



Investigation of the Antibacterial and Antioxidant properties of the major components in Shoot extract and Leaf extract of *Bambusa vulgaris*

M. D. N. I. Vidarshana, G. N. Silva, N. I. Abeyasinghe

Department of Chemistry, University of Colombo, Sri Lanka

INTRODUCTION

Medicinal plants remain a cornerstone of drug discovery, offering structurally diverse bioactive compounds with significant therapeutic potential. Among them, bamboo (*Bambusa vulgaris* var. *vittata*) is a fast-growing and widely distributed species that has long been utilized in traditional medicine for its antibacterial, anti-inflammatory, and antioxidant properties. Its shoots and leaves are particularly rich in secondary metabolites such as flavonoids, phenolics, and terpenoids, which are associated with antimicrobial and free radical scavenging activities.

With the growing concern over antibiotic resistance and oxidative stress-related diseases, the search for novel natural agents has gained renewed importance. Evaluating the pharmacological potential of bamboo extracts provides valuable insights into their possible applications in modern medicine.

In this study, bamboo shoot and leaf extracts were systematically investigated for their antibacterial and antioxidant activities, alongside the identification of key phytochemical constituents using phytochemical assays and spectroscopic techniques (FTIR and Raman). This integrated approach aimed to establish a scientific basis for the therapeutic use of bamboo and highlight its potential as a sustainable source of bioactive compounds.

METHODOLOGY

EXTRACTION

Shoot: Biological extract

Leaf: Maceration (70% ethanol)

Dry crude extracts obtained

SCREENING & ANALYSIS

FT-IR Spectroscopy

Phytochemical Screening

Raman Spectroscopy

BIO ACTIVITY ASSAYS

Antibacterial Assay (MTT assay)

Antioxidant Assays(DPPH, ABTS)

Total Phenolic Content Assay (Folin–Ciocalteu)

