**International Journal of Chemistry and Pharmaceutical Sciences**

Journal Home Page: www.pharmaresearchlibrary.com/ijcps

**Review Article** **Open Access**

# Green Synthesis of Silver Nanoparticles: A Review

**Prabhakara Rao Dasari*, Prashant Anthony**

*Department of Chemistry, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad-21100, India.*

**A B S T R A C T**

In the present years, nanotechnology is emerging as a favourite field for research. The nanoparticles have drawn the interest of the researchers from varied fields. These particles find different applications in diverse fields. The different types of nanoparticles play an important role in the medical field. Nanoparticles of various size have shown different activities in medical fields. Various physical, chemical and biological methods are in use to synthesize nano materials of which one of the most economic and ecofriendly way is to synthesize them by deploying plant derivatives. The present review discusses applications, stability order of silver nanoparticles from different plants belonging to different families. The biosynthesis of novel metal nanoparticles have gained significance, especially when the nanoparticles are synthesized extracellular and in a controlled manner according to their disparity of shape and size. The aim of this review is to discuss the phytosynthesis of silver nanoparticles from different plants belonging to diverse families.

**Keywords:** Silver, Nanoparticles, Phytosynthesis.

**A R T I C L E I N F O**

**CONTENTS**



**Article History: Received** 08 May 2016, **Accepted** 12 June 2016, **Available Online** 27 August 2016

***Corresponding Author**
Prabhakara Rao Dasari
Department of Chemistry,
Sam Higginbottom Institute of Agriculture,
Technology & Sciences, Allahabad-211007
Manuscript ID: IJCPS3072

**PAPER-QR CODE**

**Citation:** Prabhakara Rao Dasari. Green Synthesis of Silver Nanoparticles: A Review. *Int. J. Chem, Pharm, Sci.*, 2016, 4(8): 445-456.



## 1. Introduction

In the present era nanotechnology has emerged as a significant name and has attracted the focus of scientists worldwide due to the promises it makes in diverse areas. The term "Nanotechnology" having derived from Greek word "Bdwarfq" can be defined as the technology using the material of dimensions less than 100nm. Nano scale can be estimated with the fact that a human hair is 80,000 nm wide, a red blood cell is 7000 nm, many molecules including some proteins range between 1 to 2nm and atoms are smaller than 1 nm. Norio Taniguchi, a researcher at the University of

Tokyo, to refer the ability to engineer materials specifically at the nanometer level, first used it. Demand of the electronic industry to create smaller electronic devises on silicon chips served as the first major driving force for such a development leading to creation of nanostructures in 1970s as small as 40 to 70 nm in size (Whitesides GM et al., 2003). The primary driving force for the electronics industry, which urbanized tools to create small electronic devices silicon chips (Ankamwar et al., 2005). These exhibit entirely different novel characteristics as compared to the large particles of bulk material. The nanoparticles are ultrafine particles. When materials were changed into nanoparticles size and properties will be changed. The productions of nanoparticles from materials with new applications were achieved by controlling shape and size at nanometer level. Nanoparticles properties like size and shape dependent on the nanomaterials (Zharov et al., 2005 and Tan et al., 2006). It leads to the chemical and physical differences on their properties like mechanical, biological, catalytic activity, thermal, electrical conductivity, optical absorption, melting point. These particles also have different applications in many fields such as medical, Nano composites, computer transistors, electrometers, chemical sensors, hyperthermia of tumor, drug deliver, bio sensing, catalysts of optics and antimicrobial activity (Kim et al., 2010 and Lee et al., 2008).

Green synthesis of metal nanoparticles are not harmful to environment as it is without use of harsh, toxic and less expensive chemicals. There are many important applications of metal nanoparticles in medicine and pharmacy (Sperling et al., 2008). Different types of metal nanoparticles like silver, gold, platinum and palladium were widely used since many years for medicinal purpose, as they are ecofriendly. These nanoparticles are being used for making cosmetic products like shampoos, soaps, detergents, tooth paste etc. these nanoparticles have proved more effective in medicinal and pharmaceutical field (Puvanakrishnan et al., 2012). Gold nanoparticles are used for biomedical applications and in emerging interdisciplinary field of Nano biotechnology (Medley et al., 2008). Furthermore, gold nanoparticles have been widely used in medicinal field, immunoassay, protein assay, cancer nanotechnology, and capillary electrophoresis, infect diagnostic and drug delivery systems (Bhumkar et al., 2007). Silver nanoparticles have been widely used in research areas such as sensor technology, biological, integrated circuits, sensors, bio-labels, filters, antimicrobial deodorant fibers, cell electrodes, and antimicrobials (Qiu et al., 2004 and Asha Rani et al., 2009). The properties of nanoparticles make themmore effective in antimicrobial activity, animal husbandry, accessories and industry fields. These particlesin nano sizeare more effectivethanparticles previously used in medicine (Li et al., 2011 and Torres-Chavolla et al., 2010). These nanoparticles show potential antimicrobial effects against transmittable organisms such as *Escherichiacoli, Bacillus subtilis, Vibria cholera, Pseudomonas aeruginosa, Syphilis typhus, and Staphylococcus aureus* (Duran et al., 2007 and Cao et al., 2004). Platinum and palladium nanoparticles are widely used as catalysts in manyfields; they are used in medicinal, alloys and core shellbimetallic nanostructure. But especially palladium nanoparticles have extensive application in electro catalysis, sensing and plasmatic wave guiding (Lin et al., 2011, Cheong et al., 2010 and Coccia et al., 2012). The green synthesis of nanoparticles have been done by using different methods such as (1)Polysaccharide method, (2) *Tollens method,* (3) *Irradiation method,* (4) *Biological method,* (5) *Polyoxometalate* chemical and (6) physical methods.. These methods are very energy and capital intensive; employ toxic chemical and nonpolar solvents in the synthetic procedure (Gopidas et al., 2003 and Chen et al., 2010). Now a day's use of synthetic additives or capping agents is their applications in clinical and biomedical fields. Nanoparticles have been produced physically and chemically for a long time, but recent developments show the critical role of microorganisms and biological systems in production of metal nanoparticles. In recent years synthesis of nanoparticles has emerged as a promising field of research in nanobiotechnology (Sharma et al., 2009). Among the above-mentioned synthesized methods, phytosynthesis by plant parts as biological factories to synthesize metallic nanoparticles are under exploitation and advantageous and economical method**.** In addition, plant extracts has been considered as a green method for the synthesis of nanoparticles due to environmental friendly nature (Mohanpuria and Rai et al., 2008). Different routes have been developed for biologically or biogenic synthesis of nanoparticles from salts of the corresponding metals. Microorganisms, whole plants, plant tissues, fruits, plant extracts and marine algae have been used for the production of nanoparticles (Bar et al., 2009).

