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IN VITRO STUDY OF THE ANTIBACTERIAL AND ANTI-INFLAMMATORY ACTIVITY OF *THESPESIA POPULNEA* EXTRACT USING SILVER NANOPARTICLES

Krishna Verma [1], Lavanya Prathap [2]*, Taniya M [3] and Sangeetha S [4]

[1,2,3,4] Department of Anatomy, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical sciences (SIMATS), Saveetha University, 600077, Chennai, Tamil Nadu, India.
*Corresponding Author: lavanyap.sdc@saveetha.com

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Abstract

Medicinal plants have been historically utilized for their therapeutic properties, particularly in wound healing and combating infections. This study explores the antibacterial potential of *Thespesia populnea*, a member of the Malvaceae family, in combination with silver nanoparticles—a material gaining prominence in medical applications. The extract of Thespesia was synthesized with silver nanoparticles through a chemical reaction followed by calcination. The antibacterial activity was evaluated using the agar well diffusion method. Results, including SEM, FTIR, and XRD analyses, demonstrated the enhanced antibacterial efficacy of the Thespesia extract when combined with silver nanoparticles. The study highlights the synergistic effect of phytochemicals present in Thespesia extract and silver nanoparticles in combating bacterial growth. This innovative approach holds promise for advancements in wound healing and infection control. Further research could explore its potential in animal models to assess its suitability for broader medical applications. This study contributes to the ongoing discourse on leveraging natural resources and nanotechnology for public health and well-being.

Keywords: Public Health, Well-Being, İnnovation, *Thespesia Populnea*, XRD, FTIR, Antibacterial Activity.

INTRODUCTION

Since ancient times, medicinal plants have been a cornerstone of healthcare, offering safe and natural remedies for a myriad of ailments. Their use spans cultures and civilizations, with bioactive compounds found within these plants holding therapeutic potential for various health issues (Zou et al., 2023). Among these botanical treasures is *Thespesia populnea*, a flowering tree belonging to the Malvaceae family, commonly known as the Indian tulip tree. Found along coastlines globally, this versatile tree has been extensively utilized in traditional medicine for its wide array of medicinal properties (Ali et al., 2020; Bjørklund et al., 2023). The various parts of *Thespesia populnea*, including its bark, roots, flowers, leaves, and seeds, have been employed in traditional medicinal practices to treat ailments ranging from rheumatism to cholera (Bjørklund et al., 2023). Its rich phytochemical composition has garnered interest for its potential therapeutic applications. In particular, its bark has shown promise in enhancing memory in animal studies, suggesting its potential utility in treating neurodegenerative diseases In recent years, the field of nanotechnology has revolutionized medicine, offering novel approaches to diagnosis, treatment, and prevention of diseases. Among the nanomaterials gaining attention are silver nanoparticles (AgNPs), renowned for their antimicrobial properties (Kumaresan, Suganthirababu et al. 2022).The physicochemical properties of AgNPs play a crucial role in their biocidal action, making them attractive candidates for various medical applications (C et al., 2023)(BABU and MOHANRAJ 2020).

Silver compounds have a long history of use in medicine, dating back thousands of years for the treatment of bacterial infections, burns, and wounds (Dax, 2012; Pereira

et al., 2023). However, with the rise of antibiotic resistance, there has been a resurgence of interest in silver nanoparticles as potential antibacterial agents(Varshan and Prathap 2022). Nanotechnology has enabled the transformation of silver nanoparticles into diverse medical products, including dressings, nanogels, and nanolotions, offering promising alternatives to conventional antibiotics (Ali et al., 2020)(Palaniappan, Mohanraj et al. 2021)The efficacy of silver nanoparticles in medical applications depends on various factors, including their size, shape, and surface treatments, emphasizing the importance of controlled synthesis for physiological relevance(Prathap and Lakshmanan 2022). This interdisciplinary approach intersects chemistry, biology, and medicine, paving the way for innovative solutions to healthcare challenges. This introduction sets the stage for exploring the potential synergies between *Thespesia populnea* and silver nanoparticles in addressing health issues. By integrating traditional medicinal knowledge with cutting-edge nanotechnology, novel therapeutic interventions can be developed to meet the evolving healthcare needs of society. In this context, investigating the medicinal value of *Thespesia populnea*bark in treating neurodegenerative diseases emerges as a promising avenue for future research (Chockalingam, Sasanka et al. 2020).

