Green Synthesis and characterization of *Abutilon indicum* L., *Alangium salvifolium* and *Broussonetia papyrifera* (L.) AgNPs Nanoparticles

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Abstract

Green synthesis of silver nanoparticles has been achieved using environmentally acceptable plant extract. Within 15 minutes of reaction time, it has been found that Abutilon indicum leaf extract may transform silver ions into silver nanoparticles. Through UV-Vis spectrophotometer examination, the production and stability of the reduced silver nanoparticles in the colloidal solution were tracked. From the XRD pattern, the mean particle diameter of the silver nanoparticles was determined. To identify potential functional groups responsible for the transformation of metal ions into metal nanoparticles, FT-IR spectra of the leaf extract are measured following the production of nanoparticles. **keywords:** silver, transmission electron microscopy, ultraviolet spectra, visible spectra, surface plasmon resonance, antibacterial activity, X-ray diffraction, microorganisms, nanoparticles, nanofabrication, Fourier transform infrared spectra

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INTRODUCTION

Since the beginning of time, mankind have depended on nature to provide for their basic necessities, including food, clothes, shelter, fertilizers, flavors, and medicines. The great civilizations of the ancient Indians, Chinese, Arabians, and North Africans left written records of this technique, demonstrating the inventiveness of man in using plants to treat a wide range of maladies. As a result, plants have served as the foundation for complex conventional medical systems that have been around for thousands of years and still provide the human race brand-new treatments. The ancient man and their successors have amassed a vast knowledge about medicinal plants through periods of try, error, and success. The first written history comes from Mesopotamia and dates to around 2600 BC. It was inscribed on clay tablets in cuneiform. Among the substances

used were oils from plants like Cedrus species (Cedar) and Cupressus sempervirens (Cypress), Glycyrrhiza glabra (Liquorice), Commiphora species (Myrrh), and Papaver somniferum (poppy juice), all of which are still used to treat conditions like parasitic infections, inflammation, coughs, and colds [1].

Nanotechnology

A structure, device, or system that is created, produced, or used by manipulating atoms and molecules at the nanoscale, or having one or more dimensions of the order of 100 nanometers (100 millionth of a millimeter) or less, is referred to as nanotechnology. Although there are several examples of nanoscale structures in nature and many technologies have unintentionally used them for a long time, it has only lately become feasible to do them on purpose [2].

Numerous uses for nanotechnology involve novel materials with entirely unique characteristics and outcomes when compared to the identical materials produced at bigger scales. This is caused by effects that are visible at that small size but are not visible at bigger scales, as well as the extremely high surface to volume ratio of nanoparticles compared to larger particles.

Nanotechnology applications have the potential to be very helpful and have a big impact on society. The information and communications industries, as well as the food and energy industries, have already embraced nanotechnology. It is also employed in several medical products and medications. Additionally, new opportunities for reducing environmental contamination may be provided by nanomaterials [3-6].

But there may be additional health hazards associated with these novel materials. Humans have created defenses against a variety of environmental threats of varying proportions. However, they had never before been exposed to artificial nanoparticles or their unique properties. Therefore, it's possible that the immunological and inflammatory systems and other typical human defense mechanisms won't be able to react to these nanoparticles effectively. Additionally, because nanoparticles have the potential to distribute and persist in the environment, they may also have an adverse environmental effect [7, 8].

Plant Profile

Liver, the vital organ endowed with the process of detoxification, is actively involved in various other metabolic functions. As a detoxifying organ, it is exposed to high concentration of toxicants making it extremely susceptible to injury. The progress of these injuries to liver can alter the metabolic functions of the organ and lead to chronic disorders. Microbial metabolites, minerals,

environmental pollutants and chemotherapeutic agents are various hepatotoxicants that can induce such disorders in the organ.

hepatotoxicants used for hepatotoxic studies in animal models is a potent hepatotoxin, biotransformed into free radical by cytochrome P450 in liver microsomes. Due to decreased activities of antioxidant enzymes, the released free radicals bind to sulfhydryl groups such as glutathione and protein thiols. This leads to lipid peroxidation which directs ultimately to cellular necrosis [9].

***Abutilon indicum* L. (Malvaceae)**

The Malvaceae family includes the plant Abutilon Indicum (Linn.), also known as Mallow in English and a useful medicinal plant. Abutilon indicum is said to have anti-inflammatory and antiproliferative properties, anti-arthritic properties, analgesic and sedative properties, antioxidant and antimicrobial properties, hepatoprotective properties, anti-cancer, anti-diarrheal, anti-convulsant, larvicidal, wound-healing, anti-asthmatic, diuretic, immunomodulatory, and anti-estrogenic properties. It has been established that this plant contains phenolic chemicals, saponins, flavanoids, glycosides, proteins, carbohydrates, and amino acids [10-11].

Fig. 1: Abutilon indicum L.

Synonyms: Rishyaprokta, Kankatika, Balika, Rishagadha, Bhuribala

Common Name: Abutilon, Indian mallow

Habitat: Present in sub-Himalayan tract and hills up to 1,200 m and hotter parts of India

Traditional applications: It helps with gout, worms, ulcers, blood diseases, and tuberculosis. As a digestive aid, laxative, expectorant, diuretic, astringent, analgesic, anti-inflammatory, anthelmintic, demulcent, and aphrodisiac, it has a variety of uses. Decoction for sore gums and toothaches. Leaf demulcents are administered locally to boils and ulcers. Roots are recommended in cases of fever, chest pain, and urethritis. Indicated abutilon (Linn.) [12].

***Alangium salvifolium* (**Alangiaceae**)**

Herbalism is a type of traditional medicine or folk medicine that relies on using plants and plant extracts to treat ailments. Botanical medicine, medical herbalism, herbal medicine, herbology, and phytotherapy are other names for herbalism. By applying the root of Alangium salviifolium locally, traditional healers have successfully treated skin malignancies. Recent years have seen a lot of interest in ethnomedical studies of natural resources, especially those of plant origin that need to be evaluated using contemporary scientific methods including phytochemical analysis, pharmacological testing, and clinical trials [13].

Fig. 2: Alangium salviifolium Linn A. Mature plant B-C Floral bud Leaves D. Fruit E. Spine of stem

Kingdom:	Plantea
Class:	Dicotyledons
Order:	Cornales
Family:	Alangiaceae
Genus:	Alangium
Species:	Alangium salviifolium [14].

