



# International Journal of Multidisciplinary Research in Science, Engineering and Technology

*(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)*



**Impact Factor: 8.206**

**Volume 9, Special Issue 1, April 2026**



# Green synthesis of silver nanoparticles using *Aegle marmelos L.* bark extract and their characterization by UV-VIS, FTIR, XRD, SEM, EDX and Zetasizer

Dr. T. Chandrashekhar<sup>1</sup>, Ramesh Kumar Lalkota<sup>2</sup>, Dr. K. Krishna Mohan<sup>3</sup>

Assistant Professor, Department of Botany, Giriraj Govt. College (A), Nizamabad, Telangana University, India

Asst. Professor, Department of Botany, Govt. Degree College (A), Khairatabad, Hyderabad, India

Professor of Agriculture, Department of Botany, Govt. Degree College (A), Khairatabad, Hyderabad, India

Email: [t.chandhrashekar9@gmail.com](mailto:t.chandhrashekar9@gmail.com)

**ABSTRACT:** A new approach had been made to control microbial pathogen by using of silver nanoparticles (AgNps) especially synthesized from the natural medicinal plants. In the present study AgNps were synthesized from stem bark of wood apple (Telugu: Bhilva patram) *Aegle marmelos L.* It is known for rich secondary metabolites which are used as reducing, capping and stabilizing agents. When aqueous bark extract mixed with aqueous silver nitrate, the reaction mixture colour was changed due to the formation of silver nanoparticles. The synthesized AgNps are confirmed by UV-VIS spectroscopy technique. When UV-visible light passed through the sample, synthesized AgNps absorbs particular wave length of light and produced a peak at around 432 nm. Later these nanoparticles, characterized by Fourier Transform Infrared spectroscopy, analyzed that bio-molecular compounds capped with silver ions are responsible for the stabilization of the nanoparticles. X-ray Diffraction carried out for confirmation of the crystalline nature of AgNps. The size, shape and morphology of the synthesized AgNps were observed under Scanning Electron Microscope. These nanoparticles are spherical in shape with 37 nm in size. The outcome of this work can be utilized in development of value-added products and drugs from *Aegle marmelos L.*

**KEYWORDS:** *Aegle marmelos L.* bark extract, silver nanoparticles, synthesis, characterization.

## I. INTRODUCTION

Nanomaterials, particularly the nano-scale metals, draw a great deal of consideration because of their exceptional distinction in basic and physical properties contrasted with those of particles, atoms and mass materials of a similar component (Dubey, 2010). Later on, improvement of this field offered ascend to another innovation known as 'Nanotechnology' that furnishes us with an innovation and an instrument for examination and its application to biological frameworks at the nanoscale. Nanostructured materials exhibit enhanced mechanical properties, improved thermal stabilities and unique optical, magnetic and electrical behaviors. Metal nanoparticles have huge utility in electrochemical, electro-systematic and bio-electrochemical applications (Mubarak, 2011). Thus, nanotechnology is a rising field in the region of interdisciplinary research, having application in science. The probability of utilizing microorganisms and plant materials as nano-antecedents has likewise been concentrated (Rai, 2006). Thereafter, different microorganisms and plants have been used for the amalgamation of nanomaterials (Retchkiman-Schabes, 2006). Nanoparticles display totally new or improved properties when compared with the bigger particles of the mass material. In the zone of nano prescription, nanoparticles are ordinarily utilized as medication conveyance vehicles and also have been utilized in the remedial application to target explicit locales, viz., lung tissue, malignant growth treatment and inoculation. Major biological applications involve therapeutics, drug delivery, bio-imaging. In agriculture they act as sensors, fertilizers and for soil remediation and waste treatment (Jagtap and Bapat 2013, Singh et al., 2010). *Aegle marmelos L.* (family: Rutaceae) commonly known as wood apple (Bael) mainly constitutes the chemical compounds such as xanthoxole, alloimparatorin, marmesin, aegeline. It is used in traditional medicine for

treating constipation, diarrhea and dysentery, gastrointestinal problems, peptic ulcers, carminative and combat rotavirus. The fruits are used in jam making and also used in soap preparation, bark as antimicrobial agent.

