J. Indian bot. Soc. (2025) Vol. 105 (4): 303-307

e-ISSN:2455-7218, ISSN:0019 - 4468

https://doi: 10.61289/jibs2025.01.25.386

www.indianbotsoc.org

RESEARCH ARTICLE

FTIR analysis of *Bauhinia racemosa* Lam. hydroalcoholic extract

Ankit Yadav and Meenakshi Vaidya*

Abstract

Bauhinia racemosa Lam. is a tall tree that grows in Sri Lanka, China, India, and Pakistan.Various plant parts have a high therapeutic value in folklore medicine and are used to treat diarrhoea, fever, skin diseases, cough, malaria, and other conditions. *Bauhinia racemosa* has been shown to have analgesic, anti-inflammatory, antipyretic, antispasmodic, ulcer-preventing, cytotoxic, and hypotensive properties. The infrared spectra of a hydroalcoholic extract of *Bauhinia racemosa* Lam. were recorded in the present study. Absorption spectra were used to determine the vibrational assignments, intensities, and wave numbers (cm-1) of the main peak. Probable band distributions have been determined based on the components found in the sample. Functional groups found in hydroalcoholic extract includes alcohol, amines, halo compounds, alkane, and fluoro compound, etc. The identification of functional groups by FTIR helps in identifying the possible bioactive elements of *Bauhinia racemosa* Lam. leaves.The study found that plant hydroalcoholic extract offer great therapeutic potential due to their chemical makeup, which includes biologically significant functional groups. In the future, it will be utilised to treat a variety of ailments.

Keywords: *Bauhinia racemosa* Lam., Bioactive compounds, Hydroalcohol, FTIR, Functional group.

Introduction

Plants are extremely important in our daily routines. Furthermore, they are primarily utilized to cure various human diseases, treat ailments, and restore the health of affected organs from the beginning of time. Approximately 80% of the world's population relies exclusively or primarily on traditional treatments for their healthcare requirements. Today, some 70,000 to 80,000 plant species are used for medicinal or aromatic reasons worldwide. This is due to several biologically active and naturally occurring phytochemicals found in different parts of plants.

Plants produce these chemical compounds as part of their normal metabolic activities to protect their own cells from environmental hazards such as pollution, stress, drought, UV exposure, and pathogenic attack (Gibson *et al*. 1998, Mathai *et al.* 2000 and Izhaki, 2002), which provide health benefits for humans in addition to those attributed to macronutrients and micronutrients (Hasler and Blumberg, 1999). Plants are rich in functionally active secondary metabolites and vital nutrients (Khan *et al.* 2011, Khan *et al.* 2012). Recent research have established the nutritional and nutraceutical benefits of many plant tissues, showing their economic significance (Khan and Giridhar 2014).

Bauhinia racemosa Lam. belonging to the family Fabaceae is often found in Pakistan, India, Sri Lanka, Myanmar, and China. It is a beneficial plant for filling gaps in forest plantings and reducing soil erosion (Panda *et al*. 2015). *Bauhinia racemosa,* often known as the Bidi leaf tree, is notable for making bidis from its leaves. It is cultivated for both its economic importance and its stunning beauty. The tree is gorgeous and blooms for months. The plant's white blossoms are used for apiculture, curries, and pickles. The plant serves as feed for goats, sheep, and cattle. The tree also produces important fibers and gums. The bark is utilized for

S.V. K. M's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Empowered Autonomous) Affiliated to University of Mumbai, Vile-Parle (West), Mumbai 400056, India.

***Corresponding Author:** Meenakshi Vaidya, S.V. K. M's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce and Economics (Empowered Autonomous) Affiliated to University of Mumbai, Vile-Parle (West), Mumbai 400056, India, E-Mail: meenakshi.vaidya@mithibai.ac.in

How to cite this article: Yadav, A., Vaidya, M. (2025). FTIR Analysis of *Bauhinia racemosa* Lam. Hydroalcoholic Extract. *J. Indian bot. Soc.*, Doi: 10.61289/jibs2025.01.25.386

Source of support: Nil

Conflict of interest: None.

Received: 22/11/2024 **Accepted:** 25/01/2025 **Published online**: 30/04/2025

tanning and coloring. The wood is firm and heavy, making it suitable for manufacturing ploughs and yokes, as well as fuel (Gupta *et al*. 2004, Kumar *et al*. 2011).

