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Study On The Phytochemistry Of Ethanol Extracts From The Leaves And Bark Of Ficus Sycomorus L. : Evaluation Of Antioxidant Activity

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Abstract
Ficus sycomorus L. is a medicinal plant widely used in traditional medicine in West Africa for various therapeutic purposes. The objective of this study is to evaluate and compare the in vitro antioxidant activities of ethanolic extracts from the leaves and bark of Ficus sycomorus L. Antioxidant potential was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay at various concentrations. Both parts of the plant exhibit antioxidant activity, but the leaf extract proved to be more effective than the bark extract at the lowest concentrations. The highest inhibition percentage, 82.03 %, was recorded for the leaf extract at 1.25 mg·L⁻¹, while the bark extract showed a maximum inhibition of 74.69 % at 10 mg·L⁻¹. The leaf extract has an estimated IC_{50} value of approximately 0.58 mg·L⁻¹, compared to an IC_{50} of approximately 0.096 mg·L⁻¹ for ascorbic acid, used as a positive control. These results support the traditional use of Ficus sycomorus L. and suggest its potential as a source of natural antioxidants with possible pharmaceutical applications.

Keywords : *Ficus sycomorus L., antioxidant activity, DPPH assay, ethanolic extract, traditional medicine.*

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I. Introduction

Free radicals and reactive oxygen species play a significant role in the pathogenesis of various chronic diseases, including cardiovascular disorders, diabetes, cancer, and neurodegenerative diseases. Antioxidants are compounds that can prevent or delay oxidative damage caused by these free radicals through their electron-donating properties [1].

Natural antioxidants derived from medicinal plants have attracted considerable scientific attention due to their health benefits and lower toxicity compared to synthetic antioxidants. Traditional medical systems, particularly in Africa, have preserved extensive knowledge regarding the therapeutic potential of indigenous plants. *Ficus sycomorus L*. (Moraceae family), commonly known as the sycamore fig tree, is a large deciduous tree native to Africa and the Middle East, widely distributed in West African countries, notably Senegal [2].

In traditional medicine, various parts of Ficus sycomorus L. have been used to treat a range of health conditions, including inflammation, infections, cardiovascular disorders, and metabolic diseases [3]. Previous phytochemical studies on *Ficus sycomorus L*. have reported the presence of polyphenolic compounds, flavonoids, and other bioactive molecules that may contribute to its biological activities [4].

More recent studies have also confirmed the presence of phenolic compounds and flavonoids in the fruits of *Ficus sycomorus L*. [5], demonstrated marked antioxidant activity for bark extracts obtained using dichloromethane [6], and characterized the acute and subacute toxicity profile as well as a gastroprotective effect of an ethanolic bark extract in rats [7], thereby reinforcing the pharmacological interest in this species and the relevance of continuing its phytochemical evaluation.

The objective of this study was to conduct a comparative phytochemical evaluation of the antioxidant activities of ethanolic extracts prepared from the leaves and bark of Ficus sycomorus L. using the DPPH free radical scavenging assay, with the aim of providing scientific evidence for their traditional medicinal uses and identifying which part of the plant possesses superior antioxidant properties.

II. Materials And Methods

Plant Material

Fresh leaves and bark of *Ficus sycomorus L*. were collected from the wild during the month of September 2025. The plant material was authenticated by botanical experts at the herbarium of the Faculty of Science and

Technology in Dakar, ensuring proper identification as *Ficus sycomorus L*. (Moraceae). Reference specimens were preserved for future use. The plant parts were carefully cleaned, dried in the shade at room temperature, and then ground into a fine powder using a mechanical grinder.

Figure 1 : Photograph of the leaves and bark of *Ficus sycomorus L.*

Extraction Procedure

The extraction was performed according to established pharmacognostic protocols. Dried plant powder (30 g) was macerated in 300 mL of 96 % ethanol at room temperature (25 ± 2°C) for 6 days. The macerate was then filtered through Whatman filter paper (Grade 1). The filtrate was concentrated under reduced pressure using a rotary evaporator at 40°C. The concentrated extract was then dried in a desiccator for one week and stored at 4°C pending analysis.

Phytochemical Studies

Phytochemical screening is a qualitative analysis based on precipitation or color reactions that confirm the presence or absence of secondary metabolites. In this study, the screening focused on the detection of polyphenols, flavonoids, sterols, polyterpenes, catechols, leucoanthocyanins, and glycosides. We characterized these different groups using the techniques described by Ronchetti et al. [8]. Polyphenols were identified using the $FeCl_3$ test and Stiasny's reagent ; flavonoids, leucoanthocyanins, and polyterpenes were identified using the Liebermann-Burchard test [9].