## II. MATERIALS AND METHOD

### Collection of Experimental Material

Stem bark of *Aegle marmelos L.* collected from Kamareddy rural district area of Telangana State. The chemical silver nitrate ( $\text{AgNO}_3$ ) was purchased from Merk (Mumbai). All the solutions were prepared with double distilled water.

### Preparation of bark powder

The collected bark of plant was first rinsed thoroughly under tap water and then with triple distilled water to remove all impurities. This was then air dried and thoroughly grinded to form a uniform mixture, about 30g of this mixture was soaked in triple distilled water taken in a 100 mL beaker to obtain 1.2% (w/v) concentrated extract. Filtration was done after 24 h with the help of Whatman filter paper no. 42 and a bright orange coloured extract was finally obtained. This was stored in a refrigerator for further use.

### Synthesis of Silver nanoparticles

For the biosynthesis of silver nanoparticles, 1 ml of bark extract was mixed with 9 ml of 1 M  $\text{AgNO}_3$  solution, pH-9 adjusted at room temperature and was kept in dark for 24 h. After the stipulated time, a brown–yellow colour solution was obtained. The colour of the solution is due to the formation of AgNps, confirmed by UV–Vis studies. The purification of AgNps was done after centrifugation and repeated washings and the concentrated slurry was collected after discarding the supernatant. The collected silver nanoparticles were allowed to air dry.



Fig1. *Aegle marmelos L.* plant



Fig2. Bark



Fig3. Bark powder

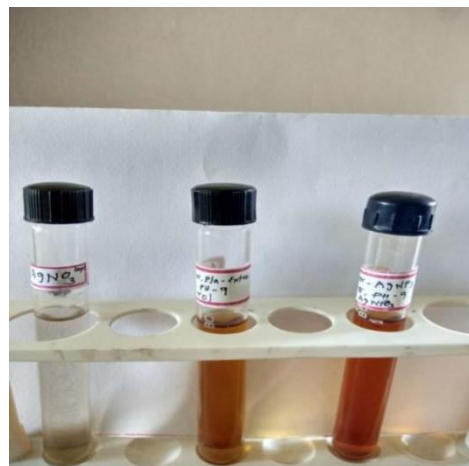


Fig4. AgNO<sub>3</sub>, bark extract, AgNps

### Characterization of silver nanoparticles (Ag NPs)

#### UV-Vis Spectroscopy analysis

The bio reduced aqueous extract containing AgNps is confirmed by taking an aliquot of 100 micro liter of the extract for measuring the absorbance. The absorption was maximum at the wavelength of 200-600 nm when scanned by UV-Visible spectrophotometer. This spectroscopic method useful for the detection of prepared metallic nanoparticles. It was observed that spherical AgNps display a Surface Plasmon Resonance (SPR) band at around 432 nm.

#### Fourier Transform Infrared Spectroscopy (FTIR) Analysis

FTIR is a chemical analytical technique which is widely used in organic synthesis. FTIR spectroscopy measures the infrared intensity versus wave number of light. An infrared light interacting with the matter tends to stretch, contract and bend the chemical bonds. Due to which, a chemical functional group adsorb infrared radiation in a specific wave-number range apart from the structure of the rest of the molecules. The relationship between the chemical structure and band wave number position is used to identify the functional group in a sample.

#### X-Ray Diffraction (XRD) analysis

X-ray diffraction used to examine the overall oxidation state of the particles as a function of time that is phase identification and characterization of the crystal structure of the nanoparticles. X-rays produced when the electrons of high energy struck a heavy metal target like tungsten or copper. When electrons punch this material, some of the electrons come close to the nucleus of the atoms and are deflected because of their opposite charges. Due to this deflection, the energy of the electron decreases. This decrease in energy results in producing the x-rays. Generally, Bragg's Law is used to know the crystal structures of different solid compounds.

#### Scanning Electron Microscopy (SEM) Analysis

Scanning Electron Microscopy is a common method for surface and morphological characterization at the nanometer to micrometer scale. Carry out this test by preparing thin film of the sample on a carbon coated copper grid.

#### Energy Dispersive x-ray Spectroscopy (EDX) Analysis

EDX is a powerful technique which is used for the analysis of elements. This instrument attached with SEM Energy dispersive X-ray spectroscopy is mainly used to identify the presence of different elements in a sample, it is necessary to verify the presence of desired element in a sample.

