VOLUME 8 ISSUE 2 2022

ISSN 2454-3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 8, No. 2, 47-58 (2022)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Phytochemical Analysis of Crude Plant Extracts and Laboratory Synthesized Green Nanoparticles from *Acacia auriculiformis* A. Cunn. ex Benth.

Kaur Amandeep[1*] and Singh Devinder[2]

[1]Department of Zoology, Sri Guru Teg Bahadur Khalsa College, Sri Anandpur Sahib, Punjab, India
[2]Department of Physics, Sri Guru Teg Bahadur Khalsa College, Sri Anandpur Sahib, Punjab, India

**Corresponding Author*

Received: 7th June, 2022; **Accepted:** 10th July, 2022; **Published online:** 16th July, 2022

https://doi.org/10.33745/ijzi.2022.v08i02.008

Abstract: Recently the research and analysis of green nanoparticles (NPs) synthesized with plant extracts has been expanded significantly due to their biological activities. From the variety of agents used for nanoparticles synthesis, silver (Ag) is the most preferred due to its recommended use in medical field as best topical bactericides from ancient times. In the present study, crude bark extracts of *Acacia auriculiformis* A. Cunn. were used for nanoparticles synthesis and comparison of their biochemistry with crude extract was assessed by using biochemistry analytical techniques viz; UV-Visible spectrophotometer (UV-Vis), Fourier transform infra-red spectrophotometer (FTIR), Photoluminescence (PL) and Direct Light Scattering analysis (DLS).

Keywords: *Acacia auriculiformis,* Silver nanoparticles, UV-Visible spectrophotometer, Fourier transform infra red spectrophotometer, Photoluminescence, Direct Light Scattering analysis

Citation: Kaur Amandeep and Singh Devinder: Phytochemical analysis of crude plant extracts and laboratory synthesized green nanoparticles from *Acacia auriculiformis* A. Cunn. ex Benth. Intern. J. Zool. Invest. 8(2): 47-58, 2022.

https://doi.org/10.33745/ijzi.2022.v08i02.008

Introduction

In 20th century, Nano materials come in culture very swiftly. Similar nanoparticles as well as green nanoparticles enter the research field for medicinal and analytical departments of various national and international agencies. Nanoparticles (NPs) can be synthesized by using certain organic agents (mainly carbon) and inorganic (metal ions like silver and gold) agents (Singh *et al*., 2011). Silver (Ag) is the most preferred NPs synthesis agent because of its great bioactivity and safe nature to humans (Lavanya *et al*., 2013). For synthesizing stable silver nanoparticles, soluble starch as both the reducing and stabilizing agents can be used (Shrivastava *et al*., 2012). The scientific community also shifted their concern towards ecofriendly, natural and cheaper method of NPs synthesis by using organic agents like microorganisms and plant extracts (Mohanpuria

et al., 2008). Also the use of plant extracts and compounds is most popular for silver nanoparticles (NPs) synthesis due to the gamut of biological activities, easy availability and faster as well as cheaper rate of NP's synthesis with them (Huang *et al*., 2007; Awwad *et al*., 2012). The nanoparticles had been clinically used for infection, vaccines and renal diseases (Malhotra *et al*., 2010). The plant extract of petals of herbal species like *Punica granatum*, *Datura metel* and Aloe vera (Chandran *et al*., 2006) and stem extracts of *Svensonia hyderobadens*is (Linga *et al*., 2011) had been effectively used for NPs synthesis and investigated for their antimicrobial activities.

Nanoparticles could be synthesized by various approaches like photochemical reactions in reverse micelles, thermal decomposition, sonochemical and microwave assisted process (Santosh and Marzan, 2002; Prashar *et al*., 2009). Nanocrystalline silver particles have found tremendous applications in the field of high sensitivity biomolecular detection and diagnostics (Schultz *et al*., 2000), antimicrobials and therapeutics (Rai *et al.*, 2009; Elechiguerra *et al*., 2005) and micro-electronics (Gittins *et al*., 2000).

A. auriculiformis (also called as Black wattle and Australian Kikkar), is an important medicinal plant and widely distributed member of family Fabaceae and subfamily Mimosoideae, and is a rich source of polyphenols and tannins (Singh and Sehgal 2001). It's anti-helminthic, anti-filarial, anti-insect and microbicidal effects have been well demonstrated (Mandal *et al.,* 2005; Kaur *et al.,* 2009; 2010; 2012; 2014a, b). The medicinal as well as biological properties of *A. auriculiformis* at cellular stage (Du *et al*., 2007), drug delivery and diagnostics imaging cancer detection (kairemo *et al*., 2008) have been investigated. To our knowledge there exists no report regarding silver nanoparticles (NPs) synthesis using bioactive extracts of important medicinal plant, *A. auriculiformis*. In the present study, biochemistry of crude extracts (methanol -- AAM; acetone-- AAA and water-- AAW extracts) of *A. auriculiformis* as well as synthesized nanoparticles was explored.

Materials and Methods

The bark of *A. auriculiformis* was collected from Chandigarh, India. The plant species was identified by comparing it with the specimen available in the herbarium (voucher number 6422) of the Guru Nanak Dev University, Amritsar, India. Utmost care was taken to select the healthy bark.

Preparation of bark extract:

Procurement and extraction of plant material: The bark of *A. auriculiformis* was procured and washed with tap water (thrice) and dried in oven at 30 ^{0}C for overnight and ground to a fine powder with grinder. The extracts of *A. auriculiformis* were prepared by maceration extraction method in which the bark was dissolved in solvent.