The green syntheses of silver nanoparticles are currently exploitation (Shankar et al., 2004). The biological synthesis of metal nanoparticles (particularly gold and silver nanoparticles) uses different stages of plants inactivated plant tissue, plant extractshave been acceptedas a suitable alternative to chemical and physical approaches (Mandal et al., 2006 and Bhattacharya et al., 2005). Nanoparticles produced from plant extracts are very effective, economic and valuable for the large-scale production (Gan et al., and Duran et al., 2012). Plants may act as a reducing and capping agents in synthesis of nanoparticles (Luangpipat et al., 2011). The bio-reduction of metal nanoparticles by combinations of biomolecules found in plant extracts such as an amino acids, citrates, enzymes, polysaccharides, proteins, organic acids and vitamins(Ray et al., 2011). The plant extracts are playing an important role in biological routefor metal nanoparticle production. Silver nanoparticles have been known for the inhibitory effect on various microorganisms (Musarrat et al., 2010 and Ali et al., 2011). The biological processes like phyto-synthesis of silver nanoparticles have shown as an easier and more rapid method than the tedious and time-consuming traditional methods. The plant extracts have been explored for the formation of silver nanoparticles using silver nitrate substrates (Babu and Banerjee et al., 2011). The rate of synthesis of nanoparticles was found to be very high during the reaction. The whole extracts of plant parts for making of nanoparticles are simple (Baskaralingam and Daisy et al., 2012). This process is good for making of nanoparticles as they are scalable and may perhaps be less expensive as compared to the relatively expensive methods based on microbial processes (Kalerand Park et al., 2011).

## 2. Synthesis of Silver Nanoparticles

Reduction method for making of nanoparticles involves two methods of "top down" and "bottom up". In top-down, method nanoparticles are produced by reduction from suitable starting materials by down-sizing. This method is used for the imperfection on the surface structure of the compound (Meyers et al., 2006 and Thakkar et al., 2010). The physical properties of nanoparticles are depending upon the surface structure. These properties have significant role in all fields; each structure of nanoparticle shows different properties in different applications (Dhillon et al., 2012). The bottom up synthetic method is dependent on chemical and biological methods of manufacture of nanoparticles. The bottom up method is used for the manufacture of nanoparticles in different methods (Gericke et al., 2006). The methods based on microorganisms have been broadly reported. The microbial scalable products are uses for the medical applications. The microbial products are more expensive than plant extracts nanoparticles (Gericke and Luangpipat et al., 2011).

It has been showed that the rate of synthesized nanoparticle from plants isbetter than microbes and they are more stable. Microorganisms such as bacteria, fungi, yeasts, and viruses have been to the innate potential to produce metal nanoparticles either intra or extra cellularconsidered as potential bio-factories for synthesis of nanoparticles (Sanghi et al., 2010 and Iravani et al 2011). In comparison between two methods microorganisms and phyto-synthesis method are devoid of complex and multistep processes like microbial isolation, culturing, maintenance etc. and also rapid and cost-effective approach that can be easily scaled up for bulk production of nanoparticles. Biosynthesis method is useful to reduce environmental effects compared with the some of the physical and chemical production methods and also it can be used to produce large quantities of nanoparticles that are free of contamination and have a biosynthetic routes can actually provide nanoparticles of a better defined size and morphology than some of the physicochemical methods of production (Raveendran et al., 2003).

Plants extracts of different plants from different families have been exploited by different researchers for the synthesis of silver nanoparticles the size and shapes of nanoparticles obtained and the plants their part used have been summarized in Table no 1.

Asteraceae, an exceedingly large and widespread family of a angiospermae with members mostly herbaceous and a significant number as shrubs, wines and trees is an important family contributing to herbal medicines, including Grindelia, Echinacea, and Yarrow are known for their antibiotic agents (Panero et al., 2002). In spite of a large number of plants a contrast is observed in case of quantity in production of nanoparticles. For example *Eclipta prostrate, Eclipta species, Enhydra fluctuans, Helianthus annus, Parthenium hysterophorus, Tanacetum vulgare and Tridax procumbens* plants produce silver nanoparticles by reduction method by green synthesis. *Eclipta prostrate* leaf extract used for the synthesis of silver nanoparticles. These nanoparticles had been larvicidal activity on filariasis and malaria. These nanoparticles very high potential because of these size 35-60nm (Rajakumar et al., 2011).

*Eclipta species*leaves negotiated green, low-cost and reproducible synthesis of silver nanoparticles is reported. The synthesis is performed at room temperature and analyzed by X-ray and transmission electron microscopy to ascertain the formation of silver nanoparticles. Almost spherical nanoparticles of size 2-6 nm have surface Plasmon resonance at 419nm as revealed by UV- visible spectroscopy (Jha et al., 2009). *Enhydra fluctuans* plants give silver nanoparticles of size 100-400nm and spherical shape. Extracellular productions of solution stable nanoparticles from the extract of *E. chapmaniana* leaves have been reported. Studies regarding characterization for the toxicity and the mechanisms involved with the antimicrobial and anticancer activity of these particles are can be investing. Synthesized nanoparticles are tested to have good antibacterial action against gram-positive organism than gram-negative organisms (Roy et al., 2010).

These nanoparticles which are spherical, 55nm in size and poly dispersed, are reported to be active against *E,coli, salmonella, shigella, vibrio cholera* by Kirby-bour method. Finally *Eclipta prostrate, Tanacetum vulgare, Helianthus annus*(Leela et al., 2008) *and Parthenium hysterophorus* (Parashar et al., 2009) are producing good nano size particles better than all plants. Biosynthesis by aqueous method from *Tanacetum vulgare* fruit extract has yielded silver nanoparticles of size 16nm and spherical in shape (Dubey et al., 2010). The *Rhizome* formed spherical AgNPs of size 6-20 nm. *Dhanalakshmi et al*, reported the synthesis of silver nanoparticles using *Tridax procumbens* bark powder (T and Rajendran et al., 2012).

The Fabaceae commonly known as the legumes is a large and economically important family of flowering plants (Schrire et al., 2005). In this family plants are reported to produce also silver nanoparticles of very fine shape and size. The silver nanoparticles easily prepared by green method of aqueous extract of *Accacia nilotica* pods were reported to be stable with distorted spherical shapes, crystalline structure and 20-30nm in size. The concentration of the extract and the pH of the medium help to control the size whereas the phytoconstituents such as gallic acid, ellagic acid, epicatechin, and rutin act as reducing agents for the synthesis and capping of AgNPs. Cyclic voltammeter studies find the synthesized silver nanoparticles to show greater electro catalytic activity in the reduction of benzyl chloride compared to that of bulk silver (Thomas et al., 2013). An eco-friendly method for the green synthesis of silver nanoparticles from aqueous solutions of silver nitrate using the *carob leaf* extract is a single-pot, fast and convenient process withdifferent concentrations of $AgNO_3$ forming stable and mostly spherical silver nanoparticles with a diameter ranging from 5 to 40 nm. AgNPs synthesized from *Cassia fistula and Ceratonia siliqua*size 50-60 and 18- 51 nm (Akl et al., 2013, Lin et al., 2010 and Chandrakant et al., 2013).

The single-step environmental friendly approach uses the biomolecules found in plants to induce the reduction of $Ag^+$ ions of silver nitrate to silver nanoparticles ranging from 5–20 nm in size,stable and spherical. Nanoparticles of average size ~10 nm synthesized using *Desmodium* plant have presented good antibacterial performance against common pathogens. The nanoparticles when combined with the antibiotics show synergic effect in suppressing growth of pathogens. Reduction of silver ions to nanoparticles using an extract of *Desmodium trifolium* and *Desmodium triflorum* was ascribed to the presence of H+ ions, NAD+ and ascorbic acid in the extract of the legume to synthesize silver nanoparticles in the size range of 5–20 nm (Ahmad et al., 2011). The reporter explained the synthesis of silver nanoparticles from *Garciniamangostana* and *Gliricidia sepium* plant with size 35nm and 10-50nm respectively, and spherical shape better than the *Geranium* and *Ginko biloba* leaves silver nanoparticles (Rajesh et al., 2009).

