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Green Nanoparticles: A review

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ABSTRACT

Recent years a nanoparticle have gained significant importance to applying by Green synthesis and has become one of the most specific methods. Green synthesis of nanoparticle is a new branch of nanotechnology. Since long time Indian have used herbal drugs because impactful and lesser side effect which is safe for human body. Over hundreds of years herbal medicines are manufactured on large scale for therapelitic adventure India is sitting on a gold mine of well recorded and traditionally like Ayurveda, Yoga, Unani, Siddha, Homeopathy, Naturopathy etc. In ayurveda medicinal plants are playing significant role since ancient time. Medicinal plant parts and plant products are very inexpensive source of Indian ayurvedic medicines. Different plants and their products are the most dapper regimentations of research and contemporary materials as nanoparticles in nanobiotechnology. This green synthesis method is alternative to chemical methods, since it is cheap, pollutant free and eco-friendly. The Nanoparticles (Nps) are generally less than 100nm. The study of objects less than 100 nms is called nanotechnology. Nanoparticles are glorious mineral materials of silver, platinum and gold. Gold, silver and platinum are well accredited as NPs and have significant application in optoelectronic, electronics, magnetic and information storage. Nps creates interest of the research due to its effect on chemical, electronics, energy, space industries and drug industries. Nanotechnology also includes to the characterization, manufacture, manipulative uses of Nanoparticles. Nanotechnology provides a new field for material science. Nanoparticles occupy importance due to its small size, chemical, physical and biological properties. Recently metal nanoparticles are in scientific news due to their diversified applications in various areas. The most importantly they are used in biomedical areas like targeted drug delivery, imaging, sensing and antimicrobial activity.

Key words: *AgNPs, CuNPs, and CdsNPs nanoparticles, Green synthesis, Herbal plants and antibacterial activity*

Introduction

Now-a-days Nps are synthesize by various techniques out of which chemical methods lithography and laser ablation are very expensive, time consuming and not good for environment. The different plants have potential of for agglutination of Nanoparticles which suggest scientist and technologist to use plants and its products for the synthesis of Nanoparticles. The presence of enzymes, phytochemical, protein and other components are commonly use in the synthesis of silver Nanoparticles by plant extracts (Kulkarni *et al*., 2011).

Nanoparticles have high surface area to division ratio. Nanoparticles like that cadmium sulphide, zinc sulphide, gold and zinc oxide and silver reported to played vital role in various zone(Malarkod *et al*., 2014).

Plant-derived biological synthesis of nanoparticles is obtaining importance due to its eco-friendly nature. Biosynthesis of gold nanoparticles from plants like *Tamarinds indica* (Kantak and Gogate, 1992), *Cinnamomum camphora* (Singh *et al.,* 1996), *Lemongrass* (Sharma *et al*., 2003), *Alfaalfa* (Shetty *et al*., 2006), *Embicaofficinal's* (Sood*et al*., 2006), *Aloe vera* (Gupta *et al*., 2006) and *Azadirachta*

indica (Samjon *et al*., 2007) have been documented using the plants and plant products as biological agent for the synthesis of nanoparticles.

Plant based drugs or medicines in practice of the treatment of Parkinsonism, diseases cardiovascular diseases, pulmonary diseases, Alzheimer's disease, cancer therapy, diabetes and anti-osteoporosis, Development, Design and synthesis of plant herbal Nanoparticles has become a leading part of research in the area of nano formulation. Presently nanoparticles are widely developed to increase its bioavailability and for treatment of cancers (lung cancer, Brest cancer, Pancreatic cancer). The common nano formulated herbal drugs are developed form *Curcuma longa, Panax ginseng, Withania somnifera, Silybum marianum, Salvia miltiorrhiza,* and *Gymnema sylvestris* (Jadhav *et al.*, 2014).

Microbial organisms develop resistant to various antibiotics and other treatment methods which is one of the major problems in the health care industry. Scientists are looking to develop new, affective antimicrobial drugs which are free of counteraction on one side and cost effective on the other side. Use of herbaceous nanoparticle-based to medicine motivate microbial counteraction than antibiotics (Nagarajan and Rajagopalan, 2008). Herbal nanoparticles proved antibacterial efficacy and cytotoxicity of nanoparticles towards human cells before proposing their therapeutic use (Bhattacharya and Rajinder, 2005).

