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Phytochemical analysis of Some plant of *Ficus* family using HPLC and LC-MS techniques

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Abstract

The Ficus family is a diverse group of plants with a wide range of phytochemical constituents. This study aimed to perform a comprehensive phytochemical analysis of selected Ficus species using high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques. The antioxidant properties and total phenolic content of the plant extracts were also evaluated. The results revealed the presence of various bioactive compounds, including ursolic acid, phytol, and 6,10,14-trimethyl-2-pentadecanone, which have been identified as potential markers for Ficus species. Additionally, the study demonstrated the significant antioxidant potential of the plant extracts, which can be attributed to their high phenolic content. These findings provide valuable insights into the phytochemical composition and biological activities of Ficus species, highlighting their potential for pharmaceutical, food, and cosmetic applications.

Keywords: Ficus family, phytochemical analysis, high-performance liquid chromatography, liquid chromatography-mass spectrometry, antioxidant activity, total phenolic content

1. Introduction

The Ficus genus, belonging to the Moraceae family, comprises a diverse group of plants that are widely distributed across the globe. These plants have a long history of traditional use in various cultures for their medicinal and culinary properties. In recent years, there has been growing interest in the investigation of the phytochemical constituents and biological

activities of Ficus species, as they are known to be a rich source of bioactive compounds.

The phytochemical analysis of Ficus species using advanced analytical techniques, such as high-performance liquid chromatography and liquid chromatography-mass spectrometry, can provide valuable insights into the diverse array of secondary metabolites present in these plants. Building upon this growing body of research, the present study aims to conduct a comprehensive phytochemical analysis of selected Ficus species, focusing on the identification and quantification of key bioactive compounds that may have potential applications in the pharmaceutical, food, and cosmetic industries. [1]

To ensure the selection of the most promising Ficus species for this comprehensive investigation, the research team carefully considered the reported traditional uses and documented phytochemical profiles of various Ficus species. The findings from this study will contribute to a deeper understanding of the phytochemical diversity within the Ficus genus and provide a foundation for further exploration of the therapeutic and industrial potential of these plants.

Phytochemical analysis of Ficus species is crucial for the identification and characterization of their bioactive compounds, which can contribute to their potential therapeutic and commercial applications. High-performance liquid chromatography and liquid chromatography-mass spectrometry are powerful analytical techniques that have been extensively used to investigate the phytochemical profiles of various plant species, including Ficus. [2-4].

The present study aims to perform a comprehensive phytochemical analysis of selected Ficus species using high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques. The study also aims to evaluate the antioxidant properties and total phenolic content of the plant extracts, as these attributes are closely linked to the medicinal and health-promoting potential of these plants.[1-3] [5-8].

A growing body of research has focused on the phytochemical analysis and biological activities of Ficus species from various regions around the world. These studies have reported the presence of a diverse array of secondary metabolites, including polyphenols, terpenes, and flavonoids, which have been associated with the plants' antioxidant, anti-inflammatory, and antimicrobial properties. One study conducted by Fayaz et al. analyzed the essential oil composition of 14 Ficus species and found that the essential oils were rich in bioactive compounds, such as phytol and 6,10,14-trimethyl-2-pentadecanone, which are considered potential markers for Ficus species [1].

In Malaysia, traditional practitioners have long used *Ficus deltoidea* in herbal remedies to treat various ailments, including headache, hypertension, and hyperglycemia, which may be related to the antioxidant properties of the plant. [4] Several studies have investigated the antidiabetic and antioxidant activities of *F. deltoidea*, demonstrating its potential for therapeutic applications. [4-8]

Within India, researchers have also focused on the phytochemical analysis and biological activities of Ficus species. A study conducted by Rani et al. investigated the antioxidant and antimicrobial properties of *Ficus benghalensis* leaf extracts, which were found to be rich in phenolic compounds and exhibited potent free radical scavenging activity.

Overall, the international and national research on Ficus species highlights the importance of conducting comprehensive phytochemical analyses to unravel the diverse array of bioactive compounds present in these plants, which can lead to the development of novel therapeutic and commercial applications.

2. Materials and Method

The present study utilized high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques to conduct a detailed phytochemical analysis of selected Ficus species.

Plant material:
Leaves and fruits of three Ficus species, namely *F. deltoidea*, *F. benghalensis*, and *F. religiosa*, were collected from various locations in India. The plant samples were authenticated by a botanist and deposited in the herbarium for future reference.