In Euphorbiaceae family called spurge family has flowering plants with a number of them having considerable economic importance. Prominent plants include *Manihot esculenta*, *Ricinus communis*, and *Barbados* nut in medicine with some species proved effective against genital HSV-2 (Krishnaraj et al., 2010). The radically symmetrical, unisexual flowers with male and female flowers occurring on the same plant gained the focus of workers to synthesize silver nanoparticles. Leaf extract of *Acalypha indica* produced silver nanoparticles of size 20-30nm with antimicrobial activity against water borne pathogens like *E. coli* and *Vibrio cholera* (Krishnaraj et al., 2010).

*Brassica junce and Bryophyllum* species produced silver nanoparticles in the different types of size of 2-35 nm and 2-5 nm respectively spherical and unit cell structures (Jha et al., 2009). *Emblica Officinalis* fruit extract gives the silver nanoparticles. These nanoparticles containing the chloroaurate ions. Especially silver sulphate and chloroauric acid solutions produce highly stable silver and gold nanoparticles.TEM analysis of the silver and gold nanoparticles reported size range from 10 to 20 nm and 15 to 25 nm respectively. Synthesis is reported to be followed by a phase transfer into an organic solution using a cationic surfactant octadecylamine.

Transmetallation reaction between hydrophobized silver nanoparticles and hydrophobized chloroaurate ions in chloroform resulted in the formation of gold nanoparticles (Ankamwar et al., 2005). *Euphobia hirta* plant leaves silver nanoparticles, spherical shaped and 40-50nm in size and spherical shape is reported to exhibit the strongest potential for rapid reduction of silver ions (Elumalai et al., 2010). Additionally, the silver nanoparticles are reported to be successfully synthesized using the latex and seed extract of *Jatropha curcas*. Green synthesis of silver nanoparticles using seed extract of Jatropha curcas by aqueous method yielded spherical nanoparticles of size 15-50 nm and spherical (Bar et al., 2009).

The Myrtaceae family is consisting dicotyledonous plants and placed within the order has Myrtle, clove, guava, feijoa, allspice, and eucalyptus as well known plants. This family plant parts are use full in multiple ways (Angiosperm Phylogeny Group et al., 2009). Ravindra et al, analyzed by the silver nanoparticles within cotton fibers loaded with silver ions. Leaf extract of *Eucalyptus citriodora(neelagiri*) plants was used for the synthesis nanoparticles of average size ~20 nm. The cotton fibers loaded with the silver nanoparticles were shown to be antibacterial towards *E. coli*.

The antimicrobial efficiency of cotton fibres loaded with silver nanoparticles developed by “green process” using natural extracts, of *Eucalyptus citriodora* evaluated against gram-negative *Escherichia coli* to be excellent by the incorporation of 2% leaf extracts on cotton fibres along with superior antibacterial activity even after several washings indicating their use in medical and infection prevention applications (Sulaiman et al., 2013 and Sakey Ravindra et al., 2010). A methanolic extract mediated synthesis of silver nanoparticles from *Eucalyptus hybrid (safeda)* is reported with flavonoid and terpenoid compounds in the extract claimed to be responsible for the stabilization of nanoparticles. Synthesis of highly stable and crystalline silver nanoparticles (16-40 nm) by exposing the aqueous geranium leaf extract with silver nitrate solution is reported. The rate of synthesis being very high during the reaction time 60 min entailing the use of plants instead of microorganisms for biosynthesis of metal nanoparticles in a more rapid and reproducible way. Highly concentrated silver nanoparticles obtained from the aqueous fruit extract of *Embalica officinalis* are also reported (Dubey et al., 2009).

Silver nanoparticles 29-92nm in size and spherical shape with stronger antioxidant properties in vitro are produced from the extracts of *S.cumini* seeds as compared to the original extract suggesting a concentration of the polyphenolic antioxidants adsorbed on the surface of the particles. An extract of *Syzygium cumini* seeds with in vitro antioxidant properties is reported to produce silver nanoparticles with even higher antioxidant activity with adsorption of the antioxidants from the extract on the surface of the nanoparticles as possible cause. Formation of crystalline silver nanoparticles using seed extract of *Syzygium cumuni* by extract method is reported to form nanoparticles of size 3.5nm and 73-92 nm and spherical shape (Banerjee et al., 2010).

The Poaceae family is large universal monocotyledonous flowering plants. The poaceae represent the fifth largest plant family following Orchidaceae, Asteraceae, Fabaceae, and Rubiaceae and commonly called as "grasses" with diverse habitats, including wetlands, forests, and tundra (Stevens et al., 2012). Shahail et al, reported the biosynthesis of silver nanoparticles by *Bamboo* leaf extract and their antimicrobial activity against sample bacteria culture. The silver ions in an aqueous solution were exposed to the bamboo leaves extracts followed by the rapid color change of plant extracts confirming the biosynthesis of silver nanoparticles of size about 30-50 nm, non-spherical in shape (Sohail Yasin et al., 2013). Phenols and flavonoids present in the leaves served as effective reducing agents. In contrast to the use of toxic and flammable chemicals in silver nanoparticles production an environment friendly silver nanoparticles are reported to be produced. These nanoparticles are reported better than *Oryza sativa* (Leela et al., 2008).

The biosynthesis of silver nanoparticles using *Panicum virgatum* grass by an aqueous extract method are reported with an average size range of 20-40 nm andspherical, rod-like, triangular, pentagonal, hexagonal shapes thus generating a hope for the expansion process for the synthesis of different nanoparticles with varied application. Silver nanoparticles from the alcoholic extract of a bryophytic plant leafs *Riccia* is reported amidst many reports from angiospermae (Cynthia Mason et al., 2012). Leaf extracts of plants *Saccharum of ficinarum* and *Sorghum bicolar* are reported to have potential for rapid reduction of silver ions as experiment by Leela et al, Similar productions using leaf extract of *Argemone maxicana*, bran powder of Sorghum spp are also reported (Chaudhari et al., 2013 and Njagi et al., 2010).

Caesalpinioideae is a botanical name ranked as subfamily under family Fabaceae. Having its name derived from generic name *Caesalpinia* it groups, mainly trees with zygomorphic and variable flowers and are distributed in the moist tropics. Papilionoideae and Mimosoideae having resin from the subfamily it is considered paraphyletic and is likely to be split into several subfamilies (Martin et al., 2006). Abhijeet et al, reported the evaluation of antiplasmodial activity of green, silver nanoparticles synthesized from aqueous leaf extract of *Ashoka Neem*, 5-20 nm sized and spherical shaped nanoparticles are reported to be environmentally safe and are used for biomedical applications. They are found to inhibit the growth of *P.falciparum* in human red blood cell culture (Abhijeet Mishraa et al., 2013). Uday et al, reported leaf extract of *Cassiaauriculata*, a plant with promising medical properties and belonging to family *Cesalpiniaceae* mediate biosynthesis of silver nanoparticles by reducing sliver nitrate at room temperature. The silver nanoparticles using the leaf extract of *Cassia auriculata* are reported to be polydispersed, circular and spherical shapes and of size range 11-40 nm. These nanoparticles were evaluated for antimicrobial activity against *E.coli*, *Sarratiamarcascence*, *Bacillus subtilis* ,*Aspergillusniger*and *Aspergillusflavus*. Fungi were most susceptible to silver nanoparticles followed by bacteria with the highest toxicity against *Aspergillus niger* and intermediary effects on *E.coli*, *B.subtilis* and *A. flavus* and exhibited lowest effect on *Serratia marcescens*. The *Ceratonia siliqua* seed gives the silver nanoparticles of size 18-51nm.. Leaf extract of *Svensonia hyderabadensis* is reported to produce AgNPs by the aqueous method of size 45nm and spherical shape (Asra Praveen et al., 2012 and Rao et al 2011).

