



**HAL**  
open science

# Phyto-Assisted Synthesis of Silver Nanoparticles using Solanum Nigrum and Antibacterial Activity Against Salmonella Typhi and Staphylococcus Aureus

S Venkat Kumar, S Karpagambigai, P Jacqueline Rosy, S Rajeshkumar

► **To cite this version:**

S Venkat Kumar, S Karpagambigai, P Jacqueline Rosy, S Rajeshkumar. Phyto-Assisted Synthesis of Silver Nanoparticles using Solanum Nigrum and Antibacterial Activity Against Salmonella Typhi and Staphylococcus Aureus . Mechanics, Materials Science & Engineering Journal, 2017, 9 (1), 10.2412/mmse.86.22.967 . hal-01499412

**HAL Id: hal-01499412**

**<https://hal.science/hal-01499412>**

Submitted on 31 Mar 2017

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

# Phyto-Assisted Synthesis of Silver Nanoparticles using *Solanum Nigrum* and Antibacterial Activity Against *Salmonella Typhi* and *Staphylococcus Aureus*

Venkat Kumar S.<sup>1</sup>, Karpagambigai S.<sup>2</sup>, Jacqueline Rosy P.<sup>3</sup>, Rajeshkumar S.<sup>1,a</sup>

1 – School of Bio-Sciences and Technology, VIT University, Vellore, TN, India

2 – Department of Chemistry, Global Institute of Engineering and Technology, Vellore, TN, India

3 – Department of Chemistry, IFET College of Engineering, Villupuram, TN, India

a – [ssrajeshkumar@hotmail.com](mailto:ssrajeshkumar@hotmail.com)



DOI 10.2412/mmse.86.22.967 provided by [Seo4U.link](http://Seo4U.link)

**Keywords:** silver nanoparticles, green synthesis, antibacterial activity, TEM, salmonella typhi.

**ABSTRACT.** This study aims to provide a simple and eco-friendly approach for the synthesis of Ag NPs using medicinal plant *Solanum nigrum* aqueous leaf extract. Fresh leaf extract mediated the reduction of silver from higher excited state to the ground extract when mixed with 1 mM silver nitrate solution. Reduction led the synthesis of silver nanoparticle with the size range of 20-40 nm was confirmed by TEM analysis. UV-Vis analysis demonstrates the synthesis of Ag NPs by its standard peak due to SPR (Surface Plasmon Resonance). XRD analysis confirmed the crystalline nature of Ag NPs. It was further characterized by FT-IR for the confirmation of functional groups responsible for Ag NPs synthesis and elements analyzed using EDX. Our study also showed the high antibacterial effect of nanoparticle against disease causing virulent bacterial strains (*Salmonella typhi* and *Staphylococcus aureus*).

**Introduction.** *Solanum nigrum* is one of the most important traditional medicinal plants belonging to the family of solanaceae. The parts of *S. nigrum* like leaves, stem and fruits are playing a vital role in Indian daily foods.

Synthesis of silver nanoparticles using plant extracts such as fresh bark of *Pongamia pinnata* [14], papaya fruit extract [15], *Boswellia ovalifoliolata* stem bark [16], leaves of *Alternanthera dentate*, *Boerhaavia diffusa*, *Ziziphora tenuior*, *Ficus carica*, *Cymbopogon citratus*, *Acalypha indica* and *Premna herbacea* [17-23], seed extracts of *Pistacia atlantica*, *Trachyspermum ammi*, *Argyrea nervosa* and *Psoralea corylifolia* [24 – 27], fruit extract of pomegranate and grape (*Vitis vinifera*) [28-29], With these points under consideration, the present study was carried out to investigate the synthesis of silver nanoparticles using medicinal plant *Solanum nigrum*, characterized the silver nanoparticles by using UV-visible spectrophotometer, analyse the morphology of silver nanoparticles by using transmission Electron Microscope (TEM) and the nature of the silver nanoparticles by using X-Ray Diffraction Assay (XRD pattern), analyze the phytochemicals by using Fourier transform infrared spectroscopy (FTIR) present in the medicinal plants responsible for the nanoparticles synthesis.

