Synthesis and Characterization of Nanoparticles

C. Chandralekha

Abstract In the existing technology world, nano is a hot area for the researchers. Nanoparticles of very lesser size like 1 to 100 nm in dimension are used in various chemistry fields, physics related to atoms and several other fields. They were used to analyse and prove the performance of several materials which come in closer to it. Several approaches based on physics, chemistry and biology are used in preparation of these particles. But the most cost-effective, less time consumption and easier approach is the approach based on biology. In this paper, we analyse and synthesize silver nanoparticles (AgNPs) by using methods based on biology with *Ocimum sanctum*. Synthesis of silver nanoparticles was completed using tulsi by applying green synthesis method at different pH ranges. Using UV-visible spectroscopy, characterization of AgNPs was completed. Applying various ph ranges, the adsorption of dyes was conducted and resulted in adsorption of cationic and neutral dyes and pesticide reductions.

Keywords Nanoparticles · Osmium sanctum · Nanotechnology · Computing · Networks

C. Chandralekha (✉)
Head-IT Wing, Unnadha Ulagam, Coimbatore, India

A. Ramu et al. (eds.), *International Conference on Computing, Communication, Electrical and Biomedical Systems*, EAI/Springer Innovations in Communication and Computing, https://doi.org/10.1007/978-3-030-86165-0_7

1 Elementary Units of Nanotechnology: Nanoparticles

1.1 Intoduction

The basic building blocks of various applications in nanotechnology are the nanoparticles. Nanotechnology is playing a significant role in the day-to-day life of research fields. Various properties of nanoparticles vary based on their properties of physics, chemistry and biology. These properties differ based on the composition of both atoms or molecules present in them and also the entire materials. Carbon, ceramics, biomolecules, metal oxides, non-oxide ceramics and metals are some of the chemical nature of nanoparticles. Nanoparticles have several structures like cylinders, tubes, spheres, platelets and so on. The design of nanoparticles is done by modifying the surfaces to cater the requirements of application for which it will be applied for.

Various features contribute to the diversity of engineered nanoparticles. The same chemical can generate a wide variety of nanoparticles.

1.2 Categorization of Nanoparticles

There are two groups in nanoparticles. They are inorganic and organic nanoparticles. Carbon nanoparticles are present in organic nanoparticles and magnetic nanoparticles, and nanoparticles of metals like silver and gold and nanoparticles of semiconductor like zinc oxide and titanium oxide are present in inorganic nanoparticles. Inorganic nanoparticles are used frequently and effectively since they possess several material characteristics with its flexibility in the functions, and this has been identified as the best device for imaging in medicines and in the treatment of various diseases because of their attributes in dimensions and its advantages over the drugs of chemical composition. Gold nanoparticles is mostly used in carriers of drugs and in therapy related to thermo- and biology [1]. Several inorganic nanoparticles such as metallic nanoparticles and semiconductor nanoparticles portray the optical characteristics which increase the transparent nature of composites of polymer particles. Hence these inorganic nanoparticles are playing a major role in providing the optical characteristics in composites. Several gold nanoparticles depending on size are widely utilized in colouring glass for several centuries [2]. Various adaptable characteristics of inorganic nanoparticles made its usage in cellular delivery like availability, abundant functionality, rich compatibility and efficiency of drug delivery [3].

1.3 Features of Nanoparticles

The surface of the nanoparticle consists of many atoms or molecules, and the amount of surface area present in a unit volume of the nanomaterial is the important outgrowth for the nanoparticles. All these properties grow in magnitude with reducing the size of the particles. Due to the presence of physical, chemical and biological characteristics, the nanoparticles come up from two features. The major boundaries of nanoparticles are the shape which includes aspect ratios. Complex structure of nanoparticles is possible with the difficult compositions of adsorbate which depends on the growth features and the lifespan of a nanoparticle. In the liquid interface of nanoparticle, polyelectrolytes are used to change the features of surface and communication among the particles and their environment. They are used in a vast range of colloidal dispersions [4].

2 Silver Nanoparticles

The distinctive properties like shape and size based on the magnetic, electrical and optical properties that can be included in various applications such as biosensor materials, antimicrobial, electronic and cosmetic products. In the synthesization and stabilization of nanoparticles, various methods based on physical and chemical aspects have been devised.

2.1 Nanosilver

Nanosilver is a material used in nanoformulation. Nanosilver has many features which act against bacteria, and hence it is used widely in water filters to purify drinking water and in cleansing of water in swimming pools. Various methods like reduction in electrochemical, discharging of spark and synthesis of cryochemical use metallic silver confined into ultrafine particles [5]. The size of particles of nanosilver is very much lesser than 100 nm and comprises of about 15,000 to 20,000 of atoms of silver. Application of nanostructures in films, wires, tubes, etc. is possible. When measured with nano scale, the particles of silver portray the contrast features related to physical and chemical depending on pH and dissolving particulars, and the metal is compared with the biological activities [6]. The reason behind this is that the very huge amount of atoms interact with their environments because of the large surface area per mass. In recent days, nanosilver is widely utilized in products related to consumers and medicines because of the properties of silver at the nanoscale.

