Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Biofabrication of Silver Nanoparticle Synthesized by *Erigeron canadensis* L. leaf Extract

Praveen P. Satapute[1], Bheemanagouda N. Patil[*2] and BasappaB. Kaliwal[1]

[1]Department of Microbiology and Biotechnology, Karnatak University, Dharwad, KA, India
[*2]Env. Biology Lab., Dept. of Studies inBotany, Karnatak University, Dharwad, KA, India

ABSTRACT

In the present days, green nanotechnology has been revolutionized and being implemented in the many sectors for its wide usage in applied science and technology and the plant based nanoparticle synthesis is gaining a significant lead because of its low cost production and accuracy. Hence, in the present investigation, a plant based synthesis of nanoparticle was utilized. The *Erigeron canadensis*L.leaves were used for the synthesis of silver nanoparticles**.** The leaf aqueous solutions was treated with silver nitrate solution andfurther characterization was done through UV-Vis spectroscopy for the confirmation and it was detected at 404 nm absorption peak and the presence of biomolecules was confirmed by the Fourier Transform Infra-Red (FT-IR) and were identified as alkanes C-H stretching,-C=C- stretching of alkenes,CH_3CH bending of alkanes,amide group of CH stretching and C-Br stretch alkyl halides. Additionally, the morphological appearance of silver nanoparticles was identified by the Atomic Force Microscopy (AFM) and was revealed that, nanoparticles were ranging from 46 to 83 nm with spherical in shape. Based on the present outcomes, the green synthesis is inexpensive, ecofriendly and potential method for synthesis of nanoparticle in large scales.

KEYWORDS: Green synthesis, *Erigeron canadensis*L., Silver nanoparticles,FTIR and AFM.

***Corresponding Author**

Bheemanagouda N. Patil

Environmental Biology Laboratory, Department of Studies in Botany,

Karnatak University, Dharwad, Karnataka, India

Email:-bnpatil089@gmail.com

INTRODUCTION

In the recent years, nanotechnology is gaining importance because of its functional systems at a micro molecular and nanotechnology is the emerging field of interest in applied science and technology, and its main theme is in control of matter at the molecular level at scales lesser than 0.1μm, normally between 1-100 nm[1]. Additionally, nanotechnology is a multidisciplinary field and is an extension of existing sciences such as pharmaceutical research, applied physics, material sciences, colloidal science, molecular chemistry, into nano scale.

Ayurveda, a 5000-year-old Indian system of medicine had some knowledge of nano science before the term ‘nano’ was formed, naturally developed the first relation between human life and nano scale. In the 21st, century modern science started exploring nanoscience[1,2]. In the last decade, study ofnanotechnology provide a solution to all microbial cells that can bio recover specific chemicals and also act as biocatalysts for reductive dechlorination[3]. Presently, many researcheshave been undertaken to produce the most potent nanoparticles from the plant extracts[3,4,5]. Moreover, some microorganisms are found to be able producers of the nanoparticles[6,7,8]. Previously, a number of researchers have worked on theextracts of plants and plant materials and these biological agents are appeared to be ecofriendly alternatives to physical and chemical methods. In most of the studies, it was proved that, using plants aqueous solutions for the synthesis of nanoparticles are advantageous on the biological methods by reducing the maintenance of microbial culture[9,10,11]. Therefore, the present investigation was undertaken to thebio fabrication of silver nanoparticle from *Erigeron canadensis*and antibacterial activity of analysis of silver nanoparticle.

MATERIAL AND METHODS

Collection of material:

Fresh and healthy leaves of *Erigeron canadensis*L.were collected from theKarnatak University, Campus Dharwad India.

Preparation of leaf extract:

The leaves were aseptically brought to the laboratoryand were thoroughly washed in the deionized water to remove any dust and dried particles. About 20gms of the air dried leaves were incubated with 100 ml of Milli Q water in the hot water bath for 1 hr at 60 $^{\circ}$C. Thereafter, the preparation was cooled at room temperature and liquid broth of leaves was filtered using whattman no.1 filter paper at room temperature and the filtrate was stored at 4 $^{\circ}$C until the further use.

