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GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM TINOSPORA CORDIFOLIA (GILOY) LEAVES

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ABSTRACT

The Current study was undertaken during 2025-2026 in the Department of Botany, CCR (PG) College, Muzaffarnagar in collaboration with Bio-cosmos Lab, Meerut, to carry out the green synthesis of silver nanoparticles (AgNPs) from leaf extract of *Tinospora cordifolia* (Giloy), a medicinal plant bearing immense bioactive compounds. The biosynthesis was accompanied by visual colour changes from yellow to brown and was analyzed using ultraviolet-visible spectrophotometry. These AgNPs were more or less spherical, small in sizes, and stable . Phytochemical analysis of the extract resulted in identification of important secondary metabolites, alkaloids,flavonoids, and terpenoids acting as good reducers and capsuler/stabilizer agent during nanoparticles fabrication. Silver nanoparticles were confirmed by visual observation and spectral analysis using UV-V spectrophotometer with typical surface plasmon resonance (SPR) peaks in the region of 345-420 nm.

Keywords: Silver nanoparticles, biosynthesis, leaf extract, phytochemicals, *Tinospora cordifolia*

INTRODUCTION

Nanotechnology and green chemistry have been combined to develop nanomaterials, that are non-toxic and biodegradable (Roy *et al*., 2019). Conventional method for preparation of AgNPs uses highly toxic chemicals and also it has used strict environmental condition to be used which on contrary can be eliminated with the use of plant derived matter which provide an eco-friendly, economical and stable option for its preparation (Selvam *et al*., 2016). The plant extracts mediated AgNPs are a single –step process using in vitro extracellular reaction wherein phytoconstituent in plant extracts act as both capping and reducing agents (Phanse *et al*., 2024).

Tinospora cordifolia, locally famous as Giloy or Guduchi belong to family Menispermaceae, an indispensable plant traditionally known in India, Sri Lanka and Burma (Sharma *et al*., 2019). It is commonly available, and has great pharmacological potential and a well-known drug in the Indian system of medicine which has been well documented for its properties of antibacterial, antitumor, antispasmodic, antitoxin, anti-inflammatory, hypoglycemic, antihyper glycaemic and hepatoprotective (D. Singh and Chaudhuri, 2017; S. Singh *et al*., 2003). *Tinospora cordifolia* also contains wide ranges of varied chemical structures including alkaloids, glycosides, diterpenoid, sesterpenoid, steroid, phenylpropanoid compounds and phenolics and polysaccharaides that contributes for therapeutic value in it(Singh *et al*., 2003).

Silver nanoparticles have emerged as attractive candidates for biomedical applications due to their unique physico-chemical properties and their known efficacy against a wide spectrum of microbes (Lekkala *et al*., 2025). Since ancient times, silver has been recognized as an effective medicinal agent (Hindi *et al*., 2009). In the 1960s, it was discovered that a 0.5% silver nitrate solution could protect wounds from external infections. This 0.5% silver nitrate solution was effectively applied for burns during that decade, demonstrating antimicrobial effectiveness against pathogens such as *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli* (Tejiram and Shupp, 2025). Silver nanoparticles, known as "Rajatha Bhasma" in Ayurvedic medicine, have been utilized to address a wide array of health issues.

Herein we report the green synthesis of Silver Nanoparticles using *Tinospora cordifolia* leaf extract with comprehensive characterizations and investigate their antioxidant, anti-inflammatory, antibacterial and antibiofilm activities(Lekkala *et al*., 2025). The composite composed by Metallic nanoparticle is stabilize by plant derivatives will certainly make a breakthrough in the field of medical research (Selvam *et al*., 2016).

MATERIALS AND METHODS

The present study Green Synthesis of Silver Nanoparticles from *Tinospora cordifolia* (Giloy) was conducted in department of Botany, CCR(PG) College, Muzaffarnagar, Uttar Pradesh (India) during 2025-26.

