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Comparative Analysis of Physico-Chemical Properties of AgNPs Synthesized from Different Parts of *Soymida febrifuga*

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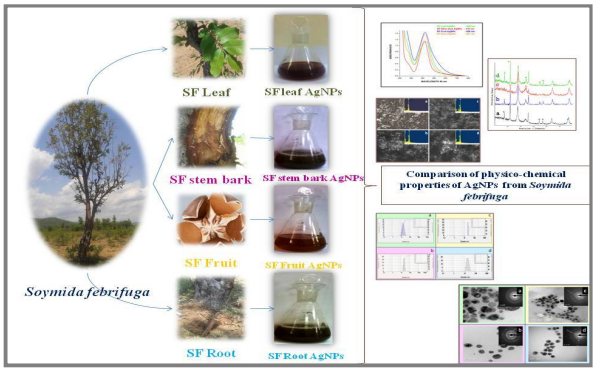
ABSTRACT

Soymida febrifuga an Indian medicinal plant is well known for its numerous therapeutic applications in Indian traditional system of medicine. It has been reported rich in phytoconstituents. In the current report, a comparative study of plant mediated silver nanoparticles (AgNPs) synthesized from aqueous extracts of different parts (leaf, stem bark, fruit and root) of SF was intended. The biosynthesized AgNPs were characterized using UV-Visible spectroscopy, Fourier Transform Infrared Spectroscopy X-ray diffraction , Scanning Electron Microscope-Energy Dispersive X-ray analysis (SEM-EDX), Nanoparticle analyzer (NPA) and Transmission Electron Microscope (TEM) to study and compare their physico-chemical properties. The spectroscopic characterization using UV-Vis and FTIR revealed the SPR resonance band between 400-430 nm and the phytoconstituents which have participated in the reduction and stabilization of the biosynthesized AgNPs, respectively. The XRD analysis revealed the face centered cubic) lattice structure in all the four SF-AgNP samples indicating the formation of crystalline AgNPs. The NPA analysis revealed the hydrodynamic diameter, zeta potential and the polydispersity index of the SF-AgNPs. The microscopic characterization using SEM and TEM displayed the structural and size features of the particles. The EDX spectra were recorded for the SF-AgNP samples to obtain the elemental profile which displayed silver as a major constituent. The study revealed that the aqueous fruit extract of SF yielded smaller AgNPs when compared to the other parts of SF.

Graphical Abstract



Keywords: *Soymida febrifuga*; Silver nanoparticles; Comparative analysis; Characterization.

INTRODUCTION

Traditional medicine has been a well established system of medicine prevalent in many countries from the pre-historic times. Many medicinal plants which form a part of flora of a country have been exploited for treatment of various life-threatening diseases as well as wound healing. India is no exception. India has been a country dependent on traditional medicine based on plant extracts till the advent of modern medicine. India has a heritage of flora which has been in use for treating tiny wounds to diseases of severe nature as well. Plants are known to contain a combination of phytochemicals which exhibit strong antibacterial [**1, 2**], antioxidant [**3, 4**] and anticancer activity [**5, 6**]. The restorative and healing properties of the plants can be attributed to their ability to produce various secondary metabolites like flavonoids, terpenoids, saponins, glycosides, alkaloids, proteins and fatty acids [**1**]. The plant extracts have both biocompatibility and non-toxicity. Several plants of medicinal importance such as *Azadirachta indica*, *Aloe vera*, *Mentha piperita* and others have been used extensively in Indian traditional medicine.

One such medicinal plant endemic to India and well known for its therapeutic, curative and healing properties is *Soymida febrifuga*. Belonging to the Meliaceae family, *Soymida febrifuga* is deciduous medicinal tree prevalently found on dry stony hills and on laterite soils endemic to India [**7**]. Various parts of SF such as leaves, stem bark, fruit and root have been reported to exhibit therapeutic effects. The presence of various phytochemicals such as alkaloids, carbohydrates, flavonoids, glycosides, phenols, saponins, steroids, terpenoids, tannins, proteins and fatty acids [**8**] in different parts of SF have contributed towards the medicinal value of SF. The extracts of SF have been used in the treatment of vaginal infections, dental diseases, uterine bleeding, hemorrhages, rheumatic swelling, oedema, wounds, stomach pains, ulcers, leprosy, dysentery and cancer[**9–11**]. The different parts of the plant SF have also shown anti-inflammatory activity. The presence of varied phytochemicals in different parts of SF has also expanded its scope in nanosilver synthesis.

