

Development and Experimental Evaluation of Silver Nanoparticles with Anti-Microbial Activity for Extract of *Abutilon Indicum*

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ABSTRACT

Herpes zoster (HZ), or shingles, is caused by localized reactivation of the varicella-zoster virus (VZV), leading to painful rashes in individuals with previous chickenpox history. In this study, aqueous extracts of *Abutilon indicum* were evaluated for antimicrobial activity and further used for the synthesis of silver nanoparticles through green synthesis. The synthesized nanoparticles were characterized using UV and FTIR spectroscopy. The aqueous extract showed maximum inhibition against *Staphylococcus aureus*, and silver nanoparticles exhibited enhanced antimicrobial potential. This suggests that *Abutilon indicum* leaf extract-based silver nanoparticles can serve as effective antimicrobial agents.

Keywords: *Abutilon indicum*, Silver Nanoparticles, Antimicrobial, UV Spectroscopy, FTIR, Herpes Zoster

INTRODUCTION

Herpes zoster (HZ), or shingles, is caused by the localized reactivation of the varicella-zoster virus (VZV), leading to a painful unilateral rash in a dermatomal distribution in individuals who have previously had chickenpox. When HZ occurs, VZV can be transmitted during the vesicular phase of the rash, causing primary infection in seronegative individuals. After primary varicella infection, VZV establishes latency in dorsal root and cranial nerve ganglia. Herpes zoster is the reactivation of this virus, spreading from a single ganglion to the corresponding dermatome and neural tissue. The VZV is a neurotropic human herpesvirus belonging to the genus *alphaherpesviridae* and is globally distributed. Its genome consists of approximately 125,000 base pairs of linear doublestranded DNA. The virus primarily infects human cells such as epithelial cells, T lymphocytes, and ganglionic neurons. VZV entry into neural cells is mediated by heparan sulfate proteoglycan and the glycogen synthase kinase 3

(GSK-3) pathway, with new virus particles potentially released 9 to 12 hours after cellular entry. Varicella is acquired through airway contact with respiratory droplets or vesicular varicella lesions. Initial viral replication occurs in the respiratory tract, followed by invasion of local lymph nodes and eventual viremia, leading to cutaneous vesicular eruptions. The incubation period for varicella ranges from 10 to 21 days, and it is contagious from 1 to 4 days before the rash appears until all lesions have dried up. Nanoparticles, typically 1 to 100 nanometers in size, exhibit unique properties distinct from their bulk counterparts. Their properties are influenced by size, shape, and composition, with smaller sizes leading to increased surface area and reactivity. Nanoparticles are used in medicine for targeted drug delivery and diagnostics, in electronics for improving device efficiency (e.g., quantum dots in displays and solar cells), and in environmental applications like water purification and catalysis. Their synthesis involves chemical methods, physical deposition, and bottom-up assembly.

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



Abutilon Indicum Plant

Abutilon indicum (L.) Sweet ssp. *Indicum* (Family: Malvaceae), commonly known as Atibala, is a significant traditional medicine used for various ailments. It has been traditionally used as a laxative, emollient, analgesic, anti-diabetic, anti-inflammatory, and blood tonic, and for treating conditions like leprosy, urinary diseases, jaundice, piles, and wounds. Studies have confirmed its antioxidant, antibacterial, analgesic, anti-inflammatory, anti-cancer, hepatoprotective, immunomodulatory, and larvicidal activities.