## MATERIALS AND METHODS

**Collection of plant.** The plant leaves of *Solanum nigrum* were collected from Katpadi, Vellore district, Tamil nadu, India.

**Preparation of plant extract.** Fresh leaves were collected and dried under shade. The dried leaves were powdered by mixer grinder. 10 g of *Solanum nigrum* powdered was taken and added 100 ml of

distilled water in a beaker and boiled for 5 to 10 minutes and are filtered through filter paper whatmann no 1. The extracts were allowed to store and are used for experimental animals.

Table 1. Biomedical applications of *Solanum nigrum*.

S. No	Applications	References
1	antibacterial activity against gram+ and gram- bacteria	[1, 2, 3]
2	anticancer activity against HeLa cell line	[4]
3	Antifungal activity	[5]
4	Antiviral activity	[6]
5	Anti ulcerogenic effect	[7]
6	Hepatoprotective activity	[8, 3]
7	Anti-inflammatory activity	[9]
8	Anti-seizure activity	[10]
9	Hypoglycaemic activity	[11]
10	Free radical scavenging property	[12]
11	Cardioprotective activity	[13]
12	Anti-seizure activity	[10]

**Synthesis of nano particles.** The filtered extract was mixed with silver nitrate solution. (1mm of AgNO<sub>3</sub>) and 90 ml of distilled water and 10ml of extracts and kept in shaker. Every 4 hour silver nitrate was detected by UV-Visible Spectrophotometer at the range of wave length of 370-510 nm.

#### Preparation of nanoparticles powder for characterization

The silver nanoparticles was prepared using centrifugation techniques, it was based on our previous studies [14]. The prepared particles were characterized using FT-IR, Transmission electron microscope and EDX.

**Antibacterial activity of AgNPs.** Antibacterial activity was performed against typhoid causing bacteria (*Salmonella typhi*) and skin disease causing bacteria (*Staphylococcus aureus*) using disk diffusion method. Disks were impregnated with 3 different concentration of nanoparticle (25 mg/ml, 50 mg/ml, 75 mg/ml). The antibacterial effects of nanoparticles were measured against a positive control (cephalexin disk). The experiment was performed in triplicate.

## RESULTS AND DISCUSSION

### Phytosynthesis of silver nanoparticles using *S. nigrum*

#### FT-IR Analysis

Fourier transform infrared spectroscopy (FT-IR) is the best tool for identify the chemical groups of different biological extracts [28]. The chemical groups *Solanum nigrum* leaves and its based synthesis of silver nanoparticles was analysed using FT-IR shown in Fig. 1 and 2. In that the main peaks at 3282.13, 2918.33 and 1613.47 corresponds to the functional groups of C-H Stretch of alkynes, C≡C Stretch of alkynes and c-c=c symmetric stretch respectively. In the *Solanum nigrum* assisted synthesis of silver nanoparticles shows well developed peak at 3332.94 and 1634.30 indicates the chemical groups of Hydrogen bonded O-H Stretch and C-C=C Symmetric stretch respectively confirms the plant phytochemical are responsible for synthesis of nanoparticles [14, 28].

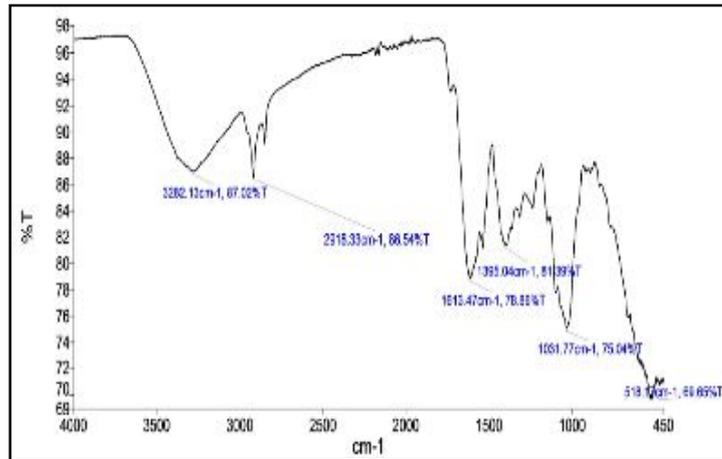


Fig. 1. *Solanum nigrum* plant leaves extract.

