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Green Synthesis of Gold and Silver Nanoparticles.

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ABSTRACT

Nanotechnology deals with the Nanoparticles having a size of 1-100 nm in one dimension. Nowadays nanoparticles have been used commercially for a wide variety of applications which includes diverse areas such as electronics energy catalysis and medicines. Gold and silver nanoparticles plays major role in the commercial applications of these nanoparticles in the field of pharmaceuticals and other medical sciences. The use of green chemistry involving plant extract and microbes is environmental friendly non-toxic and cheap. This chapter reviews the synthesis of gold and silver nanoparticles using medicinal plants bacteria fungi and algae as source for bioreduction of these metal ions.

Keywords: Green synthesis Gold nano particle (AuNPs) plant extract spices extract.

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INTRODUCTION

Nanotechnology deals with the synthesis designing of particles with dimension smaller than 100nm.The field of nanotechnology had emerged as one of the most up thrust areas of research in the modern field of material science. Nanoparticles can be broadly classified into organic nanoparticles which include carbon nanoparticles, inorganic nanoparticles include magnetic nanoparticles metal nanoparticles which includes gold and silver nanoparticles and semi-conductor nanoparticles (like titanium oxide and zinc oxide).Nanotechnology application holds greater promise for providing benefit to society in the realm of medicine. Nanotechnology provides efficient tools for drug manufacturing drug delivery and medical diagnostics. Self-assembling gold or silver nano-scale vesicles can provide key to targeted drug delivery. In the field of diagnostics methods of cancer detection based on nanoparticles by using them as contrast agents and fluorescent materials.

Why Green Chemistry?

Previously the chemicals which were used for nanoparticles synthesis were mostly toxic and lead to by-products which are harmful to ecosystem. Green synthesis gives advantage over chemical and physical method in terms of its cost effectiveness environment friendly and can be easily scaled up to large scale industrial level. Green chemistry has the ability to revolutionize drug delivery methods which are more effective less toxic and could benefit millions of patients throughout the world. A conventional method of coating drugs normally uses high temperatures high pressure energy and harsh solvents which can destroy up to fifty per cent of the molecule. This damages the active components of medicine before reaching to the patient. By using green synthesis the bioactive elements of the drug remains to be completely effective. In this technique drug particles are wrapped up in biodegradable polymer once taken in the body the polymer dissolve and the drug get released and enters the blood stream. Nanotechnology is a field of science being still under development and has a big influence on the industry from several years. Investment in its development values annually several billion dollars worldwide being equally supported by the governments and the corporates.

Gold Nanoparticles

The unique optical electronic and plasmon resonance properties of gold nanoparticles are being exploited in the field modern nantechnology. Nowadays there is a huge demand for gold nanoparticles based products because of their wide applications in areas such as electronics catalysis chemistry energy and medicine. It has been used to connect resistors conductors and other elements of an electronic chip. Gold nanoparticles produce heat when excited by light at wavelength of 700 nm. In a process called as hyperthermia therapy light is applied to a tumour with gold nanoparticles. The particles heats up and kills the tumour cells. **G**old nanoparticles can be used as probes for transmission electron microscopy as biomarkers in the diagnosis of heart diseases cancers and infectious agents for fuel cell applications. AuNPs have important function in the delivery of nucleic acids proteins gene therapy *in vivo* delivery targeting and conditions for example aggressive agents like sodium. Gold nanoparticles produced by using phytochemicals or other extract components remain stable for certain time and can be exploited for a variety of pharmaceutical purpose.

Silver Nanoparticles

The medicinal properties of silver had been known from thousands of years. Silver holds 47th position in periodic table and very ductile and malleable. Silver products have strong inhibitory and antimicrobial activities which has been exploited for centuries against various diseases and infections (Shankar et al. 2004). Silver nanoparticles had been used so far in a variety of applications. Normally it is used for intercalation material in electrical batteries as a coating for solar energy absorption as a catalyst bio labelling etc. Silver nanoparticles possess anti-fungal (Wiley 2006; [39] anti-inflammatory [35] anti-viral [34] anti-angiogenesis [40] and antiplatelet activity (Gurunathan et al.2009).