MATERIALS & METHODS: -

MATERIALS: -

Pet ether Chloroform (Solvent) Ethyl acetate (Solvent) Water (Vehicle) Silver Nitrate (Reducing agent)

Equipments: -

The equipment utilized in the study are:

Weighing balance (SHIMADZU AUX220)

Magnetic stirrer (REMI 2MLH)

Soxhlet extraction apparatus

Rotary evaporator apparatus (EV11 AGK.050)

UV-spectrophotometer (Jasco V-630)

FTIR (Jasco M-41000)

Experimental Work: -

Dried Leaves of *Abutilon Indicum*



Dried Leaves of Abutilon Indicum

Collection of Plant Material *Abutilon indicum* (Indian mallow) was collected from Kavathe Mahankal in Sangli, Maharashtra. The collection focused on preserving the plant's integrity and efficacy, ensuring correct species identification (perennial, heart-shaped leaves, yellow flowers, round fruits). Harvesting

occurred during the active growth period, typically in the morning, using clean, sharp tools to minimize damage and avoid over-harvesting. Gentle handling prevented bruising. Dried material was stored in airtight containers in a cool, dark place to maintain potency.

Drying and Grinding of Plant Material

Drying: Fresh, healthy leaves were selected, washed gently under cool running water, and patted dry. They were arranged in a single layer on a clean, dry surface with good airflow. Drying took 4-5 days in a well-

ventilated area away from direct sunlight to preserve color and essential oils. Leaves were flipped regularly for uniform drying and were ready when brittle. Dried leaves were stored in airtight containers away from light and moisture.



Grinding: Dried leaves were inspected for contaminants, then carefully placed into a clean grinder. Grinding was done gently to avoid overheating and preserve medicinal properties. The

fine powder was transferred to a clean, airtight container and labeled appropriately.



Phytochemical Evaluation of Plant Material
Qualitative chemical tests were performed to screen for various phytochemicals including carbohydrates, proteins, amino acids, alkaloids, flavonoids, steroids, tannins, glycosides, and terpenoids.

Test for Steroids: Reddish-brown color indicates presence.

Test for Alkaloids (Dragendoff's test): Orange to reddish precipitate confirms presence.

Test for Glycosides (Keller Killani test): Reddish-brown color at the junction and a bluish upper layer indicate presence.

Test for Flavonoids: Intense yellow color with dilute NaOH, becoming colorless upon acid addition, indicates presence.

Test for Tannin: Formation of blue-black precipitate with FeCl_3 indicates presence.

Test for Carbohydrate (Molish test): - Purple color indicates presence.

Test for Protein (Biuret test): - Pink color indicates presence.

Extraction of Plant Material with Different Solvents :-
Coarse powdered leaves were extracted using a Soxhlet extractor for 72 hours with Pet ether,

Chloroform, and Ethyl acetate. Water extraction was done by cold maceration for 7 days. All extracts were filtered, concentrated under reduced pressure at 40°C

using an EQUITRON Rotary evaporator, and stored at 4-8°C.

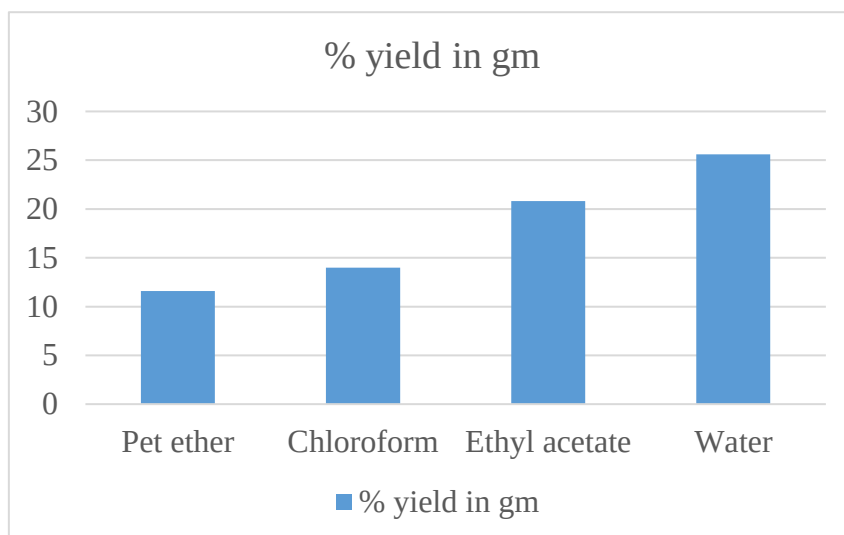


Extraction Process of Abutilon Indicum Leaves Using Different Solvents

calculated using the formula: Percentage Yield = (Actual Yield / Theoretical Yield) × 100%.

