*Available online at* www.pelagiaresearchlibrary.com

Pelagia Research Library

**Pelagia Research Library**

**Advances in Applied Science Research, 2013, 4(3):50-55**

Pelagia Research Library

**ISSN: 0976-8610**
**CODEN (USA): AASRFC**

# Kinetic study on green synthesis of silver nanoparticles using *Coleus aromaticus* leaf extract

**M. Vanaja, S. Rajeshkumar, K. Paulkumar, G. Gnanajobitha, C. Malarkodi and G. Annadurai***

*Environmental Nanotechnology Division, Sri Paramakalyani Centre for Excellence in Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi, Tamilnadu, India*

---

**ABSTRACT**

*Green synthesis method of nanoparticles is evolution from the nanobiotechnology. It is a low cost, environment benign, non toxic and large scale up process. In this study, Coleus aromaticus leaf extract was used to the bioreduction of silver ions to nanoparticles. Bioreduction process was carried out to study about the factors affecting the nanoparticles synthesis by changing the silver ion concentration, pH and temperature. 1 mM silver ion concentration, pH 8.2 and temperature 70 ºC is more favorable for maximum production of silver nanoparticles. UV-vis spectrum was used to characterize these synthesized silver nanoparticles and the SPR band was observed at 460 nm indicates particles are poly dispersed. Size and shape of nanoparticles was analyzed by Scanning electron microscope (SEM) shows polydispersed and mostly spherical shape of nanoparticles with aggregation. This green synthesis method has many advantages over the chemical method because it reduces the use of toxic metals in the synthesis process and it is a single step eco-friendly method.*

**Key words:** *Coleus aromaticus*, polydisperse, silver nanoparticles, bioreduction

---

## INTRODUCTION

Now a day Nanotechnology owes to the tremendous improvement in human life and it has a multidisciplinary research area. Among the various fields of nanotechnology, green nanotechnology provides more effective nanoparticles synthesis with expected products and economical manner [1]. Nanomaterials are new, emerging and creating progress due to their interesting electrical, optical, magnetic and chemical properties than bulk materials. Noble metal nanomaterials are great attention in various fields due to their unique properties. Noble metals such as Ru, Pd, Ag, Pt and Au [2] are exhibiting a particularly wide range of material behavior along the atomic to bulk transition [3]. Among the noble metals, silver is a prehistoric and transition metal. Silver has been widely utilized for thousands of years in human history. Silver is a health additive in traditional Chinese and Indian Ayurvedic medicine [4]. Silver nanoparticles have wide range of biomedical applications due to their large surface area compared than bulk materials [5].

Many methods are adopted for nanoparticles are physical, chemical and biological methods. Biological method of synthesis of silver nanoparticles was achieved by using bacteria [6], fungi [7, 8], algae [9, 10] and plants [11]. Green synthesis method of silver nanoparticles by extracellular using plants and plant derived compounds was more environmental favorable, less time consuming, large scaled up and low cost. Plant mediated synthesis process was more advantages over the chemical and microbe mediated synthesis method because it eliminate the culture maintaining process [13, 14]. Plants have flavonoids, alkaloids and polyphenolic compounds which may reduce the

silver ions to silver nanoparticles and acts as capping and stabilizing agent [15]. Shape and size of silver nanoparticles was depends on the physical and chemical factors. The nanoparticles synthesis was controlled by pH ant temperature of the reaction mixture [16].

In this study, medicinal valuable plant *Coleus aromaticus* leaf extracts was used for the silver nanoparticles. The optimum silver ion concentration, pH and temperature for silver nanoparticles synthesis was studied by UV-vis spectrophotometer. Morphology of silver nanoparticles was characterized by Scanning Electron Microscope.

## MATERIALS AND METHODS

### Chemicals and plant material

Silver nitrate, sodium hydroxide, hydrochloric acid were analytical grade purchased from HiMedia, Mumbai. Leaves of *Coleus aromaticus* was collected from Campus of Sri Paramakalyani Centre for Environmental Sciences, M. S. University, Alwarkurichi, Tamilnadu.