2.2 Requirement for Silver

The basic element present in our planet is the silver. The silver is not costly and rare like gold but is available naturally with the features of ductile and malleability. The more pure the silver is, the more conduction of electricity occurs with very less resistance in contact. The first two are most widely used, and the second one are not stable in the aquatic environment [7]. Metallic silver does not dissolve in water, but metallic salts and silver chloride are dissolvable in water. Fungicides, coinage and splints are some of the fields where metallic silver is extensively used. In the treatment of addiction of nicotine, mentally ill and diseases which are infectious such as syphilis, various compounds of silver like silver slats are extensively used [8].

3 Synthesization of AG Nanoparticles

Many researchers and scientists are developing materials having very good properties, working with high functions and at very less cost than the already existing materials. Various methods based on physical, chemical and biological methods of synthesis have been formulated and developed to promote the performance of nanoparticles which portray the improved features with the aim to have a good hold on the size of the particle, distribution and morphology [9, 10]. The challenges faced by the researchers in the synthesization of nanoparticles are on applying purity, size distribution, quality and quantity as economical processes which are environment -friendly in nature.

3.1 Silver Nanoparticles' Synthesis Techniques

Approaching Physically Most evaporation and condensation and laser ablation are very significant physical procedures used in the synthesis of silver nanoparticles. This evaporation and condensation method has been applied in the synthesis of several metal nanoparticles like gold, cadmium sulphide, silver and lead sulphide. The major advantages of physical approaches when compared with chemical approaches are that the absence of contamination of solvent in the thin films prepared and the uniformity present in the distribution of nanoparticles. It was already proved that using a small ceramic heater comprising a local heating source, the silver nanoparticles can be synthesized [11].

Approaching Chemically Reducing the organic and inorganic agents chemically is one of the common approaches used in synthesization of nanoparticles. In common reduction of silver ions (Ag^+) in aqueous or non-aqueous solutions, several and various reducing agents like elemental hydrogen, sodium borohydride ($NaBH_4$) and

sodium citrate are commonly used. These reducing agents reduce silver ions (Ag^{+}) and create metallic silver (Ag^{0}). This is followed by agglomeration into oligomeric clusters which in turn lead to the formation of metallic colloidal silver particles [12].

4 Tulsi Silver Nanoparticles

The better platform that can be used for the synthesis of nanoparticles are the plants since they are free from chemicals which are toxic. In addition, the usage of extracts from plants is cost-effective regarding the isolation of microorganisms when compared with the synthesis of nanoparticles by microorganisms. In this work we have explained the biosynthesis of silver nanoparticles utilizing the leaf extract of *Ocimum sanctum.*

The usage of seeds of plants, roots, bark and berries for the purpose of medications is referred to as botanical medicine or phytomedicine.

4.1 Several Species of Tulsi

Ocimum americanum This species has arisen from tropical Africa. It is also called as hoary, lime or hairy basil, and it is called as an annual herb having flowers that are white or lavender in colour in nature. Mainly it is used in medicinal fields for curing various diseases. These plants portray antioxidant and antibacterial activities.

Ocimum sanctum This is also called as tulsi in Hindi and is called as holy basil in English. This an erect, soft haired plant with a very good aroma of its herb or undershrub which is found throughout India. This tulsi is commonly cultivated in gardens. There are two categories of *Ocimum sanctum* found. They are tulsi plant with green leaves called as shri tulsi and tulsi plant with purple leaves called as krishna tulsi. *Ocimum sanctum* is held by Hindus as a sacred one, and also it is used as a medicine in daily life in homes of India for various treatments. This has various medicinal behaviours. The commonly used area are antidiabetic, anticancer, antifertility and several other diseases.

Tulsi (*Ocimum sanctum*) – Chemical Composition The family of *Ocimum sanctum* is Lamiaceae. The biogenic inert nanomaterials have applications in the detection, diagnosis and monitoring of cancer and tumour growth.

5 Materials and Methods

Collection of Plant Material First we should collect the leaves of *Ocimum* from the local garden. The collected leaves are washed thoroughly with pure distilled water in order to remove the dust particles. Then the washed leaves are then dried for an hour. Then these dried leaves are cut into small pieces.

Leaf Extract Preparation In a 250 ml beaker with 100 ml distilled water, we should add 3 g of finely sized leaves and allow them to boil for 2 h. Then we should filter the extract to remove the dust which is then stored in the refrigerator for the next characterization and other works to be carried out.

