ISSN : 0974 - 7494 Volume 8 Issue 4

Nano Science and Nano Technology

An Indian Journal

Full Paper

NSNTAIJ, 8(4), 2014 [130-137]

Synthesis of silver particles using the extracts of *Strychnos Potatorum*

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ABSTRACT

Nanostructure noble metals have unusual physicochemical properties compared to their bulk parent materials. In the recent years a large number of physical, chemical and biological techniques were applied to the characterization and the development of metal nanoparticles using *Strychnos potatorum* seeds. In the present study, we have prepared various concentrations of silver nanoparticles using Modified Precipitation Method (MPM). Analytical techniques such as Fourier Transform Infrared (FT-IR) Spectroscopy, Fourier Transform Raman (FT-RAMAN) Spectroscopy, UV-Visible spectroscopy, Scanning Electronic Microscopy, Energy Dispersive X-ray (EDX) spectral analysis and Photoluminescence methods were used to characterize the synthesized nanoparticles. The vibrational assignments, intensities and wave number (cm^{-1}) of the dominant peaks were obtained using FT-IR and FT-RAMAN spectrum. Major assignments of the bands were made with respect to the components present in the samples. The microphotograph obtained from scanning electron microscopy (SEM) and the Elementary particles were analyzed by EDX spectrum. The UV/Vis spectra show that an absorption peak, occurring due to Surface Plasmon Resonance (SPR). PL (Photoluminescence) shows absorption and optical properties of nanoparticles.

KEYWORDS

UV-Visible;
FT-IR spectra;
SEM-EDS;
Strychnos potatorum seed;
$AgNO_3$.

INTRODUCTION

Plants have been used in traditional medicine for several thousand years. Medicinal plants as a group comprise approximately 8000 species and account for about 50% of all the higher flowering plant species found in India[1]. The knowledge of medicinal plants has been accumulated in the course of many centuries based on different medicinal systems such as Ayurveda, Unani and Siddha. In a large number of countries, human population depends on medicinal plants for treating various illnesses as well as a source for livelihood. The World Health Organization (WHO) estimated that around 80% of populations of developing countries rely on traditional medicines, mostly from plant drugs, for their primary health care needs[2,3].

The *Strychnos potatorum*, is a tree belongs to the family of Loganiaeae and is found in many parts of India and Burma. The seeds are very hard and nao-poisonous. They contain no strychnine, though Brucine is present. The seeds are still used in many rural community of India for the clarification of muddy water. They are reported to be very effective as coagulant aids. This property is attributed due to presence of polyelectrolyte, proteins, lipids, carbohydrates and alkaloids containing the –COOH and free –OH surface groups in the seeds[4,5]. The fruit is also employed by the native practitioners of Hindustan, under the name of nirmali, as an emetic and in dysentery. They do not contain strychnine. The seeds reportedly posses diuretic activity[6]; antidiarrheal activity[7]; hepatoprotective and antioxidant activity[8]; antiulcer and anti-inflammatory activity[9,10]. In spite of the importance of the tree *Strychnos potatorum* Linn, the present study was undertaken to identify and to characterize the various chemical groups present in the seeds extract are reported.

MATERIALS AND METHODS

Sample preparation

The Fresh Strychnos potatorum seeds were collected from Attur Taluk, Salem District, Tamil Nadu and India. The seeds were carefully collected and placed separately in polythene bags. They were dried in a clean shade environment with cover to avoid the contamination for 10 days and then oven dried at 60 ºC for four hours. The dried seeds were ground into a fine powder using an agate mortar before characterization.

Preparation of silver nanoparticles by precipitation method

Nanoparticles are being viewed as fundamental building blocks of nanotechnology. The most important and distinct property of nanoparticles is that they exhibit larger surface area to volume ratio[11]. Metal nanoparticles have tremendous applications in science and technology. In the present investigation, the synthesis of silver nanoparticles by chemical route is discussed, which is an easy, simple and convenient route for preparing metal particles in nanometer range[12,13]. The $AgNo_3$ (Sigma) was purchased from Aldrich chemicals and used without further purification. All glass wares have been washed with deionised water and dried in oven before use.

