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A Review On Synthesis of Silver Nano Particles From Plant Extract of Leaves: An Eco Friendly Method

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Abstract - In the present time scientists, engineers and researchers have been mastering the intricacies of working with nanoscale materials. Now researchers have a clearer vision of how to create nanoscale materials with properties never envisioned before. As there is tremendous demand and wide applicability of nano particles(less than 100nM) in different field researcher are trying to synthesize it by various traditional methods such as physical, mechanical and chemical. But these methods are very expensive and some methods involve harmful chemicals. Keeping in the view of developing clean, nontoxic and eco-friendly technologies, a wide range of biological sources has been used for the synthesis of nano particle. Green chemistry processes are considered as eco-friendly method and safe method compared to all others. Nano particles are helpful in investigation and regulation at cell level interaction between synthetic and biological materials. In many areas of human science these materials are superior and indispensable due to its unique size. In this review, we worked to find out the cheap and environment friendly technique for synthesis of silver nano particles by green chemistry approached from different biological material. The importance of this study includes the use of best plant leaf with respect to cost and process followed for synthesis of silver nano particles.

Key words: ***Nano scale, Silver nanoparticle(AgNPs), Green chemistry.***

1.0 INTRODUCTION

In 1959, Richard Freynman, an American physicist and Nobel laureate, firstly used the concept of nanotechnology, reporting the lecture “There’s plenty room at the bottom” [1]. In 1980, Dr. K. Eric Drexler explored the concept of this emerging field, in particular promoting technological significance of nano scale phenomena and devices. In 2000 the broad expansion of nanotechnology was founded by united state national nanotechnology division [2]. Nano biotechnology is presently one of the most dynamic disciplines of research in contemporary material science whereby plants and different plant products are finding an imperative use in the synthesis of nano particles (NPs). In general, particles with a size less than 100 nm are referred to as NPs. Entirely novel and enhanced characteristics such as size distribution and morphology have been revealed by these particles in comparison to the larger particles of the mass material that they have been prepared from nano particles of novel metals such as Ag ,Au etc.[3]. Nano particles can be made from a fully variety of bulk materials and that they can explicate their actions depending on both the chemical composition and on the size and/or shape of the particles [4]. Because of its smaller structure, they trigger the chemical activity due to their distinctive crystallographic nature that increases surface area, hence the scope of reactivity [5].In nanotechnology, silver nano particles are the most promising one. Silver nano particles are nano particles of silver, i.e. silver particles size in range of between 1 nm and 100 and because of its nano size it have attracted intensive research interest. It is observed that silver nano particles do not affect living cells. So not able to provoke microbial resistance. It is believed that Silver nanoparticles can attach to the cell wall and disturb cell-wall permeability and cellular respiration [6]. Silver nano particles also used in textile fabrics, as food additives, and in package and plastics to eliminate microorganisms. Because of such a wide range of applications, various methods concerning the fabrication of silver nano particles as well as various silver-based compounds containing metallic silver (Ag0) have been developed [7]. The extra attention is given towards the silver nano particles because of their strong antimicrobial properties either in metallic nature or nano particles form. Silver nano particles has vast application in food processing, pharmaceutical, solar power, electronic, textile and health industries.[8,9,10, 11, 12,]

2.0 SYNTHESIS OF AgNPS

2.1. *From neem leaf*

Ten grams of freshly collected neem leaves (Acalypha indica leaves) were surface cleaned with running tap water followed by distilled water and boiled in 100ml of distilled water at 60°C for 5 min. Then, the extract was filtered and used for the biogenic synthesis of both silver and gold nanoparticles.[17]. Then the silver nano particles were obtained from neem leaves extract in which neem extract were used as reductant. The formation of silver nanoparticles was very rapid and it was completed within 30 min. Similarly, Jeyaraj et al. (2013) have recently reported that Podophyllum hexandrum leaves extract effectively synthesized silver nanoparticles at 420nm [18]. Further, High Resolution – Transmission Electron Microscopy (HR-TEM) analysis confirmed the biosynthesis and the synthesized silver nanoparticles were predominantly in spherical shape with uniform size ranging from 20nm to 30nm. It has been reported that Memecylon edule leaves extract took 3 h for synthesis of silver nano particles. [19]. However, in some studies, much faster rate of biosynthesis of silver nanoparticles was observed. For instance, from the reference of [20] it was observed that the rapid synthesized of silver nanoparticles within 15 min from Sorbus aucuparia leaves extract . Recently, it has been reported that Breynia rhamnoides stem extract rapidly biosynthesized both silver and gold nanoparticles approximately within 7 min and this is the much faster reduction process reported for the first time [21]. Recent studies have shown that biomolecules such as protein, phenol and flavonoids present in the plant extract play an important role in the reduction of metals ions and capping of the nanoparticles [22].

