RESEARCH ARTICLE

Synthesis and Evaluation of Silver Nanoparticles from Dragon Fruit Peel Extract

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ABSTRACT

Nanoparticles have garnered great interest recently because of their unique properties and wide range of applications in several industries, including environmental cleanup, medicine, and catalysis. Green synthesis techniques offer an ecologically friendly alternative to making nanoparticles using natural sources such as peel of dragon fruit chemicals as stabilizing and reduction agents. In this work, we examine the preparation and assessment of silver nanoparticles (AgNPs) employing peel extract from the dragon fruit (*Selenicereus undatus)* as a green precursor. This study aims to determine whether the extract of dragon fruit peel can be used to manufacture AgNPs, describe the physicochemical characteristics of the resulting nanoparticles, and evaluate the stability and prospective uses of these materials. Using a variety of analytical techniques, such as ultraviolet-visible spectroscopy, Fourier-Transform infrared spectra (FTIR), antioxidant capability assessment, and particle size, the synthesis process was refined through systematic exploration, and the resulting AgNPs were described. Our results demonstrate the effective creation of monodisperse AgNPs using a spherical morphology and a mean diameter of the particles of about 86.05 nm. Dragon fruit peel extracts have the potential to be an ecologically sound precursor for the production of nanoparticles; the significance of these discoveries for biological, natural, and industrial uses is reviewed. In summary, the present study adds to the expanding corpus of literature on environmentally friendly synthesis techniques and emphasizes the significance of harnessing natural resources to create sophisticated nanomaterials with improved characteristics and a low environmental footprint.

Keywords: Silver nanoparticles, dragon fruit peel extract, UV-vis spectroscopy, evaluation of nanoparticles, characterization of nanoparticles.

Key words: Symmetry C18, Remdesivir, Griseofulvin, RP-HPLC.

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INTRODUCTION

Silver nanoparticles have garnered a lot of interest due to their unique chemical, mechanical, and biological properties. An increasing trend in synthesis is moving away from traditional chemical procedures and toward green synthesis, which makes use of plant extracts for stabilizing and lowering effects. Dragon fruit peel often discarded as waste, is rich in antioxidants, polyphenols, flavonoids, and other properties, making it an excellent candidate for nanoparticle synthesis.[1] A nanoparticle is a very small particle usually less than 100 nm in size (a nanometre is one billionth of a meter) this particle can consist of a variety of compounds such as polymers metals metal oxide and biological molecules like lipid or protein nanoparticles are highly useful in a variety of fields including material science, environmental science, electronics medicine, and biology because of their small size, which frequently allows them to display special and advance quality about their bulk counterpart. nanoparticles have the potential to completely alter the drug delivery method in the field of medicine. their small size makes it possible for them to pass across biological barriers like cell membranes, allowing medication to be delivered appreciably to appropriate cells or tissue in the body. approach, side effects can be minimized and treatment efficacy may improve, in addition, medication may be made to encapsulate nanoparticles, which will protect them from digressions and increase their stability through the body until they reach their target.[2] AgNPs or silver nanoparticles, have been attractive and have a lot of interest recently because of their special qualities and many applications in a variety of fields, including medicine and catalysis. They are, intriguing possibilities for biological and pharmaceutical application because of their strong antibacterial, antifungal and anti-cancer character cities., furthermore, because of their approachability and environmental friendliness, their synthesis from a natural source is gaining study.[3] Dragon fruit peel is a rich source of bioactive substances such as a polysaccharide, flavonoids, and phenolics that may be used as a stabilizing and reducing agent for creating nanoparticles. in addition to adding value to the waste material, using agricultural waste for nanoparticles

