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GREEN SYNTHESIS OF SILVER NANO PARTICLE USING SENNA ALATA

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ABSTRACT

There is an increasing commercial demand for nanoparticles due to their wide applicability in various areas such as electronics, catalysis, chemistry, energy, and medicine. This work deals with the synthesis and characterization of silver nanoparticles using *Senna alata*. The synthesized nanoparticles were characterized by using UV–Vis absorption spectroscopy, FT-IR and SEM analysis. The reaction mixture turned to brownish gray colour after 5 hrs of incubation and exhibits an absorbance peak around 450 nm characteristic of Ag nanoparticles. Scanning Electron Microscopy (SEM) analysis showed silver nanoparticles was pure and polydispersed and the size were ranging from 10-40 nm. The approach of green synthesis seems to be cost efficient, eco-friendly and easy alternative to conventional methods of silver nanoparticles synthesis.

KEYWORDS: Electronics, catalysis, chemistry, energy, and medicine.

INTRODUCTON

Nanoparticles are small clusters of atoms about 1 to 100 nanometers long. 'Nano' derives from the Greek word "nanos", which means dwarf or extremely small. It can be used as a prefix for any unit like a second or a liter to mean a billionth of that unit. A nanosecond is a billionth of a second.

Nanotechnology is mainly concerned with synthesis of nanoparticles of variable sizes, shapes, chemical compositions and controlled dispersity and their potential use for human benefits. Although chemical and physical methods may successfully produce pure, well-defined nanoparticles, these methods are quite expensive and potentially dangerous to the environment. Use of biological organisms such as microorganisms, plant extract or plant biomass could be an alternative to chemical and physical methods for the production of nanoparticles in an eco-friendly manner.[1]

Medicinal plants have been identified and used throughout human history. Plants have the ability to synthesize a wide variety of chemical compounds that are used to perform important biological functions, and to defend against attack from predators such as insects, fungi and herbivorous mammals. At least 12,000 such compounds have been isolated so far; a number estimated to be less than 10% of the total. Chemical compounds in plants mediate their effects on the human body through processes identical to those already well understood for the chemical compounds in conventional drugs; thus herbal medicines do not differ greatly from conventional drugs in terms of how they work. This enables herbal medicines to be as effective as conventional medicines, but also gives them the same potential to cause harmful side effects.[2]

There are about 45,000 plant species in India, with concentrated hotspots in the region of Eastern Himalayas, Western Ghats and Andaman & Nicobar Island. The officially documented plants with medicinal potential are 3,000 but traditional practitioners use more than 6,000. India is the largest producer of medicinal herbs and is appropriately called the botanical garden of the world. There are currently about 2, 50,000 registered medical practitioners of the Ayurvedic system (total for all traditional systems: approximately 2,91,000), as compared to about 7,00,000 of the modern medicine.[3]

Medicinal plants have been used as an exemplary source for centuries as an alternative remedy for treating human diseases because they contain numerous active constituents of therapeutic value.

Senna alata L

Kingdom	:	Plantae
Family	:	Fabaceae
Subfamily	:	Caesalpinioideae
Tribe	:	Cassieae
Subtribe	:	Cassiinae
Genus	:	Senna
Species	:	S. alata

DESCRIPTION

Coarse, erect shrub 3-5 m tall. Leaves pinnate, 50-80 cm long with 8-14 pairs of large leaflets (largest at the farthest end) up to 17 cm long, ovate oblong, truncate or slightly notched at end. Inflorescence a long pedunculate erect, dense, oblong spike 10-50 cm, the yellow flowers (about 2.5 cm diameter) crowded and overlapping. Legume (pod) ripening black, straight, papery, winged on the angles 15-20 cm long x 1 cm wide. Seeds numerous (60) and flat.

Medicina uses of *senna alata*

The plant is laxative, antibacterial, antitumor, anti-inflammatory, diuretic, analgesic, vulnerary, weakly antifungal, hypoglycaemic and antispasmodic. They are taken internally as a remedy for constipation and to purify the blood. They can be applied as a tincture; as a poultice; powdered, then mixed with oil as an ointment; or the sap can be spread over the affected area - they form an effective treatment for skin blemishes, scabies, ringworm and other fungal skin infections. The bark is used to treat skin diseases, diarrhoea, worms, parasitic skin diseases, scabies and eczema. The root is laxative. An infusion is used in the treatment of diarrhoea, tympanites, uterus problems and filaria worm expulsion. The root is applied externally to treat sores and skin fungi. The flowers are used as a laxative and vermifuge. An infusion is used for remedying spleen conditions. A decoction combined with *Zingiber officinale*, is used as a treatment for grippe and as an abortifacient The seed is laxative and anthelmintic. It is cooked and used as a remedy for intestinal worms The leaf contains the purgative anthraquinone, and also shows some antimicrobial activity. Some of the phytochemicals in *Senna alata* and their medicinal importance: Flavonoids: Antioxidant, anti-inflammatory, anti-viral, relievehay fever, prevent heart diseases and reduce atherosclerosis, lowers blood cholesterol, reduce oxidation of low-density cholesterol.