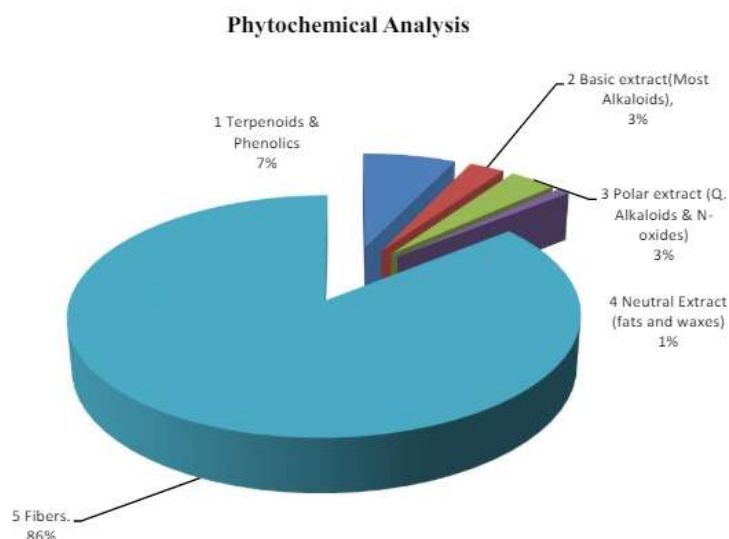
Percentage Yield of Different Solvents: -The percentage yield of desired compounds was

Sr. No	Powder of Crude Drug (gm)	Solvent	Actual Yield (gm)	Percentage Yield (%)
1	25	Pet ether	2.9	11.6
2	25	Chloroform	3.5	14.0
3	25	Ethyl acetate	5.2	20.8
4	25	Water	6.4	25.6



Conformation of Preliminary Phytochemicals by TLC:-Phytochemical screening of Abutilon indicum root, leaf, stem, and fruits with seeds showed positive results for alkaloids, saponins, terpenoids, and

phenols via thin-layer chromatography. Root extracts had the highest alkaloid content, while saponins were in leaves, stems, and seeds. Phenols were abundant in leaves and stems, indicating potential antioxidant and antimicrobial properties.



Antimicrobial Activity of Plant Extract with Staphylococcus aureus:- A swab of pure bacterial culture was evenly spread over Mueller-Hinton broth and agar plates. The treated product sample was placed on the media plate and incubated for 18-24 hours at 36°C with optimal bacterial growth conditions. The antibacterial activity was tested against Staphylococcus aureus.