Plants act as biofactories which help in synthesis of nanomaterials. With a sharp escalation in the significance of nanotechnology, the use of plant extracts containing useful phytoconstituents as a green-triggered technology has surpassed the physico-chemical synthetic procedures which are hazardous and require extreme reaction conditions which are difficult to maintain. The rising awareness among researchers about the environmental and health hazards associated with chemically synthesized and stabilized nanoparticles has created a necessity for development of cleaner and eco-friendly synthetic procedures of nanoparticles which can be employed for potential applications in the field of medicine. Silver nanoparticles have exhibited several remarkable properties. They have been used as antimicrobial agents [**12**], in consumer products such as soaps, tooth pastes and shampoos[**13**], as anticancer agents [**13**], antioxidant agents [**14**], as chemical sensors [**15**] and as catalysts in degradation of organic pollutants [**16**]. The notable properties of silver nanoparticles have created a need for development of safer procedures for synthesis of non-toxic, cost-effective and non-hazardous AgNPs from plant extracts.

The aim of the current study is to present a comparative analysis among the various properties of AgNPs synthesized from different parts of SF. The biogenic AgNPs have been synthesized separately from the aqueous extracts of SF leaf, SF stem bark, SF fruit and SF root by the reduction of aqueous 1 M $AgNO_3$ solution. The method used exploited the phytochemicals present in different parts of SF for the AgNP synthesis. The AgNPs synthesized are simple, non-hazardous, eco-friendly and inexpensive. The study aims to find out the efficiency of different parts of SF in AgNP synthesis and their physico-chemical properties.

MATERIALS AND METHODS

Materials: Silver nitrate ($AgNO_3$) was procured from Sigma-Aldrich, India. Nutrient agar was purchased from HiMedia Laboratories, Mumbai, India. Double distilled water was used for the

preparation of solutions throughout the experiment.

Collection of plant samples: The healthy and fresh parts (leaves, stem bark, fruit and root) of *Soymida febrifuga* (SF) were collected from Nallamala forest area, Mahboobnagar district, Telangana, India.

Plant material preparation: Four different parts of *Soymida febrifuga* were used for the experiment; leaves, stem bark, fruit and root. The plant parts were cut into small pieces and washed thoroughly under running tap water followed by double distilled water to remove dust particles and contaminants. The plant parts were then separately air dried at room temperature and ground into a fine powder to obtain SF leaf powder, SF stem bark powder, SF fruit powder and SF root powder respectively. The aqueous leaf extract of *Soymida febrifuga* was prepared by dissolving 0.1 g of the SF leaf powder in 100 mL double distilled water. The mixture was boiled at 60°C for 15 min, cooled and filtered using the Whattman No. 1 filter paper to obtain a clear solution of aqueous leaf extract of *Soymida febrifuga* as mentioned in previous literature [**17**]. Following the same procedure as detailed above, aqueous stem bark extract[18], aqueous fruit extract [**16**] and aqueous root extract of *Soymida febrifuga* [**15**] were also prepared. The extracts thus prepared were stored in amber colored air-tight containers under refrigeration until further use in the biological synthesis of AgNPs.

Biological synthesis of AgNPs: $AgNO_3$ was employed as a precursor in the biological synthesis of AgNPs. As reported in previous literature, the biological synthesis of AgNPs was carried out by mixing the different aqueous extracts of *Soymida febrifuga* with 1 mM $AgNO_3$ solution separately. Each of the reaction mixtures was heated and continuously stirred on a magnetic stirrer for 15 min. The appearance of reddish brown or brown color in the reaction mixture marked the formation of AgNPs. The biological synthesis of AgNPs from *Soymida febrifuga* resulted in four samples of AgNPs; leaf AgNPs [**17**], stem bark AgNPs[**18**], fruit AgNPs[**16**] and root AgNPs [**15**].

Characterization of AgNPs: The Surface Plasmon Resonance (SPR) band of all the four AgNP samples was recorded by a UV-Visible double beam spectrophotometer (Shimadzu UV-2600) operated in 200-800 nm range. The identification of functional groups which have participated in the reduction and stabilization of AgNPs was carried out using FTIR (Shimadzu IR Prestige21) operated in 250-4000 cm^{-1} range. The crystallinity and the crystalline phases of the synthesized AgNPs were determined by XRD (X'pert Pro, Pan-alytical BV, The Netherlands) scanning over a 2θ range of 20-80° with CuKα radiation (λ = 0.154 nm). The hydrodynamic size of the particles formed and their zeta potential was determined by the Nanoparticle analyzer (SZ 100, Horiba Scientific, Germany). The surface morphology of the synthesized AgNPs was analyzed using Scanning electron microscope (Quanta 400, FEI, the Netherlands). The formation of AgNPs was further confirmed by identifying the elemental composition of the sample using the Energy dispersive X-ray analysis (Zeiss EV-18). Transmission electron microscope (Tecnai G2, FEI, The Netherland) operated at a voltage of 200 kV was used for estimating the particle size and determining the surface morphology and shape of the synthesized AgNPs.