Alkaloids: To treat headache, cough and relieve fatigue Saponins: Cholesterol reduction, reduce cancer risk, immunitybuster, reduce bone loss, antioxidant, immune-stimulating Tannic acid: To treat diarrhea, anti-bacteria, anti-enzymatic and astringent properties. To treat ulcers, tooth ache and wounds. Alkaloids: Increase circulation and oxidation of fatty acid, stimulates central nervous system, respiration and blood circulation Anthocyanin: Anticancer, anti-inflammatory, reduce cardiovascular diseases Quercetin: Prevent obesity, antitoxic effect, anti-cancer, modulate enzyme activity Coumarins: Anti-tumor and anti-fungicidal activity, decrease capillary permeability, increase blood flow in vein.[4]

The plant is very important in many areas of life. The applications are so numerous. The applications include for medicinal purposes, antimicrobial activities, antioxidant activities, its nutritional values and many others. Different parts and constituents of the plant are reported to exhibit several therapeutic properties, such as antibacterial, antifungal, antimicrobial and analgesic. The leaves of this plant are used in the treatment of ringworm. The plant is traditionally acclaimed to be effective in treating skin infections in man.[5] and animals. It is also reported that the leaf is useful for the treatment of hemorrhoids, constipation, inguinal hernia, intestinal parasitosis, syphilis and diabetes. The seed is used as antihelminthic, the roots are used against uterus disorder, and the crushed leaves are used for skin infections.[6] All the parts of this plant have been reported to have one or more medicinal action especially antimicrobial activities.[7] In many parts of the world, *S. alata* leaves, fruits and flowers have long been traditionally used as laxatives and antifungal agents.[8]. The possible health benefits of dietary phenolics depend on their absorption and metabolism, which in turn are determined by their structure including their conjugation with other phenolics, degree of glycosilation/acylation, molecular size and solubility.

MATERIALS AND METHOD

COLLECTION OF PLANT MATERIAL

The healthy plant samples of *Senna alata leaves Linn* was collected from Trichy. The collected plant materials were transported to the laboratory.

PREPARATION OF LEAF POWDER

The *Senna alata leaves* was collected, washed and cut into small pieces and dried at room temperature for two weeks and made in to powder for further analysis.

EXTRACTION OF PLANT MATERIAL

Aqueous and alcoholic extracts were prepared according to the methodology of Indian pharmacopoeia. The shady dried plants materials were subjected to pulverization to get coarse powder. The coarse powder material was subjected to soxhlet extraction separately and successively with alcohol and distilled water. These extracts were concentrated to dryness in flash evaporator under reduced pressure and controlled temperature (40-50°c). The aqueous and alcohol extracts put in air tight containers stored in a refrigerator.

Preparation of Silver Nanoparticles

To 750ml of each millimolar concentration of silver nitrate, 7.5ml of the plant homogenate was added, respectively into a clean conical flask. The conical flasks were then exposed to the sunlight (while being continuously shaken) for the synthesis of the nanoparticles to begin. The colours of the mixture turns from green to brown when exposed to sunlight and once it turns to colourless the particles were settled at the bottom of the flasks.

Charecterization of Nanoparticles

UV -VIS Spectral Analysis

The bioreduction of Ag^+ions in solutions was monitored by measuring the UV-VIS spectrum of the reaction medium. The UV-VIS spectral analysis of the sample was done by using U-3200 Hitachi spectrophotometer at room temperature operated at a resolution of 1 nm between 200 and 800 nm ranges.

FT-IR Analysis

For FT-IR measurements, the Ag nanoparticles solution was centrifuged at 10,000 rpm for 30min.The pellet was washed three times with 20ml of de-ionized water to get rid of the free proteins/ enzymes that are not capping the silver nanoparticles. The samples were dried and grinded with KBr pellets and analyzed on a Shimadzu IR-IR Affinity1 model in the diffuse reflectance mode operating at a resolution of 4 cm−1.

Scanning Electron Microscopy

The supernatant from the maximum time-point of production (of silver nanoparticles) was air-dried. The synthesized silver nanoparticles were fabricated on a glass substrates were done for the determination of the formation of silver nanoparticles. The morphology and size of silver nanoparticles was investigated using Scanning Electron Microscope (VEGA 3 TESCAN). The micrograph were recorded by focusing on clusters of particles.

