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RECENT ADVANCES IN PLANT SYNTHESIS OF NANOMATERIALS

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ABSTRACT

In recent years are witnessed to utilizing dedicated plants as a sustainable, cheap, and ecofriendly source of synthesizing nanomaterials. A variety of reliable waste biomass sources can be utilized as renewable, affordable, and excellent resources for maximizing energy production. A large number of agricultural, forestry, and industrial industries use biomass as a widely available and readily available source of nanomaterial synthesis. The nanomaterials are widely used in a variety of fields at present. Researchers have worked for the last few decades to produce nanomaterials from various types of biomass such as plants, cellulose and bacteria, to produce metallic and carbonaceous nanostructures. This review describes the principle, synthesis method and merits/demerits of plant synthesis method.

KEYWORD: Plant synthesis, biomass, nanomaterials, nanostructure, hydrocarbons.

INTRODUCTION

The use of biomass-based nanomaterials has gained significant attention among researchers and stakeholders due to their cost-effectiveness, environmental friendliness, and ability to replace traditional materials in environmental, agricultural, and industrial environments. In agriculture, forestry, and industry, biomass is a widely available and widely available material that contains renewable carbon sources [1-4]. Waste products, including coffee grounds, can be converted into useful materials by utilizing waste biomass. Biological samples have a wide range of micro-structural properties, making them suitable for use in material design because both their abundance and their variety of microstructural properties allow a wide selection of biomass to be considered. It is unusual for plant derived materials to be able to self-assemble since plants do not multiply as rapidly as viruses or bacteria. As a result of its carbon and heteroatoms, macro-scale biomass offers certain levels of intrinsic doping when thermally treated, providing benefits in other areas. In order to tune the electrochemical properties of the resulting carbons, heteroatom doping from biomass is beneficial. As biomass derived materials are inorganic and dopant-derived, the exact levels and stoichiometry may vary across a broad range of options. We need to develop additional methods to control intrinsic dopant levels and minerals more precisely in the future. Literature reviews have reported that different NPs can be synthesized by prokaryotes (bacteria and actinomycetes) and eukaryotes (yeast, fungi, and plants). In addition to their use for bioleaching metals from mineral ores [5-6], yeasts are preferred for the synthesis of nanomaterials.

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Recent years have seen a great deal of attention paid to bioremediation of toxic metals like copper through biosorption, both as a scientific novelty and as an industrial application. As copper is extracted, beneficiated, and processed, high concentrations of this toxic metal are often found in wastewater from mining. The objective of this review is to review methods for directly synthesizing nanomaterials using plant as a source.

PRINCIPLE AND BACKGROUND OF BIOLOGICAL SYNTHESIS OF NANOMATERIALS

In general there are systems for which help to synthesis nanoparticles either by biological methods or by chemical method. An interaction that drives discrete components to automatically form well-defined geometries is the naturally assembled system. The interaction between atoms or molecules is the characteristics properties of matter. The very existence of life depends on the formation of complex biological structures such as the membrane, higher-order structured proteins, nucleic acids, and multicomponent protein aggregates in living cells, which are created almost exclusively through naturally assembled system [7]. Molecular assembly was first used in synthesising man-made materials during the 1980s by synthetic chemists [8]. Sadly, there is no simple, all-encompassing explanation for how such a system becomes ordered or disordered. Some of the factors involved in the formation of ordered system include the length scale of different interaction potentials, the magnitude of short-range and long-range interactions, and the nature of interactions involved. Nanotechnology has a new branch called bio-nanotechnology, which integrates biological principles with physical and chemical procedures to generate nano-sized particles for specific applications. Using bio-based protocols for nanometallic synthesis is environmentally and economically sustainable, as they are based on green chemistry principles and are easy to scale up for larger production [9]. In recent decades, nanotechnology has focused on biosynthesis of nanoparticles using biological agents like microbes or plant extracts [10].

SYNTHESIS OF NANOMATERIALS

The plant synthesis involves three main steps, namely selecting the reaction medium, selecting the biological reducing agent, and selecting non-carcinogenic substances for the stability of nanoparticles. Some important method for synthesis of nanoparticles is given in following table:

Bottom Up Approaches of Biosynthesis	**Top Down Approaches**
Plant synthesis	Mechanical milling
Fungi	Chemical eatching
Algae	Thermal method by laser
Yeasts	sputtering
Bacteria	Electro-explosion

There are several other biological methods under top up approach reported in literature[11-13]. In recent times, the plant and biological bottom-up synthesis of nanoparticles has drawn more attention from researchers because of their less toxic effects and feasibility. In this approach, nanoparticle synthesis is accomplished using biological systems such as bacteria, yeast, and fungi extracts, plants etc which are also eco-friendly and cost-effective.

