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Synthesis and characterization of Silver Nanoparticles

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Abbreviations: TEM: Transmission Electron Microscope; SEM: Scanning Electron Microscope; XRD: X-Ray Diffractometer; FTIR: Fourier Transform Infrared Spectrometer; XPS: X-Ray Photoelectron Spectrometer; DLS: Dynamic Light Scattering

Introduction

Silver (Ag) is a noble transition metal element that is white and glossy and has the highest levels of reflectivity, electrical conductivity, and thermal conductivity. Before it was known that microbes are what cause infections, it is evident that silver was employed for its medicinal properties [1]. Silver is used for many different things, including making pottery, money, making chemicals, foils, sutures, and different medication formulations like ointments, lotions, and creams, among others. It is pharmaceutical science's most effective metal therapeutic agent for the treatment of microbiological and/or surgical infections [2]. Silver is also employed in the interdisciplinary field of nanoscience, where products' applications depend on the fundamental characteristics that their nanoscale nature endows with them [3]. The fastest-growing area of research that benefits people, animals, and other environmental elements is nanotechnology. One of the best nanotechnology inventions, nanoparticles (NPs), apply to daily problems in this planet [4]. Natural, manmade, or unintentionally produced materials with particles of sizes between 1 and 100 nm are known as nanoparticles. Inorganic and organic nanoparticles fall into separate types. Metal semi-conductors like ZnO, ZnS, and Cd, magnetic nanoparticles like Co, Ni, and Fe, and metallic nanoparticles like Ag, Au, Cu, and Al make up inorganic nanoparticles [5]. Additionally, carbon nanoparticles are a component of organic nanoparticles. (E.g., carbon nanotubes, quantum dots, etc.).

Due to their high surface to volume ratio and exceptional physical and chemical characteristics, metal nanoparticles play a significant role in applications. (Optical activity, catalytic nature, magnetic property, electric property, and antibacterial properties). These nanoparticles' small size and high surface area contribute to their superior biological activities as compared to metal particles [6]. Nanoparticles made of gold and silver (another noble metal) offer exceptional qualities and can be applied in many different fields. Nanoparticles made of gold and silver have unique qualities that are usefully adaptable [7]. Due to their distinctive physicochemical properties [8], silver nanoparticles are increasingly being used in a variety of industries, including pharmaceutical, food, cosmetics, health sciences, metallurgy, and other industrial domains.

AgNPs have shown effective in the past in the biomedical field, agriculture, textile industry, and wastewater treatment [9]. AgNps is an environmentally friendly medication since it controls microbial development. Silver nanoparticles are produced by chemical, physical, and biological processes. Pure, well-structured particles are produced by chemical and physical procedures, but the chemicals are costly, hazardous, and labor-intensive [10]. Surprisingly, biologically produced AgNPs have a higher yield and are more soluble and stable in nature. Of all the techniques, biological synthesis is the quickest, simplest, safest, and most repeatable. Additionally, when adjusted under certain circumstances, green techniques result in well-structured nano size and morphological characteristics [11]. generating silver nanoparticles from fungus, bacteria, plant metabolites, and plant extracts. When creating nanoparticles, capping agents such as sugars, proteins, polyphenols, alkaloids, and terpenoids with functional groups are used. As a result, the reaction's nanoparticles are stabilized and shielded from aggregation [12]. It is well known that biologically produced nanoparticles have antimicrobial, antibacterial, antifungal, cytotoxic, antioxidant, and insecticidal properties. For the production of silver nanoparticles, bacteria including E. coli and Lactobacillus sp. are frequently utilized [13]. Despite the enormous promise for stabilizing AgNPs, there haven't been many attempts to make the technology widely available.

The many chemical and physical processes used to create Ag-NP are typically pricy and hazardous [14]. "Green synthesis" is another name for the biological process of Ag-NP biosynthesis. As biological sources for green synthesis, plant extracts, microbes, and animal products are employed [15]. The creation of nanoparticles through green synthesis has been the focus of numerous researchers. 1) Extracts or microbes are combined with the silver solution during the various processes of green synthesis. 2) The temperature, pH, incubation time, silver salt concentration, and reactant concentration are all optimized in the formation of nanoparticles. 3) UV-visible spectroscopy is used to analyze nanoparticles 4) Characterization of nanoparticles using a transmission electron microscope (TEM), a scanning electron microscope (SEM), an X-ray diffractometer (XRD), a Fourier transform infrared spectrometer (FTIR), an X-ray photoelectron spectrometer (XPS), and dynamic light scattering (DLS) [16].

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