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# Editorial on Plant-Mediated Synthesis of Iron Nanoparticles

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**Abstract**

In the recent years, nanotechnology has emerged as a state-of-the-art and cutting edge technology with multifarious applications in a wide array of ýelds. It is a very broad area comprising of nanomaterials, nanotools, and nanodevices. Amongst nanomaterials, majority of the research has mainly focused on nanoparticles as they can be easily prepared and manipulated. Physical and chemical methods are conventionally used for the synthesis of nanoparticles; however, due to several limitations of these methods, research focus has recently shifted towards the development of clean and eco-friendly synthesis protocols. Magnetic nanoparticles constitute an important class of inorganic nanoparticles, which ýnd applications in different areas by virtue of their several unique properties. Nevertheless, in comparison with biological synthesis protocols for noble metal nanoparticles, limited study has been carried out with respect to biological synthesis of magnetic nanoparticles. This review focuses on various studies outlining the novel routes for biosynthesis of these nanoparticles by plant resources along with outlining the future scope of work in this area.

Conventional nanoparticle synthesis methods like attrition and pyrolysis have drawbacks such as defective surface formation, low production rate, high cost of manufacturing, and large energy requirement. Chemical synthesis methods (e.g., chemical reduction, sol gel technique, etc.) involve the usage of toxic chemicals, formation of hazardous byproducts, and contamination from precursor chemicals Hence, there is a growing need to develop clean, nontoxic, and environment-friendly procedures for nanoparticle synthesis. Some of the distinct advantages that biological synthesis protocols have over the conventionally used physical and chemical methods are

(a) clean and eco-friendly method, as toxic chemicals are not used

(b) the active biological component like enzyme itself acts as a reducing and capping agent, thereby reducing the overall cost of the synthesis process

A very wide range of biological resources like microorganisms (bacteria, yeast, fungi, algae, and viruses) and plants can be used for nanoparticle synthesis. While microbe-based protocols have been developed from the cumulative research efforts of several authors, plant-mediated biological synthesis of nanoparticles has gained importance only in the recent years . Plant extracts reduce the metal ions in a shorter time as compared to microbes. Depending upon plant type and concentration of phytochemicals, nanoparticles are synthesized within a few minutes or hours, whereas microorganism-based methods require a longer time. The major drawback of microbe-mediated nanoparticle synthesis is the obligatory constraint of aseptic conditions, which requires trained staff, and raises the scaling-up cost. All these reasons, along with the easy availability of plants in nature, make them more preferred biological resources than microbes.

Magnetic nanoparticles have emerged as a new class of important nanoparticles as they possess many exceptional properties like superparamagnetism, high coercivity, and so forth. These nanoparticles, when synthesized by conventional methods, have several limitations such as the following.

(a) Nanoscale zero-valent iron particles (nZVI) synthesized by physical and chemical methods are highly reactive in nature and tend to form aggregates, which ultimately results in loss of reactivity .

(b) The magnetic nanoparticles synthesized by conventional methods cannot be used in biomedical applications wherein nonpolar organic solvents are used .

A review paper on microbial synthesis of magnetic nanoparticles has been published by Abhilash et al. Two principal mechanisms, namely, biologically induced mineralization (BIM) and biologically controlled mineralization (BCM), have been discussed, by which microbes synthesize iron oxide nanoparticles. However, plant-mediated synthesis of magnetic nanoparticles has remained a relatively unexplored research area with the majority of papers being published only in the last two years. To the best of our knowledge, a comprehensive review article summarizing the notable ýndings of researchers in this ýeld has not been produced. This paper aims to ýll this lacuna and provide an updated consolidation of the published literature regarding biosynthesis of magnetic nanoparticles by plant resources along with its advantages and future scope of work in this area. The paper is divided into three main sections depending upon the usage of plant resources for nanoparticle synthesis, namely, in the form of the extract, whole plant part (biomass), and as a template.