In the present day, metal nanoparticles can be synthesized by plants biochemically. As an

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alternative to chemical procedures and physical methods, the plant synthesis of metal nanoparticles (especially gold and silver nanoparticles) is receiving more attention. Plant extracts are highly efficient at synthesizing metal nanoparticles, so they can be applied to a wide range of applications. Several plant extracts can be used for reducing and capping metal nanoparticles in nanoparticles synthesis, providing a valuable alternative to large-scale manufacturing. Using plant extracts to reduce metal nanoparticles (e.g. enzymes, proteins, amino acids, vitamins, polysaccharides, and organic acids such as citrates) is an environmentally safe. In this review, we discuss the plant synthesis of metal nanoparticles using different plant extract.

The first time that rod-shaped nanoparticles have been formed by biomaterials has been reported by Armendariz et al. [14]. A solution with potassium tetracholoaurate concentration of 0.3 mM at pHs of 2-6 at room temperature was used to form gold nanoparticles from wheat biomass. According to the results, wheat biomass was able to reduce Au(III) to Au(0), producing tetrahedral, hexagonal, decahedral, icosahedral multitwinned, irregular, and rod-shaped nanoparticles.

Geranium leaves were treated separately with chloroaurate ions, resulting in rapid metal ion reduction and the formation of gold nanoparticles of variable sizes when exposed to chloroaurate ions. After 60 minutes of reaction, the AuCl4 - ions were almost completely reduced, with particles primarily decahedral and icosahedral in shape (20-40 nm) [15].

The lixivium of sundried C. camphora leaves was used by Huang et al. [16] to produce silver nanoparticles in continuous-flow tubular micro-reactors, where polyols were used as possible reductants. According to Harris et al. [17], the uptake of metallic silver by Brassica juncea and Medicago sativa is limited by the concentration of the substrate metal and the duration of exposure. Phytosynthesis (phytoextraction) of metallic silver nanoparticles was demonstrated by using B. juncea and M. sativa. During 72 hours of exposure to 1000 ppm silver nitrate, B. juncea accumulated up to 12.4% silver.

It was shown that M. sativa [18] could accumulate up to 13.6% silver when exposed to an aqueous medium containing a concentration of silver nitrate for 24 hours. As a result of an increase in the exposure time and substrate concentration of M. sativa, metal uptake was observed to increase. It was determined by TEM analysis that the nanoparticles were approximately spherical, with a mean size of 50 nm, in both cases. There are several reports on potential of plants for synthesis of nanomaterials, but some of the contribution is most important [19-24].

MERITS AND DEMERITS OF PLANT SYNTHESIS

Nanoparticles are relatively easy to prepare by plant synthesis, which is why they are often used in drugs when targeted at specific parts of the body. Nanoparticles penetrate small capillaries and are taken up by cells due to their small size, which enables efficient drug accumulation. In addition to providing good control of size, nanoparticles offer good protection for the drug encapsulated. In addition to increasing therapeutic efficiency and bioavailability, nanoparticles reduced fed/fasted variability, which increased drug stability by retaining the drug at the active site for a longer period of time. A stable dose form for drugs that are either unstable or have low bioavailability when formulated in non-nanoparticulate form. The carrier is biotoxic, while a drug carrying nanoparticles is not. Plant synthesized nanoparticles are natural product, they do not show any toxic effect. This method is nontoxic and product is useful for medical applications [25-26]. Nanomaterials are high

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precision materials with high quality, no specific metallurgical defects, and low cost. However, the product is low powder each time and the cost of the method is high.The main demerits of plant synthesized nanoparticles are highly reactive and unstable and prevent the agglomeration of nanoparticles. The nanoparticles are developed by this method are unequal size. The entire process occurs quickly and easily at room temperature and pressure in a single step reaction. Due to the fact that the waste products are mainly composed of plant biomaterial, they are easily disposed of in the environment as they do not require hazardous chemicals and toxic solvents.

CONCLUSIONS

Plants (especially plant extracts) are able to reduce metal ions more quickly than fungi or bacteria. These nanoparticles are more stable than those produced by other organisms. Furthermore, plant extracts are certainly better than other biosynthesis method in order to scale-up and produce well-dispersed metal nanoparticles in a safe and efficient manner. Plant extracts can be used to synthesize nanoparticles by reducing and stabilizing natural compounds. Different plant extracts and microorganisms can be used to synthesize nanoparticles of different metal. This review discusses the principle, synthesis and merits/demerits of plant metabolites. Future, nanoparticle synthesis by this method will increase productivity of these organisms through genetic modification with improved metal tolerance and accumulation capacity.

REFERENCES

[1]. Maensiri S, Laokul P, Klinkaewnarong J et al (2008) Indium oxide (In2O3) nanoparticles using Aloe vera plant extract: synthesis and optical properties. J Optoelectron Adv Mater 10:161-165.