The 50 gm of *Strychnos potatorum* seed powder (Size) was taken in 400 ml beaker with 200 ml of deionised water and stirred for 2 hours at room temperature. Then the extract was filtered and stored at 4ºC for further experiments as reducing and cappling agent. From the filtrate 4ml of extract was mixed with 20 ml of 10^{-4} m $AgNO\text{--}_3$ aqueous solution. The solution was kept at room temperature with constant stirring for 10 hrs. and observed the colour changes to brown color (Figure-1a). The appearance of a yellowish-brown colour confirms the existence of silver nanoparticles in the solution (right beaker)[14-17].

Figure 1 : Solution of silver nitrate (1 mM) before (left) and after (right) addition of seed extract solutions.

Subsequently, the solution was kept for 5 hours for the deposition of the Nanocomposites and the particles were collected in a petty dish as a white precipitate and then dried at 80° C for 2 hrs. The Brownish Nanocomposites were collected and characterized by the following methods.

CHARACTERIZATION OF SILVER NANOPARTICLES (NPs)

UV-Vis spectra analysis

The reduction of metallic silver ions was monitored using the UV-Vis spectra after 48 hours off reaction. The absorption signals was measured for the wavelength from 200-800nm on UV-Vis Double beam spectrometer.

FT-IR spectral analysis

The FT-IR spectra were recorded using BRUKER IFS 66 model FT-IR spectrometer in the region 4000–400 cm^{-1} by employing standard KBr pellet technique. Drop of sample were placed between two plates of sodium chloride, and the Salt is transparent to infrared light. The drop forms a thin film between the plates. A volatiles cover supplied with the spectrometer was used to cover the sample in order to prevent evaporation during analysis. Sample at 50 ppm concentration before and after treatment were employed for FT-IR analysis.

SEM and EDS analysis

The microphotographs of these samples were recorded using SEM JEOL model, JSE-5610 LV with an accelerating voltage of 20 kV, at high vacuum (HV) mode and secondary electron image (SEI). Typically setting at a magnification at ×15,000 (1μm) for a sample at study. The semi quantification of elemental analyses to identify the weight percentage of major and minor elements present in the samples were done using energy dispersive X-ray spectrometer (EDS), JEOL model, JSD-5610 LV with an accelerating voltage of 20 KV.

Photoluminescence (PL)

To recall Photoluminescence is a process in which a substance absorbs photons (electromagnetic radiation) and then re-radiates photons. Quantum mechanically, this can be described as an excitation to a higher energy state and then a return to a lower energy state accompanied by the emission of a photon. The samples were subjected to PL and the results are discussed.

