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Research Article

Phytochemical Screening by FTIR Spectroscopic Analysis of Three Medicinal Plants

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ABSTRACT

The goal of the current work is to use FTIR spectroscopy to examine the aqueous and ethanol extracts of the leaves of Feronia limonia, Bauhinia racemosa, and Pongamia pinnata. The FTIR spectroscopy investigations of the extracts revealed various distinctive peak values with various functional groups. The FTIR examination of leaf extracts from feronia limonia, bauhinia racemosa, and pongamia pinnata confirmed the existence of prominent peaks for proteins, amino acids, alkaloids, glycosides, saponins, phytosterols, phenols, tanin, flavanoids, and carbohydrates. The characteristic peak values and their functional groups were found using the FTIR technique on a spectrophotometer instrument. These medicinally significant plants' FTIR spectrum profiles were created as a result of the current study's findings and can be applied in industries. The nature of the therapeutic action of these plants as understood from their chemical properties could be a novel approach to developing cost-effective and safe herbal formulations to deal with dermal disorders.

INTRODUCTION

India ranks as the world's twelfth megabiodiversity hotspot in terms of the abundance of medicinal and aromatic plants. The effectiveness depends on using the right plant component and on the biological activities of the plant, which in turn depend on the presence of the right quantity of various phytoconstituents. Feronia limonia, bauhinia racemosa, and pongamia pinnata have all been cited as potential treatments for various skin conditions and disorders in the Indian medical system. The current study was created to analyse the various functional groups found in these plant extracts based on this traditional use. Knowing the chemical makeup of the components found in medicinal plants can help us understand the functional groups that are responsible for their therapeutic effects. [1] Children with stomach issues are given the juice of Feronia limonia leaves because the leaves are fragrant and carminative.

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The leaves are an astringent and are helpful for nausea, hiccoughs, and dysentery. The leaves are traditionally used in Ayurveda to treat anorexia, bronchitis, calculus, cardiac debility, cough, diarrhoea, and gastropathy. They are also antiemetic, fragrant, astringent, carminative, cardiotonic, expectorant, and purgative. The bark is helpful in liver problems and sporadically prescribed for biliousness [2].

The plant Bauhinia racemosa is a member of the Caesalpiniaceae family, sometimes referred to as "Sittacha" in Tamil and utilised in traditional medicine to cure a variety of illnesses. An astringent, the plant's stem bark is used to cure tumours, headaches, fever, and skin conditions [3–4]. The bark is effective in the Ayurvedic treatment of diarrhoea, dysentery, and malaria. In addition to curing biliousness, urinary discharges, thirst headaches, quartan fever, vatta, anal fistula, tuberculous glands, skin diseases, throat problems, tumours, diseases of the blood, and chronic dysentery and diarrhoea, the bark and leaves are also cooling, antipyretic, astringent, and vermicidal [5–6]. Santhals give root bark decoction with paste of black peppers to epileptic patients [7-8].

Pongamia pinnata has been approved for use in numerous traditional medical systems to treat a variety of human diseases and afflictions. Pongamia pinnata seed extract has hypotensive effects and causes uterine contractions. Whooping cough, chronic skin illnesses, bronchitis, persistent fever, and painful rheumatic joints are all treated with powdered seed. Scabies, leprosy, piles, ulcers, chronic fever, lever pain, and lumbago are all treated with seed oil. Its oil can be used to make biodiesel and is also used as a cooking and lighting fuel. It also has an alternative energy source that is pollution-free, safe, and renewable. Juice from the leaves is used to treat gonorrhoea, leprosy, diarrhoea, dyspepsia, and flatulence. Roots can be used to clean teeth, gums, and ulcers. For bleeding piles, bark is ingested. The plant's juices and oil both have antiseptic properties. The Pongamia pinnata plant is utilised for anti-inflammatory, anti-plasmodial, anti-nociceptive, anti-hyperglycaemic, anti-lipidoxidative, anti-diarrheal, anti-ulcer, anti-hyperammonic, CNS depressive action, and antioxidant properties in traditional medical systems like Ayurveda and Unani [9]. Alkaloids, flavonoids, essential oils, and other families of chemicals are examples of compounds whose qualities are linked to natural products. Due to the following factors, near-infrared spectroscopy has grown in importance over the years as one of the most crucial tools for analysis: it is a non-invasive analytical tool that enables quick and simultaneous qualitative and quantitative determination of natural products and their constituents. The formation of the infrared spectrum results from the electromagnetic radiation's absorption at frequencies that correspond to the vibration of particular sets of chemical bonds from within a molecule [10]. In order to rationally permit its application aspect in modern herbal medications, the present study aims to discover the functional groups and phytoconstituents found in ethanol and aqueous extracts of various plants [10–11].

