Original Research Article

FTIR spectroscopic analysis of phytochemical extracts from *Hibiscus rosa–sinensis* L. used for hair disorder

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Abstract

Functional group(s) associated with phytochemical compounds are primarily understood from FTIR spectroscopy. The presence of functional groups in medicinally used plant part extracts of *Hibiscus rosa–sinensis* L. revealed 8 number of peak values for water extract; 17 numbers for Ethanol extract; 16 numbers for Methanol and 13 numbers for Petroleum ether extracts respectively. The FT-IR study further indicates the presence of phosphorous and sulphur functions associated with flower and leaf extracts in hot Ethanol and Methanol. Use of *Japā / Javākusum* (*Hibiscus rosa–sinensis*) is found in Sanskrit medical text of *Mādhava Cikitsā* for treatment to hair disorders. The present study highlights the use and efficacy of *Hibiscus* in Sanskrit medical texts due to the presence of such functional groups and functions. The nature of therapeutic action of *Hibiscus* as understood from its chemical properties could be a novel approach in developing safer and cost effective Ayurvedic products to deal with hair disorders.

Key Words: FTIR, *Javākusum*, phytochemical, *Hibiscus rosa-sinensis, Mādhava Cikitsā.*

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INTRODUCTION

According to Australian Hibiscus Society Inc., *Hibiscus rosa – sinensis* was named in 1753 by Carl Linnaeus in his Species Plantarum[1]. *Hibiscus* species have a number of variants in flower colour ranging from white to yellow; orange to scarlet and pink shades and also in shape of flower in both single and double forms with other compatible species[2]. Dark red colour flowers (China rose) also known as blackening plant has been used for blackening of hair as well as in the tropics to polish the shoes[3]. The herbs and plant extracts have been used for the treatment and management of diseases or health disorders in medical practices from ancient period[4]. *Mādhava Cikitsā*, an important Sanskrit Medical treatise (but still not widely studied) of India in its text quoted the name of *Javākusum* (or *Japā*) that botanically identified as *Hibiscus rosa–sinensis* L. only time in one shloka under *Kshudraroga cikitsā* explaining its use along with other plants for treatment of hair disorders, especially for premature hair graying and hair loss resulting into baldness. But interestingly, all market products today for hair management use *Hibiscus* as one constituent in their respective preparations. Hence, it became a point for investigation and to know more of the phytochemicals of *Hibiscus* for rationalizing its use. Egwaikhide (2007)[3] in his study highlighted FTIR analysis of different medicinal plant extracts and confirmed the presence of amide, alcohols, phenols, alkanes, carboxylic acid, esters, ethers, amines, aldehydes and aromatic compounds, etc. with major peaks. FTIR findings have played a very important role in pharmaceutical preparations in recent years[5,6]. FTIR has also been used as a valuable tool for differentiating, classifying and selecting closely related microbial strains, plant species and other organisms[7,8]. World Health Organization (WHO) described plant as a unit with one or more organs, which contain substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs[9]. These substances are extracted from plant parts in different solvent systems as phytochemicals and further analysis of

these using modern tools and techniques reveal the functional groups and functions associated with the compounds for understanding the medicinal or therapeutic properties of the compounds and the plants. The present study is therefore aimed at identifying the functional groups and phytoconstituents in different solvent extracts of flower and leaf parts of *Hibiscus rosa –sinensis* by FTIR spectroscopic analysis that could logically enable its applied aspect in present day herbal requirements.

MATERIALS AND METHODS

Plant materials: Healthy flowers and leaves of *Hibiscus rosa–sinensis* were collected between June 2017 to Nov 2017 from local gardens at Latur. Healthy plant materials were washed under running tap water to remove the dust and other external pollutants. The plant materials were then kept in shade for around 15-20 days for drying. The dried flowers and leaves were grinded to fine powder in a mixer individually and the powder was stored in clean dry bottles separately.

Preparation of plant extract: Soxhlet extraction: Soxhlet extraction of 20 g plant powder material was done in 150 ml volume using different solvents like ethanol, methanol and petroleum ether individually. Extraction cycles were continued till complete recovery of all the dissolved plant material. The extracts were then concentrated in petridishes at room temperature and stored in a refrigerator in air tight bottles for further analysis[10]. Preparation of Soxhlet extracts was done for flowers and of leaves.