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synthesis additionally promotes sustainability. utilizing our simple and environmentally friendly process, silver nanoparticles made from dragon fruit peel may be produced without the need for costly and hazardous regions that are often used in traditional processes. reduction of silver iron to generate silver nanoparticles in the presence of dragon fruits will extract is a competitive easy process. The peel extract phytochemicals work as a reducing agent to change the silver ions into silver nanoparticles and will also stabilize them to stop them from aggregation. Pitaya or dragon fruit is of fruit that is popular for its vivid pink dotted with little black seeds. the fruit skin is frequently degraded, despite the fruit itself being highly valued for its Flavors and nutritional value.[4] On the other hand, the peel of dragon fruit has a distinct set of qualities and applications. Appearance and texture depend on the type of dragon fruit peel can be brilliant pink deep red or even green it is usually thin and edible. Its name comes from its smooth smoothness, which occasionally has little scales or lumps that resemble the skin of a dragon. The peel of dragon fruits has certain nutrients, such as dietary fiber, antioxidants, and important vitamins like vitamin C, though it has been examined less than the meat. Its possible health advantages are facilitated by this mineral. Flavonoids and battalions, two kinds of antioxidants found in many fruit peels including dragon fruit peels, help in the body's defense against damaging free radicals. To improve general health and maybe reduce the risks of chronic disease, antioxidants are essential in minimizing antioxidant trace and inflammation.[5] Dragon fruit peel may be used in veterinary or culinary preparations however it is not usually eaten raw. It can provide health benefits and a mild fruity scent when added to teas or other liquids. Furthermore, some recipes use pulverized and dried dragon fruit spills as a new Tron culinary coloring and spice. Dragon fruit peel is a potential component for natural skin care products since it contains vitamins and antioxidants. Peel extract can be used as to face mask, cream, or serum to provide potential benefits such as moisturizing, anti-aging and depending on adverse environmental conditions.

MATERIAL AND METHODS

Material

Dragon fruits were collected from Wardha between August and September 2023. All chemicals used were of analytical grade and from Shandong Luba Chemical Co., Ltd., All experiments were performed at Datta Meghe College of Pharmacy, DMIHER (DU), Wardha.

Preparation of DFP Extract

Dragon fruits were collected, cleaned, and washed with distilled water thoroughly to remove any dirt or debris from the peel. Cut a dragon fruit and carefully peel the outer skin of the dragon fruit to separate it from the inner flesh. Ensured only the peel was collected for extraction. Once the peel was separated, it was dried in a hot air oven. Drying helps preserve the peel and facilitates extraction by removing excess moisture. After drying, grind the dried peel into a fine powder using a blender or grinder. Collected a fine DFP powder. Then 1g of DFP powder was boiled within 25 ml of distilled water for 1 hr and centrifuged for 10 min at 16000 rpm. Filtered the solution to remove solid particles or impurities, obtaining a clear extract.[6]

Preparation of $AgNO_3$ solution

The volumetric flask should be filled with around 100 ml of water after it has been cleaned and dried. While stirring, add roughly 8.25 grams of silver nitrate. combined with an additional 700 ml of distilled water. Water was added to reach the 1000 ml capacity.[7]

Preparation of Silver Nanoparticles

1ml of DFP extract was mixed with 1000 mL of AgNO3 at 80^0 C for 20 min and continuously stirred at 800 rpm in an auto-stirring apparatus pH was set to 10 with continuous heating with NaOH and observed reaction until colour changes (white to yellow to dark brown). Cool and centrifuged for 30 min at 1300 rpm in a cooling centrifuge. Precipitate wash with water or alcohol. Recentrifuged, dried at 60^0 C for 24 hr.[8]

Characterization of AgNPs

Fourier-Transform Infrared Spectroscopy (FTIR)