MATERIALS AND METHODS:

From the Kada area, feronia limonia, bauhinia racemosa, and pongamia pinnata leaves are harvested. Anandrao Dhonde, also known as Babaji Mahavidyalaya Kada, a botanist in the department of botany, recognised the plant leaves. To get rid of any earthy material, dirt, or other contaminants, plant components were carefully cleaned with distilled water. To preserve the fresh green colour of the plant material and to stop the loss of active chemicals, it was dried at room temperature under shade. The dried plant material was ground into a coarse powder and extracted

with ethanol and aqueous solvent before being kept in an airtight container.

PHYTOCHEMICAL ANALYSIS:

The following qualitative chemical analyses were performed on aqueous and ethanolic extracts of feronia limonia, bauhinia racemosa, and pongamia pinnata constituents in order to identify the various phytoconstituents present [12].

Fourier Transform Infrared Spectrophotometer (FTIR):

The concentrated extracts of *feronia limonia, bauhinia racemosa and pongamia pinnata* were used for FTIR analysis in Perkin Elmer Spectrum Version model.

RESULT AND DISCUSSION:

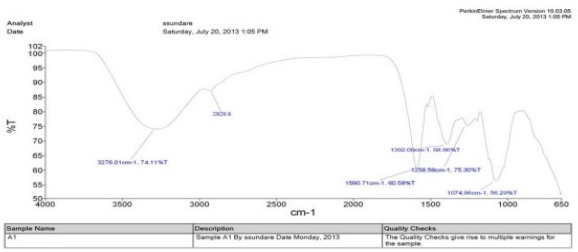
Table:1. Preliminary phytochemical screening of the aqueous extracts of plants.

Sr. No.	Phytochemicals	Feronia limonia	Bauhinia Racemosa	Pongamia pinnata
1	Carbohydrate	-	+	+
2	Alkaloid	--	+	+
3	Glycoside		+	+
4	Saponin	+	+	+
5	Phytosterol	-	+	+
6	Phenol	-	+	+
7	Tanin	-	+	+
8	Flavanoid	-	+	+
9	Protein and amino acid	+	-	-

Table: 2. Preliminary phytochemical screening of the ethanolic extracts of plants.

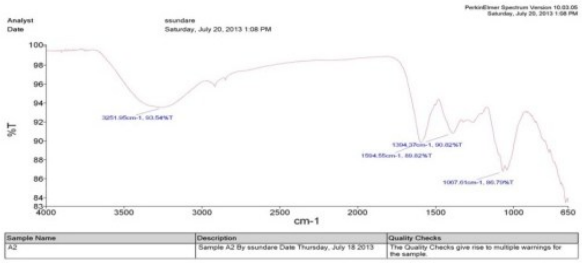
Sr. No.	Phytochemicals	Feronia limonia	Bauhinia Racemosa	Pongamia pinnata
1	Carbohydrate	+	+	+
2	Alkaloid	+	+	+
3	Glycoside	-	-	+
4	Saponin	+	-	+
5	Phytosterol	-	-	-
6	Phenol	+	-	+
7	Tanin	+	+	+
8	Flavanoid	+	+	+
9	Protein and amino acid	+	+	+

Figures 1 to 6 show the FTIR spectra for the leaves of Feronia limonia, Bauhinia racemosa, and Pongamia pinnata that were produced in water and ethanol. The information in tables 1 to 3 FTIR study of leaf extracts from feronia limonia, bauhinia racemosa, and pongamia pinnata revealed peak values, along with the likely functional Group. The descriptions of FTIR spectra results that can be used to effectively employ plant extracts are provided below.