Biosynthesis and Characterization of Silver nanoparticles:

10 mL of the leaf extract was mixed with 90 mL of 1 mM aqueous silver nitrate solution and pH was adjusted to 10 using the 0.1N NaOH. Further, to confirm the presence of nanoparticle, the mixture of filtrate and 1 mM aqueous silver nitrate was scanned in UV-Visible Spectroscopy (JascoCorporation, Tokyo, Japan)at 800 to 200 nm. The Mixture of nanoparticle was centrifuged at 4500 g in room temperature and dispersion was repeated to confirm the elimination of excess natural reducing agent and purified pellet were dried in oven at 55 $^{\circ}$C and the fine powder was grid with KBr in mortar and pestle to form the pellet using the pressure gauge and the spectra was measured using the Fourier Transform Infra-Red (FT-IR) Nicolet FT-IR 6700 (Thermo scientific)was utilized for identification of biomolecules involved in reduction, capping and stabilization for bio fabrication of silver nanoparticles by plant extract. Further, the functional groups were annoted using the IR spectra Chart.

Morphology analysis of nanoparticle by Atomic Force Microscopy(AFM):

The dried pellet of nanoparticle was mixed with Milli Q water and subjected to sonication at 230 V, 50 Hz (Ultra sonic bath Fisherbrand). After, drop of sonicated solution was placed on the dry clean glass slide and air dried. The size and appearance of nanoparticle were determined using the AFM (Tap190Al-G) with a nanosurf easy scan.

RESULTS

Leaves of*Erigeron Canadensis L.*plant (Fig. 1) was chosen because of its hemorrhage, menorrhagia, diarrhea, dysentery, cystitis, calculus, bronchial catarrhal and hemoptysis applications. The pale yellow colored plant extract was treated with silver nitrate and the color of the mixture was turned to the brown because of surface plasmon resonance (SPR). Further, the mixture was analyzed, the silver nanoparticle was confirmed and detect at 404 nmwavelength (Fig. 2).

Fig. 1: Habit of the *Erigeron canadensis* L.

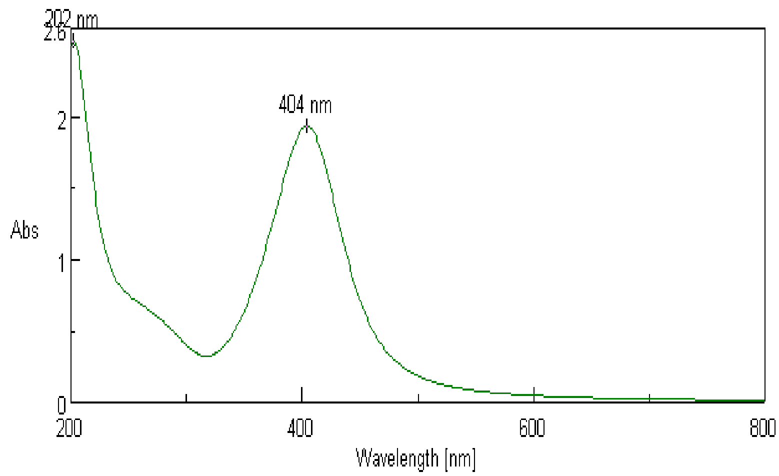

Fig. 2: UV-Vis spectrum of silver nanoparticles synthesized from *E. canadensis*L.leaf extracts

IR spectral probe of silver nanoparticle, molecular functional groups in the formation of silver nanoparticle is presented in Figure 3. IR bands at 3728, 3448, 2924, 2855, 1751, 1641, 1583, 1540, 1458, 1384, 1260, 1159, 1101, 1025, 827, 794, 765 and 588 cm^{-1}(Table 1). The band at 3728 cm^{-1} can be attributed to free OH stretching vibrations of amide. The sharp bands at 2924 and 794 cm^{-1} correspond to alkane of C-H stretching and amide group of CH respectively. The two medium peaks at 2855 and 1384 cm^{-1} may be from alkane C-H stretching and CH_3CH of alkanes. The peak at fingerprint region 765 and 588 is assigned to amide group of C-Cl stretching alkyl halides and C-Br stretching of alkyl halide, these bioactive molecules are involved in the reduction, capping and stabilization of silver nanoparticles.

