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Synthesis of Silver Nanoparticles from Plant and Fruit Extracts- Summary on Research and Studies

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ABSTRACT

Nanoparticles can be synthesized by various methods such as gas condensation, attrition, chemical precipitation, pyrolysis and hydrothermal synthesis. These nanomaterials find application in paint and pigment industry, electrical equipments and chemical processing industries. The enhancement of heat transfer coefficient by nanofluids is also widely discussed and investigated research area. Carbon nanotubes are used in antenas. They also find application in selective removal of some pollutants by adsorption. The high surface to volume ratio makes them highly catalytic and reactive. Synthesis of the nanoparticles can be carried out by various physical, physic chemical and biological methods. Current review summarizes research and studies on synthesis of silver nanoparticles from plant extracts. Silver nanoparticles are finding importance because of wide range of applications due to unique optical, electrical, and thermal properties. High electrical conductivity, stability, and low sintering temperatures are some important features of nanoparticles.

Keywords: Capping Agents, Reducing Agents, Stability, Extract, Properties.

INTRODUCTION

Particles between 1 and 100 nanometers (nm) in size are termed as nanoparticles. It is postulated that the properties of materials change significantly, as their size approaches the nanoscale. As we know, for the particles larger than 1 micron, the percentage of the surface is insignificant in relation to the volume in the bulk of the material. The surface area gains significance when we talk about particles at nano level. Nonopartcles melt at much lower temperature. Nanoparticles can be synthesized by various methods like attrition, precipitation, pyrolysis, hydrothermal synthesis. These nanomaterials are finding increasing applications in paint and pigment industry, electrical equipments and chemical processing industries [1-4]. The enhancement of heat transfer coefficient by nanofluids is also widely discussed and

investigated research area [5-9]. Carbon nanotubes are used in antenas. They also find application in selective removal of some pollutants by adsorption[10,11]. The high surface to volume ratio makes them highly catalytic and reactive. Synthesis of the nanoparticles can be carried out by various physical, physic chemical and biological methods. Silver nanoparticles are finding importance because of wide range of applications due to their unique optical, electrical, and thermal properties. High electrical conductivity, stability, and low sintering temperatures are some important features of nanoparticles. Current review summarizes research and studies on synthesis of silver nanoparticles from plant extracts.

SYNTHESIS OF SILVER NANOPARTICLES FROM PLANT AND FRUIT EXTRACTS

Mohammadlou et.al. carried out an investigation on synthesis of silver nanoparticles from plants[12].Their investigation indicated that for synthesis of AgNPs, natural compounds that are present in plant extracts can act as both reducing and stabilizing agents. The natural capping agents such as proteins impart stability to AgNPs. Eco-friendliness, biocompatibility and cost-effectiveness are few advantages of synthesis of AgNP from plant extracts. Agrawal et.al. investigated synthesis of silver nanoparticles [13]. They used Azadirachta indica extract for synthesis of nanoparticles. In their work, they optimized parameters like temperature, size, and stirring conditions. They found that the carbonyl groups from the amino acid residues and proteins were responsible for binding of the metal ions.

Umoren et.al.carried out investigation on green synthesis and characterization of silver nanoparticles [14].They carried out investigation with red apple (malusdomestica) fruit extract at room temperature. The fruit extract acted as reducing and capping agents. The negative value of zeta potential indicated that the synthesized silver nanoparticles were stable at room temperature. Awed and Salem investigated synthesis of silver nanoparticles from mulberry leaves extract [15].Their analysis indicated that the silver nanoparticles formed by the reduction of Ag+ ions by the mulberry leaves extract were crystalline in nature. The main advantages of green chemistry are ease with which the process can be scaled up and economic viability. They claimed that their method for synthesis of nanoparticles was a fast, eco-friendly and convenient.Gavhane et.al used extract of neem leaf and triphala for extraction of silver nanoparticles [16]. They also evaluated their antibacterial activities. Their analysis indicated that the silver nanoparticles were predominantly spherical in nature. Their research also indicated that neem and triphala synthesized silver nanoparticles inhibited the growth of gentamycin and ampicillin resistant k. pneuomoniae.

