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Comparative Study of Phytochemical Composition, Antioxidant activity, Anti- inflammatory activity and FTIR spectral analysis of *Justicia adhatoda* (L.) flower extract

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Abstract

Background: *Justicia adhatoda* (L)., a member of the Oleaceae family, is widely recognized in the fragrance industry for its aromatic compounds. It also holds great importance in traditional and Ayurvedic medicine due to its diverse therapeutic properties. While the flowers and leaves of this plant are extensively studied for their medicinal benefits, the stem is also known to contain bioactive constituents that contribute to its pharmacological potential.

Objectives: The aim of the present study was to carry out qualitative and quantitative phytochemical analysis, evaluate antioxidant and anti-inflammatory activities, and perform FT-IR spectral analysis of the floral parts of *J. adhatoda.*

Method: Methanol and aqueous solvents were used for the extraction of flower material. Qualitative screening was conducted to detect various phytochemicals. Total phenolic content was determined using the Folin-Ciocalteu method, while total flavonoid content was estimated by the Aluminium chloride spectrophotometric method. Antioxidant potential was assessed through the DPPH free radical scavenging assay. FT-IR analysis was performed to identify the functional groups present in the extracts.

Result: The phytochemical screening revealed the presence of flavonoids, triterpenoids, steroids, phenols, amino acids and proteins in both extracts. Methanolic extract additionally contained tannins, glycosides and alkaloids, whereas steroidal glycosides were found only in the aqueous extract. Saponins and carbohydrates were absent in both. Quantitative analysis showed that methanolic extract had higher phenolic 280.54 ± 0.15 mg GAE/g and flavonoid content 248.25 ± 0.14 mg QE/g compared to aqueous extract 195.20 ± 1.30 mg GAE/g and 168.82 ± 0.25 mg QE/g. In the DPPH assay, the IC50 values were 32.30 µg/mL for Ascorbic acid, 42.12 µg/mL for methanolic extract and 47.12 µg/mL for aqueous extract. At 50 µg/mL, methanolic and aqueous extracts exhibited 57.2 ± 0.403% and 52.1 ± 0.31% scavenging activity respectively. FT-IR analysis confirmed the presence of phenols, alcohols, carboxylic acids, amides, aldehydes, ketones, alkanes, alkenes, aromatics, amines and alkyl halides.

Conclusion: The study concludes that *J. adhatoda* flowers are rich in bioactive compounds and possess significant antioxidant potential. These findings are useful for standardization and further research is needed to isolate active constituents for development of nutraceuticals and drugs.

Keywords: *Justicia adathoda,* Phytochemical Screening, Total flavonoids, Antioxidant activity, DPPH, Anti-inflammatory, FT-IR Spectral, Pharmacological activity

1. Introduction

From ancient times, human beings have relied on plant-based products as traditional herbal medicines. The therapeutic compounds present in plants are derived from various parts such as leaves, flowers, roots, fruits, bark and seeds. In recent times, herbal medicines of plant origin have gained more importance in disease prevention because natural drugs are safer, cause fewer adverse effects, and are environmentally degradable compared to synthetic drugs [1]. Plants have played a vital role in sustaining human health and improving quality of life for thousands of years. Several traditional systems of medicine including Ayurveda, Unani, Siddha, Homeopathy and Naturopathy have been using plant materials as effective remedies for various diseases. The World Health Organization (WHO) has reported that nearly 80% of the global population depends on traditional medicine for primary healthcare, and most of these treatments are based on plant extracts or their active principles [2-3].

Justicia adhatoda L., commonly known as Vasaka, Adhatodai, Bansa and Basak, belongs to the family Acanthaceae. It is a well-known medicinal plant in Ayurvedic and Unani systems of medicine. The plant has opposite branches with white, pink or purple flowers. It is highly valued in Ayurveda for treating respiratory problems like cold, cough, asthma and tuberculosis [4-5]. Its primary pharmacological actions are expectorant and antispasmodic. The importance of Vasaka in respiratory ailments is highlighted by the ancient saying, “No man suffering from phthisis need despair as long as the Vasaka plant exists” [6-8] . In Ayurveda, *J. adhatoda* is used for its mucolytic and expectorant properties and is considered a key

herb for cough, bronchitis, asthma and common cold. According to Charaka Samhita, these effects are due to its bioactive constituents. The plant contains phytochemicals such as alkaloids, glycosides, sterols and phenolic acids [9-10].