Protocol for extraction of plant material: Dried bark powder (3 kg) was suspended in 1000 ml acetone and kept on shaker for 24 h at room temperature. After 24 h, the suspended solid was filtered off through Whatman No. 1 filter paper and filtrate was collected. This procedure was repeated thrice to obtain three filtrates of extract. The three filtrates were combined and solvent was removed under vacuum using rotary evaporator to obtain solid residue. This light brown coloured dried material was named as "Acetone Extract" of *A. auriculiformis* (AAA). Other extracts i.e. methanol (AAM) and water (AAW) were also obtained with the similar method.

Protocol for synthesis of nanoparticles:

1. Took finely powdered extract of the plant.
2. Prepared the stock solution of the plant material with 10 mg/ml conc. of extract in 100 ml of 7% DMSO.
3. Prepared 1mM $AgNO_3$ (silver nitrate) solution.
4. Added $AgNo_3$ solution to extract solution in 9:1.
5. Mixed 900 ml of $AgNO_3$ solution to 100 ml of plant extracts of test conc.
6. Incubated the solution for 2-3 h and filter it.
7. Dried the solution in hot air oven 40-50 ^{0}C.

8. Ground the dried material into fine powder.
9. Washed the powder with NaCl (sodium chloride). If white precipitates formed, filter it using Whatman filter paper.
10. Dried it and powdered the material.
11. Stored the material for further experimentation in air tight containers.

Phytochemical studies:

Synthesized nanoparticles and crude bark extracts were sent to different analytical laboratories (Punjab University, Chandigarh and Guru Nanak Dev University, Amritsar Sahib) of Punjab, India for Phytochemical analysis with UV-Vis, FTIR, PL and DLS analysis.

Results and Discussion

UV-Visible spectrophotometer analysis:

The UV-Vis spectra obtained for three bark extracts (Acetone, Methanol and water extract) and their corresponding nanoparticles (Acetone NPs, Methanol NPs and Water NPs) are shown in Figures 1, 2 and 3. The spectra showed absorption maxima at 580nm. The peak at 580nm showed the sharp peaks of benzene vapour showing effect on band shape (Stephen, 2000).

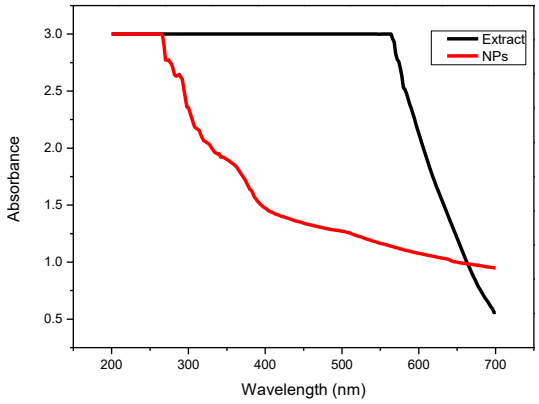


Fig. 1: UV-Visible spectra of Acetone extract of *Acacia auriculiformis* and synthesized NPs.

The spectra of silver solution containing acetone bark extract showed absorption maxima at 275 nm whereas an absorption window form 350 nm to 400 nm was recorded, which may be assigned to surface Plasmon of various metal nanoparticles (Lakowicz, 1997).

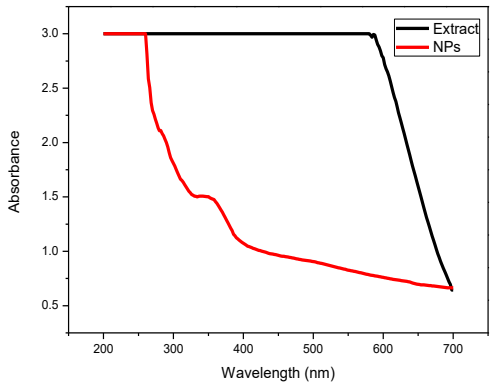


Fig. 2: UV-Visible spectra of Methanol extract of *Acacia auriculiformis* and synthesized NPs.

The spectra of silver solution containing methanol bark extract showed absorption maxima at 275 nm whereas an absorption window form 380 nm to 420 nm was recorded, which may be assigned to surface Plasmon of various metal nanoparticles (Sarkar *et al.,* 2012).

The spectra showed absorption maxima at 280 nm. The peak at 280 nm showed the quantum dots and metal–silica core shell of metal compounds (Walia and Acharya, 2015).

The spectra of silver solution containing water bark extract showed absorption maxima at 275 nm whereas an absorption window form 520 nm to 700 nm was recorded, which may be assigned to surface Plasmon of various metal nanoparticles (Sarkar *et al.,* 2012).

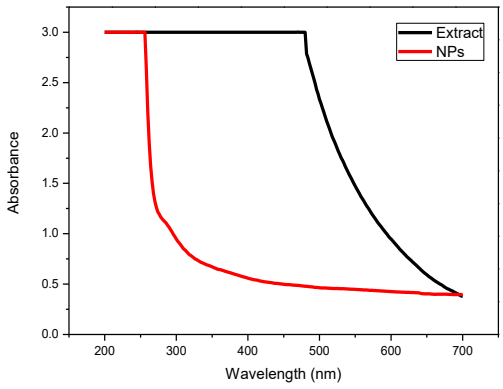


Fig. 3: UV-Visible spectra of Water extract of *Acacia auriculiformis* and synthesized NPs.