Figure 1. (A) Dragon fruit (B) Separated and dried DFP (C) DFP powder

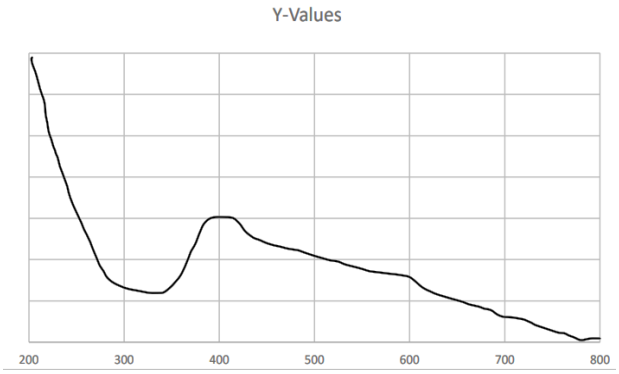

Figure 2: UV-Vis spectroscopy of AgNPs from DFP extract

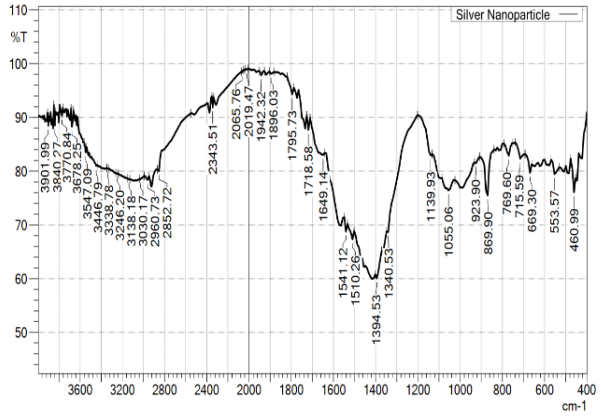

Figure 3: Fourier-Transform Infrared Spectroscopy (FTIR)of AgNPs of DFP extract

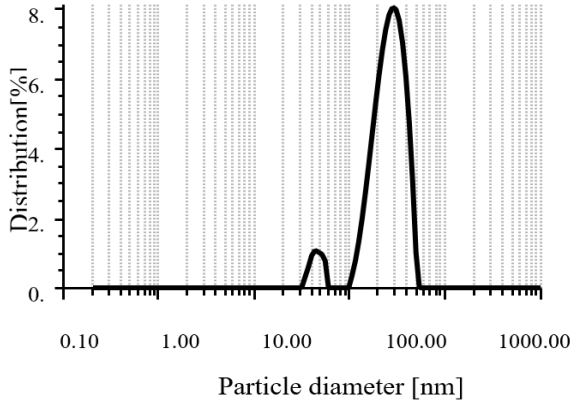

Figure 4: Particles size of silver nanoparticles of DFP extract

The Fourier transform (FTIR) in infrared spectroscopy is a useful analytical technique for distinguishing organic, polymeric, and rarely inorganic substances. The functional groups in the extract that might be in charge of the reduction and stability of silver nanoparticles (AgNPs) were found using FTIR evaluation of the dragon fruit peeled extract before the synthesis of AgNPs. Important Notes: - Wide Peak, measuring 3200–3500 cm^{-1}: Stretching of O-H vibrations, which are generally linked to the hydroxyl groups that occur in alcohols and phenols, are shown by this peak. These groups have a reputation for being reducing. At 1600–1650 cm^{-1}, the peak: The C=C stretching vibrations that characterize aromatic compounds are shown by this peak. Both flavonoids and polyphenols frequently contain aromatic rings. The peak between 1700 and 1750 cm^{-1} is thought to be caused by C=O stretching vibrations, which are a sign of carbonyl groups found in carboxylic acids, ketones, and aldehydes. Peaks at 1000-1300 cm^{-1}: These peaks correspond to C-O stretching vibrations, suggesting the presence of alcohols, ethers, carboxylic acids, and esters. FTIR Analysis of Synthesized AgNPs Following the production of silver nanoparticles by an extract from dragon fruit peel, FTIR analysis was carried out on the dried AgNPs to detect alterations in the functional groups and validate their participation in both reduction and stabilization procedures.[9]

Key Observations: Shift and Reduction in the O-H Stretching Peak: The broad peak at 3200-3500 cm^{-1} was shifted to a lower frequency and reduced in intensity, indicating the involvement of hydroxyl groups in the reduction of Ag+ ions. Disappearance of the Carbonyl Peak: The peak at 1700-1750 cm^{-1} (C=O stretching) diminished significantly, suggesting that the carbonyl groups played a role in the reduction process, possibly through oxidation to carboxylate ions. New Peaks at 1350-1450 cm^{-1}: These peaks, corresponding to C-H bending vibrations, suggest the formation of new bonds or compounds during the synthesis process. Shifts in Aromatic C=C Stretching: The peak at 1600-1650 cm^{-1} showed a slight shift, indicating the interaction of aromatic groups with silver nanoparticles, likely through π-electron interactions.[10]