Silver nano particles (AgNPs) obtained from plant reduction of silver nitrate solutions using neem leaf extracts. Due to varying properties of the mentioned plant species, AgNPs recovered from this are of non uniform in size ranges from 82.2nM to 200nM.[3] The amount yield is depend on concentration of leaf extract and duration of reaction allowed.[3]. FTIR analysis it was found that they have efficient capping and stabilization properties of these AgNPs. [3,13]

2.2 *From Olive leaf*

2.0 gof olive leaf broth was boiled for 15 min, filtrated and completed to 100 ml to get the extract. The filtrate used as reducing agent was kept in the dark at 10°C to be used within one week. A stock solution of $AgNO3$ 2x 10^{-2} M was prepared by dissolving 0.34 g/100 ml de-ionized water.Quasi-spherical silver nano particles were synthesized using olive leaf extract as reductant and stabilizer. This study revealed that the aqueous olive leaf extract has no effect at the concentrations used for preparation of the Ag nanoparticles Average size of the silver nano particles was tunable by simply changing the extract concentrations used and pH of the reactions. Quantitative analyses indicated that reduction of the silver precursor was promoted at elevated pH due to increased activity of olive leaf extract constituent. As a result, the number of nucleus and thus size of the silver nano particles ranges from 20nm to 25nm and decreased with increased pH of the reactions. The silver particles became more spherical- like in shape [14]. As the concentration of the olive leaf extract increases, the absorption peak gets more sharpness and blue shift was observed from 458 to 441 nm. This blue shift indicates a reduction in the mean diameter of the silver nanoparticles. The blue shifted and sharp narrow shape SPR band indicating the formation of spherical and homogeneous distribution of silver nanoparticles was observed. This was further confirmed by TEM images of leaf extract mixed samples using 1 and 5 ml extract at room temperature after 24 h incubation. The results indicate that the average particle size of the synthesized silver nanoparticles is highly influenced by the concentration of leaf broth. Increasing leaf extract concentration in the reaction mixture decreases the particle size [14, 3].

2.3 *From Tulsi leaf*

Silver nano particles (AgNPs) obtained from plant reduction of silver nitrate solutions using tulsi leaf extracts. Owing to varying properties of the plant species, AgNPs obtained from tulsi leaf has 28nm in size and rectangular in shape. [15] The mean particle diameter of silver nanoparticles was calculated from the XRD pattern according to the line width of the plane, refraction peak using the following Scherrer'equation.[16]

$$D = \frac{k\lambda}{\beta^{\frac{1}{2}} \cos\theta}$$

The equation uses the reference peak width at angle θ , where k is the X-ray wavelength (1.5418 A ˚), $\beta^{1/2}$ is the width of the XRD peak at half height and K is a shape factor From FTIR analysis it was found that it has efficient capping and stabilization properties of this AgNPs. [3, 13]

2.4 *From mangosteen leaf*

For synthesis of silver (Ag) nanoparticles the leaf extract (1.5 ml) was added to 30 ml of 10^{-3} MAgNO3 aqueous solution in a 250-ml Erlenmeyer flask and heated on water bath at 75 °C for 60 min. Reduction of silver nitrate to silver ions was confirmed by the color change from colorless to brown.[24]. It is evident that there is variation in particle sizes and the averagesize estimated was 35 nm and the particle size ranged from 6 to 57 nm which was determined by UV Vis-spectroscopy.[26]

The first factor considered was temperature, as the temperature increased, the rate of silver nanoparticles formation also increased. The size is reduced initially due to the reduction in aggregation of the growing nanoparticles.

The second factor considered was pH of the reaction medium. Acidic condition suppresses the formation of silver nanoparticles but the basic condition enhances the formation of silver nanoparticles. Large nanoparticles were formed at lowerpH (pH 4), where as small and highly dispersed nanoparticles were formed at high pH (pH 8). At low pH, the aggregation of silver nanoparticles to form larger nanoparticles was believed to be favored over the nucleation .At higher pH, however, the large number of functional groups available for silver binding facilitated a higher number of silver nanoparticles to bind and subsequently form a large number of nanoparticles with smaller diameters. But at higher pH agglomeration of nanoparticles took place.

The third factor was the time required for the completion of reaction. As the duration of reaction increases, more silver nanoparticles are formed. Due to the instability of the silver nanoparticles formed, an optimum duration is required, as silver nanoparticles agglomeration after the optimum duration resulting in larger particle sizes. The optimum time required for the completion of reaction from our study was 60 min.

The next factor was concentration of silver nitrate solution. Different concentration of silver nitrate solution was used to get maximum silver nanoparticles and the maximum yield with 1 mM silver nitrate solution. But the silver nano particles obtained this process from mangosteen leaves were not better antibacterial activity than neem and papaya leaves.[25]

2.5 *From tea leaf*

By using tea as a capping agent, 20–90 nm silver nanoparticles were synthesized with crystalline structure. Reaction temperature and the dosage of the tea extract showed an effect on the production efficiency and formation rate of nanoparticles [27]. The size of spherical shaped silver nanoparticles is ranging from 5 to 20 nm, as evident by TEM.[28]. The spherical nanoparticles were observed at higher leaf extract concentration, as infer from the TEM imaging [29].