DATA INTERPRETATION

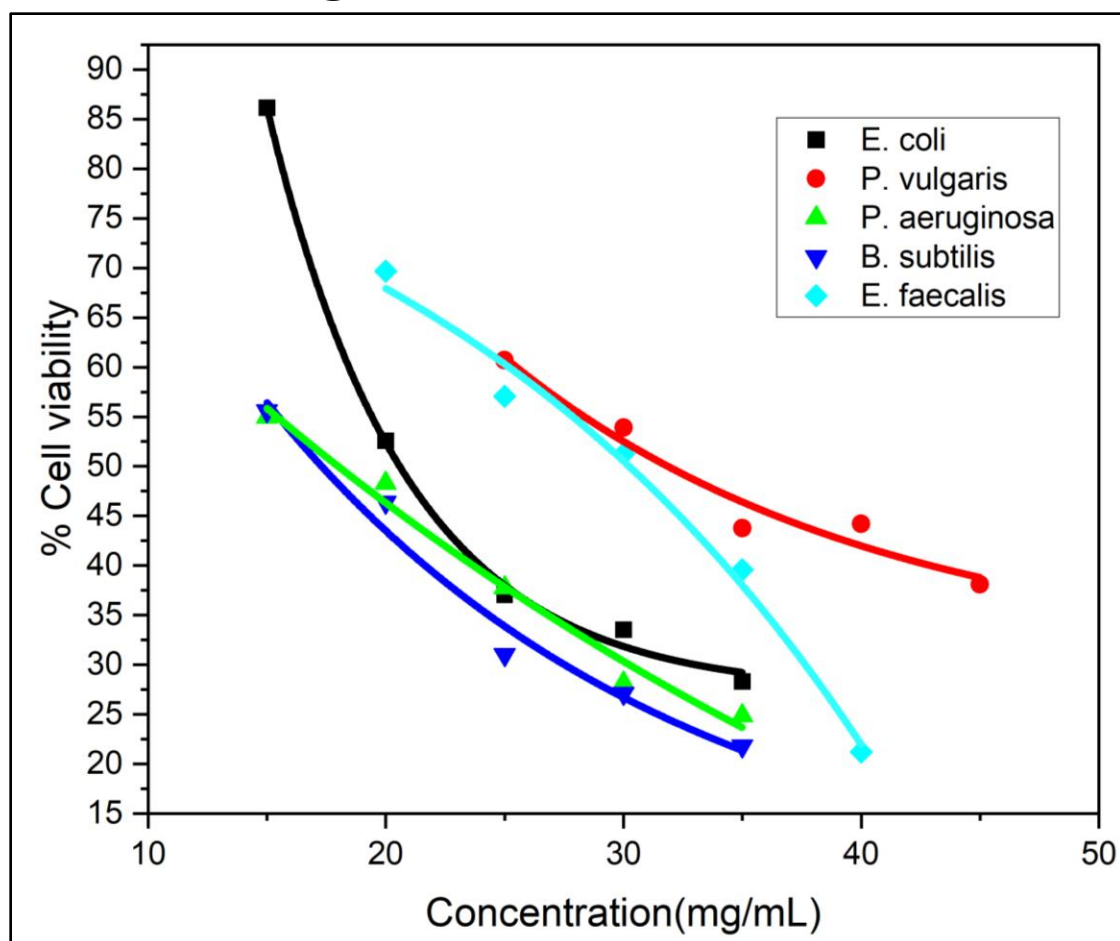
Calculation of IC/EC values

Shoot vs. leaf comparison

Evaluation of Antibacterial activity

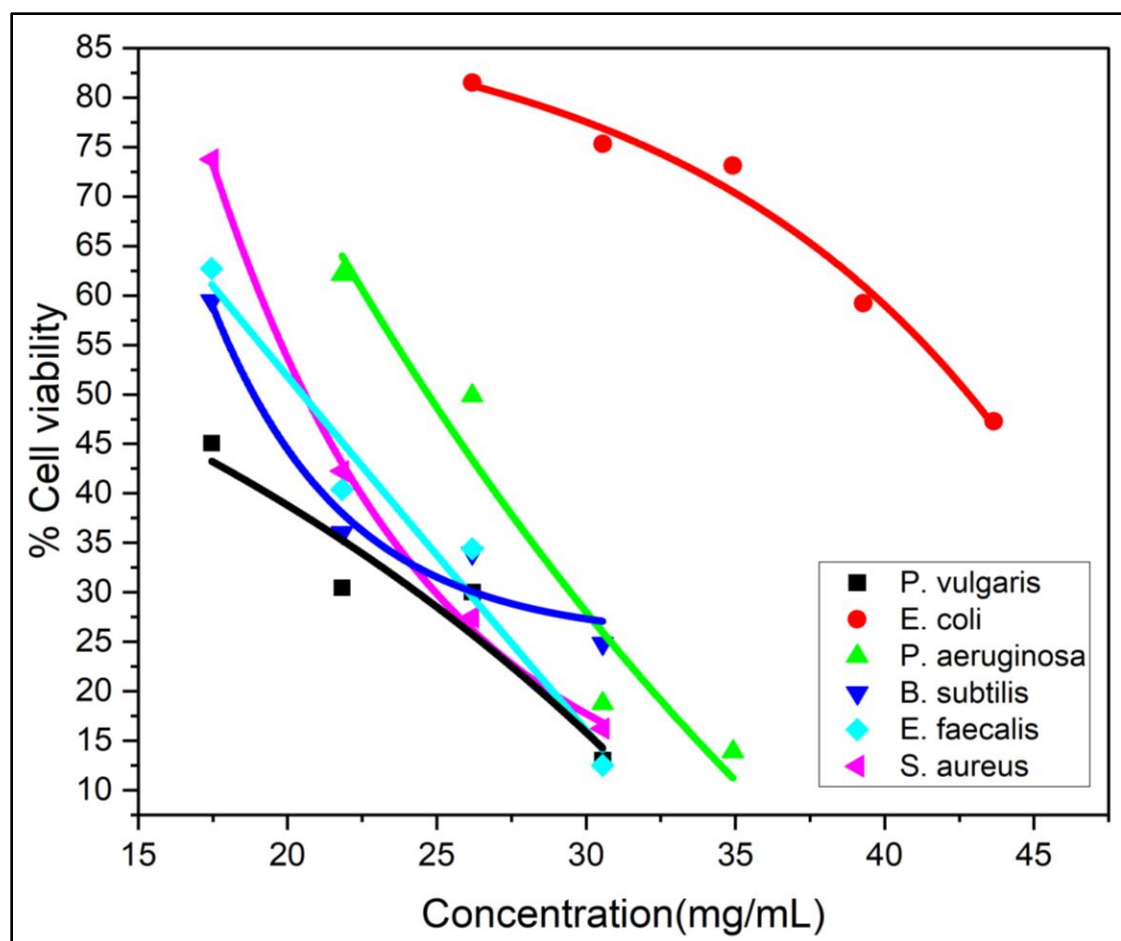
The antibacterial activity of bamboo shoot and leaf extracts was evaluated using the MTT assay. Both extracts demonstrated inhibitory effects against Gram-positive and Gram-negative bacteria, with lower IC values indicating higher susceptibility in Gram-positive strains.