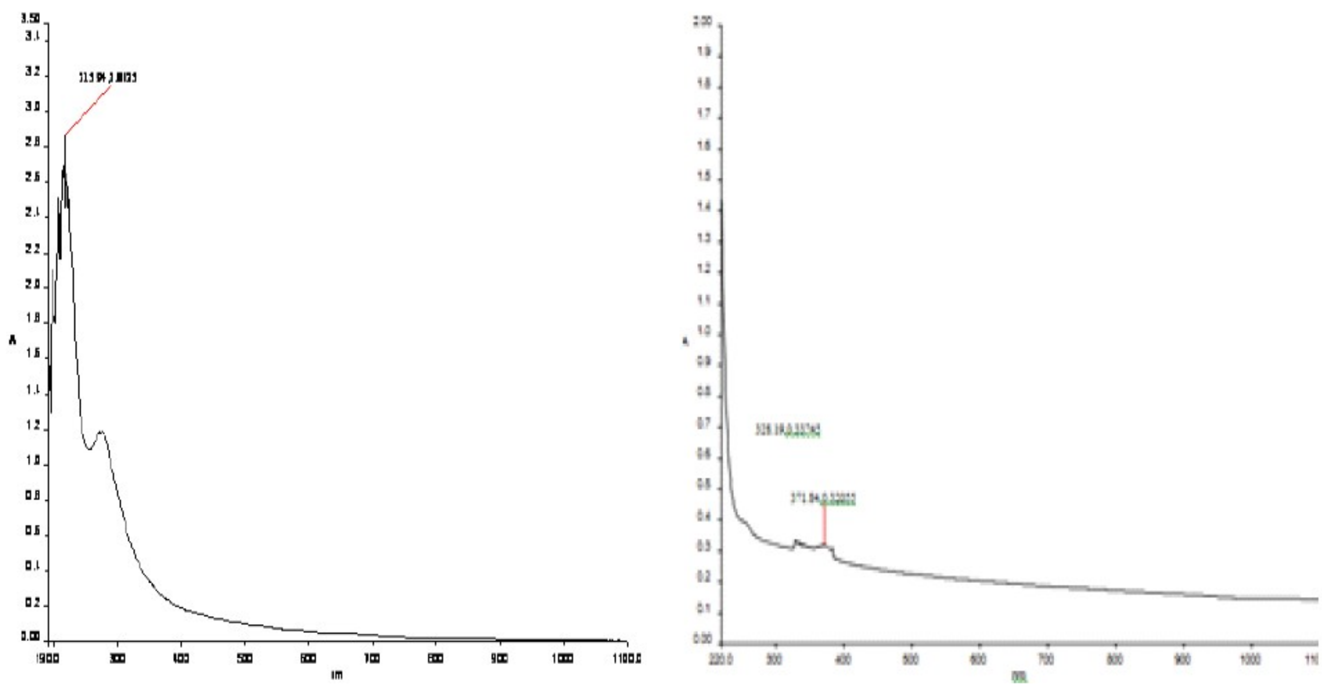
RESULTS AND DISCUSSION

UV-Vis spectral studies

The results of UV-Vis spectral analysis of pure and synthesized nano particle extracted from Strychnos Potatorum seeds were reported in Figures 2(a,b). The reduction of silver ions during the reaction of Strychnos potatorum seed extract were easily followed by UV-Vis spectroscopy. The absorption spectrum of pure and silver NPs exhibits a well defined absorption peak at 205 nm and 371 nm respectively. It is observed that the silver SPR band is centered at about 371nm and the reduction of silver ions. The lambda max is 40 and band due to n-π^* transition in a compound with conjugated π system is usually intense and frequency referred to as the R-band.

