

## Phytochemical Screening and Functional Groups Identification of *Cardiospermum halicacabum* L. Leaves

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**Background:** The phytochemical components are extremely important to facilitate the search for the particular effectiveness of the plant in medicine. Identification of the chemical nature of phytochemical compounds present in medicinal plants will provide information about the various functional groups responsible for its medicinal properties. Thus, the need to investigate the phytochemicals from various plants has been exponentially increasing. *Cardiospermum halicacabum* L. is one of the most important medicinal plants belonging to the Sapindaceae family. This investigation was administered to study phytochemical and FT-IR analysis of a various solvent extracts of *Cardiospermum halicacabum* L. leaves.

**Results:** The preliminary phytochemical analysis of *Cardiospermum halicacabum* L. leaves extract revealed the presence of carbohydrates, glycosides, alkaloids, phytosterol, fixed oils, saponins, proteins, and amino acids, phenolic compounds, flavonoids, and tannins. As a result, the phytochemical analysis of aqueous extracts revealed the presence of more phyto components followed by petroleum ether, and chloroform extracts. FT-IR spectroscopy confirmed the existence of various chemical components such as alcohol, alkanes, aromatic compound, carboxylic acid, aldehydes, alkenes, amides, nitro compounds and alkyl halides in the leaves extract of *C. halicacabum* L. The functional groups observed in the various extracts probably indicate the presence of carbohydrates, glycosides, alkaloids, amino acids, phenols, flavonoids, tannins, and saponins. The results obtained from FTIR analysis are significant with the preliminary qualitative analysis.

**Conclusions:** Extractions of any crude drug with a certain solvent result in a solution that contains various phyto-components. The composition of these phyto-components in the respective solvent provides initial information about the quality of a drug sample. The presence or absence of a certain component plays an important role in the decision about the medicinal properties of the plant. As a result, the phytochemical analysis of aqueous extracts revealed the presence of more phyto-components followed by petroleum ether, and chloroform extracts which can be beneficial in a therapeutic approach.

*Key words:* *Cardiospermum halicacabum*, Various solvents, FT-IR analysis, Functional groups, Phytochemical screening.

Today, in this modern world highly effective synthetic drugs are readily available but have a long list of possible bad side effects. Because of this, many people rely on herbal medicines which can provide new inputs into the drug development strategy. Herbal medicine is based on traditional medicine and exists all over the world. Each of these traditional medicines has its origin and a private basic philosophy (Vogel, 2003). India is one of the countries with the greatest medical and cultural diversity in the world (Archana Sharma *et al.*, 2013). Herbal medicines are on the advance in developing countries, and herbal medicines are now firmly established in medical care (Mukerjee and Verpoorte, 2003).

The medicinal properties of any plant are due to the presence of a variety of secondary metabolites in them. Phytochemicals are naturally found in medicinal plants in all the parts namely, leaves, stems, and roots which play an important role in curing diseases. The phytochemical components are extremely important to facilitate the search for the particular effectiveness of the plant in medicine. Thus, the need to investigate the phytochemicals from various plants has been exponentially increasing.

Fourier transform infrared spectroscopy is perhaps the most generally utilized technique for classifying chemical components and has been used in several countries as a necessary method for identifying drugs for the pharmacopeia (Subashini *et al.*, 2015). FTIR spectroscopy is considered to be a reliable and sensitive method for detecting functional groups in plant extracts, and it has been determined in the IR range of 400-4000  $\text{cm}^{-1}$  (Florence and Jeeva, 2015). This may be the most important and authoritative method to determine the types of chemical groups (functional groups) present in a compound. The wavelength of the fascinated light is a characteristic of the chemical bond which might be seen in the annotated spectrum (Sahayaraja *et al.*, 2015). Identification of the chemical nature of phytochemicals contained in medicinal plants provides information about the various functional groups responsible for their medicinal properties.

*Cardiospermum halicacabum* L. is one of the most important medicinal plants of the Sapindaceae family. The local names for this plant are Balloon vine, Puff-ball, Heartseed Vine, Heart pea, Love in a puff (Krishna Murti *et al.*, 2010). *C. halicacabum* contains certain phytochemicals that support its role in the medicinal field. It has anti-inflammatory, antidiarrheal, antiparasitic, antipyretic, antifungal, anxiolytic activity, adulticidal activities, urinary tract infections suppression, and antihyperglycemic properties (Asha and Ushpangadan, 1999; Khunkitti *et al.*, 2000; Selloum *et al.*, 2003; Sheeba and Asha, 2009; Veeramani *et al.*, 2015). Its chemical constituents are well documented (Harborne, 1998; Deepan *et al.*, 2012; Sagadevan *et al.*, 2013; Annadurai *et al.*, 2013; Mohaddesi *et al.*, 2016; Vadivazhagi, 2020). The purpose of this study is to use FT-IR analysis to determine the functional groups of various *Cardiospermum halicacabum* leaf extracts.