Silver Nitrate Solution Preparation We should prepare a fresh solution of silver nitrate by adding 17 mg of silver nitrate in 10 ml of pure water. In order to avoid reduction, we should cover this solution with aluminium foil in the dark.

6 Characterization Method

In order to confirm the production of silver nanoparticles, we use several methods for characterization of the green silver nanoparticles. In addition to the determination of size distribution profile and surface morphology, it is possible to find out the actual size of the particle. We use the following instrument to characterize the green silver nanoparticles.

UV-Vis Spectroscopy When we add *O. sanctum* leaf extract with solution of silver nitrate, we get a change of colour of the solution from transparent to dark yellow since there are silver nanoparticles produced. In order to find out the optical property of biosynthesized silver nanoparticles, we analyse the samples using UV-Vis spectroscopic at room temperature which is operated at a resolution of 1 nm to 250 nm and 700 nm ranges. The peak of the silver nanoparticles prepared at all pH by green synthesis lies between the range 420 and 480 nm.

7 Application of Tulsi AgNPs

Adsorption of Dyes We dissolve less quantities of solid dye (methylene blue and neutral red each 5 mg in 50 ml in double the distilled water in order to prepare the stock solutions of reactive dye). Several concentrations of dye were obtained by diluting this solution so as to form it as the working solution. We carried out this experiment using all the 5 ph (pH 4, 5, 7, 9, 11). In the 5 ml of tulsi solution of each ph, 100 μl of working solution of each dye at all ph was kept in the darkest place by adding all ph and then stirring at 30 °C. We use UV-Vis spectrophotometer to take

reading every 5 min and 25 min. The methylene blue showed peak at 660 nm and neutral red at 550 nm.

8 Conclusion

The efficient route for the synthesis of nanoparticles was performed at different ph mediums using the silver nanoparticles with *Ocimum sanctum* leaf extract which provided environmental-friendly, simple and efficient route for the synthesis. The size of the synthesized nanoparticles was 10 to 100 nm at different ph ranges, and their shape is sheet and sphere. A thin layer of tulsi is surrounded around the nanoparticles which contains carbohydrates and camphor taken from the characterization using a UV-Vis spectrophotometer technique. From these techniques we come to know that in the shape determination of the nanoparticles, the concentration of plant extract to metal ion plays a significant role. The highly concentrated nanoparticles appear in sheet -shaped size, whereas the lower concentrated nanoparticles appeared in spherical shape. Thus based on the reduction of metal ions, the sizes of the nanoparticles in different ph ranges are different.

References

1. Cheon, J., Horace, G.: Inorganic nanoparticles for biological sensing, imaging and therapeutics. J. Mater. Chem. **19**, 6249–6250 (2009)
2. Caseri, W.: Inorganic nanoparticles as optically effective additives for polymers. Chem. Eng. J. **196**(5), 549–572 (2009)
3. Xu, Z.P., Pai, Z.Q., Lu, G.Q., Yu, A.B.: Inorganic nanoparticles as carriers for efficient cellular delivery. Chem. Eng. Sci. **61**, 1027–1040 (2006)
4. Liufu, S., Xiao, H., Li, Y.: Investigation of PEG adsorption on the surface of zinc oxide nanoparticles. Adv. Powder Technol. **145**, 20–24 (2004)
5. Chen, X., Schluesener, H.J.: Nanosilver: a nanoproduct in medical applications. Toxicol. Lett. **176**, 1–12 (2008)
6. Lok, C.N., Ho, C.M., Chen, R., et al.: Proteomic analysis of the mode of antibacterial action of silver nanoparticles. J. Proteome. Res. **5**, 916–924 (2006)
7. Ramya, M.: Green synthesis of silver nanoparticles. Int. J. Pharm. Med. Bio. Sci. **1**, 54–61 (2012)
8. Granqvist, C., Buhrman, R.A., Wyns, J., et al.: Far-infrared absorption in ultrafine AI particles. Phys. Rev. Lett. **37**(10), 625–629 (1976)
9. Shibata, S., Aoki, K., Yano, T., et al.: The physics and chemistry of sol gel processing. J. Sol-Gel Sci. Technol. **11**, 279–286 (1998)
10. Shankar, S.S., Ahmad, A., Sastry, M.: Geranium leaf assisted biosynthesis of silver nanoparticles. Biotechnol. Prog. **19**, 1627–1631 (2003)
11. Jung, J.O., Noh, H., Kim, S.: Metal nanoparticle generation using a small ceramic heater with a local heating area. J. Aerosol Sci. **37**, 1662–1670 (2006)
12. Korbekandi, H.I., Abbasi, S.: Production of nanoparticles using organisms. Crit. Rev. Biotechnol. **29**, 279–306 (2009)