Fourier Transform Infrared Spectrophotometer (FTIR) is perhaps the most powerful tool for identifying the types of chemical bonds (functional groups) present in compounds. The wavelength of light absorbed is characteristic of the chemical bond as can be seen in the annotated spectrum. By interpreting the infrared absorption spectrum (IR), the chemical bonds in a molecule can be determined (Ashokkumar and Ramaswamy 2014). Observing the IR spectra allows for the detection of modest changes in primary and secondary metabolites in leaves (Surewicz *et al*. 1993). FTIR is used to demonstrate the structure of an unknown composition and the strength of absorption spectra related to the molecular composition or concentration of corresponding chemical functional groups (Bobby *et al*. 2012). FTIR has been used to detect the intricate structures of plant secondary metabolites, as well as to characterize bacterial, fungal, and plant species (Hori and Sugiyama 2003).

Ramamurthy and Kannan, (2007) analyzed the bioactive compounds in dry leaf powder of *Calotropis gigantea* by FTIR spectroscopy. Kareru *et a*l. (2008) analysed saponins in 11 plants, identifying bidesmosidic, oleanane-type triterpenoids in *Albizia anthelmintica*, *Senna singueana*, *Maytenus senegalensis*, *Senna didymomotrya*, *Terminalia brownii*, and *Prunus africana*, and monodesmosidic triterpenoids in *Entada leptostachya* and *Rapanea rhododendroides*.

Muruganantham *et al*. (2009) analyzed the FTIR and EDS spectra of plant parts, including leaves, stems, and roots of *Eclipta alba* and *Eclipta prostrate* and reported the presence of functional groups such as carboxylic acids, amines, amides, sulphur derivatives, polysaccharides, nitrates, chlorates, and carbohydrates, which contribute to their medicinal properties.

Ragavendran *et al*. (2011) identified functional groups in carboxylic acids, amines, amides, sulphur derivatives, polysaccharides, organic hydrocarbons, and halogens that contribute to distinct therapeutic properties of *Aerva lana*. Starlin *et al*. (2012) analysed ethanolic extracts of *Ichnocarpus frutescens* using FTIR, revealing functional group components such as amino acids, amides, amines, carboxylic acids, carbonyl compounds, organic hydrocarbons, and halogens.

Pednekar and Raman, (2013) used FTIR to analyse the methanolic leaf extract of *Ampelocissus latifolia*. They found only transition metal carbonyl compounds and aliphatic fluoro compounds. Dhivya and Kalaichelvi, (2017) investigated UV-Vis spectroscopic and FTIR analysis of *Sarcostemma brevistigma*, wight. and arn. FTIR analysis revealed the presence of alcohols, phenols, alkanes, alkynes, alkyl halides, aldehydes, aromatics, nitro compounds, and amines in the powder particle. Mabasa *et al* (2021) investigated the metabolites present in the leaves of *Momordica balsamina* by FTIR spectroscopy.

Literature review on *Bauhinia racemosa* reveals that solvents such as ethanol, chloroform, acetone, and petroleum ether have been analyzed for their functional groups using FTIR spectroscopy. However, no work has been reported on hydroalcoholic solvent. Recognizing this gap, an attempt has been made in the present study to analyze the functional groups of phytoactive compounds present in the hydroalcoholic leaf extract of *Bauhinia racemosa*.

Material and Method

Collection and identification of plant material

B. racemosa Lam. fresh leaves were collected from Rani Baug, Mumbai, India. The species was identified and authenticated at the Blatter Herbarium (Accession no. PD-431), St. Xaviers College, Mumbai. The leaves were shade-dried, cut into small pieces, and coarsely powdered.

Preparation of extract

The leaf powder was subjected to Soxhlet extraction using hydroalcoholic solvent (60:40). The extraction process involved 10 siphon cycles for 8 hours, resulting in a dark green solvent that separated phytoconstituents from plant. The extract was collected, and the solvent was removed through simple evaporation at room temperature. The concentrated extract was used for further investigation.

FTIR sample preparation

Dried powder (hydroalcoholic extract) of the test plant was used for FTIR analysis. To make translucent sample discs, 1 mg of dry powder was encapsulated in 10 mg of KBr pellet. The powdered pellet sample was loaded in FTIR spectroscope (Shimadzu, IR Affinity 1, Japan), with a scan range from 400 to 4000 cm ^{1} with a resolution of 4 cm ^{1}.