## MATERIALS AND METHODS

### Collection and processing of plant material

*Cardiospermum halicacabum* L. was collected in February 2021 in Rettaimalai, Tiruchirappalli District, Tamil Nadu, and South India. The collected plants were washed with water to remove soil and dust. The plant material was dried for four to five days in the shade and cut into small pieces, then grind into a coarse powder. The powder was used to extract the active ingredients.

### Extraction of the plant material

The coarse powder was placed in the Soxhlet apparatus and extracted successively with various solvents such as aqueous, petroleum ether, and chloroform. The extract was then filtered and evaporated on a rotary evaporator. The dried extracts were stored in the refrigerator for further experiments.

### Preliminary phytochemical studies

The leaf extract of various solvents was qualitatively determined for the presence of alkaloids, carbohydrates, glycosides, proteins and free amino acids, fixed oils, phenolic compounds, tannins, flavonoids, saponins, and sterols according to the standard method provided by Harborne, (1998).

### FTIR analysis

The Fourier Transform Infrared Spectrophotometer (FTIR) is perhaps the most powerful tool for identifying the different types of chemical bonds (functional groups) present in compounds. The wavelength of the absorbed light is characteristic of the attraction, which can be seen across the entire spectrum. Chemical bonds in a molecule can be determined based on its IR absorption spectrum. Dry powder from various solvent extracts of plant material was utilized for the FTIR examination. 10 mg of the dry extract powder was packed in 100 mg of KBr pellet, to prepare translucent sample disks. The powder sample was placed in a Fourier transform IR spectroscope (PERKIN ELMER, IR) with a scanning range from 400 to 4000  $\text{cm}^{-1}$  with a resolution of 4  $\text{cm}^{-1}$ .

## RESULTS

### Preliminary phytochemical studies

Preliminary phytochemical screening of the *C. halicacabum* leaf extract of various solvents (aqueous, petroleum ether, and chloroform) presented in Table 1. The preliminary phytochemical analysis of aqueous leaf extract revealed the presence of seven compounds i.e. carbohydrates, glycosides, alkaloids, fixed oils, saponins, phenolic compounds, tannins, and absence of phytosterols, proteins, and flavonoids. Petroleum ether leaf extract revealed the presence of 6 compounds i.e. carbohydrates, glycosides, phytosterol, saponins, proteins, and flavonoids. Preliminary phytochemical analysis of Chloroform and extract revealed the presence of 3 compounds such as alkaloids, fixed oils, and saponins.