Historical Significance: The historical use of medicinal plants and silver compounds in traditional medicine had laid the foundation for exploring their therapeutic potential in modern healthcare(Wangkheirakpam 2018). This historical context provided valuable insights into the safety and efficacy of these natural remedies.

Cultural Heritage: The utilization of *Thespesia populnea* and silver nanoparticles in traditional medicine reflected a rich cultural heritage, with indigenous communities passing down knowledge of plant-based remedies through generations(Jayasri, Prasad et al. 2023).

Advancements in Nanotechnology: The rapid advancements in nanotechnology had opened new avenues for medical research and innovation. The ability to engineer silver nanoparticles with precise physicochemical properties had revolutionized their applications in healthcare(Navya and Daima 2016).

Potential Therapeutic Applications: Beyond antimicrobial properties, silver nanoparticles had shown promise in various therapeutic areas, including wound healing, cancer therapy, and drug delivery(Zivic, Grujovic et al. 2018). Their multifunctional nature had sparked interest in exploring diverse medical applications.

Interdisciplinary Collaboration: The interdisciplinary nature of research involving medicinal plants and nanotechnology had fostered collaboration between scientists, clinicians, and traditional healers. This collaborative approach had facilitated the translation of scientific discoveries into tangible healthcare solutions.

Ethnopharmacological Insights: Ethnopharmacological studies had provided valuable insights into the traditional uses of *Thespesia populnea* and other medicinal plants(Chumbhale, Pawase et al. 2010). Understanding the cultural context of plant-based medicine had contributed to the identification of novel therapeutic targets and drug discovery.

Future Directions: Despite significant progress, there remained untapped potential in harnessing the synergies between traditional medicine and modern technologies. Future research endeavors could explore novel formulations, extraction techniques, and therapeutic modalities to optimize the efficacy and safety of plant-based remedies

and nanomaterials. These additional points offer further depth and context to the introduction, highlighting the multifaceted nature of research in medicinal plants and nanotechnology.

MATERIALS AND METHODS

20 mL of the Thespesia extract was added to 20 g of silver nitrate solution to synthesize Silver nanoparticles. This reaction solution was kept for 3 hr to synthesize silver nanoparticles. To obtain the dried precipitate, the solution was placed in a 100°C oven for 5 hours (Ali et al., 2020; C et al., 2023). Further, the precipitated silver nitrate NPs were calcined at 500°C for 3 h. Antimicrobial activity was measured with the agar-well diffusion method (C et al., 2023; Zahran et al., 2023).

Protein Denaturation Assay

The albumin denaturation inhibition assay was carried out as described by Khanna et al (Khanna et al. 2023). The reaction mixture contains a range of sample quantities (100-500 g/ml), 1% aqueous solution albumin fraction, and 1N HCl to change the pH. The reaction mixture underwent a 20-minute incubation at 37 °C, a 20-minute heating stage at 51 °C, and a 20-minute cooling stage at room temperature. The mixture's absorbance at 660 nm was measured using a spectrophotometer, and the following formula was used to calculate the activity while using aspirin as a reference.

$$\text{Protein inhibition (\%)} = (\text{Abs Control} - \text{Abs Sample}) / (\text{Abs Sample}) \times 100$$

RESULTS:

The phytochemical test showed the different types of chemicals present in the extract.