Photo luminescence Spectroscopy (*PL*):

A Photoluminescence (PL) spectrum obtained from the crude bark extract and NPs is given in Figures 4, 5 and 6. From the spectrum, it was seen that PL excitation intensity peak appeared at 625 nm with steady intensity of 1000 au till emission peak at 650 nm. PL spectrum showed NPs excitation peak at 625 nm and emission peak at 670 nm with the similar intensity of 1000 au for crude extract. During the comparison of spectra of crude extract and NPs, the shift in excitation intensity peak from 630 nm to 670 nm from crude extract to NPs was recorded (Fig. 4).

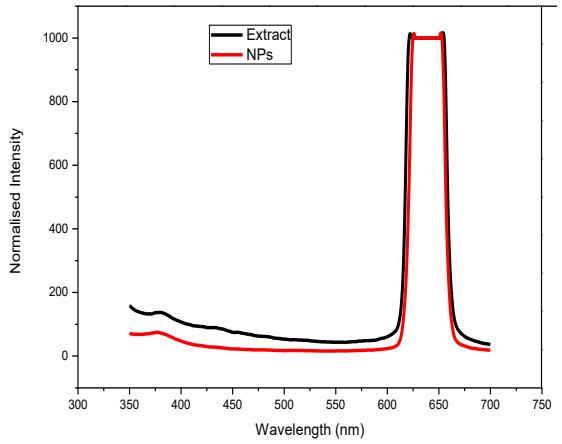


Fig. 4: Photo luminescence spectra of Acetone extract of *Acacia auriculiformis* and synthesized NPs.

A Photoluminescence (PL) spectrum obtained from the crude bark extract is given in Figure 5. From the spectrum, it was seen that PL excitation intensity peak appeared at 620 nm with steady intensity of 1000 au till emission peak at 650 nm. PL spectrum showed NPs excitation peak at 620 nm and emission peak at 670 nm with the similar intensity of 1000 au for crude extract. During the comparison of spectra of crude extract and NPs, the shift in excitation intensity peak from 650 nm to 670 nm from crude extract to NPs was recorded. The PL peaks at 610 nm to 640 nm showed Si =Si binding sites at the surface of oxygen. The Peaks at 650 nm to730 nm showed Si-nano crystallites with different sizes (Loken, 1990).

From the spectrum, it was seen that PL excitation intensity peak appeared at 610nm with steady intensity of 1000 au till emission peak at 650 nm. PL spectrum showed NPs excitation peak at 630 nm and emission peak at 670 nm with the similar intensity of 1000 au for crude extract. During the comparison of spectra of crude extract and NPs, the shift in excitation intensity peak from 630 nm to 670 nm from crude extract to NPs was recorded (Fig. 6.).

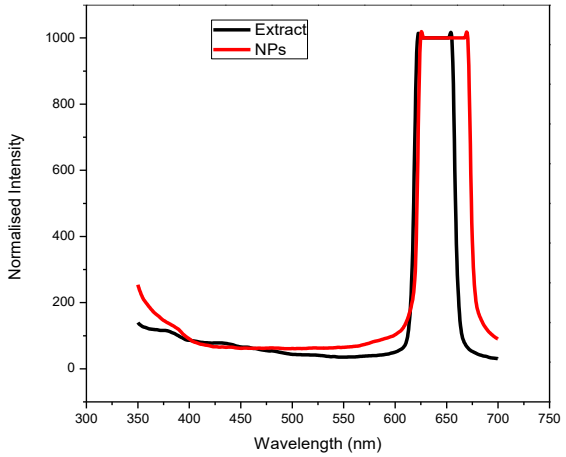


Fig. 5: Photo luminescence spectra of Methanol extract of *Acacia auriculiformis* and synthesized NPs.

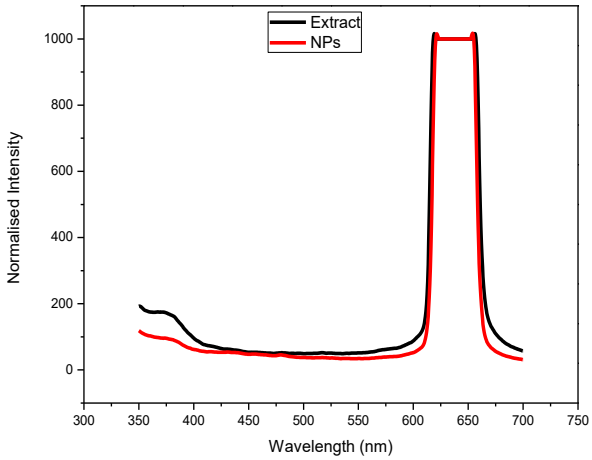


Fig. 6: Photo luminescence spectra of Water extract of *Acacia auriculiformis* and synthesized NPs.

The PL peaks at 630 nm to 650 nm showed Si=O binding sites at the surface of oxygen. The Peaks at 630 nm to730 nm showed Si-nano crystallites with different sizes (Siu and Stokes, 2000). Some Peaks at 610-700 nm showed Si-Si

bonds and annealing of Si-NPs (Mijares and Morates, 2009).

Fourier transform infra-red spectrometer (*FTIR*):

FTIR spectra analysis for crude extract (Figs. 7A, 8A, 9A) and synthesized nanoparticles (Figs. 7B, 8B, 9B) revealed presence of ten and thirteen absorption peaks in the two spectrums, respectively. The peaks assigned for the spectrums are summarized in Tables 1, 2 and 3.

