ISSN – 2277-7911
Impact Factor – 5.519

YOUNG RESEARCHER
A Multidisciplinary Peer-Reviewed Refereed Research Journal

Jan-Feb-Mar 2024
Vol. 13 No. 1

Applications Of Extracts Of Commonly Consumed Teas In India

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DOI - 10.5281/zenodo.11025615

Abstract:

The use of microorganisms or plant extracts for the biological production of nanoparticles is a significant aspect of nanotechnology, given its ecologically sustainable nature and absence of hazardous chemicals. This work reports the production of silver nanoparticles by the use of Chinese tea leaves extract derived from Camellia sinensis. The produced nanoparticles underwent characterization using UV-vis spectroscopy, X-ray diffraction (XRD), transmission electron microscopy (TEM), and Fourier transform infrared (FTIR) spectroscopy. The XRD study indicates that the produced silver nanoparticles possess a face-centered cubic structure. The TEM picture revealed the presence of well-dispersed silver nanoparticles of around 4 nm in size. The use of green manufactured nanoparticles has applications in several sectors, including cosmetics, food industry, and medical.

Keywords: Applications, Extracts, Teas, India, Nanoparticles and silver Nanoparticles.

Introduction:

Due to the fact that and silver nanoparticles have a powerful capacity to eliminate microbiological species, and greatly acknowledged as being among the most effective antibacterial compounds in the disciplines of medicine and biology. They have been used for the prevention and treatment of a broad variety of ailments, including infections, for an almost uncountable number of millennia. Silver nanoparticles have been demonstrated to have anti-platelet, anti-fungal, anti-inflammatory, and anti-angiogenesis properties, according to further research that has been conducted. Over the last several years, the area of silver nanoparticles has seen a substantial amount of developments and expansions. At the moment, these chemicals may be discovered in a variety of products, including wound dressings, ointments, garments, and food containers or implant coatings. The Food and Drug Administration of the United States of America has given its permission for a wide variety of applications that include silver nanoparticles. Puch-erh tea is widely acknowledged in China as a beverage that has healing properties. There is a correlation between the high antioxidant content of pu-erh drinks and their capacity to lower blood pressure, lower cholesterol levels, prevent cardiovascular disease, and enhance the microbiota in the digestive system.

Through the use of an extract of pu-erh tea leaves (*Camellia sinensis*), the purpose of our study is to develop a method that is both chemically and environmentally sustainable for the reduction and encapsulation of silver nanoparticles. In this research, a unique and uncomplicated method is presented for the effective production of silver nanoparticles at room temperature, making use of knowledge that is currently available within the scientific community. Using biological microorganisms or plant extracts, green synthesis methods have gained popularity as a simple alternative to chemical synthesis. These approaches have grown more common.

When compared to chemical approaches, the process of green synthesis offers a number of advantages, including the ability to be scaled up for large-scale manufacturing, cost-efficiency, and environmental friendliness. Three essential steps are normally included in the green synthesis process. These steps are as follows: (1) the selection of an appropriate solvent medium; (2) the selection of an environmentally benign reducing agent; and (3) the selection of non-toxic chemicals to ensure the stability of the nanoparticles. Utilizing plant extracts for nanoparticle synthesis, in contrast to other biological approaches, has the potential to remove the need for time-consuming cell culture maintenance and enables large-scale manufacture in non-sterile conditions. This is a significant advantage over other nanoparticle synthesis methods. The production of metal nanoparticles that are free of any harmful properties has become an increasingly challenging endeavour in recent years. The primary purpose of this area of research is to generate nanoparticles made of metal while simultaneously minimizing the use of elements that are harmful to the environment. For the purpose of producing silver nanoparticles in a variety of sizes and shapes, a number of different chemical and physical processes have been used. Microwave irradiation, chemical reduction, the photochemical technique, electron irradiation, and the sonoelectrochemical process are some of the methods that are used.

On the other hand, a considerable number of processes that have been well documented often include several stages, a substantial amount of energy consumption, little modifications to the materials, arduous purification methods, and the use of hazardous chemicals. Certain hazardous chemical species have the capacity to cling to the surface of nanoparticles due to the chemical makeup of nanoparticles, which might possibly lead to severe consequences. There is a possibility that this issue might be resolved by using environmentally acceptable techniques for the synthesis of nanoparticles. Consequently, it is of the utmost importance to develop a method that is also environmentally friendly for the production of nanoparticles.