Flavonoids, phenolic compounds, saponins, oil and fat, protein and amino acids, tannins, carbohydrates, and alkaloids are found in the Thespesia extract.

Table 1: Qualitative phytochemical analysis of *Thespesia populnea*extract.

S.No	Phytochemical Analysis	Citrus peel extract
1	Flavonoids	Present
2	Phenolic compounds	Present
3	Saponins	Absent
4	Oil and Fat	Absent
5	Protein & Amino acid	Present
6	Tannins	Present
7	Carbohydrates	Present
8	Alkaloids	Present

Anti-inflammatory activity

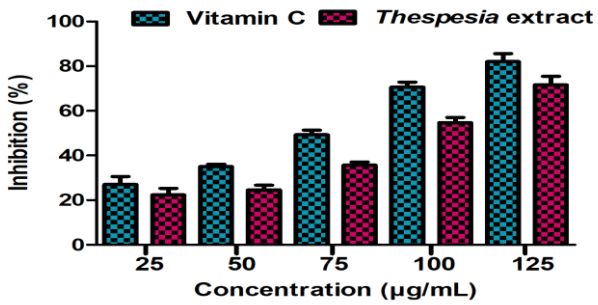


Figure 1: Anti-inflammatory activity of *Thespesia populnea*extract.

The anti-inflammatory activity of green synthesized silver nanoparticles from *Thespesia populnea*extract has been investigated by the inhibition of albumin denaturation activity.

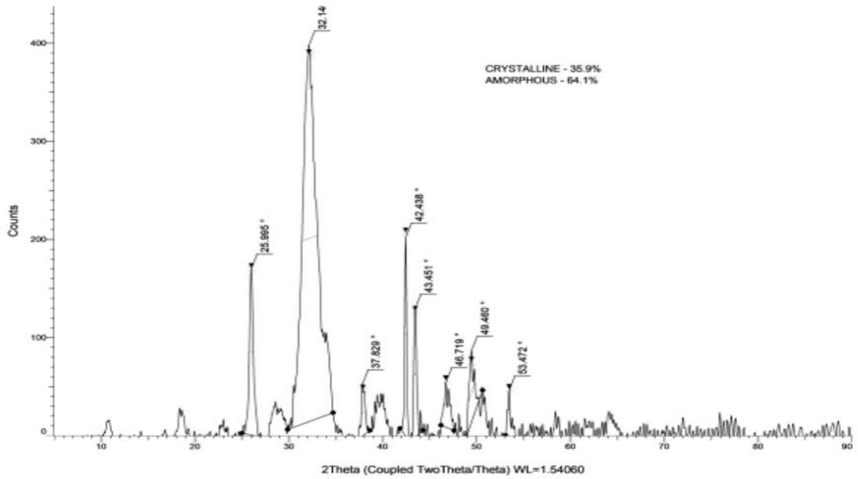


Figure 2: XRD-pattern of Silver Nanoparticles of *Thespesia populnea*Extract

Figure 1 represents the XRD pattern of silver nanoparticles in *Thespesia populnea*extract. well-defined diffraction peaks at 25°, 32.4°, 38.2°, 42.3°, 44.5°, 46.1°, 49.14°, and 53.27°, respectively.

