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Review on the Silver Oxide Nanoparticles

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Abstract*: The need for silver nanoparticles (AgNPs) is rising quickly in numerous industries, including medicine, pharmaceuticals, healthcare, food and beverage, consumer goods, cosmetics, etc. Owing to its numerous uses, including its antibacterial qualities, household, medical equipment, food industry, wound dressing, in diagnostic, orthopaedic, and as an anticancer agent, it has been utilised in a variety of settings. These nanoparticles are said to be special in nature and have the capacity to alter their physical, chemical, and biological properties, making them useful for a variety of applications. AgNPs can be prepared via physical, chemical, or biological methods. The biological method is the least complicated, environmentally friendly, and commercially viable of the three. It also requires the least amount of power, forceful exertion, and dangerous chemicals. It is crucial to describe the manufactured nanoparticles before using them for any purpose, including those related to medicine, human welfare, or the healthcare sector, in order to assess any potential safety concerns. AgNPs are analysed using a variety of analytical techniques, including UVVis spectroscopy, XRD, FTIR, DLS, XPS, SEM, TEM, and AFM. Applications for AgNPs include anticancer, antifungal, antibacterial, and other uses.*

Keywords: Biological, Silver Nanoparticles, Cancer, Diagnostic.

I. INTRODUCTION

Antibiotic properties. The recommended nanoparticle is Ag.because it is nontoxic to humans and possesses antibacterial properties. Antibacterial activity is defined as the removal of germs from the body or the slowing of their growth without harming neighbouring cells. Silver nanoparticles are created using a variety of techniques, including physical, chemical, and biological ones. The need for silver nanoparticles is rising quickly across a wide range of industries, including medicine, pharmaceuticals, healthcare, food, consumer goods, cosmetics, etc. These nanosized particles are found to be in unique in nature and are also able to change their physical, chemical, and biological properties, which is why they can be used in for various purposes. Due to its uses, it has been used for its numerous applications, including antibacterial properties, household, medical devices, and food industry, wound dressing, in diagnostic, orthopaedic, and a cancer agent.

To create these AgNP and meet the standards for AgNPs, a variety of approaches are used. Physical and chemical procedures are typically found to be expensive and harmful. Nevertheless, nanoparticles produced by biological methods have great yields, high solubilities, and good stability. Out of the three methods, the biological method has been found to be the simplest, most environmentally friendly, commercial, and one step method. It also doesn't require dangerous chemicals, high temperatures, or pressures.[3] For the synthesis of nanoparticles, various materials such as leaf extract, bark, roots, stems, and leaves are also used. Therefore, it is crucial to characterise these nanoparticles after they have been created since their physicochemical qualities may have a significant impact on their biological characteristics.

Before using nanoparticles for any purpose, such as medicine, human welfare, or the healthcare sector, it is crucial to characterise the previously created nanoparticles in order to assess potential safety concerns [3]. It is crucial to examine the distinctive characteristics of any nanomaterial, such as particle size, particle size distribution, shape, surface area, aggregation, solubility, etc., before determining its toxicity or biocompatibility.

The following analytical methods are utilised to analyse these AgNPs:

UVV is spectroscopy, XRD, FTIR, DLS, XPS, SEM, TEM, AFM, etc. [4] Creation of AgNPs having a predetermined structure, i.e. For various biomedical applications, uniformity in size, shape, and functionality is crucial. The physicochemical characteristics of the medicine can increase the bioavailability of any agent following systemic as well as localised administration of AgNP. [5] As we are all aware, cancer is a complex disease in which cells grow out of control for a variety of reasons, including a mix of genetic, internal, and environmental influences. It is commonly known that chemotherapy, surgery, radiation therapy, and targeted therapy are all used to treat cancer. Moreover, these treatments can be exceedingly painful and expensive. [6] As a result, it is important to find cancer treatments that are efficient, affordable, and sensitive. AgNPs have been discovered to be useful in the treatment of cancer as well as in the diagnosis of the disease. Aside from this, AgNPs also have uses in the fight against cancer, fungus, and bacteria.[7]

Silver Nanoparticle Synthesis

Physical and Chemical Techniques AS I have mentioned, there are three ways to make AgNPs: physically, chemically, and biologically. These nanoparticles are prepared in a physical approach using the evaporation condensation method with a tube boiler operating at room temperature. Pyrolysis and spark discharge were two prior methods that were employed to create the nanoparticles. This procedure is safe because it doesn't use any harmful chemicals, thus speed and radiation's usage as a reducing agent are additional benefits. Apart from this, other drawbacks include low yield, solvent contamination, high energy consumption, and occasionally uneven distribution.[8] In chemical procedures, AgNPs can be made using either water or many other organic solvents.