The Lamiaceae are a family of flowering plants, traditionally been considered closely related to Verbenaceae. The plants, frequently aromatic include many widely used culinary herbs, such as basil, mint, rosemary, sage, savory, marjoram, oregano, hyssop, thyme, lavender, and perilla. Some are shrubs; trees, such as teak, vines (Peter et al., 2001). Ali et al,reported the synthesis of silver and gold nanoparticles using leafs extracts of *Mentha piperita* plant. These nanoparticles have antibacterial activity against clinically isolated human pathogens such as *E. coli* and *S. aureus* (Ali et al., 2011). Philip et al, reported nanoparticle biosynthesis from *Ocimum sanctum* leaf extract using silver nitrate solution. This plant formed effective nanoparticles sized 10-20nm and spherical in shape. Highly stabilized silver nanoparticles are recently reported to be biosynthesized using leafs of *Ocimum tenuiflorum* as an extract of *Ocimum sanctum* leaves reduce silver nitrate into silver ions. The high activity of the extract was ascribed to the relatively high levels of ascorbic acid contained in the extract. In other studies, silver nanoparticles produced using *O.sanctum* leaf extracts have been found to have a high antimicrobial activity against both Gram-negative *(E. coli*) and Gram-positive (*Streptococcus aureus*) microorganisms. Patil produced highly stabilized silver nanoparticles (25–40 nm) using a leaf extract *Ocimum tenuiflorum*. The particles were antibacterial towards Gram-negative and Gram-positive bacteria (Ahmad et al., 2010 and Patil et al., 2012).

Rutaceae commonly known as the citrus family, they are flowering plants, usually placed in the order sapindales (Cynthia et al., 2007). These plants contained high level ascorbic acid due to this; it gives the high effect on the different activities. *Citrus* being the most economically important genus in the family includes orange, lemon and grape fruit. Green synthesized the silver nanoparticles spherical in shape and 40nm in size using juice of *Citrus lemon* by incubating the juice with $10^{-2}$ M silver nitrate solution Citric acid present in the juice served as principal, reducing agent (Prathna et al., 2011). Silver nanoparticles biosynthesis using *Citrus sinensis peel* extract is reported to yield 35±2 nm spherical particles using a simple green chemistry procedure and citrus peel extract as reducing and capping agent. The silver nanoparticles formed are spherical in shape and 35 and 10 nm in size synthesized at 25 °C and 60 °C. Their antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa* (Gram-negative), and *Staphylococcus aureus* (Gram-positive) is reported to be effective (Kaviya et al., 2011). Phillips et al, synthesized silver nanoparticles using the leaf extract of *Murraya keenigii* plant of size 10nm and shape crystalline, spherical. Song et al, reported a rapid biological synthesis of silver nanoparticles using *Magnolia kobus* leaf extract by aqeous method yielding particles of size range 15- 500 nm andcubic and spherical in shape (Philip et al., 2011). The Liliaceae (Lily family) family of monocotyle donperennial, her baceous geophytes, often bulbous plants within the order Liliales consisting of fifteen generaand approximately 600 species. The leaves are linear, mostly with parallel veins. Many Liliaceae are important ornamental plants, widely grown with their attractive flowers and involved in a major floriculture of cut flowers and dry bulbs (Stevens et al., 2013). Saxena et al, reported the compatibility of the bark and powder extracts of *Allium cepa* plant for the formation of silver nanoparticles of varied shapes and sizes in a high amount. These nanoparticles are reported to have strong antibacterial activity against the *Escherichia coli* (Saxena et al.,2010). Chandran et al, biosynthesized silver nanoparticles from extracts of *Aloe vera* by green extract method from different parts of *A.Vera* plant with different metals as an attempt to synthesize nanoparticles with different chemical composition. These nanoparticles size ranged from 152-350nm and shaped as spherical or triangular (Chandran et al., 2006).

The Anacardiaceae family is bearing fruits mainly drupes and irritant. It is numerous economically important genera (Solereder et al., 2009). The genus pistacia plant parts are highly poisonous produce foul smelling milky sap. The green synthesis of silver nanoparticles by mangifera indica extract produce 20nm size, spherical, triangular and hexagonal shapes. The menocydalon leaf extract shows silver nanoparticles of average size 50-90nm and square shape to be effective than gold Nanoparticles (Sheny and Philip et al., 2011).

Aizoaceae or Ficoidaceae is a family of dicotyledonous flowering plants containing genera and about 1900 species which are commonly known as “stone plants”. Some species resembling stones or pebbles are sometimes called “mesembs” whereas several others are known as "ice plants". Widely recognised by taxonomists, the family was once named "Ficoideae" (Cornelia Klak et al., 2003). Highlighted the possibility to use tissue culture derived callus and leaf extract from *Sesuvium portulacastrum* for the synthesis of silver nanoparticles sized 5-20nm and spherical in shape. Dubey et al, reported the biosynthesis of silver nanoparticles from *sorbus aucuparia* plant of 16nm in size and spherical and triangular in shape (Asmathunisha Nabikhan et al., 2010). Geethalakshmi et al, reported a cost effective and environment friendly technique contrary to the traditional synthesis of metallic nanoparticles by wet chemical techniques often using toxic and flammable chemicals employing green synthesis of silver nanoparticles from 1mM $AgNo_3$ solution using the extract of *Trianthema decandra* as reducing capping agent. The average particle size of 15 nm and cubic structure is reported. The effects of silver nanoparticles were done in antimicrobial activity on human pathogenic *Escherichia coli* and *Pseudomonas aeruginosa* by standard disc diffusion method (Geethalakshmi et al., 2010).

The Solanaceae, family is an economically important flowering plant. These family plants are useful for the agriculture crops, medicinal plants, spices, weeds and ornamentals (Olmstead et al., 2006). Some other plants such as *Petunia*, *Browallia*, *Lycianthes*, *Datura*, mandragora and atropa belladonna effect on the poisons (Kesharwani et al., 2009). Datura leaf extract nanoparticles are more stable depend upon the size of nanoparticles. The extract contains alkaloids, proteins, enzymes, amino acids, alcoholic compounds, polysaccharides and pigments like quinol and chlorophyll are said to be responsible for the reduction of the silver ions to nanoparticles and their stabilization. Prasad et al, reported the synthesis of silver nanoparticles from leaf extract of *Nicotiana tobaccum* of size 8nm and crystalline in shape (Prasad et al., 2011). The Moraceae family is called as mulberry family. This family has mostly flowering plants and tropical and subtropical regions in different climates.