RESULTS AND DISCUSSION

Observation of visual change: The synthesis of AgNPs is commonly characterized by the color change to reddish brown or dark brown color as evident from literature [**18–20**]. The genesis of AgNPs on the addition of aqueous extracts of different parts of *Soymida febrifuga* to the precursor salt solution was marked by a visual color change from light yellow or orange to reddish brown or dark brown color. The visual color change indicative of formation of leaf AgNPs, stem bark AgNPs, fruit AgNPs and root AgNPs is shown in Figure 1a, 1b, 1c and 1d, respectively. The color of the solution post formation of AgNPs is due to the excitation of SPR which is contingent on the particle size of the AgNPs **[15, 16, 20, 21]**. To understand the reaction and the agents involved in the formation of AgNPs, the AgNP colloidal solution was analyzed further using UV-Visible spectroscopy and FTIR.

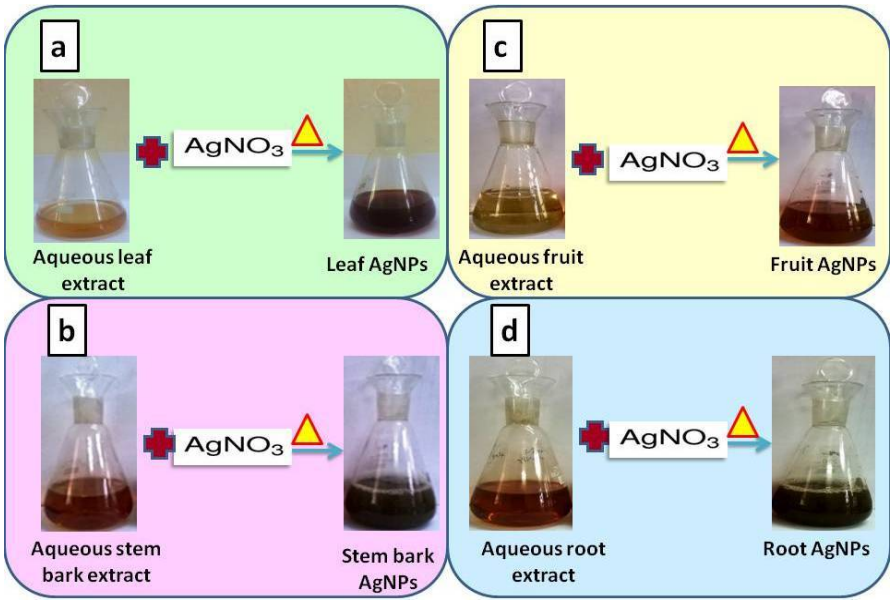


Figure 1. Color change during the formation of **(a)** SF leaf AgNPs **(b)**SF stem bark AgNPs **(c)**SF fruit AgNPs **(d)** SF root AgNPs.

UV-Visible Spectroscopy: The visual color change on the formation of AgNPs was further confirmed using UV-Vis. UV-Vis is a technique used to confirm the formation of AgNPs and to study their size-dependent optical properties [19]. SPR band in the range of 400-500 nm is considered a characteristic of AgNPs [22]. In the present work, SPR bands at 429 nm [17], 416 nm [18], 426 nm [16] and 421 nm [15] as evident from figure 2 confirmed the reduction of silver ions to metallic nanosilver using aqueous extracts of SF leaf, SF stem bark, SF fruit and SF root, respectively. SPR band at approximately 420 nm which is similar to the present work was reported earlier in the synthesis of AgNPs using an aqueous solution of Saudi *Origanum vulgare* L. plant extract [23].

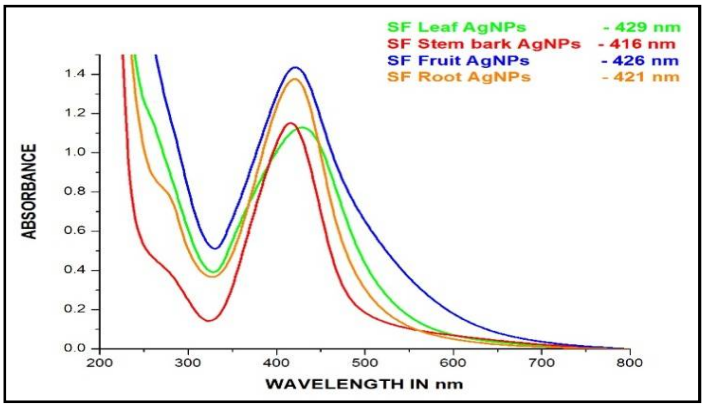


Figure 2. UV-Visible absorbance spectra of SF AgNPs.