Justicia adhatoda has been extensively used in Ayurvedic, Siddha and modern systems of medicine. Various studies have reported its wide range of pharmacological activities including antibacterial, anti-inflammatory, antiulcer, hypoglycemic, cardioprotective, antitubercular, antiviral, hepatoprotective, antimutagenic and antioxidant properties [11-22]. Medicinal plants are rich sources of antioxidants which protect the body from oxidative damage caused by free radicals. Antioxidants help in preventing chronic diseases such as cancer, heart diseases, diabetes, cataract, rheumatoid arthritis and Alzheimer's disease. Most of these antioxidant compounds are obtained from plant sources and are used in dietary supplements. In the present study, preliminary phytochemical analysis, estimation of total phenolic and flavonoid content, and evaluation of antioxidant and anti-inflammatory activities were carried out in methanolic and aqueous extracts of *Justicia adhatoda* flowers,

This study was subjected for the preliminary phytochemical analysis, quantification of the total phenolic content and flavonoid content, Antioxidant and Inflammatory activity in *Justicia adathod*a flower methanolic and aqueous extracts.

Fig: 1 *Justicia adathoda* flowering plant

Scientific Classification: [23]

Kingdom: Plantae
Subkingdom: Tracheobionta
Super division: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Asteridae
Order: Scrophulariales
Family: Acanthaceae
Genus: Justicia
Species: *Justicia adathoda*

2. Method and Materials

2.1 Collection of plant material

Fresh flowers of *Justicia adhatoda* L. were collected from the Mainpat forest region of Surguja District, Chhattisgarh, India during April 2026. The collected plant material was identified and authenticated by Prof. Rijwan Ulla, Taxonomist, Department of Botany, Rajeev Gandhi Govt. Autonomous Post Graduate College, Ambikapur, Surguja, Chhattisgarh, India.

2.2 Preparation of extract

250 g of shade-dried and powdered *Justicia adhatoda* flowers were taken and subjected to extraction separately in a Soxhlet apparatus using methanol and distilled water as solvents. After extraction, the mixtures were filtered while hot. The solvents were then removed by distillation and the remaining traces were eliminated under reduced pressure. The prepared methanolic and aqueous extracts were stored in a refrigerator at 4°C for further experimental use.

2.3 Preliminary phytochemical analysis

The qualitative analysis of *Justicia adhatoda* flower extracts was performed to detect the presence of various phytoconstituents. The screening was carried out by following standard methods described by Harborne (1973) and Solomon et al. (2013). Both methanolic and aqueous extracts were tested for the presence of

phenols, flavonoids, reducing sugars, saponins, aldehydes, ketones, terpenoids, and cardiac glycosides [24-25].

2.4 Estimation of total phenolic content (TPC)

The total phenolic content was estimated using the Folin Ciocalteu colorimetric method [26]. Various concentrations of Gallic acid solutions in methanol (20, 40, 60, 80 and 100 µg/ml) were prepared. An aliquot of 1 ml Gallic acid of each concentration was added to tube containing 5 ml of (10%) Folin-Ciocalteu reagent and 4 ml of 7% Na_2CO_3 were added to get a final volume of 10 ml. The mixture was shaken and kept for 90 minutes at room temperature. Then the absorbance was measured at 720 nm by UV Visible spectrophotometer against Gallic acid. Total phenolic content was denoted as mg Gallic Acid Equivalents (GAE).

2.5 Estimation of total flavonoid content (FC)

Total flavonoid content was measured by the Aluminium Chloride colorimetric assay [27]. In this method Quercetin was used as standard. 1mlof extract or standard solution of quercetin in series of 20, 40, 60, 80 and 100 (µg/ml) was taken in 10 ml volumetric flask containing 4 ml of distilled water. To the flask, 0.3 ml of 5% $NaNO_2$was added. After five minutes, 2 ml 1M NaOH was added and final volume made up to 10ml by adding distilled water. The absorbance was recorded at 510 nm using UV-Visible spectrophotometer.