#### Zetasizer analysis

To confirm the size of the synthesized silver nanoparticles, their nanometer range, size distribution by intensity, size distribution by number was analyzed.



### III. RESULTS AND DISCUSSION

#### UV-VIS Spectroscopy

The selected template has been used for the synthesis of AgNps, after the interaction of bio-template with silver nitrate ( $\text{AgNO}_3$ ) solution, the colour change was observed due to the excitation of surface plasmon resonance. The formation of silver nanoparticles was monitored by UV-VIS spectroscopy, the surface plasmon resonance (SPR) of AgNps was reported at around 432 nm.

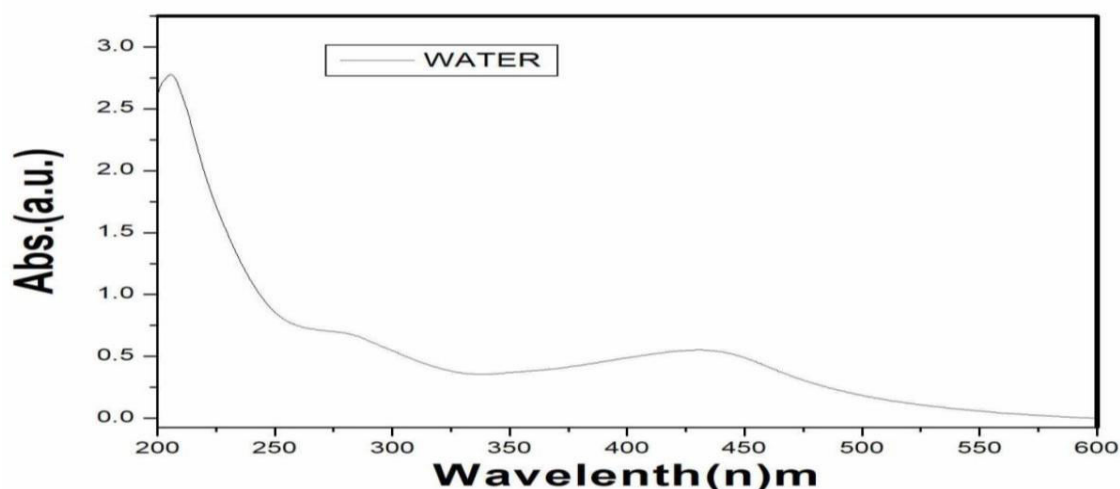


Fig.6. UV-VIS Spectroscopy image depicted synthesized AgNps of *Aegle marmelos L*

#### FTIR Spectroscopy analysis

The Fourier Transform Infra-Red analytical technique was used to identify the biomolecules for capping and stabilization of the synthesized silver nanoparticles. Bark extract of *Aegle marmelos* AgNps shows several major peaks at  $3444\text{ cm}^{-1}$ ,  $3419\text{ cm}^{-1}$ ,  $3410\text{ cm}^{-1}$ ,  $2926\text{ cm}^{-1}$ ,  $2854\text{ cm}^{-1}$ ,  $2360\text{ cm}^{-1}$ ,  $2341\text{ cm}^{-1}$ ,  $1635\text{ cm}^{-1}$  and  $1629\text{ cm}^{-1}$ .