Reduction of Metal Ions by Microbes

There have been several research conducted where microbes have shown the ability to reduce metal ions to the nanoparticles. [27] 1Studied the formation of silver nanoparticles by various bacteria

(*Pseudomonas stulzeri Escherichia coli Vibrio cholerae Pseudomonas aeruginosa Salmonells typlus Staphylococcus currens* and by photoautotrophic cyanobacterium *Plectonema boryanum.* Silver nanoparticles were synthesized by using the supernatant of *Bacillus licheniformis, Klebsiella pneumonia* [28] , [30] *Aspergillus niger* [41], [42]. Similar reports were observed for bio-reduction of gold ions by Prokaryotic bacteria *Rhodopseudomans capsulate* [16] *Shewanella algae[23]* strains of *Pseudomonas aerruginosa* [17] *Bacillus licheniformis* [18] *Sargassum wightii* [48] *Thermomonos* [44]. The bio synthesis of silver and gold nanoparticles has been achieved with the fungus *Fusarium oxysporum* [2]. Silver nanoparticles had been synthesized using different fungal strains *Penicillium brevicompactum* WA 2315 (Shaligram et al.2009) *Fusarium semitectum* [7] *Penicillium fellutanum* [21] *Cladosporium cladosporioides* [6] *Trichothecium* sp [1] Silver mine- inhabiting *Pseudomonas* sp(Joerger et al.2000) *Aspergillus fumigatus* [9] . Edible mushroom *Volvariella volvacea* was used for the synthesis of metal nanoparticles [36]. Nano-crystals of gold and silver have been synthesized using lactic acid bacteria [33].

Plant Extracts for Synthesis of Nanoparticles

Nature is a very rich wealth of crude extracts from leaves and tissues of diverse species from plant kingdom. Recently vegetal active substances plant tissues or fruits have been used in nanoparticles synthesis as well. Plants are a big source of various therapeutic compounds which have been exploited from so many years in the field of medicine. In the past few decades there has been tremendous growth in the field of herbal medicine because of their natural origin with minimum side effect. The use of nanotechnology in field of medicine results in targeted and specific drug delivery with minimum of toxicity and still maintaining good therapeutic effects. The world health organization (WHO) has listed 21000 plants used for medicinal purpose. Extracts from plants usually contain various polyphenols such as flavonoids which may prove to be excellent reducing agents useful for the synthesis of silver and gold nanoparticles. These newly synthesized nanoparticles were characterized by electron microscopy (TEM) UV-Vis spectroscopy X diffraction (XRD) energy dispersive X-ray (EDX) and Fourier transform infrared spectroscopy (FTIR). The first report of the synthesis of gold and silver nanoparticles from plant extract is attributed to *Medicago sativa* (alfalfa). *Chenopodium album* is an obnoxious weed and reported to have antifungal and antioxidant properties so the aqueous leaf extract from this plant had been used for preparation of 10-30 nm silver and gold nanoparticles which can be applied for a variety of applications [12]. *S*ilver nanoparticles biosynthesis was conducted using *Cycas* leaf extract (Jha and Prasad 2009)by using the latex of *Jatropha curcas* (Bar et al.2009) bark powder *Cynnamn zeylanicum* [43] *Mentha piperita* . Extracellular synthesis of gold nanoparticles was achieved using the leaf extracts of two plants *Magnolia kobus* and *Diopyros kaki* [49]. Parashar introduced the synthesis of silver nanoparticles using Parthenium leaf extract. [45]synthesized silver nanoparticles using *in vitro* cultures of *Brassica juncea*. There are numerous reports about used of various plants with medicinal properties given in Table-1 for the reduction of metal ions.

CONCLUSIONS

Biosynthesis of nanoparticles shows a beautiful intersection between nanotechnology biotechnology and physical chemistry. This technology had gained so much attention nowadays due to growing demand of environmental friendly technology for material synthesis. Till date different species of microorganisms such as bacteria fungi and yeast have been explored for synthesis of nanoparticles. Plants mediated nanoparticle synthesis has become a subject of interest across the globe with various plant species being explored and evaluated for synthesizing of nanoparticles. Nanoparticles synthesized via plants have been used for both industrial and pharmaceutical benefits for human being. Additional research in this area can further increase the potential in biosynthesis of nanoparticles.

