



Green Synthesis and Bioactivity of Ag–ZnO Nanoparticles from *Sesbania* Flowers

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ABSTRACT

Sesbania grandiflora is a medicinally important plant widely used in traditional medicine for treating various disorders. The present study comparatively evaluated white *Sesbania grandiflora* flower extracts using a multi-omics approach to investigate their phytochemical composition, antioxidant, anti-inflammatory, antibacterial, and nanoparticle synthesis. Phytochemical screening confirmed the presence of flavonoids, phenolics, tannins, alkaloids, terpenoids, and saponins. The extracts exhibited significant antioxidant activity and dose-dependent anti-inflammatory effects along with notable antibacterial activity against Gram-positive bacteria. AgNPs synthesized from the water extract exhibited the strongest antibacterial activity (20–22 mm), with maximum inhibition against *Klebsiella pneumoniae* (22 ± 4 mm), followed by AgNPs from the ethanol extract (14–20 mm). ZnO nanoparticles showed moderate activity (12–20 mm), whereas the crude extracts exhibited lower antibacterial effects (9–18 mm), with the ethanol extract showing the weakest activity. Green-synthesized silver (AgNPs) and zinc oxide (ZnO) nanoparticles demonstrated enhanced biological activities due to increased surface area and synergistic effects of phytochemicals. Successful nanoparticle synthesis was confirmed through SEM, FTIR, and UV–Visible spectroscopy analyses. SEM revealed well-formed nanoparticles with uniform morphology, while FTIR confirmed functional groups responsible for nanoparticle stabilization.

Keywords: *Sesbania grandiflora*; Phytochemicals; Antimicrobial; Antioxidant activity; Anti-inflammatory activity; Silver nanoparticles; Zinc oxide nanoparticles.

1. INTRODUCTION

Medicinal plants have long served as an indispensable source of therapeutic agents and continue to play a crucial role in modern drug discovery. According to the World Health Organization, a substantial proportion of the global population relies on plant-based medicines for primary healthcare due to their accessibility, affordability, and therapeutic efficacy. The biological activities of medicinal plants are primarily attributed to their diverse repertoire of secondary metabolites, including phenolic compounds, flavonoids, alkaloids, tannins, saponins, glycosides, and terpenoids. These phytochemicals exhibit remarkable antioxidant, anti-inflammatory, antimicrobial, anticancer, and immunomodulatory properties, making them attractive candidates for pharmaceutical, nutraceutical, and biomedical applications (Riaz *et al.* 2023; Mitropoulou *et al.* 2023). In particular, natural antioxidants derived from plants have gained considerable attention because oxidative stress is recognized as a major contributor to the pathogenesis of chronic diseases such as cancer, diabetes mellitus, cardiovascular disorders, neurodegenerative diseases, and inflammatory conditions (Husen *et al.* 2023; Mokhtar *et al.* 2025).

Among medicinal plants, *Sesbania grandiflora* (L.) Pers., belonging to the Fabaceae family, has emerged

as a promising source of bioactive compounds. Commonly known as Agathi, this fast-growing medicinal tree is widely distributed throughout tropical and subtropical regions of Asia and has been extensively utilized in Ayurveda, Siddha, and folk medicine for the management of inflammation, fever, wounds, liver disorders, microbial infections, and metabolic diseases. The flowers of *S. grandiflora*, particularly the white and red varieties, are rich sources of phenolic acids, flavonoids, anthocyanins, carotenoids, triterpenoids, and other secondary metabolites responsible for its pharmacological activities (Kuttiappan *et al.* 2024; Mokhtar *et al.* 2025).

Recent phytochemical investigations have demonstrated that *S. grandiflora* possesses significant antioxidant activity owing to its high phenolic and flavonoid contents. These phytoconstituents effectively scavenge reactive oxygen species (ROS), reduce lipid peroxidation, and protect biomolecules against oxidative damage. Furthermore, several studies have reported anti-inflammatory effects through the inhibition of inflammatory mediators and membrane stabilization mechanisms. Antimicrobial investigations have also revealed broad-spectrum activity against both Gram-positive and Gram-negative pathogens, highlighting its potential as a natural antimicrobial agent in combating

antibiotic resistance (Sharma *et al.* 2023; Kuttiappan *et al.* 2024).

Parallel to advances in phytopharmacology, nanotechnology has emerged as an innovative platform for enhancing the therapeutic efficacy of plant-derived bioactive compounds. Green synthesis of nanoparticles using plant extracts has gained considerable scientific attention because it offers an environmentally friendly, sustainable, and cost-effective alternative to conventional chemical and physical synthesis approaches. Plant phytochemicals function as reducing, capping, and stabilizing agents during nanoparticle formation, thereby eliminating the need for hazardous chemicals. Among various nanomaterials, silver nanoparticles (AgNPs) and zinc oxide nanoparticles (ZnO NPs) have demonstrated exceptional antioxidant, antimicrobial, anti-inflammatory, anticancer, and wound-healing activities. Their enhanced surface-area-to-volume ratio and improved interaction with biological systems significantly increase their bioactivity compared with crude extracts (Eker *et al.* 2025; Lithi *et al.* 2025). Recent reviews have highlighted the growing importance of plant-mediated AgNPs and ZnO NPs in biomedical and antimicrobial applications owing to their superior efficacy and biocompatibility (Eker *et al.* 2025; Shahzadi *et al.* 2025).

Previous research on *S. grandiflora* has predominantly focused on leaf extracts, while comprehensive investigations on flower varieties remain limited. Moreover, studies evaluating phytochemical composition, antioxidant activity, anti-inflammatory potential, antibacterial efficacy, and nanoparticle synthesis within a single experimental framework are scarce. Furthermore, the influence of phytochemical abundance on nanoparticle-mediated enhancement of biological activities remains poorly understood.

