Synthesis of Nano Particles From Aloe Vera Extract – Review Paper

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Abstract: In modern science Nanotechnology is an ablaze field for the researchers. Nanoparticles are used immensely due to its small size, orientation, physical properties, which are reportedly shown to change the performance of any other material which is in contact with these tiny particles and having a size of 1-100 nm in one dimension, is used significantly concerning medical chemistry, atomic physics and all other known fields. These particles can be prepared easily by different chemical, physical, and biological approaches. For the past few years, there has been a considerable research on the basis of Novel drug delivery system, using particulate vesicle systems as such drug carriers for small and large molecules. Nanoparticles have been improving the therapeutic effect of drugs and minimize the side effects. Basically, Nanoparticles have been prepared by using various techniques as such dispersion of preformed polymers, polymerization of monomers and ionic gelation or co-aeration of hydrophilic polymer.

Keywords: Nanoparticles, Green Synthesis, Aloe Vera, Nanotechnology, Polymeric Nanoparticles

Introduction:

Nano materials have attracted tremendous interest due to their noticeable performance in electronics, optics, and photonics. Nano materials are typically classified into three groups: 0-dimensional, 1-dimensional and 2-dimensional. 0-dimensional nanostructures, referred to as quantum dots or nanoparticles with an aspect ratio near unity, have been extensively used in biological applications (Liu et al., 2010; Hoshino et al., 2004). 2-dimensional nano materials, such as thin films, have also been widely used as optical coatings, corrosion protection and semiconductor thin film devices. One-dimensional (1D) semiconductor nanostructures such as nanowires, nano rods (short nanowires), nano fibres, nano belts and nanotubes have been of intense interest in both academic research and industrial applications because of their potential as building blocks for other structures (Weintraub et al., 2010). 1D nanostructures are useful materials for investigating the dependence of electrical and thermal transport or mechanical properties on dimensionality and size reduction (or quantum confinement) (Xia et al., 2003). They also play an important role as both interconnects and functional units in the fabrication of electronic, optoelectronic, electrochemical and electromechanical nano devices (Yi et al., 2005). Among the one-dimensional (1D) nanostructures, zinc oxide (ZnO) nanowire is one of the most important nano materials for nanotechnology in today’s research (Wang, 2009).

Nanotechnology is a modern field of science which plays a dominant role in day to day life aspects and it is making an impact in all spheres of human life and creating a growing sense of excitement in the life sciences especially biomedical devices and in other field (Prabhu et al., 2010). Nanotechnology deals with production, manipulation and use of material ranging in nanometres (Kavitha et al., 2013). Human life gets an impact role in all sphere mainly in the field of nanotechnology (Jannathul Firdhouse et al., 2012). The field of nanotechnology is one of the most active areas of research in modern material sciences. Nanoparticles exhibit completely new or improved properties based on specific characteristics such as size, distribution and morphology. Nanoparticles of noble metals, such as gold, silver, platinum and zinc oxide are widely applied in products that directly come in contact with the human body, such as detergent, cosmetic products and tooth paste, besides medical and pharmaceutical applications.

There are various methods for NPs formation such as sol-gel process, chemical precipitation, hydrothermal method, microwave, chemical vapour deposition (Sharma et al., 2009; Parvulescu et al., 2010). The above methods involve the usage of hazardous reagents for synthesis of nanoparticles. In view of an environmental sustenance, there is an urgent need to develop an eco-friendly method of synthesis of nano materials. Therefore, there is a growing need...
to develop environmentally friendly processes for nanoparticle synthesis without using toxic chemicals. Biological methods for nanoparticle synthesis using microorganisms, enzymes and plants or plant extracts have been suggested as possible eco-friendly alternatives to chemical and physical methods (Shankar et al., 2004; Vigneshwaran et al., 2007). Biological methods of synthesis have paved way for the “greener synthesis” of nanoparticles and these have proven to be better methods due to slower kinetics, they offer better manipulation and control over crystal growth and their stabilization. This has motivated an upsurge in research on the synthesis routes that allow better control of shape and size for various nano-technological applications.

General description of Aloe vera

Aloe vera is a hardy, perennial, tropical, drought-resistant, succulent plant belonging to the Liliaceae family which, historically has been used for a variety of medicinal purposes. It has a vast traditional role in indigenous system of medicine like ayurveda, siddha, unani and homeopathy. Clinical evaluations have revealed that the pharmacological active ingredients are concentrated in both the gel and rind of the Aloe vera leaves. Aloe vera is a stem less or very short-stemmed plant growing to 60–100 cm height, spreading by offsets. Mature plants can be grown as tall as four feet with average height around 26-28 inches. Each plant has 12 to 16 leaves usually and weighs up to 2-3 kg on maturity. The plants can be harvested after every 6 to 8 weeks by removing 3-4 leaves per plant. It produces erect unbranched flowering stalks in the second year in winter season, which grows 90-150 cm tall. It bears bright yellow and orange flowers, which are arranged in auxiliary spike (Bunyapraphatsara et al., 1996; Langmead et al., 2004).