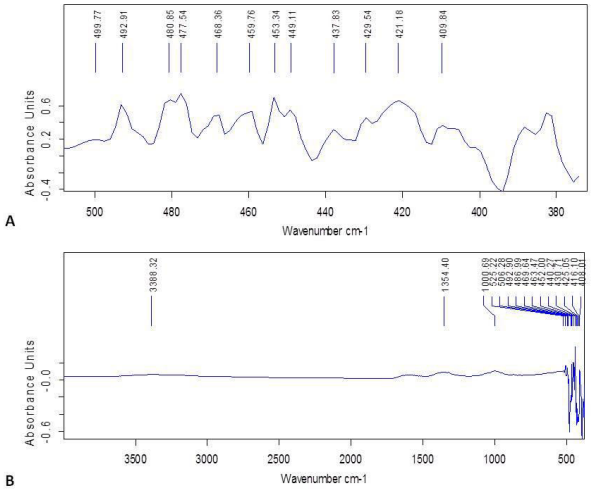


Fig. 7: FTIR spectra of A) acetone extract of *Acacia auriculiformis* and B) synthesized NPs.

With the presence of one extra peaks i.e. at 416.10 cm^{-1}, it may be concluded that the peaks were due to the presence of silver ions in the solution. The peaks between 400 to 500 cm^{-1} exhibited oxygen bonds by infra- red active vibration modes and peak at 410 cm^{-1} exhibited Triterpene compounds (Satish and Janakiraman, 2012). The NPs showed two highest peaks at 1354.40 cm^{-1} and 1000.69 cm^{-1}. The peaks between 1200 to 1350 cm^{-1} showed C-H bend. The peaks between at 500 to 600 cm^{-1} also showed C=C-H:C-H bend (Morones and Camacho, 2005).

FTIR spectra analysis for crude methanol extract (Fig. 8 a) and synthesized nanoparticles (Fig. 8 b) revealed presence of ten and thirteen absorption peaks in the two spectrums, respectively. The peaks assigned for the spectrums are summarized in Table 2. With the presence of two extra peaks i.e. at 423.97 cm^{-1} and 410.55 cm^{-1}, it may be concluded that these peaks were due to the presence of silver ions in the solution.

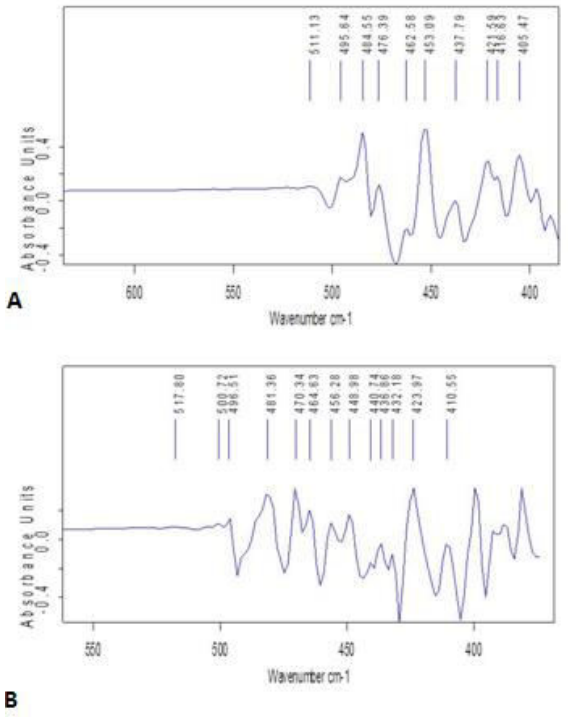


Fig. 8: FTIR spectra of A) methanol extract of *Acacia auriculiformis* and B) synthesized NPs.

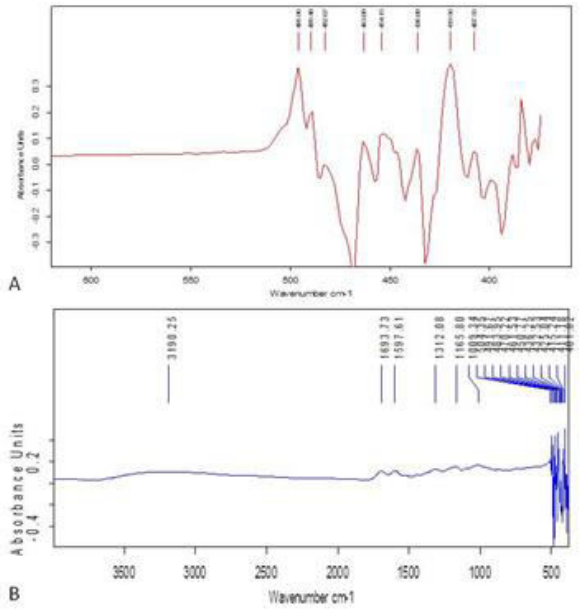


Fig. 9: FTIR spectra of A) Water extract of *Acacia auriculiformis* and B) synthesized NPs.