The formation of an SPR band at lower wavelengths indicates the formation of small-sized AgNPs [24]. The formation of small spherical AgNPs in the size range of ≤ 25 nm was reported to be correlated to the SPR band formed at ≤ 420 nm [25–27]. The peak width also indicates the dispersity of the particles, size, shape, morphology, interactions among particles, composition and dielectric environment of the AgNPs [19, 22, 24]. The polydispersity of the AgNP sample is indicated by the broad SPR peak [19]. The appearance of narrow SPR band at shorter wavelengths closer to 420 nm indicated the presence of small-sized spherical dispersed AgNPs in all the four samples. The presence of varied phytochemical constituents and reducing groups in the aqueous extracts of SF leaf, SF stem bark, SF fruit and SF root resulted in the different SPR bands formed.

FTIR Analysis: The FTIR analysis of the AgNPs synthesized from aqueous extracts of different parts of *Soymida febrifuga* and assignment of the FTIR peaks to the corresponding functional groups has been displayed in the table 1. From the FTIR peak assignment, it was identified that flavonoids present in the aqueous leaf extract and root extract of *Soymida febrifuga* participated in the reduction and stabilization of SF leaf AgNPs and SF root AgNPs. The FTIR peaks found in the SF stem bark AgNPs sample and SF fruit AgNPs sample predominantly displayed amino acids and proteins which played a major role in the reduction and capping of AgNPs. The fruit AgNPs were further stabilized and capped by lipids which resulted in formation of small sized AgNPs.

Table 1. FTIR peak assignment of SF AgNPs

Sample	Frequency wave number (cm^{-1})	Functional groups assigned	Reference
SF Leaf AgNPs	3728 3275 3149	Stretching vibration of OH group of flavonoids or phenols	[22, 28]
	2920 2850	Stretching vibrations of CH_2 and CH_3 groups	[28]
	1735	Stretching vibration of C=O of flavonoids	[29]
	1670	Bending vibration of amide I band	[18]
	1639	Stretching vibration of C=C groups due to aromatic ring deformation due to flavonoids and amino acids; C=O stretching vibration of flavonoids, polyphenols and catechins	[28]
	1544	Carbonyl containing compound which may be involved in AgNP formation	[30]
	1384	Bending vibration of C-H	[15]
	1020	Stretching vibration of C-O bond or OH group vibration	[31]
SF Stem bark AgNPs	3388 3371	Stretching vibration of OH groups	[22]
	2920	Stretching vibration of CH_2 and CH_3 groups	[28]
	1707	Stretching vibration of C=O carbonyl group	[29]
	1608	Asymmetric stretching vibration of C=O and/or Aromatic stretching vibration of C=C	[31]
	1514	Amide II linkage of proteins	[31]
	1382	C-H deformation and AgNP binding with hydroxyl and carboxylate groups of proteins	[32]
	1024	OH deformation of phenolic OH groups	[31]
SF Fruit AgNPs	3192	OH bonds present in proteins, fatty acids, carbohydrates and lignin	[16]
	2918	Stretching vibration of amide II band of proteins; Asymmetric stretching vibrations of C–H respectively in –CH2 present in lipids, proteins, carbohydrates, and esters	[16]
	1598	Asymmetric stretching vibrations of C = O in carboxylate group	[16]
	1382	C-H deformation and binding of AgNPs with the hydroxyl and carboxylate groups of proteins	[16]
	1066	Stretching vibration of N–C bond in aliphatic amine groups	[16]
	1041	Stretching vibrations of C–O bond	[16]
SF Root AgNPs	3082	Stretching vibration of OH bond of phenols	[15]
	1604	Asymmetric stretching vibration of C=O and/or Aromatic stretching vibration of C=C	[31]
	1512	Stretching vibrations of C=C of phenyl rings of flavonoids	[15]
	1022	OH deformation of phenolic OH groups	[31]

XRD analysis: XRD studies revealed useful information about the crystallite size and phase variety of AgNPs. The XRD data comprising of 2θ values, d spacing values, assigned lattice planes, FWHM values, lattice parameter and crystallite sizes of the synthesized AgNPs obtained on analysis of *Soymida febrifuga* leaf AgNPs, stem bark AgNPs, fruit AgNPs and root AgNPs has been depicted in table 2. The XRD spectra of all the four samples of SF AgNPs have been displayed in figure 3.

