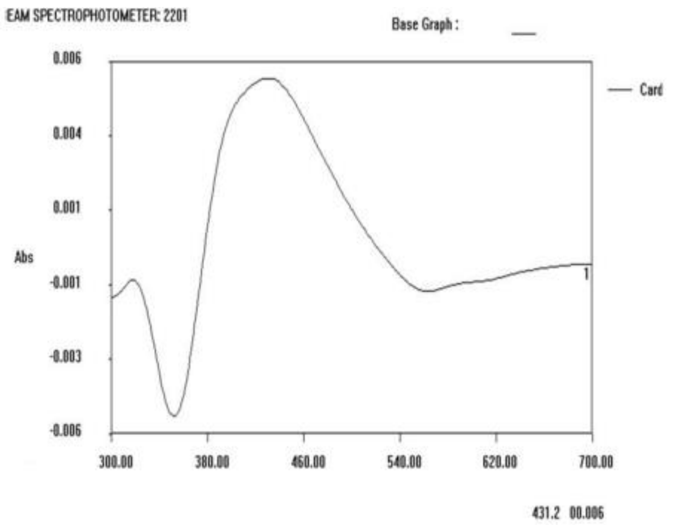

Figure 5: Third observation of UV-Vis spectrum of silver nanoparticles synthesized

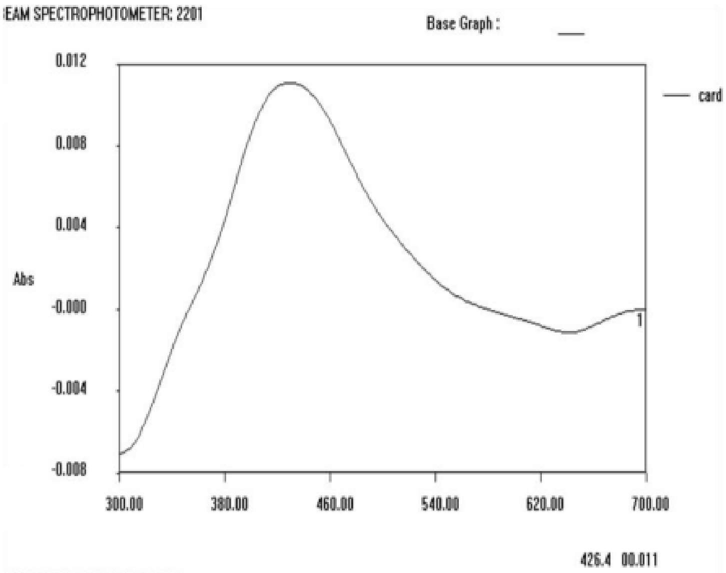

Figure 6: Fourth observation of UV-Vis spectrum of silver nanoparticles synthesized

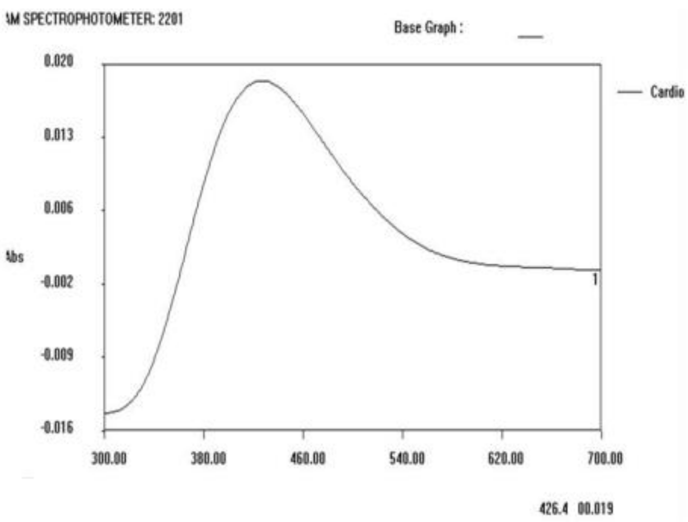

Figure 7: Fifth observation of UV-Vis spectrum of silver nanoparticles synthesized

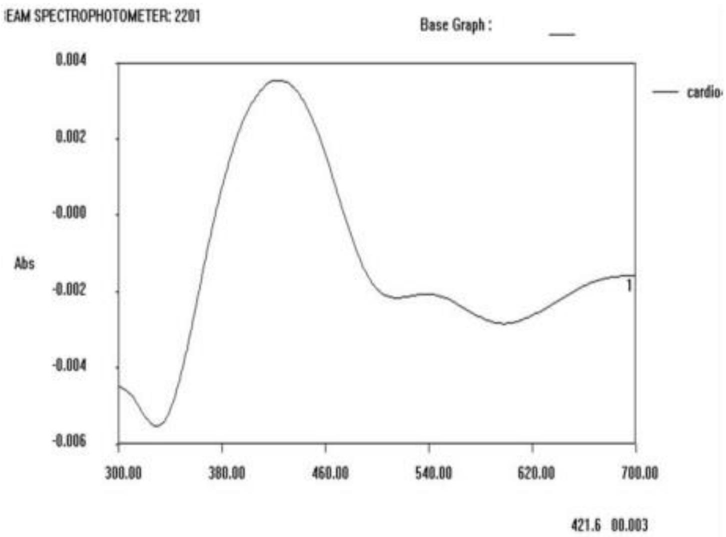

Figure 8: Sixth observation of UV-Vis spectrum of silver nanoparticles synthesized

Enzymes, proteins, amino acids, polysaccharides, vitamins, and other biomolecules in these extracts work together to reduce Ag+ ions in a complicated yet ecologically safe way. Many potential uses exist for silver nanoparticles (AgNPs) because of their unique characteristics. These include chemical reaction catalysts, solar energy absorbent coatings, electrical batteries, medicinal components, chemical and biosensing sensors, and spectrally selective coatings.

V. CONCLUSION

The research proved that silver nanoparticles (AgNPs) may be synthesized environmentally by employing an aqueous Dianthus caryophyllus leaf extract. According to UV-Visible spectrophotometry, which showed absorption maxima between 400 and 450 nm, the presence of AgNPs was further verified by a visible color shift from yellowish-green to dark brown. This proved that nanoparticles less than 25 nm were present. Plant extract contains biomolecules with reducing capacities, including proteins and amino acids, which are responsible for the biosynthesis process. With possible uses in areas including biosensing, medicines, and catalysis, the environmentally friendly and cost-effective synthesis process offers a viable alternative to the traditional methods of producing AgNPs. This process for synthesising nanoparticles is not only eco-friendly but also straightforward, efficient, and in line with sustainable norms.

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