

Sustainable Green Synthesis of Nanoparticles

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The synthesis of nanoparticles (NPs) with diverse chemical compositions, size distributions, and controlled monodispersity is a critical area of research in nanoscience and technology. Recently, metallic NPs have received particular interest in various fields ranging from material science to biotechnology. A large number of reports are available on various aspects of metallic NPs synthesis and applications. Many processes are followed for the synthesis of NPs, including chemical, physical and biological methods. The chemical and physical methods are not usually ecofriendly and have several drawbacks such as high cost, use of toxic chemicals, involvement of expensive instrument, requirement of high pressure and high energy. As a consequence, biosynthesis processes of NPs are gaining importance since these are made in low cost, non-toxic, biocompatible and eco-friendly. Research reports indicate that the biosynthesis of NPs involves basically three main steps, including (1) selection of solvent medium, (2) selection of environmentally benign reducing agent and (3) selection of nontoxic substances as surfactant for particle stability. Green chemistry integration into nanotechnology is especially important when nanomaterials are to be used in medical applications such as imaging, drug delivery, disinfection, and tissue repair [1-4].

The selection of solvent medium and selection of eco-friendly nontoxic reducing and stabilizing agents are the most essential issues which must be considered in green synthesis of metal NPs. Eco-friendly methods of NPs synthesis using microorganisms (bacteria, fungi and algae) and plant (leaf, root, flower and seed) extracts have been suggested as possible environmental free alternatives to chemical and physical methods (Figure 1). The mechanism of synthesis mostly involves the microbial intracellular and extracellular enzymes or the plant phyto-compounds that act on the respective compounds to give the desired NPs. Bacteria,

actinomycetes, yeast and fungi continue to be investigated in synthesis of metallic NPs. The major benefit of using plant extracts for synthesis of NPs is that they are easily available, safe and nontoxic in most cases, with broad variety of metabolites that can aid in the reduction of ions and are quicker than microbes in the synthesis process. The use of plants or plant extracts are the most adopted method of green, ecofriendly production of NPs because the plants are widely distributed, easily available much safer to handle and act as a source of several metabolites. The NPs were prepared by mixing the metal salt with aqueous or solvent extract of plant material. For the preparation of uniform size and shape, the researchers have to optimize the reaction conditions such as concentration of the extract, concentration of metal salts, temperature, pH, medium of the reaction and time of the reaction [5-8].

Figure 1: Ecofriendly approach of NPs preparation.

The main mechanism considered for the process was plant-assisted reduction due to presence of plant phytochemicals. Controlling uniform size, shape, and bulk production of nanoparticles are major challenges for researchers in the field of biological synthesis.

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