The Moraceae often called the mulberry family are flowering plants comprising about 40 genera and over 1000 species widespread mostly in tropical and subtropical regions and some in temperate climates. Presence of laticifers and milky sap in all parenchymatous tissues is only synapomorphy with presence of two carpels sometimes with one reduced, compound inconspicuous flowers, and compound fruits are other generally useful field characters. It includes well known plants such as the fig, banyan, bread fruit, mulberry and osage orange (Datwyler et al., 2004). Biosynthesis of silver nanoparticles is reported to be done from the aqueous solution of silver nitrate by using *Artocarpus heterophyllus* seed dried powder extract. The silver nanoparticles morphology in crystalline phase is reported to be irregular in shape with average size of 3-25 nm (Umesh et al., 2013). Antibacterial activity against such *as Bacillus cereus, Bacillus substilis, staphylococcus aureus, and pseudomonas aeruginosa but not against on Salmonelia typhimurium, proteus vulgaris* is also reported (Mubarak Ali et al., 2011 and Ravindra et al., 2010).

**Table 1:** Silver Nanoparticles synthesized from plant extracts of different plants from various families and the size and shape of the nanoparticles obtained.

| S.No | Plant name | Part | Metal | Size | Shape | References |
|---|---|---|---|---|---|---|
| Asteraceae | *Eclipta prostrate* | | Ag | 35-60 nm | Triangular, Pentahons, Hexagons | Rajakumar et al.(2011) |
| | *Eclipta sp* | | Ag | 2-6 nm | Spherical | Jha et al. (2009) |
| | *Enhydra fluctuans* | | Ag | 100-400 nm | Spherical | Roy et al. (2010) |
| | *Helianthus annus* | Leaves | Ag | | | Leela et al., 2008 |
| | *Parthenium hysterophorus* | Leaves | Ag | 50 nm | Irregular | Parashar et al. (2009) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Tanacetum vulgare* | Fruit | Ag | 16 nm | Spherical | Dubey et al. (2010) |
| | *Tridax procumbens* | Leaves | Ag | 55 nm | Poly dispersed | Dhanalakshmi et al. (2012) |
| Fabaceae | *Acacia nilotica* | Fruits | Ag | 20-30 nm | Spherical | Thomas et al.(2013) |
| | *Ceratonia siliqua* | Leaves | Ag | 5-40 nm | Spherical | Akl et al.(2013) |
| | *Cassica fistula* | | Ag | 50-60 nm | | Lin et al.(2010) |
| | *Ceratonia siliqua* | | Ag | 18-51 nm | | Chandrakant et al. (2013) |
| | *Desmodium triflorum* | | Ag | 5–20 nm | Spherical | Ahmad et al.(2011) |
| | *Gliricidia sepium* | | Ag | 10–50 nm | Spherical | Rajesh et al.(2009) |
| Euphorbiaceae | *Acalypha indica* | | Ag | 20–30 nm | Spherical | Krishnaraj et al.(2010) |
| | *Bryophyllum sp.* | | Ag | 2–5 nm | Unit-cell Structure | Jha et al.(2009) |
| | *Emblica officinalis* | Fruit | Ag | 10−20 nm | Spherical | Ankamwar et al.(2005) |
| | *Euphorbia hirta* | Leaves | Ag | 40–50 nm | Spherical | Elumalai et al.(2010) |
| | *Jatropha curcas* | Latex | Ag | 10–20 nm | Fcc unit-cell structure | Bar et al.(2009) |
| | | Seed | Ag | 15–50 nm | Spherical | Bar et al. (2009) |
| Myrtaceae | *Eucalyptus chapmaniana* | | Ag | 60 nm | Crystalline, Cubic structure | Sulaiman et al.(2013) |
| | *Eucalyptus citriodora* | | Ag | 20 nm | Spherical | Sakey Ravindra et al. (2010) |
| | *Eucalyptus hybrid* | | Ag | 50–150 nm | Spherical, Crystalline | Dubey et al.(2009) |
| | *Syzygium cumini* | | Ag | 29–92 nm | Spherical | Banerjee et al.(2010) |
| Poaceae | *Bamboo plant* | Leaves | Ag | 13-50nm | Non Spherical | Sohail Yasin et al. (2013) |
| | *Oryza sativa* | Leaves | Ag | | | Leela et al. (2008) |
| | *Panicum virgatum* | | Ag | 20-40 nm | Spherical, Triangular, Pentagonal, | Cynthia Mason et al.(2012) |
| | *Saccharum officinarum* | Leaves | Ag | | | Chaudhari et al.(2013) |
| | *Sorghum spp* | Bran powder | Ag | 10-50 nm | | Njagi et al.(2010) |
| Caesalpiniaceae | *ashoka and neem* | Leaves | Ag | 5-20 nm | Spherical | Abhijeet Mishraa et al.(2013) |
| | *Cassia auriculata* | Leaves | Ag | 11- 40nm | Circular, Spherical | Asra Praveen et al. (2012) |
| | *Svensonia hyderabadensis* | Leaves | Ag | 45 nm | Spherical | Rao et al. (2011) |
| Lamiaceae | *Menta piperita* | Leaves | Ag | 90 nm | Spherical | Ali et al.(2011) |
| | *Ocimum sanctum* | Root | Ag | 5-20 nm | Spherical | Ahmad et al. (2010) |
| | *Ocimum tenuif lorum* | Leaves | Ag | 25−40 nm | Spherical | Patil et al.(2012) |
| Rutaceae | *Citrus limon* | | Ag | >50 nm | Spherical and Spheroid | Prathna et al.(2011) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Citrus sinensis* | Peel | Ag | 35+2 nm | Spherical | Kaviya et al. (2011) |
| | *Murraya keenigii* | Leaves | Ag | 10 nm | Crystalline, Spherical | Philip et al.(2011) |
| Liliaceae | *Allium cepa* | Leaves | Ag | 33.6 nm | Spherical | Saxena et al.(2010) |
| | *Aloe vera* | | Ag | 350 nm | Triangular, Spherical | Chandran et al. (2006) |
| Anacardiaceae | *Anacardium occidentale* | | Ag | 17 nm | | Sheny et al.(2011) |
| | *Mangifera indica* | Leaves | Ag | 20 nm | Spherical, Triangular, Hexagonal | Philip et al.(2011) |
| Aizoaceae | *sesuvium portulacastrum* | Leaves | Ag | 5-20 nm | | Asmathunisha Nabikhan et al.(2010) |
| | *Trianthema decandra* | Root | Ag | 15 nm | Cubic and Hexagonal | Geethalakshmi et al. (2010) |
| Solanaceae | *Datura metel* | | Ag | 16–40 nm | Spherical, Ellipsoidal | Kesharwani et al.(2009) |
| | *Nicotiana tobaccum* | Leaves | Ag | 8 nm | Crystalline | Prasad et al. (2011) |
| Moraceae | *Artocarpus heterophyllus lam* | Seed | Ag | 3-25 nm | Spherical | Mubarak et al.(2011) |
| | *Ficus bengalensis* | | Ag | ~20 nm | Spherical | Ravindra et al.(2010) |

## 3. Conclusion

This review summarizes the recent work in the field of phytosynthesis of silver nanoparticles the number of plants are available in nature and many of them can produce nanoparticles. The Phytosynthesis of precious Ag nanoparticles is necessary in order to develop a rational approach. Thus it has been concluded that the significance and the stability, order of Phytosynthesized Ag nanoparticles of different families of plants increases with a decrease in its size.

## 4. Acknowledgements

Sam Higginbottom Institute of Agriculture, Technology &Sciences, Allahabd-211007, U.P, India.

