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RESEARCH ARTICLE

Preliminary Investigation of Synthesizing Silver Nanoparticles from the Different Biological Source: A Modern Eco-friendly Tool

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ABSTRACT

Nanotechnology is nothing about designing the particles or materials, in nanoscale production. It involves a lot of chemical and physical method to control the size of nanoparticles produced, which creates pressure and toxicity to the environment, but the rise of biological method to synthesis will overcome all the drawbacks that have been reported earlier. Silver nanoparticles were successfully synthesized from silver nitrate through a simple, green and natural route using the different parts of a plant, lichen and mushroom. Silver Nanoparticle synthesis is proved under UV-Vis absorption spectroscopy, synthesized nanoparticles were quite stable and no visible changes were observed even after a month or so. Nanoparticles have wider application in the medical world like gene therapy, Cancer therapy, drug delivery, etc. and medical world also accepts the biological world of non-polluted, Eco-friendly and non-expensive nature of synthesizing nanoparticles.

KEYWORDS

Eco friendly, biological method, mushroom, plants, *Ganoderma lucidum*, *Phellinus igniarius*, *Parmelia sulcata*, *Parmelia perlata*, *Poystichen aerostichoides*, *Garcinia cambogia*, *Agaricus bisporous*, *Santalam album*, *Courouptia guianesis*, *Tridax procumbens*, *Myristica fragrans*, *Calotropis gignatea*, *Kigelia pinnata*

INTRODUCTION

Nanotechnology is the art of manipulating the particles in nanometer. Nano size range of particle has been found in the universe for millions of years[1], it has been known for ages. This has been used in the preparation of medicines especially in siddha, eg churanam-it will be in size of nanoparticles, and still today it's in the world wide market. Nowadays nanoscale materials have been found in use in different areas such as electronics, biomedical, pharmaceutical, cosmetics, catalyst and material application.

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Due to the advancement of technology, there has been a worldwide increase in investment in nanotechnology[2]. Biological method of synthesizing metal nanoparticles brings a "green revolution" in the field of nanotechnology. Especially synthesizing of silver nanoparticles by biological sources from prokaryotes and Eukaryotes[3-9] like bacteria, fungi[11], mushroom[12,13] and plants[14-17]. Then the formation of nanoparticles and size could be varied by altering parameters such as temperature, pH, substrate, concentration and exposure time in synthesizing. Various techniques, chemical[18-21] and mechanical method have been used in the production of nanoparticles[22-24].

Table 1: Mushroom, Plants and lichens used for the synthesizing of silver nanoparticles

S. No	Binomial Name	Common name	Family	Part Used	Activity	Images/ References
1	*Ganoderma lucidum*	Reishi, lingzhi	Ganodermataceae	Fruiting body	Anti-hyperglycemic effect, immune-modulating,Immuno-stimulating,anti-mutagenic,anti-cancer,antioxidant	 [26-29]
2	*Phellinus igniarius*	Willow bracklet	Hymenochaetaceae	Fruiting body	Immunoregulatory Pulmonary inflammation, renal protective, Antioxidant	 [30-36]
3	*Parmelia sulcata*	Shield lichen	Parmeliaceae	Thallus	Anti-viral,anti-tumor, anti-inflammatory, analgetic, antipirethic, antiproliferative, antiprotosoal	 [37-40]
4	*Parmelia perlata*	Stone flowers	Parmeliaceae	Thallus	antimicrobial , Anti-viral, anti-oxidant activity analgesic, antipyretic antispasmodic potential	 [38,41-44]
5	*Agaricus bisporous*	Button mushroom	Agaricaceae	Fruiting body	antiinflammatory, hypoglycemic hypocholesterolemic	 [45-47]
6	*Polystichen acrostichoides*	Christmas fern	Dryopteridaceae	Leaf	blood purifier, emetic, febrifuge treatment for chills, fevers, pneumonia, stomach or bowel complaints rheumatism	 [48,49]
7	*Garcinia cambogia*	Brindal Berry	Clusiaceae	Leaf Fruit Water liquid	Anti-obesity	 [50-54]

