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Short Communication

Silver Nanoparticles: Synthesis, Characterization, and Applications of Recent Research

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DESCRIPTION

Due to their unique features at the nanoscale compared to their bulk composition, nanomaterials have improved research in the materials, biomedical, biological, and chemical sciences over the past two decades. Due to the development of various technologies for synthesizing particular shapes and sizes, applications of nanoparticles in industries including medicine and agriculture have increased. Due to the tunable physical and chemical characteristics of silver nanoparticles, extensive research has been done to increase its usefulness [1].

Due to their low toxicity and biocompatibility, Ag NPs' antibacterial capabilities are finding use in boosting the activity of medications (such as Amphotericin B, Nystatin, and Fluconazole) and composite scaffolds for controlled release of medications and targeted delivery of medications. Ag NPs are a top-notch material for constructing (bio) sensors, such as surface-enhanced Raman spectroscopy, for detecting biomarkers, illnesses, contaminants, and greater catalytic activity in photochemical reactions, thanks to its surface plasmon resonance property [2].

In addition to this, highly conducting Ag NPs are employed to create electrocardiograms in flexible and wearable sensors. Ag NPs are made by physical-chemical or biological techniques, although each strategy has advantages and disadvantages. The utilization of physicochemical synthesis is hampered by the high cost and use of dangerous chemicals. Similar to that, biological synthesis can be a good option for therapeutic activities like cancer therapy even though it is not always repeatable for extensive use. Ag NPs are cytotoxic when used excessively, and their uncontrolled release into the environment could have an impact on both aquatic and terrestrial biota. Ag NP research has always been motivated by the goal to create a technology with possible advantages and little damage to the environment or public health. In this review, we've made an effort to give readers some insight into the use of silver nanoparticles (Ag NPs) in a variety of fields as well as into the most recent synthesis and characterization methods for Ag NPs [3].

It is thought that the discipline of nanotechnology was conceptually born from the renowned visionary lecture "There's plenty of room at the bottom" delivered by the American physicist Richard Feynman. Currently, it is inescapable in practically all branches of science, including engineering, medicine, the environment, and agriculture. Nanotechnology makes use of hybrid, organic, and inorganic materials. Due to their antibacterial properties, metals like silver and copper have been used by humans for a very long time. At the moment, their potential uses in consumer goods including textiles, shampoo, hygiene products, and contraceptives are being investigated [4].

Ag NPs are used in sensors such chemiluminescence sensors, surface-enhanced Raman spectrometry sensors, fluorescence sensors, and colorimetric sensors because of their surface plasmon resonance capabilities. These sensors are used to find environmental pollutants like pesticides, heavy metals, and ammonia that are released into the air. Similar to this, the treatment of diseases like cancer is protracted due to the illness's late detection; Ag NPs have aided in early identification. Additionally, Ag NPs can be used for pollution cleanup because of their superior catalytic properties for the breakdown of contaminants like nitroarenes and organic dyes due to their high surface-to-volume ratio. Additionally, Ag NPs are less harmful to mammalian cells than other metal nanoparticles, and due to their relatively tiny size, they can quickly pass past the cell membrane and enter the body of the organism and could act as an antibacterial agent [5].

Ag NPs have a lot of surface energy, which causes them to aggregate and lose antibacterial potential. This problem can be resolved by placing Ag NPs on a solid support structure. Ag NPs' strong electrical conductivity is used to create an electronic ink-like gadget. When deposited on the compound's surface, it increases the conductivity of 2D sensors like graphene oxide. This characteristic also aids in the identification of heavy metals. Ag NPs can be made *via* physicochemical or biological methods, depending on the reducing agents employed. In the prior method, Ag NPs were created by introducing chemicals, light, laser, electricity, sound, microwave, etc. into the substrate. For the

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latter, however, secondary metabolites or enzymes from bacteria, fungus, and primarily polyphenol-rich natural sources are employed. The physicochemical method of synthesizing nanoparticles is not cost-effective or ecologically friendly. However, these limitations are circumvented *via* biological synthesis, allowing for the production of Ag NPs with different crystallinities and structural variations. Ag NPs' shape, size, surface charge, propensity to aggregate, and rate of dissolution all influence the materials chemistry of the particles [6].

CONCLUSION

Ag NPs' adjustable features have piqued researchers' interest in the material for a very long time. Typically, metabolites from biological sources and sodium citrate, ascorbate, and sodium borohydride are used to reduce silver salts to create the nanoparticles. The Ag NPs' antibacterial qualities make them desirable for preventing infectious diseases, purifying water, and getting rid of plant infections. To employ the particles outside of the lab, more study is necessary. It is never easy to create inexpensive, evenly distributed, well-dispersed nanoparticles since no synthesis technique is flawless. Similar to how silver nanoparticles' effects on the environment and human health may make their widespread use problematic, research on the buildup and mode of action of Ag NPs inside the a human body is necessary.

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