### Preparation of leaf extract

Leaves of *C. aromaticus* was washed with Tween 20 for surface sterilization and washed thoroughly by double distilled water for three times. About 20 g of leaves were cut into fine pieces and boiled with 100 ml of double distilled water at 60 ºC for 10 min. After boiling process the extract was filtered through Whatman No 1 filter paper. Collect the supernatant and stored at 4 ºC for further nanoparticles synthesis process.

### Synthesis of silver nanoparticles

Typical synthesis process of silver nanoparticles, 10 ml of leaf extract was added into 90 ml of 1 mM silver nitrate aqueous solution and incubated at room temperature. Formation of brown colour was indicates synthesis of silver nanoparticles.

To study the optimum factors for silver nanoparticles synthesis, the experiments were carried out at different conditions are silver ion concentration (1, 2, 3, 4 and 5 mM), pH (5.2, 6.2, 7.2, and 8.2) and temperature (20 ºC, 35 ºC, 40 ºC and 70 ºC). The pH of the reaction mixture was adjusted by using 0.1 N sodium hydroxide and 0.1 N Hydrochloric acid. The effect of these parameters on the synthesis of silver nanoparticles was monitored by UV-vis spectrophotometer.

### Characterization of green synthesized silver nanoparticles

The reduction of silver ions ($Ag^{+}$) to silver nanoparticles ($Ag^{0}$) was spectrometerically identified by double beam UV-Vis spectrophotometer (Perkin Elmer, Singapore) at different wavelength (400- 700 nm). The graph of wavelength on X-axis and absorbance on Y-axis was plotted. Morphological characters such as size and shape of green synthesized silver nanoparticles was analyzed by Scanning Electron Microscope (Philip model CM 200). The thin films of the sample was prepared on a carbon coated copper grids by just dropping a very small amount of the sample, extra solution was removed by using blotting paper and the grids were allowed to dry by putting it under the mercury lamp for 5 min and the images were recorded.

## RESULTS AND DISCUSSION

### Visual observation

Formation of silver nanoparticles was preliminarily well known by changing of yellow to brown while adding leaf extract with silver ion solution due to the excitation of free electrons in the nanoparticles [17]. The colour formation was occurs within a few min after addition of leaf extract. Metal nanoparticles exhibits different colours in solution due to their optical properties. Silver nanoparticles were characterized by forming of brown colour. Previously, increasing colour intensity with in 30 min was observed using leaf extract of *Acalypha indica* [18].

### UV-Vis spectrophotometer analysis

### Effect of silver ion concentration

The UV-vis spectrum (Fig. 2) shows effect of silver nitrate concentration in the silver nanoparticles synthesis by using the leaf extract of *C. aromaticus*. Characteristic surface plasmon absorption band was observed at 460 nm for the brown coloured silver nanoparticles synthesized from 1 mM silver nitrate. At the 1 mM concentration shows narrow band with increased absorbance whereas other concentrations shows broad peak at 460 nm. The absorption

was increased while increasing the concentration of silver ions from 1mM to 5 mM. In 1 mM concentration the nanoparticles synthesis and size reduction was started quickly due to the more availability of functional groups in the leaf extract. While increasing the substrate concentration the large size and aggregation of nanoparticles was occurred due to the occurrence of compete between silver ions and functional groups of 10 ml leaf extract. Thus, the optimization study showed a significant effect of concentration on the synthesis of silver nanoparticles. This investigation concludes that the optimum silver nitrate concentration 1 mM is suitable for nanoparticles synthesis. Similarly, increasing intensity indicates increasing concentration of nanoparticles. Higher concentration of silver nitrate suggests the formation of larger nanoparticles [19].