8	*Santalam album*	Sandal wood	Santalaceae	Leaf Bark	heart, stomach, liver, anti-poison, fever, memory improvement blood purifier hemorrhage bleeding piles, vomiting, poisoning, hiccoughs initial phase of pox, urticaria, eye infections, inflammation of umbilicus	 [55-57]
9	*Courouptia guianesis*	Cannon ball	Lecythidaceae	Leaf Flower Fruit	antioxidant properties, protection against allergies, inflammation, platelet aggregation, microbes ,ulcers, heptatotoxins, viruses and tumors	 [58-60]
10	*Tridax procumbens*	Coat buttons	Asteraceae	Leaf	Immunomodulatory, Antidiabetic, Anti-hepatotoxic, Anti-oxidant, Anti-inflammatory, Analgesic and marked depressant action on Respiration	 [61-68]
11	*Myristica fragrans*	nutmug	Myristicaceae	Leaf Fruit Seed covering	anti-inflammatory, anti-cancer antifungal, antibacterial, larvicidal and antioxidant	 [69-73]
12	*Calotropis gignatea*	Gigantic Swallo w wor	Apocynaceae	Flower Latex	Asthma,Abortifacient, Analgesic, Antinociceptive activity, Antifertility, emmenagogue , Anti-inflammatory activity, Anthelmintic activity, Anti cancer activity , Anti dote,Anti tumor activity, Anti-diarrheal, anti dyssentry , Antimicrobial activity, Antiviral activity	 [73-84]

13	*Kigelia pinnata*	Sausage tree	Bignoniaceae	Flower Fruit Leaf	Treatment for sexually transmitted diseases, dysentery, leprosy, miscellaneous, microbial, parasitic infections, skin ulcers, and neoplastic Diseases	 [85-88]

Unfortunately the chemicals used like sodium borohydrate, thiophenol, thiourea, macro capto acetate, etc. are toxic enough in is polluting the environment in the larger scale. The production of nanoparticles by bio source will not use any harmful chemicals. This provides a better and a toxic free environment[25].

Some specific plant parts or mushrooms have been taken for the studies (Table 1).

MATERIAL AND METHODS

Source of Silver Nitrate

Silver nitrate was purchased from sigma laboratories Pvt Ltd

Extraction and Processing of the Sample

Source of Latex

Crude latex was obtained by cutting the green stems of different plants. Milky white latex and watery latex both were stored at – 20^{0}C until use. All the aqueous solutions were prepared using triply distilled de-ionized water[89].

Source of Leaf, Flower, Seed and Fruit

Different parts of the plant were taken such as leaves, fruits, flowers, seeds and seed outer coating were washed several times with de-ionized water. The extract used for the synthesis of silver nanoparticles were prepared by taking 20 g of samples thoroughly washed, finely cut and boiled with 100ml of triply distilled de-ionized. The extract obtained was filtered through Whatman No 1 filter paper. The filtrate was collected and stored at 4°C for further use[90].

Source of Thallus and Fruiting Body

The mushrooms and lichens were shredded and mixed with triply de-ionized water in the proportion of 68gms in 250ml water. It was boiled for 2 minutes, cooled and filtered with Whatman No 1 filter paper. Then filtrate was stored at 4°C for further use[91].

Synthesis of Ag Nanoparticles

Source of Latex

In a typical reaction procedure, 3 ml crude latex was diluted to 100 ml using triply distilled de-ionized water to make it 3% and 25 ml of this latex solution was taken and heated at 60^{0}C with constant stirring for 15 min in water bath. Separately 25ml 2 milimolar aqueous silver nitrate solution was prepared and heated at 60^0 C with constant stirring for 15 min in water bath. Then both of it was mixed and heated at 80^{0}C for 30 to 45 mins and silver nano particles were obtained gradually. This naturally occurs nanoparticles are generated by the erosion and chemical degradation of plant[89].