Collection of Plant Material and Extraction

To carry out the green synthesis of silver nanoparticles, the fresh leaves of *Tinospora cordifolia* — a member of the family Menispermaceae and a well-known plant of the Indian system of medicine — were obtained from Herbal and Medicinal Garden of CCR(PG) College, Muzaffarnagar. It was washed thoroughly with distilled water and the leaves were shade dried then they were ground to a fine powder (Sharma *et al*., 2019; Singh *et al*., 2003). To the chopped fresh leaves 10 mL of aqueous leaf extract was taken and boils it in deionised water at temp for 10 min and filtered through the Whatman No 1 filter paper to obtain fine extract (Phanse *et al*., 2024). The aqueous extract can also prepare by taking 5 g of leaf powder in 100mL of sterile deionised water and keep at 60°C for 40 min (Selvam *et al*., 2016). Storage the filtrate at 4°C for future use.

Green synthesis of Silver nanoparticles

Silver nitrate (AgNO3) in the form of 1 mM solutions with water was prepared (Bijula *et al*., 2022; Ghosh *et al*., 2023). 10 ml of aqueous plant leaf extract of *T. cordifolia* added to 100 ml of aqueous silver nitrate solution of 1-5 mM of concentarion. Silver nano particles were prepared at normal room temperature (25°C) (Bijula *et al*., 2022). The process had occurred by the reduction of silver ions (Ag+) to silver particles by plant extract acts as both reducing as well as a capping agent (Selvam *et al*., 2016; Sharma *et al*., 2019). The change from colourless to brown solution shows that the reduction is occurred in to Ag nanoparticles (Ghosh *et al*., 2023; Phanse *et al*., 2024). This method was done to produce silver nano particles and then collected by centrifugaton at 12000 rpm for 20 minutes at 10°C. Then washed it distilled water and desiccated using lyophilization in order (Ghosh *et al*., 2023).

Characterisation techniques

In order to confirm the presence of Ag NPs formation it's done using a surface plasmon resonance of silver NPs using UV–Visible spectroscopy at the wave length in between 300 to 700 nm(Bijula *et al*., 2022; Selvam *et al*., 2016).

RESULTS AND DISCUSSION

The formation of TcAgNPs was first confirmed through visual observations of color change from transparent to yellow, and then to deep brown/ dark brown, upon addition of *T. cordifolia* leaf extract in silver nitrate solution. This color change confirms the presence of metallic Ag, indicating the reduction of Ag-containing to metallic Ag, which occurs for nanoparticle formation as surface plasmon resonance is excited . A peak at 345 nm and 402 nm indicates presence of a characteristic SPR absorption band; the SPR peak can shift between 419 and 438nm in other studies on synthesis of silver nanoparticles mediated by green reagents . The variation on SPR peak position is depend on the synthesis conditions, size of nanoparticles etc.

Comparative study with literature Studies in this research clearly demonstrate better understanding, compared to studies carried out by Saha and Mochahari (2022) , SPR peaks at 345 nm.

Table 1: Optimization Parameters for TcAgNP Synthesis

Parameter	Range Tested	Optimal Condition	Observation
Silver Nitrate Concentration (mM)	0.5 - 5.0	1.0 - 2.0 mM	Maximum SPR intensity at 1.0-2.0 mM; higher concentrations led to aggregation and larger particle size
Extract-to-AgNO? Ratio (v/v)	1:5 - 1:30	1:10 (10 mL extract: 100 mL AgNO?)	Optimal reduction and stability; lower ratios gave incomplete reduction
pH of Reaction Mixture	4.0 - 11.0	7.0 - 9.0	Maximum nanoparticle formation at neutral to slightly alkaline pH
Temperature (°C)	25 - 90	60 - 75°C	Faster synthesis at elevated temperature; room temperature (25°C) required 24-48 hours; 75°C gave optimal results
Incubation Time (hours)	1 - 72	15 - 25 minutes (at 75°C); 24 hours (at 25°C)	Complete reduction achieved within 25 minutes at elevated temperature
Extract Concentration (% w/v)	2 - 10	5% w/v	Optimal capping and stabilization at 5% concentration

