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GREEN SYNTHESIS OF METALS NANOPARTICLES AND THEIR APPLICATION

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Nantechnology usually considers objects with at least one of the size dimension below 100 nm. At this size range, particles exhibit properties which are different with macroscale materials. These unusual properties are gaining importance in the areas of biomedical sciences, drug-gene delivery, optics, electronics, energy science, catalysis and many others. That is reason why the production of nanoparticles (gold, silver, platinum, and copper) with innovative applications can be achieved by controlling the size and shape on the nanometer scale.

Nanoparticles exhibits size and shape-dependent properties. Both properties heavily influence the properties of nanoparticles which are of interest for applications ranging from biosensing and catalysts to optics, antimicrobials, and modern electronics. The special interest of the synthesis research is shape design. There are many reports about successful synthesis of nanoparticles with different shapes: nanoprisms, nanostars, nanotriangles, nanocubes, nanorods and others.

In recent years, the development of metallic and metal oxide nanoparticles in an eco-friendly or "green" manner using biological materials has attracted significant attention. Nanoparticles can be prepared by physical, chemical, electrochemical, sonochemical, irradiation, and biological routes. However, the biological route is most preferred and it includes microbial nanosynthesis (use of microrganisms) and phytonanosynthesis (use of plants) approaches. The biogenic reduction of metal ions to the base metal is quite rapid, can be conducted readily at room temperature under sunlight conditions, can be scaled up easily, and the method is eco-friendly. The reducing agents involved include various water-soluble metabolites (e.g., alkaloids, terpenoids, polyphenolic compounds) and coenzymes. Other advantages of phyto-nanotechnology include the safer nature of synthesis, biocompatibility, non-toxic nature, cost-effectiveness, sustainability, and environmental friendliness, as well as a lack of underlined special culture preparation and isolation techniques. In addition, biosynthesis involving the use of plant extracts usually occurs in aqueous medium, which is cheap and offers no limitations in terms of applications.

Despite the extensive studies and wide publicity in the field of phytosynthesis of nanoparticles, there are number of problems which need to be solved. First problem is a achievement of high reproducibility at the green synthesis of nanoparticles using plants. The composition of plant material depends from many factors – solar year, the plants are under a variety of environmental pressures including water stress, lack or excess of essential nutrients, changes in the soil pH, herbivores and parasites attack, competition among species, excess or lack of light exposure and others. Beyond the environmental pressures there is also the incidental (e.g., pollution) and intentional anthropic actions (for instance, application of pesticides and herbicides). Moreover, the age of a plant also may influence in the presence and concentration.

The second problem is scaling-up the production of nanoparticles. The challenges of scaling up the nanoparticles green synthesis using plants include the low abundance of raw materials (e.g., non-cultivated plants), lack of appropriate equipment to render the necessary amounts, difficulty to control the molecular composition, and the heterogeneity of plant extracts.

Predictability of nanostructures formation and activity represents a third problem which needs to be solved. The next few years will demonstrate whether or not simulators will have a feasible application in the green synthesis of nanoparticles.

In order to increase the confidence of the green synthesis of nanoparticles by plants, some paradigm shift must take place. Firstly, researchers have to understand the mechanisms underlying the bioreduction, nucleation, growth, and stabilization of nanoparticles using plants and accept that this task could not be satisfactorily accomplished without a consideration of the phenomenon as whole and including all related variables. Secondly, they should prospect innovative solutions for current and future challenges towards the reliable and efficient use of nanoparticles synthesized using plants.

Finally, researchers must prove that green synthesis of nanoparticles using plants is predictable, reproducible, scalable, and safe to be used on multiple threads.