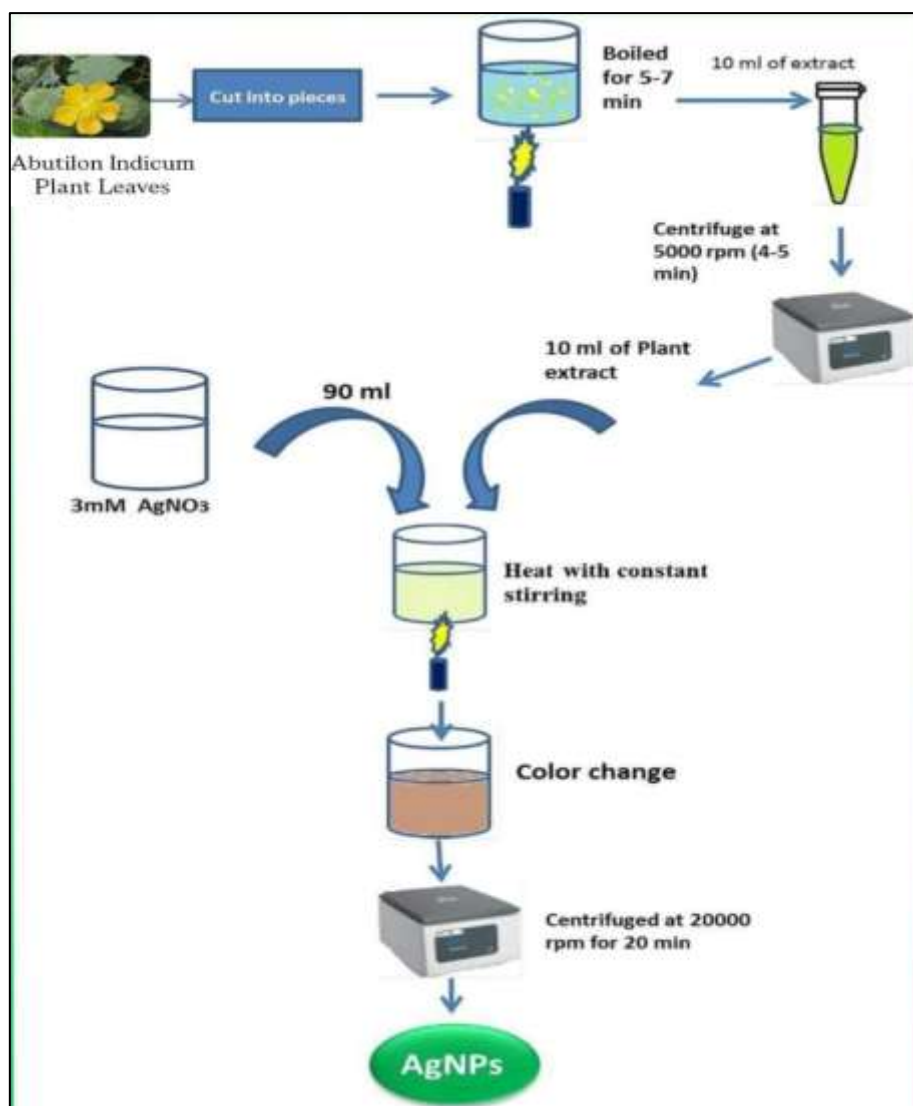
Selection of Potent Extract for Activity Based on antimicrobial activity:- The aqueous extract of Abutilon indicum leaves showed the maximum zone of inhibition, particularly at 800mg concentration. Considering solubility and physicochemical tests, the water extract had high solubility of active ingredients, making it the potent extract.

Preparation of Silver Nanoparticles:- Silver nanoparticles were prepared using a bioreduction method (green synthesis).

Preparation of silver nitrate solution:- A fresh solution of silver nitrate was prepared by dissolving a specific quantity in double-distilled water.

Preparation of green silver nanoparticles:- 10 ml of plant water extract was added to 90 ml of silver nitrate solution with constant stirring for bioreduction. The color changed to reddish-brown, indicating nanoparticle formation. Complete reduction occurred within 25-30 minutes, followed by 24-hour incubation at room temperature.