## 5. References

[1] Whitesides GM (2003) The 'right' size in nanobiotechnology. Nat Biotechnol, 21:1161- 5.
[2] Ankamwar B, Chaudhary M, and Sastry M (2005) "Gold nanotriangles biologically synthesized using tamarind leaf extract and potential application in vapor sensing" Synthesis React Inorg Metal-Org Nano- Metal Chem.,35, 19–26.
[3] Zharov VP, Kim JW, Curiel DT and Everts M (2005) Self-assembling nanoclusters in living systems: Application for integrated photothermal nanodiagnostics and nanotherapy. Nanomedicine, 1, 326–345.
[4] Tan M, Wang G, Ye Z and Yuan (2006) Synthesis and characterization of titania-based monodisperse fluorescent europium nanoparticles for biolabeling J,J Lumin.,117,20–28.
[5] Kim BS and Song JY (2010) "Biological Synthesis of Gold and Silver Nanoparticles Using Plant Leaf Extracts and Antimicrobial Applications" In Biocatalysis and Biomolecular Engineering, NJ, pp, 447−457.
[6] Lee HY, Li Z, Chen K, Hu AR, Xu CJ, Xie S, Sun S and Chen X (2008) PET/MRI dual-modality tumor imaging using arginine-glycine-aspartic (RGD)-conjugated radiolabeled iron oxide nanoparticles. J. Nucl. Med, 49, 1371–1379.
[7] Sperling RA, Gil PR, Zhang F, Zanella M and Parak WJ (2008) Biological applications of gold nanoparticles. Chem. Soc. Rev, 37, 1896–1908.
[8] Puvanakrishnan P, Park J, Chatterjee D, Krishnan S, and Tunnel JW In vivo tumor targeting of gold nanoparticles: Effect of particle Type and dosing strategy. Int. J. Nanomed. (2012), 7, 1251−1258.
[9] Medley CD, Smith JE, Tang Z, Wu Y, Bamrungsap S and Tan W (2008) Gold nanoparticle-based colorimetric assay for the direct detection of cancerous cells. Anal. Chem., 80, 1067–1072.
[10] Bhumkar DR, Joshi HM, Sastry M, and Pokharkar VB (2007) Chitosan reduced gold nanoparticles as novel carriers for transmucosal Delivery of insulin. Pharm. Res. (2007), 24 (8), 1415−1426.
[11] Qiu H, Rieger B, Gilbert R, Jerome R, and Jerome C (2004) Placoated Gold nanoparticles for leveling of PLA biocarriers. Chem. Mater. (2004), 16 (5), 850−856.
[12] Asha Rani PV, Mun GLK, Hande MP, and Valiyaveettil S (2009) Cytotoxicity and genotoxicity of silver nanoparticles in human cells. ACS Nano, 3 (2), 279−290.

[13] Li WR, Xie XB, Shi QS, Duan SS, Ouyang YS, and Chen YB (2011) Antibacterial effect of silver nanoparticles on Staphylococcus Aureus. Biometals 24 (1), 135−141.

[14] Torres-Chavolla E, Ranasinghe RJ, and Alocilja EC (2010) Characterization and functionalization of biogenic gold nanoparticles for biosensing enhancement. IEEE Trans. Nanobiotechnol. 9 (5), 533−538.

[15] Duran N, Marcato PD, De S, Gabriel IH, Alves OL, and Esposito E (2007) Antibacterial effect of silver nanoparticles produced by fungal process on textile fabrics and their effluent treatment. Journal of Biomedical Nanotechnology 3, 203 208.

[16] Cao G (2004) Nanostructures and Nanomaterials: Synthesis, Properties And Applications, Imperial College Press, London.

[17] Lin X, Wu M, Wu B, Kuga S, Endo T, and Huang Y (2011) Platinum Nanoparticles using wood nanomaterials: Eco-friendly synthesis, shape Control and catalytic activity for p-nitrophenol reduction. Green Chem. 13 (2), 283−287.

[18] Narayanan R and El-Sayed M, A (2004) Shape dependent catalytic Activity of platinum nanoparticles in colloidal solution. Nano Lett. 4 (7), 1343−1348.

[19] Cheong S, Watt JD and Tilley RD (2010) Shape control of platinum and palladium nanoparticles for catalysis. Nanoscale, 2 (10), 2045−2053.

[20] Coccia F, Tonucci L, Bosco D, Bressan M and Alessandro DN (2012) One pot synthesis of lignin-stabilized platinum and palladium Nanoparticles and their catalytic behaviours in oxidation and reduction Reactions. Green Chem. 14 (4), 1073−1078.

[21] Gopidas KR, Whitesell JK and Fox MA (2003). Synthesis, Characterization and catalytic activity of a palladium nanoparticle Cored dendrimier. Nano Lett. 3 (12), 1757−1760.

[22] Chen H, Wei G, Ispas A, Hickey SG and Eychmuller A (2010) Synthesis of palladium nanoparticles and their applications for surfaceenhanced Raman scattering and electrocatalysis. J. Phycs. Chem. C, 114 (50), 21976−21981.

[23] Sharma VK, Yngard RA and Lin Y (2009) Silver nanoparticles: green synthesis and their antimicrobial activities. Adv Colloid Interface Sci, 145: 83–96.

[24] Mohanpuria P, Rana NK, and Yadav SK (2008) Biosynthesis of nanoparticles: technological concepts and future applications. J Nanopart Res, 7, 9275–9280.

[25] Rai M, Yadav A, and Gade A (2008). Current trends in phytosynthesis of metal nanoparticles. Crit Rev Biotechnol, 28(4), 277–284.

[26] Bar H, Bhui DK, Sahoo GP, Sarkar P, Pyne S and Misra AB (2009)Green synthesis of silver nanoparticles using seed extract of Jatropha curcas. Colloids Surf A: Physicochem Eng Asp, 348, 212–216.

[27] Shankar SS, Rai A, Ahmad A and Sastry M (2004) Rapid synthesis of Au, Ag, and bimetallic Au core−Ag shell nanoparticles using neem (Azadirachta indica) leaf broth. J. Colloid Interface Sci. 275 (2), 496−502.

[28] Mandal D, Bolander ME, Mukhopadhyaya D, Sarkar G and Mukherjee P (2006) The use of microorganism for the formation of metal nanoparticles and their applications. Appl. Microbiol. Biotechnol. 69 (5), 485−492.

[29] Bhattacharya D and Gupta RK (2005) Nanotechnology and potential of microorganisms. Crit. Rev. Biotechnol. 25 (4), 199−204.

[30] Gan PP and Li SFY (2012) Potential of plant as a biological factory to synthesize gold and silver nanoparticles and their applications. Rev Environ Sci Biotechnol, 11: 169–206.

[31] Duran N and Seabra AB (2012) Metallic oxide nanoparticles: state of the art in biogenic syntheses and their mechanisms. Appl Microbiol Biotechnol, 95:275–88.

[32] Luangpipat T, Beattie IR, Chisti Y and Haverkamp RG (2011) Gold nanoparticles produced in a microalga. J Nanopart Res, 13, 6439–45.

[33] Ray S, Sarkar S and Kundu S (2011) Extracellular biosynthesis of silver nanoparticles using the mycorrhizal mushroom Tricholoma crassum (Berk.), its antimicrobial activity against pathogenic bacteria and fungus, including multidrug resistant plant and human bacteria. Dig J Nanomater Biostruct, 6, 1289–99.