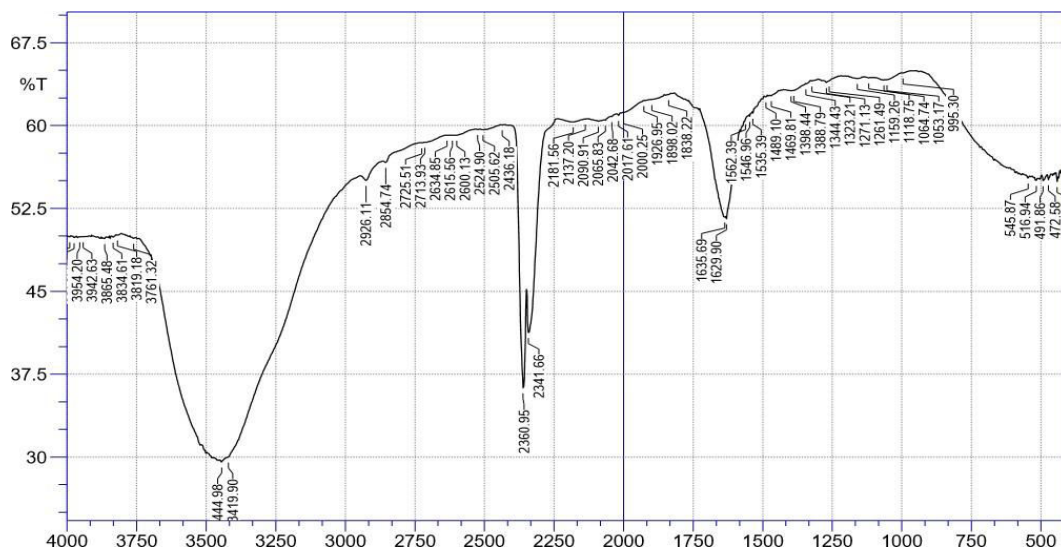


Fig.7. FTIR Spectroscopy image represent synthesized silver nanoparticles of *Aegle marmelos* L.

The peak at 3444 cm<sup>-1</sup> represents the O-H group stretching (bonding) vibration in alcohols, flavonoids, and phenols. The absorption peak at 2964 cm<sup>-1</sup>, and 2854 cm<sup>-1</sup>, probably shows N-H group stretching vibration of the amide-II of proteins. While peak situated at 2360 cm<sup>-1</sup>, and 2341cm<sup>-1</sup>, shows strong binding vibration of C-N group of aromatic and aliphatic amines. While the peak absorbed at 1635 cm<sup>-1</sup> to 1629 cm<sup>-1</sup> corresponds to binding vibration of the amide-I C-O group.

**XRD (X-Ray Diffraction)**

The exact nature of the silver particles formed can be deduced from the XRD spectrum of the sample. XRD pattern of the plant derived AgNps shows three intense peaks in the whole spectrum of 2 theta value ranging from 10<sup>0</sup> to 80<sup>0</sup> (Fig.8). The silver particles formed were in the form of nano crystals, as evidenced by the peaks at 2 theta values of 75.8<sup>0</sup>, 43.3<sup>0</sup>, 45.7<sup>0</sup> corresponding to (100), (92) and (75) planes for silver, respectively. The unassigned peaks could be seen due to the crystallization of bio-organic phase that occurs on the surface of the nanoparticle. The X-ray diffraction peaks were found to be broad around their bases indicating that the silver particles are in nano sizes. The peak broadening at half maximum intensity of the X-ray diffraction lines is due to a reduction in crystallite size, flattening and micro-strains within the diffracting domains. The average size of the crystallite estimated as 37 nm.