Metal precursors, reducing agents, and capping agents are the main 3 ingredients in this chemical reaction. In essence, the reduction of metal involves two phases, i.e., Nucleation and growth of subsequent.[9] AgNPs can be made using both "topdown" and "bottomup" methods. In the "topdown" approach, massive metals are mechanically ground with the aid of a colloidal protective agent, which results in stability. Chemical reduction, sonodecomposition, and electrochemical processes are all included in the second method, sometimes known as "bottomup" procedures. The key benefit of the chemical approach in this situation is the high yield, but the method's main drawback is its high initial cost. Second, the ingredients that are employed to create AgNPs via this chemical process are extremely poisonous and dangerous. [9]

Green Synthesis Methodology (Biological Method)

Green synthesis of silver nanoparticles is favoured because it is economical, environmentally friendly, and only requires one step and doesn't require dangerous chemicals, high temperatures, or pressures. For the synthesis of nanoparticles, various materials including leaf extracts, bark, roots, stems, leaves, fungus, etc. are employed. In addition, certain additional nanoparticles, including AgNP, are generated using small molecules, such as vitamins and amino acids, as an alternative to chemical processes [10]. According to numerous studies, these AgNPs are produced efficiently and without the use of any poisonous or dangerous substances. Different types of bacteria, such as Lactobacillus strains, Brevibacteriumcasei, Pseudomonas stutzeri, Escherichia coli, and fungi, such as Fusarium oxysporum et al., are used to make AgNPs. [11,12] The three main components of biological synthesis are solvent, reducing agent, and nontoxic material. The main benefit of the biological method is the availability of amino acids and proteins because in this ecofriendly material is used which is less toxic towards both the environment and humans. Synthesizing nano-particle of controlled size and shape is one of the most important requirements for preparation of nanoparticle. Further benefits of AgNPs include the availability of abundant materials, a low time commitment, stability, etc. Size and form of AgNPs are known to be the most crucial characteristics, as the biological activity of AgNPs solely depends on these two factors. [14] Small size nanoparticles are proven to be more effective and to have better qualities, according to the research.

Characterization

Monitoring the physiochemical characteristics is crucial for the safety and effectiveness of each nanoparticle. Thus, representation is crucial to checking or evaluating the functional characteristics and properties of produced nanoparticles. As I mentioned earlier, there are many techniques that are used for the characterization of these

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nanoparticles. These techniques include XRD, FTIR, DLS, UVVis spectroscopy, TEM, SEM, and XPS. With the use of these techniques, we are able to determine various characteristics of synthesised nanoparticles.[15] Techniques for characterization are shown in Figure 1. In this method, produced AgNPs can interact with the particular light wavelength. Because colloidal suspensions do not require calibration of the sample or the solution, this technique is found to be simple, reliable, sensitive, efficient, and selective in many nanoparticles. The Surface Plasmon Resonance (SPR) band, which is often caused by coupled fluctuation of AgNPs electrons in resonance with light wave, is a result of the free movement of electrons in AgNP due to the valence band and conduction band being discovered to be very close to each other in the studies. The size of the particles, the dielectric medium, and the chemical environment are the three key factors that affect how well AgNP is assimilated from the sample. By using SPR, the peak can be accurately attributed to particles of a size between 2 and 100 nm. [16]

Spectroscopy via Ray Diffraction (XRD)

Here, using this technique, one can investigate both molecular and crystalline structure, as well as determine quantitative movement in chemical species, degree of crystallinity, particle size, etc. XRD. With the aid of this XRD technique, it is possible to determine the structural characteristics of a wide variety of substances, including glasses, superconductors, inorganic catalysts, and polymers. [17] When light strikes a crystal, numerous diffraction patterns are created, and these patterns can then be used to reveal the physiochemical characteristics of the crystal's structure. When a powder specimen is used, the beams that are diffracted typically originate from the sample, allowing that beam to reflect the product's physiochemical structure.[17] Essentially, XRD is the principal technique to determine whether a product is crystalline. In addition to this, this technique is employed in many different scientific fields, including forensic science, environmental science, pharmaceutical science, and conducting qualitative analyses to identify structural flaws.[17] One drawback of this XRD method is that crystal growth can occasionally be challenging. This is the sole drawback of XRD. [17]

Involuntary Light Scattering (DLS)

Physiochemical parameters or the evaluation of manufactured nanoparticles is a crucial criterion for the investigation of biological activities utilising the radiation scattering approach. DLS can be used to estimate particle sizes ranging from submicron to one nanometer. Smaller particles can be easily recognised by this method because it can determine particles ranging from 2500 nm [18]. This method essentially depends on the interaction between light and particles. It is the method that is most frequently used to measure particle size and particle size distribution. DLS uses Rayleigh scattering, which occurs when nanoparticles are on the edge, to quantify the light that is dispersed from a laser that can travel through a colloid. The hydrodynamic size of the particles can then be determined by analysing the variation of the scattered light force that serves as a time purpose. It has been noted that the size obtained by DLS is better than that from TEM; Brownian motion may be the cause of this. This technique primarily assesses the size of particles in an aqueous solution. [18]

Ray Photoelectron Spectroscopy (XPS)

This XPS technique is used to estimate empirical formulae. Electron Spectroscopy for Chemical Analysis is another name for XPS (ESCA). High hoover is often the environment in which this approach is applied. We can locate, recognise, and characterise particular groups of macromolecules aromatic rings using the XPS technique. Also, it aids in providing access to information about qualitative, quantitative, and speciation that relates to the surface of sensory organs.[20]

Scanning Electron Microscopy (SEM) many approaches, including a number of electron microscopy techniques, are utilised to learn more about nanotechnology and nanosciences. SEM is one of them. SEM is a method that is fundamentally utilised to ascertain the particle morphology.