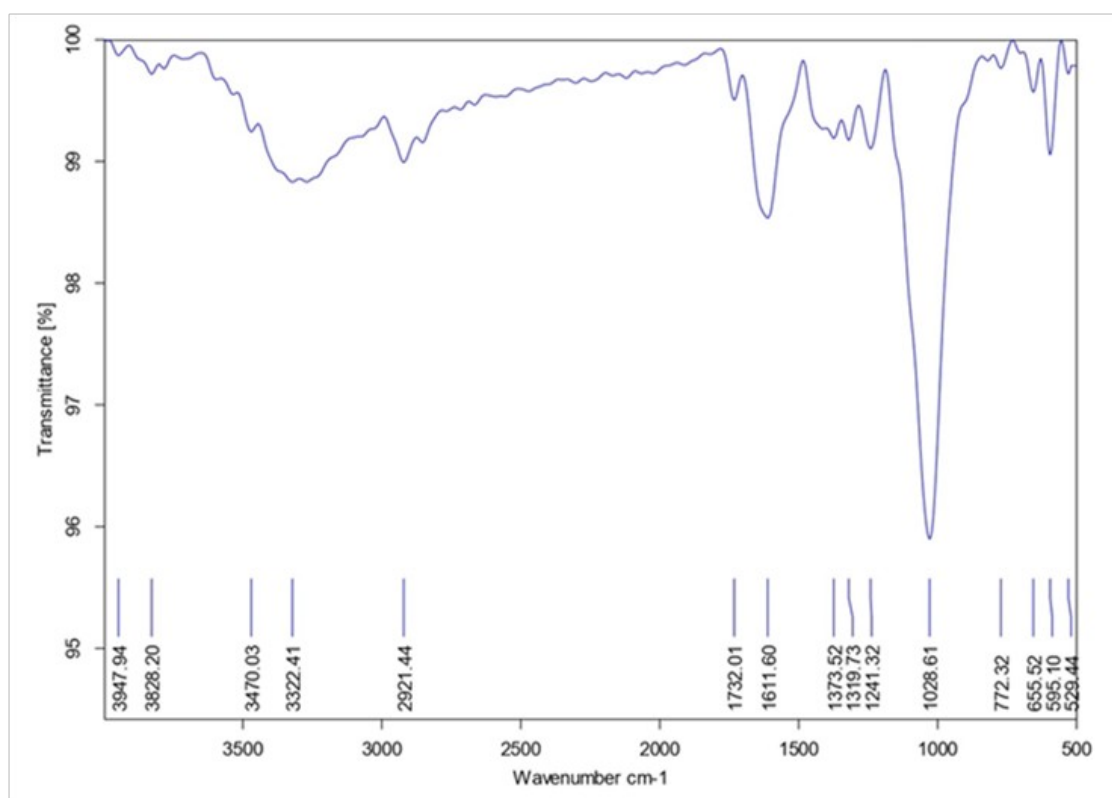


Figure 1. FT-IR spectrum of aqueous extract of *C. halicacabum* L.

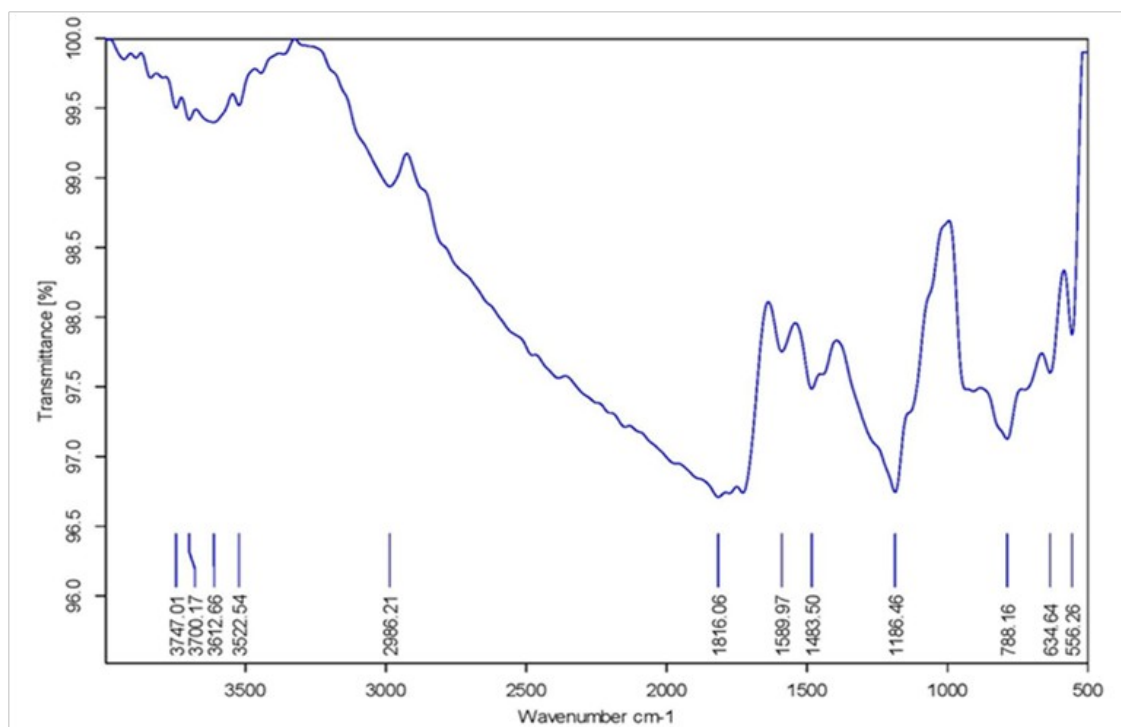


Figure 2. FT-IR spectrum of petroleum ether extract of *C. halicacabum* L.