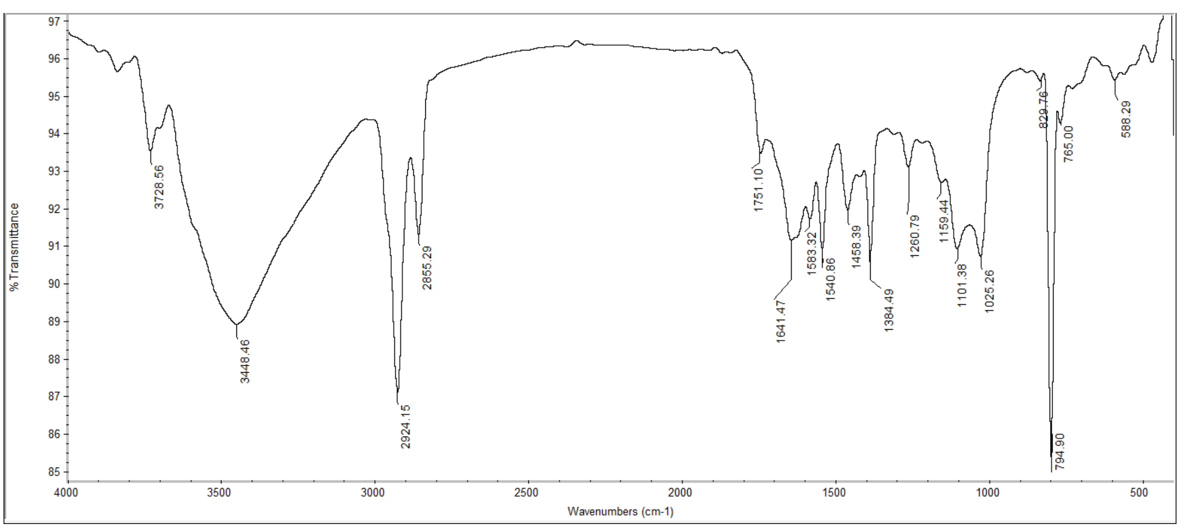

Fig. 3: FTIR spectra of silver nanoparticles synthesized by *E. canadensis*L.leaf extract

Table 1: FTIR shows the functional group involved synthesis of silver nanoparticles

Sl. No.	Absorption peak (cm^{-1})	Functional groups
1	588	C-Br stretching of alkyl halides
2	765	C-Cl stretching alkyl halides
3	794	Amide group of CH stretching
4	829	C-Cl stretching of alkyl halides
5	1025	Ethers =C-O-C symmetric stretching
6	1101	Aldehydes and ketones bending of C-C-C
7	1159	C-N stretching vibration of the proteins
8	1260	C-H waging of alkyl halides
9	1384	CH_3CH bending of alkanes
10	1458	Aromatic compound of C=C stretching
11	1540	Alkanes and alkyl groups
12	1583	1° amines
13	1641	-C=C- stretching of alkenes
14	1751	Esters of C=O stretching
15	2855	Alkanes C-H stretching
16	2924	Alkanes C-H stretching
17	3448	Alcohol and phenols of –OH stretching
18	3728	OH groups of amide

The size and shape of silver nanoparticles were confirmed by the atomic force microscope analysis. The figure 4a shows the size of the nanoparticles is ranges from 46 to 83 nm with spherical in shape, the height of the nanoparticles are 21-57 nm (Fig. 4b). The distance between the each particle is 5 nm to 265nm it shows that particles are highly dispersive in nature.

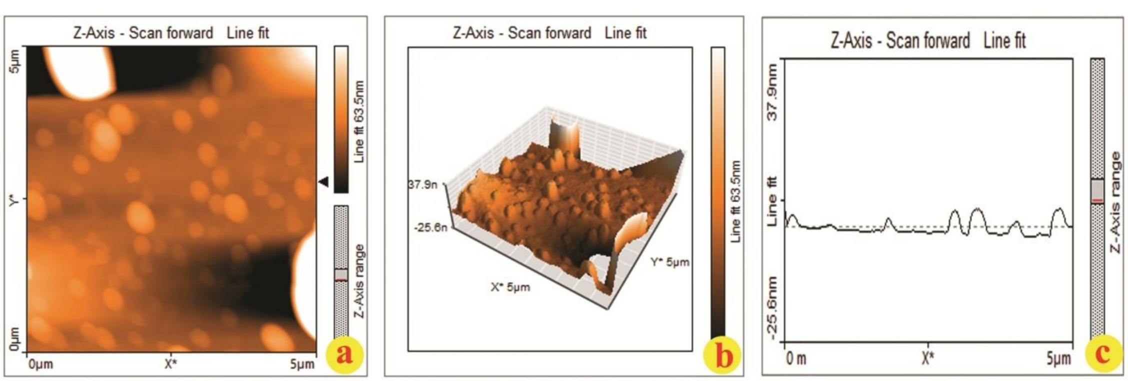

Fig. 4: AFM images of a. 2D structure; b. 3D structure; c. distance between the particles