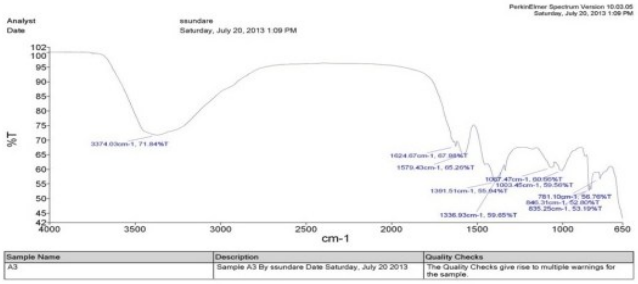
(a)

***Fig. (a): Feronia limonia* in aqueous extract**



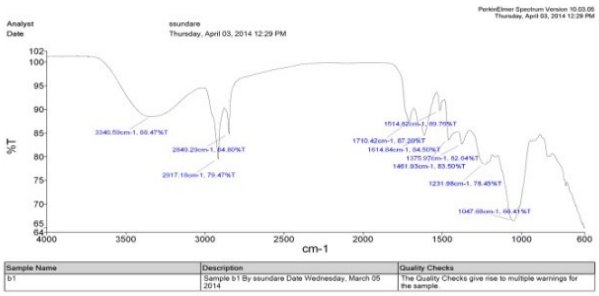
(b)

***Fig. (b): Bauhinia Racemosa* in aqueous extract**



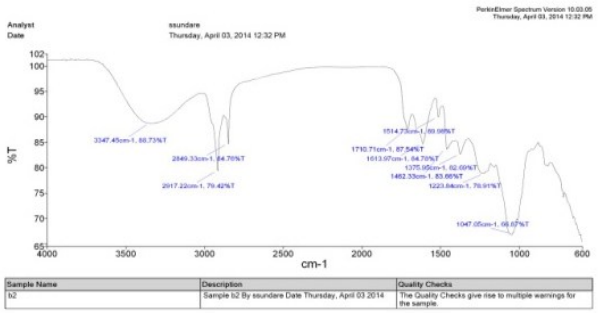
(c)

***Fig. (c): Pongamia pinnata in* aqueous extract.**



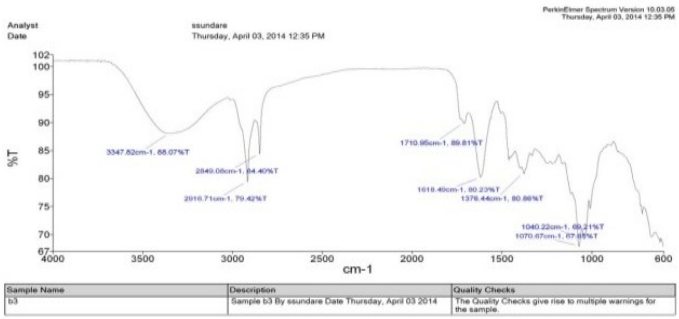
(a)

***Fig. (a): Feronia limonia* in ethanol extract**



(b)

***Fig. (b): Bauhinia Racemosa* in ethanol extract**



(c)

***Fig. (c): Pongamia pinnata in* ethanol extract**

Table: 3. *Feronia limonia* in aqueous extract:

Peak No.	Extract prepared in	Frequency cm^{-1}	Types of functional group
1	Aqueous medium	3276	N-H stretching
2		2929	C-H stretching
3		1590	Asymmetric stretching NO_2
4		1392,	symmetric stretching NO_2
5		1258	C-O of Ether
6		1074	C-O of Ether
1	Ethanol medium	3340	O-H stretching
2		2917	C-H stretching
3		2840	C-H stretching
4		1710	C=O group
5		1614,	C=C group
6		1514,	C-C stretching
7		1375	C-O stretching
8		1461	C=C of benzene ring
9		1231	C=C-O-C symmetric stretching
10		1047	C-OH stretching

Table :4. *Bauhinia Racemosa* in aqueous extract:

Peak No.	Extract prepared in	Frequency cm^{-1}	Types of functional group
1	Aqueous medium	3251	O-H stretching
2		1594	C=C stretching
3		1394	-NO_2 group
4		1067	C-O stretching
1	Ethanol medium	3347	O-H stretching
2		2917	C-H stretching
3		2849	C-H stretching
4		1710	C=O group
5		1613	C=C stretching of benzene ring
6		1514	C=C-C stretching of benzene ring
7		1462	C=C of benzene ring
8		1375	-NO_2 group
9		1223	C=C-O-C symmetric stretching
10		1047	C-OH stretching

Table:5. *Pongamia pinnata* in aqueous extract:

Peak No.	Extract prepared in	Frequency (cm^{-1})	Types of functional group
1	aqueous	3374	O-H stretching
2		1624	C=C stretching
3		1579	C=C stretching
4		1391	C-C of benzene ring
5		1067	C-O stretching
6		846	Unknown

7		835	Meta substituted benzene ring
8		781	Para substituted benzene ring
1	Ethanol	3347	O-H stretching
2		2849	C-H stretching
3		2916	C-H stretching
4		1710	C=O group
5		1618	C=C group
6		1376	$-NO_{2\ group}$ stretching
7		1070	C-H stretching
8		1040	C-H stretching

Due to C-H stretching connected to an aromatic ring, Feromia limonia contains a distinctive peak of 2929 cm^{-1} in its aqueous extract. Due to asymmetric and symmetric stretching of the -NO2 group, respectively, the bands at 1590 cm^{-1} and 1392 cm^{-1} are present. The N-H and C-H stretching of the alkyl group are responsible for the peak at 3276 cm^{-1} and 2929 cm^{-1}, respectively.

The peaks at 3340 cm^{-1} and 2849 cm^{-1} in the ethanolic extract are caused by the -CHO group's O-H and C-H stretches, respectively. The peaks at 2917 $cm^{-1}$and 1710 cm^{-1} are caused by the stretching of C-H and C=O, respectively. The band at 1231 cm^{-1} was discovered as a result of the aromatic ether's asymmetric C-O-C stretching. The presence of the benzene ring was confirmed by the band at 1461 cm^{-1}. Due to O-H stretching, the peak of the Bauhinia racemosa aqueous extract is 3251 cm^{-1}. The stretching of C=C caused the peak at 1594 cm^{-1}. The -NO2 group is responsible for the band at 1394 cm^{-1}. the peak that C-O stretching produced, measuring 1067 cm^{-1}.

The Bauhinia racemosa ethanolic extract the peak at 3347 cm^{-1}, 2917 cm^{-1}, and 2849 cm^{-1} caused by the stretching of the O-H and C-H. The presence of a benzene ring is confirmed by bands at 1613 cm^{-1}, 1514 cm^{-1}, and 1462 cm^{-1}. The band caused by the NO2 group was detected at 1375 cm^{-1}. Due to stretching of the C-OH group and the keto (C=O) group, the band at 1710 cm^{-1} and 1047 cm^{-1}.

Due to O-H stretching, an absorption band at 3400 cm^{-1} was discovered. The presence of the benzene ring is confirmed by the peaks at 1624 cm^{-1} and 1579 cm^{-1}. Due to -NO2 and C-O stretching, the band appears at 1391 cm^{-1} and 1067 cm^{-1} respectively. The band at 781 cm^{-1} and 835 cm^{-1} is caused by benzene that has been meta- and parasubstituted. These bands can all be seen in the aqueous extract.

Due to O-H stretching, the ethanolic extract of Pongamia pinnata exhibits an absorption band at 3347 cm^{-1}. Stretching of the C-H results in the band at 2849 cm^{-1} and 2916 cm^{-1}, respectively. The keto (C=O) group is responsible for the band at 1710 cm^{-1} and 1618 cm^{-1}. Due to symmetric and asymmetric stretching of the -NO2 group, the band at 1376 cm^{-1} forms. Due to C-H stretching, the band appears at 1040 cm^{-1} and 1070 cm^{-1}.

The presence of bound N-H/C-H/O-H stretching of amines and amides may be the cause of the extremely strong absorption band seen between 3373 and 3422 cm^{-1}.[13] The presence of amino acids is indicated by the extremely strong absorption band seen in the 1600–1660 cm^{-1} area. The presence of polymeric hydroxyl derivatives is indicated by the high absorption band between 3200 and 3400 cm^{-1}. Primary amine can be detected by N-H vibration.[14] The methylene group in aliphatic molecules exhibits C-H symmetric stretching in the band seen at about 2848 cm^{-1}. [14-15] The region of C=C stretching

occurs between 1511 and 1561 cm^{-1}. Similar to this, the Chelated C=O stretching vibrations are in the 1621–1635 cm^{-1} range and are located on the lower wave number side.[16]. The lack of absorbance between 2220 and 2260 cm^{-1} suggests that none of the medicinal plant extracts used included any cyanide groups. This demonstrates that the study's sampled did not include any hazardous materials.[17].

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