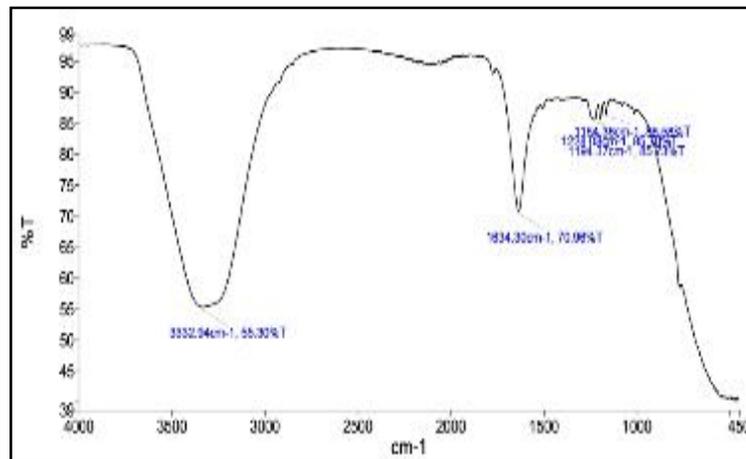


Fig.2. *Solanum nigrum* plant leaves extract mediated silver nanoparticles.

**UV-vis spectroscopy analysis.** The UV–visible absorption spectra result reveals a one step procedure for the preparation of the Ag NPs. The scale of wavelength was fixed between 380 and 480 nm, the surface Plasmon resonance (SPR) of the Ag NPs formed corresponded to 430 nm and there was an increase in intensity till 10 min 24 hr as a function of time without any shift in the peak wavelength (**Fig. 3**). It can be observed that the reduction of silver ions reaches saturation within 24 hr of reaction and after that, only slight variations can be noted in the intensity of SPR bands. This result indicates that the reaction is completed in 24 hrs [27, 30].

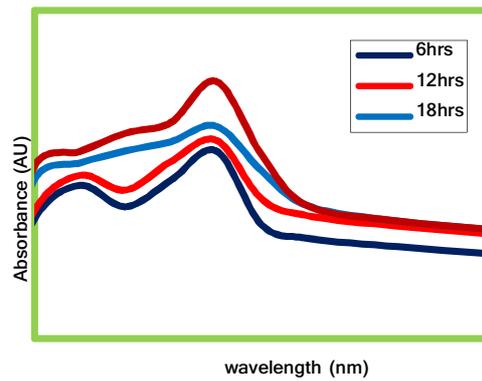


Fig. 3. UV-vis spectrum of silver nanoparticles by *Solanum nigrum*.

### TEM and EDX analysis

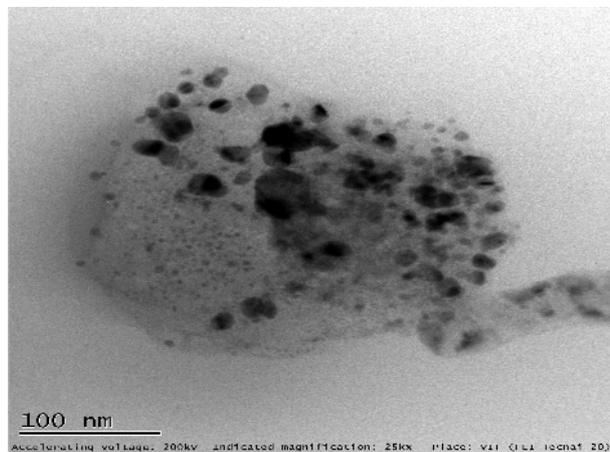


Fig. 4. Tem image and EDX spectrum of silver nanoparticles synthesized by *S. nigrum*.