It bears thick fleshy leaves in rosette, which gives it a distinct appearance. The leaves are green to grey-green, with some varieties showing white flecks on the upper and lower stem surfaces. The margin of the leaf is serrated and has small white teeth. The flowers are produced in summer on a spike up to 90 cm height, each flower pendulous, with a yellow tubular corolla 2–3 cm long (Wynn, 2005). Like other Aloe species, Aloe vera forms arbuscular mycorrhiza, a symbiosis that allows better access of the plant to mineral nutrients in soil (Lorenzetti et al., 1964).

Traditional properties

A. vera has been one of the most important plants used in folk medicine. The Egyptians referred to Aloe as the "plant of immortality" and included it among the funerary gifts buried with the pharaohs. The healing benefits of Aloe were recognized in the ancient Indian, Chinese, Greek and Roman civilizations. It is traditionally used to heal wounds, relieve itching and swelling and is known for its anti-inflammatory and antibacterial properties. A. vera is a member of the lily family and is very cactus like in its characteristics. It is one to two feet tall and its leaves are succulent, broad at the base and pointed at the tips, with spines along the edges (Jones, 2007).

It is used in Ayurvedic formulations for appetite stimulant, purgative, emmenagogue and antihelmintic, cough, colds, piles, debility, dyspnea, asthma and jaundice. It is widely used in Ayurvedic formulations for liver protection and general debility. Hair oil made from A. vera helps to prevent premature graying of hair and makes them strong and free from dandruff. Ayurvedic formulation made of juice from A. vera helps to improve immunity and protects heart, brain and other vital organs of body. The healing effect of aloe results from its ability to prevent injury to epithelial tissues and promote healing of injured tissues. It also has antibacterial and antifungal qualities and increases blood flow to wounded areas. It stimulates fibroblasts, the skin cells responsible for wound healing and the manufacture of collagen, the protein that controls the aging process of the skin and wrinkling.

The skin absorbs A. vera up to four times faster than water; it appears to help the pores of the skin open and receive the moisture and nutrients of the plant. Due to its soothing and cooling qualities, A. vera recommends for a number of skin conditions. The leaf gel is applied several times a day for light burns and wounds, for mild sun burn apply the paste on affected areas and wash it off after 15 minutes. In addition to the skin, other epitheliums in our body include the lining of the gut, the bronchial tubes and the genital tract, which also benefit from the healing effect of A. vera (Joseph and Raj, 2010)

When taken internally, A. vera juice aids the digestion and absorption of nutrients, helps control blood sugar, increases energy production, promotes cardiovascular health, improves liver function, and boosts the immune system. The pulp is used extensively for treating constipation, enlargement of spleen, zymotic disease and chengamaari (a type of venereal infection). For balancing digestion and elimination take 1 tablespoon A. vera gel in the morning on an empty stomach. Aloe helps clear the toxins out of the digestive system, facilitates digestion and improves the functioning of the kidneys, liver and gall bladder (Agarwal and Sharma, 2011).
Synthesis of silver Nanoparticles from Aloe vera

Silver nanoparticles are receiving an increased attention in the field of agriculture. The study of antifungal properties of green synthesised silver nanoparticles (AgNPs) from Aloe vera leaf extract against two pathogenic fungus Rhizopus sp. and Aspergillus sp. are carried out. Results revealed that synthesised nanoparticles showed strong absorption maximum at 400 nm corresponding to the surface plasmon resonance. The prepared nanoparticles were characterized by SEM, FT-IR and UV–Vis spectroscopy. From the scanning photograph it is clear that particles are heterogeneous in shape such as rectangular, triangular and spherical with uniform distribution. FT-IR study showed sharp absorption peaks at 1,631 and 3,433 cm\(^{-1}\) for amide and alcoholic hydroxide groups, respectively. On the other hand, synthesised silver nanoparticles showed highest antifungal activity against Aspergillus sp. than Rhizopus sp. by application of 100 μL of 1 M silver nanoparticles with maximum inhibition of the growth of fungal hyphae. However, microscopic observation revealed that synthesised nanoparticles caused detrimental effects on conidial germination along with other deformations such as structure of cell membrane and inhibited normal budding process of both the tested species. Therefore, it has been concluded that Aloe vera leaf extract origin silver nanoparticles have tremendous potentiality towards controlling pathogenic fungus. However, further research is needed to check the efficacy of size-dependent AgNPs on different species of fungus (Shreya Medda et al., 2014).