UV-Vis Spectroscopy

To create silver nanoparticles, carefully mix extract from dragon fruit peel with a solution of silver nitrate ($AgNO_3$). Gather samples of the homogeneous AgNP solution at different points in time to track the reaction's development. Pour the alcohol used for the extraction procedure into a cuvette. In the UV-Vis spectrophotometer, insert the cuvette and do a baseline scan. By taking this step, you can be sure that any absorbance observed during sample analysis is a result of the nanoparticles and not the solvent. Pour the particles of AgNP solution into a sterile cuvette. A scan window between 200 and 800 nm should be selected on the spectrophotometer. Surface plasmon resonance (SPR) peaks are usually observed in this region in silver nanoparticles.[11]

The absorption spectrum can be obtained by inserting the cuvette containing the sample into the wavelength spectrophotometer and performing a scan. When searching for silver nanoparticles, look for the distinctive SPR peak, which often appears between 400 and 450 nm. When the nanoparticles are stimulated by light, the electrons collectively oscillate, producing this peak. AgNPs are present as shown by a peak at about 420 nm. Broader ranges of particle sizes are indicated by broad peaks, while sharp and narrow peaks point to an evenly sized distribution of the nanoparticles.[12] There exists a correlation between the concentration of nanomaterials in the solution and the heights of the SPR peak. An increased absorbance suggests an increased AgNP concentration. To see how the nanoparticles are growing, plot their absorption at the highest point in the SPR (420 nm, for example) against

time. AgNP creation and growth are shown by a steady rise in absorbance over time.[13]

Determination of Particle Size (AgNPs)

Characterizing nanoparticles involves measuring their particle size. These parameters are crucial for understanding the physical stability, surface charge, and interaction properties of nanoparticles in various applications.[14] The particle size determination of AgNPs synthesized using dragon fruit peel extract was conducted using dynamic light scattering (DLS) analysis. The narrow size distribution observed in the DLS analysis are indicative of the effective capping and stabilizing action of the phytochemicals present in the dragon fruit peel extract. These natural compounds, such as polyphenols and flavonoids, not only facilitate the reduction of silver ions but also prevent aggregation by stabilizing the nanoparticles through surface adsorption.[15]

Antioxidant Activity

Prepare the phosphomolybdate reagent by mixing ammonium molybdate, sulfuric acid, and sodium phosphate in distilled water. Extract the antioxidants from the sample of dragon fruit peel extract using a solvent of ethanol.[16] Dilute the sample extract to ensure the concentration falls within the assay's measurable range. Combine a known volume of the sample extract with the phosphomolybdate reagent in a test tube. Incubate the mixture at 95°C for 90 minutes to ensure the reaction reaches completion. Allow the reaction mixture to cool to room temperature after incubation. Measure the absorbance of the green phosphomolybdate complex at 695 nm using a UV-Vis spectrophotometer.[17] Prepare a calibration curve using standard solutions of a known antioxidant of ascorbic acid and plot the absorbance versus concentration. Use the calibration curve to determine the total antioxidant capacity of the sample by comparing its absorbance to that of the standards.[18]