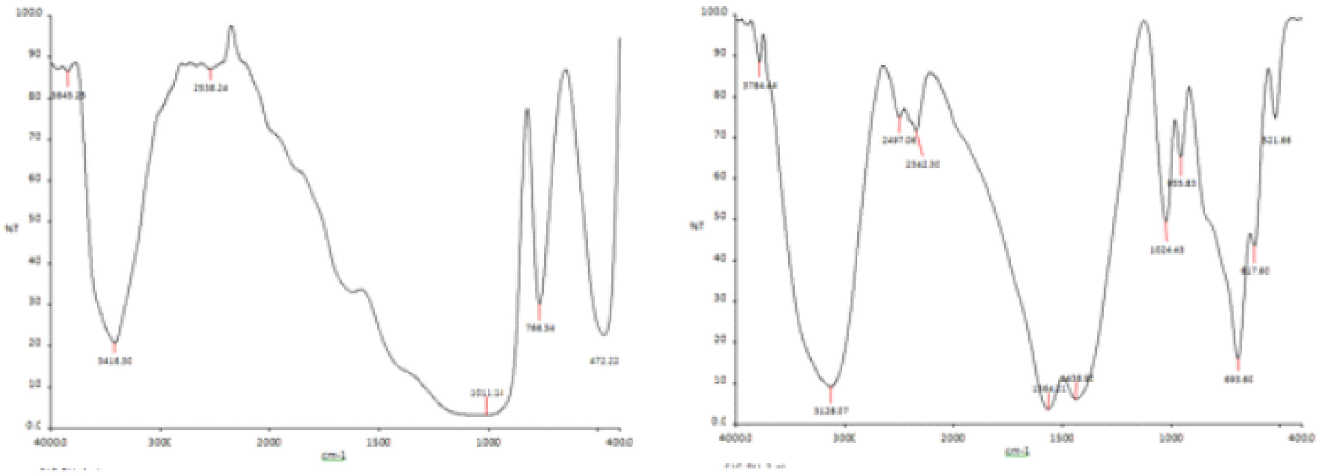
FT-IR studies

The FT-IR and FT-RAMAN analysis of the un-



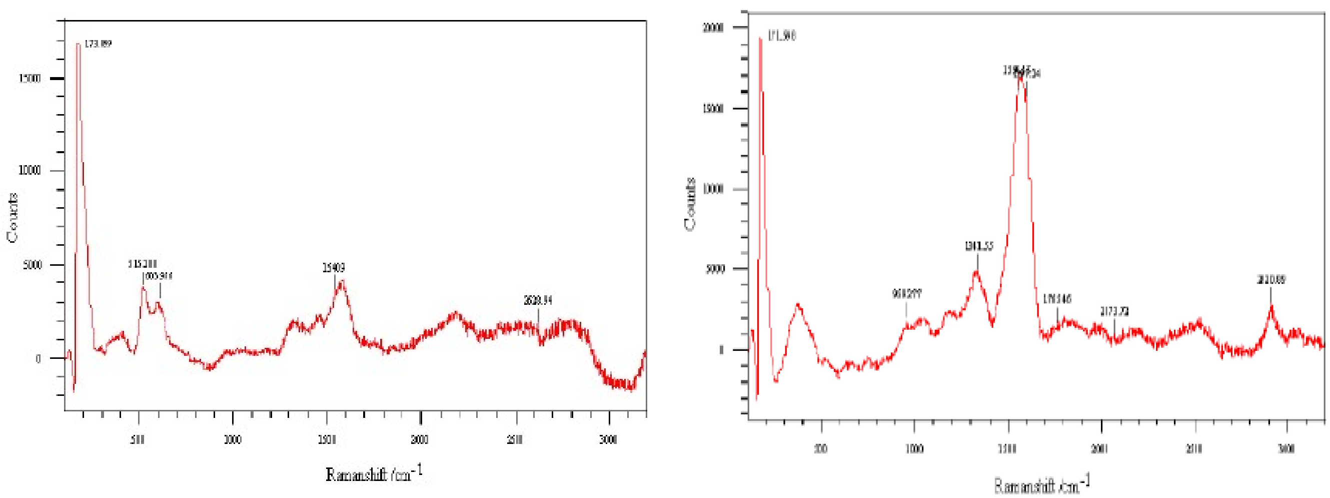
(a) **(b)**

Figure 2 : UV-Vis spectra of (a) pure and (b) synthesized silver NPs



(a) (b)

Figure 3 : FT-IR spectra of (a) pure and (b) synthesized silver NPs



(a) (b)

Figure 4 : FT-Raman spectra of (a) pure and (b) synthesized silver NPs

treated and silver NPs treated Strychnos potatorum seeds are shown in Figures 3 (a,b) and 4(a,b). The absorption bands, the wave number (cm^{-1}) of dominant peak obtained from absorption spectra are presented in TABLE 1.

From the table, it may be seen that, the very strong absorption band observed around 3416-3438 cm^{-1} may be due to the presence of bonded N–H/C–H/O–H stretching of amines and amides. The very strong absorption band observed at 2497 and 2623cm^{-1} shows the presence of amino acids in the both FT-IR and FT-RAMAN spectrum. The very strong absorption band appearing in the region of 2910 and 3128 cm^{-1} for the sample due to N–H stretching vibration of NH_3 group shows the presence of primary amines in both NPs. The C-H stretching methylene group appears near 2910 cm^{-1} in the FT-Raman. A symmetrical stretching of NO_2 group results in strong absorption in the region 1640-1642 cm^{-1} indicates that the presence of amines (protein). This confirms the evidence that the seeds are rich in protein. The very strong absorption band observed between 1403 and 1400 cm^{-1} in seed due to the presence of C–O/O–H bending. The strong band occurring at 1024, 1011 cm^{-1} and 960cm^{-1} is due to the presence of C–O stretching vibration in secondary alcohol[1,2,9]. The presence of very strong band at 1011 cm^{-1}, 1024 cm^{-1} and 960 cm^{-1} shows the presence of symmetrical C–O–C stretching in vinyl ether. Moreover, the band absorption at 1024 cm^{-1} indicates the presence of polysaccharides. Many C–O–C groups exhibit characteristic bands at 1011 -960 cm^{-1} spectral range and generally the strong band at 603,617, and

