Biological synthesis of nanoparticles using *Aloe vera*, *Chamomile*, and *Licorice* extracts

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Abstract

Nanotechnology is now an integrated feature of most modern research in agriculture. Nanomaterials are being widely used for enhancing soil fertility and strengthening its organic cycle and subsequently, improving yields of important crops. These particles can be prepared easily through different chemical, physical, and biological approaches. In this paper, biological method of preparation of Zinc, Iron, and Silver nanoparticles are described using the extracts of three medicinal plants which are commonly used for their important pharmaceutical properties, namely chamomile, licorice, and aloe vera. Also, the analytical techniques used to confirm the quality of the produced bio-NPs are explained.

Keywords: aloe vera, biological synthesis, chamomile, herbal extract, licorice, nanoparticles

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Introduction

Nanotechnology deals with the production, manipulation, and use of material ranging in nanometers. Originally flourished in material science, it is considered as one of the most active areas of research not only in modern material sciences (Parthasarathy et al., 2016), but also in most other areas of scientific inquiry.

Given its potentials, nanotechnology has also found important applications in agricultural practices. These include, but are not limited to,enhancing soil fertility and strengthening its organic cycle (e.g., through application of nanofertilizers), pesticides and pest controlling programs, and improving crops and cultivating strategies (Khushbakht et al., 2021).

Of immediate relevance to plant physiology is investigation of the effects of nanoparticles on biochemical, physiological, and morphological attributes of plants with nutritional, medicinal, and industrial values. These effects on plant growth and metabolism can be both favorable and harmful (Ma et al., 2010). Variations in the basic elements and forms of nanoparticles (e.g., metals such as Ag, Cu, and Zn, and also their oxides), modes of applications (e.g., foliar spraying, through irrigation water, etc.), dose of application,

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plant growth stage of application (exposure time), and the very plant species receiving the treatment open up a huge area of research in the field. To these, one can add various types and levels of abiotic stresses to investigate the mechanism of effects of nanomaterial on plants under salinity, drought, and stresses.

Nanoparticles have been shown to be effective in inducing secondary metabolites and physiological responses in plants. In fact, reports on the application of NPs as elicitors to induce the production of secondary metabolites are already available. NPs have been reported to be capable of relieving reactive oxygen species (ROS) accumulation and malondialdehyde (MDA) contents of plant organs by induction of antioxidant enzyme activities (Lei et al., 2008). Similarly, phenols and flavonoids are found to be induced by nanoparticles (Ghorbanpour, 2015; Homaee and Ehsanpour, 2015). Shavalibor et al. (2021) observed that bio-synthesized Silver nanoparticles (Ag NPs) stimulated growth indices and improved secondary metabolite contents of *Melissa Officnalis* L. In another study, Ghorbanpour and Hadian (2015) used carbon nanotubes as an elicitor to produce rosmarinic and caffeic acids in *Satureja khuzestanica*. Also, the positive effects of Ag NPs such as growth promotion and biochemical attributes (chlorophyll, carbohydrate, protein contents, and antioxidant enzymes) have been reported n Indian mustard, common bean, and maize (Salama et al., 2012; Gruyer et al., 2013).

NPs are generally prepared by using various techniques such as dispersion of preformed polymers, polymerization of monomers, and ionic gelation or co-aeration of hydrophilic polymers (Parthasarathy et al., 2016`). Along with chemical and physical routes, green synthesis procedures are recently attracting more and more attentions (Sathishkumar et al., 2016; Vithiya and Sen, 2011) since biological methods are generally considered as non-toxic and environmentally friendly practices (Gurunathan et al., 2009). Biological methods of NPs synthesis usually involve using plants and their extracts, algae, microorganisms, and enzymes and biomolecules.

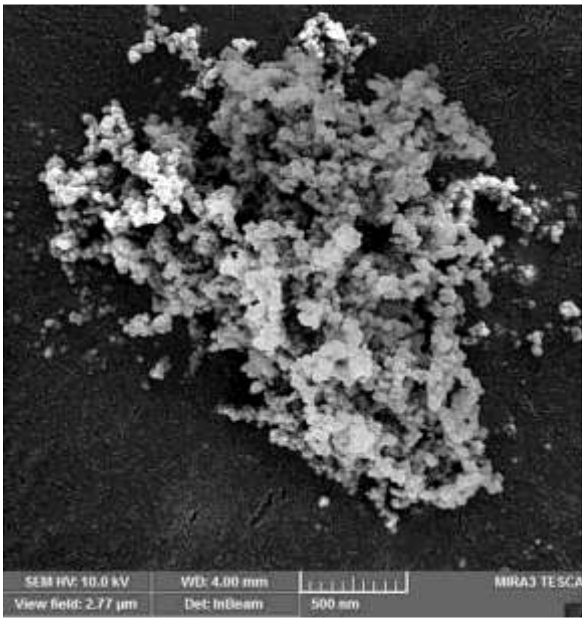

Fig I. SEM image of Iron oxide nanoparticles

The use of plants and their extracts as reducing agents is a very feasible, cost-effective, and eco-friendly method for the production of NPs.In this paper, biological method of preparation of Zinc, Iron, and Silver nanoparticles are described using the extracts of three medicinal plants which are commonly used for their important pharmaceutical properties, namely chamomile, licorice, and aloe vera.

Bio-NPs synthesis method

Prepare fresh Aloe vera gel, chamomile flowers, or roots of licorice (20 g) and shadowed-air dry at room temperature for ten days. Then keep plant materials in the hot air oven at 60 ℃ for 24-48 hours. Pulverize the relevant parts of each plant and macerate them with ethanol (70%). Filter the extracts through Whatman filter paper (No. 1).