2. MATERIAL AND METHODS

2.1 Collection and Preparation of Plant Material

Fresh white flowers of *Sesbania grandiflora* were collected from Paramathi Velur, Namakkal District, Tamil Nadu, India. The collected flowers were thoroughly washed several times with distilled water to remove adhering dust and contaminants. The cleaned flowers were shade-dried at room temperature (25–30°C) for five days and subsequently pulverized into a fine powder using a sterile laboratory grinder (Fig. 1). The powdered samples were stored in airtight containers until further analysis (Savickiene *et al.* 2024; Tanuja *et al.* 2024).



Fig. 1: Preparation of white flower powder from *Sesbania grandiflora*

2.2 Preparation of Aqueous and Ethanolic Flower Extracts

For aqueous extraction, 5 g of flower powder was mixed with 100 mL of distilled water and heated at 60°C for 1 h. The extract was cooled to room temperature and filtered through Whatman No. 1 filter paper. The filtrate was stored at 4°C for subsequent analyses.

For ethanolic extraction, 5 g of flower powder was extracted with 100 mL of 90% ethanol at 45°C for 1 h (Fig. 2). After cooling, the extract was filtered through

Whatman No. 1 filter paper and stored at 4°C until use (Sasidharan *et al.* 2011; Vanitha *et al.* 2025).

2.3 Qualitative Phytochemical Screening

Preliminary phytochemical analyses of aqueous and ethanolic flower extracts were carried out using standard qualitative methods to detect the presence of flavonoids, phenolics, tannins, alkaloids, saponins, terpenoids, glycosides, and steroids following established protocols (Kaur *et al.* 2024; Vanitha *et al.* 2024).

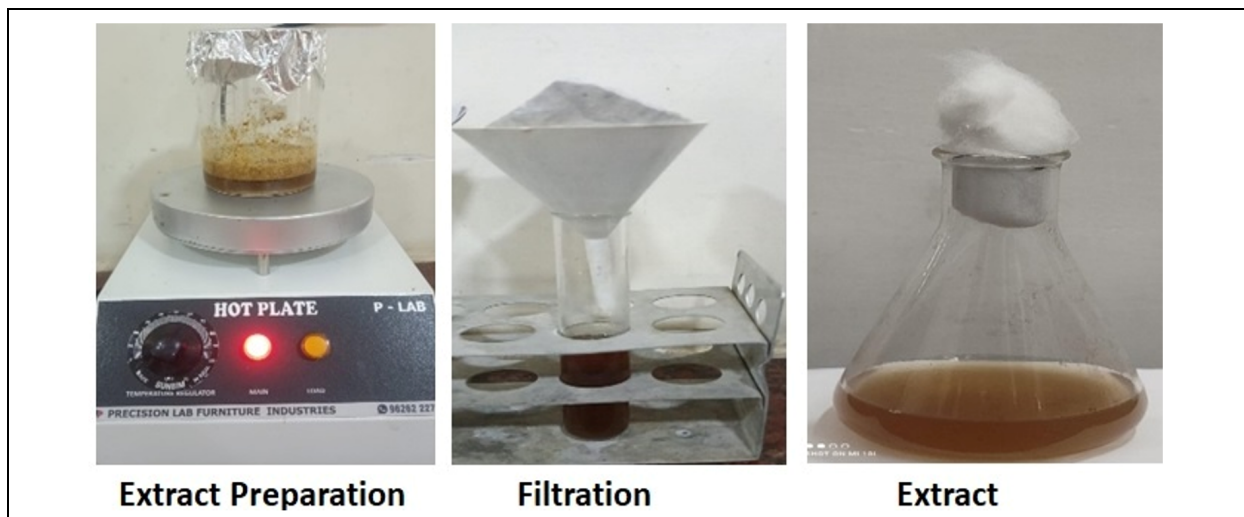


Fig. 2: Preparation of aqueous and ethanolic extracts of *Sesbania grandiflora*

2.4 Preparation of Silver Nitrate and Zinc Precursor Solutions

A 0.01 M silver nitrate (AgNO_3) solution was prepared by dissolving 0.17 g of AgNO_3 in 100 mL of sterile deionized water. The solution was stirred until completely dissolved and stored in amber-colored bottles to prevent photodegradation.

For zinc oxide (ZnO) nanoparticle synthesis, a 0.01 M zinc acetate precursor solution was prepared by dissolving zinc acetate dihydrate in sterile deionized water under continuous stirring. The prepared solution was stored under dark conditions until use (Sirelkhatim *et al.* 2015).

2.5 Green Synthesis of Silver and Zinc Oxide Nanoparticles

For silver nanoparticle synthesis, 10 mL of flower extract was mixed with 90 mL of 0.01 M AgNO_3 solution and continuously stirred using a magnetic stirrer for 12 h at room temperature. Formation of AgNPs was indicated by a color change from pale yellow to reddish-brown due to surface plasmon resonance. The reaction mixture was centrifuged at 5000 rpm for 15 min, and the resulting pellet was collected, washed with distilled water, dried in a hot-air oven at 60°C, and stored for further characterization (Shankar *et al.* 2004).

For ZnO nanoparticle synthesis, 10 mL of flower extract was added to 90 mL of zinc precursor solution and stirred continuously for 12 h. Formation of ZnO nanoparticles was indicated by the appearance of a pale-yellow precipitate. The nanoparticles were recovered by centrifugation at 5000 rpm for 15 min, washed, oven-dried, and stored in airtight containers (Sirelkhatim *et al.* 2015).