Fourier Transform Infrared Spectrophotometer (FTIR): Concentrated herbal extracts of flower and leaf of *Hibiscus rosa-sinensis* were used for FTIR analysis in Parkin Elmer. model no L1600401 Spectrum Two DTGS Serial Number 107435, UK with a scan range from 400 to 4000cm^{-1} as per instrument manual.

RESULT AND DISCUSSION

The FTIR spectra for flower and leaf extracts prepared in different solvents of *Hibiscus rosa-sinensis* are represented in figure 1 to 8. The data in the table 1 and 2 show peak values present in the flower and leaf extracts as obtained by FTIR analysis and the probable functional groups, used to predict the chemical and biological activities of biomolecules. Following descriptions are FTIR results that could be interpreted for effective use of the plant products.

FTIR studies: Water extracts of flower and leaf (WEFL): Water extract of *Hibiscus* Flower (WFE) exhibited the characteristic bands at 3307.11cm^{-1} indicating the presence of alcohol and phenol (O-H) groups, and at 1635.90 cm^{-1} for carbonyl (C=O) group. Interestingly, observation of leaf extract in water (WEL) showed bands at 3368.71cm^{-1} indicating the presence of amines (N-H) group, at 2926.85 cm^{-1} for (C-H) stretching, at 1626.43 cm^{-1}, at 1400.05 cm^{-1} for aldehyde (C-CHO) group, at 1053.78 cm^{-1} for sulfoxide (S=O) group and at 597.32 cm^{-1} (Unknown) group.

Ethanol extracts of flower and leaf (EEFL): Ethanol extract of *Hibiscus* flower (EFE) exhibited the characteristic bands at 3306.99 cm^{-1} indicating the presence of amines (N-H) group, at 2982.08 cm^{-1} presence of alkane (C-H) group, at 1639.23 cm^{-1} for carbonyl (C=O) group, at 1385.20 cm^{-1} of tert-Butyl CH_3 group, and peak band at 877.03 cm^{-1} indicating sulfur function as ester (S-OR) group. The ethanol extract of leaf showed bands at 2975.20 cm^{-1} indicating the presence of aromatic C-H stretching, at 1087.56 cm^{-1} with (C-O-C) stretching group, at 2926.85 cm^{-1} for (C-H) stretching, at 1626.43 cm^{-1}, at 1400.05 cm^{-1} aldehyde (C-CHO) group, at 1044.77 cm^{-1} (C-O) valence vibration polysaccharide, and sulfur functions (S-S) disulfide groups at peak value 534.65 cm^{-1} and 512.65 cm^{-1} respectively.

Methanol extracts of flower and leaf (MEFL): Methanol extract of *Hibiscus* flower (MFE) exhibited the characteristic bands at 3339.31 cm^{-1} indicating the presence of amines (N-H) group as well as band at 533.63 cm^{-1} indicating presence of sulfur functions disulfide (S-S) groups. Methanol extract of leaf bands were observed at peak value 3338.93 cm^{-1} showing presence of amines (N-H) group, at 1684.74 cm^{-1} indicating alkene (C=C) group, and function of phosphine at peak value 1080. 90 cm^{-1} with (PH_3) bending.

Petroleum ether extracts of flower and leaf (PEEFL): Petroleum ether extract of *Hibiscus* flower (PEFE) exhibited the characteristic bands at at 1335.73 cm^{-1} indicating the presence of nitro compounds (N=O) group, at 1001.46 cm^{-1} ethers (R-O-R) group and at 764.31 cm^{-1} presence of alkenes (C-H) group. The petroleum extract of leaf had peak value at 2881.19 cm^{-1} indicating the presence of alkane (C-H) group, oxidised nitrogen functions (N=O) at peak value 1525.29 cm^{-1} and at 1334.72 cm^{-1}, for amines (C-N) group at 1002 cm^{-1} and at 764.89 cm^{-1} presence of esters (S-OR) group.

As per study of Muruganantham (2009)[11] FTIR spectral analysis of medicinal plant parts like leaf, stem and roots of *Eclipta alba* Hassk and *Eclipta prostrate* Linn. reported the presence of carboxylic acids, amines, amides, sulphur derivatives. As per the investigation of Yamunadevi (2012)[12] the FTIR analysis results of *A. lanata* stem validated the presence of amide, alcohols, phenols, amines, alkanes, ketones, primary amines, nitro compounds, alcohols, carboxylic acids, esters, ethers, alkyl halides and aliphatic amines.