Material And Method:

Material:

Sample Collection and Preparation:

The sample of commercial tea (including herbal, green, and black varieties) were gathered from a variety of brands and assortments. The specimens were desiccated in an oven at 37°C for six days. After the materials had dried, they were weighed and combined with a warring blender. Subsequently, they were submerged in methanol for a duration of two days prior to their filtration through Whatman No. 1 paper. The methanol was completely extracted using a vacuum evaporator set at 50°C, resulting in the formation of a viscous substance. The crude extracts were weighed and stored at 4°C prior to analysis. The tea samples must be stored in airtight containers to prevent contamination and maintain their quality.

Preparation of Tea Powder:

The tea samples were grounded into a fine powder utilizing a mortar and pestle or grinder. For subsequent analysis, place the pulverized samples in hermetic containers that are appropriately labelled.

Figure 1 Powdered Samples

Method:

Synthesis of Silver Nanoparticles:

The tea leaves extract was Prepared by measuring 10 grams of tea leaves in a 500 millilitre beaker, adding 100 milliliters of distilled water, and keeping it at a temperature of 60 degrees Celsius for 10 minutes before pouring out the liquid. The solution underwent filtration using a 0.45 µm Millipore membrane filter, followed by a 0.2 µm Millipore membrane filter. The manufacture of silver nanoparticles included the reaction of 100 mL of $AgNO^3$ (1 mM) with 12 mL of tea extract in an Erlenmeyer flask at room temperature. Observation was made of any changes in the color of the solution.

Characterization:

XRD:

X-ray diffraction (XRD) is a non-invasive method used to examine the atomic or molecular structure of materials. It is most effective for materials that exhibit crystalline or partly crystalline properties (i.e., materials with periodic structural order), although it is also used to investigate non-crystalline materials.

FTIR:

Fourier-transform spectroscopy is a less straightforward method for acquiring same information about chemical bonds and functional groups. Instead of emitting a beam of light with a single wavelength, this method emits a beam that contains many frequencies of light simultaneously and quantifies the amount of light absorbed by the sample.

Optical Property:

The optical characteristics of nanomaterials, including absorption, transmission, reflection, and light emission, are dynamic and may vary dramatically from those of the corresponding bulk material. Furthermore, the optical characteristics of the synthesized Ag nanoparticles were examined using a UV-visible (UV-Vis) absorption double beam spectrophotometer, namely the Perkin Elmer Lambda 35 model. The spectrophotometer was equipped with a deuterium and tungsten iodine lamp, and the analysis was conducted at room temperature within the wavelength range of 300-600 nm.

Morphology:

Nanotubes and nanowires are examples of high aspect ratio nanoparticles, which exhibit many configurations such as helices, zigzags, belts, or even nanowires with length-dependent diameter. Small-aspect ratio morphologies include spherical, oval, cubic, prism, helical, or pillar shapes. The morphology of the Ag nanoparticles was examined using Transmission Electron Microscopy (TEM, Hitachi, H7100). The Ag nanoparticles underwent sonication for a duration of 15 minutes using a sonicator operating at a frequency of 50 Hz, namely the Soniclean model. Subsequently, the solution was immersed into a copper grid at ambient temperature. Following the drying process, the sample was subjected to analysis at 80 kilovolts.

Particle Size Distributions:

The particle size distributions were calculated using the UTHSCSA Image Tool Program (version 3.00; Dental Diagnostic Science, UTHSCSA, San Antonio, TX). Various commercially accessible devices may be used to ascertain the particle size and dispersion of nanoparticles. Instruments may be used for the examination of desiccated powders and particles dispersed in a liquid medium. Typically, there are two fundamental approaches to determining particle size.

One approach involves examining the particles and doing precise measurements of their size.

Results and Discussion:

The visual inspection revealed that the color of the solution in the Erlenmeyer flask, which contains pu-erh tea extract and $AgNO_3$ solution, had changed. After a period of five minutes, the solution of $AgNO_3$/tea extract went from being colorless to having a light brown hue, and then it ultimately became a dark brown color (Figure 2). The appearance of this shift in hue is evidence that silver nanoparticles are being formed in the solution. Without the addition of $AgNO_3$, the tea extract did not exhibit any color changes. The creation of silver nanoparticles was further validated by the use of transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and ultraviolet-visible spectroscopy (UV-vis).

Figure 2 Aqueous solution of 10^{-3} M $AgNO_3$ with pu-erh tea leaves extract (A) before adding the tea extract and (B) after addition of tea extract at 5 minutes.

XRD Patterns:

The XRD patterns for the silver nanoparticles that were produced by the extract of pu-erh tea leaves are shown in Figure3. There were five primary distinctive diffraction peaks for silver that were found at 2θ = 38.4, 44.5, 64.8, 77.7, and 81.7. These peaks correspond to the crystallographic planes of face-centered cubic (fcc) silver crystals, which are (111), (200), (220), (311), and (222), respectively (JCPDS 00-004-0783). There were no peaks from any other phase that were seen, which demonstrates that nanoparticles of single-phase silver with a cubic structure have been immediately produced.