The synthesised AgNPs were crystalline with sizes of 70.70 ± 22-192.02 ± 53 nm as revealed using XRD and SEM. The sizes of AgNPs can be varied through alteration of times and temperatures used in their synthesis. These AgNPs were investigated for potential use as an antibacterial agent to inhibit pathogenic bacteria. Their antibacterial activity was tested on P. aeruginosa and S. aureus. The results showed that AgNPs had a high antibacterial which depended on their synthesis conditions, particularly when processed at 100°C for 6 h and 200°C for 12 hrs. The cytotoxicity of AgNPs was determined using human PBMCs revealing no obvious cytotoxicity. These results indicated that AgNPs@AV can be effectively utilized in pharmaceutical (Patcharaporn Tippayawat et al., 2016).

Sarah Ibrahim hashoosh et al., 2014, explained the role of Aloe vera extract as a reducing agent for the production of Ag nanoparticles. The UV-VIS spectrophotometer showed shift peak at 400nm and scanning electron microscope (SEM) showed the rectangular morphology of as prepared Ag nanoparticles with a size of (500) nm. These nanoparticles gave significant effect on Gram negative bacteria E.coli and Gram positive bacteria S.aureus at concentration 3.5 mg\(\text{ml}\)⁻¹, but it did not have any antifungal effect on Candida albican, Pencillium spp and Aspergillus niger.

Evaluation of the antifungal properties of green synthesised silver nanoparticles (AgNPs) from Aloe vera leaf extract against two pathogenic fungus Rhizopus sp. and Aspergillus sp was examined by Shreya Medda et al., 2014. Results revealed that synthesised nanoparticles showed strong absorption maximum at 400 nm corresponding to the surface plasmon resonance. The prepared nanoparticles were characterized by SEM, FT-IR and UV–Vis spectroscopy. From the scanning photograph it is clear that particles are heterogeneous in shape such as rectangular, triangular and spherical with uniform distribution. FT-IR study showed sharp absorption peaks at 1,631 and 3,433 cm\(^{-1}\) for amide and alcoholic hydroxide groups, respectively. On the other hand, synthesised silver nanoparticles showed highest antifungal activity against Aspergillus sp. than Rhizopus sp. by application of 100 μL of 1 M silver nanoparticles with maximum inhibition of the growth of fungal hyphae. However, microscopic observation revealed that synthesised nanoparticles caused detrimental effects on conidial germination along with other deformations such as structure of cell membrane and inhibited normal budding process of both the tested species. Therefore, it has been concluded that Aloe vera leaf extract origin silver nanoparticles have tremendous potentiality towards controlling pathogenic fungus. However, further research is needed to check the efficacy of size-dependent AgNPs on different species of fungus.

The various plant materials for the biosynthesis of nanoparticles is considered a green technology, as it does not involve any harmful chemicals. The study reports that silver nanoparticles (Ag NPs) were synthesized from a silver nitrate solution by commercially available plant powders, such as Solanum tricocbatum, Syzygium cumini, Centella asiatica and Citrus sinensis. Ag NPs were characterized by UV–vis spectrophotometer, X-Ray Diffraction (XRD), Atomic Force Microscopy (AFM) and fourier transform infrared (FTIR) spectroscopy. The formation and stability of the reduced silver nanoparticles in the colloidal solution were monitored by UV–vis spectrophotometer analysis. The mean particle diameter of silver nanoparticles was calculated from the XRD pattern, according to the line width of the plane, and the refraction peak, using Scherrer’s equation. AFM showed the
irregular shapes of Ag NPs, and the formation of silver nanoparticles was found to be 53, 41, 52 and 42 nm, corresponding to Syzygium cumini, Citrus sinensis, Solanum tricocatum and Centella asiatica, respectively. FTIR spectroscopy confirmed the presence of protein as the stabilizing agent surrounding the Ag NPs. Antimicrobial activity of the silver bio-nanoparticles was performed by a well diffusion method. The highest antimicrobial activity of Ag NPs synthesized by C. sinensis and C. asiatica was found against Pseudomonas aeruginosa (16 mm). The Ag NPs synthesized in this process were found to have efficient antimicrobial activity against pathogenic bacteria (Logeswari et al., 2013).

Synthesis of Zinc Oxide Nanoparticles from Aloe vera

Lakshmi et al., 2012 have reported the antibacterial study of zinc oxide nanoparticles synthesized from Aloe vera hot extract (ZnO-AH), cold extract (ZnO-AC) and chemical method (ZnO-C) on six clinically isolated strains namely, Bacillus subtilis, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Salmonella typhi and Staphylococcus aureus. Significant activity was seen in the zinc oxide particles synthesized by chemical method and particles obtained using Aloe vera cold extract. ZnO-AH showed lesser activity. There was a significant difference in the antibacterial activities of ZnO-AH and ZnOAC though both synthesized in a similar manner. This variation was because of the size as the size of ZnO-AH is much more than that of ZnO-AC. The smaller the size of nanoparticles better is their activity (Yamamoto 2001, Makhluf et al., 2005).