Importantly, the extracts also showed activity against Gram-negative bacteria, which are generally more resistant and challenging to treat due to their complex cell wall structure. These findings highlight the broad-spectrum potential of bamboo-derived extracts, emphasizing their significance as natural antimicrobial agents.



Gram strain	Bacteria	IC50 (average)
Gram Positive	<i>B. subtilis</i>	16.62 mg/mL
Gram Positive	<i>E. faecalis</i>	29.11 mg/mL
Gram Negative	<i>P. vulgaris</i>	34.89 mg/mL
Gram Negative	<i>E. coli</i>	24.08 mg/mL
Gram Negative	<i>P. aeruginosa</i>	18.01 mg/mL

Figure 1: Dose-responsive curve indicating the % cell viability vs Shoot concentration and their respective IC values

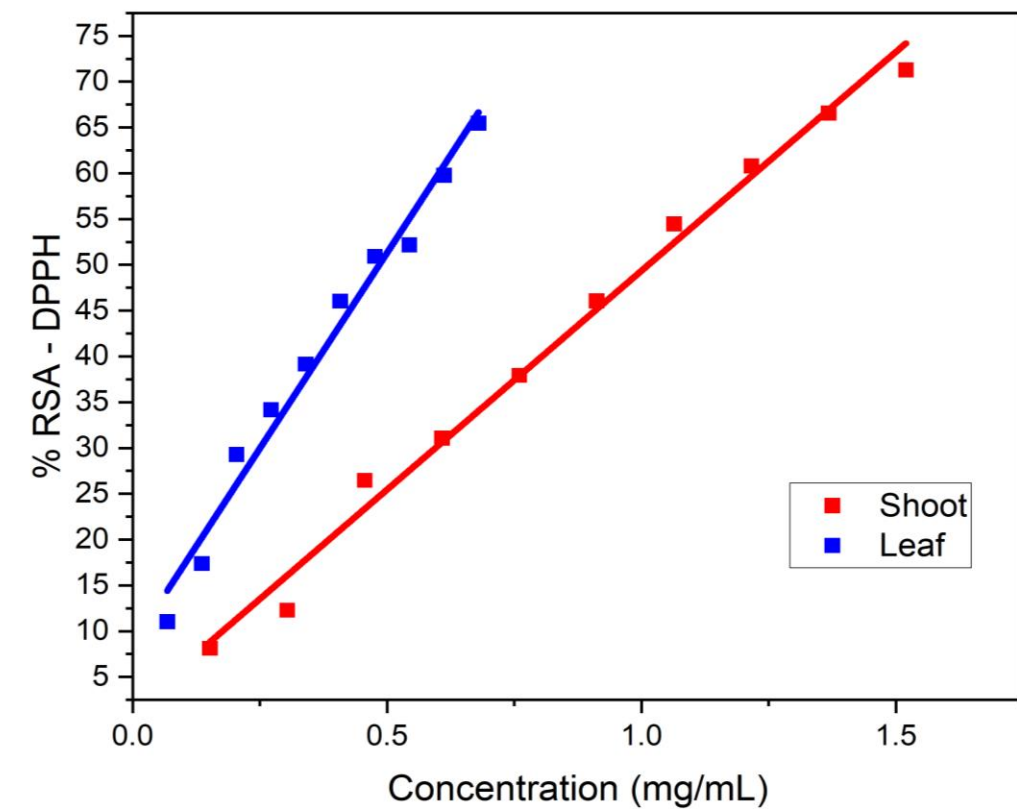


Gram strain	Bacteria	IC50 (average)
Gram Positive	<i>S. aureus</i>	22.29 mg/mL
Gram Positive	<i>B. subtilis</i>	19.37 mg/mL
Gram Positive	<i>E. faecalis</i>	20.44 mg/mL
Gram Negative	<i>P. vulgaris</i>	20.13 mg/mL
Gram Negative	<i>E. coli</i>	44.41 mg/mL
Gram Negative	<i>P. aeruginosa</i>	24.85 mg/mL

Figure 2: Dose-responsive curve indicating the % cell viability vs Leaf concentration and their respective IC values