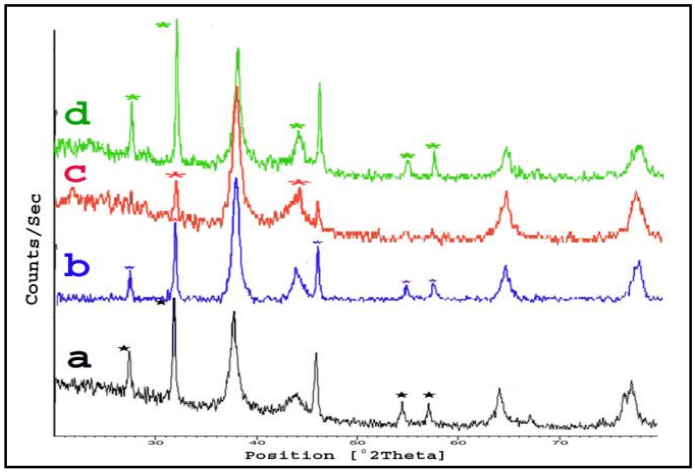


Figure 3. XRD spectrum of **(a)** SF leaf AgNPs **(b)** SF stem bark AgNPs **(c)** SF fruit AgNPs **(d)** SF root AgNPs

The four samples were found to be in accordance with the reported pattern confirmed by JCPDS Card No. 04-0783 [33]. This showed that SF leaf AgNPs, SF stem bark AgNPs, SF fruit AgNPs and SF root AgNPs exhibited face-centered cubic lattice structure. The signal positions and intensities of the XRD peaks clearly indicated that the particles formed were AgNPs and were crystalline in nature. The crystallization of organic content of *Soymida febrifuga* extract as a cap on the surface of AgNPs can be confirmed by the broadening of peaks [25] and the additional unassigned peaks [23] in the X-ray diffraction spectrum of all the four samples of SF AgNPs.

The average crystallite sizes of the AgNPs were different for the four samples indicating the influence of phytochemicals in reducing the size of the particles. The SF leaf AgNPs and SF root AgNPs showed an average crystallite size of 22.5±6 nm and 19.2 ±10 nm respectively. Similar results were obtained from the XRD analysis of AgNPs synthesized from *Bombax pendantrum* leaf extract [33]. The AgNPs synthesized from the *Soymida febrifuga* aqueous leaf extract and root extract displayed larger crystallite size when compared to the AgNPs synthesized from the *Soymida febrifuga* aqueous stem bark and fruit extract which displayed an average crystallite size of 13.2±4 nm and 13.0±4.5 nm respectively. This can be attributed to the flavonoids and their derivatives present in larger amounts in the SF aqueous leaf and root extract and the presence of amino acids and proteins in larger quantities in the SF aqueous stem bark and fruit extract.

Table 2. Parameters obtained on XRD analysis of AgNPs synthesized from the aqueous extracts of *Soymida febrifuga*

Sample	2θ (deg)	d spacing (nm)	Lattice plane (h k l)	FWHM β (deg)	Lattice parameter	Crystallite size D (nm)	Average crystallite size (nm)
SF Leaf A+gNPs	37.7269	0.2384	111	0.3936	4.129	22.29	22.5 ± 6
	45.8551	0.1978	200	0.3149	3.956	28.62	
	64.0647	0.1453	220	0.4723	4.109	20.73	
	77.1291	0.1235	311	0.5760	4.096	18.43	
SF Stem bark AgNPs	37.9512	0.2368	111	0.6298	4.101	13.94	13.2 ± 4
	43.9512	0.2058	200	0.6298	4.116	14.21	
	64.2876	0.1447	220	0.6298	4.095	15.57	
	77.1934	0.1234	311	1.1520	4.095	9.22	
SF Fruit AgNPs	37.9457	0.2371	111	0.5510	4.107	15.93	13.0 ± 4.5
	44.2700	0.2046	200	0.6200	4.092	14.45	
	64.3994	0.1445	220	1.1520	4.088	8.52	
	77.3560	0.1233	311	0.7882	4.091	13.49	
SF Root AgNPs	37.6954	0.2386	111	0.3149	4.133	27.85	19.2 ± 10
	45.8150	0.1980	200	0.4723	3.9612	19.08	
	64.0017	0.1454	220	0.4723	4.114	20.73	
	77.0434	0.1236	311	1.1520	4.102	9.21	

SEM-EDX analysis: The morphological characterization of the synthesized AgNPs was carried out using SEM analysis. The SEM micrographs of SF leaf AgNPs, SF stem bark AgNPs, SF fruit AgNPs and SF root AgNPs as seen in figure 4 revealed dispersed particles of spherical morphology. Similar formation of spherical silver nanoparticles was revealed from the SEM analysis of AgNPs synthesized from *Bauhinia tomentosa* leaf extract [34].