Source of Leaf, Flower, Seed and Fruit

1mM Silver Nitrate solution was prepared and to that 10ml extract solution was added with constant stirring. The formation of silver nanoparticles can be observed by the gradual change of colour from yellow to brown[90].

Source of Thallus and Fruiting Body

35mg $AgNO_3$ is dissolved in 250mL water. To obtain silver colloids 6ml of mushroom and

lichen extract was added in 30ml of $AgNO_3$ solution. The formation of Ag nanoparticles is

Indicated by light yellow colour and the reduction are complete in 30min[91].

Characterization Techniques

UV-VIS spectroscopy

The characterization technique involves ultra-violet and visible spectroscopy UV-Vis absorption spectra were measured using a shimadzu UV-1601 spectrometer at the range 200-800nm.It shows the nature of the particle through different absorption peaks of various samples. The colour changes arise from the excitation of surface plasmon vibrations with the silver nanoparticles. The Surface Plasmon Resonance of silver nanoparticles produced a peak centred near 390-450 nm.

RESULTS AND DISCUSSION

Silver nanoparticles effective antimicrobial agents[89] are widely recognized and have been used in the various medical applications. There are many methods for synthesis, metal nanoparticles. In the present study, a biological method for synthesizing silver nanoparticles have been carried out by using various biological sources like Plants, Mushrooms and lichens variety (table 1).

The plant, mushroom and lichen extracts are reported to have lots of bioactive compounds and polysaccharides[92], which display a wide role in biological activities including immune system development. The biological sources used in the study have only limited information available. The additional of biological source with silver nitrate solution under the agitating condition at room temperature, resulted in the gradual change of colour from pale yellow to golden yellow/dark brown after 30 minutes to 5 hours accordingly to source used. (Table 2 & 3) and in some other source there showed no colour change even after 24hours respectively.

The appearance golden yellow/ brown colour clearly indicates the formation of silver nanoparticles in the reaction mixture[93]. The characteristics, colour change from pale yellow to brown of colloidal silver nanoparticles solution is due to the excitation of surface plasmon vibrations and provides an expedient spectroscopic moniker of their formation. There are several hydroquinones with excellent redox properties that could be act as an electron shuttle in metal reductions[94,95]. Thus, it shows an evident electron shuttle or others reducing agents released by various biological sources are capable of reducing silver ions to silver nanoparticles.

Table 2: Physiochemical properties of silver nanoparticles synthesized

S. No	Binomial Name		Results	Colour form	Properties	UV-Vis spec Nm	specification
1	*Ganoderma lucidum*	*F*	+	Brown	Water soluble	420	Stable for almost 5 months
2	*Phellinus igniarius*	*F*	+	Brown		414	Stable for almost 3 months
3	*Parmelia sulcata*	*T*	+	Dark brown		432	Stable for almost 2 months
4	Parmelia perlata	T	+	Pale brown		436	Stable for almost 2 months

5	*Agaricus bisporous*	*F*	+	Yellow		496	Stable for almost 1 months
6	*Polystichen acrostichoides*	*L*	+	Golden yellow		398	Stable for almost 1 months
7	*Garcinia cambogia*	*L*	+	Golden yellow		401	Stable for almost 2 months
		F		Golden yellow		410	
		LI	-	Pale		367	
8	*Santalam album*	*L*	-	Pale		312	-
		B	-	Pale yellow		350	
9	*Courouptia guianesis*	*L*	+	Brown	Water soluble	435	Stable for almost 2 months
		FL	+	Brown		422	
		FR	+	yellow		389	
10	*Tridax procumbens*	*L*	–	Pale		282	-
11	*Myristica fragrans*	*L*	+	brown		422	Stable for almost 2 months
		S	+	Golden yellow		412	
		SC	+	Golden yellow		403	
12	*Calotropis gignatea*	*LA*	+	Dark brown		436	Stable for almost 1 months
13	*Kigelia pinnata*	*L*	–	Pale yellowish		327	-
		F	-	Pale yellowish		210	