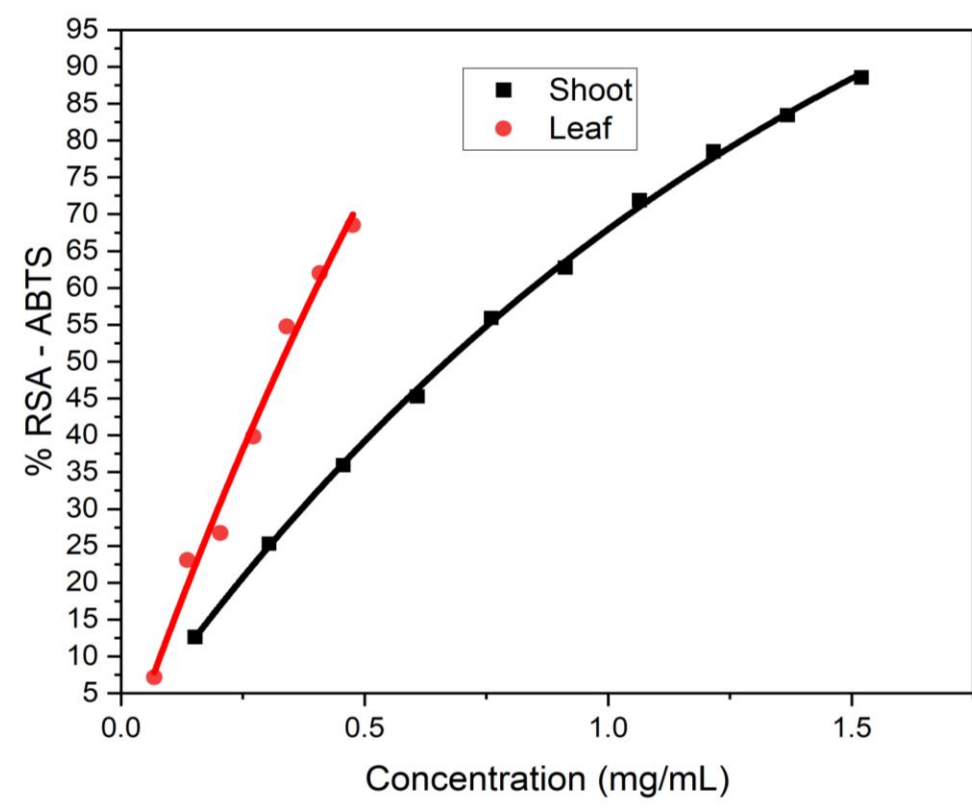
Evaluation of Antioxidant activity

The antioxidant potential of bamboo shoot and leaf extracts was assessed using DPPH and ABTS radical scavenging assays. The EC values indicated that the leaf extract exhibited stronger antioxidant activity than the shoot extract. Although both extracts showed moderate activity compared to the standard antioxidant ascorbic acid, the results remain significant, demonstrating that bamboo-derived extracts possess considerable free radical scavenging ability, contributing to their therapeutic potential.



Extract	EC ₅₀ (mg/mL) - DPPH
Shoot	1.014 mg/mL
Leaf	0.485 mg/mL

Figure 3: Graph of DPPH % RSA vs Extract concentration and their respective EC values



Extract	EC ₅₀ (mg/mL) - ABTS
Shoot	0.727 mg/mL
Leaf	0.327 mg/mL

Figure 4: Graph of ABTS % RSA vs Extract concentration and their respective EC values

RESULTS

Phytochemical Analysis

Preliminary phytochemical screening of bamboo shoot and leaf extracts confirmed the presence of major secondary metabolites such as flavonoids, quinones, phytosterols, saponins, and other phenolic compounds.