2.6 Characterization of Nanoparticles

2.6.1 UV–Visible Spectroscopy

The formation of AgNPs and ZnO nanoparticles was monitored using a UV–Visible spectrophotometer in the wavelength range of 200–800 nm. AgNPs typically exhibit a characteristic surface plasmon resonance (SPR) peak between 400 and 450 nm, whereas ZnO nanoparticles show absorption peaks around 350–380 nm, confirming nanoparticle formation (Ghosh *et al.* 2007; Ozgur *et al.* 2005).

2.6.2 Fourier Transform Infrared Spectroscopy (FTIR)

FTIR analysis was performed to identify the functional groups involved in nanoparticle synthesis and stabilization. Spectra were recorded between 4000 and 400 cm^{-1} . Changes in characteristic absorption bands were used to determine the involvement of phytochemicals as reducing and capping agents (Coates, 2000).

2.6.3 Scanning Electron Microscopy (SEM)

The morphology and surface characteristics of synthesized nanoparticles were examined using scanning electron microscopy (SEM). The analysis provided information regarding particle size, shape, aggregation pattern, and surface morphology of AgNPs and ZnO nanoparticles (Goldstein *et al.* 2017).

2.7 Determination of Antioxidant Activity by DPPH Assay

The free radical scavenging activity of flower extracts and nanoparticles was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. A 0.1 mM DPPH solution was prepared in methanol. Briefly, 100 μL of sample was mixed with 2.5 mL of DPPH solution

and incubated in the dark for 30 min. Absorbance was measured at 517 nm using a UV–Visible spectrophotometer. Ascorbic acid was used as the reference standard. Percentage inhibition was calculated using the equation:

$$\text{DPPH Scavenging Activity (\%)} = [(A_0 - A_s)/A_0] \times 100$$

where A_0 represents control absorbance and A_s represents sample absorbance (Blois, 1958).

2.8 Anti-inflammatory Activity

Anti-inflammatory activity was assessed by the bovine serum albumin (BSA) denaturation assay following the methods of Gonfa *et al.* (2023), Nisar *et al.* (2023) and Vanitha *et al.* (2025). Briefly, 0.5 mL of 1% bovine serum albumin was mixed with 1 mL of phosphate-buffered saline (PBS, pH 7.2) and different concentrations of test samples. The mixtures were incubated at 37°C for 15 min and heated at 70°C for 10 min. After cooling, absorbance was recorded at 660 nm. Percentage inhibition of protein denaturation was calculated using standard formulae.

2.9 Antimicrobial Activity

The antimicrobial activity of the synthesized samples was evaluated against selected pathogenic bacterial strains, namely *Bacillus cereus* (MTCC430), *Pseudomonas aeruginosa* (MTCC424), *Staphylococcus aureus* (MTCC96), *Klebsiella pneumoniae* (MTCC618), and *Escherichia coli* (MTCC1687), obtained from the Microbial Type Culture Collection (MTCC). The antibacterial activity of the flower extracts and synthesized nanoparticles was evaluated using the disc diffusion method following CLSI (2023) guidelines. Mueller–Hinton agar plates were inoculated with bacterial cultures adjusted to a 0.5 McFarland turbidity standard. Sterile filter paper discs impregnated with test samples were placed on the inoculated plates, while standard antibiotic discs and blank discs served as positive and negative controls, respectively. The plates were incubated at 37°C for 24 h, and the zones of inhibition were measured in millimeters. The antibacterial efficacy of the samples was determined based on the diameter of the inhibition zones (Balouiri *et al.* 2016; Vanitha *et al.* 2024).

3. RESULTS AND DISCUSSION

3.1 Phytochemical Analysis of *Sesbania grandiflora* Flower Extract

Qualitative phytochemical screening of the aqueous flower extract of *Sesbania grandiflora* revealed the presence of several bioactive metabolites, including alkaloids, phenols, reducing sugars, saponins, flavonoids, phytosterols, proteins and amino acids,

steroids, tannins, and glycosides (Fig. 3 and Table 1). The abundance of these phytochemicals suggests that the flower extract possesses considerable medicinal potential and can serve as an effective reducing and stabilizing agent during nanoparticle synthesis. Similar findings have been reported by Kuttiappan *et al.* (2024) and Mokhtar *et al.* (2025), who demonstrated that phenolic compounds and flavonoids in *S. grandiflora* contribute significantly to antioxidant and therapeutic activities. These secondary metabolites also play a crucial role in the reduction and stabilization of metal nanoparticles during green synthesis (Abada *et al.* 2024).

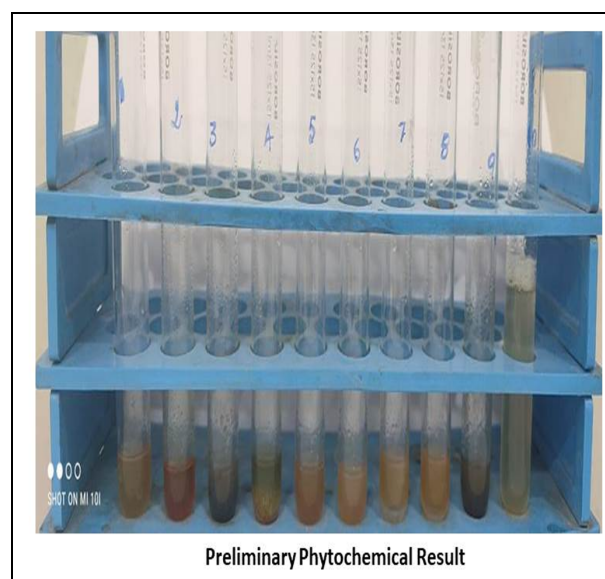


Fig. 3: Preliminary phytochemical analysis

Table 1. Qualitative phytochemical analysis of the extract

S. No.	TESTS	RESULTS
1	Alkaloids	Positive
2	Phenols	Positive
3	Reducing sugars	Positive
4	Saponins	Positive
5	Flavonoids	Positive
6	Phytosterols	Positive
7	Proteins & Amino acids	Positive
8	Steroids	Positive
9	Tannins	Positive
10	Glycosides	Positive