DISCUSSION

Nanoparticles exhibit completely new, unique or improved physical, chemical, and biological properties compared to the larger particles present in the bulk material[12]. Nanoparticles with decreasing size, present a high surface-to-volume ratio. Since the nanoparticles have increased surface energy the specific surface area of nanoparticles is directly proportional to their biological effectiveness[13]. The usage of nanoparticles is gaining popularity in this century as they show defined optical, magnetic, mechanical, electronic, chemical, catalytic and antimicrobial properties. Due to the large surface area to volume ratio and a high fraction of atoms on the surface of metallic nanoparticles, they are gaining importance for their significant antibacterial properties. This fact is attracting the attention of scientists due to the growing microbial resistance against antibiotics and metal ions and development of resistant strains[14,15]. Controlled size and composition of nanoparticles are of fundamental interest since they provide solutions to environmental and technological challenges in the areas of catalysis, solar energy conversion and waste water treatment. Synthesis and application of nanomaterial's from 1 to 100 nanometers (nm) is an gaining impetus in the field of research[16,17].

Traditionally nanoparticles have been fabricated and stabilized by various physical and chemical methods; of them, photochemical reduction, electrochemical methods and chemical reduction, are widely used[18,19]. Global warming and climate change have induced a worldwide awareness and serious measures are taken to reduce the generation of hazardous wastes. Recently, bio-inspired approaches has led to the development of the clean and green methods of synthesis, which are preferred for economic and environmental concerns over other synthetic methods. Physical methods such as molecular beam epitaxy, chemical vapor deposition etc., require expensive and high technology and they are also not energy-efficient[20,21]. In chemical methods organic surface passivation reagents such as thiophenol[22] thiourea[23], marcapto acetate[24], etc. which prevent nanoparticles from aggregation are toxic and pollute the environment if large scale nanoparticles are produced. They are not environment friendly. Increasing awareness about the global environmental issues has led researchers to focus on 'green chemistry' and adopt simple and eco-friendly technology. Biosynthesis of nanoparticles offers many advantages over the usual physical and chemical methods which employ toxic chemicals. They are unacceptable in the field of medicine due to which the fields of nanoparticles synthesis has recently developed new innovative technologies employing bacteria[25] (Ahmad et al., 2003), yeast[4], fungi[26,27,28] or plants[29,30,31,32] all of which are present in the process of natural recycling. In biosynthesis technology which involve microorganisms, the products of microbe activities such as enzymes/proteins present in the environment or those which are force-secreted from them when they meet specific metal ions are responsible for the yield of highly stable intra- or extracellular nanoparticles[4,27,28,33,34].

The ability of plants extracts in the reduction of metal ions is known for decades but is also the least explored biological method. However green nanotechnology is gaining impetus due to the effective engineering of expected products in an effective economical manner and the total elimination of harmful chemicals. Synthesis of metal nanoparticles of gold, silver and of a gold-silver-copper alloy have been reported in plants[7,33,35,36,37,38]. Gold, silver, and copper nanoparticles form stable dispersions, which are used in the area of optoelectronics, Surface-Enhanced Raman Scattering (SERS) detection, photonics, photography, catalysis and biological labeling[39,40]. Studies indicate that biomolecules such as proteins, phenols, flavonoids, carbohydrates etc. play an important role in reducing and capping of the ions to their nanosize[41,42].

CONCLUSION

The outcomes of present investigation reveals that, the plant mediated green synthesis of silver nanoparticle is cost effective and environmentally friendly method using the leaf extract of *Erigeron canadensis*as a bio reducing agents. Thesynthesized silver nanoparticles are spherical in shape and mono-dispersed in appearance and ranges from 21-57 nm. These biogenic silver nanoparticles are used in pharmaceuticals and biomedical sensors for detecting the various diseases.

ACKNOWLEDGEMENT

Authors are thankful to Department of Botany, Biotechnology and Microbiology.

CONFLICT OF INTEREST

Authors don’t have any conflict of interest related to the manuscript.

REFERENCES

1. DubeySP, Lahtinen M, Sillanpaa M. Tansy fruit mediated greener synthesis of silver and gold nanoparticles. Process Biochem. 2010; 7:1065-1071.
2. Taniguchi N. On the basic concept of nano-technology Proc Intl Conf Prod Eng Tokyo, Part II, Japan Society of Precision Engineering 1974; 5-10.
3. Logeswari P, Silambarasan S, Abraham J. Synthesis of silver nanoparticles using plants extract and analysis of their antimicrobial property. J. Saudi ChemSoc 2012;10.1016/j.jscs.2012.04.007.