F-FRUITING BODY, T-THALLUS, L-LEAF, FL-FLOWER, FR-FRUIT, S-SEED, SC-SEED COVERING, LA-LATEX, LI-WATERY LIQUID

Absorption peak of silver nano particles using the different extract under UV- Vis absorption spectroscopy

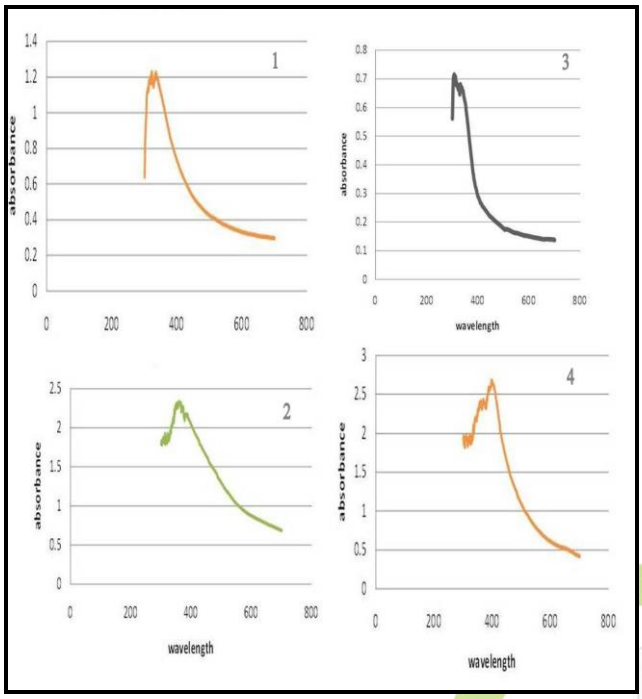

Figure: (1) *Ganoderma lucidum-fruiting body* (2), *Phellinus igniarius- fruiting body* (3), *Parmelia sulcata-thallus* (4), *Parmelia perlata-thallus*

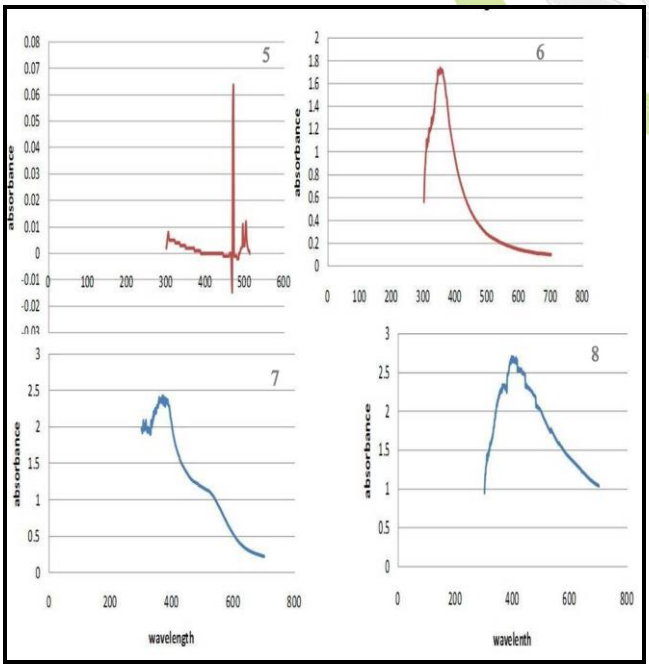

Figure: (5) *Agaricus bisporous-fruiting body* (6), *Polystichen aerostichoides-leaf* (7), *Garcinia cambogia-leaf* (8), *Garcinia cambogia-flower*