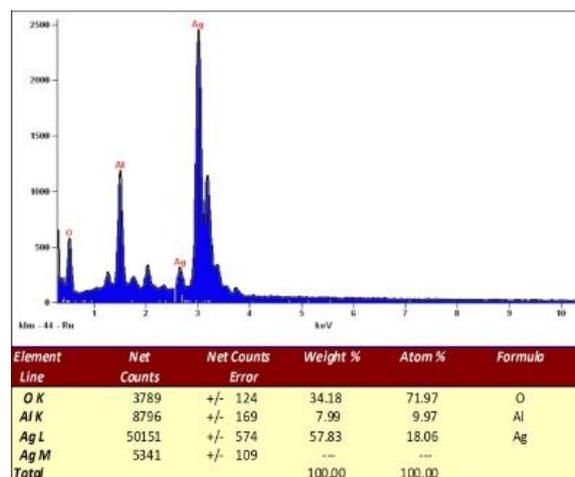


Fig. 5. Tem image and EDX spectrum of silver nanoparticles synthesized by *S. nigrum*.

The morphology of phytochemical mediated silver nanoparticles was viewed by TEM. Fig. 4 shows a well-dispersed AgNPs has identified in the sizes range 20–40 nm. The particles are clearly identified by their spherical, pseudospherical and some of undefined shapes because the nanoparticles are

associated with phytochemicals present in the *Solanum nigrum* leaves extract. The phytochemicals of plant extracts have been bind with the nanoparticles and some time it shows undefined shape in the background of the images and EDX analysis [24, 25, 30]. The results of elemental analysis also confirmed that the silver nanoparticles are bind with the biochemicals present in the plant extract (Fig. 5).

**Antimicrobial activity of silver nanoparticles.** The synthesized AgNPs were used for the antibacterial actvtiy against disease causing pathogens such as *Salmonelltyphi* and *Staphylococcus aureus*. Silver nanoparticles are the very major antimicrobial agents having good antimicrobial capability against different type of gram positive and gram negative microorganisms [14, 30, 31]. The Fig. 6 and 7 shows the antibacterial actvtiy of AgNPs and its zone of inhibition against *S. typhi* and *S. aureus*.