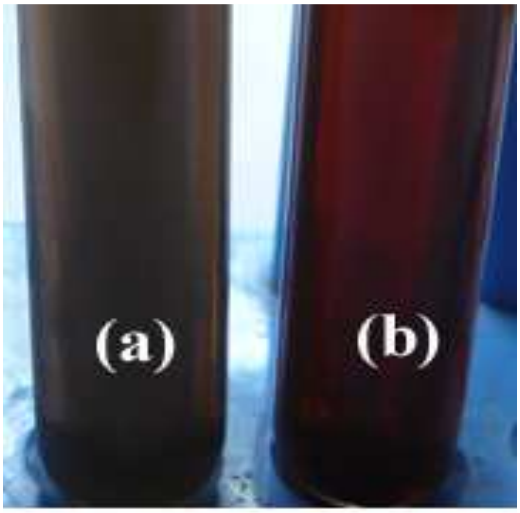


**Fig.1. colour change yellow to brown indicate formation silver nanoparticles (a) leaf extract (b) after addition of leaf extract into 1 mM $AgNO_3$**

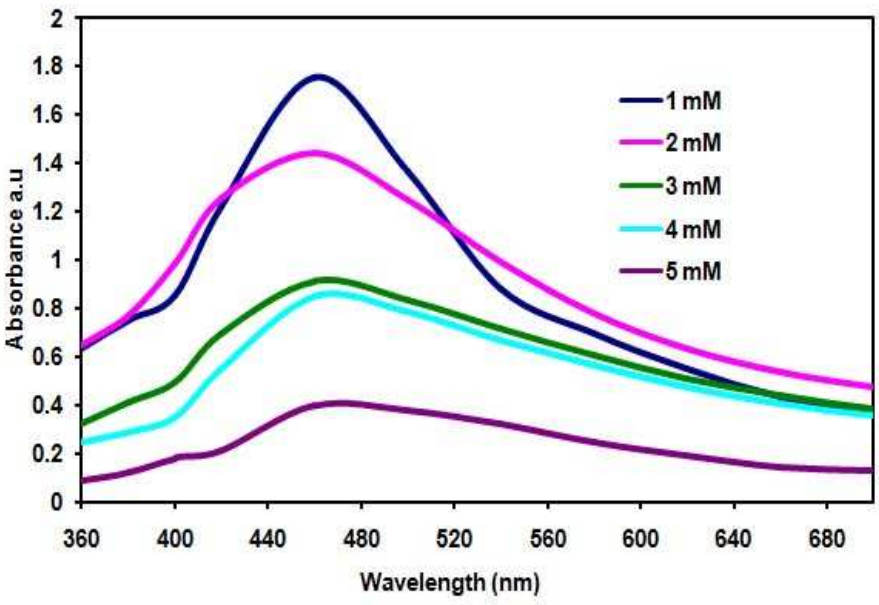


**Fig.2. UV Spectrum of synthesis of silver nanoparticles at different concentration of $AgNO_3$**

**Effect of pH**

pH play an important role in the nanoparticles synthesis, this factor induce the reactivity of leaf extract with silver ions. The influence of pH in the nanoparticles was evaluated under different pH of the reaction mixture by the leaf

extract (Fig. 3). In low pH, small with broadening SPR band was formed indicates formation of large size of nanoparticles. In *Coleus aromaticus* leaf mediated synthesis alkaline pH 8.2 shows narrow peak at 460 nm with maximum production with sharp peak. The sharp peak indicates formation of spherical shape of silver nanoparticles [20]. Several results are reported pH is plays an important role in shape and size control synthesis process of silver nanoparticles. The present investigation indicates alkaline pH is more suitable for synthesis of silver nanoparticles. Similarly, Pandey et al. [21] reported that the gold nanoparticles show maximum stability at the pH 10 using aqueous extract of *Momordica charantia*.