TABLE 1: The absorption bands, the wave number (cm^{-1}) of dominant peak obtained from absorption spectra.

Functional groups	Pure Sample		Synthesized Nanoparticles (NPs)	
	FTIR	FT-Raman	FTIR	FT-Raman
	wave number (cm^{-1})	wave number (cm^{-1})	wave number (cm^{-1})	wave number (cm^{-1})
Carboxylic Acid				
O-H stretching	-	-	3128(B)	2910(M)
O-H stretching	-	-	1438(S)	-
Amine				
N-H stretching	3416(S)	-		-
NH_2 torsion	-	123(VS)	-	171
N-H bending	-	1509(W)	1564	-
C-N stretching	1011(S)	-	1024(S)	1150(VS)
Amide				
N-H stretching	3416(S)	-	-	-
NO_2 Rocking	-	516(W)	--	-
Amino Acids				
C-O stretching	-	-	1438(S)	1315(M)
O-H stretching	-	2623(S)	2497(S)	-
Polysaccharide				
C-O-C stretching	1011(VS)	-	1024(S)	960(M)
Carbohydrate				
N-H wagging	766(S)	-	693(S)	834(VS)
Aldehydes				
C-H bending	-	-	1438(S)	1315(W)
Halogens				
C-X stretching	766(S)	603(M)	617(S)	834(M)
Alcohols				
O-H stretching	3416(B)	-	-	

834 cm^{-1} is assigned to the vibration of C–X in hydroxyl group in both spectral analysis. The stretching vibrations assigned to the C–X linkage occur in the region at 700–600 cm^{-1}. The weak absorption band of 603, 617 cm^{-1} indicates the presence of sulphate. The bromine compound shows an infrared band in the region of 600–500 cm^{-1}[1,9]. The more intense bands occurring at 3416 cm^{-1}, 2910 cm^{-1}, 2623cm^{-1}, 2497 cm^{-1}, 1438 cm^{-1}, 1054 cm^{-1}, 1024cm^{-1}, 693 cm^{-1} and 603 cm^{-1} corresponding to O–H/N–H, C–H, C–O and C–Cl/C–X stretching / bending vibrations respectively indicate the presence of amino acids, alkenes, nitrates, ethers, organic halogen compounds and carbohydrates present in the Strychnos potatorum Seed.