Table 1: FTIR spectral peak values and functional groups obtained for flower extract of *Hibiscus rosa–sinensis*

Sr. No.	Peaks value in WEF	Type of functional group	Peaks value in EEF	Type of functional group	Peaks value in MEF	Type of functional group	Peaks value in PEEF	Type of functional group
1	3307.11	O-H	3306.99	N-H	3339.31	N-H	2024.39	Unknown
2	1635.90	C=O	2982.08	C-H	604.94	R-X	1526.82	-C—C-
3			1639.23	C=O	592.71	Unknown	1403.14	$-NO_2$
4			1385.20	CH_3	570.05	Unknown	1335.73	$-NO_2$
5			1085.52	C-N	559.26	Unknown	1001.46	Unknown
6			1044.34	C-N	548.04	CH_3	764.31	Unknown
7			877.03	S-OR	533.63	S-S		
8					524.01	Unknown		
9					477.10	C_6H_{12}		
10					453.61	Unknown		

WEF- water extract of flower; EEF-ethanol extract of flower; MEF- methanol extract of flower; PEEF- petroleum ether extract of flower

Table 2: FT-IR spectral peak values and functional groups obtained for leaf extract of *Hibiscus rosa–sinensis*

Sr. No.	Peaks value in WEL	Type of functional group	Peaks value in EEL	Type of functional group	Peaks value in MEL	Type of functional group	Peaks value in PEEL	Type of functional group
1	3368.71	O-H	2975.20	C-H	3338.93	N-H	2881.19	C-H
2	2926.85	C-H	1087.56	C-O-C	2020.41	Unknown	2024.41	Unknown
3	1626.43	C=C	1044.77	C-O	1634.74	C=C	1525.29	N=O
4	1400.05	C-CHO	879.20	S-OR	1080.90	PH_3	1402.96	S=O
5	1053.78	S=O	594.23	Unknown	550.05	Unknown	1334.72	N=O
6	597.32		567.84	Unknown	463.95	Unknown	1002.42	C-N
7			534.65	S-S			764.89	S-OR
8			512.65	S-S				
9			479.02	Unknown				
10			457.70	Unknown				

WEL- water extract of leaf; EEL-ethanol extract of leaf; MEL- methanol extract of leaf; PEEL- petroleum ether extract of leaf

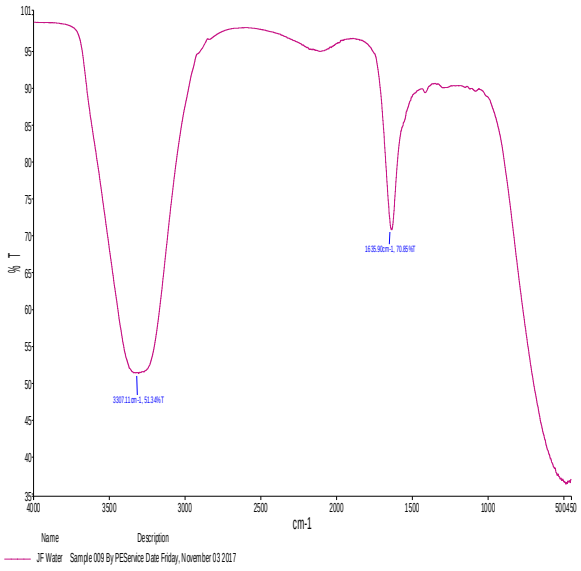


Figure 1:

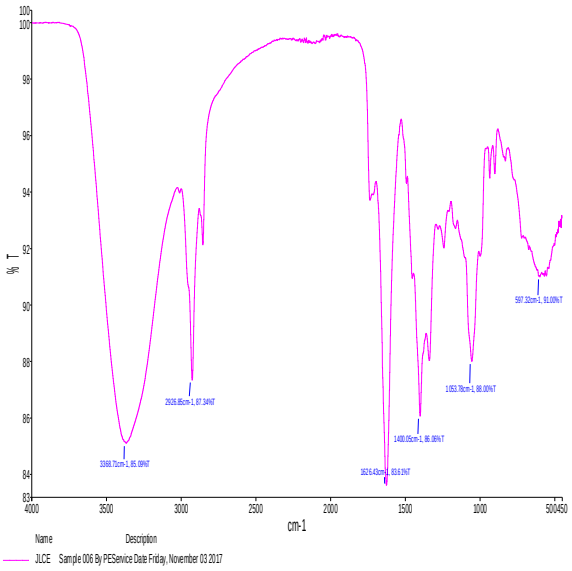


Figure 2:

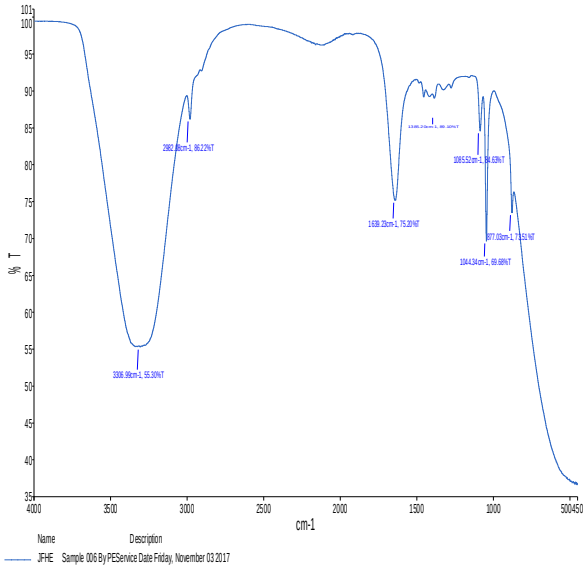


Figure 3:

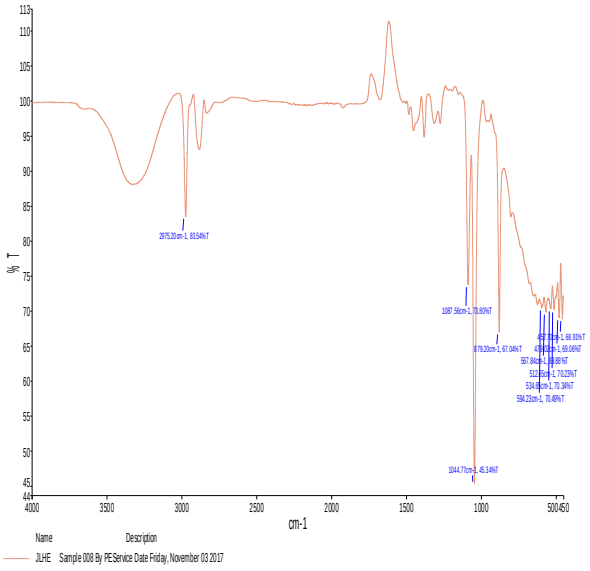


Figure 4:

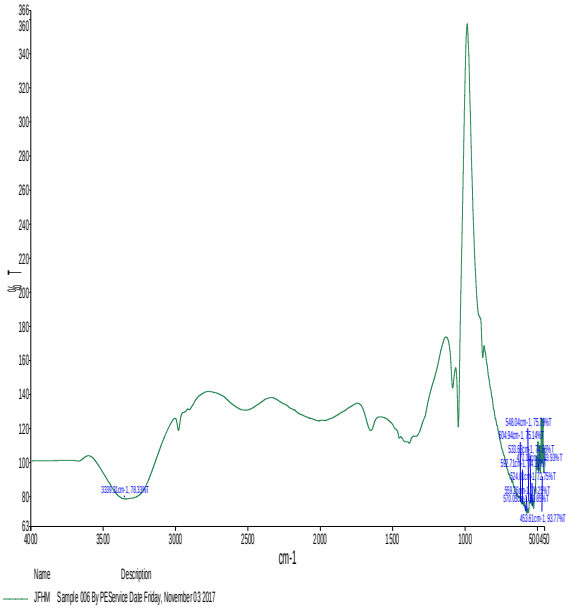
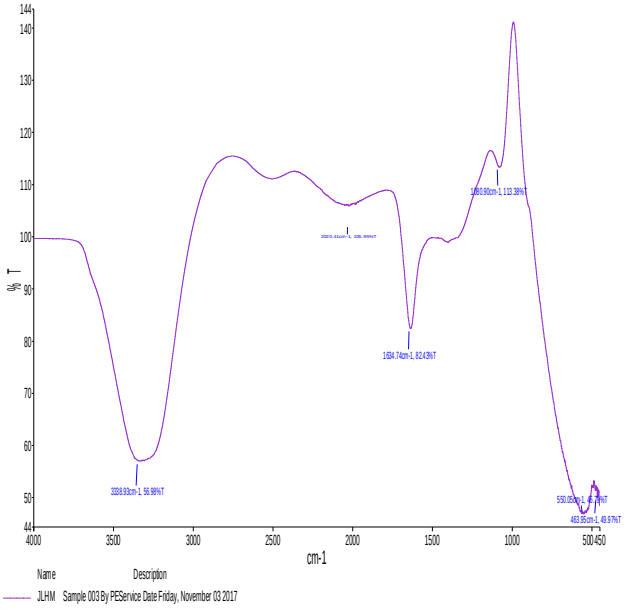


