

RESEARCH PAPER

Phytochemical Profiling and Antibacterial Potential of *Phlogacanthus thyrsoformis* Root Extract

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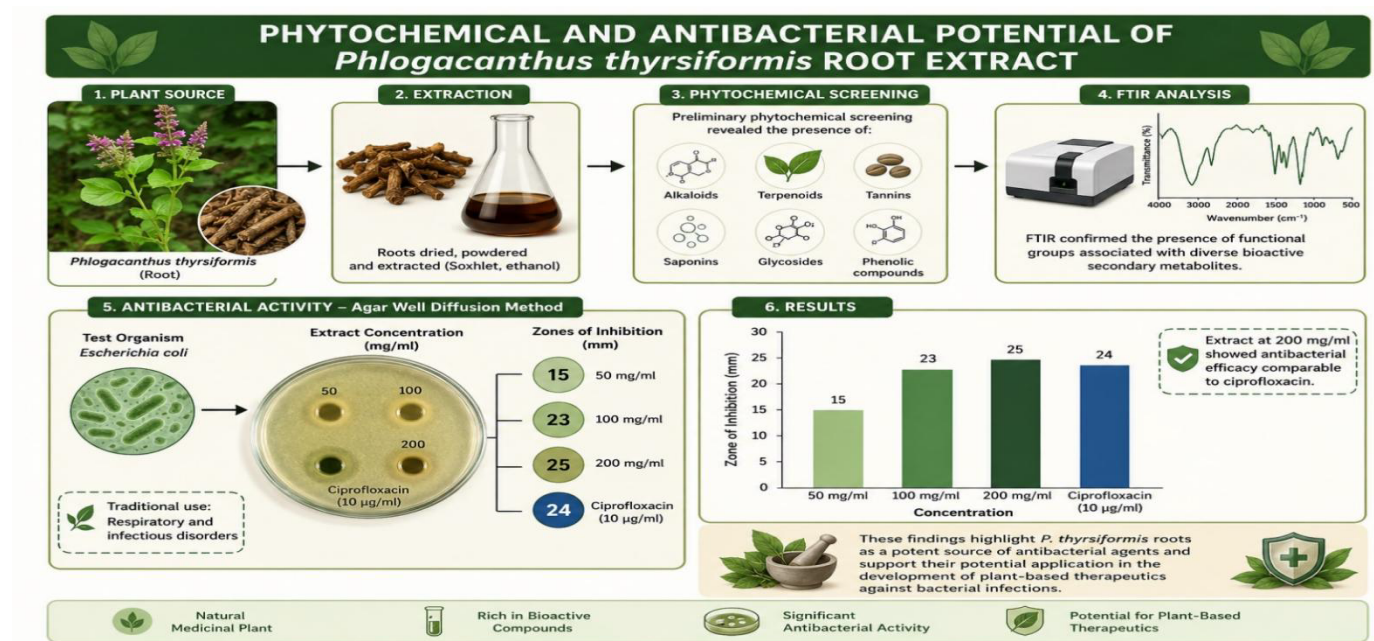
ABSTRACT

Phlogacanthus thyrsoformis is a medicinal plant that is used to treat respiratory and infectious diseases. The study was conducted to study the phytochemical and antibacterial activities of root extract of *P. thyrsoformis*. The preliminary phytochemical screening revealed the presence of alkaloids, terpenoids, tannins, saponins, glycosides and phenolic compounds. Fourier Transform Infrared Spectroscopy confirmed the presence of functional groups of various bioactive secondary metabolites. The extract was tested for antibacterial activity against *Escherichia coli* by agar well diffusion method. The extract concentration showed antibacterial activity with zones of inhibition of 15, 23 and 25 mm at 50, 100 and 200 mg/ml respectively. The highest concentration showed antibacterial effect comparable to ciprofloxacin (24mm). These findings confirm the roots of *P. thyrsoformis* as a source of antibacterial agents and support their potential use in the development of plant-based therapeutics against bacterial infections.

Keywords: *Phlogacanthus thyrsoformis*, Antibacterial activity, Phytochemical screening, FTIR, *Escherichia coli*, Natural products.