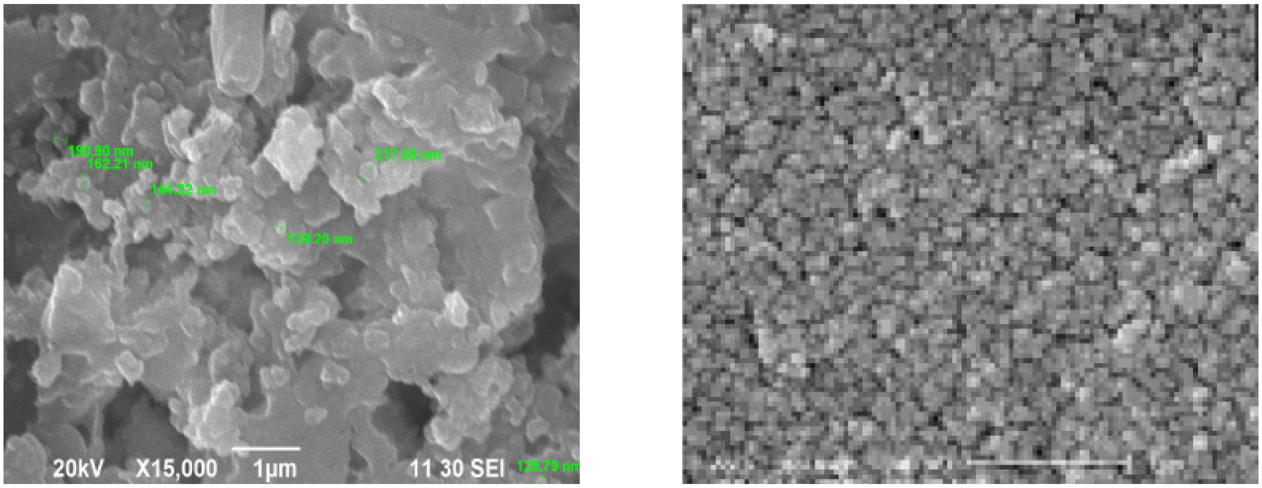
SEM analysis

The SEM analysis of the untreated and silver NPs treated Strychnos potatorum seeds are presented in Figures 5(a,b). For SEM analysis, drop of the sample were placed on carbon coated copper grids. The films on the grids were allowed to dry prior to record on JEOL-SEM model, JSM-5610LV microscope.

The morphology and size of the particles are determined by the SEM images. The nano particles were observed in a particle magnification of 15,000X operating at 2 KV. The SEM ocimum santum encapsulated nano particles reveals that the synthesized particles were in nano size. The particles were roughly spherical in shape in pure sample with the diameter of 100 nm to 300 nm. It can be reduced to synthesized particles were in obtained product has mixture of tip nano rods, nano flakes and nano prisms with the length of 5 nm to 50 nm. The even distribution of the nano particles on the surface was visualized. It is clearly revealed that the particle size is decreased for untreated to $AgNO_3$ nanoparticles tread of Strychnos potatorum seeds.

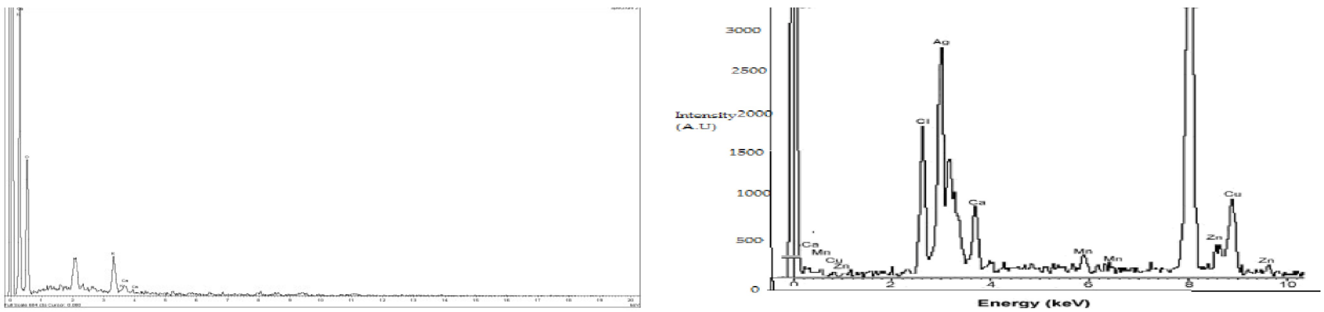
EDS analysis

The results of Energy dispersive x-ray spectroscopic (EDS) analysis of untreated and silver NPs extracted from Strychnos potatorum seeds are presented in Figures 6(a,b). Trace elements are estimated by determining the percentage abundance (%) of elements such as Cl, Ca, Zn, Cu, Mn, Ag and K present in the collected



(a) (b)

Figure 5 : SEM analysis of (a) pure and (b) synthesized silver NPs



(a) (b)

Figure 6 : EDX spectra of (a) pure and (b) synthesized silver NPs

samples were reported in TABLE 2 and Figure 6.