RESULTS AND DISCUSSION

The absorbance of AgNPs on DFP extract using UV-Vis Spectrophotometer

The initial value that was used as a benchmark for the creation of AgNPs as the synthesis time increased is evident in the UV-Vis spectrum results and the solution's color shift. The broadest wavelength of the extract from dragon fruit peel solution, which was synthesized in the 200–800 nm wavelength range, was measured to characterize the UV–Vis spectrum. As silver nanoparticles formed, the solution's color changed from white to pale yellow and finally to reddish brown. The surface Plasmon resonance method and the reduction of silver ions were the causes of the color changes in the solution during the production of silver nanoparticles. Figure 2 displays parameters that may validate the production of silver nanoparticles based on the UV-Vis spectrum. In this experiment, the absorbance peak of nanoparticles of silver was observed at 420 nm, indicating that there had been an alteration of the nanoparticles between the AgNO3 solution and dragon fruit peel extract. Silver. The plasma that coats the surface of the silver nanoparticles can absorb colloidal solutions to a maximum at wavelengths of 200-800 nm. The solution's absorbance rises as the synthesis time increases, demonstrating a direct correlation between the rate decrease and the synthesis time increase. Nevertheless, the ability to absorb value and the solution's color changes stopped being noticeable after 30 minutes. This suggested that the production of silver nanoparticles ceased when the reduction rate reached a constant point, indicating that the silver salt had fully reduced. The absorbance value shows how much silver nanoparticles were generated; the higher the absorbance, the more silver nanoparticles there were. The functional groups found in the extract underwent considerable modifications during the FTIR examination of silver nanoparticles produced from the dragon-fruit peel extract, indicating their significance in the nanoparticle production process. The potential biological moiety was investigated using FTIR, or Fourier-transform infrared spectroscopy. Figure displays the frequency of vibration in the 400–4000 cm-1 range. The mixture had a variety of functional groups, according to FTIR analysis. There were noticeable changes and drops in these peaks' intensity that were noted. The locations of the FTIR signature are 3446 (O-H), 1718.05 (C=O), 2960 (-CH), 1340.53 (C-H), and 1649.1 (C=C). In the reaction mixture, amide groups such as Cl, Br, and I were assigned the following numbers: 1649.14 (Amide-I), 1039 (-CN), 6690 (Halides such as Cl, Br, and I), stretching of C-O of carboxylic acid and derivatives, C-N of amines that are aliphatic or alcohol/phenol, N-H deformation of amines, and C-H deformation of alkynes. The FTIR spectra alterations demonstrated unequivocally that the natural chemicals present in the extract of dragon fruit peel were essential in the reduction and stabilization of the silver nanoparticles. The FTIR study sheds important light on the processes by which extract from dragon fruit peels promotes the creation of nanoparticles of silver (AgNPs). The extract's FTIR spectrum revealed prominent peaks linked to carbonyl (C=O) and hydroxyl (O-H) groups, as well as the -NH of an amide group, the C-O bending of the carboxylic acid and its derivatives, C-N of an aliphatic amines, C-H stretch of alkanes, and aromatic rings—all of which are indicative of flavonoids, polyphenols, and other phytochemicals. These functional groups are known for their strong reducing and capping capabilities, which are essential for nanoparticle synthesis. These spectral changes highlight the dual role of the phytochemicals in the dragon fruit peel extract: they act as reducing agents, transforming silver ions into nanoparticles, and as capping agents, stabilizing the nanoparticles and preventing their aggregation. The efficacy of extract from dragon fruit peel as a natural synthesis agent is demonstrated by its dual activity, which is essential for generating stable, homogeneous silver nanoparticles. Thus, the spotted shifts and fresh peak positions in the FTIR spectrum highlight the efficient and environmentally friendly character of this process by offering a clear molecular-level knowledge of the reactions and transformations taking place during the creation of silver nanoparticles. The particle size determination of AgNPs synthesized using dragon fruit peel extract was conducted using dynamic light scattering (DLS) analysis. The DLS results indicated that the synthesized AgNPs had

a mean particle size of 82.05 nm. The size distribution was relatively narrow, suggesting a uniform population of nanoparticles. Additionally, the polydispersity index (PDI) was low, further confirming the uniformity and monodispersed of the nanoparticles. These findings were consistent across multiple batches, indicating reproducibility of the synthesis process. The mean particle size of 82.05 nm is within the optimal range for many biomedical applications, including antimicrobial activity, due to the increased surface area-to-volume ratio, which enhances interaction with microbial cells. The narrow size distribution and low PDI observed in the DLS analysis are indicative of the effective capping and stabilizing action of the phytochemicals present in the dragon fruit peel extract. These natural compounds, such as polyphenols and flavonoids, not only facilitate the reduction of silver ions but also prevent aggregation by stabilizing the nanoparticles through surface adsorption. This dual functionality is essential for maintaining the colloidal stability of the nanoparticles over time. Moreover, the consistency in particle size across different synthesis batches underscores the reliability and reproducibility of the green synthesis method. This consistency is crucial for scaling up the production of AgNPs for various applications, ensuring that the nanoparticles exhibit uniform properties regardless of the production scale.