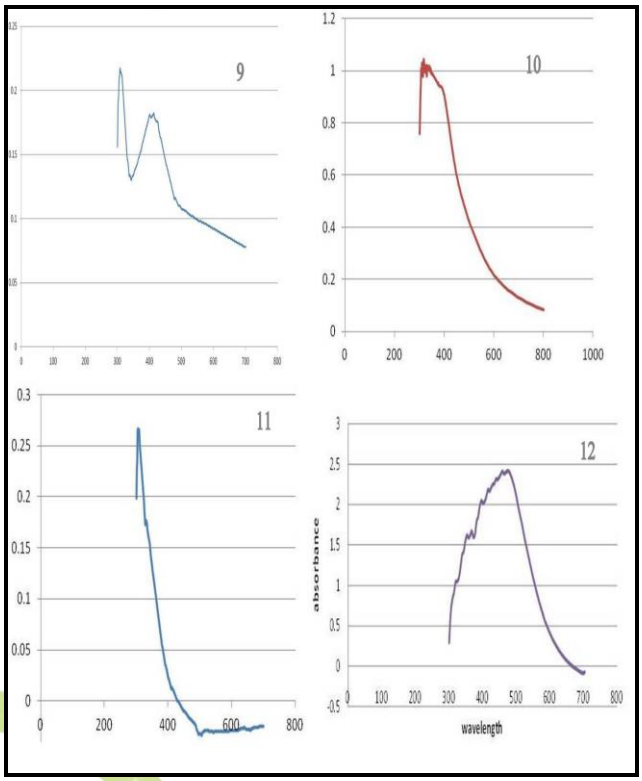

Figure: (9) *Garcinia cambogia-fruit* (10) *Santalam album-leaf* (11) *Santalam album-bark* (12) *Courouptia guianesis-leaf*

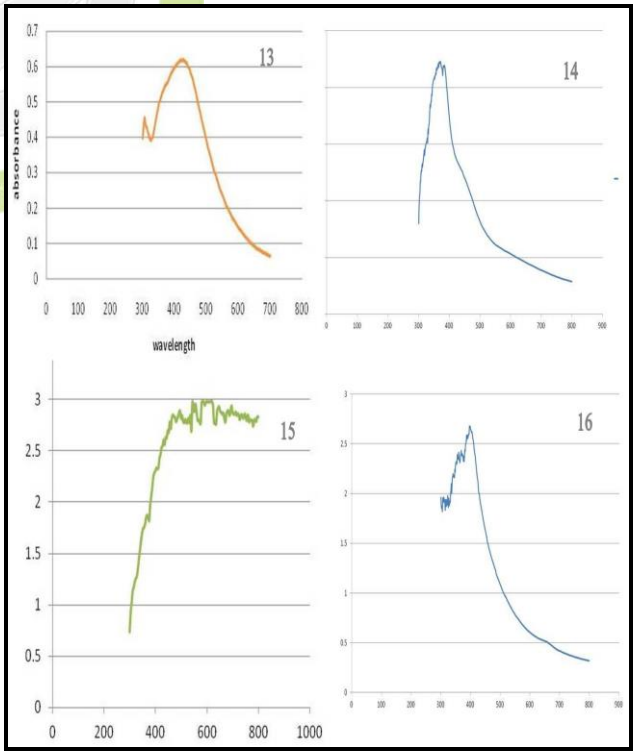

Figure: (13) *Courouptia guianesis-flower* (14) *Courouptia guianesis-fruit* (15) *Tridax procumbens-leaf* (16) *Myristica fragrans-leaf*