***Broussonetia papyrifera* (L.) Vent (Moraceae)**

Paper mulberry, also known as Broussonetia papyrifera, is a deciduous tree or shrub that naturally occurs in nations throughout Asia and the Pacific, including India, China, Thailand, and the United

States. The fruits have been used in China to cure impotence and ocular diseases. The roots, barks, and fruits are all employed in traditional Chinese remedies. Numerous chemicals have been discovered as a result of intensive research on the chemical makeup of paper mulberry [15, 16].

Fig. 3: Broussonetia papyrifera (L.) plant

Kingdom:	Plantae, **Division:**	Tracheophyta	
Class:	Magnoliopsida, **Order:**	Rosales	
Family:	Moraceae, **Genus:**	Broussonetia	
Species:	papyrifera		

Broussonetia papyrifera (L.) Vent., is a traditional medicinal plant in China and the great attention has been paid for their pharmacological effects, such as improving memory, anti-oxidation, anti-microbe, immuno-modulation. *B. papyrifera* fruit was also used to treat Alzheimer's disease by changing some special proteins levels in the blood and delaying the development of dementia. Its total flavonoids could protect human keratinocytes from ultraviolet A damage. Polysaccharides, a group of biological macromolecules, widely exist in animals, plants, and microorganisms. Polysaccharides have been studied extensively due to their hematopoiesis, immune regulation, anti-oxidation, anti-cancer [17].

Plant Collections

A fresh green leaves of *Abutilon indicum* L., *Alangium salvifolium* and Broussonetia papyrifera (L.) were collected in the month of November from the botanical garden of Department of Dravyaguna, Banaras Hindu University, Varanasi, India was brought to the laboratory, shade dried under room temperature and powdered using an electric blender.

Preparation of the extracts

The plant material which was powdered and stored was used for extraction. A weighed quantity of each of the plant powdered material was extracted by Hot continuous extraction

(Soxhlet) with ethanol 1(100%) were extracted with solvents using a Soxhlet apparatus and heat on 60 ºC for 11 hr. The yield of the plant extracts. The standard extracts obtained from plants were then stored in a refrigerator at 4°C for further use for phytochemical investigation and pharmacological screening [18].

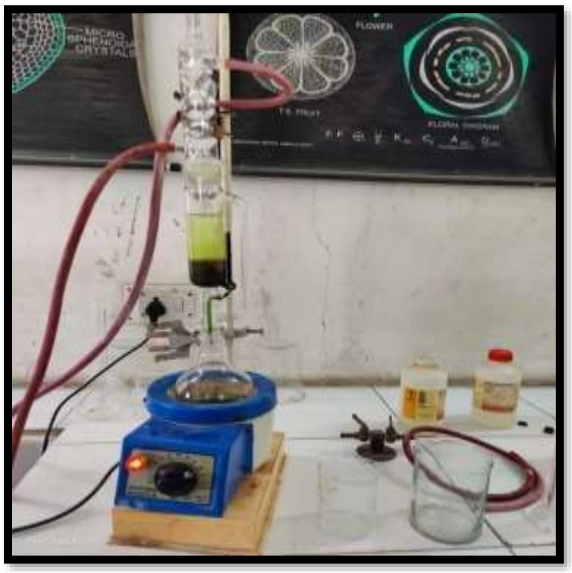


Fig 4: Extraction process performed

Qualitative phytochemical analysis

General screening of the raw plant powder, alcoholic and aqueous extracts of the plant material is carried out for qualitative determination of the groups of organic compounds present in them [19].

Green synthesis of AgNPs

It is well known that the general principle of synthesis of metal nanoparticles from a salt solution is based upon the use of a reducing agent in the presence of a capping agent. Generally metal nanoparticles have high reactivity and are vulnerable easily in the air environment. Capping agents stabilize the nanoparticles and prevent them from aggregating apart from modifying their morphology. Commonly used reductants include plant extracts, borohydride, citrate, ascorbate, elemental hydrogen, tetrabutylammonium borohydride, organometallic compounds, dimethylformamide, potassium bitartrate, alcohols and polyols. Polyvinyl pyrrolidone, polyvinyl alcohol, gelatin, carboxymethylcellulose, polyacrylonitrile, starch, gelatin, heparin, chitosan, bovine serum albumin, polysaccharides and oleyl amine are the most often used capping agents for MNPs, which can cover a larger surface area of the nanoparticles and prevent them from aggregation. Synthesis of metal nanoparticles using plant extracts is cost effective and therefore

can be used as an economic and valuable alternative for the large-scale production of metal nanoparticles.

Characterization of Nanoparticle

UV-Visible spectroscopy

UV Vis spectrophotometry is the most crucial and straightforward method for verifying the creation of nanoparticles. Utilizing a UV visible spectrophotometer to track the surface plasmon resonance band (300–700 nm), AgNP production was confirmed.

FTIR spectroscopy

The functional groups responsible for the creation of silver nanoparticles were identified, and the FTIR spectrum was recorded, using the Fourier Transform InfraRed Spectrophotometer (FTIR, Bruker, Billerica, MA, USA). These functional groups might support the stability, capping, and reduction of silver nanoparticles. The spectral array from 400 to 4000 cm1 was used for FTIR. For FTIR measurements, a solution of produced silver nanoparticles was spun for 30 min. at 10,000 rpm.

High resolution transmission electron microscopy (HR-TEM)

TEM is a microscopy technique whereby a beam of electrons is transmitted through an ultra- thin specimen, interacting with the specimen as it passes through.The interaction of the electrons passing through the specimen creates an image, which is then enlarged and focused onto an imaging device, like a fluorescent screen, a layer of photographic film, or a sensor, to be detected.

X-ray diffraction (XRD) studies

Using X-ray diffraction (XRD), the crystalline structure of the biosynthesized AgNPs was examined. A powdered sample was used, and the diffraction pattern was captured using the scanning mode, which was run at 30 mA current, 40 kV voltage, and Cu/K radiation at 20-70 in 2 angles. The Debye-Scherrer equation was used to determine the average crystalline size of AgNPs. The equation is as follows:

$D = k\lambda\beta\cos\theta$ where k = shape factor (0.94).

λ = X-ray wavelength (λ = 1.5418 Å);

β = full width at half maximum (FWHM) in radians.

and θ = Bragg's angle [20].