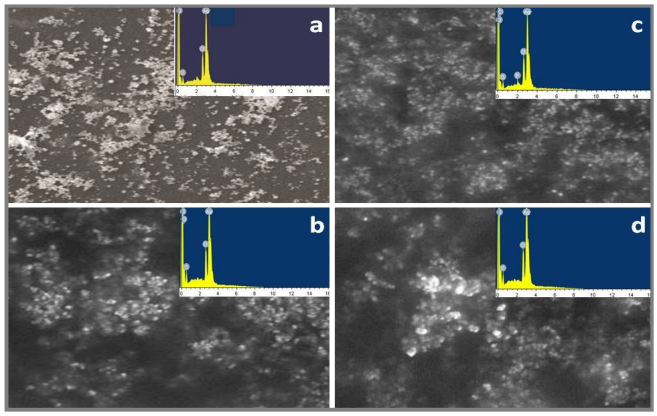


Figure 4. SEM micrographs with EDX spectra in the inset of **(a)** SF Leaf AgNPs **(b)** SF Stem bark AgNPs **(c)** SF Fruit AgNPs **(d)** SF Root AgNPs.

The elemental composition of the synthesized AgNPs was analyzed using the EDX. The elemental profiles of the AgNPs synthesized from aqueous extracts of SF leaf, SF stem bark, SF fruit and SF root are displayed in table 3. The sharp intense signal at 3KeV attributed to the surface plasmon resonance indicated the presence of Ag as the main element [25, 35, 36] as seen in the inset of figure 4 and as evident from the graph seen in figure 5. The other signals were noticed in the AgNP samples signifying the characteristic absorption of oxygen, chlorine and phosphorus indicating the presence of phytochemical constituents of *Soymida febrifuga* aqueous extract as a stabilizing agent on the surface of AgNPs. Similar results were found in the EDX spectra of AgNPs synthesized from *Origanum vulgare* [23]and AgNPs synthesized from *Bauhinia tomentosa* [34].

Table 3. Elemental profiles of SF AgNPs

Sample	Silver (Ag) (wt %)	Oxygen (O) (wt %)	Chlorine (Cl) (wt %)	Carbon (C) (wt %)	Phosphorus (P) (wt %)
SF Leaf AgNPs	81.45%	10.29%	8.25%	---	---
SF Stem bark AgNPs	80.35%	10.13%	9.53%	---	---
SF Fruit AgNPs	82.37%	9.63%	9.95%	-2.90%	0.95%
SF Root AgNPs	80.79%	9.46%	9.75%	---	---

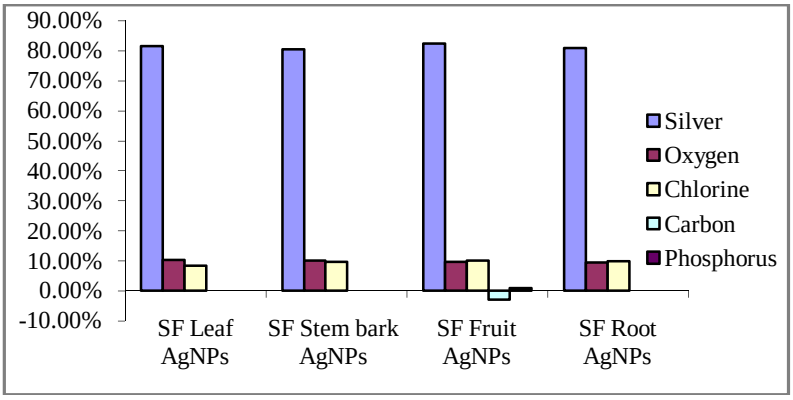


Figure 5. Graph showing the presence of Silver in large amounts in the SF AgNP samples as evident from EDX Spectra.

Nanoparticle Analyzer: The data obtained on analysis of SF AgNPs using the NPA has been displayed in table 4 and figure 6. The hydrodynamic diameter of the SF AgNPs for all the four samples was found to range between 20-30 nm. The hydrodynamic diameter of SF AgNPs synthesized from all the four parts was found to be smaller than AgNPs synthesized from mint leaf extract [**30**]. The polydispersity index was found to be lesser than 0.5 for all the four AgNP samples. However, the PDI was 0.474 and 0.471 for SF leaf and root AgNPs which can be attributed to the flavonoids which are acting as capping agents. Flavonoids have a general structure of a 15 carbon skeleton consisting of two phenyl rings and a heterocyclic ring. The bulk structure of flavonoids may be attributed to the PDI values obtained for SF leaf and SF root AgNPs. The PDI values of 0.295 and 0.042 were identified for SF stem bark and fruit AgNPs respectively which may be attributed to the proteins, amino acids and lipids which are acting as capping agents.