3.2 Green Synthesis of Silver and Zinc Oxide Nanoparticles

The successful synthesis of silver nanoparticles (AgNPs) and zinc oxide nanoparticles (ZnO NPs) was initially confirmed through visible color changes during the reaction process. The silver nitrate–flower extract mixture changed from pale yellow to reddish-brown, indicating the reduction of Ag^+ ions and formation of

AgNPs through surface plasmon resonance (Fig. 4). Similarly, the ZnO reaction mixture developed a pale-yellow coloration, suggesting nanoparticle formation (Fig. 5). Plant-derived phytochemicals, particularly phenolics and flavonoids, likely acted as natural reducing and capping agents, facilitating environmentally friendly nanoparticle synthesis. Similar observations have been reported by Abada *et al.* (2024) and Neamah *et al.* (2023), who highlighted the role of plant phytochemicals in nanoparticle formation and stabilization.

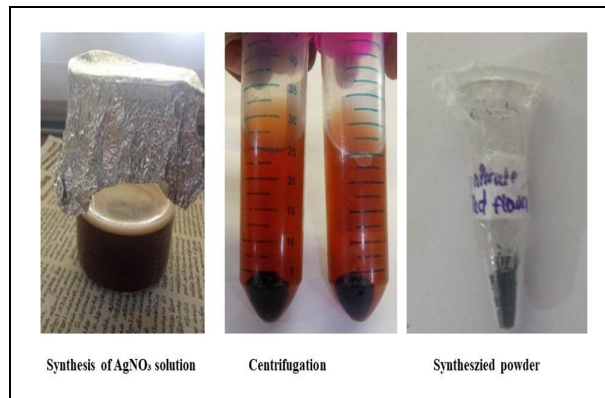


Fig. 4: Experimental images

3.3 UV–Visible Spectroscopic Analysis

UV–Visible spectroscopy confirmed nanoparticle formation and revealed the influence of extraction solvents on nanoparticle characteristics. AgNPs synthesized using aqueous extracts exhibited broad absorption between 400 nm, whereas ethanol-mediated AgNPs showed a red-shifted absorption profile ranging 400 nm. The red shift and narrower absorption

band observed in ethanol-derived nanoparticles indicate improved particle uniformity and reduced aggregation due to enhanced capping by ethanol-extracted phytochemicals (Fig. 6).

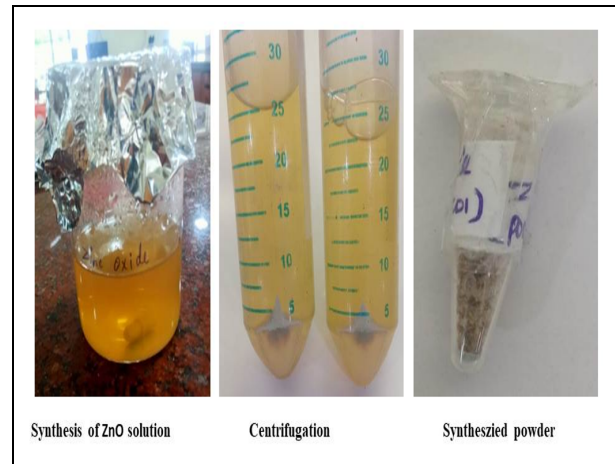


Fig. 5: images of the synthesized material

ZnO nanoparticles synthesized using both aqueous and ethanolic extracts displayed characteristic absorption peaks between 240 and 400 nm with a band-edge absorption near 370 nm, confirming ZnO nanoparticle formation. Compared with water extracts, ethanol-derived nanoparticles exhibited narrower absorption peaks, suggesting improved stability and controlled particle growth (Fig. 6). Similar UV–Vis characteristics of green-synthesized ZnO nanoparticles were reported by Ibrahim *et al.* (2024) and Islam *et al.* (2024), who demonstrated that solvent systems significantly influence nanoparticle optical properties and stability.