2.6 In-Vitro Antioxidant Activity

DPPH Free Radical Scavenging Assay

DPPH assay is widely used to evaluate the antioxidant potential of plant extracts. 2,2-diphenyl-1-picrylhydrazyl is a stable free radical which provides a simple and reliable method for estimating the antioxidant capacity of both natural and synthetic compounds. The principle of this method is based on the reduction of DPPH radical by antioxidant compounds present in the extract. DPPH shows maximum absorption at 517 nm and appears deep violet in color. When antioxidants donate hydrogen, DPPH gets reduced and the color fades to yellow. The extent of decolorization is directly proportional to the antioxidant concentration. In the present study, 2.95 mL of methanolic DPPH solution (100 µM) was mixed with 0.05 mL of different concentrations of plant extracts ranging from 10 to 50 µg/mL. The reaction mixture was thoroughly mixed and incubated at room temperature in dark for 30 minutes. After incubation, the absorbance was recorded at 517 nm using UV-Vis spectrophotometer. Ascorbic acid was used as the reference standard. A lower absorbance value indicates higher free radical scavenging activity [28-29].

The antioxidant activity was expressed as percentage inhibition and calculated using the following formula:

$$\% \, Inhibition = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

Where, $A_{control}$ = Absorbance of DPPH without extract

A_{sample} = Absorbance of DPPH with extract

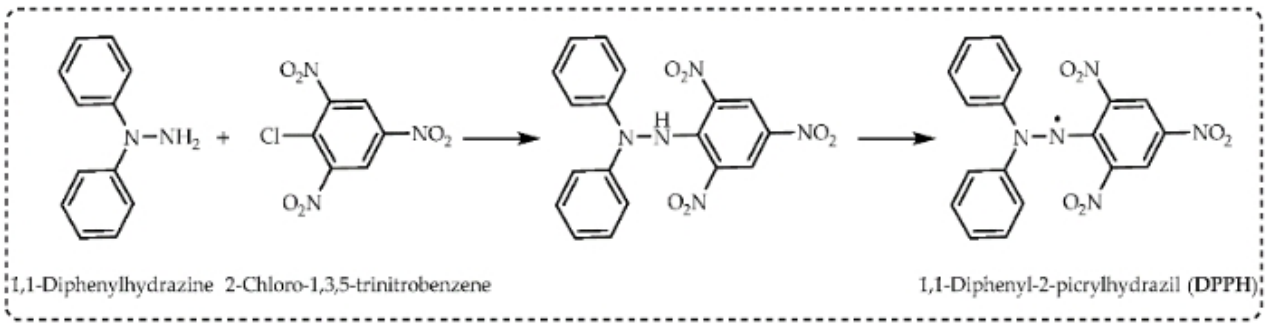


Fig 2: The synthesis route of 1,1-diphenyl-2-picrylhydrazil radicals (DPPH·).

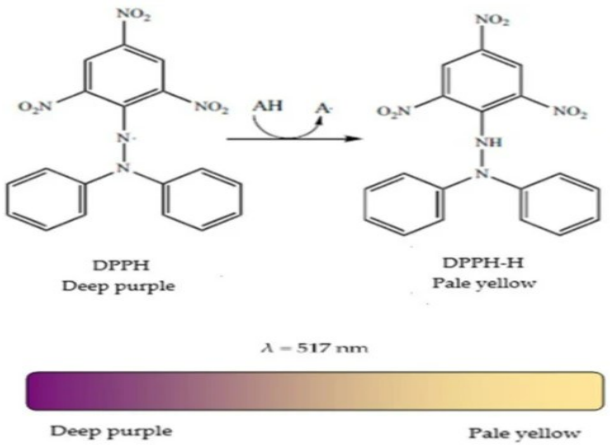


Fig.3. DPPH scavenging mechanisms by an antioxidant (AH)

2.7 In-Vitro Anti-Inflammatory Activity

Egg Albumin Denaturation Inhibition Assay

The anti-inflammatory potential of *Justicia adathoda* flowers extracts was assessed by their ability to inhibit heat-induced denaturation of egg albumin protein. Denaturation of tissue proteins is one of the well-documented causes of inflammatory diseases. Therefore, compounds that can prevent protein denaturation are considered to possess anti-inflammatory activity. The assay was carried out by following the method of Fetni et al. with minor modifications. In this experiment, 2 mL of test extract at different concentrations or the standard drug Sodium Diclofenac was mixed with 2.8 mL of phosphate buffered saline (pH 6.5) and 0.2 mL of fresh egg albumin. The mixtures were kept for incubation at 37°C for 15 minutes. Subsequently, the samples were subjected to heat treatment at 70°C in a water bath for 5 minutes to induce protein denaturation. After cooling, the absorbance of each reaction mixture was recorded at 660 nm using a spectrophotometer. The increase in absorbance indicates protein precipitation [30-31].