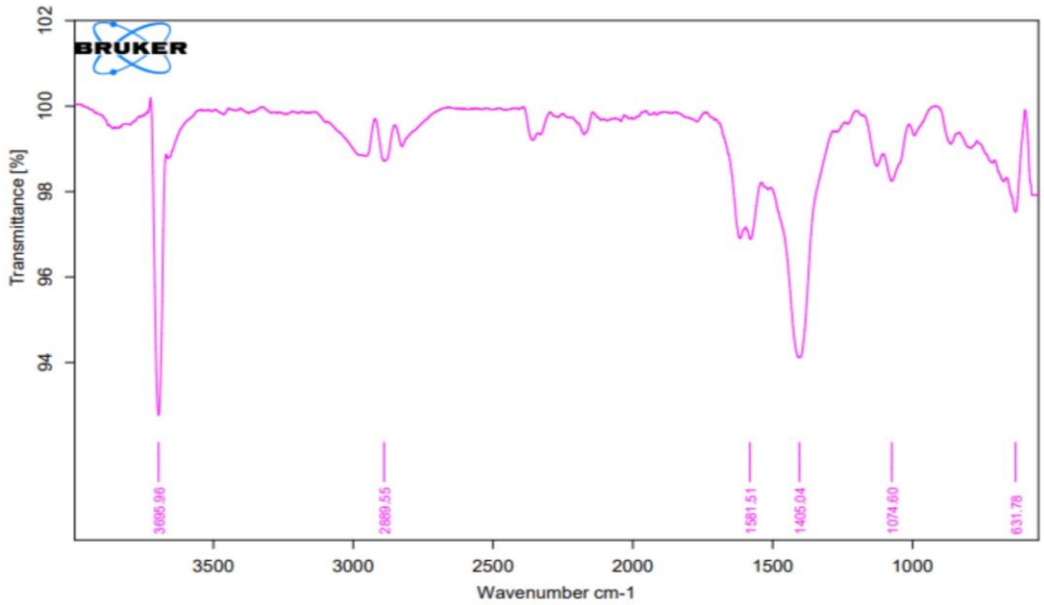


Figure 3: FTIR-pattern of Silver Nanoparticles of *Thespesia populnea*extract

The nanoparticles were capped with FTIR, which was used to check for putative bioactive substances. Typically, the reduction process in bark extract would cause the phytochemical components to serve as a capping agent (Shukla & Iravani, 2018). The FTIR showed the different functional groups present in the extract. In this investigation, the bioactive chemicals that were capping the nanoparticles were visible in the peaks.

FTIR results showed 3695.96, 2889.55, 1581.51, 1405.04, 1074.60, and 631.78 cm-1.

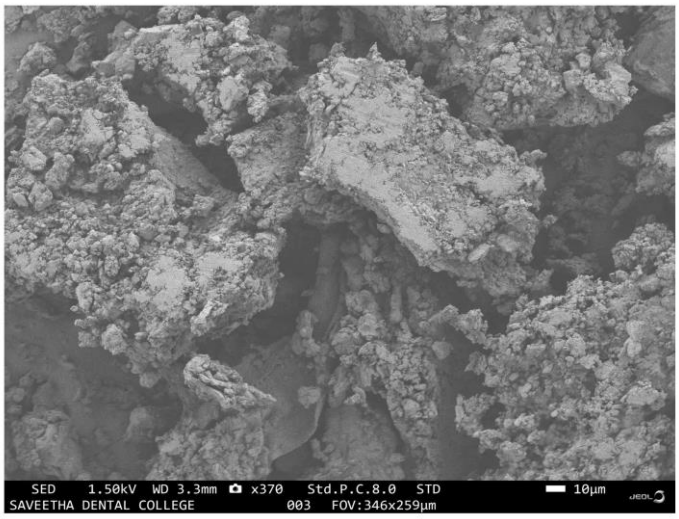
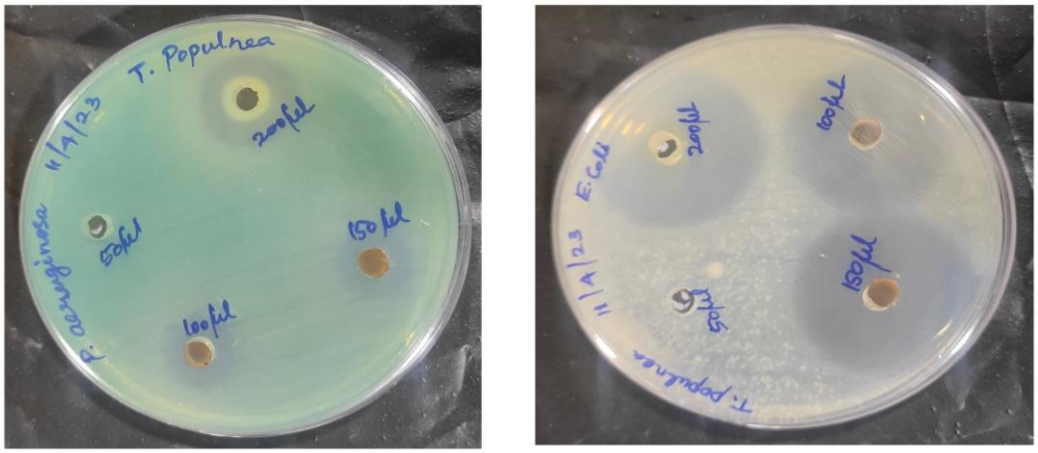