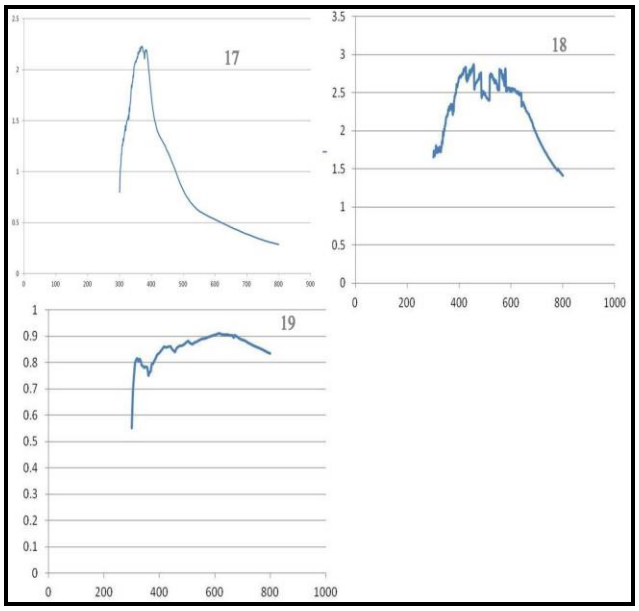

Figure: (17) *Calotropis-latex,* (18) *Kigelia pinnata-leaf 19, Kigelia pinnata-flower*

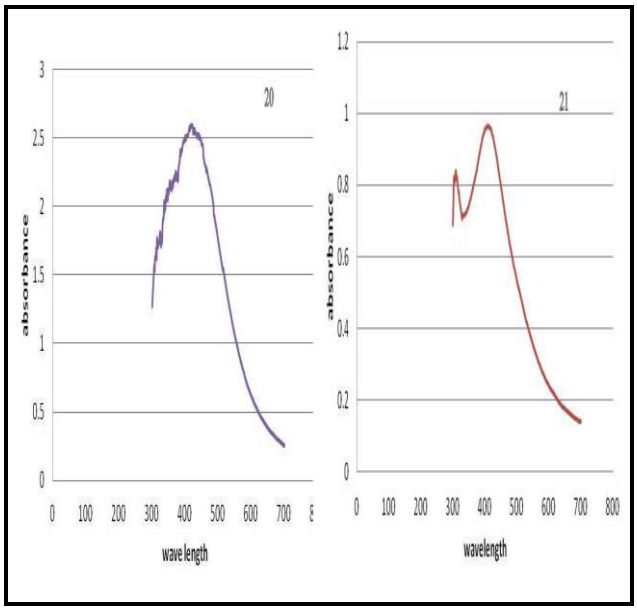

Figure: (20) *Myristica fragrans-seed* (21) *Myristica fragrans-seed covering*

Table 3: Ranking of biological source according to the time taken for silver nanoparticles reduction

S. No	Biological source	Parts	Reduction Time	Rank
1	*Ganoderma lucidum*	F	15 minutes	3
2	*Phellinus igniarius*	F	20 minutes	4
3	*Parmelia sulcata*	T	10 minutes	2
4	*Parmelia perlata*	T	5 minutes	1
5	*Agaricus bisporous*	F	3 hours	9
6	*Polystichen acrostichoides*	L	30 minutes	5
7	*Garcinia cambogia*	L	30minutes-1 hour	7
		F		
		LI	Nil	Nil
8	*Santalam album*	L	Nil	Nil
		B	Nil	Nil
9	*Courouptia guianesis*	L	1.5 hour	8
		FL	20 minutes	4
		FR	1 hour	8
10	*Tridax procumbens*	L	Nil	Nil
11	*Myristica fragrans*	L	1.5 hours	8
		S	45 minutes	6
		SC	45 minutes	6
12	*Calotropis gignatea*	LA	3-4.5 hours	10
13	*Kigelia pinnata*	L	Nil	Nil
		F	Nil	Nil

It clearly states the reduction of silver nanoparticles happened due to their polyphenolic compounds present in the sample. The ranking of biological source in the reduction can be observed in the table 3.

CONCLUSION

Nano science is the study of phenomena and manipulation of materials at "nanoscale" size. In the present scenario the nanotechnology field has risen and one of the most competitive fields currently. It just the preliminary screening analysis of biological sources for synthesis of silver nanoparticles, for the detail study and confirmation of silver nanoparticles the following method has to carried out: X-ray diffraction spectroscopy (X R D) , Fourier transform infrared (FTIR),Transmission electron microscopy(TEM) & scanning electron microscopy(S E M).In future the following parameter and kinetic study to be practiced to control the size of the nanoparticles, and the various application oriented study can be also opted. Some of the biological sources that have been selected for the study are first to be reported for synthesis of silver nanoparticles.

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