Results and Discussions

Table 1: Yield and nature of the extracts

S. No.	Plant material	Quantity used for extraction in grams	Type of the extract	Nature of the extract	Yield	
					G	%
1	*Abutilon indicum* L. (Malvaceae)	200	Methanolextract	Dark brown solid	132.9	13.3
2	*Alangium salvifolium* (Alangiaceae)	200	Methanolextract	Brown solid	93.27	10.9
3	*Broussonetia papyrifera* (L.) Vent (Moraceae)	200	Methanol extract	Greenish brown solid	58.9	5.9

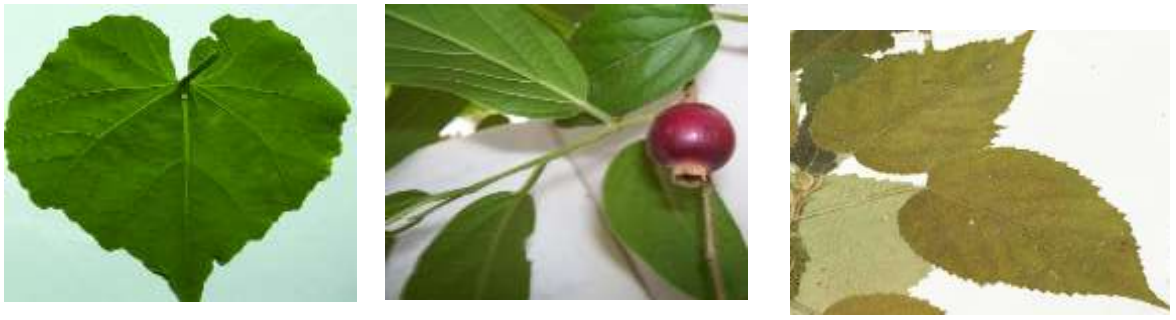
Physico-chemical analysis

Table 2: Physicochemical parameters of *Abutilon indicum* L., *Alangium salvifolium, Broussonetia* papyrifera, powdered leaves

Parameters	Yield (%w/w)		
	***Abutilon indicum* L**	***A. salvifolium***	**B. papyrifera**
Loss on drying	6.20	5.29	6.94
Total ash	8.03	6.80	9.12
Acid insoluble ash	5.50	6.01	6.62
Water soluble ash	2.51	2.36	2.56
Pet ether soluble extractive	5.12	4.95	5.16
Chloroform soluble extractive	12.15	11.13	13.01
Alcohol soluble extractive	18.11	17.26	19.04
Water soluble extractive	12.04	13.01	13.11

Macroscopical Analysis of leaf Abutilon indicum L. (Malvaceae), Alangium salvifolium (Alangiaceae), Broussonetia papyrifera (L.)

The leaves of *Abutilon indicum* L. (Malvaceae), *Alangium salvifolium* (Alangiaceae), Broussonetia papyrifera (L.) evaluated macroscopically. The plant possesses 7-8 pairs of leaf lets,which are alternate in arrangement. The leaves are pinnately compound and shaped obovate or oblanceolate, base attenuate or cuneate, apex obtuse; margin entire, secondary veins are pinnately arranged and petiolate where petiole is 0.3-0.6 cm in length. The size of each leaflet was 2-4 cm long, 0.8 to 1cm wide. Fresh leaves were green, odorless and have bitter taste.



Abutilon indicum L **Alangium salvifolium** **Broussonetia papyrifera (L.)**

Fig: 5 Macroscopic characteristics of leaf *Abutilon indicum* L. (Malvaceae), *Alangium salvifolium* (Alangiaceae), Broussonetia papyrifera (L.)

Qualitative and quantitative analysis of Abutilon indicum L, Alangium salvifolium and Broussonetia papyrifera (L.) leaves

The qualitative and quantitative phytochemical analysis of Abutilon indicum L, Alangium salvifolium and Broussonetia papyrifera (L.) leaf extracts revealed the following results.

The methanolic extracts of the Abutilon indicum L, Alangium salvifolium and Broussonetia papyrifera (L.) revealedthe presence of alkaloids, carbohydrates, flavonoids, phlobatannins, reducing sugar, terpenoids, saponins, steroids and tannins are present.

Table 3: Qualitative phytochemical analysis of medicinal plant leaves extracts

Phytochemical compounds	Abutilon indicum L	Alangium salvifolium	B. papyrifera (L.)
Alkaloids	+	-	-
Carbohydrates	+	-	+
Flavonoids	+	+	+
Phenol	-	-	-
Phlobatannins	-	-	+
Protein	-	-	-
Reducing sugar	-	+	-
Saponins	+	+	+
Steroids	+	+	-
Tannins	+	+	+
Terpenoids	+	+	+

(+) Present (-) absent

Synthesis of Biogenic Silver Nanoparticles

Green Synthesis at Optimized Parameters

Green synthesis of AgNPs were prepared by the established condition. At the initial state reaction mixture was colorless. When we add leaf extract with silver nitrate ($AgNO_3$) it turns to Colour change when the nanoparticles were settled down.

Abutilon indicum (L.)

Abutilon indicum (L.) leaf extracts were mixed with 60 mL of AgNO3 (1 mM) solution. At room temperature, the resulting decrease in Ag+ ions was periodically observed. The reaction mixture's hue changed from light green to yellowish brown after 3 hours of incubation, signaling the creation of nanoparticles.

Alangium salvifolium

A leaf extract amount of 10 ml was applied to 30 ml of 0.1 mM AgNO3. Within 15 minutes, they began to form, continuing for up to 2 hours. they particles remained stable for almost a month. The solution had a color shift from pale yellow to reddish brown following visual irradiation.

Broussonetia papyrifera (L.)

B. papyrifera leaf extracts were changed from yellowish green to reddish brown when combined with an aqueous solution of AgNO3 (1 mM). Within 10 minutes of the reaction being set up, the entire reaction mixture had taken on a brown hue. Even months after their synthesis, the B. papyrifera leaf's produced AgNPs were seen to be extremely stable in solutions, which established the plant as the biomaterial source for the production of nanosized Ag particles.

Abutilon indicum L

Alangium salvifolium

Broussonetia papyrifera (L.)