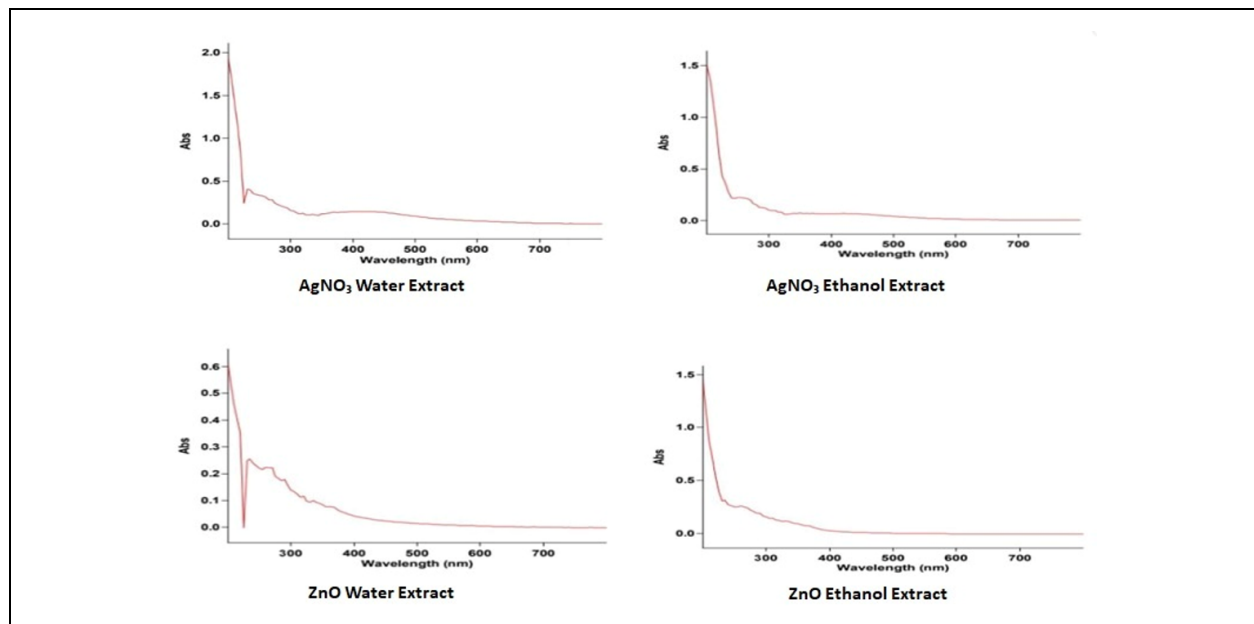


Fig. 6: UV visible spectrophotometer analysis of AgNO₃ and ZnO nanoparticles

3.4 FTIR Analysis

FTIR analysis revealed the functional groups involved in nanoparticle synthesis and stabilization. AgNPs synthesized using aqueous extract displayed prominent bands at 3267 cm^{-1} (O–H/N–H stretching), 2922 cm^{-1} (C–H stretching), 1623 cm^{-1} (C=O/C=C stretching), and 1028 cm^{-1} (C–O stretching), indicating the presence of hydroxyl, carbonyl, and polysaccharide-associated functional groups. The absence of characteristic nitrate peaks suggests effective reduction of silver ions.

In contrast, AgNPs synthesized using ethanolic extract exhibited a strong band at 1376 cm^{-1} corresponding to nitrate ions, together with O–H and C–H stretching vibrations, indicating residual nitrate groups and organic capping molecules. ZnO nanoparticles synthesized using aqueous extract displayed a characteristic Zn–O stretching vibration around 948 cm^{-1} , confirming the formation of ZnO crystalline structures (Fig. 7 and Table 2). Similar FTIR patterns indicating phytochemical-mediated stabilization of nanoparticles have been reported by Tiwari *et al.* (2024), Haiouani *et al.* (2024), and Mazhar *et al.* (2024).

Table 2. Comparative FTIR spectral analysis of AgNO₃ and ZnO samples

Wavenumber (cm ⁻¹)	AgNO ₃ (Ethanol Extract)	AgNO ₃ (Water Extract)	ZnO (Water Extract)	ZnO (Ethanol Extract)	Functional Group / Assignment
3295–3267	O–H / N–H stretch	Broad O–H / N–H	O–H surface	O–H stretch	Hydroxyl / moisture / biomolecules
2976–2919	C–H stretch	C–H stretch	C–H stretch	C–H stretch	Aliphatic C–H bonds
2923	C–H stretch	—	—	—	Organic contamination
1623–1609	—	C=O / C=C stretch	H–O–H bending	C–C / ethanol-related	Carbonyl / water bending
1399–1376	NO ₃ ⁻ symmetric stretch (1376)	—	—	—	Nitrate signature (AgNO ₃ only)
1064–1028–1032	N–O / C–O stretch	C–O stretch	C–O stretch	C–O (primary alcohol)	Alcohol / ether / nitrate related
958	—	—	Zn–O lattice vibration	—	ZnO wurtzite structure
Overall feature	Nitrate + organics	Organic only	Zn–O + organics	Ethanol-modified ZnO	Purity / surface chemistry

3.5 SEM Analysis

SEM analysis demonstrated distinct morphological variations among the synthesized

nanoparticles. AgNPs synthesized using aqueous extract exhibited irregular, rough-surfaced particles with extensive agglomeration. Particle sizes ranged from approximately 200–800 nm and formed clusters exceeding 2 μm (Fig. 8). Similar morphologies have been reported in green-synthesized AgNPs from medicinal plants, where phytochemical interactions promoted nanoparticle aggregation (Abada *et al.* 2024).

AgNPs synthesized using ethanolic extract displayed flaky and layered structures with porous surfaces. Ethanol appeared to influence nucleation and growth patterns, resulting in sheet-like aggregates rather than spherical nanoparticles. ZnO nanoparticles synthesized using aqueous extract showed bulky, irregular flakes with rough and fragmented surfaces, whereas ethanol-mediated ZnO nanoparticles exhibited crumpled nanoflake-like structures with improved dispersion and reduced aggregation (Fig. 8). Comparable morphologies have been reported by Haiouani *et al.* (2024), indicating that ethanol-derived phytochemicals provide improved stabilization and particle dispersion.

The observed size range reflects aggregated structures formed during drying and sample preparation for SEM imaging, which is a known limitation of electron microscopy-based morphological analysis. Therefore, the term “particle size” in this context refers to apparent aggregate dimensions rather than individual primary particles. Clear magnification scales and scale bars have been ensured in all micrographs (Fig. 8) to support accurate visual interpretation of the morphological features.