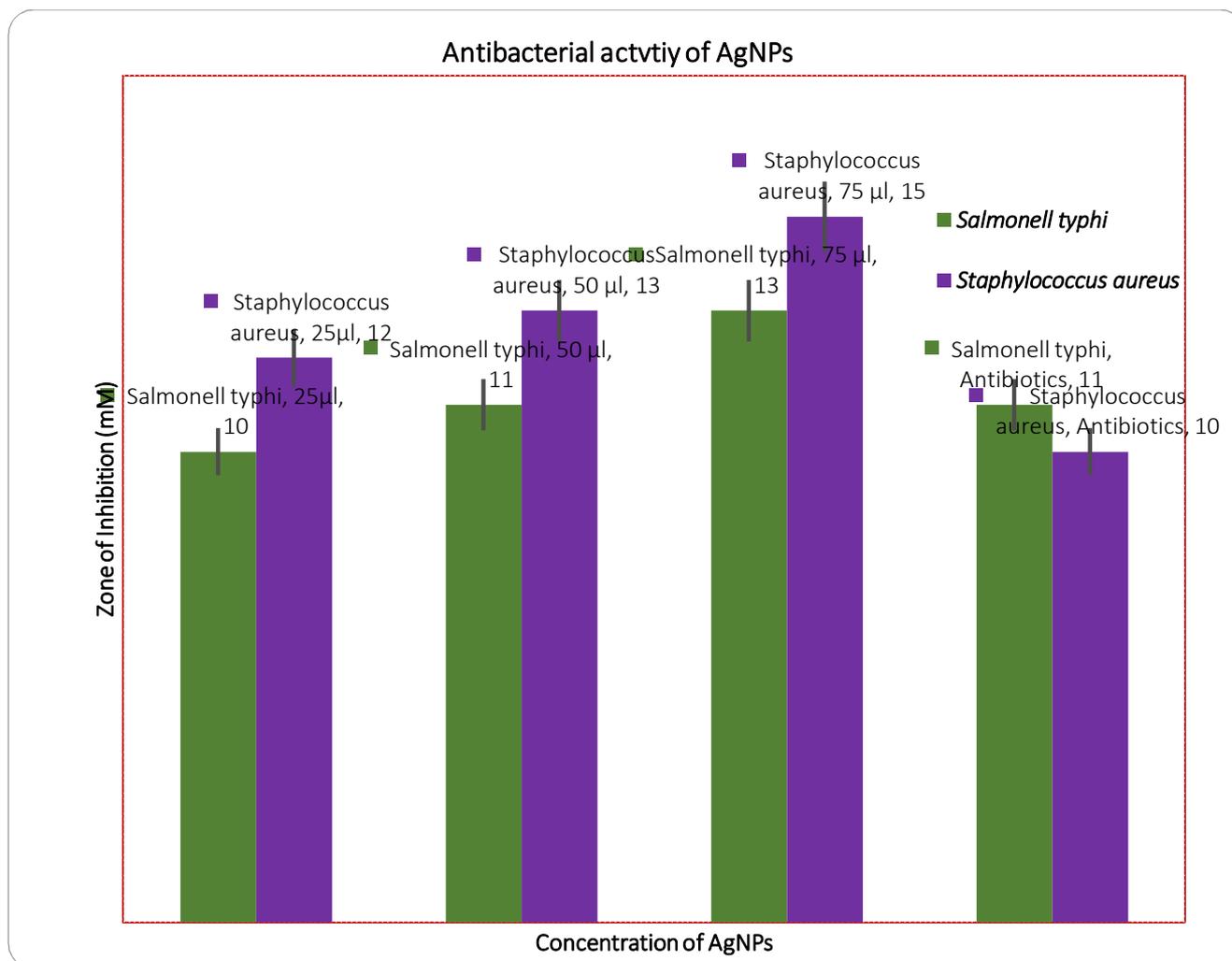


Fig. 6. Antibacterial analysis of AgNPs.



Fig. 7. Antibacterial analysis of AgNPs against *Salmonella typhi* and *Staphylococcus aureus*.

**Summary.** The present study confirms the synthesis of Ag nanoparticles by *Solanum nigrum* leaf extract. The extract acted as both reducing and capping agent and thus, stabilized the nanoparticles efficiently clearly demonstrated by the results. Uv-vis analysis confirmed the nanoparticle synthesis and EDX analysis depicts the presence of elemental silver. TEM analysis shows the synthesized nanoparticles with size range 20-40 nm. Nanoparticles show considerably high anti microbial effect against both the strains i.e. salmonella typhi and staphylococcus aureus when compared to standard antibiotic used. This suggests that it could be used as a potential drug against both the bacterial strain in future.