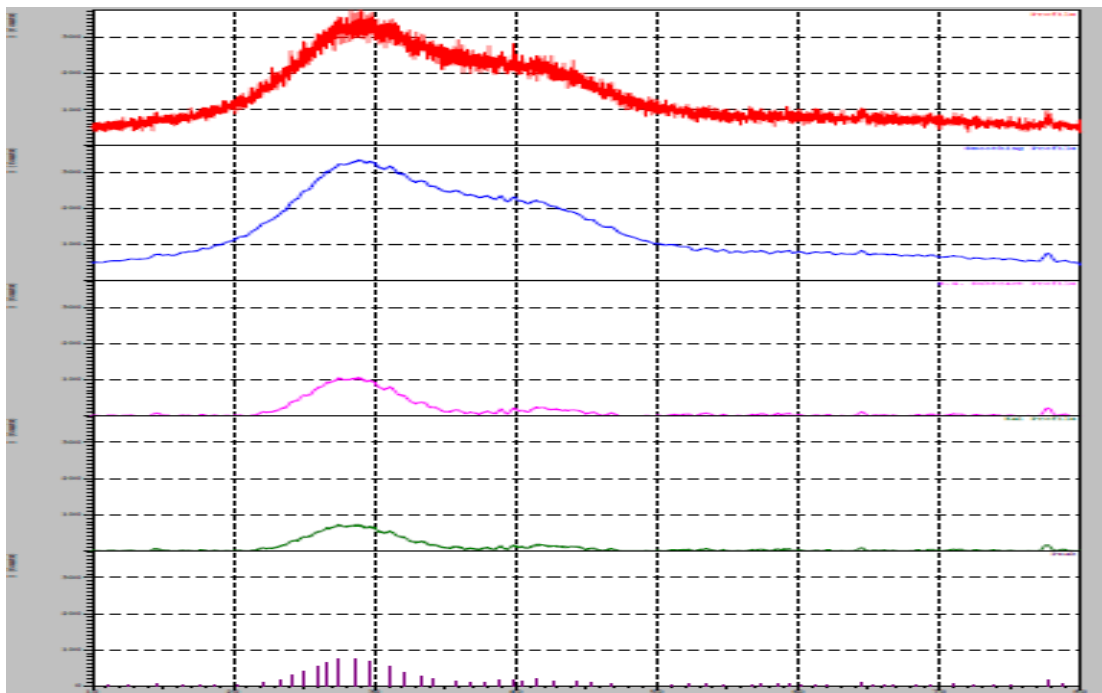


Fig. 8. X-Ray Diffraction image of *Aegle marmelos L*

**SEM analysis**

SEM image shows the morphological character, size and surface of the synthesized AgNps. *Aegle marmelos.L.* bark extract SEM microscopy revealed that the AgNps average size 108-263 nm. with clearly observed spherical and undifferentiated shape.

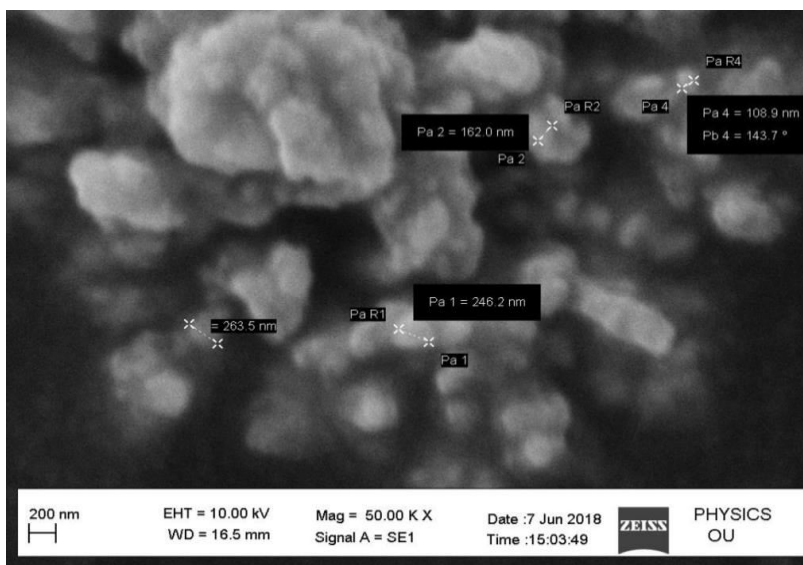


Fig9. SEM image of synthesized silver nanoparticles by *Aegle marmelos L*



### EDX (Energy Dispersive X-ray spectroscopy)

EDX Spectroscopic analysis confirmed the presence of the signal characteristic of elemental silver. Energy dispersive absorption photographs of derived AgNps are shown in *Figure 10*. All the peaks of Ag are observed and are assigned. Silver nano crystallites display an optical absorption band peak at approximately 3 keV. which is typical of the absorption of metallic silver nano crystallites due to surface plasmon resonance. Elements C and O are also seen.