Calculation of % Inhibition:

The percentage inhibition of protein denaturation was determined using the formula:

$$\%\ Inhibition = \frac{Abs_{control} - Abs_{sample}}{Abs_{control}} \times 100$$

Where,
Abs $_{control}$ = Absorbance of the control reaction
Abs $_{sample}$ = Absorbance of the test sample

All assays were performed in triplicate and results were expressed as mean ± standard deviation. The ability of the extract to suppress protein denaturation was taken as a measure of its in-vitro anti-inflammatory activity.

2.8 Fourier Transform Infrared Spectroscopic Analysis

FT-IR spectroscopy is a highly effective analytical technique used for the identification and characterization of functional groups present in organic and inorganic compounds. The principle is based on the absorption of infrared radiation by molecules at specific frequencies, which corresponds to the vibrational modes of chemical bonds. Each absorption band in the IR spectrum is characteristic of a particular bond, and thus helps in elucidating the structural components of the sample.For FT-IR analysis, the dried powder of different solvent extracts of the plant material was used. To prepare the sample, 10 mg of the extract was mixed uniformly with 100 mg of dry KBr and compressed to form a transparent pellet. This KBr pellet method ensures proper transmission of IR rays through the

sample. The prepared pellets were analyzed using FT-IR spectrophotometer (Shimadzu, IR Affinity-1, Japan). The spectra were recorded over a wavenumber range of 400 cm^{-1} to 4000 cm^{-1} with a resolution of 4 cm^{-1}. The peaks obtained in the spectrum were interpreted to identify the presence of various functional groups such as hydroxyl, carbonyl, amine, and aromatic compounds [32]. This analysis helps in correlating the phytochemical constituents with the pharmacological activities of the plant extracts.

3. Result and Discussion

3.1 Phytochemical Screening

Preliminary phytochemical screening was performed on methanolic and aqueous extracts of *Justicia adathoda* flowers to identify the presence of various bioactive compounds. The qualitative analysis showed variation in phytoconstituents between the two extracts. Both methanolic and aqueous extracts tested positive for flavonoids, triterpenoids, steroids, phenolic compounds, amino acids and proteins. The methanolic extract additionally contained tannins, glycosides and alkaloids. Steroidal glycosides were found only in the aqueous extract. Saponins and carbohydrates were absent in both the extracts (Table 1.1).

Table 1.1:Phytochemical present in *Justicia adathoda* flowers of methanol and aqueous extract

S.N	Phytochemical Test	Methanol Extract	Aqueous Extract
1	Flavonoid	+	+
2	Saponins	-	-
3	Tannins	+	-
4	Steroidal Glycoside	-	+
5	Triterpeniods	+	+
6	Glycoside	+	-
7	Carbohydrates	-	_
8	Alkaloids	+	_
9	Steroids	+	+
10	Phenolic Compound	+	+
11	Amino Acids and Proteins	+	+

Present (+), Absent (-)

The presence of diverse phytochemicals in plant extracts is responsible for their medicinal properties. In the present study, flavonoids and phenolic compounds were detected in both extracts. These compounds are well known for their antioxidant, anti-inflammatory and free radical scavenging activities. Alkaloids and tannins present in the methanolic extract are reported to possess antimicrobial, analgesic and anti-inflammatory properties. Triterpenoids and steroids found in both extracts are associated with wound healing and anti-inflammatory effects. The absence of saponins and carbohydrates suggests that these metabolites are either not present in *Justicia adathoda* flowers or are not soluble in the solvents used. The methanolic extract showed a wider spectrum of phytochemicals compared to the aqueous extract, which may be due to the

higher extraction efficiency of methanol for both polar and non-polar compounds [33] . Thus, the presence of flavonoids, phenols, alkaloids and tannins in the extracts supports their traditional use and provides a scientific basis for further evaluation of antioxidant and anti-inflammatory activity.

3.2 Estimation of total phenolics and total flavonoids content

The results given in table 2 show that the total phenol content and total flavonoid of *Justicia adathoda* flowers are methanolic 280.54± 0.15, 248.25± 0.14 and aqueous extract 195.20 ± 1.30, 168.82± 0.25 respectively. The above results showed that aqueous extract contain less phenolic and flavonoids content than the alcoholic extract. It may due to the solubility of principle contents presence be higher in case of alcoholic solvent, thus it has been accepted that it is a universal solvent for the extraction of plant constituents.