FTIR spectra analysis for crude water extract (Fig. 9 a) and synthesized nanoparticles (Fig. 9 b) revealed presence of ten and thirteen absorption

Table 1: FTIR spectra analyses for crude acetone extract and silver nanoparticles (NPs)

S. No.	Absorption peaks (cm^{-1})	
	Acetone extract	**NPs**
1	499.77	**1354.40**
2	492.91	**1000.69**
3	480.85	525.22
4	477.54	506.28
5	468.36	492.90
6	458.76	486.99
7	453.34	469.64
8	449.11	463.47
9	437.83	452.00
10	429.54	440.27
11	421.18	430.71
12	409.84	**425.05**
13	-	**416.10**

Table 2: FTIR spectra analysis for crude methanol extract and silver nanoparticles (AgNPs)

S. No.	Absorption peaks (cm^{-1})	
	Methanol extract	**AgNPs**
1	511.13	517.80
2	-	**500.72**
3	495.64	496.51
4	484.55	481.36
5	476.39	470.34
6	462.58	464.63
7	453.09	458.28
8	437.79	448.98
9	421.59	440.74
10	416.63	436.86
11	405.47	432.18
12	-	**423.97**
13	-	**410.55**

Table 3: FTIR spectra analysis of crude water extract and silver nanoparticles (NPs)

S. No.	Absorption peaks (cm^{-1})	
	NPs	**Water extract**
1	407.96	401.82
2	411.18	419.96
3	415.24	436.08
4	425.04	454.15
5	432.53	465.09
6	436.25	482.67
7	450.77	489.49
8	461.53	495.96
9	470.22	-
10	483.96	-
11	491.67	-
12	504.36	-
13	**1009.34**	-
14	**1186.80**	-
15	**1597.61**	-
16	**1693.73**	
17	**3190.25**	-

peaks in the two spectrums respectively. The peaks assigned for the spectrums are summarized in Table 3.

With the presence of two extra peaks i.e. at 401.82 cm^{-1} and 411.18 cm^{-1}, it may be concluded that these peaks were due to the presence of silver ions in the solution. The peaks between 400 to 500 cm^{-1} exhibited oxygen bonds by infra red active vibration modes and peak at 410 cm^{-1} exhibited Triterpene compounds (Satish and Janakiraman, 2012).

The NPs showed two highest peaks at 3190.25 cm^{-1} and 1693.73 cm^{-1} and these peaks exhibited the carbon–carbon triple bond and having multiple broad peaks (Maoela *et al.* 2009**)**.

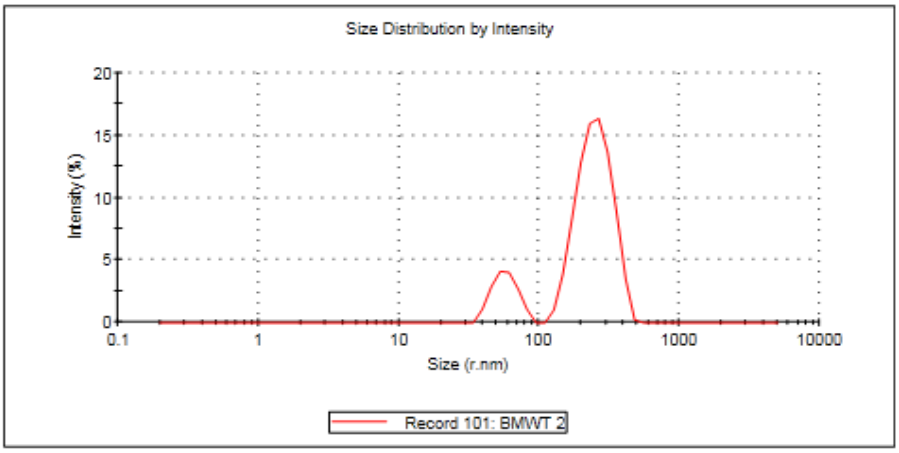
Direct Light Scattering Analysis (*DLS*):

The particles size distribution of synthesized silver NPs was evaluated by DLS measurement using a Zetasizer, version 6.32.DLS analysis which is a latest technique which works on Brownian movement of electrons when strike to certain objects. With the help of that striking, the size of the target object can be assessed. Biological materials or other chemicals of biological origin can be observed for their size with DLS analysis. The DLS analysis is summed up in Figures 10, 11 and 12 for crude bark extracts of *A. auriculiformis* obtained with Acetone, methanol and water, respectively. The NPs synthesized with acetone, methanol and water showed DLS results which are given in Figures 13, 14 and 15, respectively.

In the present study, silver nanoparticles size is in the range of 25 nm to 95 nm and the crude extract size range from 55 nm to 100 nm. It clearly indicated the reduction in particle size (Figs. 10-15).

			Size (r.nm):	% Intensity	Width (r.nm):
Z-Average (r.nm):	307.4	Peak 1:	254.8	84.1	68.59
PdI:	0.768	Peak 2:	57.82	15.9	11.32
Intercept:	0.866	Peak 3:	0.000	0.0	0.000