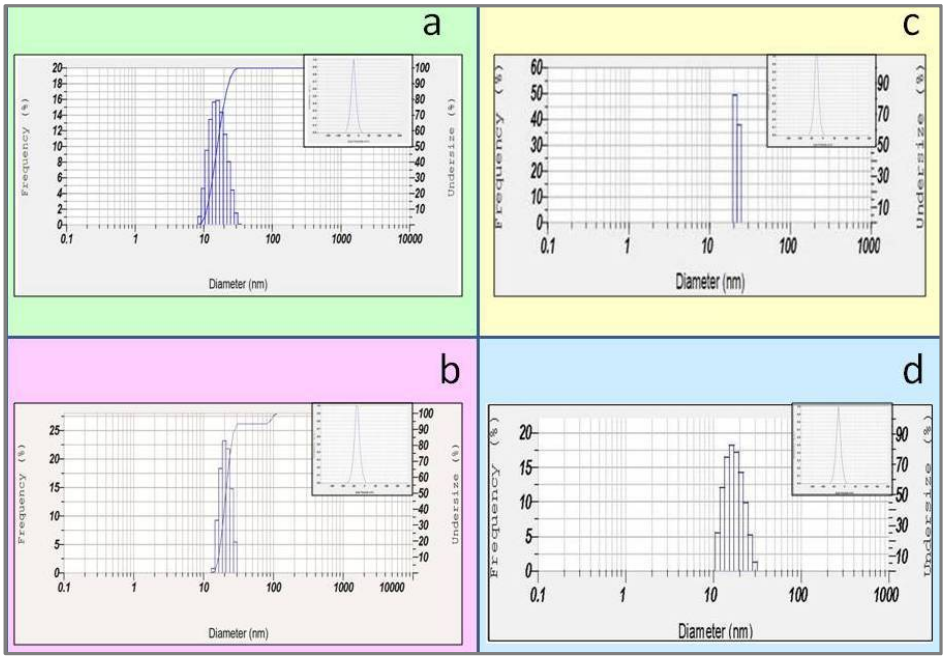


Figure 6. Particle size distribution with zeta potential in the inset from DLS measurements using Nanoparticle analyzer of SF Leaf AgNPs **(b)** SF Stem bark AgNPs **(c)** SF Fruit AgNPs **(d)** SF Root AgNPs.

The zeta potential values which depict the stability of AgNPs were in the range of -24.2 mV to-34.7 mV. Zeta potential values greater than +25 mV or lesser than -25 mV indicate greater stability of the particles [**35**]. This indicated that SF AgNPs were highly stable. The order of relative stability of SF AgNPs was SF stem bark AgNPs > SF root AgNPs > SF fruit AgNPs> SF leaf AgNPs based on the zeta potential. The negative charge on the surface of the SF AgNPs may be assigned to the phytochemicals participating in the reduction and stabilization of AgNPs such as flavonoids, proteins, amino acids, lipids and others. The stability of the AgNPs can also be attributed to the negative zeta potential which confirms the repulsive forces among the AgNPs [**36**].

Table 4. NP analyzer data of SF AgNPs

Parameter	SF Leaf AgNPs	SF Stem bark AgNPs	SF Fruit AgNPs	SF Root AgNPs
Hydrodynamic diameter	20.5 nm	25 nm	30 nm	25 nm
Polydispersity index (PDI)	0.474	0.295	0.042	0.471
Zeta potential	-24.2 mV	-34.7 mV	-27.2 mV	-28 mV

Transmission Electron Microscope: The TEM micrographs of AgNPs synthesized from different parts of *Soymida febrifuga* have been depicted in figure 7. The TEM images show that the AgNPs were well dispersed with mostly spherical nanoparticles. However, there were some particles with

irregular shapes which is a characteristic of biosynthesized nanoparticles [37]. The size range of the AgNPs as devised from the TEM micrographs was similar for SF leaf AgNPs (10-40 nm) and SF root AgNPs (10-35 nm) which can be attributed to the flavonoids and their derivatives present in the SF leaf and root extract. The size range of the AgNPs as devised from the TEM micrographs was found to be 15–35 nm for SF stem bark AgNPs which can be attributed to the proteins present in the SF stem bark extract. SF fruit AgNPs were found to be in the size range of 5-15 nm which can be attributed to the proteins and lipids of SF fruit extract as capping agents. The presence of long chain fatty acids cause repulsions among AgNPs resulting in smaller, highly monodispersed and stable AgNPs from the SF fruit extract. AgNPs synthesized using aqueous *Ficus retusa* leaf extract were also found to be in the size range of 5–35 nm when observed under TEM [38]. The concentric rings in the selected area electron diffraction (SAED) pattern with bright dots indicated the crystalline nature of AgNPs which is in agreement with the XRD data.