Table 2**:** Estimation of total phenolics and total flavonoids content in *Justicia adathoda* flower

S.N.	Extract	Test Parameter	Results(mg/g) (±SEM)
1.	Methanol	Total phenolic Total Flavonoids	280.54± 0.15 248.25± 0.14
2.	Aqueous	Total phenolic Total Flavonoids	195.20± 1.30 168.82± 0.25

3.3 Antioxidant Activity

DPPH Scavenging Activity

The DPPH radical scavenging potential of *Justicia adathoda* flower extracts was assessed and the findings are presented in Table. The DPPH assay is commonly employed by researchers as a quick, simple, and dependable approach for evaluating the in-vitro antioxidant capacity of plant extracts. DPPH is a stable free radical which gets converted into a stable diamagnetic molecule upon accepting an electron. The characteristic absorption peak of DPPH radical in methanol occurs at 517 nm. The IC50 value of the standard Ascorbic acid was determined to be 32.30 µg/mL. The methanolic and aqueous extracts of the flower exhibited IC50 values of 42.12 µg/mL and 47.12 µg/mL, respectively. To understand the role of these bioactive compounds in biological systems, further investigations are necessary, as they may contribute to the traditional medicinal uses of this plant for various ailments [34]. The DPPH radical scavenging activity of *Justicia adathoda* flowers was tested and compared with Ascorbic acid. The percentage inhibition of the flower extracts was recorded at different concentrations i.e. 10, 20, 30, 40, 50 µg/mL and above, along with the standard. At 50 µg/mL concentration, the maximum scavenging activity was observed as 57.2 ± 0.403 % for methanolic extract and 52.1 ± 0.31 % for aqueous extract (Table 3).

Table 3: DPPH Free radical scavenging capacity of Flower extract of *Justicia adathoda*

S. No	Concentration µg/ml	% free radical scavenging activity (DPPH)		
		Methanol Extract	Aqueous Extract	Ascorbic acid (Standard)
1.	10	37.58 ± 0.30	25.7±0.84	40.4±0.41
2.	20	41.48 ± 0.33	30.1±0.68	44.9±0.39
3.	30	45.4 ± 0.27	37.6±0.61	48.7±0.59
4.	40	49.5 ± 0.288	44.8±0.64	54.36 ±0.41
5.	50	57.2 ±0.403	52.1±0.31	60.72 ±1.01
6	IC_{50}	42.12	47.12	32.30

The DPPH assay was used to assess the in-vitro antioxidant potential of *Justicia adathoda* flower extracts. The results showed a concentration-dependent increase in free radical scavenging activity for both methanolic and aqueous extracts as well as for the standard Ascorbic acid. At 50 µg/mL, the methanolic extract exhibited 57.2 ± 0.403% inhibition, the aqueous extract showed 52.1 ± 0.31%, while Ascorbic acid showed 60.72 ± 1.01% inhibition. The IC50 values were found to be 32.30 µg/mL for Ascorbic acid, 42.12 µg/mL for methanolic extract and 47.12 µg/mL for aqueous extract. The lower IC50 of methanolic extract compared to aqueous extract indicates its higher antioxidant potency (fig 4). This activity may be attributed to the presence of flavonoids, phenols and other phytoconstituents identified in the preliminary screening. Although both extracts showed less activity than the standard, their significant DPPH scavenging ability suggests that *J. adathoda* flowers have potential antioxidant compounds. These findings support the traditional use of the plant in oxidative stress-related disorders and warrant further isolation of active constituents.