2.6 *From Carica Papaya leaf*

Fresh leaves of C. papaya (25 g) were diced into fine pieces and transferred to sterile 250 mL conical flask. MilliQ WATER 200 mL was added to the flask and heated at 60°C for 5– 10 min and incubated on sand bath for 30 min to facilitate the formation of aqueous extract. The aqueous leaf extract of C. Papaya and 1 mM $AgNO_3$ were mixed in the ratio of 1:4 and heated on a sand bath at 60°C for 30 min until change in colour was observed. The colour change indicated the formation of silver nanoparticles[35]. The size of the silver nanoparticles can be determined by using the image magnifying software and this software will be able to magnify the particles with size less than 10 nm and give clear morphological data. The SEM and TEM analyses showed the particle size between 50 and 200 nm and average size of silver nanoparticles between 5 and 40 nm with a spherical morphology [30]. Nano materials had proven to be the efficient mode of drug delivery in modern science [31]. The utilization of medicinal plant materials, microbes, enzymes for synthesis of nanoparticles has been revolutionized in recent years and could serve as alternative for antibiotics [32]. The CPL-AgNPs showed particle size ranging in between 5 and 200 nm, which may confer the ability to penetrate the cells/microbes and execute the bactericidal property. The mechanism of action of silver nanoparticles is ambiguous in microorganism [33, 34]

Table-1 Silver nanoparticles from different plant leaf extract, their size and shape

Name of the leaf	Size in nM	Shape	Reference
Neem leaf	82.2-200	Spherical	[17]
Olive leaf	20-25	Spherical	[14]
Tulsi leaf	28	Rectangular	[3]
Tea leaf	20-May	Spherical	[28]
Mangosteen leaf	Jun-57	------------	[26]
Papaya leaf	6-200	Spherical	[33,34]
Aloe vera leaf	50-350	Spherical, Triangular	[39]
Abutilonindicum leaf	17-Jul	Spherical	[40]
Nelumbonucifera leaf	25-80	Triangular	[41]
Eclipta prostrate leaf	35-60	Triangular, Pentagonal,	[42]

3.0 CONCLUSION

There is a rapidly growing awareness towards green chemistry and use of green route for synthesis of metal nanoparticles lead to a desire path to develop environment-friendly techniques. Benefit of synthesis of silver nanoparticles using plant extracts is enormous that it is an eco-friendly, energy efficient, cost effective, easily availability, provides healthier work places and communities, protecting human health and environment leading to lesser waste and safer products. Hence production of silver nanopartcles from plant material is the best practice method but further study is needed to conclude it. For the syntheses of nanoparticles employing plants can be advantageous over other biological entities which can overcome the time consuming process of employing microbes and maintaining their culture which can lose their potential towards synthesis of nanoparticles. Hence in this regard use of plant extract for synthesis can form an immense impact in coming decades. In the present study it was found that silver nano particle produced from different leaves are different in shape, size and antibacterial functions. It cocluded that no particular size and shape of nano particles can be obtained from different plant materials. There is a significant variation in chemical compositions of plant extract of same species when it collected from different parts of world and may lead to different results in different laboratories. This is the major drawback of syntheses of silver nanoparticles using plant extracts as reducing and stabilizing agents and there is need to resolve this problem. This paper has reviewed recent knowledge and trend of bioreductive approaches for formation of silver nanoparticles using different plant leaf systems..In the current study it was also noticed that amount of formation of silver nano particles depends on many factors such as concentration of leaf extract, pH of the solution, time of reaction and temperature. There are many more factors exist which may affect the formation of silver nano particles which are to be found out Current aspects of process which includes biological sources should focus towards the use of highly structured physical and biosynthetic activities of microbial cells to achieve better controlled manipulation of the size and shape of the particles. In addition, improvements on biogenesis process are needed for the development of cheaper processes that in microorganisms where proteins [38, 39] and angiosperms where carboxylic groups, amino groups, proteins and carbohydrates are present in the source extract, believed that play a key role in the biosorption and bioreduction process for the formation of nanoparticles. It cannot be conclude that a particular plant leaf can be used for economical extraction of silver nano particles. But the plant synthesized silver nanoparticles could be of immense use in medical field for their efficient antimicrobial function.[15]

4.0 FUTURE SCOPE

The exact mechanism for the formation of nanoparticle by using biological resources is still being investigated and several possible ways have been proposed [37]. Lots of research work still need to be executed to understand the effect of time, temperature, light and other parameters regarding the phytoformation of Nanoparticles. Furthermore effect is needed in order to develop more productive process for metallic nanoparticle production.

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