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Graphical Abstract



INTRODUCTION

Medicinal plants have been used for centuries in traditional healthcare systems, and they continue to be important in modern medicine for treating and preventing illness. A large percentage of the world's population uses herbal medicines as health remedies, especially in developing countries. Medicinal plants are a rich source of various bioactive phytochemicals and have various pharmacological effects such as antibacterial, antimicrobial, antioxidant, anti-inflammatory and anticancer (Ningthoujam, Singh, Laldingliani, Singh, and Kumar, 2023; Saikia, Baruah, Hasnu, Natha, Akhtar, and Tanti, 2018; Aslam and Ahmad, 2016). Phenolic compounds, tannins, glycosides, terpenoids, phenolic compounds and saponins are other phytochemicals in medicinal plants.

The synthetic drugs have side effects and the increasing incidence of antimicrobial resistance has sparked interest in the use of plant-derived bioactive compounds as safer and more effective alternatives to the synthetic drugs. Natural products are still a rich source of potential new drugs due to their wide variety of structures and biological activities (Tamanna, Saha, Hoque, Aktaruzzaman, and Hasan, 2024; Mohammed, 2019; Singh, 2015).

A few members of the family Acanthaceae are medicinally important. One among them is *Phlogacanthus thyrsoformis* Nees. This species has been gaining increasing scientific interest due to its wide traditional use and biological properties (Ningthoujam, Singh, Laldingliani, Singh, and Kumar, 2023). It is widely distributed in Northeast India and other Indo-Malayan regions where it is traditionally used in the treatment of respiratory disorders like asthma, bronchitis, cough, fever and inflammatory conditions, jaundice, rheumatism and malaria (Ningthoujam, Singh, Laldingliani, Singh and Kumar, 2023; Saikia, Baruah, Hasnu, Natha, Akhtar and Tanti, 2018). Its traditional use in the alleviation of respiratory ailments further emphasized its ethnomedicinal importance among the inherent communities of Northeast India during the COVID-19 (Ningthoujam, Singh, Laldingliani, Singh and Kumar, 2023).

Phytochemical analyzes have revealed the presence of secondary metabolites such as flavonoids, phenolic compounds, tannins, glycosides, diterpenoids, alkaloids, phytosterols and terpenoids in *P. thyrsoformis* (Bora, Syiem and Bhan, 2019; Ponneganti, Murty, Bagul, Borkar and Radhakrishnanand, 2022; Singh, Sahana, Rama and Kumar, 2020). The pharmacological potential of the plant was enhanced by the identification of bioactive components by advanced metabolomic profiling using LC-ESI-QTOF-

MS/MS and GC/QTOF-MS analysis (Ponneganti et al., 2022 Murty, Bagul, Borkar and Radhakrishnanand, 2022). These components include naringenin, derivatives of cinnamic acid, polyphenols and other molecules with antioxidant properties. The species has been traditionally employed for medicinal purpose, which is validated by the reports of its phytoconstituents with antioxidant, antimicrobial, anti-inflammatory, antidiabetic and cytoprotective activities (Tamanna et al., 2024; Ponneganti et al., 2022).

Previous studies have demonstrated significant antioxidant and antibacterial activities of *P. thyrsoformis* extracts. More recent research has also reported enzyme inhibitory effects and anticancer activity, specifically through the induction of apoptosis in human cancer cell lines (Ningthoujam et al., 2023; Kumar et al., 2017; Chanu et al., 2021).

MATERIALS AND METHODS

Preparation of Root Powder

Dried *Phlogacanthus thyrsoformis* roots were pounded using a mortar and pestle, after that they were further grind with suitable mechanical milling to obtain a rough powder after obtaining the powder the material was stored in tightly closed containers. (Handa 2008) (Fig 1 and 2)

Maceration Process

About 50 g of the root powder was accurately measured and then transferred into a clean glass container, a solvent mixture made by combining 300 mL methanol with 200 mL distilled water, giving 500 mL in all, was added. The vessel was closed firmly and kept at room conditions for one to two weeks so maceration could occur. During this interval, the contents were agitated from time to time to promote efficient movement of plant constituents into the solvent. (Azwanida, 2015; Handa 2008) (Fig 3)

Filtration Process

After the maceration stage, filtration through Whatman No. 1 paper was performed to remove the plant solids and obtain the liquid portion. The collected filtrate, which held the extracted phytochemical components, was transferred into a clean receptacle. (Harborne, 1998) (Fig 4)

Evaporation of Filtrate

The filtrate was placed into a porcelain dish and warmed carefully in water bath maintained at 50–60°C so that the solvent could evaporate slowly. The warming step was continued until a semi-solid extract was produced. (Azmir 2013) (Fig 5 and 6)

Drying of Extract

Semi-solid extract was moved into a hot-air oven set to 40–45°C to remove the remaining moisture. After

complete drying, the crude extract obtained was grind to a powder then kept in airtight containers, and saved for later testing. (Azmir 2013) (Fig 7)