## References

- [1] Kavishankar G.B, Lakshmidivi N, MahadevaMS. Phytochemical analysis and antimicrobial properties of selected medicinal plants against bacteria associated with diabetic patients. International Journal of Pharma and BioSciences. 2 (4): 2011;509-518
- [2] Ali NS, Singh K, Khan MI, Rani S. Protective effect of ethanolic extracts of *Solanum nigrum* on the blood sugar of albino rats. IJPSR. 1 (9): 2010; 97-99.
- [3] R. Bhavani, G. Geetha, J. Santhoshkumar and S Rajeshkumar, (2015) Evaluation of Antibacterial action and Hepatoprotective efficiency of *Solanum nigrum* leaves extract on acetaminophen induced hepatotoxicity. Research J. Pharm. and Tech. 8 (7) : 893-900.
- [4] Patels S, Gheewala N, Suthar A., Shah A. In-vitro cytotoxicity activity of *Solanum nigrum* extracts against Hela cell lines and Vero cell lines. International journal of pharmacy and pharmaceutical sciences. 1 (1): 2009;38-46.
- [5] Sridhar TM, Josthna P, Naidu CV. Antifungal activity, phytochemical analysis of *Solanum nigrum* (L.) - an important antiulcer medicinal plant. Journal of Ecobiotechnology 3 (7): 2011 (Linn.) - An important antiulcer medicinal plant. Journal of Experimental Sciences. 2 (8): 2011; 24-29.
- [6] Javed T, Usman AA, Sana R, Sidra R, Sheikh R. In-vitro antiviral activity of *Solanum nigrum* against Hepatitis C Virus. Virology Journal. 8:2011; 26.
- [7] Jainu M, Devi CSS. Antioxidant effect of methanolic extract of *Solanum nigrum* berries on aspirin induced gastric mucosal injury. Indian Journal of Clinical Biochemistry, 19 (1): 2004; 57-61.
- [8] Elhag RAM, Badwi MAE, Bakhiet AO, Galal M. Hepatoprotective activity of *Solanum nigrum* extracts on chemically induced liver damage in rats. Journal on Veterinary Medicine and Animal Health. 3 (4): 2011;45-50.
- [9] Ravi V, Saleem TSM, Patel SS, Raamamurthy J Gauthaman K. Anti-inflammatory effect of methanolic extract of *Solanum nigrum* Linn berries. International Journal of Applied Research in Natural Products. 2 (2): 2009;33-36.
- [10] Noel NW, Joseph AA, Helen OK, Steven SG, Asa A. Antiseizure activity of the aqueous leaf extract of *Solanum nigrum* Linn (solanaceae) in experimental animals. African Health Sciences. 2008; 8 (2), 74-79.

- [11] Akubugwo I. E, Obasi N.A, Chinyere G.C and Ugbogu A. Mineral and phytochemical contents in leaves of *Amaranthus hybridus L* and *Solanum nigrum L*. subjected to different processing methods. African Journal of Biochemistry Research. 2 (2): 2008; 040-044.
- [12] Rawani A, Ghosh A Chandra G. Mosquitolarvicidal activities of *Solanum nigrum L*. leaf extract against *Culex quinquefasciatus*. Parasitol Res. 107: 2010; 1235–1240.
- [13] Balaji R, Prakash G, Suganyadevi P, Aravinthan K M. Evaluation of cardio protective Activity of Methanolic Extract Of *Solanum nigrum Linn*. in Rats. International Journal of Drug Development & Research. 3 (3):2011; 139-147.
- [14] S Rajeshkumar (2016) Synthesis of silver nanoparticles using Fresh bark of *Pongamia pinnata* and its antibacterial action against gram positive and gram negative pathogen Resource-Efficient Technologies 2 (2016) 30–35.
- [15] D.Jain, H.K.Daima, S.Kachhwaha, S.L.Kothari. Synthesis of plant-mediated silver nanoparticles using papaya fruit extract and evaluation of their anti-microbial activities. Digest Journal of Nanomaterials and Biostructures. 2009; 4: 557–563.
- [16] Kannan Badri Narayanan, Hyun Ho Park, Natarajan Sakthivel Extracellular synthesis of mycogenic silver nanoparticles by *Cylindrocladium floridanum* and its homogeneous catalytic degradation of 4-nitrophenol Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 116 (2013) 485–490.
- [17] Nakkala JR, Mata R, Kumar Gupta A, Rani Sadras S. Biological activities of green silver nanoparticles synthesized with *Acorous calamus* rhizome extract. Eur J Med Chem 2014; 85: 784–94.
- [18] U. Kanagavalli, A. Mohamed Sadiq, Sathishkumar, S. Rajeshkumar. Plant Assisted Synthesis of Silver Nanoparticles Using *Boerhaavia diffusa* Leaves Extract and Evolution of Antibacterial Activity. Research J. Pharm. and Tech 2016; 9 (8): 1064-1068.
- [19] Ulug B, Haluk Turkdemir M, Cicek A, Mete A. Role of irradiation in the green synthesis of silver nanoparticles mediated by Fig. (*Ficus carica*) leaf extract. Spectrochim Part A: Mol Biomol Spectrosc 2015; 135: 153–61.
- [20] Geetha N, Geetha TS, Manonmani P, Thiyagarajan M. Green synthesis of silver nanoparticles using *Cymbopogon Citratus* (Dc) Stapf. Extract and its antibacterial activity. Aus J Basic Appl Sci 2014; 8 (3): 324–31.
- [21] Masurkar SA, Chaudhari PR, Shidore VB, Kamble SP. Rapid biosynthesis of silver nanoparticles using *Cymbopogon Citratus* (Lemongrass) and its antimicrobial activity. Nano-Micro Lett 2011; 3 (3): 189–94.
- [22] Kumarasamyraja D, jeganathan NS. Green synthesis of silver nanoparticles using aqueous extract of *acalypha indica* and its antimicrobial activity. Int J Pharm Biol Sci 2013; 4 (3): 469–76.
- [23] Kumar S, Daimary RM, Swargiary M, Brahma A, Kumar S, Singh M. Biosynthesis of silver nanoparticles using *Premna herbacea* leaf extract and evaluation of its antimicrobial activity against bacteria causing dysentery. Int J Pharm Biol Sci 2013; 4 (4): 378–84.
- [24] Sadeghi B, Rostami A, Momeni SS. Facile green synthesis of silver nanoparticles using seed aqueous extract of *Pistacia atlantica* and its antibacterial activity. Spectrochim Part A: Mol Biomol Spectrosc 2015; 134: 326–32.
- [25] Vijayaraghavan K, Nalini S, Prakash NU, Madhankumar D. One step green synthesis of silver nano/microparticles using extracts of *Trachyspermum ammi* and *Papaver somniferum*. Colloid Surf B Biointerfaces 2012; 94: 114–7.
- [26] Thombre R, Parekh F, Patil N. Green synthesis of silver nanoparticles using seed extract of *Argyrea nervosa*. Int J Pharm Biol Sci 2014; 5 (1): 114–9.