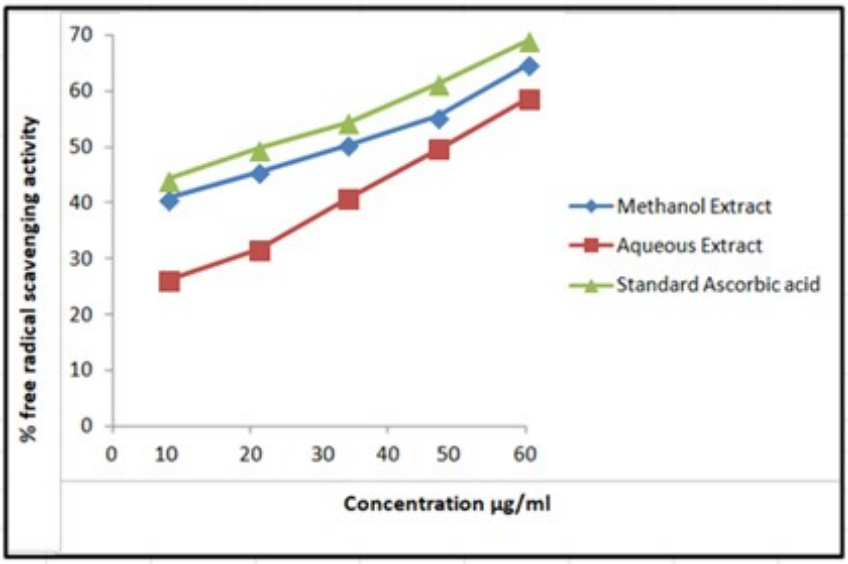


Fig 4**:** DPPH Free radical scavenging capacity of Flower extract of *Justicia adathoda*

3.4 Anti-inflammatory Activity

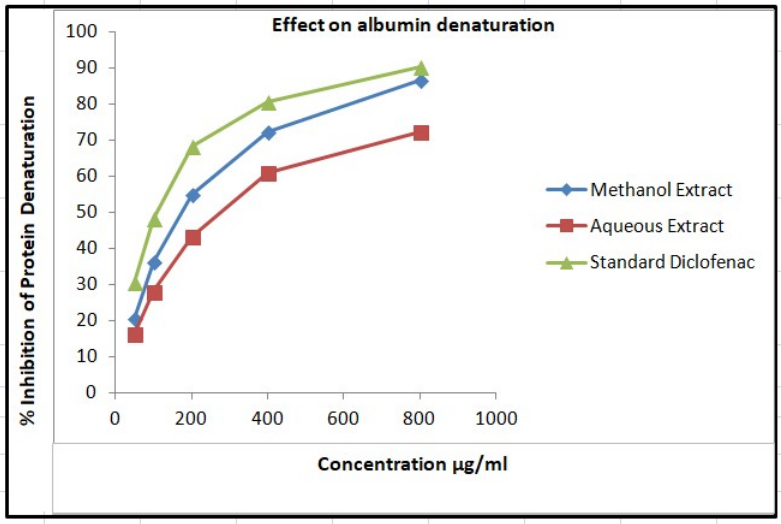
Heat-Induced Protein Denaturation Assay

The anti-inflammatory activity of methanolic and aqueous extracts of *Justicia adathoda* flowers was evaluated using the heat-induced protein denaturation method. Diclofenac sodium was used as the standard reference drug. The extracts were tested at concentrations of 50, 100, 200, 400 and 800 µg/mL. A dose-dependent increase in % inhibition was observed for both extracts and the standard. At the highest concentration of 800 µg/mL, the methanolic extract showed 86.64% inhibition, the aqueous extract showed 72.40% inhibition, while Diclofenac showed 90.30% inhibition. The IC50 values were found to be 174.12 µg/mL for methanolic extract, 275.54 µg/mL for aqueous extract and 109.02 µg/mL for Diclofenac. The lower IC50 of methanolic extract compared to aqueous extract indicates its higher anti-inflammatory potential (Table 5).

Table 5: Effect of *Justicia adathoda* flower extract on heat induced protein denaturation

S.N.	Concentration (µg/ml)	% Inhibition of Protein Denaturation		
		Methanol Extract	Aqueous Extract	Standard Diclofenac Drug
1	50	20.50	16.30	30.65
2	100	36.25	28.15	48.20
3	200	54.80	43.36	68.15
4	400	72.35	60.94	80.72
5	800	86.64	72.40	90.30
6.	IC50 (µg/ml)	174.12	275.54	109.02

Heat-induced protein denaturation is one of the causes of inflammation. The ability of plant extracts to prevent protein denaturation is considered as an indicator of their anti-inflammatory potential. In this study, both methanolic and aqueous extracts of *Justicia adathoda* flowers demonstrated significant inhibition of protein denaturation in a concentration-dependent manner. The methanolic extract exhibited higher activity than the aqueous extract at all tested concentrations. At 800 µg/mL, the methanolic extract showed 86.64% inhibition, which was comparable to the standard Diclofenac 90.30%. The IC50 value of methanolic extract 174.12 µg/mL was lower than that of aqueous extract 275.54 µg/mL, suggesting that methanol is more effective in extracting bioactive anti-inflammatory compounds. The activity may be attributed to phytochemicals such as flavonoids, phenols and alkaloids present in the extracts. Although both extracts showed less potency than Diclofenac, the results support the traditional use of *J. adathoda* for treating inflammatory conditions (fig 5). Further studies are needed to isolate and characterize the active constituents responsible for this activity.