Figure 5:



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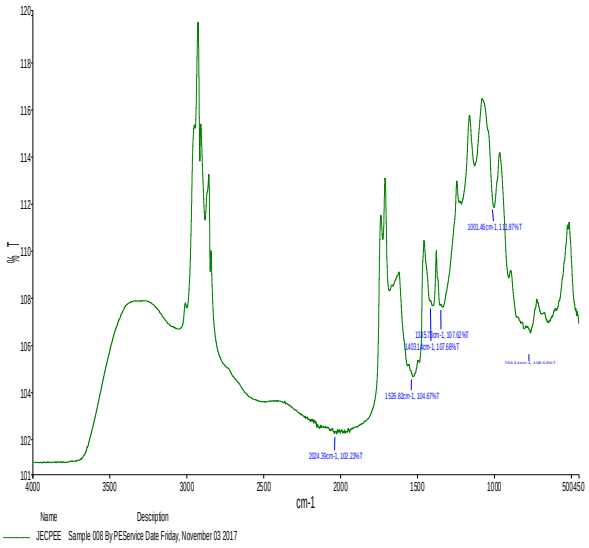

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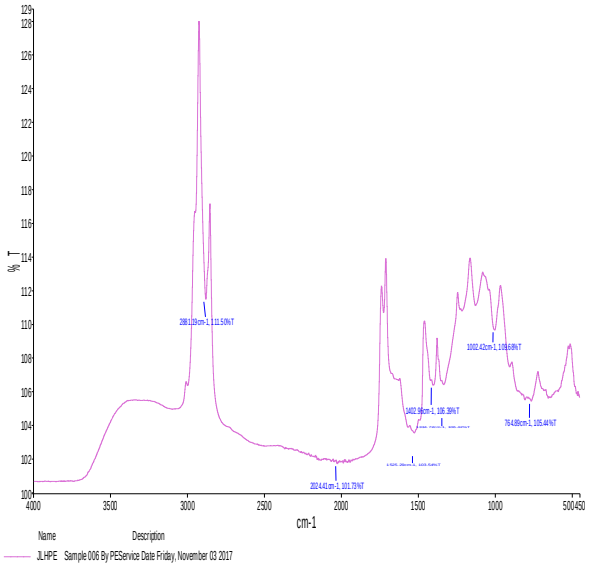

Figure 8:

Figure 1: FTIR spectrum of WEF of *Hibiscus;* **Figure 2:** FTIR spectrum of WEL of *Hibiscus;* **Figure 3:** FTIR spectrum of EEF of *Hibiscus;* **Figure 4:** FTIR spectrum of EEL of *Hibiscus;* **Figure 5:** FTIR spectrum of MEF of *Hibiscus;* **Figure 6:** FTIR spectrum of MEL of *Hibiscus;* **Figure 7:** FTIR spectrum of PEEF of *Hibiscus;* **Figure 8:** FTIR spectrum of PEEL of *Hibiscus*

This present FTIR study revealed 17 different functional groups including two important functions like phosphine and sulphur derivatives being associated with *Hibiscus* flower and leaf parts, out of which many are known for their molecular characteristics and therapeutic actions. The reduction of disulfide bonds helping to maintain the molecular weight of keratin and increasing the efficiency of dissolution of the phyto compounds are mainly monitored by phosphine group (Buultjens et al 1990)[13]. Presence of phosphine in *Hibiscus* therefore relates the importance of its leaf as a constituent in the hair oils and hair treatments. Further, the hot methanolic extract of flower and ethanolic extract of leaf contained more possible functional groups than other solvent extracts. Functional groups like amines act as conditioners and antioxidants. Cationic molecules provide stability due to their attraction to negatively charged damaged hair surfaces and improve the shine and colour of the hair reducing static electricity. (Bhushan and chen, 2006)[14]. Similarly fatty alcohol helps in easy spreading of hair products when applied on dry hairs to make it soft, greasy oily and smooth (La Torre et.al, 2006)[15]. The functional additives control the viscosity, enhance colour, scent and act as medically active ingredient that help in hair disorder treatment and management. Thus, FTIR data collected could be supportive for process development and formulation of safe and effective hair products from *Hibiscus* in future.

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