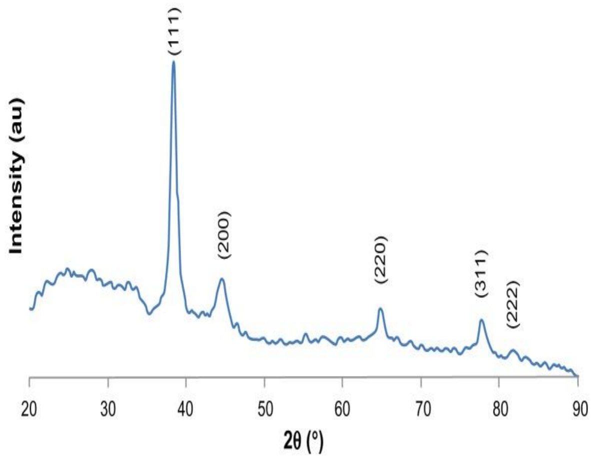

Figure 3 XRD patterns of Ag nanoparticles.

The size of the crystallites is often proportional to the breadth of the peaks produced by XRD. For the purpose of determining the average crystallite diameter based on the half width of the diffraction peaks, the Debye-Scherrer equation was as follows: The equation for D is D = (kλ)/ (β cos θ), where D represents the mean crystallite size of the powder, λ is the wavelength of Cukα, β represents the whole width at half-maximum, θ represents the Bragg diffraction angle, and k is a constant for the calculation. For the purpose of calculating crystalline size, the (111) plane was used. When using the Debye-Scherrer equation, it was discovered that the average crystallite size of the silver nanoparticles that were manufactured was 3.42 nanometres.

UV-vis Absorption Spectrum:

The produced Ag nanoparticles' UV-vis absorption spectra is seen in Figure 4. Silver nanoparticles possess unbound electrons that exhibit surface Plasmon resonance (SPR) absorption, resulting from the synchronized oscillation of silver nanoparticle electrons in harmony with light waves. Ag strong absorption peak was detected at a wavelength of 436 nm, indicating the presence of silver. The absence of any further peaks in the spectrum demonstrates that the synthesized products consist only of Ag.

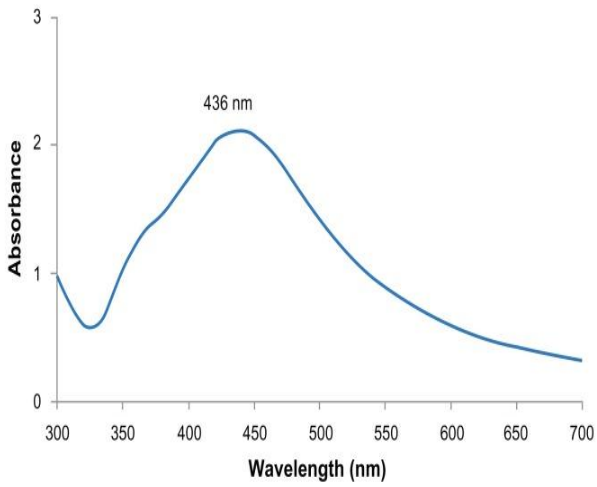

Figure 4 UV-vis spectrum of Ag nanoparticles.

FTIR Measurement:

A Fourier Transform Infrared (FTIR) measurement was conducted to determine the biomolecules that may be responsible for capping and decreasing the Ag nanoparticles produced using tea leaf extract. Three distinct infrared bands are detected at 3271 cm^{-1}, 1637 cm^{-1}, and 386 cm^{-1} (Figure 5). The prominent peak at 3271 cm^{-1} may be attributed to the stretching of N—H and O—H bonds in the protein's linkage. The band at 1637 cm^{-1}, with medium intensity, is caused by the stretching of the C = O bond in the amine I group. This group is typically found in proteins, suggesting that proteins are present as capping agents for the silver nanoparticles. The inclusion of proteins as capping agents enhances the stability of the produced nanoparticles. Conversely, the strong and wide peak seen at 386 cm^{-1} may be attributed to the presence of Ag metal.