Table: 4 Colour confirmations of synthesized AgNPs using different plant extract

Plant Extracts Synthesis of AgNPS	Colour change
Abutilon indicum L	yellowish brown
Alangium salvifolium	reddish brown
Broussonetia papyrifera (L.)	reddish brown

UV-Visible Spectrometer for The Green Synthesis of AgnpsAbutilon Indicum L

Silver nanoparticles' UV-visible spectra were recorded in a water media. The silver nanoparticles are responsible for the prominent 435 nm absorption peaks. It is conceivable that leaf protein serves as a template for the creation of silver nanoparticles and stabilizes them. Surface-plasmon resonance (SPR) measurements of the A. indicum (L.) Sweet and Ag/A. indicum (L.) Sweet emulsions over the wavelength range of 200-700 nm were used to monitor the synthesis of AgNPs. The produced nanoparticles' size, shape, morphology, composition, and dielectric environment affect the SPR bands [27].

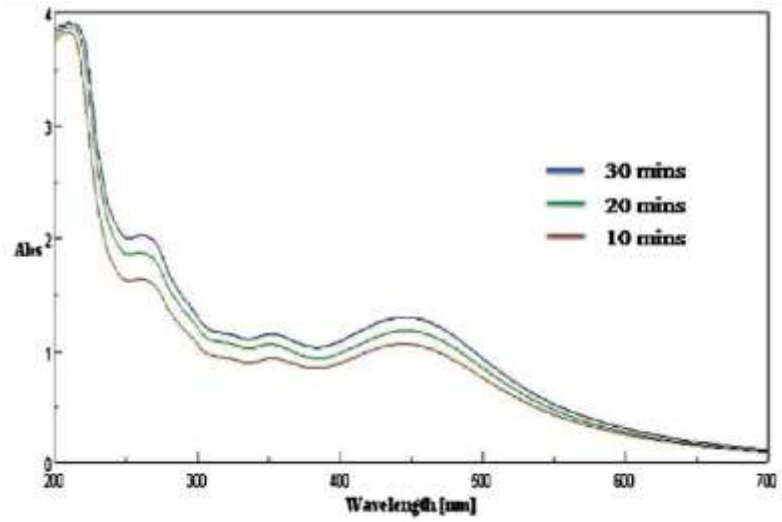


Fig:6 UV-Spectra of Abutilon indicum L

The characterisation method made use of visible and ultraviolet spectroscopy. From 300 nm to 700 nm in continuous measurement, UV-Vis absorption spectra were taken, and the leaf powder extract was employed as the baseline reference for the baseline correction.

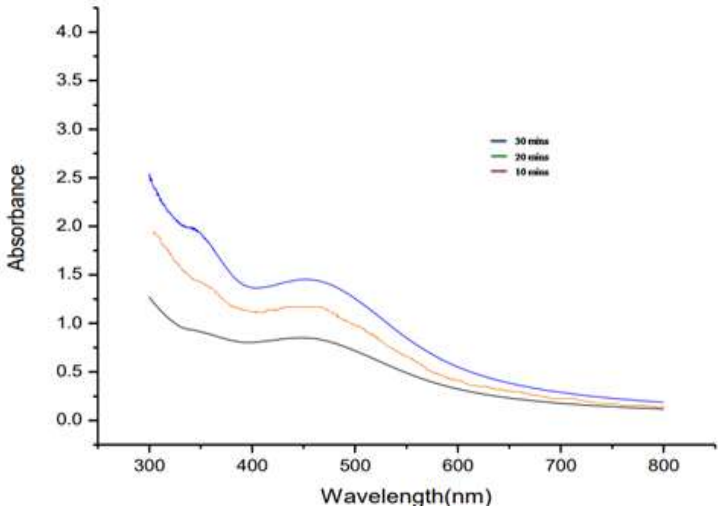


Fig:7 UV-Spectra of Alangium salvifolium

The characterization technique involved ultra-violet and visible spectroscopy. UV-Vis absorption spectra were measured using UV-spectrometer from 300nm to 700nm continuously and the leaf powder extract was used as the reference for the baseline correction.

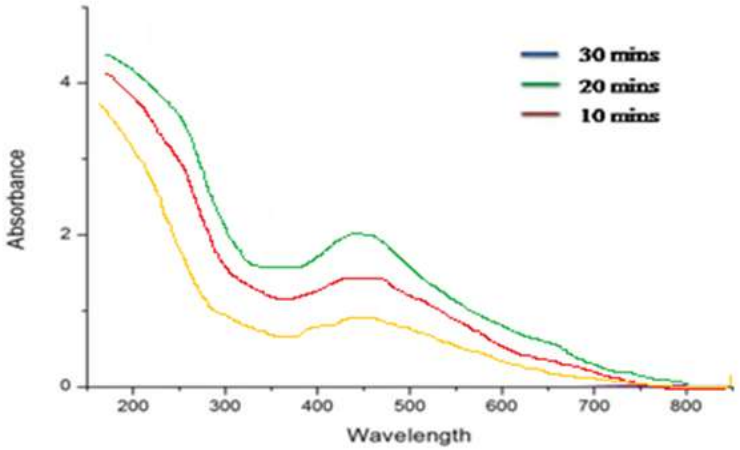


Fig:8 UV-Spectra of Broussonetia papyrifera (L.)

FT-IR spectroscopy analysis

Abutilon indicum (L.)

FT-IR spectrum taken after a layer of silver nanoparticles had been in contact with protein molecules for 24 hours. Primary and secondary amines' stretching vibrations were attributed to the bands observed at 3,280 and 2,924 cm-1, respectively. At 1,651 cm-1 and 1,548 cm-1, respectively, the equivalent bending vibrations were observed. The C-N stretching vibrations of aromatic and aliphatic amines, respectively, are responsible for the two bands seen at 1,379 and 1,033 cm^{-1}. the silver nanoparticles' surrounding protein acts as a stabilizing agent. According to

previous reports, enzymes found in the cell walls of mycelia can attach to nanoparticles through the electrostatic attraction of negatively charged carboxylate groups in the form of free mine groups or cysteine residues in the proteins. The overall peaks from the FT-IR analysis support the discovery of protein in the silver nanoparticle samples.