RESULTS AND DISCUSSION

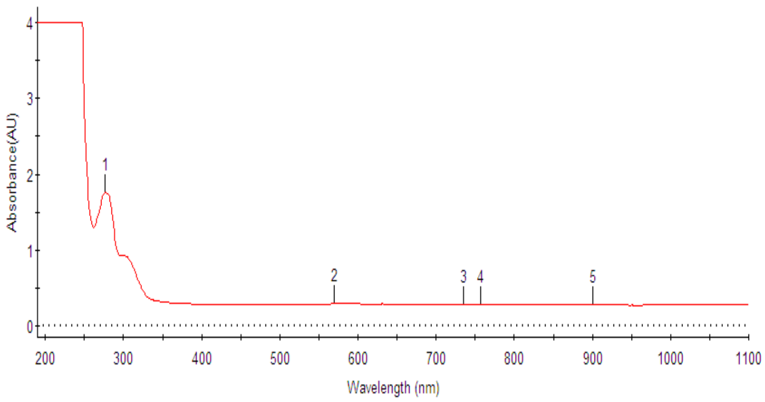

Fig. 1: Uv-Vis Analysis Of Senna Alata.

Table 2: Uv-vis Analysis of *Senna Alata.*

S.NO	Wave Length	Absorbance
1	276.15	1.7600
2	570.20	0.2963
3	735.40	0.2896
4	756.55	0.2901
5	901.15	0.2892

Table 3: Indication of Color Change In The Synthesis Of Silver Nano Particle (Snps)

Note: +++: Dark brown.

S. No.	Plant leaf extract+AgNo3	Color change		pH change		Color intensity	Time	Result
	Scientific name	Before	After	Before	After			
1	*Senna alata*	Light yellow	Brown	4.0	4.60	+++	20 min	Positive

Table`3: Ft-Ir Analysis of *Senna Alata.*

S. No.	Frequency Range	Wave Length Range	Type and Group
1	3907.14	3900-3950	oximes
2	3464.79	3500-3200	alcohols, phenols
3	2967.03	3300–2500	carboxylic acids
4	2728.77	2830-2695	aldehydes
5	2196.56	2260-2100	alkynes
6	1673.79	1760-1665	carbonyls (general)
7	1365.86	1370-1350	alkenes
8	1155.21	1250-1020	aliphatic amines
9	840.24	850-550	alkyl halides
10	597.80	690-515	alkyl halides

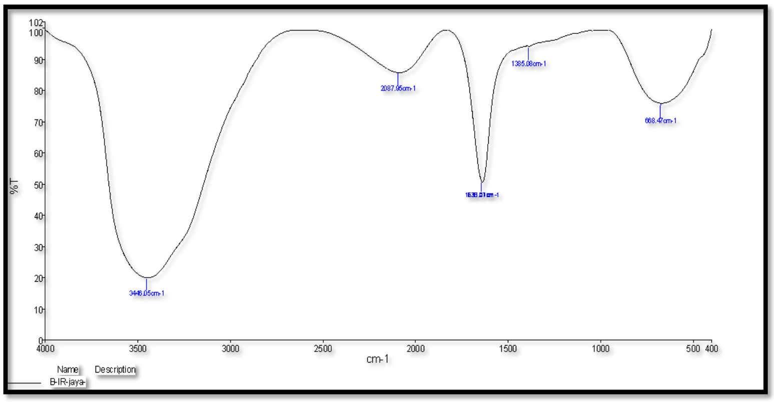

Figure 2: Ftir Analysis of *Senna Alata l* Extracts.

Table 4: Ftir Analysis of *Senna Alata l* Extracts.

S. No.	Frequency Range	Type of Bond	Type and Group
1	3444	o–h stretch, h–bonded	aldehyde
2	2082	o–h stretch	carboxylic acids
3	1638	–c(triple bond)c-stretch	alkynes
7	676	c–h wag (–ch2x)	alkyl halides

UV- VIS SPECTROSCOPY

The reduction of silver metal ions to silver nanoparticles was preliminarily analysed using UV-Vis Spectrophotometer between 300-700nm (Table 2 and fig 1). This analysis showed an absorbance peak at 420 nm which was specific for Ag nanoparticles. UV–visible spectroscopy is an important technique to determine the formation and stability of metal. Nanoparticle in aqueous solution. The reaction mixture changes the colour by adding various concentrations of metal ions. These color changes arise because of the excitation of surface plasmon vibrations in the silver Nanoparticle.[9] It shows yellowish to dark brown in colour. The dark brown colour of silver colloid is accepted to surface plasmon resonance (SPR) arising due to the group of free conduction electrons induced by an interacting electromagnetic field.