Indeed quite a large number of heavy metals are essential to plants, animals and human beings. These include chlorine, zinc, calcium, potassium, manganese, copper, nickel, zinc, cobalt, chromium, molybdenum and vanadium. They are indeed like vitamins and essential for human life. The deficiency of one of these elements may cause serious health problems. It may be observed from TABLE 2 that Chlorine was considered to be non-essential for plants. The concentration of Chlorine is found to be 85.55% in pure sample as compared to 52.91% of synthesized sample.

TABLE 2 : Elemental analysis (%) in pure and synthesized silver nanoparticles

Element	Weight (%)	
	Pure sample	Synthesized NPs
Cl	85.55	52.91
Zn	-	1.24
Cu	-	1.78
Mn	-	3.13
Ca	2.81	1.54
K	11.67	-
Ag	-	39.41
Total	100%	100%

EDX analysis

The concentration of calcium is found to be 2.81(%) and concentration of potassium is found to be 11.67 (%) in pure sample. However, the concentration of calcium is 1.54 % found to be synthesized sample. The concentration of Zinc 1.24 (%), Copper 1.78 (%) and manganese is found to be 3.13 (%) in the synthesized samples and these elements are not observed in pure sample . The concentration of silver is found to be 39.41 (%), confirms the presence of silver nanoparticles in the synthesized samples.

Photoluminescence study

The room temperature Photoluminescence spectra of silver Nanoparticles calcined at 400 ºC are shown in Figure 7.

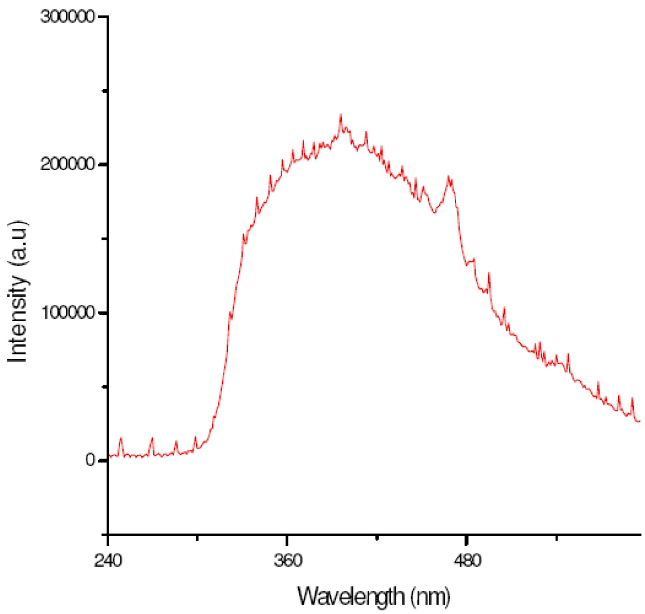


Figure 7 : Shows the photoluminescence study silver nanoparticles

A broad and maximum emission peak appeared at around 400 nm and its band gap value is around 3.1 eV. The dominant peak at 396 nm corresponds to the band edge emission. The peak at 468 nm is due to artifact. The peak at 548 nm arises from the oxygen vacancy of silver nano materials because of recombination of a Photo generated hole in valence band with an electron in conduction Band.

CONCLUSION

The bio -synthesis of silver NPs using Strychnos potatorum seeds are simple, non toxic and efficient. This green chemistry approach is amenable to large scale commercial production. The use of environmental benign and renewable plant material offers enormous benefits of eco-friendliness and compatibility for biomedical and pharmaceutical applications. Thus, the synthesized silver NPs could have a high potential for use in biological and energy science applications. This method is inexpensive and highly recommended to be used in large scale production of silver NPs. The reduction of silver ions during the reaction process was easily followed by UV-Vis spectroscopy. The main functional group of these plants is wedelolactone which is confirmed by FT-IR study. The presence of characteristic functional groups of carboxylic acids, amines, amides, polysaccharides, nitrates and carbohydrate are responsible for various medicinal properties of both herbal plants. The various functional groups and trace elements are identified using FTIR and EDX analysis. The SEM images reveal the nano nature of the prepared samples. Photoluminescence spectra of silver Nanoparticles calcined at 400 ºC a broad and maximum emission peak appeared at around 400 nm and its band gap value is around 3.1 eV

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