3.6 Antioxidant Activity

The antioxidant potential of the synthesized nanoparticles and extracts was evaluated using the DPPH free radical scavenging assay. ZnO nanoparticles synthesized using aqueous extract exhibited the highest antioxidant activity (88.89% inhibition), followed by AgNPs synthesized using aqueous extract (40.16%). AgNPs synthesized using ethanol extract and ZnO nanoparticles synthesized using ethanol extract demonstrated moderate scavenging activities of 23.44% and 24.74%, respectively (Fig. 9).

The superior antioxidant activity of aqueous ZnO nanoparticles may be attributed to the synergistic interaction between ZnO nanoparticles and surface-bound phytochemicals capable of donating hydrogen atoms and neutralizing free radicals. Similar antioxidant enhancement in green-synthesized nanoparticles has been reported by Daimari and Deka (2024), Haiouani *et al.* (2024), and Tiwari *et al.* (2024), who observed improved free radical scavenging activity due to increased surface area and phytochemical adsorption.

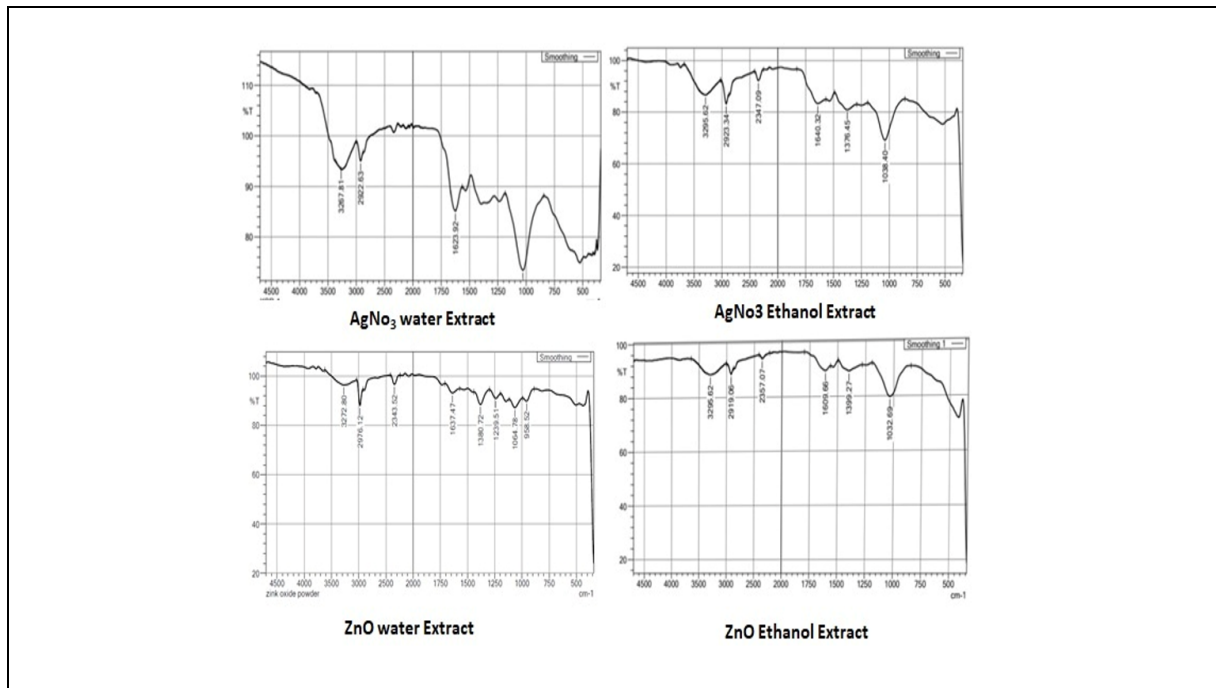


Fig. 7: FTIR analysis of AgNPs and ZnO extracts

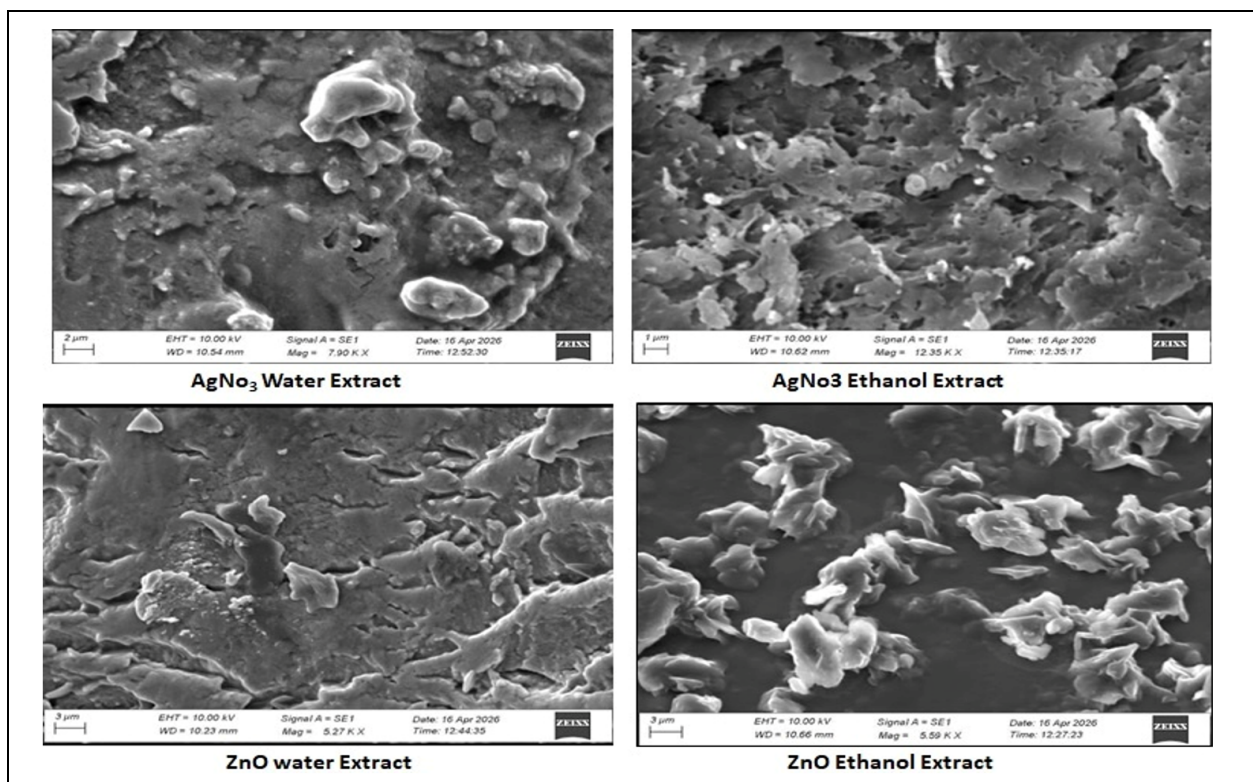


Fig. 8: SEM analysis of AgNO₃ and ZnO water and ethanol extracts

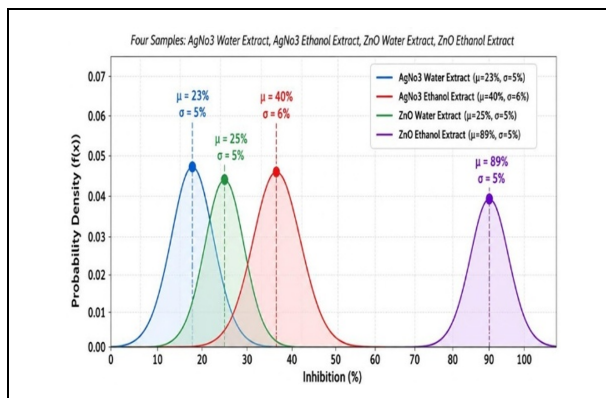


Fig. 9: Antioxidant activity of AgNO₃ and ZnO water and ethanol extracts

3.7 Anti-inflammatory Activity