Result

The vibrational spectrum of a chemical molecule is regarded as a distinctive physical characteristic (Wongsa *et al.* 2022). In this study, the absorption spectra were recorded within the range of 4000–400 cm^{-1} is shown in Table 1 & Figure 1.

Due to O-H stretching and N-H stretching, the hydroalcoholic extract of *Bauhinia racemosa* peaks at 3749.62 cm^{-1}, 3624.25 cm^{-1}, 3522.02 cm^{-1}. The presence of alkane group was detected at 2980.02 cm^{-1} and 2879.72 cm^{-1}. The band caused due to O=C=O stretching was peaked at 2347.37 cm^{-1}, 2341.58 cm^{-1} and 2326.15 cm^{-1}. At 2823.79 cm^{-1} peak carboxylic acid and phenols peaked. Conjugated aldehyde was detected at 1703.14 cm^{-1}.

C=N stretching confirmed the presence of Imine / Oxime at its peak in 1660.71 cm^{-1}. Due to C-H bending, alkane was confirmed at its peak 1454.33 cm^{-1}. C-N stretching confirmed

the presence of amines at peak 1083.99 cm^{-1} , 1195.99 cm^{-1} , 1213.23 cm^{-1} and 1033.85 cm^{-1}.

Anhydride was detected at peak 1049.28 cm^{-1} . C-F stretching confirmed the presence of fluro-compound at 1018.41 cm^{-1} . C-I stretching and C-Br stretching show the presence of a halo-compound at 507.28 cm^{-1} , 518.85 cm^{-1} and 538.14 cm^{-1} . 1,3-disubstituted group was identified at 879.54 cm^{-1} .

Discussion

The pharmacological action of crude drugs and their therapeutic applications can be attributed to the presence of bioactive constituents, such as tannins, flavonoids, alkaloids, and various aromatic compounds. These secondary metabolites not only contribute to the therapeutic potential of plants but also serve as natural defense mechanisms against microorganisms, insects, and herbivores.

Spectroscopic techniques have emerged as powerful analytical tools for both qualitative and quantitative analysis of pharmaceutical and biological materials. The characterization of secondary metabolites using chromatography and spectroscopy offers valuable insights into the composition and formulation of plant species. Additionally, these techniques enable the identification of unique chemical fingerprints and patterns, further enhanced by chemometric analysis for precise recognition and evaluation. FT-IR is a fast, non-destructive technique used to fingerprint plant extracts or powders, providing detailed

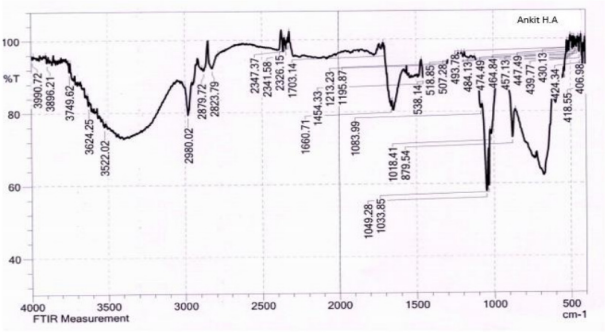

Figure 1: *Bauhinia racemosa* hydroalcoholic extract spectral analysis

Table 1: FTIR Interpretation of *Bauhinia racemosa* leaf hydroalcoholic extract

No	Wave number cm^{-1} [*Bauhinia racemosa*]	Wave number cm^{-1} [Chandra,2019]	Functional group assignment	Phyto compounds Identified
1.	507.28	500-600	C-I stretching	Halo compound
2.	518.85	515-690	C-Br stretching	Halo compound
3.	538.14	515-690	C-Br stretching	Halo compound
4.	879.54	860-900	C-H bending	1,3-disubstituted
5.	1018.41	1040-1050	C-F stretching	Fluoro compound
6.	1033.85	1020-1250	C-N stretching	Amine
7.	1049.28	1040-1050	CO-O-CO stretching	Anhydride
8.	1083.99	1020-1250	C-N stretching	Amine
9.	1195.99	1020-1250	C-N stretching	Amine
10.	1213.23	1020-1250	C-N stretching	Amine
11.	1454.33	1450	C-H bending	Alkane
12.	1660.71	1640-1690	C=N stretching	Imine / Oxime
13.	1703.14	1685-1710	C=O stretching	Conjugate aldehyde
14.	2326.15	2349	O=C=O stretching	Carbon dioxide
15.	2341.58	2349	O=C=O stretching	Carbon dioxide
16.	2347.37	2349	O=C=O stretching	Carbon dioxide
17.	2823.79	2500-3300	O-H stretching	Carboxylic acid, Phenols
18.	2879.72	2840-3000	C-H stretching	Alkane
20.	2980.02	2840-3000	C-H stretching	Alkane
21.	3522.02	3500	N-H stretching	Primary amine
22.	3624.25	3584-3700	O-H stretching	Alcohol
23.	3749.62	3700-3584	O-H stretching	Alcohol