Result quality : Refer to quality report



Malvern Instruments Ltd
www.malvern.com

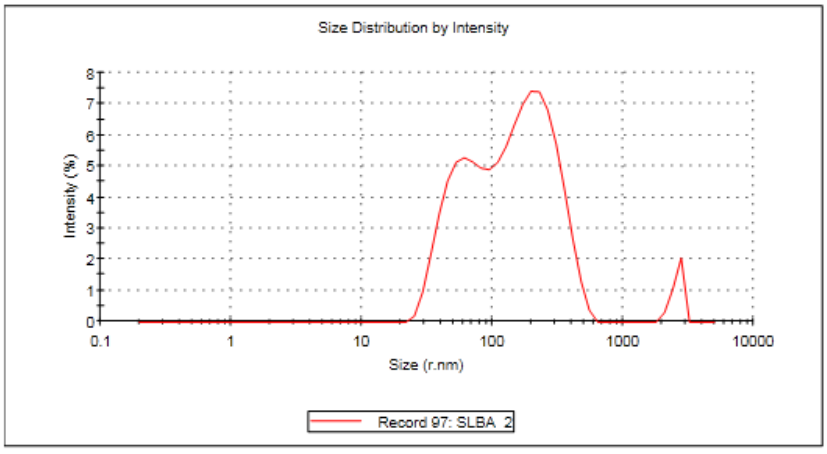
Zetasizer Ver. 6.34
Serial Number : MAL1075125

File name: Dr.A.K Paul
Record Number: 101
12 Aug 2013 6:18:59 PM

Fig. 10: DLS analysis of crude acetone extract of *A. auriculiformis.*

			Size (r.nm):	% Intensity	Width (r.nm):
Z-Average (r.nm):	111.8	Peak 1:	216.6	61.7	96.47
PdI:	0.491	Peak 2:	62.06	35.0	19.64
Intercept:	0.845	Peak 3:	2599	3.3	238.0

Result quality : Refer to quality report



Malvern Instruments Ltd
www.malvern.com

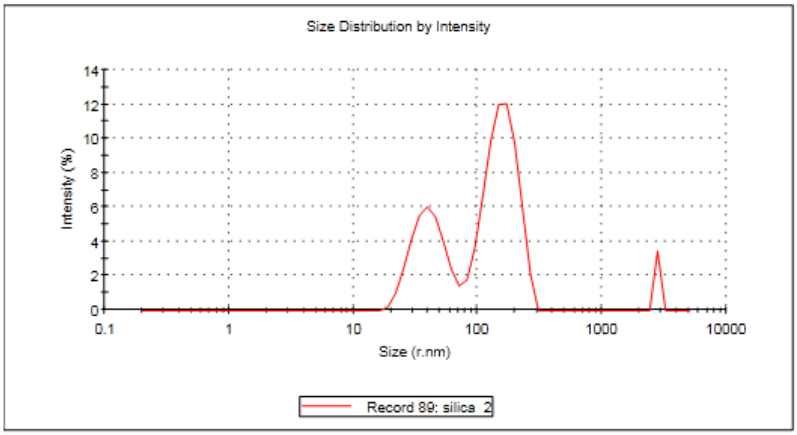
Zetasizer Ver. 6.34
Serial Number : MAL1075128

File name: Dr.A.K Paul
Record Number: 97
12 Aug 2013 5:59:19 PM

Fig. 11: DLS analysis of crude methanol extract of *A. auriculiformis.*

			Size (r.nm):	% Intensity	Width (r.nm):
Z-Average (r.nm):	158.1	Peak 1:	157.4	64.3	45.29
PdI:	0.627	Peak 2:	41.21	32.3	12.19
Intercept:	0.863	Peak 3:	2780	3.4	3.052e-5

Result quality : Refer to quality report



Malvern Instruments Ltd
www.malvern.com

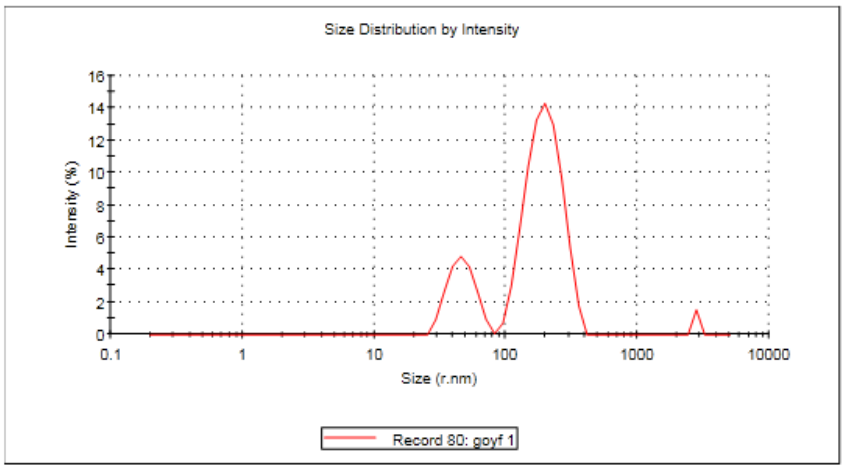
Zetasizer Ver. 6.34
Serial Number : MAL1075128

File name: Dr.A.K Paul
Record Number: 89
12 Aug 2013 5:27:36 PM

Fig. 12: DLS analysis of crude water extract of *A. auriculiformis.*

			Size (r.nm):	% Intensity	Width (r.nm):
Z-Average (r.nm):	174.2	Peak 1:	201.1	78.0	58.45
PdI:	0.527	Peak 2:	46.93	20.5	10.63
Intercept:	0.880	Peak 3:	2780	1.5	3.052e-5

Result quality : Refer to quality report



alvern Instruments Ltd
ww.malvern.com

Zetasizer Ver. 6.34
Serial Number : MAL1075128

File name: Dr.A.K Paul
Record Number: 80
12 Aug 2013 4:59:25 F

Fig. 13: DLS analysis of synthesized NPs with acetone extract of *A. auriculiformis.*