Fig, 5: Anti-inflammatory activity of *Justicia adathoda* methanolic extract using egg albumin Protein denaturation

3.5 FTIR Spectral Data Interpretation

FT-IR study Table 4.6 shows the functional groups of the organic and inorganic compounds of the plant extract. The FTIR methods was performed on a spectrophotometer system, which was used to detect the characteristics peak values and their functional group. FTIR spectroscopy was performed to identify the functional groups present in the methanolic extract of *Justicia adathoda* flowers. The spectrum showed several characteristic absorption peaks in the range of 473.54 cm^{-1} to 4584.99 cm^{-1}. The major peaks at 473.54-655.83 cm^{-1} and 853.54 cm^{-1} indicated C=C bending of alkenes. A peak at 1046.43 cm^{-1} corresponded to C=C bending of primary alcohol. C-O stretching of ether and phenol was observed at 1210.43 cm^{-1} and 1320.33 cm^{-1} respectively. O-H bending peaks at 1425.46 cm^{-1} and 1625.10 cm^{-1} suggested the presence of aldehyde and alkane groups. C-H bending at 1716.72 cm^{-1} indicated carboxylic acid. Peaks at 2080.32 cm^{-1} and 2350.36 cm^{-1} corresponded to C=C stretching of conjugated anhydride and C=O stretching of carbon dioxide. C≡C stretching of alkane was seen at 2891.42 cm^{-1}. C-H stretching at 3260.80 cm^{-1} and 3330.24 cm^{-1} indicated alkene and alcohol. Broad O-H stretching peaks at 3330.24 cm^{-1}, 3942.67 cm^{-1} and 3933.99 cm^{-1} confirmed the presence of alcohol groups (fig 6,7) . FT-IR analysis of methanol flower and aqueous extracts of Crotalaria spectabilis confirmed the presence of phenols, alcohols, carboxylic acid, amide, aldehydes, ketones, alkanes, alkenes, aromatics, amines and alkyl halides which show major peaks (Table 6) [35].

Thus, FTIR analysis confirms that *J. adathoda* flower extract is rich in bioactive functional groups that may be responsible for its medicinal properties. Further isolation is required to identify the specific compounds.

Table 6: FT-IR spectrum of Methanolic and Aqueous extract of *Justicia adathoda*

Extract	Peak Value (cm^{-1})	Group	Class
Methanol Extract	473.54-655.83	C=C bending	Alkene
	853.54	C=C bending	alkene
	1046.43	C-O stretching	Primary Alcohol
	1210.43	C-O stretching	Ether
	1320.33	O-H Bending	Phenol
	1425.46	O-H Bending	Aldehyde
	1625.10	C-H Bending	Alkane
	1716.72	C=C Stretching	Carboxylic acid
	2080.32	C=O Stretching	Conjugated Anh
	2350.36	C≡C stretching	Carbon dioxide
	2891.42	C-H stretching	Alkane
	3260 .80	C-H Stretching	Alkene
	3330.24	O-H Stretching	Alcohol
	3942.67	O-H Stretching	Alcohol
Aqueous Extract	423.39-659.68	C=C bending	Alkene
	831.44	C=C bending	Alkene
	1058.97	C-O Stretching	Ether
	1219.06	C-O stretching	Ether
	1412.92	C-H Bending	Aldehyde
	1591.34	N-H Bending	Amine
	2194.12	C=O Stretching	Conjugated Anh
	2355.19	C-H Stretching	Alkane
	2809.44	C-H Stretching	Alkane
	2883.70	C-H Stretching	Alkene
	3118.06	C-H Stretching	Alkane
	3263.70	O-H Stretching	Alcohol
	3805.72	O-H Stretching	Alcohol

Spectral differences are the objective reflection of componential differences. By using FT-IR spectrum, we can confirm the functional constituent's presence in the given parts and extract, identify the medicinal materials from the adulterate and even evaluate the qualities of medicinal materials The results of the present study coincided with the previous observations observed by various plant biologist and taxonomist many researchers applied the FT-IR spectrum as a tool for distinguishing closely associated plants.