**Fig: 1 Coarsed root****Fig: 2 Grinding****Fig: 3 Maceration****Fig: 4 Filtration****Fig: 5 Evaporation****Fig: 6 Drying****Fig: 7 Extract****RESULTS****Phytochemical Screening Finding**

A phytochemical assessment of the extract showed that it contains several bioactive constituents for its medicinal and therapeutic value. The following table presents the phytochemicals observed during the evaluation. (Table 1)

Table 1: Phytochemical screening Root Extract

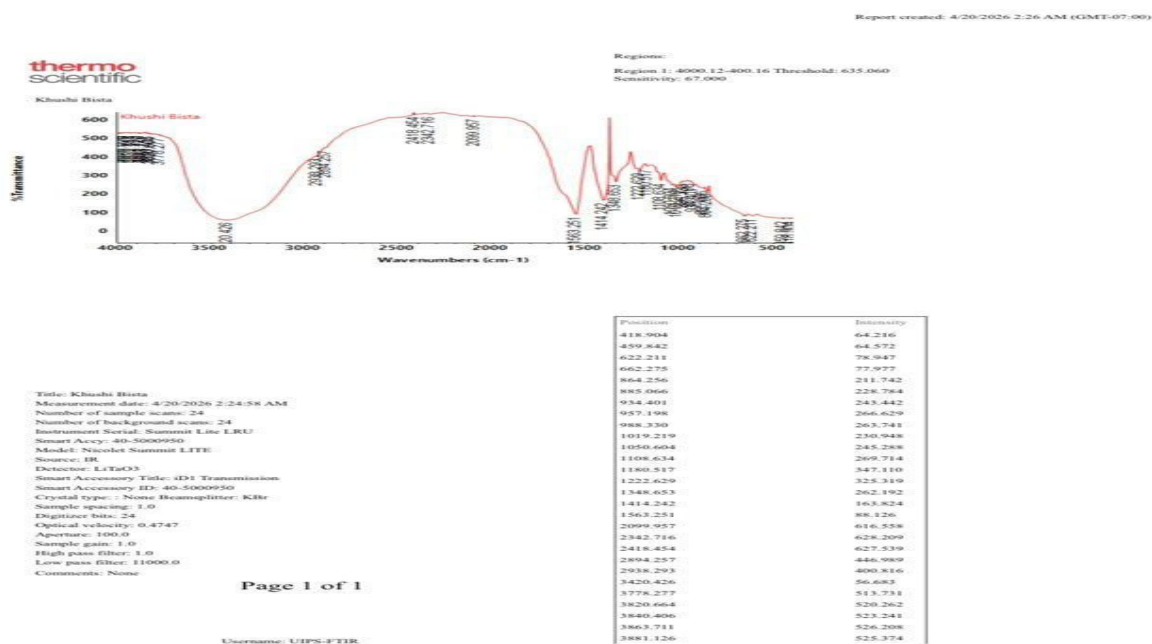
Sr. no	Phytoconstituents	Test method	Observation	Interference
1	Alkaloids	Mayer	Orange Precipitate formed	Present (+)
2	Flavanoids	Alkaline	Pink/red colour developed	Not present (-)
3	Terpenoids	Salkowski Test	Reddish–brown layer formed	Present (+)
4	Tannins	Ferric Chlorid Test	Blue-black coloration	Present (+)
5	Saponins	Foam Test	Foam formation	Present (+)
6	Glycosides	Keller Killianini Test	Brown ring at interface	Present (+)

7	Phenols	Ferric chloride Test	Dark blue colour	Present (+)
8	Amino acid	Ninhydrin Test	Purple/violet colour	Not present (-)

FTIR (Fourier Transform Infrared Spectroscopy)