			Size (r.nm):	% Intensity	Width (r.nm):
Z-Average (r.nm):	190.9	Peak 1:	141.6	82.7	30.40
PdI:	0.619	Peak 2:	31.20	17.3	5.508
Intercept:	0.853	Peak 3:	0.000	0.0	0.000

Result quality : Refer to quality report

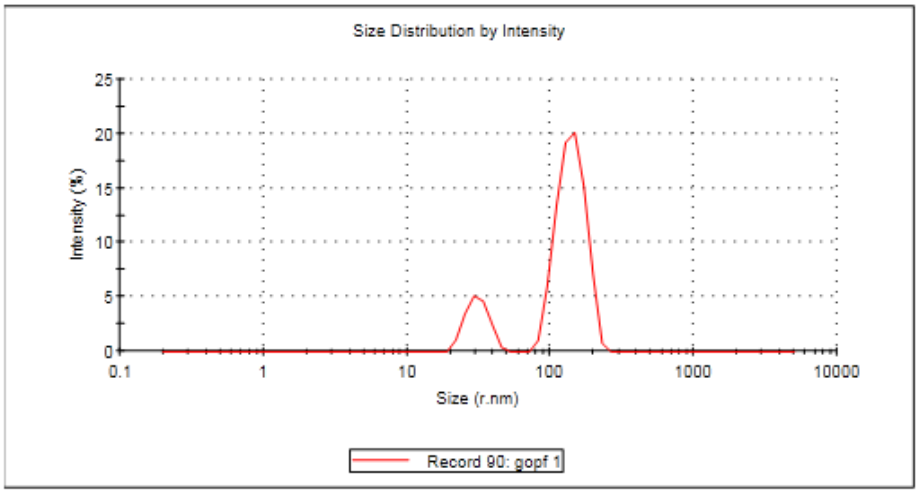


Fig. 14: DLS analysis of synthesized NPs with methanol extract of *A. auriculiformis.*

			Size (r.nm):	% Intensity	Width (r.nm):
Z-Average (r.nm):	211.6	Peak 1:	126.1	71.0	43.43
PdI:	0.721	Peak 2:	435.0	22.8	102.5
Intercept:	0.844	Peak 3:	26.99	6.2	5.101

Result quality : Refer to quality report

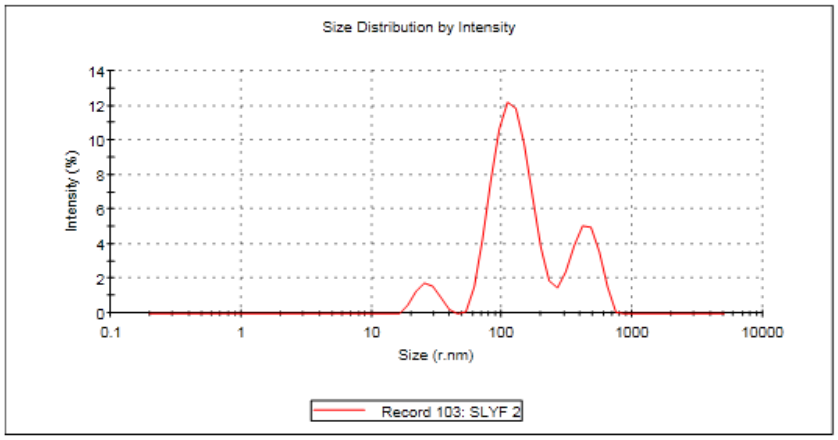


Fig. 15: DLS analysis of synthesized NPs with water extract of *A. auriculiformis.*

DLS analysis determined the average particles size distribution profile of synthesized nanoparticles and capping agent enveloped the metallic particles along with the metallic core (Sujitha *et al.,* 2013).

Conclusion

The present paper provided an idea about the green and ecofriendly synthesis method for silver nanoparticles. All the characterization techniques clearly revealed the reduction in particles size of crude extract with the addition of silver and the reaction resulted in silver nanoparticles synthesis. The biomedical applications of silver nanoparticles will be more pronounced when the ecofriendly and natural agents of synthesis take the place of conventional chemical agents.

References

Awwad AM, Salem NM and Abdeen AO. (2012) Biosynthesis of silver nanoparticle using *Olea europaea* leaves extract and its antimicrobial activity. J Nanosci Nanotechnol. 2: 164-170.

Chandran PS, Chaudhary M, Pasricha R, Ahmad A and Sastry M. (2006) Synthesis of gold nanotriangles and silver nanoparticles using Aloe vera plant extract. Biotechnol Prog. 22: 577-583

Du L, Liu X, Jiang H and Wang E. (2007) Biosynthesis of nanoparticle assigned by *E. coli* DH5α and its application on direct Electrochemistry haemoglobin. J of Electrochem Commun. 9: 1165-1170.

Elechiguera L, Burt JL, Morones JR and Lara HH. (2005) Interaction of silver nanoparticles with HIV-1. J Nanotechnol. 3: 1-10.

Gittins DI, Bethell D, Nichols RJ and Schiffrin DJ. (2000) Diode-like electron transfer across nanostructured films containing a redox ligand. J Materials Chemi. 10: 79-83.

Huang J, Zhan G, Zheng B, Sun D, Lu F, Lin Y, Chen H, Zheng Z, Zheng Y and Li Q. (2011) Biogenic Silver Nanoparticles by *Cacumen Platycladi* extract: Synthesis, formation mechanism and antibacterial activity. J Indust Engineer Chem Res. 50: 9095-9106.