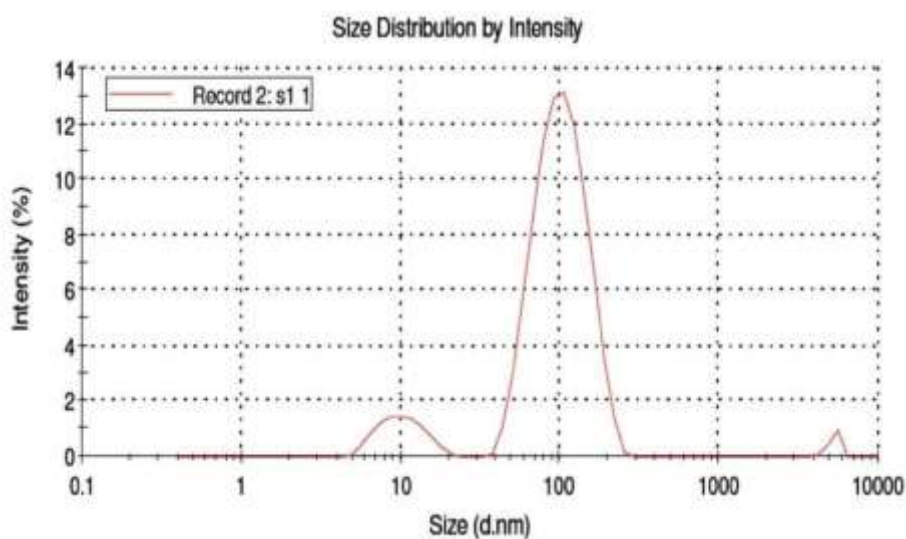
Isolation of polyherbal silver nanoparticles:- The solution was centrifuged at 20000 rpm for 20 minutes. The supernatant was discarded, and this step was repeated thrice to collect the silver nanoparticles.



Evaluation of Silver Nanoparticles: -

Particle Size: - Vesicle size was determined using a Horiba Analyser. 1 ml of the formulation was diluted

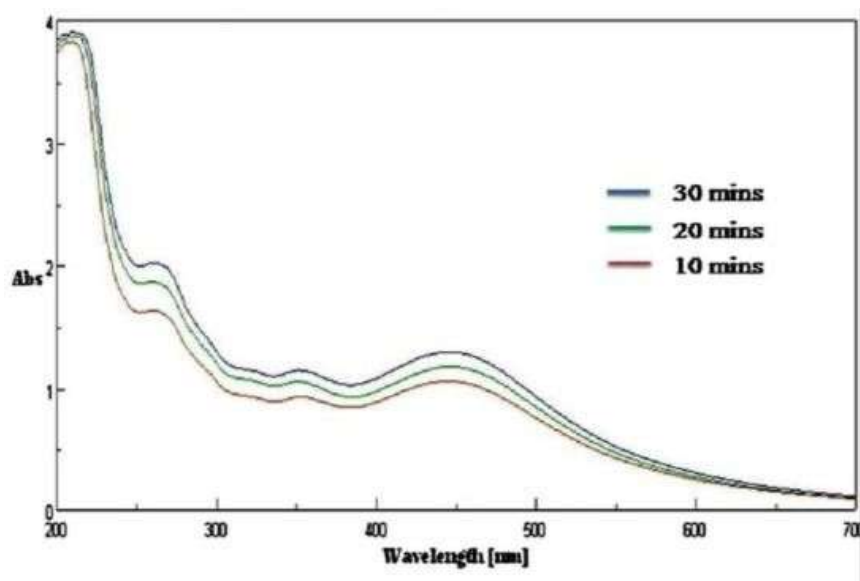
with 10 ml distilled water and placed in a polystyrene cuvette in a thermostatic chamber at 25°C. Detection was at a scattering angle of 90°. The size of the particle in diameter 106 nm were noticed.