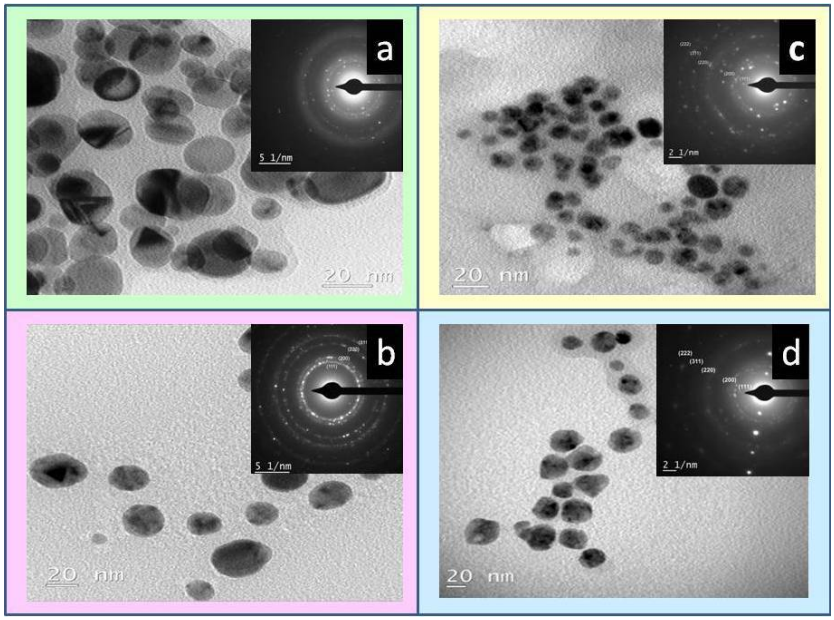


Figure 7. Microscopic images from TEM **(a)** SF Leaf AgNPs **(b)** SF Stem bark AgNPs **(c)** SF Fruit AgNPs **(d)** SF Root AgNPs.

APPLICATION

Plant based synthesis of AgNPs has proved to be a useful alternative to use of hazardous chemicals and costly physical procedures. The use of *Soymida febrifuga* as a potential source for the synthesis of AgNPs has been exploited. The different parts of *Soymida febrifuga* can be used for the large scale production of AgNPs which is non-toxic, cost-efficient and eco-friendly. The as prepared AgNPs can be further applied as effective antimicrobial agents, potential catalysts in degradation of organic pollutants and as chemical and biosensors for detection of different compounds. The SF AgNPs can be further used in various biomedical and chemical applications.

CONCLUSION

The study successfully demonstrated the use of aqueous extracts of different parts of *Soymida febrifuga* such as leaf, stem bark, fruit and root as reducing and stabilizing agents in reducing ionic silver to nanosilver. In UV-Visible spectroscopic analysis, AgNPs synthesized from aqueous stem bark extract of SF gave a more prominent peak at 416nm compared to other AgNP samples. The average crystallite sizes revealed from XRD analysis showed SF fruit and stem bark AgNPs had smaller crystallite size in comparison to SF leaf and root AgNPs. The SEM-EDX analysis displayed

spherical AgNPs in all the four samples with a strong peak at 3KeV. The NP analyzer data showed that SF fruit AgNPs were highly monodispersed, SF leaf AgNPs had more hydrodynamic diameter and zeta potential values with greater stability was displayed by SF stem bark AgNPs. The TEM analysis displayed smaller sized spherical AgNPs from SF fruit sample in comparison to leaf, stem bark and root AgNPs. The study revealed that the aqueous fruit extract of SF acted as a better reducing and stabilizing agent in nanosilver synthesis. The presence of proteins and lipids in the SF fruit extract resulted in the small, spherical and monodispersed AgNPs. The SF stem bark AgNPs were found to be the next better sample followed by SF root AgNPs and SF leaf AgNPs. However, the synthesis of AgNPs from plant extracts is exclusively dependent on the variety of phytochemicals predominantly extracted into the extract. For *Soymida febrifuga* mediated AgNPs, the fruit extract was found to contain phytochemicals which reduced the AgNPs more than the stem bark, root and leaf aqueous extracts. Further research has to be taken up in future to understand the phytochemical composition of SF extracts in much detail and the mechanism of synthesis of AgNPs.

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