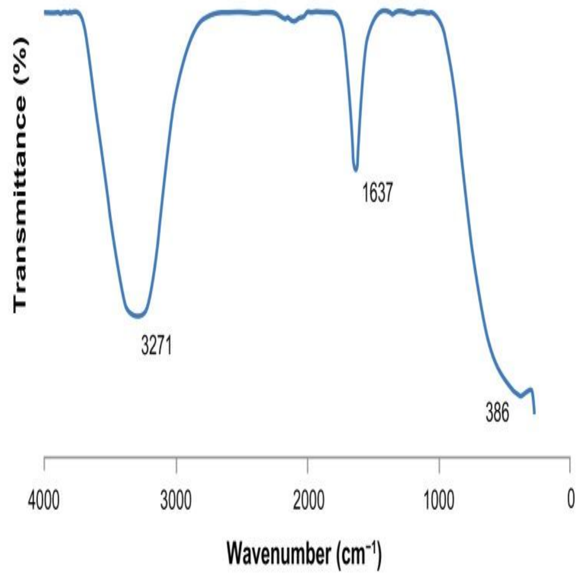

Figure 5 FTIR spectrum of Ag nanoparticles.

Transmission Electron Microscopy (TEM):

The use of transmission electron microscopy (TEM) has been applied to analyze and determine the dimensions, configuration, and structure of artificially created silver nanoparticles. Figure 6A displays the transmission electron microscopy (TEM) picture of silver nanoparticles. The picture clearly shows that the silver nanoparticles have a spherical morphology, which matches the shape of the SPR band in the UV-vis spectrum. Figure 6B displays the histogram depicting the distribution of sizes of silver nanoparticles. The average particle size determined from the TEM picture is 4.06 nm, which closely corresponds to the particle size obtained from the XRD study. The technology of synthesizing silver nanoparticles in an ecologically friendly manner has the potential to be used in a wide range of sectors. Silver nanoparticles have several applications, such as being used as a covering for solar energy, bio-labelling, food packaging, antibacterial agent, and medicine delivery. Multiple investigations have been conducted on the use of metal nanoparticles in water filtration systems, mostly owing to their antibacterial and pesticide elimination capabilities. In addition, silver nanoparticles have a significant impact in the field of medicine.

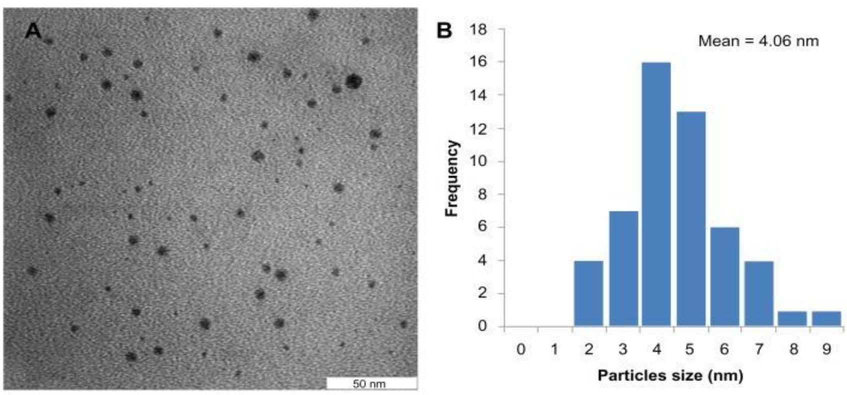

Figure 6 (A) TEM image and (B) particles size distribution of Ag nanoparticles synthesized by tea leaves extract.

Silver nanoparticles serve as biomarkers for the early identification and monitoring of diseases, such as cancer and Alzheimer's disease. They are particularly useful in identifying tumors for cancer treatment and diagnosing Alzheimer's disease at an early stage. This work presents a sustainable method for producing Ag nanoparticles by using an extract derived from tea leaves. This process offers a straightforward and environmentally friendly approach to produce silver nanoparticles at ambient temperature, eliminating the need for toxic reducing agents like sodium borohydride and any capping or dispersion agents. The analysis revealed that the silver nanoparticles manufactured using green methods consisted of spherical particles with a high degree of crystallinity. The particle sizes were regulated within the range of 2 to 10 nm.

Summary and Conclusion:

This study presents a method for the creation of silver nanoparticles that is beneficial to the environment. The method involves the use of an extract that is derived from tea leaves. The manufacture of silver nanoparticles at room temperature may be accomplished in a straightforward manner that takes into account environmental concerns using this process. In addition to removing the need for potentially hazardous reducing agents like sodium borohydride, it also removes the need for any additional agents that could be necessary for capping or dispersion. Silver nanoparticles that were manufactured using methods that were less harmful to the environment were found to be made of spherical particles that had a high degree of crystallinity, as shown by the results of the inquiry. Through careful manipulation, the sizes of the particles were brought down to a range that was between 2 and 10 nanometres.

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