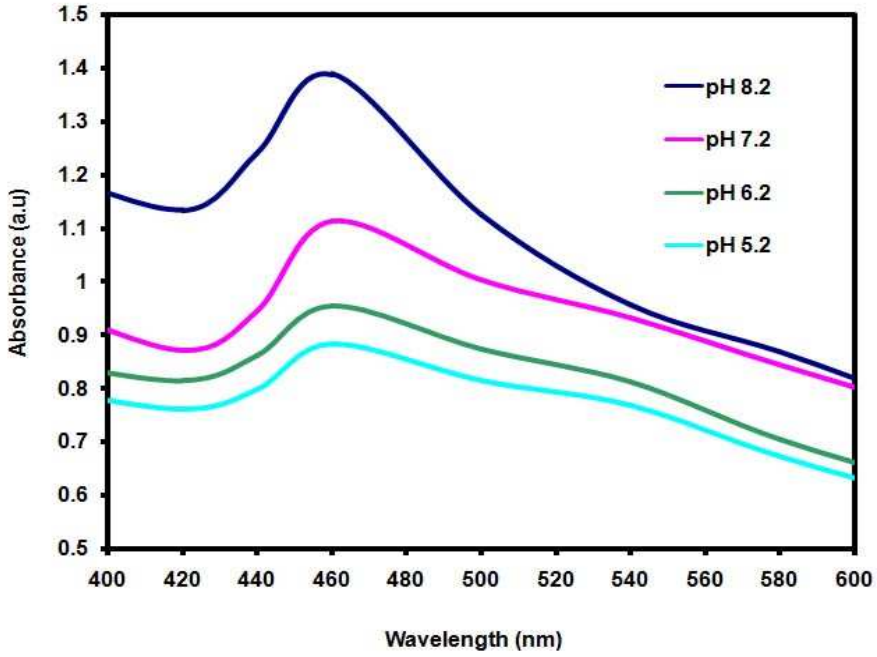


**Fig.3. UV spectrum shows effect of pH in the nanoparticles synthesis**

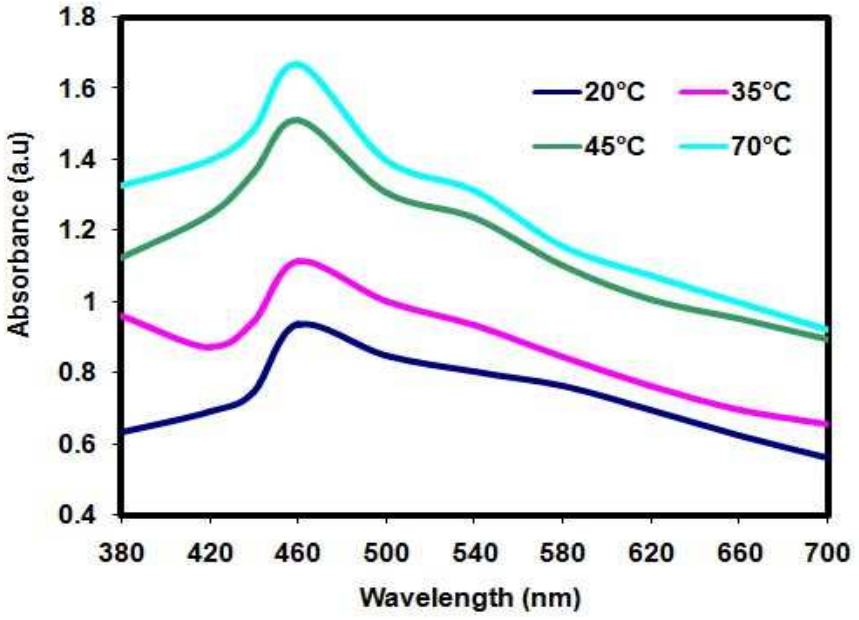


**Fig.4. Effect of temperature in the nanoparticles synthesis using leaf extract of *C. aromaticus***

**Effect of temperature**

Temperature is play one of the important physical parameter on the synthesis of silver nanoparticles. Fig. 4 shows the effect of temperature in the nanoparticles synthesis. The synthesis of nanoparticles was increases while increasing the reaction temperature by using the leaf extract of *C. aromaticus*. The absorbance band was broadened and positioned at 470 nm and 450 nm at the temperature of 20 °C and 35 °C, respectively. The higher rate of reduction was occurred at higher temperature due to the consumption of silver ions in the formation of nuclei whereas the secondary reduction was stopped on the surface preformed nuclei [22]. The broadening peak was obtained at low temperature shows formation of large sized nanoparticles and the narrow peak was obtained at high temperature, which indicates the formed nanoparticles are small in size and the higher rate of reduction of silver ions was occurred in the 70°C. Finally, it was concluded that higher temperature was optimum for nanoparticles synthesis.

**Scanning Electron Microscope**

The size, shape and distribution of green synthesized silver nanoparticles were characterized by Scanning Electron Microscope (Fig 5). It shows particles are spherical with average size 45 nm and also individual nanoparticles were aggregated