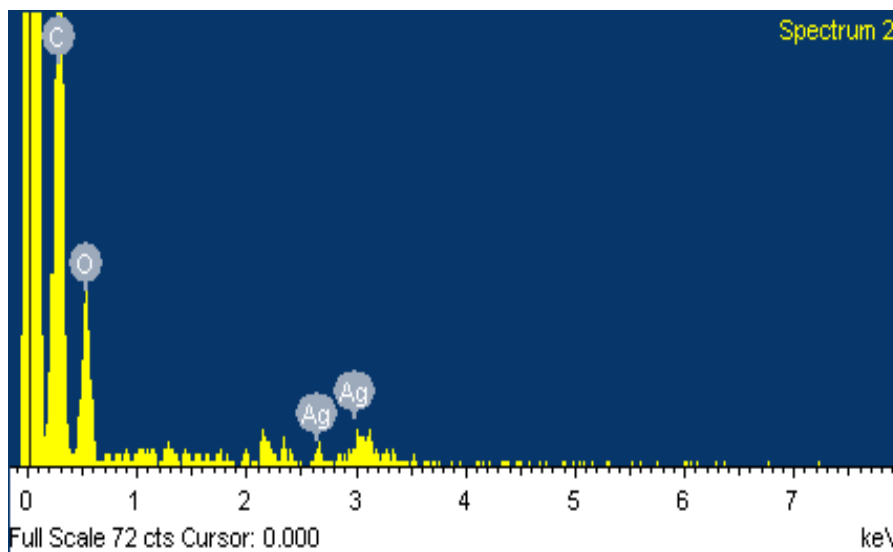


Fig. 10 EDX Spectroscopy image shows different elements present in the sample

### Zetasizer particle analysis

The synthesized silver nanoparticles were further determined and confirmed by the characteristic peaks observed in Zeta sizer image, which indicates that the average diameter range of the particles as 37 nm. as represented in the graph in fig. 11 based on size, distribution and intensity respectively. This instrument confirm the silver nanoparticles formed from the bark extract of *Aegle marmelos L.*

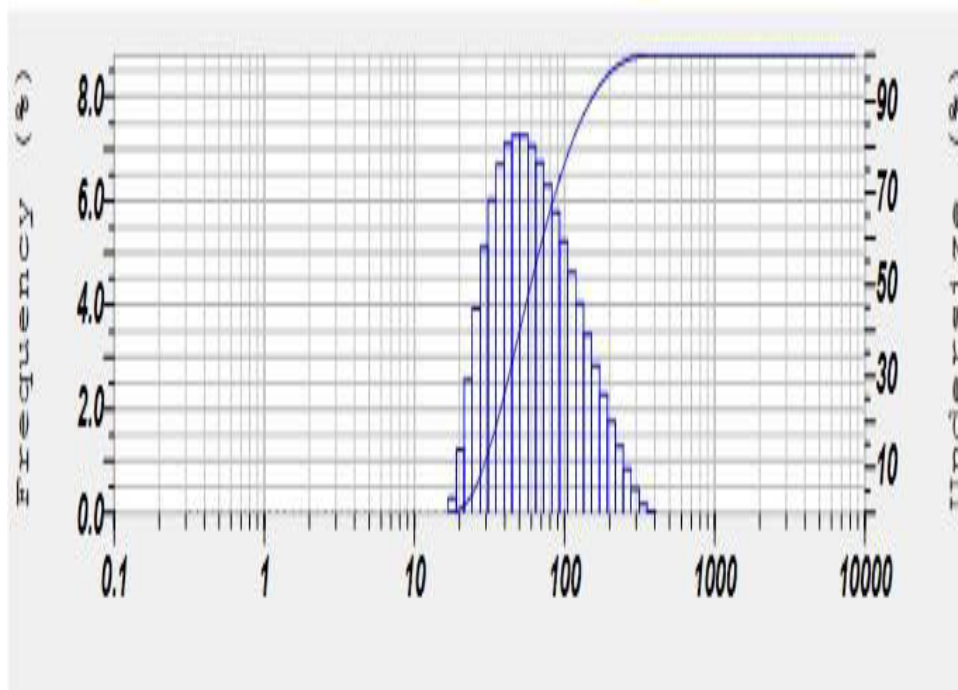


Fig.11. Zetasizer particle image represents size of the synthesized AgNps of *Aegle marmelos L*

#### IV. CONCLUSION

The present investigation concluded the green synthesis of silver nanoparticles, by using the bark extract of *Aegle marmelos L* plant as capping and reducing agent having advantages such as more available, eco-friendly and safe. The protocol has been optimized to provide rapid and large-scale production of AgNps. The *Aegle marmelos L* bark extract resulting formation of AgNps were proven by different analytical techniques such as UV-VIS, FTIR, SEM, EDX, XRD and Zetasizer method. Further studies require to formulate nano based biological applications in the fields of nanomedicine and agriculture. Advancement in green synthesis method may take Nanotechnology to new eco-friendly approach in near future.

