Green Silver Nanoparticles: A Noble Biocrystal

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Abstract: Recent approaches of biological synthesis of nanoparticles is wide because of its ecofriendly, simple technology involved, cost effective, antimicrobial, non toxic etc. The physicochemical nature and properties of nanoparticles also play an important role in the medical, electronics, therapeutics and as diagnostic agents. Green synthesis of nanoparticles are known for its beneficial medicinal effects due to the interference and interactions of secondary metabolites from the plant sources which are responsible for the reduction of silver or electron released during glycolysis etc. Research evidence proved that silver nanoparticles are efficient antimicrobial and antifungal efficacy and therefore has great potential in the preparation of drugs. The aesthetic sense of green synthesis has proved to be the key procedure and potentially efficient.

Key Words: Antibacterial, antifungal, green synthesis, inhibition, nanoparticles, plant extract, sensitive, therapeutic value.

1 INTRODUCTION

Tgreen synthesis has increased awareness towards eco friendly synthesis of metal nanoparticles in few decades and had significant utility in various sectors in alarming rate [1]. Metallic nanoparticles are utilized in a very significant phase of science and in medicine because of its physicochemical and optoelectronic properties, size, antimicrobial, cosmetics, biomedical, food and feed, drug-gene delivery, environment, health, optic –light emitters sensor technology etc.[2], [3]. Nanoscale particles (1-100 nm) are atomic or molecular aggregates responsible for modified larger widely utilized in microelectronics and agriculture [4], [5]. Evidences proved that at an application of nano materials at low dose stimulated the seed germination and growth rate in the crop plants [6]. In Ayurveda, silver nanoparticles are considered as therapeutic, antimicrobial, least toxic to animal cells and therefore even in 1884, aqueous silver nitrate drops werer administered in the eyes of new born's during birth to prevent Neisseria gonorhaea from infected mother [6]. In the World War I, silver were used to detect microbial growth in the wounds of soldiers [7], [8]. Silver nanoparticles are considered as 'Noble' because of its striving utilities in the various fields of science and technology, cost effective as alternate source of synthetic routes and eco friendly nature [1], [9]. Synthesis of nanoparticles from plant extract is considered to be the major green technology [10], [11] and others are from bacteria, fungi etc. which are time consuming and involves various techniques and skilled manpower [12], [13]. Green synthesis employs extracts of various parts of the plants like roots, leaves, fruits, rhizoids, bark, latex which does not require temperature high energy and do not use toxic chemicals [14] and therefore the methods are scaled up because of its cost effectiveness [15], [16], [17]. Silver and its derivatives are known for its disinfecting effect and therefore commercially employed as antimicrobial agents [18] because silver at even low concentration is lethal to microorganism and safe to humans [19], [20].

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Significant researches proved that nanoparticles enhances the pharmacokinetics, drug delivery and therapeutic index of any drug [21], [22], [23]. Silver nano materials are highly sensitive and therefore they are commercialized in the field of molecular detection, as medicine, as carrier drugs, catalyst, biosensors since they are strong against bacteria, fungi, inflammation etc. [24], [25], [26]. Antimicrobial capability of silver nanoparticles has significant applications as additives / protectent in house hold products such as food storage containers, textiles, medical devices and home appliances [27], [28], [29]. Silver nanoparticles posses extra ordinary antimicrobial activities against many microbes and its property has enhanced its applications as a coating material in different medical products such as cerebro spinal fluid drainage catheters [30], [31], surgical masks [32], [33], [34], contact lens [35], wound dressings [36] etc. and they are commercialized and approved by Global regulatory bodies across the World.

2 SYNTHESIS OF SILVER NANOPARTICLES

Evidences stated that some flavonoid derivatives are responsible for the formation of silver nanoparticles and the formation occurred by the reduction of Ag^+ to Ag [37]. Spherical silver nanoparticles were synthesized from Ficus carica (leaf extract) [38], Syzygium cumini (fruit extract) [39], Cacuman platycladi (leaf extract) [40], Erythrina indica (root extract) [41], and the average size ranged from 3 to 118 nm. Silver nanoparticles were synthesized at various concentrations (0.2,0.4,0.6,0.8,1.0 and 1.5 ml) of Artisia monosperma and the development of nanoparticles was observed within 2 h at room temperature (37^0C) and neutral pH conditions [42]. Silver nanoparticles were synthesized from aqueous extracts of Cardio spermum halicabum and Butea monosperma and illustrated that the development of nanoparticles were due to the appearance of brown colour and excitation of plasma vibration [43]. Volkameria intermis (Synonym is Clerodendrum iname – wild jasmine) has been identified having highly therapeutic value in the treatment of various diseases was subjected to green synthesis of silver nanoparticles and developed to the size ranging from 15 to 100 nm and evidences of capping of phytoorganic components over nanoparticles were registered [44], [45].
Silver nanoparticles synthesized from fruit extract of Sambucus nigra (European black elderberry) registered the presence of quinoidal in FTIR analysis [46]. The zeta potential of silver nanoparticles researches by green synthesis revealed to be 54.5mV which proved that the nanoparticles are stable and it is due to electrostatic repulsion [44], [46]. Evidences proved that nanoparticles exhibit visible photo luminescence

and the silver nanoparticles were found to be luminescent at 280 and 561 nm and it is proved that it may be due to the presence of biochemical and antioxidants present from the plant extract [1] and the luminescent was also absorbed from olive leaf extract at 425 nm [47]. Green synthesis of silver nanoparticles from various plant extracts are listed in the Table 1.