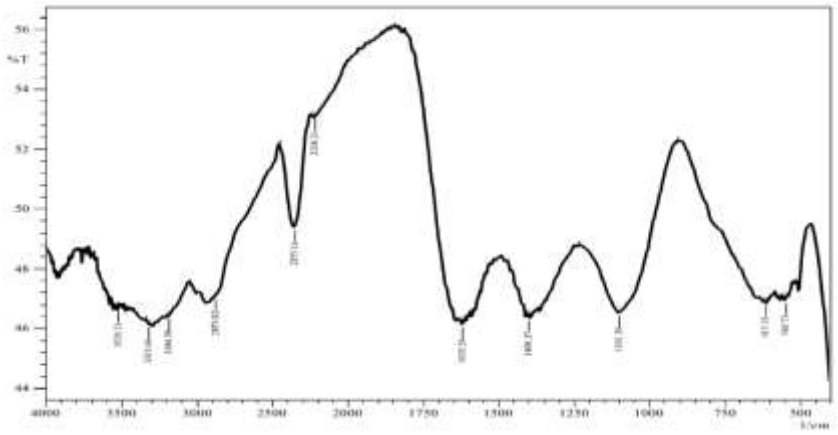


Fig:9 FTIR Spectra of Abutilon indicum L

Alangium salvifolium

Peaks at wave numbers 1634.4, 2933.7, and 3295.4 in FTIR studies support the production of silver nanoparticles. Variation in carbohydrates, lipids, and proteins was seen in the band between 650 and 1750 cm-1. The biggest category is proteins, and the peptide group, which is a structural repeat unit in proteins, produces up to 9 distinctive bands. The protein infrared spectrum has two important bands called amide I and amide II. The strongest protein absorption band is amide I.

Stretching vibrations of the C = O (70–85%) and C–N groups (10–20%) dominate in its regulation. It occurs between the frequencies of 1600 and 1700 cm-1. The backbone shape and hydrogen bonding arrangement define the precise band position. Amide II is more complicated than amide I and is located between 1510 and 1580 cm-1.

For 40 to 60 percent of the potential energy, in-plane N-H bending is the principal source of amide II. The remaining potential energy is produced by stretching vibrations of the C-N (18–40%) and C-C (approximately 10%).

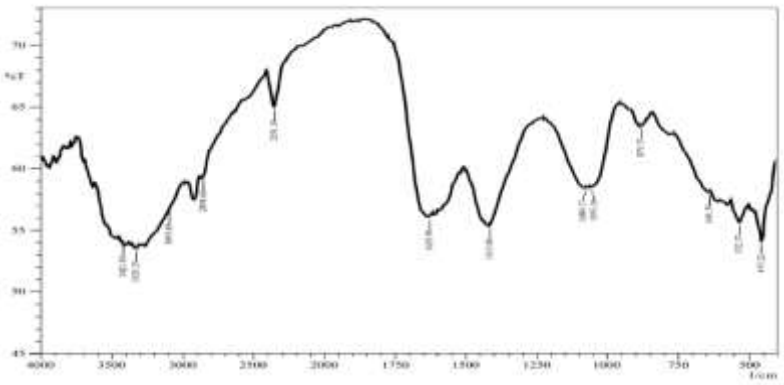


Fig:10 FTIR Spectra of Alangium salvifolium

Broussonetia papyrifera (L.)

Fig. 7 shows the FTIR spectra of a B. papyrifera leaf extract sample containing silver nanoparticles. Alcohols and phenols with H-bonded bonds exhibit O-H stretching in the band at 3368 cm-1. O-H stretch carboxylic acids correlate to the peak at 2927 cm-1. The assignment at 1652 cm-1 relates to primary amines with an N-H bent. The peak at 1381 cm-1 is due to the aromatic amine group's C-N stretching, while the bands seen at 1089, 1042, and 1059 cm-1 are due to the C-N stretching of alcohols, carboxylic acids, ethers, and esters, respectively.

As a result, proteins and metabolites such as terpenoids with functional groups of alcohols, ketones, aldehydes, and carboxylic acids surrounded the produced nanoparticles. By analyzing FTIR studies, we were able to confirm that the carbonyl group from amino acid residues and proteins has a stronger ability to bind metal, suggesting that the proteins may act as a cap for metal nanoparticles like silver to prevent agglomeration and thereby stabilize the medium. This implies that biological molecules may be able to produce silver nanoparticles in the aqueous media and stabilize them at the same time [28].

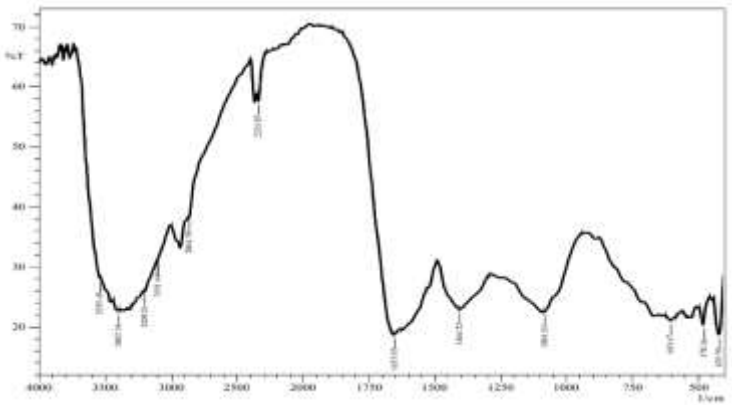


Fig:11 FTIR Spectra of Broussonetia papyrifera (L.)

Scanning Electron Microscopy of Green Synthesized Agnps

The SEM image gave more information on the size and morphology of the produced AgNPs. On a copper grid with carbon coating, AgNPs were deposited (Fig. 5.7a). Because AgNPs are spherical, it was discovered that they are extremely dispersed. Small AgNPs are observed adhering to the surfaces of very big biomolecules in the current investigation.