insights into their chemical composition. Understanding the overall phytochemical properties of an extract relies significantly on functional group analysis. Furthermore, identifying functional groups plays a crucial role in assessing structure-activity relationships, providing valuable insights into the biological and chemical behavior of the compounds present (Dhivya and Kalaichelvi, 2017).

Therefore, in the present study FTIR technique has been employed to investigate hydroalcoholic solvent extract of *B. racemosa*. The FTIR analysis revealed the presence of various phytoconstituents, including alkaloids (N-H stretching), polyphenols, and flavonoids (O-H stretching), as well as terpenes (C-H stretching). The functional groups identified in the test plant include aldehydes, alkenes, amines, amides, alcohols, phenols,halo-compound, fluro-compound, carboxylic acids and anhydrides. These compounds are all classified as secondary metabolites, highlighting the plant's diverse phytochemical profile. The results are in agreement with Pramila and Jirekar (2023).

Conclusion

Overall, the findings suggest that the hydroalcoholic leaf extract of *B. racemosa* could serve as a potential source of phytoconstituents. The study highlights the need for further research to isolate and identify active molecules within the crude extract. Comprehensive investigations into the *in silico*, *in vitro*, and *in vivo* biological activities of these compounds are essential to uncover new and more effective plant-derived bioactives.

Acknowledgement

The authors are thankful to Mr. Vikas Jha (Senior analyst) National Facility for Bio-pharmaceutical for providing necessary laboratory facilities.

References

Ashokkumar R and Ramaswamy M (2014). Phytochemical screening by FTIR spectroscopic analysis of leaf extracts of selected Indian Medicinal plants. *Int. J. Curr. Microbio. Appl. Sci.* **3(1):** 395-406.

Bobby M N, Wesely E G and Johnson M (2012). FT-IR studies on the leaves of *Albizia lebbeck* benth. *Int. J. Pharm. Pharm. Sci.* **4(3):** 293-296.

Chandra, S. (2019). Fourier transform infrared (Ft-Ir) spectroscopic analysis of *Nicotiana plumbaginifolia* (Solanaceae). *J. Medi. Plants*, **7(1):** 82-85.

Dhivya SM and Kalaichelvi K (2017). UV-Vis spectroscopic and FTIR analysis of *Sarcostemma brevistigma*, wight. and arn. *Int. J. Herb. Medi.* **9(3):** 46-49. http:// dx.doi.org/10.22159/ijcpr.2017v9i3.18890

Dhivya K and Kalaichelvi K (2017). Screening of phytoconstituents, UV-VIS Spectrum and FTIR analysis of *Micrococca mercurialis* (L.) Benth. *Int. J. Herb. Med*, **5(6):** 40-44.

Gibson E L, Wardle J and Watts CJ (1998). Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. *Appetite.* **31(2):** 205-228. https://doi.org/10.1006/appe.1998.0180

Gupta M, Mazumder U K, Kumar R S and Kumar T S (2004). Antitumor activity and antioxident role of *Bauhinia racemosa* against Ehrlich ascites carcinoma in Swiss albino mice. *Acta Pharmacol Sin.* **25(8):** 1070-1076.

Hasler C M and Blumberg J B (1999). Phytochemicals: biochemistry and physiology. Introduction. *The Journal of nutrition.* **129(3):** 756S–757S. https://doi.org/10.1093/jn/129.3.756S

Hori R and Sugiyama J (2003). A combined FT-IR microscopy and principal component analysis on softwood cell walls. *Carbohydrate Polymers*.**52(4):** 449-453. https://doi.org/10.1016/S0144-8617(03)00013-4

Izhaki I (2002). The role of fruit traits in determining fruit removal in East Mediterranean ecosystems. In *Seed dispersal and frugivory: ecology, evolution and conservation. Third International Symposium-Workshop on Frugivores and Seed Dispersal, São Pedro, Brazil, 6-11 August 2000* pp. 161-175. Wallingford UK: CABI Publishing. https://doi.org/10.1079/9780851995250.0161