These bioactive constituents are closely linked to the antioxidant and antimicrobial effects observed in the study. The detailed results of the screening are summarized in the given table.

Phytochemical	Test	Shoot	Leaf
Alkaloids	Wagner's reagent test	+	+
Phytosterols	Salkowski reaction test	+	+
Amino acids	Ninhydrin test	+	–
Flavonoids	Ferrie Chloride Test	+	+
Quinones	HCl test	–	+
Saponins	Foam test	+	+
Resins	Acetone Test	–	–

Table 1: Phytochemical analysis of Shoot and Leaf extracts (+ indicates the presence and – indicates the absence of phytochemicals)

Evaluation of Total Phenolic Content

The total phenolic content (TPC) of bamboo shoot and leaf extracts was determined using the Folin–Ciocalteu assay. The leaf extract exhibited a comparatively higher TPC value (3.4935 mg GAE/g dry weight) than the shoot extract (2.7080 mg GAE/g dry weight).

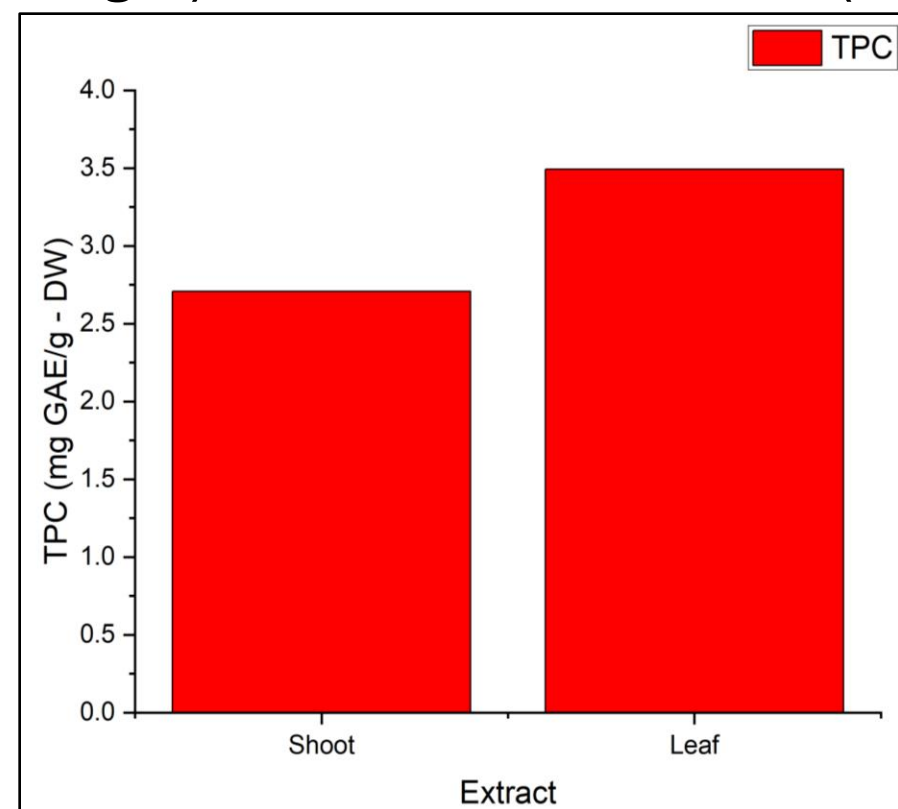


Figure 5: The TPC of Shoot and Leaf extracts

FT-IR Analysis

Fourier-transform infrared (FTIR) spectroscopy of bamboo shoot and leaf extracts revealed characteristic absorption bands corresponding to functional groups associated with amino acids, aromatic amines, carbohydrates, proteins, flavonoids, tannins, and terpenoids.