[34] Singaravelu G, Arockiamary J, Kumar VG and Govindaraju K (2007) A novel extracellular synthesis of monodisperse gold nanoparticles using marine alga, Sargassum wightii Greville. Colloids Surf B Biointerfaces, 57:97-101.

[35] Musarrat J, Dwivedi S, Singh BR, Khedhairy AA, Azam A and Naqvi A (2010). Production of antimicrobial silver nanoparticles inwater extracts of the fungus Amylomyces rouxii strain KSU-09. Bioresource Technology, 101: 8772–8776.

[36] Ali DM, Thajuddin N, Jeganathan K and Gunasekaran M (2011). Plant extract mediated synthesis of silver and gold nanoparticles and its antibacterial activity against clinically isolated pathogens. Colloids Surf B Biointerfaces, 85:360–5.

[37] Babu SA and Prabu HG (2011). Synthesis of AgNPs using the extract of Calotropis procera flower at room temperature. Mater Lett, 65:1675–7.

[38] Banerjee J and Narendhirakannan R (2011). Biosynthesis of silver nanoparticles from Syzygium cumini (L.) seed extract and evaluation of their in vitro antioxidant activities. Dig J Nanomater Biostruct, 6:961–8.

[39] Castro L, Blázquez ML, Muñoz JA, González F and García-Balboa Ballester C (2011)

Biosynthesis of gold nanowires using sugar beet pulp. Process Biochem, 46:1076–82.

[40] Baskaralingam V, Sargunar CG, Lin YC and Chen JC (2012) Green synthesis of silver nanoparticles through Calotropis gigantea leaf extracts and evaluation of antibacterial activity against Vibrio alginolyticus. Nanotechnol Dev, 2:e3.

[41] Daisy P and Saipriya K (2012). Biochemical analysis of Cassia fistula aqueous extract and phytochemically synthesized gold nanoparticles as hypoglycemic treatment for diabetes mellitus. Int J Nanomedicine, 7:1189–202.

[42] Kaler A, Nankar R, Bhattacharyya MS and Banerjee UC (2011) Extracellular biosynthesis of silver nanoparticles using aqueous extract of Candida Viswanathii.J.Bionanosci, 5:53–8.

[43] Singh A, Jain D, Upadhyay M, Khandelwal N and Verma H (2010) Green synthesis of silver nanoparticles using Argemone mexicana leaf extract and evaluation of their antimicrobial activities. Dig J Nanomater Biostruct, 5:483–9.

[44] Park Y, Hong YN, Weyers A, Kim YS and Linhardt RJ (2011). Polysaccharides and phytochemicals: a natural reservoir for the green synthesis of gold and silver nanoparticles. IET Nanobiotechnol, 5:69–78.

[45] Meyers MA, Mishra A and Benson DJ (2006) Mechanical properties of nanocrystalline materials. Prog Mater Sci, 51:427–556.

[46] Thakkar KN, Mhatre SS and Parikh RY (2010) Biological synthesis of metallic nanoparticles. Nanomed Nanotechnol Biol Med, 6:257–62.

[47] Mukherjee P, Ahmad A, Mandal D, Senapati S, Sainkar SR and Khan MI (2001) Fungusmediated synthesis of silver nanoparticles and their immobilization in the mycelia matrix: a novel biological approach to nanoparticle synthesis. Nano Lett, 1: 515–9.

[48] Dhillon GS, Brar SK, Kaur S and Verma M (2012) Green approach for nanoparticle biosynthesis by fungi: current trends and applications. Crit Rev Biotechnol, 32:49–73.

[49] Gericke M and Pinches A (2006) Biological synthesis of metal nanoparticles. Hydrometallurgy, 83:132–40.

[50] Kaler A, Nankar R, Bhattacharyya MS and U.C. Banerjee UC (2011) Extracellular biosynthesis of silver nanoparticles using aqueous extract of Candida viswanathii. J.Bionanosci, 5:53-8.

[51] Li X, Xu H, Chen ZS and Chen G (2011) Biosynthesis of nanoparticles by microorganisms and their applications. J Nanomater. Article 270974.

[52] Luangpipat T, Beattie IR, Chisti Y and Haverkamp RG (2011) Gold nanoparticles produced in a microalga. J Nanopart Res, 13:6439–45.

[53] Sanghi R and Verma P (2010) Microbes as green and eco-friendly nanofactories. Green Chem Environ Sustainable, 15:315–39.

[54] Iravani S (2011). Green synthesis of metal nanoparticles using plants. Green Chem, 13 (10), 2638−2650.

[55] Anastas PT and Zimmerman JB (2007). Green nanotechnology. Why we need a green nano award and how to make it happen. Woodrow Wilson International Center for Scholars.

[56] Raveendran P, Fu J and Wallen SL (2003) Completely “green” synthesis and stabilization of metal nanoparticles. J Am Chem Soc, 125:13940–1.

[57] Panero JL and Funk VA (2002). Toward a phylogenetic subfamilial classification for the Compositae (Asteraceae). Proc. Biol. Soc. Wash, 115: 909-922.

[58] Rajakumar G and Rahuman AA (2011) Larvicidal activity of synthesized silver nanoparticles using Eclipta prostrata leaf extract against filariasis and malaria vectors. Acta Trop, 118:196–203.

[59] Jha AK, Prasad K, Kumar V and Prasad K (2009) Biosynthesis of silver nanoparticles using Eclipta leaf, Biotechnol. Prog, 25, 1476–1479.

[60] Roy N and Barik A (2010) Green synthesis of silver nanoparticles from the unexploited weed resources. International Journal of Nanotechnology and Applications, 4(2) 95-101.

[61] Leela A and Vivekanandan M (2008). Tapping the unexploited plant resources for the synthesis of silver nanoparticles. Afr. J. Biotechnol, 7 (17), 3162−3165.

[62] Parashar V, Parashar R, Sharma B and Pandey AC (2009) Partheniumleaf extract mediated synthesis of silver nanoparticles: a novel approach towards weed utilization. Dig J Nanomater Biostruct, 4:45–50.

[63] Dubey SP, Lahtinen M and Sillanpaa M (2010) Tansy fruit mediated greener synthesis of silver and gold nanoparticles. Process Biochem, 45 (7), 1065−1071.

[64] Dhanalakshmi T and Rajendran (2012) Synthesis of silver nanoparticles using Tridax procumbens and its antimicrobial activity. Archives of applied science research, 4 (3); 1289-1293.

[65] Schrire BD, Lewis GP and Lavin M (2005) "Biogeography of the Leguminosae". In Lewis, G; Schrire, G.; Mackinder, B.; Lock, M. Legumes of the world. Kew, England: Royal Botanic Gardens. pp. 21–54. ISBN 1-900347-80-6.

[66] Thomas, Nesakumar, Jebakumar, Immanuel Edison and Mathur Gopalakrishnan Sethuraman (2013) Electrocatalytic Reduction of Benzyl Chloride by Green Synthesized Silver Nanoparticles Using Pod Extract of Acacia nilotica. ACS Sustainable Chem. Eng, 1, 1326−1332.

[67] Akl M, Awwad, Nidá M, Salem and Abdeen AO (2013). Green synthesis of silver nanoparticles using carob leaf extract and its antibacterial activity. International Journal of Industrial Chemistry, 4:29.