#### REFERENCES

1. A. Rai, A. Singh, A. Ahmad, M. Sastry, Role of halide ions and temperature on the morphology of biologically synthesized gold nanotriangles, *Langmuir* 22 (2006) 736–741.
2. Chopra, R.N., I.C. Chopra, K.L. Handa and L.D. Kapur, 1958. *Chopra's Indigenous Drugs of India*. 2nd Edn., UN. Dhar and Sons Private Ltd., Calcutta, pp: 408.
3. D. Mubarak Ali, N. Thajuddin, K. Jeganathan, M. Gunasekaran, Plant extract mediated synthesis of silver and gold nanoparticles and its antibacterial activity against clinically isolated pathogens, *Colloids Surf. B Biointerfaces* 85 (2011) 360– 365.
4. Jensen, S.R., H. Franzyk and E. Wallander, 2002. Chemotaxonomy of the OleaceaeIridoids as taxonomic markers. *Phytochemistry*, 60: 213-231.
5. Khatune, N.A., M.A. Mosaddik and M.E. Haque, 2001. Antibacterial activity and cytotoxicity of *Nyctanthes arbor-tristis* flowers. *Fitoterapia*, 72: 412-414.
6. Kirtikar, K.R. and S.D. Basu, 1935. *Indian Medicinal Plants* Basu. 2nd Edn., Vol. 3. Lolit Mohan Basu, Allahabad, India, pp: 1526-1528.



7. Md.M.R. Mollick, B. Bhowmick, D. Maity, D. Mondal, I. Roy, J. Sarkar, D. Rana, K. Acharya, S. Chattopadhyay, D. Chattopadhyay, Green synthesis of silver nanoparticles-based nanofluids and investigation of their antimicrobial activities, *Microfluid. Nanofluid.* 16 (2014) 541–551.
8. N. Ahmad, S. Sharma, Md.K. Alam, V.N. Singh, S.F. Shamsi, B.R. Mehta, A. Fatma, Rapid synthesis of silver nanoparticles using dried medicinal plant of basil, *Colloids Surf. B Biointerfaces* 81 (2010) 81–86.
9. Nadkarni, A.K., 1976. *Indian MateriaMedica*. 1st Edn., Popular Prakashan, Mumbai, India.
10. P.S. Retchkiman-Schabes, G. Canizal, R. Becerra-Herrera, C. Zorril-la, H.B. Liu, J.A. Ascencio, Biosynthesis and characterization of Ti/Ni bimetallic nanoparticles, *Opt. Mater.* 29 (2006) 95–99.
11. Puri, A., R. Saxena, R.P. Saxena, K.C. Saxena, V. Srivastava and J.S. Tandon, 1994. Immunostimulant activity of *Nyctanthes arbor-tristis* L. *J. Ethnopharmacol.*, 42: 31-37.
12. S.P. Dubey, M. Lahtinen, H. Sa` rkka` , M. Sillanpa` a` , Bioprospective of *Sorbusaucuparia* leaf extract in development of silver and gold nanocolloids, *Colloids Surf. B Biointerfaces* 80 (2010) 26–33.
13. Saxena, R.S., B. Gupta and S. Lata, 2002. Tranquilizing antihistaminic and purgative activity of *Nyctanthes arbor tristis* leaf extract. *J. Ethnopharmacol.*, 81: 321-325.
14. Saxena, R.S., B. Gupta, K.K. Saxena, V.K. Srivastava and D.N. Prasad, 1987. Analgesic antipyretic and ulcerogenic activity of *Nyctanthes arbor-tristis* leaf extract. *J. Ethnopharmacol.*, 19: 193-200.
15. A.Singh, D. Jain, M. K. Upadyay, N. Khandeshwal, (2010) Green synthesis of silver nanoparticles using *Argimonemexicana* leaf extract and evolution of their antimicrobial activity.
16. Society ShriGulabkumaverbaAyurvedic, 1949. *CharakSamhita*. Vol. 5. AyurvedicMundralaya, Jamnagar, pp: 23-24.
17. U.Jagtap, V.A. Bapat(2013) Green synthesis of silver nanoparticles using *Artocarpus heterophyllus* L. seed extract and its anti-microbial activity.



INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | [ijmrset@gmail.com](mailto:ijmrset@gmail.com) |

[www.ijmrset.com](http://www.ijmrset.com)