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Antimicrobial Potential of *Solanum Nigrum* Against Escherichia Coli and Staphylococcus *Aureus*

Gunjan Yadav[1], R. Sujatha[2], Renu Verma[3*]

[1,2,3]Faculty of Engineering and Technology, Rama University, Kanpur

***Corresponding Authors mail:** renuverma.fet@ramauniversity.ac.in

ABSTRACT

Solanum nigrum (S. nigrum), commonly known as Black Nightshade, is a traditional medicinal plant extensively used in Indian ethnomedicine. This study evaluates the antibacterial potential and phytochemical profile of *S. nigrum* leaf extracts through GC-MS analysis. The ethanolic extract demonstrated a pronounced zone of inhibition (25 mm) against E. coli at 625 µg/mL. Hydro-methanolic and hydro-acetonic extracts were also analyzed for their phenolic and flavonoid content, polyphenolic composition (via RP-HPLC), and volatile constituents (via GC-MS). Major phytochemicals including terpenoids, glycosides, flavonoids, and steroids contributed to the observed antimicrobial activity. These findings indicate the promise of S. nigrum as a natural source of antimicrobial agents for pharmaceutical and agricultural applications.

Keywords: Solanum nigrum, Gas Chromatography, Mass Spectrometry, Antibacterial activity, Phytochemicals

INTRODUCTION

The global rise in multidrug-resistant bacteria has intensified the search for novel and effective antimicrobial agents from natural sources. Medicinal plants are rich in bioactive compounds with therapeutic applications, often exhibiting antimicrobial properties. Among these, Solanum nigrum L., belonging to the family Solanaceae, is traditionally known in India as Makoi. This herbaceous plant grows in tropical and subtropical climates and is known for its wide range of pharmacological properties. Used in Ayurvedic and Unani systems of medicine, S. nigrum has been employed to treat ulcers, hepatic disorders, fever, asthma, and skin infections. Previous studies have highlighted its antioxidant, anti-inflammatory, hepatoprotective, and anticancer effects. However, its antimicrobial potential, particularly against clinically important pathogens like Escherichia coli (a Gram-negative bacterium) and Staphylococcus aureus (a Gram-positive bacterium), warrants deeper investigation.

Numerous studies have explored the antimicrobial activities of Solanaceae members. Abbas et al. (2014) reported significant antimicrobial action in S. nigrum and S. xanthocarpum fruit extracts. Al-Snafi (2018) reviewed traditional uses of Iraqi medicinal plants and emphasized the pharmacological importance of S. nigrum. The efficacy of plant-derived antimicrobial compounds is often attributed to secondary metabolites like alkaloids, flavonoids, terpenes, and phenolic acids. GC-MS and HPLC profiling have become essential tools in identifying these active principles.

While there are scattered reports on the antibacterial activity of S. nigrum, few combine chemical profiling with bioactivity assays targeting drug-resistant bacteria. This study attempts to bridge that gap through a comprehensive phytochemical and antimicrobial analysis.

MATERIALS AND METHODS

Plant Collection and Preparation

Mature S. nigrum plants were collected from the medicinal garden at Rama University, Kanpur. The collected specimens were authenticated and cleaned under running water, shade-dried at room temperature, and pulverized into a fine powder using a mechanical grinder.

Extraction Procedure

Soxhlet extraction was performed using ethanol, hydro-methanol (70:30), and hydro-acetone (60:40) as solvents. Approximately 50 grams of powdered sample were subjected to extraction for 6–8 hours. The resultant crude extracts were filtered, evaporated to dryness, and stored at 4°C for further use.

Antibacterial Testing
Antibacterial assays were conducted using the disc diffusion method. The bacterial strains E. coli and S. aureus were obtained from the Microbiology Laboratory of Rama University. Nutrient Agar (NA) and Mannitol Salt Agar (MSA) plates were used for culture. Discs soaked with extract concentrations of 125, 250, 500, and 625 µg/mL were placed on inoculated agar plates and incubated at 37°C for 24 hours. Ciprofloxacin (10 µg) served as the positive control.

-MS Analysis
The ethanolic extract was subjected to GC-MS using a Thermo Scientific TRACE 1300 GC system coupled with an ISQ mass spectrometer. Helium was used as the carrier gas at a flow rate of 1.0 mL/min. Identification of compounds was achieved by comparing spectra with the NIST library database.

RESULTS AND DISCUSSION

GC-MS Analysis
The GC-MS chromatogram revealed 43 distinct peaks corresponding to various phytochemicals. Notable bioactive compounds included:

Table 1: Phytochemicals in the leaf extract

Compound	Relative Abundance (%)	Known Activity
Oxetane, 3-(1-Methylethyl)-	15.16%	Antibacterial
2-Hexadecen-1-ol	12.06%	Antimicrobial, Emollient
Vitamin E (Alpha-Tocopherol)	11.93%	Antioxidant
Gamma-Tocopherol	9.07%	Anti-inflammatory
Hexadecenoic Acid	6.41%	Antimicrobial
Squalene	1.19%	Antioxidant, Skin-protective
Gamma-Sitosterol	2.70%	Antifungal, Antimicrobial

These compounds collectively contribute to the observed bioactivity, suggesting a synergistic mode of action.

Antibacterial Assay
Among all concentrations tested, 625 µg/mL of ethanolic extract exhibited the highest inhibition zone against E. coli (25 mm) and moderate inhibition against S. aureus (18 mm). These values were comparable to the standard antibiotic control. The hydro-methanolic and hydro-acetonic extracts also showed activity, though slightly less pronounced.

The differential susceptibility between Gram-negative and Gram-positive strains may be attributed to differences in cell wall composition. Gram-negative bacteria like E. coli possess an outer membrane that can restrict the penetration of certain compounds, yet S. nigrum extract effectively breached this barrier an indication of potent antimicrobial agents within.

Role of Phytochemicals
Phenolic compounds can denature bacterial proteins, while flavonoids disrupt cell wall integrity and inhibit nucleic acid synthesis. Terpenoids and glycosides act by interfering with membrane permeability. The synergy among these groups may enhance antibacterial potency, as seen in this study.

CONCLUSION

The study confirms that Solanum nigrum possesses significant antibacterial properties against E. coli and S. aureus, correlating with the presence of various bioactive phytochemicals identified by GC-MS. These results provide scientific validation for its traditional use and encourage further exploration for drug development. Future studies should focus on:

REFERENCES

[1]. Abbas K, Niaz U, Hussain T, Saeed MA, Javaid Z, Idress A, Rasool SJ (2014). Antimicrobial activity of fruits of Solanum nigrum and Solanum xanthocarpum. Acta Pol Pharm, 71(3): 415–421.
[2]. Al-Snafi AE. Traditional uses of Iraqi medicinal plants. IOSR J Pharm. 2018;8(8):32–96.
[3]. Cowan MM (1999). Plant products as antimicrobial agents. Clin Microbiol Rev, 12(4):564–582.
[4]. Parekh J, Chanda S (2007). In vitro antimicrobial activity and phytochemical analysis of some Indian medicinal plants. Turk J Biol, 31:53–58.
[5]. Doughari JH et al. (2009). Phytochemical screening and antibacterial evaluation of the leaf and root extracts of *Cassia alata* Linn. *Afr J Pharm Pharmacol*, 3(10): 417–423.