Figure 4: SEM analysis of Silver Nanoparticles of *Thespesia populnea*extract

Scanning electron microscopy shows us the surface structures, i.e., the morphology of the surface. Scanning electron microscope evaluation has been used to determine the size and morphology of silver nanoparticles. SEM examination with an average size of 35.4 nm for silver nanoparticles.



S.No	Micro organisms	Zone of Inhibition			
		50 µL	100 µL	150 µL	200 µL
1	P. aeruginosa	-	5 mm	7 mm	9 mm
2	E.Coli	-	11 mm	18 mm	21 mm

Figure 5: Antibacterial activity of Silver Nanoparticles of *Thespesia populnea*extract

In antimicrobial investigation the *Thespesia populnea*silver nanoparticles, the zone of inhibition was found to be 5 mm, 7 mm, and 9 mm for *P.aeruginosa.* The zone of inhibition was found to be 11 mm, 18 mm, and 21 mm for *E.Coli*, respectively.

DISCUSSION

The findings of this study underscore the importance of exploring novel antimicrobial compounds amidst the growing concern of antibiotic resistance. Nanoparticles, particularly nanoceria, have emerged as promising candidates due to their excellent oxidative properties and precise engineering for specific applications(Othman, Gowda et al. 2024). The integration of nanoparticles with medicinal plants, such as Thespesia populnea, presents a potential avenue for developing effective antimicrobial agents(Rahman, Sadaf et al. 2024). The observed antimicrobial and antioxidant activities of Thespesia extract corroborate traditional medicinal uses, validating its therapeutic potential. The combination of Thespesia extract with copper nanoparticles further enhances its efficacy, particularly in treating skin infections and other ailments. These findings support the notion that natural remedies, including plant extracts, hold significant promise in combating microbial infections and promoting overall health(Girija and Ganesh 2022). Moreover, the experiment involving cookies made from sorghum, orange flesh, sweet potato, and mushroom protein highlights the potential of dietary interventions in managing conditions like hyperglycemia. While further research is warranted to elucidate the mechanisms underlying these effects, the observed reduction in symptoms suggests the utility of dietary modifications in promoting health(Aditya, Girija et al. 2021). Overall, the multifaceted approach employed in this study, integrating traditional medicine with modern nanotechnology and dietary interventions, demonstrates the potential for synergistic effects in addressing contemporary healthcare challenges. Further investigation into the mechanisms of action and optimization of formulations could pave the way for the development of novel therapeutics with enhanced efficacy and safety profiles.

CONCLUSION

The study concludes that the Thespesia extract, along with silver nanoparticles, showed antimicrobial and anti-inflammatory activity. The phytochemical test showed the presence of tannins, phenolic compounds, saponins, proteins, amino acids, carbohydrates, and alkaloids. The SEM showed the morphological structure of the silver nanoparticles, which were seen as spherical shaped particles. The XRD showed the crystalline nature of the compound, and in the end the FTIR showed the different functional groups present in the material being used.

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