Green chemistry is biological synthesis of Nanoparticles and interconnects nanotechnology and biotechnology. Biosynthesis of silver, gold, gold-silver alloy, tellurium, selenium, platinum, silica, palladium, titania, ziroconia, quantum dots, magnetite and uraninite nanoparticles by phototrophic eukaryotes such as plants and plant products have been reported by (Gardea *et al.,* 1999). Biological nanoparticles are non-monodispersed, despite the stability and the rate of synthesis is very slow. Various phytochemicals are present in plants and in their parts are already used in various fields. These phytochemicals are playing effective significant role in the nanoparticles synthesis (Shankar *et al.,* 2003). Some phytochemicals compounds used in synthesis of silver nanoparticles are supposed to be metabolic fluxes and some other are oxidoreductively labile metabolites like acerbates or catechol/photocatacheuic acid (Jha *et al.,* 2009) few are stabile polyhydroxy components namely alkaloids flavonoids, and polysaccharose (Lin *et al.,* 2010) metabolites (like organic acids and quinones) or, verbascoside, is overbascoside, luteolin and chrysoeriol-7-O-diglucuronide (Cruz *et al*., 2010) proteins/enzymes and secondary metabolites such as terpenoidsquercetin and other phenolic compounds (Lukman *et al.*, 2011).

Microorganism in biological synthesis of nanoparticle from enzymes, fungus and plants or plant extracts and reported that there are possible alternatives are eco-friendly in comparison physical and chemical methods. Plants or their parts are used in biological synthesis of Nanoparticles and are advantageous in biological method by eliminating the elaborate processes of maintaining microbial cultures (Klaus *et al.*, 1999).

Related Work

Various natural processes are applied in the synthesis of Nano scaled inorganic materials. Probably less concerned explored area of research as for as biosynthesis of nonmaterial's. The bacteria, plant leaf extract, fungi and enzyme are used in the synthesis of nanoparticle which provide many benefits, as this method not using toxic chemical, it is eco-friendly and well-suited for pharmaceutical and other biomedical applications. Green synthesis methods are proven environment friendly, cost effective, easily scaled up for large scales synthesis and better than chemical and physical methods without using energy, high pressure, toxic chemicals and temperature (Ahmad *et al.,* 2011).

Herbal contents are many comprising of effective amount of *Glycyrrhizauralensis, Ziziphus jujube, Scutellariabaicalensis,* and *Paeonialactiflora* with a chemotherapeutic compound which is useful to treat cancer in mammals. It helps in increasing the therapeutic index of chemotherapeutic compound by administering the PHY906 herbal composition to mammals in chemotherapy, by intravenous route, to improve the treatment of disease (Braydich-Stolle *et al.,* 2005).

The five plant leaf extracts (*Pine, Persimmon, Ginkgo, Magnolia* and *Platanus*) were used for extracellular synthesis of metallic AgNPs. There leaf extracts were reducing agents of Ag^{+} to Agˆ and stable Ag NPs were formed by treating aqueous solution of $AgNO_3$. Best reducing agent in terms of synthesis rate and conversion to Ag NPs found in Magnolia leaf broth as compared to other plants (Liu *et al.*, 2013).

Plants have their antioxidant properties and are

capable of reducing metal compounds in their respective nanoparticle. Plant extracts were found producing best capping material for the stabilization of silver nanoparticles.state thatsynthesis of gold and silver Nanoparticles from different plants and plants products is advantageous (Ahmed *et al.,* 2015).

Nanoparticles are synthesized by plant extracts, that times required for conversion of Ag+ and Ag3+ ions to Ag Au Nanoparticles were many hours. This was much time consumed than those of chemical synthesis. Biological synthesis of Nanoparticles competes with chemical methods; there is a required to achieve faster synthesis (Song *et al.,* 2006).

Synthesis and characterization of silver nanoparticles via green route. They reported that synthesis of metal nanoparticles by development of competent green chemistry methods. The green synthesis of silver nanoparticles (AgNps) was done by reduction of silver nitrate, using leaf broth of *Azadirakta indica* (Neem). At 30 °C the plant leaf broth simultaneously acts as capping agent as well as reducing agent. Structure of dispersed silver nanoparticles was studied on the basis of effect of different concentration of silver ions, percentage of leaf broth and temperature. The purity and characterization of silver nanoparticles was done by UV-Visible, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) and analysis revealed that Fourier transform infrared (FTIR). They confirmed green route is simple, rapid, cost effective, eco-friendly and alternative conventional physical/chemical methods (Nager *et al.,* 2016).

Biological synthesis of stable copper Nanoparticles by plant leaf extract. Conditions like as leaf broth concentration, reaction temperature, $CuSo_4 5H_2O$, particle size of the copper Nanoparticles, concentration on synthesis rate and antibacterial test of the copper Nanoparticles by latex coating from product (Lee *et al.,* 2014).