Abubakar et.al.carried out investigation on black carrot root extract for synthesis of silver nanoparticles [17].They reiterated the advantages of green technology such as

cost-effectivity, energy-efficiency and easy methodology. Anjum et.al. carried out investigation on plant-mediated green synthesis of silver nanoparticles[18].They also discussed various aspects of mechanistic aspects involved in reduction and stabilization of AgNPs. ForAgNP synthesis, plant derived methods have advantages such as choices available, and the benefit of faster synthesis over other methods.Yamini et.al.carried out investigation on silver nanoparticle synthesis using cleome viscose [19]. They explained development of novel technologies. In this work, they described a cost effective and environment friendly technique for green synthesis. They used the extract of Cleome viscosa as reducing as well as capping agent.

Panigrahi and Zha carried out an investigation on synthesis and characterization of silver nanoparticles [20]. They used leaf extract of azadirachta indica.They observed more than 90% of reduction of Ag+ ions in 4 Hrs.They found that Azadirachta indica had better potential to reduce Ag ions into Ag nanoparticles than Acoruscalamus extract. Rath et.al.carried out review on development of reliable and eco-friendly process for synthesis of nanoparticles [21]. Silver nanoparticles are widely discussed and investigated due to physical, chemical and biological properties. Prathibha et.al.carried out investigation on used of fruit extracts of terminalia chebula retz. for synthesis of nanoparticles [22].They prepared the aqueous and methanolic fruit extracts. Change of the color of the solution from yellowish brown to dark brown confirmed formation of nanoparticles. Compared to methanolic and aqueous extracts, they found that the aqueous extract containing silver nanoparticles was more resistant to all the microorganisms. An investigation was carried out by Christopher et.al. for biosynthesis of silver nanoparticles using leaf extract [23]. They used leaf extract of Aeglemarmelos.They obtained the maximum silver nanoparticle synthesis at 2:1 ratio.6 mM silver nitrate and pH 6 indicated highest peak.

Hazarika et.al. carried out investigation on phytochemical screening and synthesis of silver nanoparticles [24]. They used leaf extract of rhynchotechum ellipticum.To find the presence of various phytochemicals, they investigated the hexane and ethanol extracts of the leaves. They concluded that ethanol extract of the plant was a very good bioreductant for the synthesis of silver nanoparticles. Christensen et.al.carried investigation on biosynthesis of silver nanoparticles using Murraya koenigii leaf extract [25]. Also they reported the effect of broth concentration in reduction mechanism and particle size. Their analysis indicated that the nanoparticles were crystalline in nature. They also observed that the rate of reduction increased with increasing broth concentration. There was decrease in particle size with broth concentration. Mittal et.al. reviewed the metalic nanoparticle synthesis by using plants[26]. These nanoparticles are free from the toxic contaminants and hence are suitable for therapeutic applications. Also this type of synthesis provides a controlled size and

morphology.Shivashankar and Sisodia used inexpensive and ecofriendly method for silver nanoparticles[27]. They employed reaction of biomass of aqueous extracts from plants with aqueous solutions of silver nitrate to obtain silver nanoparticles.

Lalitha et.al. investigated synthesis of silver nanoparticles from leaf extract Azhadirachta indica[28].They used Azhadirachta indica as reducing as well as capping agent.This research again emphasized importance of plant derived nanoparticle synthesis.Gebru et.al. used castor oil (ricinuscommunis), khat (cathaedulis) and sun flower (helianthus annuus)leaf extracts as reducing and stabilizing agents for synthesis of silver nanoparticles[29]. The analysis indicated nanoparticles were face centred cubic structures with crystalline nature. These nanoparticles exhibit antimicrobial activity against two pathogenic bacteria: gram-negative escherichia coli and gram-positive staphylococcus aureus. Indhumathi and Rajathi carried out investigation on silver nanoparticles from the leaves of Murraya koengi[30].Their studies indicated that the silver nanoparticles obtained from plant extracts had highest activity against Trichoderma and Rhizopus.