The phytosynthesis of silver nanoparticles was confirmed firstly by visual observation: the yellowish colour of petal extracts turned to brown after addition of $AgNO_3$ 10.3 M solution due to excitation of surface plasmon vibrations indicating the formation of silver nanostructures.[10]

FTIR ANALYSIS

FTIR measurement was carried out to identify the possible biomolecules responsible for antimicrobal activity using *Senna alata*extract**.** This spectrum shows lot of absorption bands (Fig.2) indicates the presence of active functional groups in the*Senna alata*. The intensity peaks are slightly increased for the period of 3444, 2082, 1638 cm-1 as well as some intensity peaks decreased like 1385, and 665 cm-1. Fig 2 shows the band at 3444 correspond to O-H Stretching vibrations of aldehyde. The peak at 2082 represents to C-H in plane bend to alkenes. The peak at 1638 corresponds to C-H, C-Br stretching vibrations to alkyl halides. The weak band at 668 indicates C-O, C-N stretching vibrations and it corresponds to the presence of alcohols, carboxylic, acids, ethers, esters and aliphatic amines in the seed extract.

Fourier transform infrared (FTIR) spectrometry measures the vibrations of bonds within chemical functional groups and generates a spectrum that can be regarded as a biochemical or metabolic “fingerprint” of the sample. By attaining IR spectra from plant samples, it might possible to detect the minor changes of primary and secondary metabolites. At present, particularly in phytochemistry, FTIR has been exercised to identify the concrete structure of certain plant secondary metabolites.[11]

FTIR is one of the most widely used methods to identify the chemical constituents and elucidate the compound structures to propose in medicinal purposes. Previous researchers carried out the FTIR to notice the minor changes of primary and secondary metabolites and to recognize the concrete structure of certain plant secondary metabolites. The characteristics functional groups are responsible for the medicinal properties of plant are confirmed by FTIR analysis.[12] (Owoyale et al, 2005). Using FTIR spectrum, we can confirm the functional constituent's presence in the given parts and extract, identify the medicinal materials from the adulterate, and even evaluate the qualities of medicinal materials. Similarly, Cayratiatrifolia plant stems ethanolic extract holds more phytochemical and bioactive compounds which were confirmed using FTIR.[13]

SEM

The SEM image showing the high intensity of silver nanoparticles synthesized by *Senna alata* extract further confirmed the development of silver nanostructures. Plate: 4. Shows the SEM image of SNPs. It has further provided further insight into the morphology and size details of the silver nanoparticles. SEM analysis showed the particle size of about 10 µm as well the crystal structure of the nanoparticles. The silver nanoparticles synthesized via green route are highly toxic to multidrug resistant bacteria hence has a great potential in Biomedical applications. The present study showed a simple, rapid, economical route to synthesized silver nanoparticles. Application of such eco-friendly nanoparticles in bactericidal, wound healing and other medical and electronic applications makes this method potentially exciting for the large scale synthesis of other inorganic materials (nano-materials).

Our results are supported by the following findings. Today nanomaterials are at the primary stage of fast developing nanotechnology phase. Nanomaterials are facilitating modern technology to deal with nano-sized objects, their unique properties especially size-dependent one makes them superior materials and essential in human activities. Currently, nanomaterials are already being used in medical applications such as drug carriers, strong antibacterial, detection for pathogens/proteins and tissue engineering etc. There is some new development towards controlling the properties of nanomaterials, e.g. new method has been reported in which magnetic nanoparticles are driven to the tumour for drug release or just heating in order to destroy the surrounding tissues. In wound healing management, a new therapeutic response has been developed in which drug is released accordingly to the type of wound, open or closed, large or small and drug is released at specifcrates. In tissue en- gineering, a wool keratin/Ha nano-composite has been reported in which cells showed improved feasibility ratio of organics and inorganics similar with those of natural bones. For antibacte- rial properties different applications has been reported such as silver nanoparticles loaded surgical masks and surface modi¯ed cotton by nano titanium dioxide with great antibacterial properties etc.[14]

CONCLUSION

In conclusion, this green chemistry approach toward the synthesis of AgNPs or SNPs possesses several advantages *viz,* easy process by which this may be scaled up, economic viability, etc. Applications of such eco-friendly nanoparticles in bactericidal, wound healing, other medical and electronic applications makes this method potentially stimulating for the large-scale synthesis of nanomaterials. The present study included the bio-reduction of silver ions through medicinal plants extracts and testing for their antimicrobial activity. On further analysis, from this *Senna alata*, we could find a safe, natural antibacterial agent to combat the diseases caused by *Sterptococcuspneumoniae, Enterobactersp*and *Proteus sp.* In addition to that, with the assistance of biotechnology, clinical research and bioinformatics, we would definitely find an alternate safe drug candidate from this *Senna alata* unripe fruit.

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