shows large nanoparticles. This aggregation took place due to the presence of cell components on the surface of nanoparticles and acts as capping agent. Silver nanoparticles were synthesized using leaves extract of *Acalypha indica* showed the size of the control silver nitrate obtained was greater than 1000 nm, where as synthesized Ag NPs measured 20–30 nm in size [17].

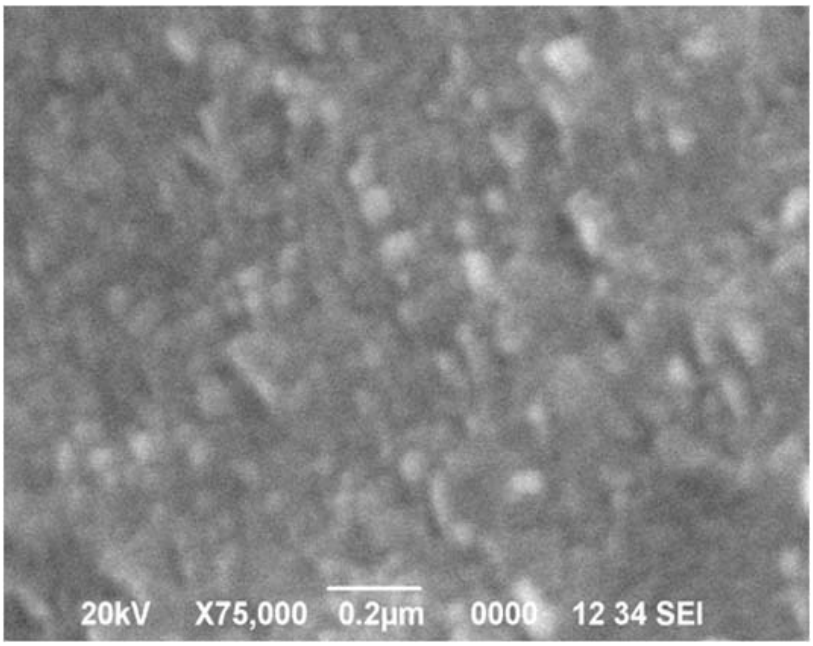


**Fig.5. SEM image of synthesized silver nanoparticles shows polydispersed silver nanoparticles**

*C. aromaticus* is a medicinal plant and it was used in the Indian system of medicine. It has several antioxidant compounds are rosmarinic acid, chlorogenic acid and caffeic acid [23]. Being the major polyphenol in *C. aromaticus*, the rosmarinic acid was more likely to be responsible for most of the observed antioxidant activity, it may involve in the reduction of silver ions ($Ag^{+}$) to silver nanoparticles ($Ag^{0}$).

## CONCLUSION

This present investigation shows green synthesis silver nanoparticles using *C. aromaticus* leaf extract is more compatible, large scaled up and less time consuming process. Rapid synthesis of silver nanoparticles was attained maximum when altering such effective parameters. Leaf extract was acts as a capping agent and reducing agent in the nanoparticles synthesis. It is a better source for the rapid synthesis of silver nanoparticles. This green method is a

single step process, economic viability; effective and rapid production of nanoparticles could be used to biomedical and environmental applications.