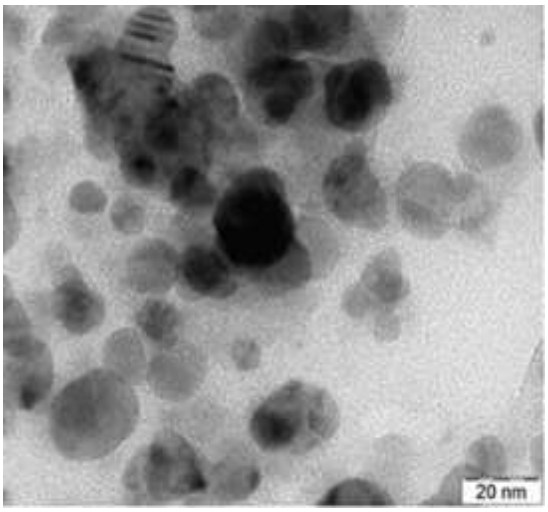


Fig:12 SEM of Abutilon indicum L

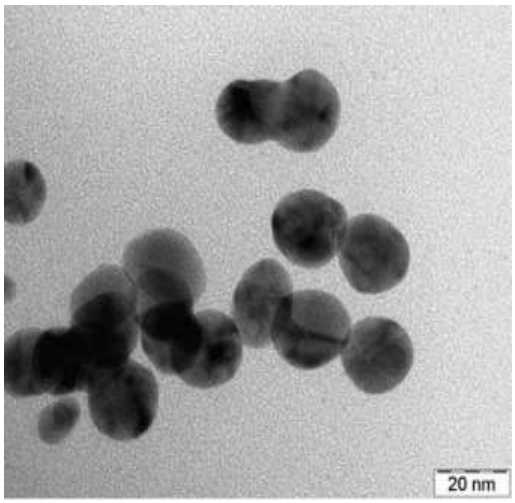


Fig:13 SEM of Alangium salvifolium

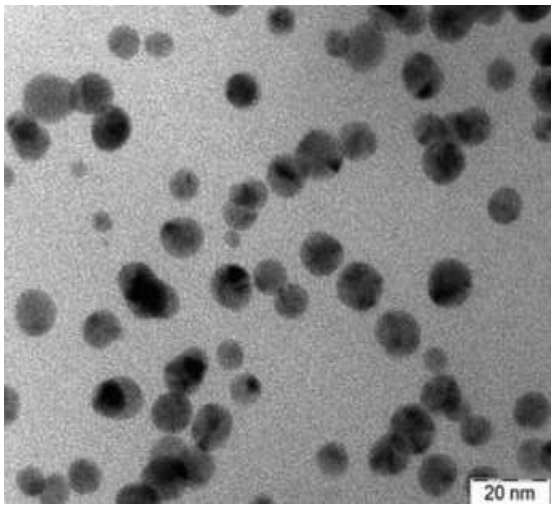


Fig:14 SEM of Broussonetia papyrifera (L.)

XRD analysis

Using A. indicum (L.) Sweet leaf extract, the XRD pattern of produced silver nanoparticles was recorded, and the typical XRD pattern is displayed (Fig. 4). By comparing the peaks with JCPDS

data, the peaks are identified at 2h places, 10.0884 and 14.6254 plans of silver. The recorded XRD pattern displays the silver nanoparticle-related peaks in addition to these.

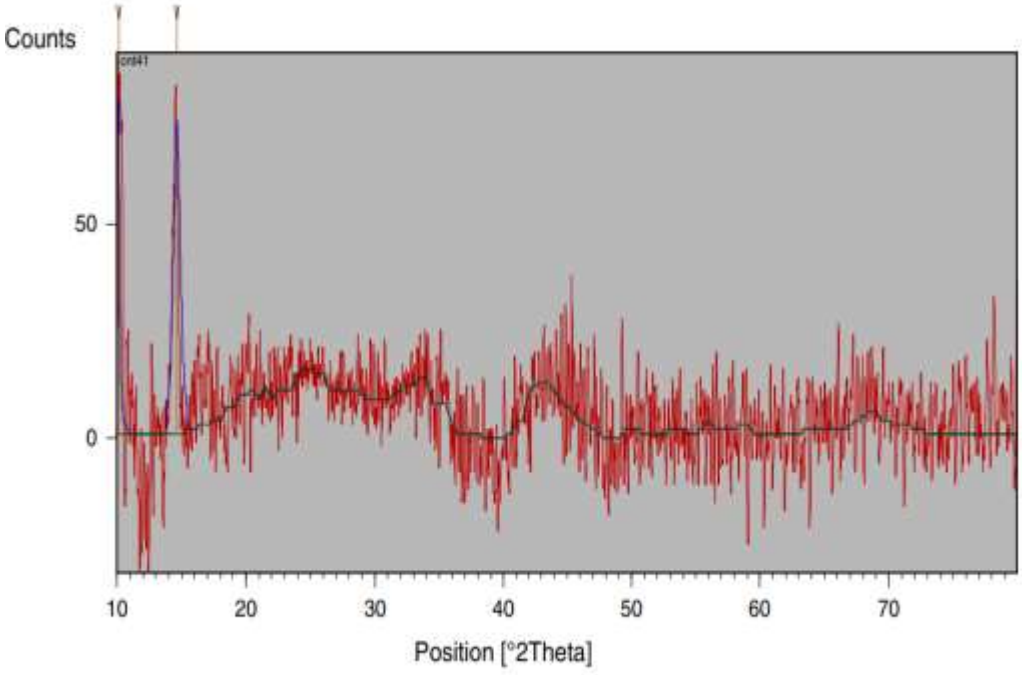


Fig:15 XRD pattern of silver nanoparticles A. indicum (L.)