Mamia et al., 2014 reported a novel synthesis for In3O2 and ZnO Nanoparticles with particle sizes in the range of 10 to 30 nm using indium nitrate and zinc nitrate solutions. They utilized A. vera extract as a solvent instead of organic solvents. The antibacterial and antifungal activities of the particles were studied using S. aureus, S. pyogenes, P. aeruginosa, E. coli and S. typhi and the fungal strains were A. niger, A. flavus, A. fumigatus, Rhizopus indicus and Mucor indicus. Highest inhibitory activity against the tested bacteria were displayed by the extracts with ZnO + In2O3 + A. vera. A. niger growth was also inhibited by the extract. It was concluded that ZnO nanoparticles mixed with A. vera were effective in inhibiting bacterial growth.

Nano-sized ZnO particles of specific morphology were synthesized using the plant leaf extracts of Aloe vera. The structures, morphology, optical properties, surface area and thermal behaviour of these fabricated ZnO nanoparticles were characterized by X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Ultra violet visible spectroscopy (UV-vis), Photoluminescence (PL)/ fluorescence spectroscopy, Brunauer-Emmett-Teller (BET) analysis and Thermo gravimetric analysis (TGA). Photo degradation and antibacterial activity of the nanoparticles were studied (Elizabeth Varghese and Mary George, 2015).

Ayeshamariama et al., 2014 studied about the development and analysis of disease treatments and preventive measures to avoid any dangerous outbreak of epidemic proportions are important. Modern methods of detection and treatment include tissue culture, nanotechnology, radiation, and laser technology. We report the synthesis of nanocrystalline materials by combustion methods with Aloe vera extract powder. ZnO + A. vera produces a change in its structural and optical properties. Structure, microstructure and optical characterizations of the as-prepared nanocrystalline ZnO (ZnO + A. vera) powders were carried out using XRD, TEM and SEM to determine their morphology. Antibacterial and antifungal tests show that ZnO nanoparticles mixed with A. vera are effective in inhibiting bacterial growth.

Jeeya Lakshmi et al., 2012 study involved synthesis of Zinc Oxide nanoparticles using biological and chemical reducing agents. The aim was to compare the yield, nature and antimicrobial activity of nanoparticles synthesized by the two methods. In biological method, hot and cold Aloe vera leaf extract; and in chemical method, sodium hydroxide was used as reducing agents. Nanoparticles synthesized by the two methods were characterized by XRD and SEM. It was evident from SEM images that particles obtained by biological method were rod shaped and those synthesized by chemical method were spherical. Antibacterial study was carried out on gram-positive and gram negative bacterial strains by agar-well diffusion method and their MIC values were determined. ZnO-AC showed almost consistent activity on all the strains, whereas ZnO-AH and ZnO-C showed greater activity on some strains compared to others. ZnO-AH showed least overall activity on all strains as compared to ZnO-AC and ZnO-C.

Synthesis of Gold Nanoparticles from Aloe vera

Biogenic gold nano-triangles and spherical silver nanoparticles were synthesized by a simple procedure using Aloe vera leaf extract as the reducing agent. This procedure offers control over the size of the gold nano-triangle and thereby a handle to tune their optical properties, particularly the position of the longitudinal surface plasmon resonance. The kinetics of gold nano-triangle formation was followed by UV-vis-NIR absorption
spectroscopy and transmission electron microscopy (TEM). The effect of reducing agent concentration in the reaction mixture on the yield and size of the gold nano-triangles was studied using transmission electron microscopy. Monitoring the formation of gold nano-triangles as a function of time using TEM reveals that multiply twinned particles (MTPs) play an important role in the formation of gold nano-triangles. It is observed that the slow rate of the reaction along with the shape directing effect of the constituents of the extract are responsible for the formation of single crystalline gold nano-triangles. Reduction of silver ions by Aloe vera extract however, led to the formation of spherical silver nanoparticles of 15.2 nm ± 4.2 nm size (Prathap et al., 2006).

**Conclusion:**

Nanoparticles present an extremely attractive platform for a diverse range of applications. The single step process for biosynthesis of nanoparticles provided by it attracts more researchers to go for future developments in the area of electrochemical sensor, biosensors, medicine, healthcare and agriculture. In this review, nanoparticles synthesis using different methods for Silver, Zinc and Gold Nanoparticles are articulated.

The synthesis of nanoparticles in nanobiotechnology area has augmented its importance to create eco-friendly, cost-effective, stable nanoparticles. From variety of investigations on nanotechnology for synthesis of nanoparticles it is found that it is safer and superior by using natural plants. With the huge plant diversity much more plants are still not reconnoitred for the synthesis of nanoparticles and its applications in pharmaceutical and agricultural industries.

**References:**