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Table 1: Table showing preparation of gold and silver nanoparticles using extracts of medicinally important plants

Plant name	Gold/Silver	Medicinal properties	References
Aloe vera	Gold/silver	Good healing properties anti-inflammatory used as laxative antiviral and antitumor activity moisturizing and anti-aging effect antioxidative antipyretics antiseptic effect	[10], [37]
Neem(Azadirachta)	Silver/Gold	To control leprosy intestinal helminthiasis treat respiratory disorders constipation rheumatism chronic syphilitic sores and indolent ulcer skin infections cure blood morbidity.	[47]
Avena sativa	Gold	Traditionally used as nerve tonic-in cases of nervous exhaustion depression insomnia used for treatment of osteoporosis and high blood pressure helpful in cases of depression menopausal symptoms calm hyperactive children used as a natural aphrodisiac increasing the excitability of muscles. Used externally in treatment of eczema acne and dry skin.	[3]
Alfalfa	Gold	Diuretic slightly laxative in nature help in regulating the bowel movements treating heart diseases and other arterial problems effective in treating respiratory discomfort and disorders	[15]
Lemongrass	Gold	Anti-pyretic relives pain antioxidant normalize cholesterol levels. Treats gastro-enteritis and relieves constipation.	[46]
Olive	Silver	Treating fever and malaraia antioxidant ntinflammatory Olive extract inhibit cell to cell transmission of HIV1	[16],[22], [31]
Bauhinia tomentosa	Gold	Leaves exhibited cytotoxic and antioxidant activity while flowers were found to possess antihyperglycemic and antilipidemic activity	[32]
Gymnema sylvestre (GS)	gold	To treat diabetes mellitus lowers blood sugar stimulates the heart uterus and circulatory systems and exhibit hepatoprotective activities	[5]
Mucuna pruriens	Gold	Nerve tonic. possible role to treat Parkinson's disease	[4]
Zingiber officinale	Gold	Anti-platelet agent with anti-inflammatory and analgesic properties	[25]
Mirabilis jalapa	Gold	Roots are aphrodisiac diuretic and purgative used for treatment of dropsy treat scabies and muscular swellings diarrhoea indigestion and fevers	[51]
Stevia rebaudiana	Gold	For treatment against cancer diabetes obesity cavities hypertension fatigue depression infection. hypoglycemic hypotensive vasodilating taste improving sweetening anti-fungal anti-viral anti-inflammatory and anti-bacterial properties	[29]
Perilla frutescens leaf extract	Gold/Silver	Anti-inflammatory benefits that reduce allergy symptoms may convey anti-cancer benefits which is useful for managing autoimmune conditions such as rheumatoid arthritis lupus and asthma.	[8]
Murraya Koenigii	Silver	leaves has glycemic lipidemic antioxidant antimicrobial and free radical scavenging activities	[11]
Tagetes erecta	gold	treat stomach ache parasites diarrhea liver illnesses vomiting indigestion and toothache relieves chest pain reduces the anxiety purifies blood heals wounds relieving Rheumatic pains cold bronchitis ulcer disease of the eyes and uterus.	[24]
Memecylon umbellatum	Silver/Gold	astringent antispasmodic antitumor neuroleptic activities to treat leucorrhoea and gonorrhea	[19]
Garcinia mangostana	Silver	anti-inflammatory antioxidant anti-proliferate immunostimulatory antiplasmodial antibacterial activity	[20] [53]
Coleus aromaticus	Silver	Malarial fever hepathopathy renal and vasical calculi cough chronic asthma hiccough bronchititis antiheminithic colic and convulsions	[52]
Hibiscus rosa-sinensis	Gold	Anti-infectious anthelmintic anti-inflammatory diuretic antipyretic the young leaves and flowers are used in inducing abortion and as a cure for headache.	[54]
Toona ciliata	Gold	Antioxidant antipyretic hypoglycaemic antimicrobial antiulcer antitumor and cytoyoxic effect	[38]
Trianthema decandra	Gold/silver	Antioxidant and antimicrobial properties	[14]
Arnebia nobilis	Silver	Wound healing properties	[13]
Syzygium Cumini	Gold	Ant inflammatory activity used to treat anemia Seed extract helps to lower blood pressure reduces blood sugar level quickly leave juice is used for gingivitis	[50]

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