Fig 6: Shows the FT-IR frequency range of methanol *Justicia adathoda* flower extract

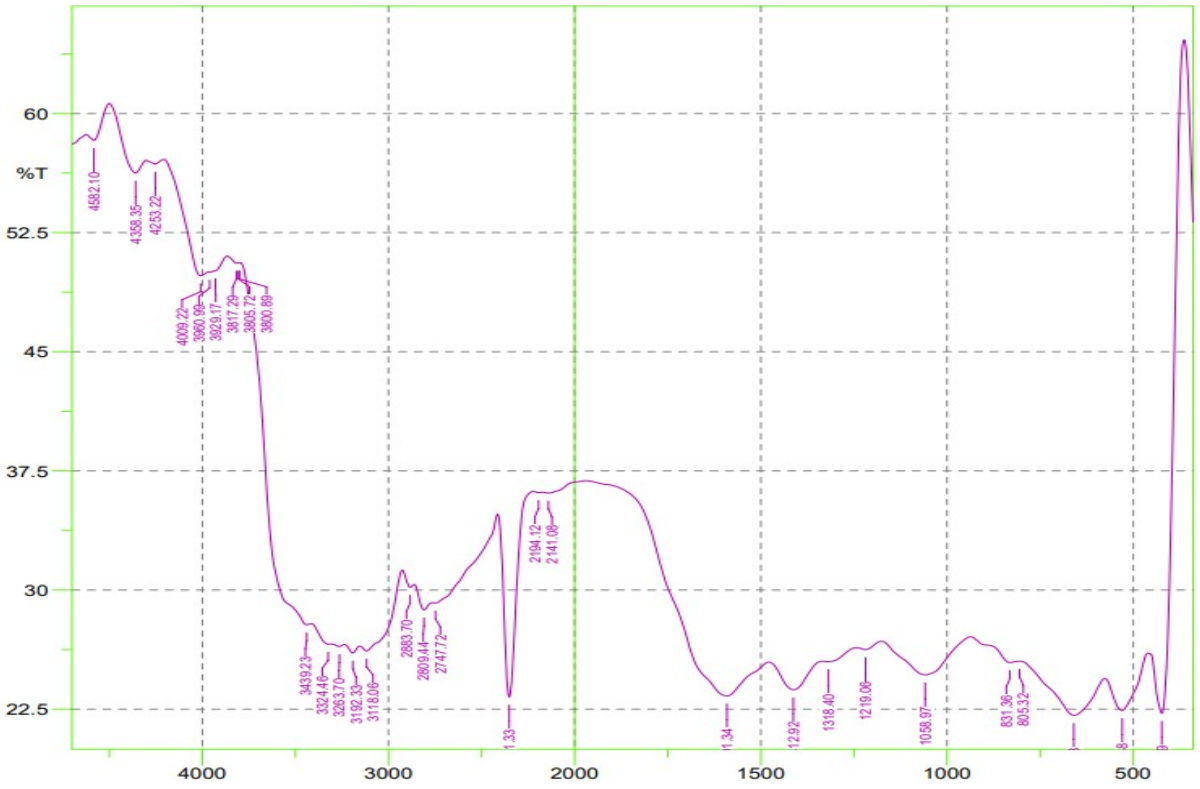


Fig 7: Shows the FT-IR frequency range of Aqueous *Justicia adathoda* flower extract

4. Conclusion

The plant *Justicia adathoda* is widely used for the treatment of a wide range of illnesses, many of which are well documented and detailed in pharmaceutical applications. The plant's various components and chemical constituents guarantee that it may be utilised to treat a wide range of diseases. Ultimately, it may be used as a therapy strategy and to create a unique, innovative drug delivery system. To examine its possible further actions, screening and bioassay are required, as well as sufficient information about the compounds and their structure-activity connection investigations the plant *Justicia adathoda* is widely used for the treatment of a wide range of illnesses, many of which are well documented and detailed in pharmaceutical applications. The plant's various components and chemical constituents guarantee that it may be utilised to treat a wide range of diseases. Ultimately, it may be used as a therapy strategy and to create a unique, innovative drug delivery system. To examine its possible further actions, screening and bioassay are required, as well as sufficient information about the compounds and their structure-activity connection investigations.

5. Conflicts of interest

The authors declare no conflict of interest.

6. Acknowledgments

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