- [27] Sunita D, Tambhale D, Parag V, Adhyapak A. Facile green synthesis of silver nanoparticles using *Psoralea corylifolia*. Seed extract and their in-vitro antimicrobial activities. *Int J Pharm Biol Sci* 2014;5 (1):457–67.
- [28] Gnanajobitha G., Rajeshkumar, S., Kannan C and Annadurai, G. 2012. Preparation and characterization of fruit-mediated silver nanoparticles using pomegranate extract and assessment of its antimicrobial activity (2013) *Journal of Environmental nanotechnology* 2 (1), 04-10.
- [29] G Gnanajobitha, K Paulkumar, M Vanaja, S Rajeshkumar, C Malarkodi, G Annadurai and C Kannan Fruit mediated Synthesis of Silver Nanoparticles using *Vitis vinifera* and Evaluation of their Antimicrobial Efficacy (2013) *Journal of Nanostructures in Chemistry* 3 (67): 1-6.
- [30] S. Rajeshkumar Phytochemical constituents of fucoidan (*Padina tetrastromatica*) and its assisted silver nanoparticles for enhanced antibacterial activity (2016) *IET Nanobiotechnology* doi: 10.1049/iet-nbt.2016.0099.
- [31] Rajeshkumar S, Malarkodi C, Vanaja M., Annadurai G Anticancer and enhanced antimicrobial activity of biosynthesized silver nanoparticles against clinical pathogens *Journal of Molecular Structure* 1116 (2016) 165-173.

Cite the paper

Venkat Kumar S., Karpagambigai S., Jacqueline Rosy P., Rajeshkumar S. (2017). [Phyto-Assisted Synthesis of Silver Nanoparticles using \*Solanum Nigrum\* and Antibacterial Activity Against \*Salmonella Typhi\* and \*Staphylococcus Aureus\*](#). *Mechanics, Materials Science & Engineering*, Vol 9. doi:[10.2412/mmse.86.22.967](#)