Antioxidant Assay

The dragon fruit skin extracted demonstrated a strong antioxidant ability when subjected to an antioxidant test with phosphomolybdate reagents. Using spectrophotometry, the complex's absorbance was calculated at 695 nm. The extract's antioxidant activity increases with its absorption. The extract from dragon fruit peel was found to have a strong antioxidant activity based on the obtained absorbance value. This dragon fruit peel extract appears to be rich in antioxidants, including polyphenols, flavonoids, flavonoids, and vitamin C, based on the high absorbance value recorded in the antioxidant test. These antioxidants are essential for scavenging reactive oxygen species and free radicals, which shields tissues and cells from oxidative damage. The extract has a considerable antioxidant activity, which suggests that it may have health benefits, such as lowering the risk of long-term conditions like cancer, heart disease, and neurological problems. The extract's antibacterial and anti-inflammatory qualities may also be aided by the antioxidants present in it, which would increase its potential for medicinal use. In summary, the findings underscore the health benefits and functional significance of extract from dragon fruit peels as an organic supply of antioxidants, endorsing its application in culinary, medicinal, and cosmetic fields.

CONCLUSION

Numerous nanoparticles were produced from the dragon fruit; however, the peel and other waste material of the fruit were not employed in the manufacture of the nanoparticles, therefore we utilized the waste material to make the nanoparticles, peel included. An effective and sustainable method for creating nanoparticles with desired characteristics is the production of silver nanoparticles utilizing extract from dragon fruit peel. This study's exact oversight of particle size, homogeneity, and stability shows how this green synthesis approach can be applied to a wide range of industrial, biomedical, and environmental applications. This study's exact oversight of particle size, homogeneity, and stability shows how this green synthesis approach can be applied to a wide range of industrial, biomedical, and environmental applications. This technology provides an economical and environmentally friendly substitute for traditional nanoparticle production processes by utilizing naturally occurring reducing and stabilizing chemicals found in waste from agriculture such as dragon fruit peel. In order to optimize the attributes of AgNPs for particular applications, future research could examine the optimal setting of synthesis parameters. Additionally, it could look into the possible synergistic effects of adding more natural draws or additives to improve nanoparticle performance. Overall, the synthesis of AgNPs from dragon fruit peel extract holds great promise for advancing nanotechnology while promoting sustainability and reducing environmental impact. The characteristics of the produced silver nanoparticle were extensively examined using a range of analytical techniques, including UV-Vis spectroscopy, FTIR, Particles size, and antioxidant Analyse. According to the UV-Vis spectrum measurements, the optimum outcomes for nanoparticle synthesis were obtained at an extract for 30 minutes at a synthesis temperature of 70°C. At this temperature, the isolation hue turned visibly brown and the silver nanoparticles' absorbance peak was measured at 420 nm. According to FTIR analysis revealed the occurrence of diverse functional groups in the mixture. Notable shifts and reductions in the intensity of these peaks were observed. 3446 (O-H), 1718.05 (C=O), 2960 (-CH), 1340.53 (C-H), and 1649.1 (C=C) are the locations where the FTIR signature appears. The stretching vibration of the amino C-H stretch of alkanes, the -NH of an amide group that is found within the reaction mixture, and the values 1649.14 (Amide-I), 1039 (-CN), and 6690 (Halides like Cl, Br, and I) were assigned. The synthetic AgNPs' mean particle size was found to be 82.05 nm, based on the DLS data. There was evidence of a homogeneous population of nanoparticles due to the relatively narrow size distribution. The dragon's fruit peel extract showed a notable antioxidant potential, according to an antioxidant test carried out with phosphomolybdate reagents. Using spectrophotometry, the complex's absorbance was calculated at 695 nm. This dragon fruit peel extraction appears to be rich in antioxidants, including polyphenols, flavonoids, flavonoids, and vitamin C, based on the high absorbance value recorded in the antioxidant test.

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