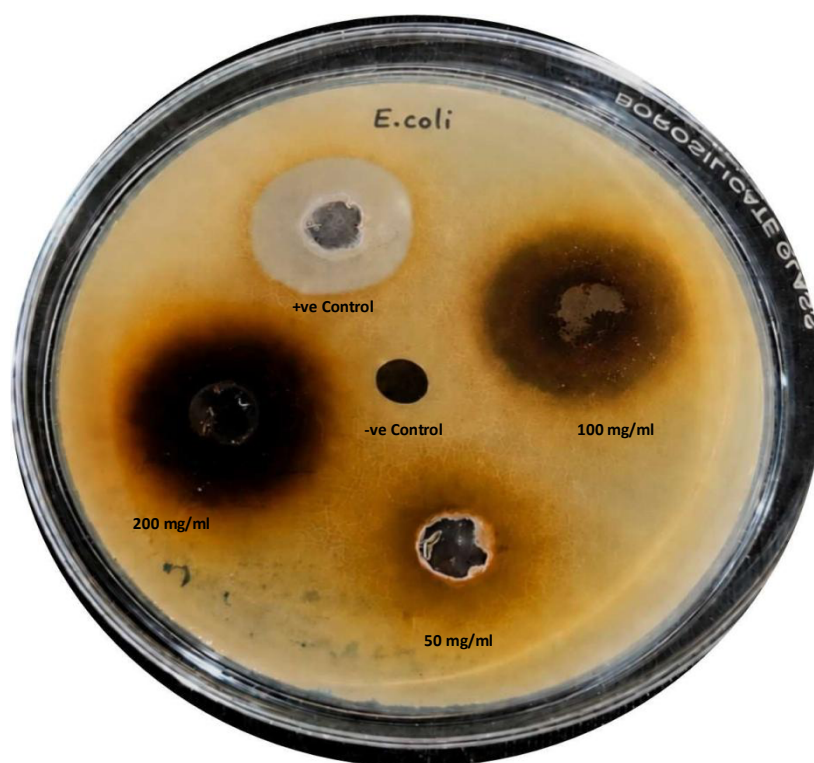
Fourier Transform Infrared Spectroscopy (FTIR) analysis of the *Phlogacanthus thyrsoformis* root extract revealed a strong, broad band around 3420 cm^{-1} corresponding to O–H stretching, characteristic of alcohols and phenolic compounds, which indicates the presence of phenols and flavonoids known for antioxidant and antimicrobial activities. Bands at 2938 cm^{-1} and 2894 cm^{-1} were attributed to C–H stretching, suggesting the presence of terpenoids and other aliphatic constituents. A weak signal near 2342 cm^{-1} may arise from atmospheric CO_2 or unsaturated compounds, while a peak at 2099 cm^{-1} suggests the presence of unsaturated groups or triple bonds. The band at 1563 cm^{-1} corresponds to aromatic C=C stretching and N–H bending, indicating proteins and alkaloids, both associated with pharmacological and antibacterial effects. Peaks at 1414 cm^{-1} and 1348 cm^{-1}

represent C–H bending and C–N stretching, suggesting the presence of aromatic and nitrogen-containing compounds. Signals between 1222 cm^{-1} and 1019 cm^{-1} are attributed to C–O and C–O–C stretching typical of alcohols, ethers, esters, and glycosidic bonds, indicating the presence of glycosides with medicinal and antimicrobial properties. Additionally, several minor peaks in the fingerprint region below 1000 cm^{-1} emphasize the complex phytochemical nature of the extract. Overall, the FTIR findings confirm that the root extract contains major phytochemical groups such as phenols, flavonoids, alkaloids, terpenoids, glycosides, alcohols, and aromatic compounds, all of which are associated with antibacterial, antioxidant, and therapeutic activities, and these likely contribute to the extract's efficacy against pathogenic microorganisms.



Antibacterial Activity**Table 2: Zone of inhibition test sample against *E.coli***

Test Microorganism	Test Sample 200 mg/ml	Test Sample 100 mg/ml	Test Sample 50 mg/ml	Positive Control	Negative Control
C	25 mm	23 mm	15 mm	24 mm	NA

**Figure 8: Antimicrobial Activity against *E. coli*****Antimicrobial Activity of Test Sample Against *Escherichia coli***

The antimicrobial activity of the test sample was evaluated against *Escherichia coli* using the agar well diffusion assay. The efficacy of the sample was determined by measuring the diameter of the zone of inhibition (ZOI) formed around the wells containing different concentrations of the test sample and comparing the results with the standard antibiotic ciprofloxacin.

The results demonstrated a concentration-dependent inhibitory effect of the test sample against

E. coli. The highest antimicrobial activity was observed at a concentration of 200 mg/mL, which produced a zone of inhibition of 25 mm. This inhibition zone was slightly larger than that produced by the positive control, ciprofloxacin (24 mm), indicating excellent

antibacterial potential of the test sample at higher concentration. At a concentration of 100 mg/mL, the test sample exhibited a zone of inhibition of 23 mm, which was comparable to that of ciprofloxacin. This observation suggests that the bioactive compounds present in the test sample remain effective even at reduced concentrations and possess significant antibacterial properties against *E. coli*.