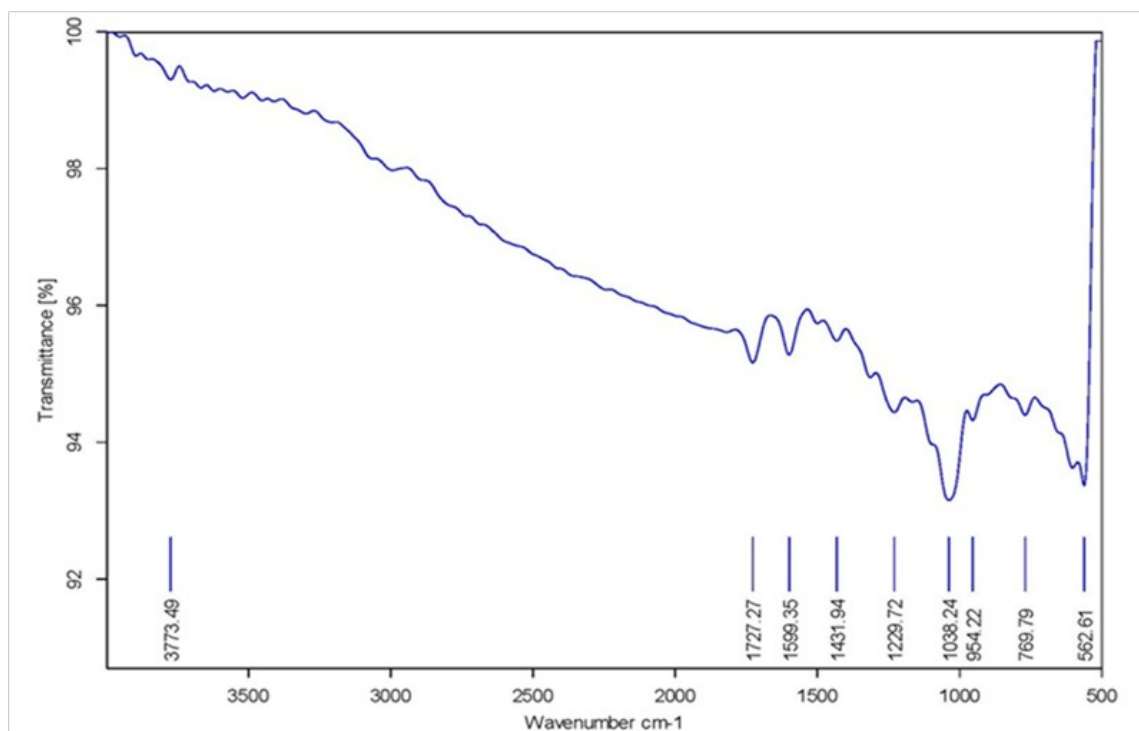


Figure 3. FT-IR spectrum of chloroform extract of *C. halicacabum* L.

**Table 1** Preliminary phytochemical screening of *C. halicacabum* leaf extract

S.No	Components	Aqueous	Petroleum ether	Chloroform
1	Carbohydrates	+	+	-
2	Glycosides	+	+	-
3	Alkaloids	+	-	+
4	Phytosterol	-	+	-
5	Fixed oils	+	-	+
6	Saponins	+	+	+
7	Proteins and amino acids	-	+	-
8	Phenolic compounds	+	-	-
9	Flavonoids	-	+	-
10	Tannins	+	-	-

(+) = Present and (-) = Absent

**Table 2** FT-IR frequency range and functional groups of aqueous extract of *C. halicacabum*

Frequency range	Molecular motion	Functional group
3947.94 - 3828.20	O-H Non-bonded	Hydroxyl group
3470.03	O-H stretch	Alcohols
3322.41	N-H stretch	Amines
2921.44	C-H stretch	Alkanes
1732.01	C-H stretch	Aldehydes
1611.60	C=C stretch	Aromatic compounds
1373.52 - 1319.73	NO <sub>2</sub> stretch	Nitro compounds
1241.32 - 1028.61	C-F stretch	Alkyl & Aryl halides
772.32	C-H-Plane bend	Alkenes & Aromatics
655.52	C-Br stretch	Alkyl & Aryl halides
595.10 - 529.44	C-Cl stretch	Alkyl & Aryl halides