4. Kowshik M, Ashtaputre S, Kharazzi S, Vogel S, Urban J, Kulkarni SK, Paknikar KM. Extracellular synthesis of silver nanoparticles by a silver-tolerant yeast strain MKY3. Nanotechnology.2003; 14:95-100.
5. Awwad AM, Salem NM, Abdeen AO. Green synthesis of silver nanoparticles using carob leaf extract and its antibacterial activity. International Journal of Industrial Chemistry.2013; 4:29.
6. Klaus T, Joerger R, Olsson E, Granqvist CG. Silver-based crystalline nanoparticles, microbially fabricated. J ProcNatlAcadSci USA 1999; 96:13611-13614.
7. Nair B, Pradeep T. Coalescence of nanoclusters and formation of submicron crystallites assisted by Lactobacillus strains. Cryst Growth Des 2002; 2: 293-298.
8. Konishi Y, Uruga T. Bioreductive deposition of platinum nanoparticles on the bacterium Shewanella algae. J Biotechnol.2007; 128:648-653.
9. Shankar SS, Ahmed A, Akkamwar B, Sastry M, Rai A, Singh A. Biological synthesis of triangular gold nanoprism. Nature. 2004; 3: 482.
10. Jae YS, Beom SK. Rapid biological synthesis of silver nanoparticles using plant leaf extracts. Bioprocess BiosystEng 2009; 32:79-84.
11. Dubey M, Bhadauria S, Kushwah BS. Green synthesis of nanosilver particles from extract of Eucalyptus hybrida (Safeda) leaf. Dig J NanomatBiostruct 2009; 4(3):537-543.
12. Li L, Hu J, Yang WA, Paul A. Band Gap Variation of Size- and Shape-Controlled Colloidal CdSe Quantum Rods *Nano Letters,* 2001; 1(7):349-351.
13. Perez C, Fernandez LE, Sun J, FolchJL, Gill SS, Soberon M, Bravo A. Bacillus thuringiensis subsp. israelensis Cyt1Aa synergizes Cry11Aa toxin by functioning as a membrane-bound receptor. ProcNatlAcadSci USA 2005; 102:18303-18308.
14. Rai M, Yadav A, Gade A. Silver nanoparticles as a new generation antimicrobial. Biotechnol Adv. 2009; 27:76-83.
15. Gong P, Li H, He X, Wang K, Hu J, Zhang S, Yang X. Preparation and antibacterial activity of Fe3O4@Ag nanoparticles. Nanotechnology. 2007: 18(28):604-611.
16. Dahl JA, Maddux BLS, Hutchison JE. Toward greener nano synthesis Chem. Rev., 2007; 107:2228-2269.
17. Hutchison JE. Greener nanoscience: a proactive approach to advancing applications and reducing implications of nanotechnology. ACS Nano. 2008; 2:395-402.
18. Chen X, SchluesenerHJ. Nanosilver: A nanoproduct in medical application. Toxicol. Let.2008; 176(1):1-12.
19. Frattini A, Pellegri N, Nicastro D. Sanctis DO. Effect of amine groups in the synthesis of Ag nanoparticles using aminosilanes. Mat Chem Phys. 2005; 94:148-152.