Further reduction in concentration to 50 mg/mL resulted in a zone of inhibition of 15 mm. Although lower than the zones observed at 100 mg/mL and 200 mg/mL, the presence of a distinct inhibition zone confirms that the test sample retained antimicrobial activity even at the lowest tested concentration. The decrease in inhibition zone diameter with decreasing concentration indicates a dose-dependent response of the bacterial strain to the test sample.

No zone of inhibition was observed in the negative control (normal saline), confirming that the observed antibacterial activity was solely due to the bioactive constituents present in the test sample and not due to any experimental interference. The agar plate shown in Figure 1 further supports the quantitative findings, where clear zones surrounding the wells containing the test sample and positive control indicate inhibition of bacterial growth. The largest clear zone was evident around the well containing the 200 mg/mL concentration, while the smallest zone was observed around the 50 mg/mL concentration.

The results indicate that the test sample possesses strong antibacterial activity against *Escherichia coli*. The antimicrobial efficacy increased with increasing

concentration of the sample, suggesting that higher concentrations contain greater amounts of active phytochemicals responsible for bacterial growth inhibition. The comparable or slightly superior activity of the 200 mg/mL concentration relative to ciprofloxacin highlights the potential of the test sample as a promising source of natural antimicrobial agents. The antibacterial activity may be attributed to the presence of various bioactive compounds such as phenolics, flavonoids, tannins, terpenoids, alkaloids, or other secondary metabolites capable of disrupting bacterial cell membranes, inhibiting enzyme activity, interfering with nucleic acid synthesis, or causing leakage of intracellular components. These mechanisms collectively contribute to bacterial growth suppression.

Microscopic Morphology of Test Microorganism

Pink Colour, Bacilli

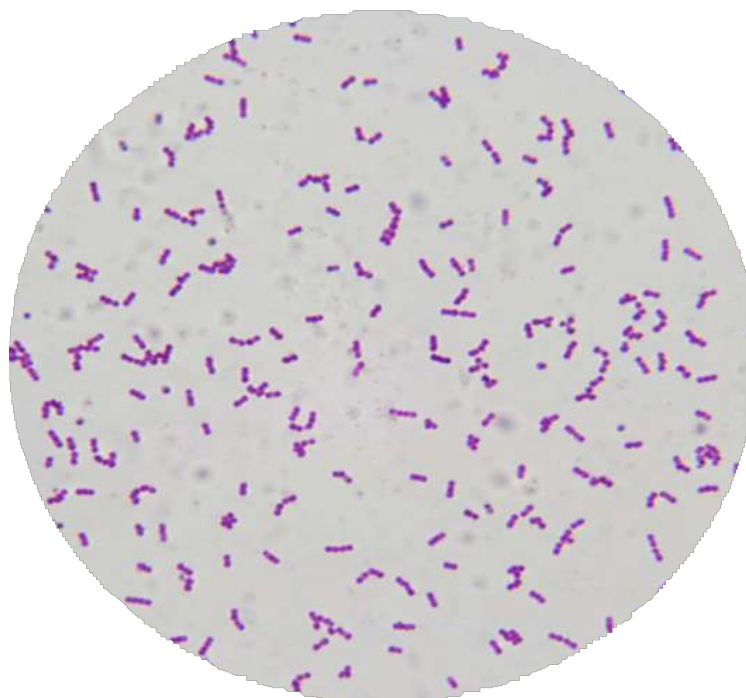


Figure 9: Microscopic Study

Conclusion

This study highlights the promising antibacterial potential of hydro-methanolic root extracts from *Phlogacanthus thyrsoformis* against *Escherichia coli*. Phytochemical screening revealed a rich spectrum of compounds, including alkaloids, terpenoids, tannins, saponins, glycosides, and phenolic compounds, while FTIR analysis confirmed the presence of functional groups linked to these bioactive metabolites. The agar well diffusion assay demonstrated notable antibacterial effects, with the extract showing the greatest inhibition at 200 mg/mL (25 mm zone of

inhibition), followed by 100 mg/mL (23 mm) and 50 mg/mL (15 mm). Remarkably, the extract's efficacy at higher concentrations matched or even surpassed that of the standard antibiotic ciprofloxacin (24 mm). These results point to the extract's rich antimicrobial profile and its potential as a natural alternative in developing antibacterial treatments for *E. coli* infections.

