Applications of Silver Nanoparticles

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ABSTRACT

Due to its diverse applications, nanotechnology has emerged as the most promising and rapidly expanding subject of study. The development of reliable, environmentally friendly methods for synthesising nanoparticles could be a significant advancement in the field of nanotechnology. Nanoparticles have distinct chemical and physical characteristics that are advantageous in many different sectors. Due to their numerous applications, silver nanoparticles have emerged as a research hotspot among metallic nanoparticles. Because of their outstanding chemical, physical, and biological characteristics, silver nanoparticles are significant. Silver nanoparticles offer a wide range of uses as antifungal, antiviral, and antibacterial agents due to these special properties. They are excellent antioxidants, have a great catalytic effect on dye degradation, can be used to treat a variety of illnesses, and have wound-healing properties.

INTRODUCTION

Due to its practicality in modifying metals to their nano scale, which drastically alters their physical, chemical, and optical properties, nanotechnology is very significant in the current century. Nanotechnology will give scientists and engineers new tools for understanding and controlling matter at the molecular level, building novel structures with fundamentally different molecular organization, and exploiting novel molecular features. Nanoscale matter differs from bulk matter in terms of its chemical, biological, magnetic, electrical, and other properties. As a result, faster, better, and less expensive goods can be produced. Silver nanoparticles (AgNPs) are a special type of metal among many others because they have strong antibacterial and local surface plasmon resonance properties. As a result, they are particularly useful as broad-spectrum antibacterial agents, improved surface enhanced Raman spectroscopy, biomedical and chemical/biosensor materials, biomarkers, and so on. AgNPs have been applied by scientists in a

variety of fields, including catalysis, food packaging, sensors, biomedicine, the cosmetic and textile industries, biology, coatings, optoelectronics, antimicrobial activities, DNA sequencing, weather change and contamination control, information storage, fresh water technology, energy generation, and optoelectronics. AgNPs are used as anti-infection, delivery, and tranquillizer agents. Additionally, silver nanoparticles have numerous uses in electronic devices, adhesives, pastes, inks, and other materials due to their high conductivity (Zhang etal., 2016).

Applications of Silver Nanoparticles (AgNPs)

1) Food packaging

AgNPs are utilised in food packaging because of their antibacterial properties, which help to prevent microbial contamination and extend shelf life. AgNPs can be incorporated into both biodegradable (starch, cellulose, agarose, chitosan) and non-biodegradable (polyvinyl chloride, polyethylene, vinyl alcohol) polymers to create food packaging materials. It provides these food packaging materials with higher physicochemical qualities, decreased hydrophilicity, and better biodegradability (Duncan, 2011).

2) Environmental Applications

With regard to pathogenic bacterial strains as well as fungal strains, the reverse osmosis membrane integrated into AgNPs demonstrated excellent antifungal and antibacterial activity. With this manufacturing, less pre-treatment or cleaning with hazardous chemicals is required, which minimises the demand for desalination plants, industrial wastewater treatment, agricultural farms, and applications for the production of drinking water. To prevent water from becoming contaminated by microbes, AgNPs can be utilised as a coating material in PVC pipes for drinking water. Microscopy, physical separation, and ion selective electrode are used to analyse the commercial garment silver wastewater treatment in water and its operation in wastewater treatment plants (Mpenyana-Monyatsiet al., 2012).

3) Medical Applications

AgNPs are utilised in medication administration to decrease toxicity, increase specificity and decrease dosage. By lowering the activity of these local matrix metalloproteinases (MMPs) and boosting neurotraumatic neutrophil death, it is used in imaging and wound healing. Interferon gamma and tumour necrosis factor alpha, which are implicated in inflammation, can be inhibited byAgNPs. Bone cement, which is used to replace artificial joints, contains AgNPs. Due to the potential antibacterial properties of nanosilver, polymethylmethacrylate contains nanosilver and is referred to as bone cement. The capacity to use nanosilver for biosensing exists. The plasmonic characteristics of the nanosilver make it a strong option for bioimaging (Austin et al., 2014). AgNPs are very sensitive nanobacteria that can be utilised for imaging and targeting of tissues, cancers, DNA, proteins, and tiny compounds.

4) Agriculture

AgNPs are used for both the prevention and treatment of plant diseases. By improving soil nutrient uptake and seed germination in a variety of plants, nanosilver functions as nanofertilizers.Nanosilver is a state-of-the-art tool for pest control that is efficient, non-toxic, and safe. AgNPs can be used in place of pesticides to boost crop output.

5) Textiles

When applied as an antibacterial treatment, AgNPs can significantly enhance the colour and tenacity of textiles. AgNPs differ from conventional dyes in that the colour of the fabric is determined by the shape and size of the nanoparticles rather than the chromophores found in conventional dyes. Both synthetic and natural colours are easily discoloured by washing and ultraviolet (UV) exposure.In contrast to conventional synthetic dyes, the colour created by AgNPs is UV-resistant and stays the same as long as there isn't a change in particle size due to growth or reduction of isolated nanoparticles.

CONCLUSION

The above review covers green synthesis and applications of silver nanoparticles. AgNPs have a wide range of potential applications in medicine, environment, cosmetics, textiles, food packaging, sensors, and so on, but their most preferred function is anti-inflammatory and antibacterial activity. This is being applied in various ways in the medical field. Although the uses of AgNPs are expected to expand in the future, their accumulation in the environment and long-term effects on humans and animals are still to be understood.

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