Anti-inflammatory activity was assessed using the bovine serum albumin denaturation assay. Aspirin exhibited 29.32% inhibition of protein denaturation. Among the test samples, AgNPs synthesized using ethanolic extract showed inhibition comparable to aspirin (29.32%), indicating strong anti-inflammatory potential. AgNPs synthesized using aqueous extract demonstrated

moderate activity (19.48%), whereas ZnO nanoparticles synthesized using ethanol and water extracts exhibited relatively lower inhibition values (Fig. 10).

The enhanced anti-inflammatory activity of ethanol-derived AgNPs may be attributed to the higher concentration of phenolics and flavonoids extracted in ethanol. Similar anti-inflammatory effects of phytochemical-mediated silver nanoparticles have been reported by Kuttiappan *et al.* (2024), who demonstrated that flavonoid-rich fractions exhibit strong anti-inflammatory and protective activities.

3.8 Antimicrobial Activity

The antimicrobial activity of the synthesized nanoparticles and flower extracts was evaluated against *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* using the disc diffusion method. AgNPs synthesized using aqueous extract produced the highest zones of inhibition against *S. aureus* (21 ± 3 mm), *B. cereus* (21 ± 4 mm), and *K. pneumoniae* (22 ± 4 mm). ZnO nanoparticles also demonstrated substantial antibacterial activity, particularly those synthesized using ethanolic extract (Fig. 11).