To synthesize nanoparticles, add 100 mL 0.005 M Zinc acetate ($ZnC_4H_6O_4$), 100 mL 0.001M Iron chloride ($FeCl_2$) plus 0.002 M Iron nitrate ($Fe(NO_3)_3$) or 100 mL 0.001M Silver nitrate salts solution to double distilled water containing 10% aloe vera gel, chamomile flower, or licorice root extracts along with 1 M Sodium hydroxide, 1 M Ammonia and 1 M Sodium borohydride as a catalyst and stir severely. The immediate change of color at this stage indicates the formation of

Silver (Ag), Zinc (Zn), or Iron (Fe) nanoparticles. Dry and then powder the samples with a mortar (Khaghani and Ghanbari 2017; Asadian et al., 2020) before using them in your experimental studies.

Analytical techniques

During nanoparticle formation, the surface plasmon resonance (SPR) can be visualized by the change in its color and is measured with a UV-vis spectrophotometer over the entire reaction period. The size and shape of the formed nanoparticles are determined using a transmission electron microscope (TEM) (here Hitachi 7600 with an accelerating voltage of 120 kV), and its crystalline nature is determined using an X-ray diffraction pattern. The compounds present in extracts are analyzed using Fourier Transform Infrared (FTIR) spectroscopy.

Scanning electron microscopy (SEM) images of Iron oxide nanoparticles are illustrated in Fig.(I), These SEM results show synthesis of nanoparticles with suitable dispersion and mediocre diameter less than 40 nm. As expected, due to magnetic properties a little agglomeration is observed. SEM images of ZnO nanoparticles are shown in Fig. (II). These images depict nanoparticles with diameter about 30 nm. Figure (III) shows X-ray diffraction pattern (XRD) graph of hexagonal phase of ZnO (80-0075 JCPDS, number 227 of Fd-3m space group). Finally, Fig. (IV) shows XRD of Iron oxide that is in agreement with the literature and shows an inverse spinel cubic phase (JCPDS Number:75-0033).

Conclusion

Nanoparticles present a desirable platform for a diverse range of applications. In this paper, synthesis of Silver, Zinc, and Iron nanoparticle was described using materials sampled from three different medicinal plant species. Even though these bio-synthesized nanomaterials are mainly prepared for subsequent investigation of their therapeutic effects, the basics of biological method of preparing nanoparticles used in agriculture and studies in the field of plant physiology are the same.

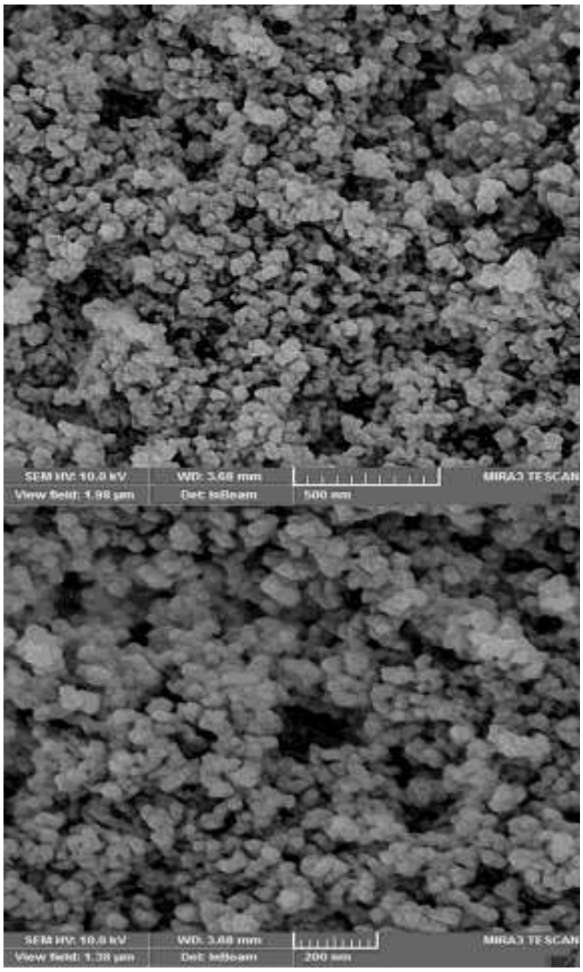

Fig. II. SEM images of Zinc oxide nanoparticles

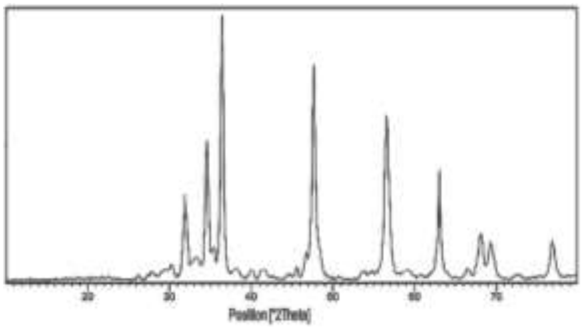

Fig.III. XRD pattern of zinc oxide nanoparticles

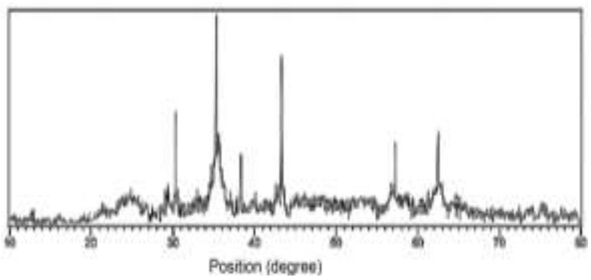

Fig. IV. XRD pattern of iron oxide nanoparticles

Using natural sources, i.e. plant extracts, for preparation of nanoparticles and their applications in agricultural practices affords a safe, eco-friendly, and cost-effective solution for research to improve crops with nutritional, pharmaceutical, and industrial significance

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