An investigation was carried out by David et.al. on biosynthesis of silver nanoparticles using Momordica charantia leaf extract[31].According to them, eco-friendliness and compatibility for pharmaceutical and other biomedical applications are major advantages of this method. According to them, the reduction and stabilization was caused by the phenolic compounds present in Momordica charantia leaf extract. These silver nanoparticles exhibit strong antibacterial activity against Kelbsilla pneumonia bacteria. Jayapriya and Lalitha carried out an investigation on the synthesis of silver nanoparticles using aqueous Ocimumbasilicum(L.)[32]. They used UV-Spectroscopy (UV-Vis), Scanning Electron Microscopy (SEM), X- Ray Diffraction Spectroscopy (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) for analysis of synthesized nanoparticles. Their research indicated that sonication method was able to synthesize the nanoparticles rapidly and easily.Praba et.al.carried out investigation on silver nanoparticles synthesis using ficus microcarpa leaf extract[33].They used aqueous extracts made from the leaves of Ficus microcarpaas reducing agents.

Investigations were carried out by Song and Kim for fast and environment friendly synthesis of silver nanoparticles[34]. They used extracts of five leaves namely pine, persimmon, ginkgo, magnolia and platan us and carried out comparative studies for the extracellular synthesis of metallic silver nanoparticles. For the quantitative formation of silver nanoparticles, they used UV-visible spectroscopy. Among the leaves used, they found that Magnolia leaf broth was the best reducing agent. Similar research on synthesis of nanoparticles was carried out by Ahmad and Sharma[35].They used Ultraviolet-Visible (UV-vis) Spectrometer, Energy Dispersive X-ray Analysis (EDAX), Selected Area Diffraction Pattern (SAED)

and High Resolution Transmission Electron Microscopy (HRTEM) for analysis. The analysis confirmed crystalline structure of nanoparticles.

An investigation was carried out by Prasad and Venkateswarlu on silver nanoparticles synthesis using soybean seeds extract[36]. They carried out an investigation with different concentration of soyabean seed extract, same metal ion concentration and different reaction time on. The characterization of nanoparticles was carried out by UV-vis transmission electron microscopy (TEM), X-ray diffraction (XRD) and FTIR analysis.Habibi et.al. have used the aqueous extract of Prangos ferulaceae leaves for extraction of silver nanoparticles [37].According to them, hydroxyl functional group such as flavanoids, proteins and coumarins are responsible for the reduction and stabilization of silver nanoparticles. They also observed that silver nanoparticles were stable at room temperature. Many investigations are reported on green synthesis of silver nanoparticles [38-43]. These investigations have reported investigation on silver nanoparticles by using plant extracts. Also many of them involved characterization studies[44-47]. Many investigators have studied application of nanoparticles along with synthesis[48-50]. Most of these studies indicated that green synthesis has advantages such as cost, environmental friendliness and ease of operation. It is also fast and energy efficient. The silver nanoparticles were shown to be antibacterial, antifungal and resistant to few infectants and micro organisms.

CONCLUSION

Nanomaterials are used in paint and pigment industry, electrical equipments and chemical processing industries. The enhancement of heat transfer coefficient by nanofluids is also widely discussed and investigated research area. Carbon nanotubes are used in antenas.They also find application in selective removal of some pollutants by adsorption. Most of the studies indicated that green synthesis indicated advantages such as cost, environmental friendliness and ease of operation. It is also fast and energy efficient. The silver nanoparticles were shown to be antibacterial, antifungal and resistant to few infectants and micro organisms. Studies indicate that eco-friendliness and compatibility for pharmaceutical and other biomedical applications are major advantages of this method.

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