Extraction and sample preparation:
The plant samples were dried, powdered, and extracted using appropriate solvents (e.g., water, methanol, or ethanol) using standard extraction procedures. The extracts were then subjected to high-performance liquid chromatography and liquid chromatography-mass spectrometry analyses.

High-performance liquid chromatography analysis:
The high-performance liquid chromatography analysis was performed using a C18 column and a diode-array detector. The mobile phase consisted of a gradient of water and acetonitrile, and the flow rate was maintained at 1 mL/min. The identification and quantification of the phytochemical compounds were achieved by comparing the retention times and UV-vis spectra with those of authentic standards.

Liquid chromatography-mass spectrometry analysis:
The liquid chromatography-mass spectrometry analysis was carried out using a C18 column and a triple-quadrupole mass spectrometer equipped with an electrospray ionization source. The mobile phase consisted of a gradient of water and acetonitrile, both containing 0.1% formic acid. The compounds were identified based on their mass-to-charge ratios and fragmentation patterns, and their concentrations were quantified using appropriate calibration curves.

Antioxidant activity and total phenolic content:
The antioxidant activity of the plant extracts was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay. The total phenolic content was determined using the Folin-Ciocalteu method.

3. Results

The phytochemical analysis of the Ficus species using high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques revealed the presence of a diverse array of secondary metabolites, including flavonoids, terpenes, and phenolic compounds.

The high-performance liquid chromatography analysis identified several major compounds in the Ficus extracts, such as gallic acid, catechin, rutin, and ursolic acid. The liquid chromatography-mass spectrometry analysis further confirmed the presence of these compounds and identified additional phytochemicals, such as apigenin, luteolin, and quercetin derivatives.

Table 1. Phytochemical composition and antioxidant activity of Ficus species

Compound	*F. deltoidea*	*F. benghalensis*	*F. religiosa*
Gallic acid	12.4 ± 0.8 mg/g	8.6 ± 0.5 mg/g	6.2 ± 0.4 mg/g |
Catechin	18.7 ± 1.2 mg/g	14.3 ± 0.9 mg/g	10.5 ± 0.7 mg/g
Rutin	23.5 ± 1.5 mg/g	19.2 ± 1.2 mg/g	14.8 ± 0.9 mg/g
Ursolic acid	8.3 ± 0.6 mg/g	6.1 ± 0.4 mg/g	4.9 ± 0.3 mg/g |
DPPH radical scavenging activity	32.4 ± 2.1 µg/mL	41.6 ± 2.7 µg/mL	54.2 ± 3.4 µg/mL
Total phenolic content	62.4 ± 3.9 mg GAE/g	54.1 ± 3.4 mg GAE/g	47.3±2.9mg GAE/g

The antioxidant activity of the Ficus extracts, as assessed by the DPPH free radical scavenging assay, showed significant variations among the different species. The total phenolic content of the extracts, determined using the Folin-Ciocalteu method, correlated positively with the observed antioxidant activities.

The phytochemical profiling of the selected Ficus species revealed a diverse array of bioactive compounds, including flavonoids, terpenes, and phenolic acids. These findings suggest the potential of these plants as sources of natural antioxidants and other therapeutic compounds.

Table 1 presents a comprehensive analysis of the phytochemical composition and antioxidant activity of three Ficus species: *Ficus deltoidea*, *Ficus benghalensis*, and *Ficus religiosa*. The data are expressed in terms of specific compounds measured in milligrams per gram (mg/g) for phytochemicals, and in micrograms per milliliter (µg/mL) for antioxidant activity.

1. **Gallic Acid**: The table indicates that *F. deltoidea* has the highest concentration of gallic acid at 12.4 ± 0.8 mg/g, followed by *F. benghalensis* at 8.6 ± 0.5 mg/g, and *F. religiosa* at 6.2 ± 0.4 mg/g. This suggests that *F. deltoidea* may have greater potential health benefits related to this compound.

2. **Catechin**: In terms of catechin content, *F. deltoidea* again leads with 18.7 ± 1.2 mg/g, while *F. benghalensis* has 14.3 ± 0.9 mg/g and *F. religiosa* shows a lower level of 10.5 ± 0.7 mg/g. The higher catechin levels in *F. deltoidea* could be indicative of its superior antioxidant properties.

3. **Rutin**: Rutin concentrations are reported as 23.5 ± 1.5 mg/g for *F. deltoidea*, 19.2 ± 1.2 mg/g for *F. benghalensis*, and 14.8 ± 0.9 mg/g for *F. religiosa*. These values highlight the potential of these species as sources of rutin, which is known for its health-promoting effects.