Kareru P G, Keriko J M, Gachanja A N and Kenji G M (2008). Direct detection of triterpenoid saponins in medicinal plants. *Afri. J. Traditional, Compl. and Alt. Med.* ***5*(1)**:56-60. https://doi.org/10.4314%2Fajtcam. v5i1.31257

Khan M I and Giridhar, P (2014). The berries of Santalum album L. as a new source of cyanidin-3-glucoside and chemical profiling during different stages of berry development. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*. **84:** 689-694. https://doi.org/10.1007/s40011-014-0312-0

Khan M I, Harsha P S, Giridhar P S C P and Ravishankar G A (2012). Pigment identification, nutritional composition, bioactivity, and in vitro cancer cell cytotoxicity of *Rivina humilis* L. berries, potential source of betalains. *LWT - Food Science and Technology* **47(2):** 315-323. https://doi.org/10.1016/j.lwt.2012.01.025

Khan M I, Harsha P S, Giridhar P and Ravishankar G A (2011). Pigment identification, antioxidant activity, and nutrient composition of *Tinospora cordifolia* (willd.) Miers ex Hook. f & Thoms fruit. *Int. j. food sci. nutri.* **62(3):** 239–249. https://doi.org/10.3109/09637486.2010.529069

Kumar T, Alexander A, Dewangan D, Khan J and Sharma M (2011). Investigation of in-vitro anthelmintic activity of *Bauhinia racemosa* linn. *J. Appl. Pharma. Sci.* **1(2):**73-75.

Mabasa X E, Mathomu L M, Madala N E, Musie E M and Sigidi M T (2021). Molecular Spectroscopic (FTIR and UV-Vis) and Hyphenated Chromatographic (UHPLC-qTOF-MS) Analysis and *In Vitro* Bioactivities of the *Momordica balsamina* Leaf Extract. *Biochem. res. int. 2021*, 2854217. https://doi.org/10.1155/2021/2854217

Mathai K (2000). Nutrition in the adult years. *Krause's food, nutrition, and diet therapy, 10th ed., ed. LK Mahan and S. Escott-Stump*, **271**, 274-275.

Murugananthan S, Anbalagan G and Ramamurthy N (2009). FT-IR and SEM-EDS comparative analysis of medicinal plants, Eclipta alba Hassk and Eclipta prostrata Linn. *Romanian Journal of Biophysics.* **19(4):** 285-294.

Panda P, Das D, Dash P and Ghosh G (2015). Therapeutic potential of *Bauhinia racemosa*-a mini review. *Int. J. Pharm. Sci. Rev. Res.* **32(2):** 169-179.

Pednekar P A, and Raman B (2013). Antimicrobial and antioxidant potential with FTIR analysis of *Ampelocissus latifolia* (Roxb.) Planch. leaves. *Asian J Pharm Clin Res.* **6(1):** 157-62.

Pramila G and Jirekar D (2023). Phytochemical Screening by FTIR spectroscopic analysis of leaf extracts of *Bauhinia racemosa*. WJPR. **12(19):** 625-632.

Ragavendran P, Sophia D, Arul Raj C, and Gopalakrishnan V K (2011). Functional group analysis of various extracts of *Aerva lanata* (L.,) by FTIR spectrum. *Pharmacologyonline.* **1,** 358-364.

Ramamurthy N and Kannan S (2007). Fourier transform infrared spectroscopic analysis of a plant (*Calotropis gigantea* Linn) from an industrial village, Cuddalore dt, Tamilnadu, India. *Romanian journal of Biophysics.* **17(4)**, 269-276.

Starlin T, Ragavendran P, Raj C A, Perumal P C and Gopalakrishnan V K (2012). Element and functional group analysis of Ichnocarpus frutescens R. Br.(Apocynaceae). *Int. J. Pharm. Pharm. Sci.* **4,** 343-345.

Surewicz W K, Mantsch H H and Chapman D (1993). Determination of protein secondary structure by Fourier transform infrared spectroscopy: a critical assessment. *Biochemistry.* **32(2)**, 389–394. https://doi.org/10.1021/bi00053a001

Wongsa P, Phatikulrungsun P and Prathumthong S (2022). FT-IR characteristics, phenolic profiles and inhibitory potential against digestive enzymes of 25 herbal infusions. *Scientific Reports*, **12(1)**, 6631.