[2]. Chandran SP, Chaudhary M, Pasricha R et al (2006) Synthesis of gold nanotriangles and silver nanoparticles using Aloe vera plant extract. Biotechnol Prog 22:577-583.

[3]. Singh P, Kim Y-J, Zhang D et al (2016) Biological synthesis of nanoparticles from plants and microorganisms. Trends Biotechnol 34(7):588-599.

[4]. Deng J, Li M, Wang Y (2016) Biomass-derived carbon: synthesis and applications in energy storage and conversion. Green Chem 18(18): 4824-4854.

[5]. Kroger N, Deutzmann R, Sunper M (1999) Polycationic peptides from diatom biosilica that direct silica nanosphere formation. Science 286: 1129-1132.

[6]. He SY, Zhang Y, Guo Z, Gu N (2008) Biological synthesis of gold nanowires using extract of Rhodopseudomonas capsulata. Biotechnol Prog 24: 476-480.

[7]. Palermo V and Samor`ı P 2007 Molecular self-assembly across multiple length scales Angew. Chem. Int. Edn Engl. 46 4428.

[8]. Rubinstein I, Steinberg S, Tor Y, Shanzer A and Sagiv J, 1988,Ionic recognition and selective response in self-assembling monolayer membranes on electrodes Nature 332 426.

[9]. Siavash Iravani, Green synthesis of metal nanoparticles using plants, Green Chem., 2011,13, 2638-2650.

[10]. Parth Malik, Ravi Shankar, Vibhuti Malik, Nitin Sharma, and Tapan Kumar Mukherjee, Green Chemistry Based Benign Routes for Nanoparticle Synthesis, Journal of Nanoparticles, Volume 2014 | Article ID 302429 | https://doi.org/10.1155/2014/302429.

[11]. Albrecht M.A., Evans C.W., Raston C.L. Green chemistry and the health implications of nanoparticles. *Green Chem.* 2006; 8: 417-432.

[12]. Wang Y., Xia Y. Bottom-up and top-down approaches to the synthesis of monodispersed spherical colloids of low melting-point metals. *Nano Lett.* 2014; 4: 2047-205.

[13]. Singh A., Jain D., Upadhyay M.K., Khandelwal N., Verma H.N. Green synthesis of silver nanoparticles using Argemone mexicana leaf extract and evaluation of their antimicrobial activities. *Dig. J. Nanomater. Biosci.* 2010; 5: 483-489.V.

[14]. Armendariz, M. Jose-Yacaman, A. Duarte Moller, J. R. Peralta- Videa, H. Troiani, I. Herrera and J. L. Gardea-Torresdey, Rev.Mex. Fis. Suppl., 2004, 50, 7-11.

[15]. S. S. Shankar, A. Ahmad, R. Pasricha and M. Sastry, J. Mater. Chem., 2003, 13, 1822-1826.

[16]. J. Huang, L. Lin, Q. Li, D. Sun, Y.Wang, Y. Lu, N. He, K. Yang, X.Yang, H. Wang, W. Wang and W. Lin, Ind. Eng. Chem. Res., 2008,47, 6081-6090.

[17]. A. T. Harris and R. Bali, J. Nanopart. Res., 2007, 10, 691-695.

[18]. R. G. Haverkamp, A. T. Marshall and D. van Agterveld, J. Nanopart. Res., 2007, 9, 697-700.

[19]. Mohammadlou M., Maghsoudi H., Jafarizadeh-Malmiri H.J.I.F.R.J. A review on green silver nanoparticles based on plants: Synthesis, potential applications and eco-friendly approach. *Int. Food Res. J.* 2016; 23: 446-463

[20]. Ahmad N., Sharma S. Green Synthesis of Silver Nanoparticles Using Extracts of Ananas comosus. *Green Sustain. Chem.* 2012; 2: 141-147.

[21]. Parveen K., Banse V., Ledwani L. Green synthesis of nanoparticles: Their advantages and disadvantages. *AIP Conf. Proc.* 2016; 1724: 020048.

[22]. S. Senapati, Ph. D. thesis, University of Pune, 2005.

[23]. D. Goodsell, Bionanotechnology: Lessons from Nature, Willey-Less, New Jersey, USA, 2004, pp. 1-8.

[24]. J. Jeevanandam, Y.S. Chan, M.K. Danquah Biosynthesis of metal and metal oxide nanoparticles, ChemBioEng Rev., 3 (2) (2016), pp. 55-67.

[25]. Krutyakov Y.A, Russian Chemical Reviews. Synthesis and properties of silver nanoparticles: advances and prospects, 2008, 77(3); p. 233-257.

[26]. Nishikant C. Shinde, Nisha J. Keskar and Prashant D Argade, Nanoparticles: Advances in Drug Delivery Systems, International Journal of Advances in Pharmacy, Biology and Chemistry, Vol. 1(1), 2012, 1-6.

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