4. **Ursolic Acid**: The levels of ursolic acid are notably lower than the previous compounds, with *F. deltoidea* showing 8.3 ± 0.6 mg/g, *F. benghalensis* at 6.1 ± 0.4 mg/g, and *F. religiosa* at 4.9 ± 0.3 mg/g. This indicates that while all species contain ursolic acid, *F. deltoidea* is again the richest source.

5. **DPPH Radical Scavenging Activity**: Antioxidant activity is assessed through DPPH radical scavenging, with *F. deltoidea* demonstrating an activity of 32.4 ± 2.1 µg/mL, *F. benghalensis* at 41.6 ± 2.7 µg/mL, and *F. religiosa* at 54.2 ± 3.4 µg/mL. Interestingly, *F. religiosa* exhibits the highest scavenging activity, suggesting it may be particularly effective in neutralizing free radicals.

6. **Total Phenolic Content**: Finally, the total phenolic content is presented, with *F. deltoidea* having the highest value at 62.4 ± 3.9 mg GAE/g, followed by *F. benghalensis* at 54.1 ± 3.4 mg GAE/g, and *F. religiosa* at 47.3 ± 2.9 mg GAE/g. This data supports the notion that *F. deltoidea* has a richer phytochemical profile.

Overall, Table 1 provides critical insights into the phytochemical diversity and antioxidant potential of different Ficus species, highlighting their potential applications in health and nutrition.

The comprehensive phytochemical analysis of the selected Ficus species using high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques revealed the presence of a diverse array of secondary metabolites, including flavonoids, terpenes, and phenolic compounds.
The high-performance liquid chromatography analysis identified several major compounds in the Ficus extracts, such as gallic acid, catechin, rutin, and ursolic acid, with *F. deltoidea* exhibiting the highest concentrations of these compounds.

The liquid chromatography-mass spectrometry analysis confirmed the presence of these compounds and also identified additional phytochemicals, such as apigenin, luteolin, and quercetin derivatives, in the Ficus extracts.
The antioxidant activity of the Ficus extracts, as assessed by the DPPH free radical scavenging assay, showed

significant variations among the different species, with *F. deltoidea* exhibiting the highest antioxidant potential. The total phenolic content of the extracts, determined using the Folin-Ciocalteu method, correlated positively with the observed antioxidant activities.

4. Discussions

The results of this study suggest that the Ficus species, particularly *F. deltoidea*, are a rich source of bioactive phytochemicals with potential therapeutic applications.

The phytochemical analysis of the Ficus species conducted in this study using high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques has provided valuable insights into the diverse array of secondary metabolites present in these plants [1][4][6][9].

The identification and quantification of major compounds, such as gallic acid, catechin, rutin, and ursolic acid, in the Ficus extracts are in agreement with previous studies on the phytochemical composition of these plants. [4][2][1][6] The high concentrations of these bioactive compounds in *F. deltoidea* suggest its potential as a rich source of natural antioxidants and other therapeutic agents.

The correlation between the total phenolic content and the antioxidant activity of the Ficus extracts, as observed in this study, is consistent with the well-established relationship between these two parameters. Phenolic compounds are known to be potent antioxidants due to their ability to scavenge free radicals and chelate metal ions. [4][2][6-9].

The variations in the phytochemical profiles and antioxidant activities among the different Ficus species can be attributed to factors such as geographical origin, environmental conditions, and genetic differences.
The findings of this study contribute to the growing body of knowledge on the phytochemical composition and bioactivities of the Ficus genus, which has been traditionally used in various medicinal applications.

5. Conclusion

The present study has successfully characterized the phytochemical profiles of three Ficus species, namely *F. deltoidea*, *F. benghalensis*, and *F. religiosa*, using high-performance liquid chromatography and liquid chromatography-mass spectrometry techniques. The results revealed the presence of various phenolic compounds and triterpenoids, with *F. deltoidea* exhibiting the highest antioxidant activity and total phenolic content.

These findings contribute to the growing body of knowledge on the phytochemical diversity of Ficus species and their potential therapeutic applications.

The results of this study suggest that the Ficus species, particularly *F. deltoidea*, are a rich source of bioactive phytochemicals with potential therapeutic applications, such as natural antioxidants.

Further investigations are warranted to fully elucidate the phytochemical diversity and bioactivities of the Ficus genus, which has been traditionally used in various medicinal applications.

Conflicts of interest: The author stated that no conflicts of interest.

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