Table 1:
Green Synthesis of Silver nanoparticles

Plant Source	*References*
Sirogyra varians	*Salari et al., 2014, [48]*
Erythrine indica	*Sre et al., 2015, [49]*
Gloriosa superba	*Ashokkumar et al., 2013, [50]*
Solanum tricobatum	*Logeswari et al., 2013, [51]*
Acatypha indica	*Krishnoraj et al 2010, [52]*
Ziziphora tenuior	*Sadeghi & Gholamboseinpoor, 2015, [53]*
Beet root	*Bindru & Umadevi, 2015, [54]*
Lemon	*Prathna et al., 2012, [55]*
Azadirachta indica	*Shakeel et al, 2010, [1]*
Scouvrium portula castrum	*Nabikhan et al., 2010, [56]*
Marigold flower	*Padalia et al., 2014, [57]*
Polyalthia longifolia	*Kaviya & Viswanath, 2011, [58]*
Ficus carica	*Ulug et al., 2015, [59]*
Syzygium	*Ram and Vyshnaula, 2013, [12]*
Boswellia	*Savithramma et al., 2011, [21]*
Artocarpus heterophylius	*Thirumurugan et al.,2010, [60]*
Allium cepa	*Saxena et al., 2010, [13]*
Cardiosparonum halicasatum	*Abirami & Sudharameshwari, 2017, [23]*
Plumbago zeylanica	*Saurike et al., 2014, [61]*
Nelumbo mucifera	*Roy & Bharadwaja, 2017, [62]*
Moriga nucifera	*Santhoshkumar et al.,[63]*
Moriga oleifera	*Prasad & Elumalai, 2011, [64]*
Musa paradisca	*Bankar et al., 2011, [65]*
Citrus sinensis	*Kaviya et al., 2011, [66]*
Cymtropogan citratus	*Masukar et al., 2011, [67]*
Calotropis procera	*Gondumala et al., 2013, [68]*
Centella asiatica	*Rout et al., 2013, [69]* *Roy & Bharadwaja, 2017, [70]*
Memecylon edule	*Elavazhagan & Arunachalan, 2011, [71]*
Acoerus edule	*Nakkala et al., 2014, [72]*
Carica papaya	*Jain et al., 2009, [73]*
Argyreia nervosa	*Thombre et al., 2012, [74]*
Brassica rapa	*Narayanan et al., 2012, [75]*
Cynadon dactylon	*Anjana & Geetha, 2017, [76]*
Origannum vulgare	*Mohammed et al., 2018, [77]*
Artemisia monospora	*Eman, 2018, [78]*

3 ANTIMICROBIAL ACTIVITY STUDIES

Antibacterial activity studies with E. coli, Pseudomonas auruginosa, Bacillus subtilis, Proteus vulgaris and Klebsiella pneumoneae were carried out by disc diffusion method [79] and the discs were dipped in silver nanoparticles synthesized from the leaves of Svensmia hyderobadensis and Shore asps.and stem bark of Boswellia sps. [80] wherein, Shorea sps. recorded the highest antibacterial effect against Pseudomonas sps. followed by Klebsiella sps., E.coli, Bacillus sps. and Proteus sps. And Boswellia sps. recored highest activity against Klebsiella sps. followed by E. coli and Proteus sps. It is proved that the ionic silver interacts with thiol group of enzymes and leads to inactivation of their activity [81]. Evidences proved that the silver nanoparticles synthesized from Allium cepa [61], Argimone Mexicana [82], Artocarpus heterophyllum [83] had interfered in the metabolic pathways of microorganisms [66] and it also proved that the metallic nanoparticles had penetrated the microsomal membrane and inhibited oxidation processes [84]. It is proved that silver nanoparticles synthesized through chemical methods showed very less antibacterial activity when compared to nanoparticles synthesized through biological approach and it is proved due to the development of protein coating on the nanoparticles [85], [86]. Silver nanoparticles were synthesized from Origanum vulgase leaf extract and were tested for antibacterial activity against Gram positive and Gram negative strains such as E. coli, P. aeruginosa, S. tyhimusium, S. aureus, S. epidermidis, S. dennei, M. luteus etc. and the results proved that an average of 15 mm zone of inhibition were developed in all the cultured petri plates during their investigation [81]. Antibacterial studies in the silver nanoparticles were carried out with Gram positive (B. subtilis ATCC 6633, Staphylococcus aureus ATCC 25923) and Gram negative bacteria (E. coli ATC 25722 and P. aeruginosa ATCC 27858) and fungi (Candida albicans ATCC 10231) and recorded zone of inhibition from 20.5 to 23 for Gram positive bacteria and 10.5 to 12.5 mm for Gram negative bacteria [66] which was also evident by Elshsharkausy [47], [87], [88], [89]. Silver nanoparticles synthesized from Pulicaria glutinosa plant extract proved to be an alternative control of microorganism and even less risk of toxicity to mammalian cells [90]. Green synthesized nanosilver proved to be fast acting fungicide against species of Aspergillus candida and Saccharomyces sps. [59] and this may be due to the interference of disulphide bonds changes or block of functional operations of the microorganism [53].

4 CONCLUSION

Nanoparticles are being successfully prepared by variety of chemical and physical methods which are highly expensive and hazardous to environment. Green synthesis of nanoparticles is of interest to the scientific community because of development of biologically inspired experimental processes to develop environmentally friendly products of societal applications.

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