20. Ishikawa Y, Shibata N, Fukatsu S. Highly oriented Si nanoparticles in SiO_2 created by Si molecular beam epitaxy with oxygen implantation. Thin sol film. 1997; 294:227-230.
21. Creighton JR, Coltrin ME, FigielJJ. Observations of gasphase nanoparticles during InGaN metal-organic chemical vapor deposition. ApplPhysLett. 2008; 93:171906.
22. Ravindran V, Cabahug S, Ravindran G, Bryden WL. Influence of microbial phytase on apparent ileal amino acid digestibility of feedstuffs for broilers. Poultry Sci., 1999; 78:699-706.
23. Pattabi M, Uchil J. Synthesis of cadmium sulphide nanoparticles. Solar Energy Mater Solar Cell. 2000; 63:309-314.
24. Lin D, Edwards AS, Fawcett JP, Mbamalu G, Scott JD, Pawson T. A mammalian PAR-3–PAR-6 complex implicated in Cdc42/Rac1 and aPKCsignalling and cell polarity. Nat. Cell Biol. 2000; 2:540-547.
25. Saravanan C, Rajesh R, Kaviarasan T, Muthukumar K, Kavitake D, Halady SP. Synthesis of silver nanoparticles using bacterial exopolysaccharide and its application for degradation of azo-dyes. Biotechnology Reports. 2017; 15:33-40.
26. Duran N, MarcatoPD, AlvesOL, de Souza GIH, Esposito E. Mechanistic aspects of biosynthesis of silver nanoparticles by several *Fusariumoxysporum* strains. J Nanobiotechnol. 2005; 3:1-8.
27. Balaji D, Basavaraja S, Raghunandan D, Mahesh D, Belawadi B, Krishnamurthy P. Abbaraju V. Biosynthesis and stabilization of Au and Au–Ag alloy nanoparticles by fungus, *Fusariumsemitectum*. Sci. Technol. Adv. Mater. 2008; 9:3.
28. Ahmad A, Mukherjee P, Mandal D, Senapati S, Islam Khan M, Kumar R, Sastry M. Enzyme mediated extracellular synthesis of CdS nanoparticles by the Fungus, *Fusariumoxysporum. Am. Chem. Soc.* 2002; 124(41):12108-12109.
29. PatilBN, TaranathTC. Anti-Tuberculosis activity of biogenic silver nanoparticles synthesized by using aqueous leaf extract of *Limoniaacidissima*L. Int J Pharm Bio Sci 2016b; 7(1): 89-97.
30. Shankar SS, Rai A, Ahmad A, Sastry M. Biosynthesis of silver and gold nanoparticles from extracts of different parts of the geranium plant. Appl Nano Sci. 2004a; 1:69-77.
31. Shankar, SS., Rai, A., Ahmad, A, Sastry M. Rapid synthesis of Au, Ag and bimetallic Au core Ag shell nanoparticles using Neem (*Azardirachtaindica*) leaf broth. J.ColloidInterf. Sci. 2004b; 275:496-502.
32. Ankamwar B, Chaudhary M, Sastry M. Gold nanoparticles biologically synthesized using Tamarind leaf extract and potential application in vapour sensing. Synthesis and Reactivity in Inorganic. Metal-organic and Nano-metal Chemistry. 2005; 35:19-26.

33. Ahmad A, Mukherjee P, Senapati S, Mandal D, Khan MI, Kumar R, et al.Extracellular biosynthesis of silver nanoparticles using the fungus *Fusariumoxysporum*Colloids and Surfaces, B: Biointerfaces. 2003; 28:313-331.

34. Lee HJ, Song JY, Kim BS. Biological synthesis of copper nanoparticles using Magnolia kobus leaf extract and their antibacterial activity. J ChemTechnolBiotechnol. 2013; 88:1971-1977.

35. Joerger R, Klaus T, Granqvist CG. Biologically produced silver-carbon composite materials for optically functional thin-film coatings. Adv. Mater. 2000; 12:407-409.

36. ChandranSP, Minakshi C, Renu P, Absar A, Sastry M. Synthesis of gold nanotriangles and silver nanoparticles using *Aloe vera* plant extract. Biotechnology Progress. 2006; 22:577-583.

37. Shankar SS, Ahmad A, Pasricha R, Sastry M. Bioreduction of chloroaurate ions by geranium leaves and its endophytic fungus yields gold nanoparticles of different shapesJ. Mater. Chem. 2003a; 13:1822-1826.

38. Sathishkumar M, Sneha K. Won SW, Cho CW, Kim S, Yun YS. *Cinnamon zeylanicum* bark extract and powder mediated green synthesis of nano-crystalline silver particles and its bactericidal activity. Colloid Surf. B, 2009; 73:332-338.

39. Zavaleta CL, Smith BR, Walton I, Doering W, Davis G, Shojaei B, NatanMJ, Gambhir SS. Multiplexed imaging of surface enhanced Raman scattering nanotags in living mice using noninvasive Raman spectroscopy. ProcNatlAcadSci USA. 2009; 106:13511–13516.

40. Mourant JR, Dominguez J, Carpenter S, Short KW, Powers TM, Michalczyk R, Kunapareddy N, Guerra A, Freyer JP. Comparison of vibrational spectroscopy to biochemical and flow cytometry methods for analysis of the basic biochemical composition of mammalian cells. J Biomed Opt. 2006; 11(6):064024.

41. Vedpriya AY, Sanjay KS, Yader JP. Antimicrobial activity of Cassia occidentalis against various human pathogenic microbes. Life Sciences and Medicine Research. 2010; 9:1-10.

42. PatilBN, TaranathTC, *Limoniaacidissima* L. leaf mediated synthesis of zinc oxide nanoparticles: A potent tool against *Mycobacterium tuberculosis*. Int J Mycobacteriol. 2016a; 5(2):197-204.