Kairemo K, Ebra P, Bergston K and Pauwels KJ. (2008) Nanoparticles in cancer. J Curr Radiopharma. 1: 30-36.

Kaur A, Kaur H, Kaur AP, Arora S and Sohal SK. (2012) Biopesticidal bark extracts of *Acacia Auriculiformis* A. Cunn. Crop Improv. 1(1): 887-888.

Kaur A, Singh R, Kaur H, Sohal SK and Arora S. (2009) Growth regulatory effect of *Acacia auriculiformis* (A. Cunn.) on melon fruit fly, *Bactrocera cucurbitae* (Coquillett). Biopeste Int. 5(1): 35-40.

Kaur A, Singh R, Sohal SK, Arora S and Kaur H. (2010) Effect of *Acacia auriculiformis* extracts on the development of *Bactrocera cucurbitae* Coquillett. J Biopest. 3(2): 499-504.

Kaur A, Sohal SK, Arora S and Kaur H. (2014b) *Acacia auriculiformis*: A gamut of bioactive constituents against *Bactrocera cucurbitae.* Int J Pure Appl Zool. 4(2): 296-307.

Kaur A, Sohal SK, Arora S, Kaur H and Kaur AP. (2014a). Effect of plant extracts on biochemistry of *Bactrocera cucurbitae* (Coquillett). J Zool Entomol Stud. 2(3): 86-92.

Lakowicz JR. (1997) Principles of fluorescence spectroscopy. Springer, Singapore. ISBN-10: 0-387-31278-1.

Lavanya M, Veenavardhini SV, Gim GH, Kathiravan MN and Kim SW. (2013) Synthesis, characterization and evaluation of antimicrobial efficacy of Silver Nanoparticles using *Paederia foetida* leaf extract. J Biol Sci. 2: 28-34.

Linga RM and Savithramma N. (2011) Biological synthesis of silver nanoparticles using *Svensonia hyderobadensis* leaf extract and evaluation of their antimicrobial efficacy. J Pharm Sci Res. 3: 1117-1121.

Loken MR. (1990) Immuno fluorescence technique in flow cytometry. J Physics 2: 341-353.

Malhotra R. (2010) Mass spectrometry in life sciences, Curr Sci. 98: 140-141.

Mandal P, Babu SSP and Mandal NC. (2005) Antimicrobial activity of saponins from *A. auriculiformis*. J Filoterpia 76: 462-465.

Maoela MS, Arotiba OA, Baker PGL, Mabusela WT, Jahed N, Songa EA and Iwuoha ET. (2009) Electroanalytical determination of catechin flavonoid in ethyl acetate extracts of medicinal plants. Int J Eletrocheml Sci. 4: 1497-1510.

Mijares MA and Morates A. (2009) Photoluminescence of compounds. Superficies Vacio 22: 11-14.

Mohanpuria P, Rana KN and Yadav SK. (2008) Biosynthesis of nanoparticles, technological concepts and future applications. J Nanoparticles 10: 507-517.

Morones JR and Camacho A. (2005) The bactericidal effect of AgNPs. Nanotechnol. 16: 2346-2353.

Parashar V, Parashar R, Sharma B and Pandey AC. (2009) Parthenium leaf extract mediated synthesis

of silver nanoparticle: A novel approach for weed utilization. *Digest* J Nanomater Biostruct. 4: 45-50.

Rai M, Yadav A and Gade A. (2009) Silver nanoparticles as a new generation of antimicrobials. J Biotechnol. 27: 76-83.

Santosh PI and Marzan LML. (2002) Synthesis of silver Nanoprisms in DMF. Nano Lett. 2(8): 903-905.

Sarkar B, Mahanty A, Netam SP, Mishra S, Pradhan N and Samanta M. (2012) Inhibitory role of Silver Nanoparticle against important fish pathogen, *Aeromonas* hydrophila. J Nanomat Biostruct. 4: 70-74.

Satish S and Janakiraman NI. (2012) Infrared and Spectroscopy. J Phytochem. 4: 56-62.

Schultz S, Smith DR, Mock JJ and Schultz DA. (2000) Single-target molecule detection with no bleaching multicolour optical immunolabels. Proc Nat Acad Sci USA. 97(3): 996-1001.

Shrivastava S, Bera T, Roy A, Singh G, Ramachandrarao P and Dash D. (2007) Characterization of enhanced antibacterial effects of novel silver nanoparticles. J Nanotechnol. 18: 1-9.

Singh M, Manikandan S and Kumaraguru AK. (2011) Nanaparticles: A new technology with wide applications. Res J Nanosci Nanotechnol. 1: 1-11.

Singh S and Sehgel SS. (2001) Investigation on consistutents of *Acorus calamus* root oil dorsalis. J Entomol. 63: 340-344.

Siu GG and Stokes MJ. (2000) Blue Emitting Spectra. Appl Physics Letts. 77:1292-1294.

Stephen L. (2000) UV light absorption spectrometry. J Clin Chem. 2: 1-13.

Sujitha MV and Kannan S. (2013) Green synthesis of gold nanoparticles using *Citrus* fruits (*Citrus limon, Citrus reticulate* and *Citrus sinensis*) aqueous extract and its characterization. Spectrochim Acta A102: 15-23.

Walia S and Acharya A. (2015) Silica micro/nanospheres for theranostics: from bimodal MRI and fluorescent imaging probes to cancer therapy. Beilstein J Nanotechnol. 6: 546-558.