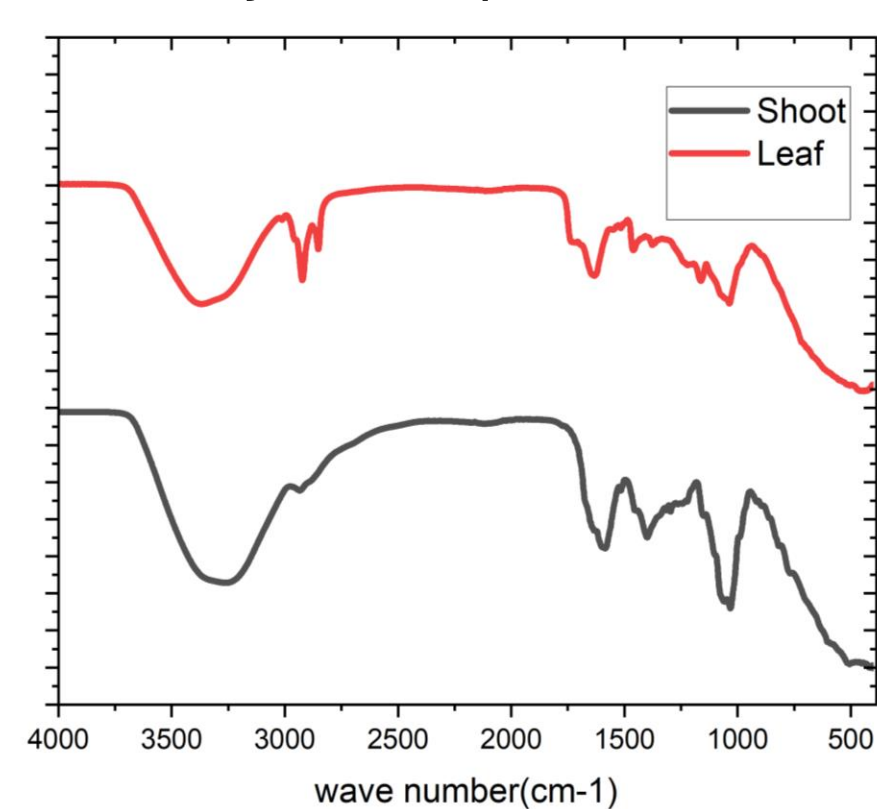


Figure 6: FT-IR spectra of shoot and leaf crude extracts

Raman spectroscopy

Raman spectroscopic analysis of bamboo shoot and leaf extracts indicated the presence of functional groups associated with polysaccharides, nucleic acids, flavonoids, amides, and peptides. However, due to the complex nature of the crude extracts containing a wide range of compounds, the detector experienced saturation, making it difficult to clearly distinguish specific peaks. In addition, a strong fluorescence background introduced noise into the spectra, which posed further challenges in accurate interpretation.

CONCLUSIONS

- Both bamboo shoot and leaf extracts inhibited bacterial growth, with significant effects against Gram-positive strains; importantly, moderate activity was also observed against Gram-negative bacteria.
- Leaf extracts showed higher antioxidant activity and phenolic content than shoots, confirming their stronger radical-scavenging potential.
- Phytochemical and spectroscopic analyses revealed diverse bioactive compounds, supporting the therapeutic potential of bamboo as a natural source of antimicrobials and antioxidants.

REFERENCES

- Stockert, J. C.; Horobin, R. W.; Colombo, L. L.; Blázquez-Castro, A. Tetrazolium Salts and Formazan Products in Cell Biology: Viability Assessment, Fluorescence Imaging, and Labeling Perspectives. *Acta Histochem.* 2018, 120 (3), 159–167. <https://doi.org/10.1016/j.acthis.2018.02.005>.
- Moon, J.-K.; Shibamoto, T. Antioxidant Assays for Plant and Food Components. *J. Agric. Food Chem.* 2009, 57 (5), 1655–1666. <https://doi.org/10.1021/jf803537k>.
- Ilyasov, I. R.; Beloborodov, V. L.; Selivanova, I. A.; Terekhov, R. P. ABTS/PP Decolorization Assay of Antioxidant Capacity Reaction Pathways. *Int. J. Mol. Sci.* 2020, 21 (3), 1131. <https://doi.org/10.3390/ijms21031131>.