**Table 3** FT-IR frequency range and functional groups of petroleum ether extract of *C. halicacabum*

Frequency range	Molecular motion	Functional group
3747.01 - 3612.66	O-H Non-bonded	Hydroxyl group
3522.54	O-H stretch	Alcohols
2986.21	C-H stretch	Alkanes
1816.06	C-H stretch	Aldehydes
1589.97 - 1483.50	C=C stretch	Aromatic compounds
1186.46	C-F stretch	Alkyl & Aryl halides
788.16	C-H-Plane bend	Alkenes & Aromatics
634.64	C-Br stretch	Alkyl & Aryl halides
556.26	C-I stretch	Alkyl & Aryl halides

**Table 4** FT-IR frequency range and functional groups of chloroform extract of *C. halicacabum*

Frequency range	Molecular motion	Functional group
3773.49	O-H Non-bonded	Hydroxyl group
1727.27	C=O stretch	Carboxylic acids
1599.35	C=C stretch	Aromatic compounds
1431.94	C-H stretch	Alkenes
1229.72 - 1038.24	C-F stretch	Alkyl & Aryl halides
954.22	=C-H bend	Alkenes
769.79	C-H-Plane bend	Alkenes & Aromatics
562.61	C-Cl stretch	Alkyl & Aryl halides

### FTIR spectral data interpretation

The FTIR spectrum is used to determine the functional groups of the active components present in the extract based on the spectrum values in the region of IR radiation (Mohrig *et al.*, 2006; Ashokkumar and Ramaswamy, 2014; Nandiyanto *et al.*, 2019). The FTIR spectrum of plant extracts (prepared in various solvents) of *C. halicacabum* was given in Fig 1 – 3. Data on the peak value and potential of functional groups obtained by Fourier-infrared spectroscopy-analysis of the presence in plant extracts (prepared in aqueous, petroleum ether, and chloroform) were presented in Tables 2 to 4. The FTIR spectrum results showed that the aqueous leaf extract having the presence of hydroxyl group, alcohols, amines, alkanes aldehydes, alkenes, aromatic compounds, nitro compounds, alkyl, and aryl halides which shows major peaks from 529.44 - 3947.94 respectively. Chloroform extract having the presence of hydroxyl group, carboxylic acids, alkenes, aromatic compounds, alkyl, and aryl halides which shows major peaks from 562.61- 3773.49 respectively. The spectrum of petroleum ether extract indicated the presence of hydroxyl group, alcohols, aldehydes, alkanes, alkenes, aromatic compounds, alkyl, and aryl halides which shows major peaks at 556.26 - 3747.01 respectively.

### DISCUSSION

The extractions of any crude with a specific solvent create a solution that contains various phytocomponents. The composition of these phytocomponents in the respective solvent can be a means of providing preliminary information about the quality of a particular drug sample. The presence or absence of a particular component plays an important role in deciding the medicinal property of the plant extract. As a result, phytochemical analysis of the aqueous extracts showed the presence of more phytocomponents, followed by petroleum ether, and chloroform extracts. Alcoholic and aqueous extracts of *C. halicacabum* L. contain tannins, flavonoids, saponins, sterols, and triterpenes (Venkat Rao *et al.*, 2006; Kurian, 1995). Parameshappa *et al.*, (2012) reported that petroleum ether extract of the plant contains sterols, carbohydrates, flavonoids, and triterpenes; Chloroform

extract contains alkaloids, coumarin, flavones, quinones, saponins, steroids, and tannins (Aishwarya *et al.*, 2014).

The results of FT-IR spectroscopy confirm the presence of various chemical components such as alcohol, alkanes, aromatic compound, carboxylic acid, aldehydes, alkenes, amides, nitro compounds, and alkyl halides in the extract of *C. halicacabum* L. leaves (Viji *et al.*, 2010). This result agrees with the result of Prabakaran *et al.*, (2014). FT-IR analysis of the extract from methanolic leaves of *C. halicacabum* shows the presence of alcohol, isocyanides, alkyl compounds, alkanes, and components containing chlorine (Sabeerali *et al.*, 2018; Mohammed Junaid *et al.*, 2020). The functional groups observed in the various extracts likely indicate the presence of carbohydrates, glycosides, alkaloids, amino acids, phenols, flavonoids, tannins, and saponins. The consequences of the FTIR evaluation are considerable for the preliminary qualitative investigation.

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### CONFLICTS OF INTEREST

The authors declare that they have no potential conflicts of interest.

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