Reference

1. Ningthoujam, T., Singh, Y. A., Laldingliani, T. B. C., Singh, S. H., & Kumar, A. (2023). Comparative study of phytochemicals, antioxidant and antibacterial activity of *Phlogacanthus thyrsoformis* Nees. and *Justicia adhatoda* Linn. Research Square.
2. Tamanna, A. J., Saha, A., Hoque, M., Aktaruzzaman, M., & Hasan, M. N. (2024). Evaluation of phytochemical screening, antioxidant, and thrombolytic activity of methanolic extract of *Phlogacanthus thyrsoflorus*. South Asian Research Journal of Pharmaceutical Sciences, 6(1), 5–11
3. Saikia, D., Baruah, P. S., Hasnu, S., Natha, S., Akhtar, S., & Tanti, B. (2018). Phytochemical screening and antioxidant activity of leaf extract of *Phlogacanthus thyrsoflorus* Nees. – a medicinal plant of Assam, India. Bioscience Discovery, 9(2), 237–243.
4. Mohammed, A. H. (2019). Importance of Medicinal Plants. Research in Pharmacy and Health Sciences, 5(2), 124–125
5. Aslam, M. S., & Ahmad, M. S. (2016). Worldwide Importance of Medicinal Plants: Current and Historical Perspectives. Recent Advances in Biology and Medicine, 2, 88–93..
6. Mani, S. (2016). Importance and Uses of Medicinal Plants – An Overview.
7. Singh, R. (2015). Medicinal Plants: A Review. Journal of Plant Sciences, 3(1-1).
8. Bioinformatics Centre, Sikkim. Medicinal Plants of Sikkim: *Phlogacanthus thyrsoformis*. Available at: Medicinal Plants of Sikkim.
9. Grierson, A. J. C., & Long, D. G. (2001). Flora of Bhutan. Royal Botanic Garden Edinburgh and Royal Government of Bhutan. Available at: Flora of Bhutan Species Description.
10. Kumar, A., Bidyapani, T., Singh, D., Sharma, N. R., & Mohan, A. (2017). Study of phytochemical compositions of leaves extracts of *Phlogacanthus thyrsoformis*, its antibacterial and silver nanoparticle derived cell cytotoxicity on HeLa cell line. Journal of Pharmacy Research. Available at: Research Article on *Phlogacanthus thyrsoformis*.
11. Deori, K., Soren, A. D., & Yadav, A. K. (2023). Toxicity assessment of *Phlogacanthus thyrsoflorus*, a traditionally used anthelmintic plant of India. Future Journal of Pharmaceutical Sciences, 9(52).
12. Bora, J., Syiem, D., & Bhan, S. (2019). Quantitative analysis of total phenolic, flavonoid contents and HPTLC fingerprinting of flower extracts of *Phlogacanthus thyrsoflorus* Nees. Journal of Pharmacognosy and Phytochemistry, 8(3), 906–911.
13. Ponneganti, S., Murty, U. S., Bagul, C., Borkar, R. M., & Radhakrishnanand, P. (2022). Phyto-metabolomics of *Phlogacanthus thyrsoformis* by using LC-ESI-QTOF-MS/MS and GC/QTOF-MS: Evaluation of antioxidant and enzyme inhibition potential of extracts. Food Research International, 161, 111874.
14. Singh, K. G., Sahana, D., Rama, T., & Kumar, D. J. (2020). Phytochemical screening and antioxidant activity of methanolic and aqueous leaf extracts of *Phlogacanthus thyrsoflorus*. International Journal of Advanced Research, 8(6), 626–631.
15. Chanu, K. V., Devi, L. G., Srivastava, S. K., Kataria, M., Thakuria, D., & Kumar, S. (2021). Methanolic extract of *Phlogacanthus thyrsoflorus* Nees leaf induces apoptosis in cancer cells. Indian Journal of Experimental Biology, 59(3).
16. Handa SS, Khanuja SPS, Longo G, Rakesh DD. Extraction Technologies for Medicinal and Aromatic Plants. Trieste, Italy: International Centre for Science and High Technology (ICS-UNIDO); 2008.
17. Azwanida NN. A review on the extraction methods use in medicinal plants, principle, strength and limitation. Med Aromat Plants. 2015;4(3):196. doi:10.4172/2167-0412.1000196.
18. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd ed. London: Chapman & Hall; 1998.
19. Azmir J, Zaidul ISM, Rahman MM, Sharif KM, Mohamed A, Sahena F, et al. Techniques for extraction of bioactive compounds from plant materials: A review. J Food Eng. 2013;117(4):426–436. doi:10.1016/j.jfoodeng.2013.01.014.