UV Spectroscopy: -

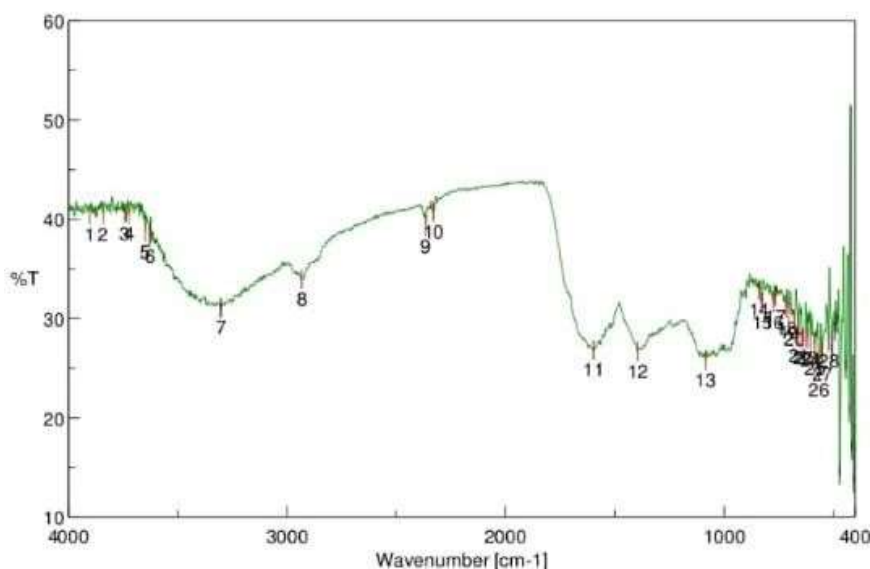
UV-visible spectra of silver nanoparticles were taken in water medium. The strong absorption peaks at 435

nm. are associated with the silver nanoparticles. It can be assumed that leaf protein acts as a template for the synthesis of silver nanoparticles and as well as stabilizing of nanoparticle

**FTIR Spectroscopy Analysis: -**

The silver nanoparticles were analyzed by FT-IR spectroscopy. The FT-IR spectrum was taken in the mid IR region of 400-4,000 cm. The spectrum was

recorded using Attenuated Total Reflectance (ATR) technique. The sample was directly placed in the zinc selenide crystal and the spectrum was recorded in the transmittance mode.

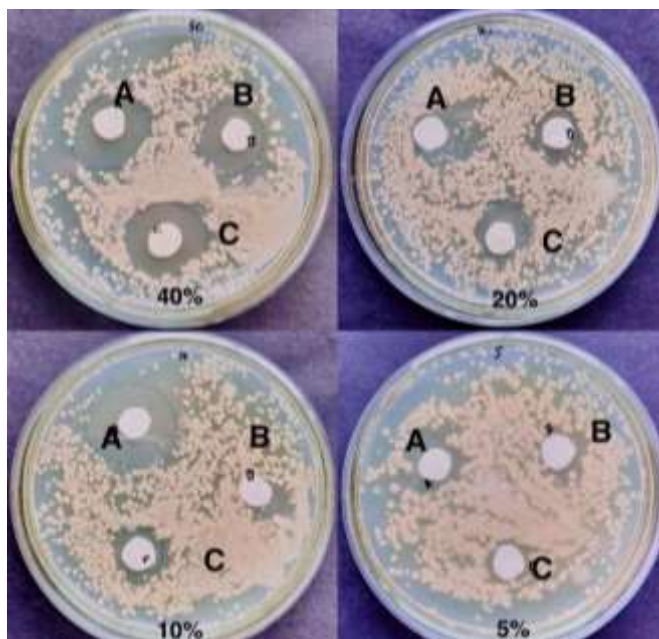


Wave no.(cm ⁻¹)	Functional group
3200-3600	OH
1700-1800	C=O
1600-1620	C=C
1000-1300	C-O

Antimicrobial Activity of Silve Nanoparticles: -

The antimicrobial activity of silver nanoparticles is reported to a large extent. The silver nanoparticles are synthesized and also show antimicrobial activity

against *S. aureus* bacteria. Silver nanoparticles were dissolved in aqueous extract having concentration of 600mg and antimicrobial activity was performed.



RESULT & DISCUSSION

Preliminary Test: -

Selection of the Herb: -

The plant selected was *Abutilon indicum*, commonly known as Atibala, belonging to the Malvaceae family. The leaves were used for their reported anti-microbial and anti-inflammatory properties.