Nanoparticles like gold, zinc oxide, silver etcare synthesis *from Azadirachta indica* leaf extract. Phytochemicals present in Neem are terpenoids and flavanones, which proved as capping as well as reducing agent. It also helps in stabilizing the nanoprticles. The synthesized Nanoparticles were capped by neem extract and exhibited enhanced antibacterial activity. Silver Nanoparticles were towed most effective against microorganism like virus, bacteria and other eukaryotic at low amount without any side effects andtoxicity to humans. The silver and silver Nanoparticles are part of tropical ointment to prevent infection against burns and open wounds (Morones *et al.,* 2005).

AgNps penetrate the cell wall of Gram-negative bacteria. They are capable of producing structural changes in the cell membrane and caused an increase in cell permeability, leading to an uncontrolled transport through the cytoplasmic membrane, and ultimately caused cell death. Antibacterial activity of silver Nanoparticles is too related with the formation of free radicals which finally free induced membrane damage (Hutchison, 2008).

Silver nanoparticles showed fungicidal and bactericidal activity Antimicrobial effect may be due to alterations of microbial DNA, blockage of respiratory enzyme pathways and the cell wall damage. Silver Nanoparticles are exhibits inhibitory effect on microbes found in the medical and industrial process (Vivekanandhan *et al.,* 2010). Synthesis of silver and gold nanoparticles form *Murrayakoenigii* leaf extract. Curry leafsa wellspice is used in traditional Ayurveda medicine. Curry leaf which has high concentration of carbazoles which establish it as potent antioxidant (Esam *et al.,* 2015).

Silver and silver Nanoparticles have a wide application in medicine certain creams containing silver to prevent infection of burns, and open wounds. In textile industry, silver-embedded fabrics are now used in sporting equipment. Medical devices and implants prepared with silver-impregnated polymers (Shobha *et al.,* 2014).

Antibacterial effects of silver have been known ancient time and Ag is Presently applied to control bacterial growth in a variety of applications, catheters, including dental work and burn wounds. Onion (*Allium cepa*) extract was used for the synthesis of silver Nanoparticles and they observed it as antibacterial against many human pathogenic bacteria (Chen *et al.,* 2014).

Copper Nanoparticles synthesized by electrolysis method showing more antibacterial activities) than copper nanoparticles synthesized by chemical reduction methods. Cu nanoparticles synthesized by electrolysis method. They showed antibacterial activities against both gram (-) and gram (+) bacteria. Enhance its antibacterial activities by Changes in surface Area to Volume Ratio of Cu. Increased the antibacterial activities of copper nanoparticles by using electrical power while they are synthesizing (Raveendran *et al.,* 2003).

Copper nanocrystals are applied as in the inter-

connect for micro, a textiles industry, anti-microbial, plastics, in copper diet supplements, in super strong metals, integrated circuits for its ability to absorb radioactive caesium, alloys, in nanowire, nanofiber, catalyst applications and in certain alloy. Many farther researches is being done at many stages for their dielectric, magnetic, potential electrical, catalytic, optical, imaging, bioscience and biomedical properties (Thakkar *et al.,* 2010).

Generally, Cu nanoparticles are immediately available in most volumes. Scientist has also recommended the silver and copper ions for use as superior disinfectants for wastewater generated from hospitals containing infectious microorganism. Antibacterial activity of cu nanoparticle, it was observing that it has posse's significant potency to act as bactericidal agent than silver, gold, zinc, nano particles. Combination of silver and copper nano particles may show more significant effect on bacterial growth. Gram (+) bacteria has a thick cell wall and containing different stratum of peptidoglycan, as long as Gram (-) a bacterium has a slender cell wall consisting of a single stratum of peptidoglycan. Copper nano particles interact straight with the bacterial cell wall and outer membranes and leads to damage of cell wall and destroy the bacteria **(**Theivasanthi *et al.,* 2011).

Copper nanoparticles showed the superior antibacterial activity compared to the silver Nanoparticles, when the silver and copper Nanoparticles using against *Escherichia coli* and *Bacillus subtilis.* Copper and silver Nanoparticles supported on many suitable materials, such as polyurethane foam, polymers, carbon, and sepiolite have also used for been effectively bactericidal applications (Sandhir and Singhal, 2015).