**Acknowledgement**
Authors gratefully acknowledge the DST-FIST sponsored programme, Department of Science Technology, New Delhi, India for funding the research development (Ref no S/FST/ESI-101/2010) to carry out this work.

**REFERENCES**

[1] EK Elumalai; TNVKVPrasad; V Kambala; PC Nagajyothi; E David. *Archives of Applied Science Research*, **2010**, 2 (6) 76-81
[2] C Panneerselvam; S Ponarulselvam; K Murugan. *Archives of Applied Science Research*, **2011**, 3 (6), 208-217.
[3] U Kreibig; M Vollmer. Springer: Berlin, **1995**.
[4] M Singh; S Singh; S Prasad; IS Gambhir. *Dig J Nanomat and Biostruc*, **2008**, 3(3), 115–122.
[5] M Rai; A Yadav, A Gade, *Biotechnol. Advances*, **2009**, 27, 76–83.
[6] D Mandal; ME Bolander; D Mukhopadhyay; S Sankar; P Mukherjee. *Appl. Microbiol. Biotechnol.* **2006**, 69, 485–492.
[7] KS Hemath Naveen; Gaurau Kumar; l Karthik; KV Bhaskara Rao. *Archives of Applied Science Research*, **2010**, 2 (6), 161-167.
[8] N Ahmad; S Sharma; MdK Alama; VN Singh; SF Shamsid; BR Mehta; A Fatma. *Colloids Surf B: Biointerf*, **2010**, 81, 81–86.
[9] S Rajeshkumar; C Kannan; G Annadurai. *Int J Pharm Bio Sci*, **2012**, 3(4), 502 – 510.
[10] S Rajeshkumar; C Kannan; G Annadurai. *Drug Invention Today*. **2012**, 4(10), 511-513.
[11] GD Gnanajobitha; G Annadurai; C Kannan. *Int J Pharma sci Res*, **2012**, 3, 323-330.
[12] GD Gnanajobitha; C Kannan; G Annadurai. *Drug Invention Today*, **2012**, 4(11), 579-584.
[13] J Anarkali; D Vijaya Raj; K Rajathi; S Sridhar. *Archives of Applied Science Research*, **2012**, 4(3), 1436-1441
[14] N C J Packia Lekshmi; S Benarcin Sumi; S. Viveka; S. Jeeva; J. Raja Brindha. Antibacterial activity of nanoparticles from *Allium* sp. *J. Microbiol. Biotech. Res*., **2012**, 2 (1):115-119
[15] JL Gardea-Torresdey; E Gomez; J Peralta-Videa; JG Parsons; HE Troiani. *Nano. Lett.* **2002**, 2, 397–401.
[16] M Gericke; A Pinches. *Gold Bull*., **2006**, 39, 22-28.
[17] M Safaepour; AR Shahverdi; HR Shahverdi; MR Khorramizadeh; AR Gohari. *Avicenna J Med Biotech*, **2009**, 2, 111-115.
[18] C Krishnaraj; EG Jagan; S Rajasekar; P Selvakumar; PT Kalaichelvan, N Mohan *Colloid Surf B: Biointerf*, **2010**, 76(1), 50-56.
[19] H Bar; DH Bhui; PG Sahoo; P Sarkar; PS De; A Misra. *Colloids Surf A Physicochem Eng Asp*, **2009**, 339, 134–139.
[20] Daizy P, *Spectrochimica Acta Part A*, **2011**, 78, 327–331.
[21] S Pondey; G Oza; A Mewada; M Sharon. *Archives of Applied Science Research*, **2012**, 4(2), 1135-1141
[22] JY Song; BS Kim, *Bioprocess Biosyst Eng*, **2008**, 32, 79–84.
[23] A Kumaran; R Joel Karunakaran. *Food. Chem.* **2007**, 100, 356–361.