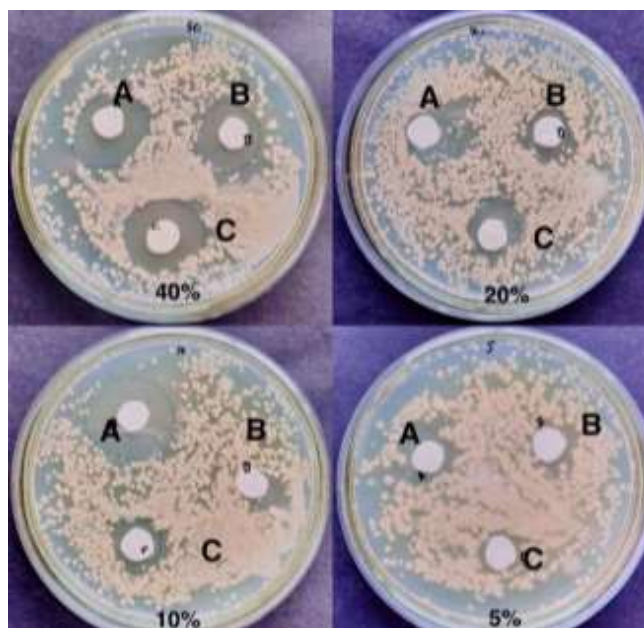
Phytochemical Investigation: -

Test	Observation
Alkaloids	Present
Amino acids	Present
Carbohydrates	Present
Flavonoids	Present
Phenolics compounds	Present
Tannins	Absent
Steroids	Absent
triterpenoids	Present
Saponins	Present

The phytochemical investigation revealed the presence of alkaloids, amino acids, carbohydrates, flavonoids, phenolics compounds, triterpenoids, and saponins. Tannins and steroids were absent.

Antimicrobial Activity of Silve Nanoparticles: -

Synthesized silver nanoparticles also exhibited antimicrobial activity against *Staphylococcus aureus* bacteria. Silver nanoparticles dissolved in aqueous extract at 600mg concentration showed an average zone of inhibition of 3.04 cm² and 3.17 cm².



The preliminary phytochemical screening of *Abutilon indicum* leaf extract confirmed the presence of key bioactive constituents including alkaloids, flavonoids, phenolics, carbohydrates, amino acids, triterpenoids, and saponins. These compounds are well-documented for their antimicrobial potential and played a vital role in the bioreduction process during the synthesis of silver nanoparticles. The aqueous extract yielded the highest percentage (25.6%), indicating superior solubility and extraction efficiency for polar compounds. Upon synthesis, the formation of silver nanoparticles was confirmed by the development of a reddish-brown color and a UV-Visible peak at 435 nm, indicative of surface plasmon resonance. FTIR analysis revealed functional groups such as OH, C=O, C=C, and C-O, suggesting involvement of polyphenolic and protein components in nanoparticle formation and stabilization. Antimicrobial studies demonstrated that silver nanoparticles synthesized using the aqueous extract exhibited enhanced inhibitory activity against *Staphylococcus aureus*, with zones of inhibition measuring 3.04 cm² and 3.17 cm² at 600 mg concentration. The particle size analysis showed nanoparticles averaging 106 nm in diameter, confirming the formation of nanosized particles with potent bioactivity.

CONCLUSION

This study successfully demonstrates that *Abutilon indicum* aqueous leaf extract can be effectively used for the green synthesis of silver nanoparticles. The

synthesized nanoparticles exhibited significant antimicrobial activity against *Staphylococcus aureus*, suggesting their potential application in the development of novel herbal-based antimicrobial agents. The presence of bioactive phytochemicals facilitated the reduction and stabilization of nanoparticles, indicating a synergistic effect between plant constituents and silver ions. This green synthesis approach offers a sustainable and biocompatible method for producing antimicrobial nanomaterials with possible relevance in pharmaceutical and biomedical fields. Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any Commercial or financial relationships that could be construed as a potential conflict of interest.

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