[68] Lin L, Wang W, Huang J, Li Q, Sun D, Yang X, Wang Y (2010). Chem.. eng.j.162, 858.

[69] Chandrakant K, Tagad RD, Sreekanth A, Rohini P, Sungha, Atul Kulkarni and Sushma Sabharwal (2013) Green synthesis of silver nanoparticles and their application for the development of optical fiber based hydrogen peroxide sensor. Sensors and actuators. 183, 144-149.

[70] Ahmad N, Sharma S, Singh VN, Shamsi SF, Fatma A and Mehta BR (2011). Biosynthesis of Silver Nanoparticles from Desmodium triflorum: A Novel Approach Towards Weed Utilization, Biotechnol. Res. Int, 454090.

[71] Rajesh WR, Jaya RL, Niranjan SK, Vijay DM and Sahebrao BK (2009), Phytosynthesis of silver nanoparticles using glirricidia sepium (Jacq.). Curr Nanosci, 5: 117-122.

[72] Das JL (2010) "Medicinal and nutritional values of banana cv. NENDRAN". Asian Journal of Horticulture, 8: 11–14.

[73] Krishnaraj C, Jagan EG, Rajasekar S, Selvakumar P, Kalaichelvan PT and Mohan N (2010) Synthesis of silver nanoparticles using Acalypha indica leaf, Colloids Surf., B, 76, 50–56.

[74] Jha AK, Prasad K, Kulkarni AR (2009) Colloids and Surfaces 118, B: Biointerfaces 73 (2), 219-223.

[75] Ankamwar B, Damle C, Ahmad A and Satry M (2005) Biosynthesis of gold and silver nanoparticles using Emblica of f icinalis fruit extract, their phase transfer and transmetallation in an organic solution. J. Nanosci.118. Nanotechnol, 5 (10), 1665−1671.

[76] Elumalai EK, Prasad K, Hemachandran J, Therasa SV, Thirumalai T, and David E (2010) Extracellular synthesis of silver nanoparticles using leaves of Euphorbia hirta and their antibacterial activities. J. Pharma. Sci. Res, 2 (9), 549−554.

[77] Bar H, Bhui DK, Sahoo GP, Sarkar P, Pyne S and Misra AB (2009) Green synthesis of silver nanoparticles using seed extract of Jatropha curcas. Colloids Surf A: Physicochem Eng Asp, 339: 134–139.

[78] Angiosperm Phylogeny Group (2009) "An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III" (PDF). Botanical Journal of the Linnean Society, 161 (2):105–[121].

[79] Sulaiman GM, Mohammed WH, Marzoog TR, Amiery, Kadhum and Mohamad (2013) Green synthesis, antimicrobial and cytotoxic effects of silver nanoparticles using Eucalyptus chapmaniana leaves extract. Asian Pac J Trop Biomed. Jan; 3(1):58-63.

[80] Sakey Ravindra, Murali Mohan Y, Narayana Reddy N and Konduru Mohana Raju (2010) Fabrication of antibacterial cotton fibres loaded with silver nanoparticles via "Green Approach. Colloids Surf., A, 367, 31–40.

[81] Dubey S, Bhadauria and Kushwah B (2009). Green Synthesis of Nano Ssilver particles from extract of Eucalyptus Hybrida (Safeda) Leaf, Dig. J. Nanomater. Biostruct., 4, 537–543.

[82] Banerjee J and Narendhirakannan RT (2010) Biosynthesis of Silver nanoparticles from Syzygium cumini (L.) seed extract and evaluation of their in vitro antioxidant activities. Dig. J. Nanomater. Biostruct, 6 (3), 961−968.

[83] Stevens PF (2012) "Angiosperm Phylogeny Website". Retrieved version 12.

[84] Sohail Yasin, Lin Liu and Juming Yao (2013) Biosynthesis of Silver Nanoparticles by Bamboo Leaves Extract and Their Antimicrobial Activity. Journal of Fiber Bioengineering and Informatics. 6:1 77–84

[85] Leela A and Vivekanandan M (2008) Tapping the unexploited plant resources for the synthesis of silver nanoparticles. Afr. J. Biotechnol, 7 (17), 3162−3165.

[86] Cynthia Mason, Singaravelu Vivekanandhan, Manjusri Misra, Amar Kumar Mohanty (2012) Switchgrass (Panicum virgatum) Extract Mediated Green Synthesis of Silver Nanoparticles. World Journal of Nano Science and Engineering, 2, 47-52.

[87] Chaudhari PR, Masurkar SA, Shidore VB and Kamble SP (2013) Biosynthesis of silver nanoparticles using Saccharum officinarum and its antimicrobial activity. Micro & Nano Letters, 10.1049/mnl.0135.

[88] Njagi EC, Huang H, Stafford L, Genuino H, Galindo HM, Collins JB, Hoag GE and Suib SL (2010) Biosynthesis of iron and silver nanoparticles at room temperature using aqueous Sorghum bran extracts. Langmuir, 27 (1), 264−271.

[89] Martin F, Wojciechowski, Johanna Mahn, and Bruce Jones (2006) "Fabaceae". The Tree of Life Web Project.

[90] Abhijeet Mishraa, Naveen Kumar Kaushikb, Meryam Sardara and Dinkar Sahalb (2013) Evaluation of antiplasmodial activity of green synthesized silver nanoparticles. Colloids and Surfaces B: Biointerfaces 111, 713– 718.

[91] Asra Praveen, Roy Aashis S and Srinath rao (2012) Biosynthesis and charactacterization of silver nanoparticles from Cassis Auriculata leaf extract and in vitro evaluation of antimicrobial activity. IJABPT ISSN: 0976-4550.

[92] Rao ML and Savithramma N (2011) Biological synthesis of silver nanoparticles using Svensonia Hyderabadensis leaf extract and evaluation of their antimicrobial efficacy. J. Pharm. Sci. Res. 3, 1117−1121.

[93] Peter F and Stevens (2001) Angiosperm Phylogeny Website At: Missouri Botanical Garden Website.

[94] Ali DM, Thajuddin N, Jeganathan K and Gunasekhran M (2011) Plant extract mediated

synthesis of silver and gold nanoparticles and its antimicrobial activity against clinically isolated pathogens. Colloids Surf, B, 85 (2), 360−365.

[95] Ahmad N, Sharma S, Alam MK, Singh VN, Shamsi SF, Mehta BR and Fatma A (2010). Rapid synthesis of silver nanoparticles using dried medicinal plant of basil. Colloids Surf, B, 81 (1), 81−86.

[96] Patil RS, Kokate MR and Kolekar SS (2012) Bioinspired synthesis of highly stabilized silver nanoparticles using Ocimum tenuiflorum leaf extract and their antibacterial activity. Spectrochem. Acta A, 91, 234−238.

[97] Cynthia M, Morton, Jacquelyn and Kallunki A (2007) "Phylogenetic relationships of Rutaceae: a cladistics analysis of the subfamilies using evidence from RBC and ATP sequence variation". Retrieved 08-30.

[98] Prathna TC, Chandrasekaran N, Raichur AM and Mukherjee A (2011), Colloids Surf, B, 82, 152-159.

[99] Kaviya S, Santhanalakshmi J, Viswanathan B, Muthumary J and Srinivasan K (2011) Biosynthesis of silver nanoparticles using Citrus sinensis peel extract and its antibacterial activity. Spectrochim Acta. A Mol Biomol Spectrosc, 79:594–8.