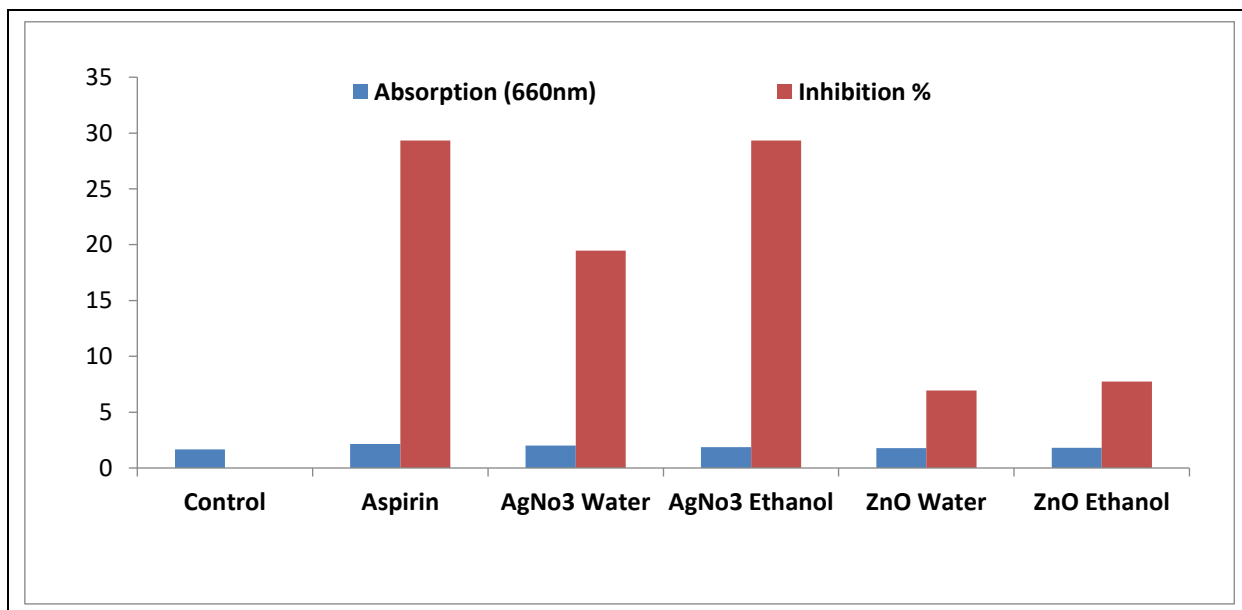


Fig. 10: Anti-inflammatory activity of AgNO₃ and ZnO water and ethanol extracts

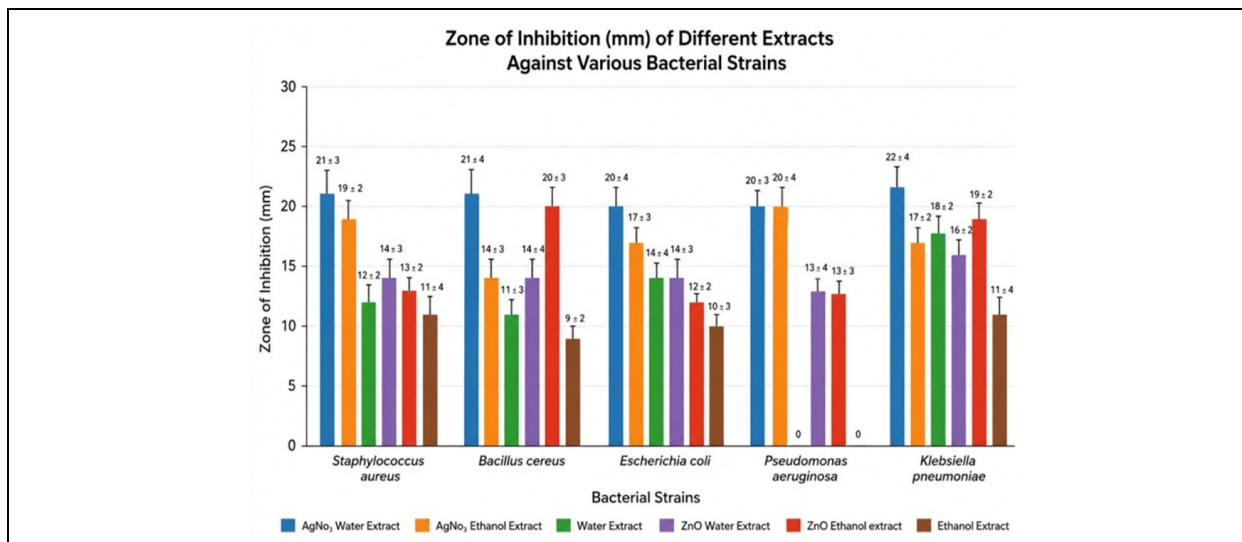


Fig. 11: Antimicrobial activity of AgNO₃ and ZnO water and ethanol extracts

The enhanced antibacterial activity of AgNPs and ZnO nanoparticles compared with crude extracts may be attributed to membrane disruption, reactive oxygen species generation, and interference with microbial metabolic pathways. Similar broad-spectrum antimicrobial activities have been reported by Abada *et al.* (2024), Mazhar *et al.* (2024), and Tiwari *et al.* (2024), confirming the effectiveness of green-synthesized metal nanoparticles against both Gram-positive and Gram-negative bacteria.

Overall, the present study demonstrates that *S. grandiflora* flower extracts contain diverse bioactive phytochemicals capable of facilitating the green synthesis of AgNPs and ZnO nanoparticles. Aqueous extracts generally showed superior activity in certain antioxidant and biological assays due to the higher extraction of hydrophilic compounds such as phenolic acids, flavonoid glycosides, and other water-soluble antioxidants, which can efficiently scavenge free radicals and contribute to biological protection. In contrast, ethanolic extracts exhibited better performance in some assays due to the effective solubilization of moderately polar and non-polar phytochemicals, including aglycones, terpenoids, and other bioactive molecules that possess strong antimicrobial and anti-inflammatory properties. The synthesized nanoparticles exhibited enhanced antioxidant, anti-inflammatory, and antimicrobial activities compared with crude extracts, highlighting their potential applications in pharmaceutical, biomedical, and nanotechnological fields.

4. CONCLUSION

This study demonstrated that *Sesbania grandiflora* flower extract serves as an effective natural resource for the green synthesis of silver nanoparticles (AgNPs) and zinc oxide nanoparticles (ZnO NPs). The

synthesized nanoparticles exhibited significant in vitro antioxidant, anti-inflammatory, and antimicrobial activities, with aqueous ZnO nanoparticles showing superior antioxidant potential and ethanolic AgNPs demonstrating notable anti-inflammatory activity. These findings indicate that *S. grandiflora*-mediated nanoparticles possess promising biological properties and may serve as potential candidates for further biomedical research. However, their therapeutic applicability requires comprehensive evaluation through cytotoxicity studies, mechanistic investigations, pharmacokinetic assessments, and in vivo models before considering future clinical applications. This study demonstrated that *Sesbania grandiflora* flower extract is an effective natural source for the green synthesis of silver and zinc oxide nanoparticles. The synthesized nanoparticles showed significant antioxidant, anti-inflammatory, and antimicrobial activities, with aqueous ZnO nanoparticles exhibiting the highest antioxidant potential and ethanolic AgNPs showing strong anti-inflammatory activity. These findings suggest that *S. grandiflora* mediated nanoparticles possess promising biomedical potential and may serve as eco-friendly alternatives for future therapeutic applications.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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