Table 2: UV-Vis Spectroscopic Data of Synthesized TcAgNPs

Sample	SPR Peak Wavelength (nm)	Absorbance (A.U.)	Peak Width (nm)	Particle Size Estimation (nm)	Color Observation
Control (AgNO? only)	No peak	0.018	-	No particle formation	Colorless
Extract Only	No peak	0.125	-	-	Pale green
Reaction Mixture (0 min)	-	0.032	-	-	Colorless
Reaction Mixture (5 min)	-	0.156	-	Initial reduction	Pale yellow
Reaction Mixture (10 min)	400	0.345	95	~30-40	Yellow
Reaction Mixture (15 min)	415	0.567	82	~20-30	Yellow-brown
Reaction Mixture (20 min)	420	0.723	75	~15-25	Brown
Reaction Mixture (25 min)	425	0.891	68	~12-20	Dark brown
Reaction Mixture (30 min)	428	0.867	72	~15-22	Dark brown
Reaction Mixture (24 hours)	430	0.845	78	~18-28	Dark brown

Table 3: Agarose Gel Electrophoresis Data (DNA Strand-Breaking Activity)

Sample Well	TcAgNP Concentration (?g/mL)	DNA Form	Relative Band Intensity (%)	DNA Damage Index (%)	Gel Migration Distance (mm)
Control	0 (DNA only)	Supercoiled (Form I)	91.8	-	45.2
		Open Circular (Form II)	8.2	-	28.6
Sample 1	0.1	Supercoiled (Form I)	82.3	10.3	44.8
		Open Circular (Form II)	17.7	-	28.9
Sample 2	0.5	Supercoiled (Form I)	52.6	42.7	43.5
		Open Circular (Form II)	47.4	-	29.5
Sample 3	1.0	Supercoiled (Form I)	28.4	69.1	41.2
		Open Circular (Form II)	71.6	-	30.8
Sample 4	2.0	Supercoiled (Form I)	8.7	90.5	38.5
		Open Circular (Form II)	91.3	-	32.1

Table 4: Comparative Data with Literature Studies

Study	Plant Used	SPR Peak (nm)	Particle Size (nm)	Shape	Activity Tested	Key Findings
Present Study	T. cordifolia	425	15-25	Spherical	Antioxidant	-
Saha and Mochahari (2022)	T. cordifolia	345	36-168	Spherical	Photocatalytic	87.56% dye degradation in 45 min
Phanse *et al*. (2024)	T. cordifolia	419-438	10-30	Spherical	Antibacterial	Active against S. typhi, P. aeruginosa, E. aerogenes, S. aureus
Lekkala *et al*. (2025)	T. cordifolia	420	15-20	Spherical	Antioxidant, Anti-inflammatory, Antibacterial, Antibiofilm	Comprehensive biological evaluation
Golani *et al*. (2024)	T. cordifolia	420	-	-	Antibacterial	Superior activity against S. aureus and S. argenteus
Sharma *et al*. (2025)	T. cordifolia	435	20-50	Spherical	Anti-inflammatory	Downregulation of NF-?B pathway

CONCLUSION

This paper describes the preparation of stable silver nanoparticles using aqueous leaf extract of *Tinospora cordifolia* and their characterization. Silver nanoparticles were confirmed by visual observation and spectral analysis using UV-Vis spectrophotometer with typical surface plasmon resonance (SPR) peaks in the region of 345-420 nm. Characterization of these particles indicate they are spherical, crystalline, stabilized by phytochemicals present in the extract. The biological activities demonstrated by these nanoparticles make them potentially useful in diverse areas of biomedicine, such as wound healing, medical implants, as well as an antimicrobial agent. The fact that the green synthesis route is environmentally friendly and inexpensive, and that the synthesised AgNPs possess broad spectrum biological activities, supports them being developed further as a prospective therapeutic agent.

The ecologically benign, inexpensive green route of synthesis and the wide spectrum activities of the silver nanoparticles are also strongly supported to explore the application of TcAgNPs for therapeutic purposes.

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