As SEM is a surface imaging technique, we can use it to analyse the surface morphology, particle size distribution, and forms of nanomaterials. We may determine the morphology of particles using SEM, and then we can either construct a histogram or count the number of particles manually or with the aid of other tools.

SEM is used in conjunction with EDX to analyse the chemical composition and determine the morphology of silver powder. [21] The disadvantage of SEM is that we are unable to determine the internal structure of the particle, but the benefit is that purity and the degree of particle aggregation can be determined using SEM. [22]

II. APPLICATIONS

From 5000 years ago, silver has been widely used for its antimicrobial properties. Ag is preferred as a nanoparticle because it is nontoxic to humans and possesses antibacterial properties. Antibacterial activity is defined as the removal of germs from the body or the slowing of their growth without harming neighbouring cells. In addition to their antibacterial properties, AgNPs are widely used for a variety of other purposes, such as antiviral activity, antifungal activity, anti-angiogenic activity, cosmetics, water treatment, health care, antioxidative, biosensing, anti-inflammatory, drug carrier, and textiles, among others.

Antimicrobial Action

Antibacterial activity is defined as either eradicating or slowing the growth of germs without damaging neighbouring cells. Ag is preferred as a nanoparticle because it is nontoxic to humans and possesses antibacterial properties. AgNPsare able to overcome the antibiotic resistance that has existed. Because of their large surfacetovolume ratio and crystallographic surface structure, AgNPs have been observed to have the potential to act as an antibacterial agent.[21] The ability of AgNPs to eradicate numerous drugresistant strains also supports this claim.[5] It has also been noted that Gramnegative bacteria exhibit more antibacterial activity than Grampositivebacteria.Those with weaker immune systems are more vulnerable to fungus infections.

The method of treating diseases caused by fungi is discovered to be quite laborious in nature. There are very few antiviral medications on the market today. [24] Antiviral medications ought to be biocompatible, nontoxic, and environmentally friendly. Biologically produced AgNPs shown effective antifungal efficacy against Bipolarissorokiniana by suppressing conidial germination. AgNPs are reported to be effective against various ailments that are brought on by fungi [7]. AgNPs also suppress indor fungal species, including those grown on agar media such as Penicillium brevicompactum, Aspergillus fumigatus, Cladosporium cladosporoides, Chaetomium globosum, Stachybotryschartaru, and Mortierella alpine.

An Anti-Inflammatory Effect

An injury or infection may cause inflammation, which is the condition in which a region of the body becomes swollen, red, hot, and occasionally painful. Moreover, it has been observed that inflammation produces an immune response that is hostile to some alien substances.

Although AgNPs have lesser anti-inflammatory effects compared to their antibacterial and anti-microbial activities, they nonetheless play a significant role in this anti-inflammatory field.

Cancer Prevention

Cancer is essentially an unchecked cell growth in a certain part of the body. One in three people worldwide are dealing with some form of cancer. For individuals with cancer, there are numerous therapies available, such as chemotherapy and radiation therapy, but they come with severe side effects and a painful procedure. It is commonly known that chemotherapy, surgery, radiation therapy, and targeted therapy are all used to treat cancer. Moreover, these treatments can be quite painful and expensive, so it is important to find cancer treatments that are efficient, affordable, and sensitive.

A number of researches have been conducted to learn more about the potential outcomes of AgNPs. It has been determined to be the most suited and a viable alternative to other cancer treatments. By encapsulating a therapeutic ingredient in a nanoparticle and using it as a medication delivery sysem, they can only target specific cells or tumours at that location.

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Microbiological Activity

V. alginolyticus and K. were unable to grow as a result of the AgNPs produced by the inflorescence of the Cocos nucifera. P. aeruginosa, B. pneumoniae, and C. P. shigelloides and P. subtilis. Microscopically, AgNPs' capacity to attach to bacterial cell walls has been demonstrated.

The most potent antidermatophytic activity and the biggest inhibition region were found in AgNPs produced using lemon peel extract. T. mentagrophytes as well as C. Compared to T, albicans had 3SD and.5SD activity, respectively. Rubrum. With diameters ranging from 78 to 98 nm, Ca salpiniacoriaria leaf extracts produced triangular, heagonal, and spherical A NPs that had stronger antibacterial activity against Escherichia coli (12 mm) and Pseudomonas aeruginosa (18 mm). The phytoconstituents capped on the produced AgNPs can start the production of reactive oxygen species and reduce the growth of hydrogen radicals, which can lead to apoptosis in C. albicans as well as S. Cerevisiae.[24]

III. CONCLUSION

As silver nanoparticles have so many applications across so many industries, they are now widely employed. In addition to its extensive usage as an antibacterial, AgNPs have a variety of other applications, including those for diagnostic and imaginative purposes, gene therapy, anti-viral, anti-inflammatory, and anti-fungal treatments. AgNPs is becoming a topic to research in instance.

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