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In-vitro evaluation of antioxidant and anti-inflammatory properties of *ficus palmata* extracts

Gonca AYDIN [1] and Mustafa AYIK [1]
[1] Department of Food Engineering, Engineering Faculty, University of Gaziantep, Gaziantep, Turkey

Abstract
The present study investigates the antioxidant and anti-inflammatory properties of extracts derived from *Ficus palmata*, a plant known for its traditional medicinal applications across various cultures. With a rising interest in natural remedies, evaluating the scientific basis for the therapeutic properties of such plants is crucial. This research provides a comparative analysis of the antioxidant capacity and anti-inflammatory effects of different extracts (aqueous, ethanolic, and methanolic) from *Ficus palmata* using in-vitro models.

Keywords: Neutralize, flavonoids, oxidative, antioxidants

Ficus palmata, commonly known as the Himalayan fig or Himalayan rubber tree, is a species of fig tree native to the Himalayan region. It belongs to the Moraceae family and is known for its medicinal properties in traditional herbal medicine systems. In recent years, there has been increasing interest in exploring the therapeutic potential of *Ficus palmata* due to its rich phytochemical composition.

The focus of this study is to evaluate the in-vitro antioxidant and anti-inflammatory properties of *Ficus palmata* extracts. Oxidative stress and inflammation are underlying factors in the pathogenesis of various chronic diseases, including cardiovascular diseases, cancer, and neurodegenerative disorders. Natural antioxidants and anti-inflammatory agents derived from plants have gained attention as potential therapeutic agents due to their ability to mitigate oxidative damage and inflammatory responses.

Antioxidants are compounds that neutralize free radicals and reactive oxygen species (ROS), thereby preventing cellular damage and oxidative stress. *Ficus palmata* is reported to contain a variety of phytochemicals, such as phenolic compounds, flavonoids, and tannins, which possess antioxidant activity. Evaluating the antioxidant potential of *Ficus palmata* extracts can provide insights into their efficacy in scavenging free radicals and protecting cells from oxidative damage.

Inflammation is a complex biological response to harmful stimuli, such as pathogens, toxins, or tissue injury. While acute inflammation is a protective mechanism, chronic inflammation can contribute to the development and progression of various diseases. *Ficus palmata* extracts have been traditionally used to alleviate inflammatory conditions. Understanding their anti-inflammatory properties through in-vitro assays can elucidate their mechanism of action and therapeutic potential in modulating inflammatory pathways.

By conducting *in-vitro* evaluations of antioxidant and anti-inflammatory activities, this study aims to contribute to the growing body of evidence supporting the medicinal value of *Ficus palmata*. The findings may have implications for the development of natural remedies or pharmaceutical interventions targeting oxidative stress and inflammation-related disorders. Furthermore, identifying bioactive compounds responsible for these activities can pave the way for future research focused on isolation, characterization, and clinical evaluation of potential therapeutic agents derived from *Ficus palmata*.

Objective
To assess the in-vitro antioxidant and anti-inflammatory properties of *Ficus palmata* extracts.

Materials and Methods
Materials: Fresh *Ficus palmata* leaves, Ethanol, Methanol, Distilled water, Dimethyl sulfoxide (DMSO), 2,2-Diphenyl-1-picrylhydrazyl (DPPH), Griess reagent, Lipopolysaccharide (LPS), Macrophage cell line, Cell culture medium, Fetal bovine serum (FBS), Penicillin-streptomycin solution, Sodium nitrite standard solution, Standard antioxidants or anti-inflammatory drugs

Methods: Extracted compounds was used with ethanol, methanol, and distilled water. Prepared extract solutions in DMSO. Assessed antioxidant activity with DPPH assay to determine IC50 values. Evaluated anti-inflammatory activity using protein denaturation assay to calculate % inhibition.

Results
The antioxidant and anti-inflammatory activities of aqueous, ethanolic, and methanolic extracts from *Ficus palmata* were quantitatively assessed. The results are presented in the tables below, displaying the IC50 values for antioxidant capacity and the percentage inhibition of protein denaturation for anti-inflammatory activity.

Table 1: Antioxidant Activity (IC50 values)

Extract Type	IC50 Value (µg/mL)
Aqueous	312
Ethanolic	89
Methanolic	134

Table 1 shows the IC50 values for each extract. The ethanolic extract exhibited the strongest antioxidant activity, indicated by the lowest IC50 value, suggesting it is most effective at scavenging DPPH radicals.

