Green Synthesis of Zinc Nanowires using *Spilanthes acmella* Leaf Extract

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**Abstract**

Biogenic synthesis of metal nanomaterials has garnered attention in current nanobiotechnology. Among other metal nanoparticles, zinc nanoparticles have gained importance due to their applications in diverse fields. In this paper, we report on the biological synthesis of zinc nanowires using *Spilanthes acmella* leaves extract as a reducing agent. Synthesized nanoparticles have been confirmed by Transmission Electron Microscopy (TEM). The characterization revealed the wire shape of zinc nanoparticles.

**Keywords:** *Spilanthes acmella*, Zinc nanowires, TEM, Green synthesis

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**Introduction**

Nanotechnology deals with the creation, manipulation and utilization of materials ranging in nanometers\(^5\). Recently, the potential applications of II-VI semiconductor nanoparticles are being considered in diverse fields due to their optical and electrical properties that depend on the size and shape of the nanoparticles\(^6\). Among the metal nanoparticles, zinc nanoparticles have grasped the attention of researchers due to their significant applications in various areas because they are stable under variable circumstances and are also safe materials to human beings\(^3\).

Synthesis of metal nanoparticles is an interesting topic due to their exceptional as well as dynamic properties which do not exist in its bulk form\(^4\). A range of physical and chemical methods have been exploited for the synthesis of nanoparticles, but most of these techniques are expensive and require toxic chemicals\(^5\). Also, these methods are potentially hazardous to health and cause adverse effects on the environment. Due to these drawbacks, scientists are focusing on the development of biological methods for the synthesis of nanoparticles\(^6,7\).

Currently, scientists are focusing on biological methods which involves the use of plants and microorganisms for the generation of nanoparticles\(^8,9\). Nanoparticles synthesis using microorganisms is a very tedious route because these microbes require extremely aseptic conditions, maintenance and needs to subculture\(^10\). In comparison with microorganisms, the use of plants is more beneficial for the synthesis of nanoparticles because it does not require any particular procedures. Due to its environment friendly nature, the use of plant system for the biosynthesis of nanoparticles is considered as a very trustworthy method\(^11\).

*Spilanthes acmella* is an ornamental plant that has been a part of traditional medicine through many generations. This plant is currently in preliminary stages of research due its high therapeutic value\(^12\). Nanoparticles synthesized from such medicinal plants might offer new range of prospectus to boost the targeting of approved diagnostics and therapeutics\(^13\).

The present study was aimed to synthesize zinc nanoparticles using leaves extract of *Spilanthes acmella*. To the best of our knowledge, this is the first report on *Spilanthes acmella* plant system for the synthesis of zinc nanowires.

**2 Materials and Methods**

2.1 Preparation of extract

*Spilanthes acmella* plant leaves were collected from Aurangabad District, Maharashtra, India. 20 gm leaves were
washed with tap water and then with sterile distilled water. *Spilanthes acmella* leaves were homogenized with 80 ml of distilled water and filtered through Whatman filter paper no.1. The extract was stored in refrigerator for further experimental use.

2.2 Synthesis of zinc nanoparticles

8 ml of *Spilanthes acmella* leaf extract was mixed with 20 ml of 3 mM zinc sulphate solution. This reaction mixture was incubated for 24 hours. Reduction of zinc ions to zinc oxide nanoparticles was monitored by a colour change of reaction mixture, was observed after incubation.

2.3 Transmission Electron Microscopy (TEM) analysis

The size, shape and morphology of synthesized zinc nanowires were characterized by Transmission Electron Microscopy. TEM analysis was performed on a PHILIPS- Model No- CM200 instrument at IIT-SAIF, Bombay, India. Prior to the sample preparation for TEM analysis, sonication of sample was done for 10 min.

3 Results and Discussions

The present study explains an ecofriendly method for the biogenic reduction of zinc nanoparticles. The process is simple which involves mixing of aqueous leaves extract with 3 mM ZnSO₄ solution. The production of zinc nanowires achieved.

3.1 Visual observation

Shah et al., biosynthesized Zn nanoparticles using aqueous extract of *Camellia sinensis* leaves. After one hour incubation of the leaf extract with Zn nitrate, the color change from pale yellow to pale brown was observed. Manokari et al., generated Zinc oxide nanoparticles by using the aqueous plant extracts of *M. mercurialis*. After incubation at room temperature, color change was observed in the reaction mixture. This change in colour indicates the formation of Zn nanoparticles. Similarly, the result obtained in the present study revealed that *Spilanthes acmella* leaves extract was exposed to 3 mM ZnSO₄ solution to which reduces a salt to its metallic nanoparticles. Several bioactive compounds present in *Spilanthes acmella* might be responsible for the biosynthesis of zinc nanowires.

3.2 TEM analysis

The appearance of color change in the reaction vessel indicated formation of zinc nanoparticles. Therefore, reaction mixture was further characterized by TEM. In present investigation, TEM micrographs taken at the range of 500 nm and 1 µm, revealed the generated zinc nanoparticles, having wire shape (Fig 2). Rajeshwari et al., reported that the biosynthesized zinc oxide nanoparticles from *Tabernaemontana divaricate* leaves were spherical in shape.

4 Conclusions

In the present study, we report a green approach for the synthesis of zinc nanowires using *Spilanthes acmella* leaves extract. This is ecofriendly and cost-effective method for the synthesis of zinc nanoparticles. Characterization of the generated zinc nanoparticles was carried out by TEM; it revealed that the zinc nanoparticles are wire shaped.

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6 Conflict of interest

The authors declare that they have no conflict of interest.

7 Author’s contributions

NP designed the experiment. NP, EK, HT and SJ carried out literature review and draft the manuscript. All authors have
participated in experimental work. GK, SJ and PK involved in characterization of nanoparticles. All authors read and approved the final manuscript.

8 References