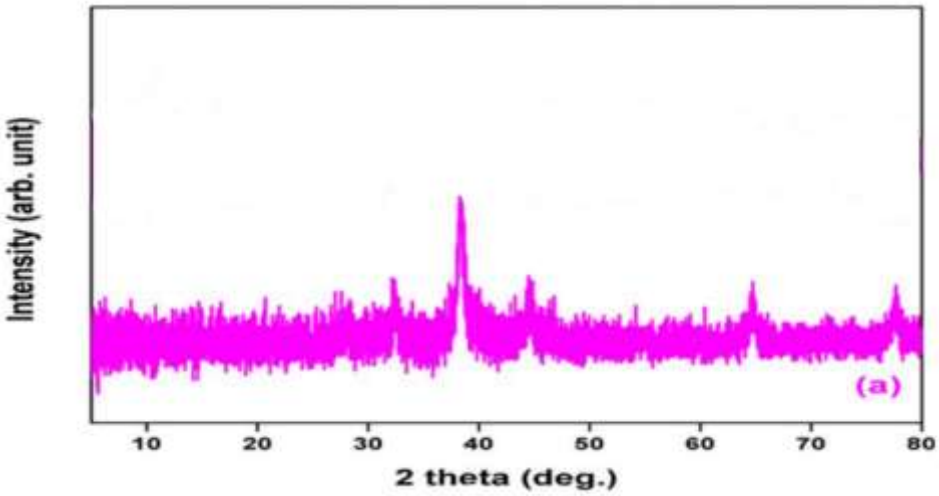


Fig:16 XRD pattern of silver nanoparticles Alangium salvifolium

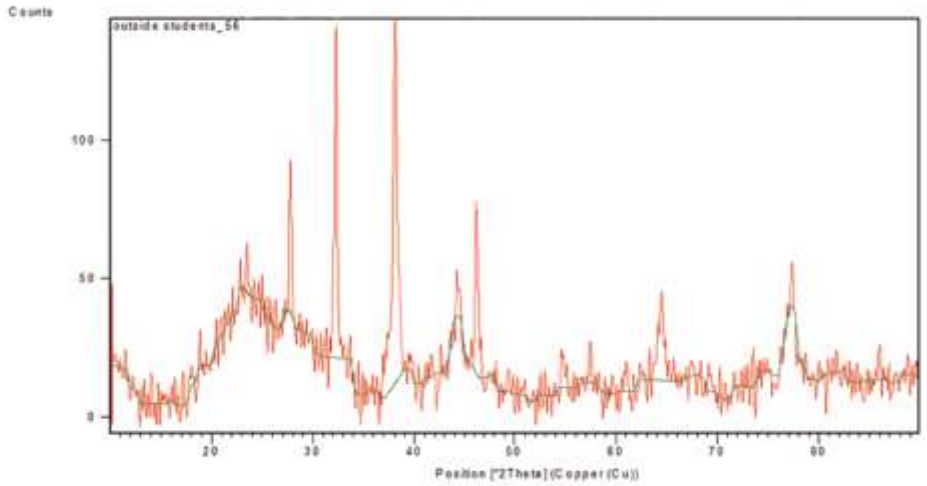


Fig:17 XRD pattern of silver nanoparticles Broussonetia papyrifera (L.)

Table: 5 Result of X-Ray Diffraction

Name Of Plant	D Value	Crystallinity	Amorphous	Size	Shape
Abutilon indicum L	2.85125	64.1%	35.9%	1.5	Hexagonal
Alangium	2.85092	61.2%	37.8%	1.5	Hexagonal
B. papyrifera	2.85126	67.3%	32.7%	1.3	Hexagonal

Particle Size Measurements

The size of the colloidal silver nanoparticles and their granulometric distribution are revealed by the particle number and their occupied volume. Particle size analysis revealed that the size of AgNPs produced at various concentrations of AgNO3 (0.7-100nm for 1mM, 3mM, 5mM, and 7mM AgNO3). Polydispersity indices (PDI)-valued nanoparticles were discovered via particle size analysis. It is shown in the table below (Table 9). As a result, compared to other AgNPs, AgNPs produced using a 5mM AgNO3 solution gave the lowest average narrow particle size.

ZETA POTENTIAL MEASUREMENT

Zeta potential measures the stability of the particles in the colloidal suspension. A minimum of +30mV and -30mV zeta potential is required for the indication of stable silver nanoparticles. For the obtained nanoparticles, synthesized using three plants and its parts extracts (leaves), zeta values were measured and showed in below Table with a peak area of 100% intensity. These values present full stabilization of the nanoparticles, which may be the main reason in producing particle sizes with a narrow size distribution index (Table.9) Majority silver nanoparticles synthesized from the six plants and different plant parts (leaves, flowers, and fruits) showed negative charge and were stable at room temperature.

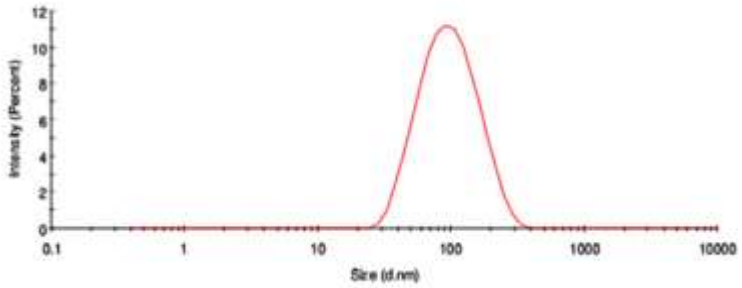


Fig:18 Zeta potential of *Abutilon indicum* L

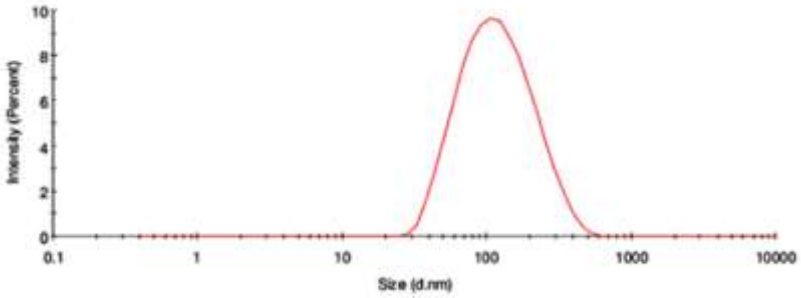


Fig:19 Zeta potential of *Alangium salvifolium*

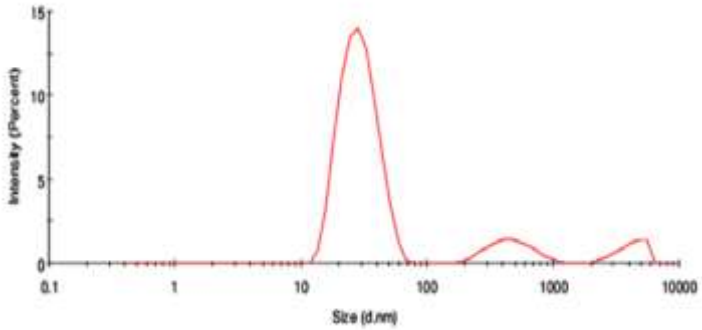


Fig:20 Zeta potential of B. papyrifera

Table: 6 Result of Zeta- potential analysis and particle size analysis

Plant sample	**Average size (nm)**	**Zeta Potential (mV)**
indicum L	**51.0**	**20.08**
Salvifolium	**34.0**	**18.99**
B. papyrifera	**32.8**	**21.81**