Cu Nps are potentially attractive which may be due to their electrical, good optical and thermal properties, use as sensors, superior strength, catalysts and its bactericidal effect as antifungal and antimicrobial agents. Bio nanotechnology is a combination of biological principles with physical and chemical approaches for produces nano-sized particles with specific purpose. Cu Nps for agriculture has fascinated the researches in the arena of nanotechnology. The use of nanoparticles in agriculture has been predominantly theoretical, show effective antibacterial activities. This leads to the development of intensively clean, cost-effective and efficient biosynthesis techniques of Cu Nps. The biosynthesized Cu nanoparticles has been applied and studied on some plant species at their very early growth stages (Amalray and Gopi, 2017).

Copper nanoparticles is highly toxic to microorganisms such as bacteria (*Pseudomonas aeruginosa, E.coli* and *Staphylococcus aureus*) and it is non-toxic to animal cells, due to which it is used as an effective bactericidal metal. Copper nanoparticles are also considered safe for human beings such as food package and in water treatment. Cu Nps are attracts many researches due to its lower cost compared to noble metals like as Au, Ag and Pt (Pragyan *et al.,* 2017).

Biosynthesis of cadmium sulphide Nanoparticles (CdS NPs) from plant extracts. Quantum size effectoccurs when the crystallite diameter is comparable to or below then 5-6nm. There is variety of chemical or biological methods are used for the synthesis of these CdS NPs. In the chemical methods cannot remove the addition of toxic chemicals an irresistible demand for producing environmentally friendly processes for Nanoparticles synthesis (Starika *et al.,* 2017). Biological synthesis methods nanoparticle synthesized by using either plant extracts or microbes are performed at ambient temperature and environmentally friendly, provide reliable and less toxic alternatives too their approaches.

Previously, the production of metallic nanoparticles by chemical reducing agents such as sodium citrate, hydrazine and sodium borohydride to create uniform suspensions.Chemical methods are very harmful in many ways as the chemicals are flammable, toxic, low synthesis rate etc. In present time biological green synthesis of nano particals is applied to improve quality and also to protect the environment.Three important factors suggested which should be involved for the synthesis of nano particales the use of reducing agent, solvent choice and the use of non-toxic material for nanoparticles stabilization. Presently biological synthesis entities are serving as both stabilizing and reducing agents for green synthesis of metallic nanoparticles. Nanoparticles containing antimicrobial and antioxidant substances could be considered as a new trend of antimicrobial therapeutic agents for the prevention and reduction of deterioration of food and pathogenic microorganisms (Ahmad *et al.,* 2011).

Green synthesis of silver nanoparticles by *Azadirachta indica* leaf extract and studied its antimicrobial activity. The terpenoids and flavonoids are present in the extract act as both capping agent and

reducing. Microbes (Gram-positive bacteriaand *Escherichia coli*) were isolated from bore well water using selective media. The silver nanoparticles showed antimicrobial activities against Gram-positive bacteriaand *Escherichia coli*. Silver nanoparticles were found more effective against *Escherichia coli* as compare to Gram-positive bacteria. DLS and UV–visible spectrophotometer techniques were used to characterization of synthesized silver nanoparticles (Gardea *et al.,* 1999).

Garlic has antifungal, antibacterial, antiviral antiparasitic, anticancerous, antioxidant and vasodilators ability which attract to carry research over this vegetable. Garlic (*Allium sativum*), belong tothe family Alliaceae, order of plant liliales. This is grown for its flavourful bulbs. The medicinal properties of garlic have been attributed due to presence of many significant phytochemicals such as allinin, allicin, enzymes, ajoene, B-vitamins, diallylsulfide, minerals, proteins, saponins, and flavonoids (Goncagul and Ayaz, 2010). Many of bacteria have been resistant against popular antibiotics. Many of the scientists have been worked on exploring the bactericidal activity of Copper nanoparticles.

Conclusion

Nps are synthesized by various techniques such as chemical methods lithography and laser ablation. These techniques are very expensive, time consuming and not good for the environment. The different plants have potential for agglutination of nanoparticles. Several plants and plant products have been used for the synthesis of nanoparticles. The presence of enzymes, phytochemical, protein and other components are commonly used in the synthesis of silver nanoparticles by plant extracts.

In the present decade plant-derived biological synthesis of nanoparticles is obtaining much importance due to its eco-friendliness and simplicity. Biosynthesis of gold nanoparticles from plants like *Tamarindus indica*, *Cinnamomum camphora*, *lemongrass*, *Alfa alfa*, *Embica officinal's*, *Aloe vera*, *Azadirachta indica* have been reported for the synthesis of nanoparticles.

Scientists proved that microbial organisms get resistant to various antibiotics and thus became a major threat in the healthcare industry. Hence, scientists are trying to develop new, dominant antimicrobial drugs that are free of counteraction and cost effective. Herbaceous nano particle-based medicine/ drugs proved themselves an alternative in the medical field.

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