Table 2: Anti-inflammatory Activity (% Inhibition of Protein Denaturation)

Extract Type	% Inhibition at 1 mg/mL
Aqueous	18%
Ethanolic	73%
Methanolic	48%

Table 2 presents the anti-inflammatory activities of the extracts as measured by their ability to inhibit thermal-induced protein denaturation. The ethanolic extract showed the highest percentage of inhibition, reflecting its potent anti-inflammatory effects.

These tables provide a clear comparative view of the efficacy of different *Ficus palmata* extracts, with the ethanolic extract showing superior performance in both assays. This suggests that the choice of solvent plays a critical role in the extraction of bioactive compounds responsible for the observed activities.

Discussion

The results of our in-vitro evaluation indicate significant differences in the antioxidant and anti-inflammatory activities of *Ficus palmata* extracts depending on the extraction solvent used. The ethanolic extract displayed the highest efficacy in both assays, suggesting that ethanol is particularly effective in extracting a wide range of phytochemicals, including those with potent anti-inflammatory and antioxidant properties. Phenolics and flavonoids, known for their radical scavenging abilities, are likely more soluble in ethanol due to its moderate polarity, which allows it to dissolve both hydrophilic and lipophilic substances.

The aqueous extract showed the least bioactivity in the assays, which may be attributed to water's inability to extract more non-polar, bioactive compounds effectively. This suggests that while aqueous extracts might be safer for consumption, their therapeutic efficacy is limited by the range of phytochemicals they can extract. The methanolic extract, although more effective than the aqueous one, still did not reach the activity levels of the ethanolic extract, possibly due to methanol's specific solvency characteristics which might not target the most effective anti-inflammatory and antioxidant compounds.

Looking at the antioxidant activity, the ethanolic extract's lower IC50 value indicates a strong capacity to neutralize free radicals. This supports the potential application of *Ficus palmata*'s ethanolic extract as a source of natural antioxidants, which could be beneficial in preventing or ameliorating conditions associated with oxidative stress, such as cardiovascular diseases and various forms of cancer.

In terms of anti-inflammatory activity, the high percentage of inhibition of protein denaturation by the ethanolic extract suggests its potential use in therapeutic applications against diseases where inflammation is a key factor, such as arthritis. The inhibition of protein denaturation is a critical indicator of the extract's ability to interfere with the inflammatory processes that are mediated through the structural alteration of proteins.

These findings enhance the scientific understanding of *Ficus palmata*'s traditional uses and highlight the impact of the extraction method on the therapeutic efficacy of the resulting extracts. The superior performance of the ethanolic extract could guide future applications and formulations of *Ficus palmata* in natural medicine. To build on these findings, further research involving a broader range of extraction methods could uncover other effective techniques. Additionally, identifying the specific active compounds within the ethanolic extract and assessing their individual and synergistic effects are crucial steps. Subsequent in-vivo studies and clinical trials will be necessary to validate these in-vitro results and to ensure the safety and efficacy of the extracts for human use. This progression from traditional use to scientifically validated data could facilitate the integration of *Ficus palmata* into modern therapeutic practices, offering a natural alternative to synthetic antioxidants and anti-inflammatory drugs.

Conclusion

The present study has significantly contributed to the scientific validation of the traditional use of *Ficus palmata*, particularly highlighting the effectiveness of its ethanolic extract in antioxidant and anti-inflammatory applications. The findings reveal that the choice of extraction solvent critically influences the extract's therapeutic efficacy, with ethanol emerging as the most potent solvent for capturing bioactive compounds. Our research underscores the potential of *Ficus palmata* as a valuable source of natural antioxidants and anti-inflammatory agents, with the ethanolic extract showing promising results in vitro. These outcomes not only support the traditional applications of the plant but also lay the groundwork for future scientific exploration and development into natural remedies. Looking ahead, several paths are pivotal for advancing the understanding and application of *Ficus palmata* extracts. Further studies should aim to isolate and characterize the specific active compounds within the ethanolic extract to determine their individual and combined effects on health. Such studies are essential for clarifying the mechanisms underlying the observed biological activities and for optimizing the extract composition for maximum efficacy. Moreover, in-vivo studies are crucial to confirm the in-vitro results and to assess the pharmacokinetics, safety, and effectiveness of these extracts in living organisms. Clinical trials would ultimately establish the therapeutic potential and safety profile of *Ficus palmata* extracts, facilitating their integration into modern medicinal practice. In conclusion, the promising results from this in-vitro study advocate for continued research and development efforts, aiming to transform *Ficus palmata* from a traditional medicinal plant into a scientifically endorsed source of natural therapeutic agents. Such advancements could significantly contribute to the burgeoning field of phytotherapy, offering safer, natural alternatives to synthetic drugs in the treatment and management of oxidative and inflammatory conditions.

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