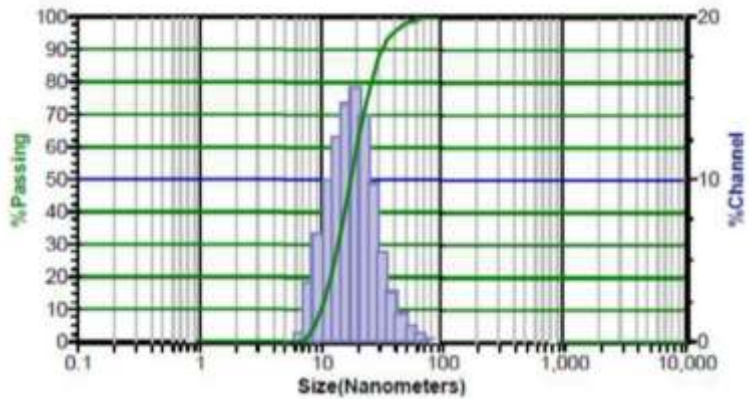


Fig:21 Particle size of *Abutilon indicum* L leaf extract mediated AgNPs

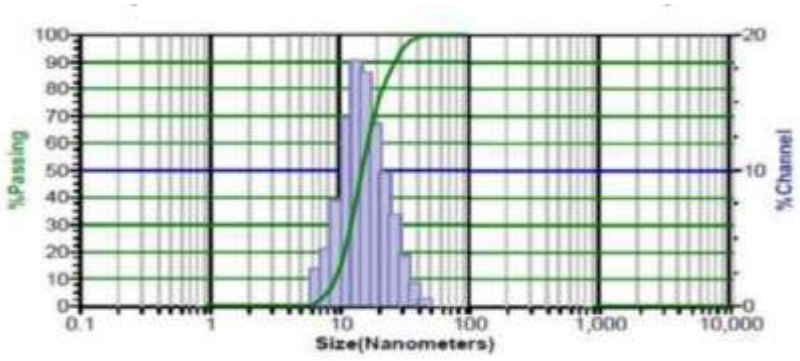


Fig:22 Particle size of Alangium *salvifolium* leaf extract mediated AgNPs

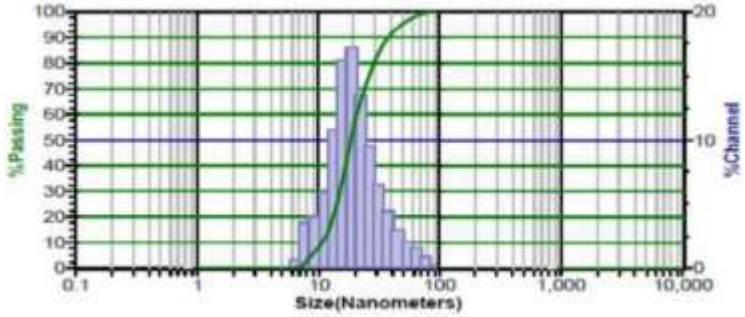


Fig:23 Particle size of B. papyrifera leaf extract mediated AgNPs

ELECTRON MICROSCOPY/ SELECTED AREA ELECTRON DIFFRACTION (SAED) ANALYSIS

The results of the study demonstrate that these plant extracts have a high capacity to synthesis AgNPs, which were consistently dispersed and had a hexagonal shape. The generated biogenic AgNPs were found to be 10–50 nm in size. AgNPs' crystalline nature is revealed by their SAED pattern. The phytoconstituents of three plant extracts are shown as caps on the produced AgNPs in TEM pictures.

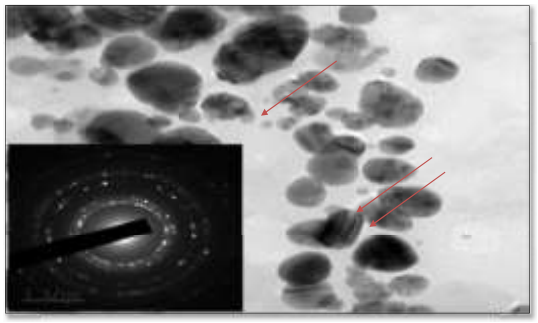


Figure: 24 (i) High Resolution Transmission Electron Microscopy studies of Abutilon indicum L, leaf extract mediated silver nanoparticles (ii) SAED pattern of Abutilon indicum L, leaf extract silver nanoparticles.

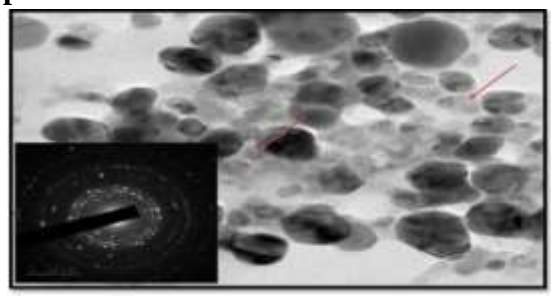


Figure: 25 (i) High Resolution Transmission Electron Microscopy studies of Alangium salvifolium Lief extract mediated silver nanoparticle (ii) SAED pattern of Alangium salvifolium Leaf extract silver nanoparticles.

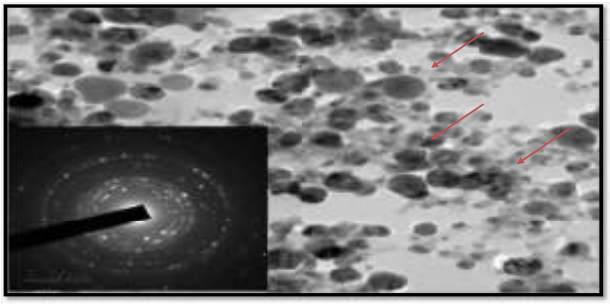


Figure: 26 (i) High Resolution Transmission Electron Microscopy studies of Broussonetia papyrifera (L.) *leaf* extract mediated silver nanoparticles (ii) SAED pattern of Broussonetia papyrifera (L.) *leaf* extract silver nanoparticle

Conclusion

In the current study, we have revealed the simple use of a natural, low-cost biological reducing agent. Liver diseases remain as one of the serious health problems. Over 10% of the world population afflicted liver diseases. It includes chronic hepatitis, alcoholic steatosis, fibrosis, cirrhosis, and hepatocellular carcinoma. However, there are no satisfactory liver protective drugs

in allopathic medical practice for serious liver disorders. We have demonstrated a green synthesis of AgNPs from silver nitrate using Abutilon indicum L, Alangium salvifolium and Broussonetia papyrifera (L.) leaves characterised the biosynthesised nanoparticles using UV, SEM, TEM and XRD. The AgNPs are stable in solution, inexpensive, eco-friendly and show reduced aggregation.

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