Antioxidant Activity

Antioxidant activity was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay according to established protocols [10,11,12]. Serial dilutions of the extracts were prepared in ethanol at concentrations ranging from 0.3125 to 10 $mg \cdot mL^{-1}$. A 3 mL aliquot of ethanolic DPPH solution (0.004% w/v) was added to 100 µL of each extract concentration. The mixture was incubated in the dark at room temperature for 30 minutes.

Absorbance was measured at 517 nm using a UV-Vis spectrophotometer. For each concentration, measurements were performed in duplicate (Absorbance 1 and Absorbance 2). The percentage inhibition (PI) of the DPPH radical was calculated using the formula :

$$PI\ (\%) = \frac{Ac\ - As}{Ac} \times 100$$

Where Ac is the absorbance of the control (DPPH solution without extract) and As is the absorbance of the sample (DPPH solution with extract).

Data analysis was used to determine the IC_{50} values (the inhibitor concentration required to reduce DPPH radicals by 50 %) using linear regression of the response curves as a function of concentration. Each assay was repeated twice, with results expressed as the mean accompanied by its standard deviation.

III. Results And Discussion

Extraction Yield

Table 1 shows the extraction yields of secondary metabolites from the leaves and bark of Ficus sycomorus L. These results highlight variations in yields depending on the plant part analyzed. Specifically, the leaves yielded 9.6 %, while the bark yielded a higher rate of 16.33 %.

Table 1 : Extraction Yields from the Bark and Leaves of *Ficus sycomorus L.*

Plant parts	Ethanol volume (mL)	Sample Masse (g)	Masse obtained (g)	Yield %
Leaves	300	30	2,88	9,6
Bark	300	30	4,90	16,33

Phytochemical Screening

A phytochemical screening was also conducted on the leaves and bark of *Ficus sycomorus L.* (Table 2).

Table 2 : Results of the phytochemical screening of the leaves and bark of *Ficus sycomorus L.*

Target compound families	Leaves	Bark
Polyphenols	++	+++
Flavonoides	-	+++
Sterols and polyterpenes	+	+
Leucoanthocyanins	+	+++
Catechols	+	++
Glycosides	-	+++

+++ : Strong coloration, ++ : Moderate coloration, + : Weak coloration, - : No coloration

Polyphenols, leucoanthocyanins, and catechols are present in both the leaves and the bark, but they are consistently more abundant in the bark. Sterols and polyterpenes are present in equivalent and moderate amounts in both parts of the plant. Flavonoids and glycosides are highly concentrated in the bark but are completely absent (or undetected) in the leaves.

The high concentration of polyphenols, flavonoids, leucoanthocyanins, glycosides, and catechols—particularly pronounced in the bark gives this plant remarkable antioxidant power. These molecules, which belong to the tannin and pigment families, are known to scavenge free radicals and protect cells against oxidative stress [13].

The bark appears to be the organ richest and most diverse in secondary metabolites. The exclusive and massive presence of flavonoids and glycosides in the bark suggests that this organ serves as a storage site for defense molecules [14]. Glycosides, for example, are often linked to defense mechanisms against herbivores or pathogens and frequently possess active pharmacological properties (such as cardiotonic, diuretic, or anti-inflammatory effects, depending on their specific type).

The moderate but consistent presence of sterols and polyterpenes in the leaves and bark indicates their fundamental structural and functional role. Sterols (such as phytosterols) are components of plant cell membranes and are also recognized in pharmacopoeia for their anti-inflammatory and cholesterol-lowering properties [15].

It should be noted that a positive correlation between total phenolic content and antioxidant capacity is generally reported in the literature [16]. However, this relationship is not strictly linear: the chemical nature, structure, and bioavailability of phenolic compounds have a greater influence on their free-radical scavenging capacity than their abundance alone. This observation could explain why the leaves, although they exhibit a phytochemical profile that is generally less rich than that of the bark (III.2), nevertheless display superior antioxidant activity (III.3) : the quality and identity of the antioxidant molecules present appear to take precedence over their mere quantity.

Antioxidant Activity

The antioxidant activities of the ethanolic extracts from the leaves and bark of Ficus sycomorus L. were evaluated at various concentrations. The results of the DPPH free radical scavenging assay are presented in Tables 3 and 4 below.

Table 3 : In vitro antioxidant activity of the ethanolic extract of Ficus sycomorus L. leaves

Concentration ($mg.mL^{-1}$)	Average absorbance and standar deviations	PI (%)
2,5	0,1415 ± 0,0005	79,65
1,25	0,125 ± 0,003	82,03
0,625	0,3045 ± 0,0835	56,22
0,3125	0,4615 ± 0,0125	33,64

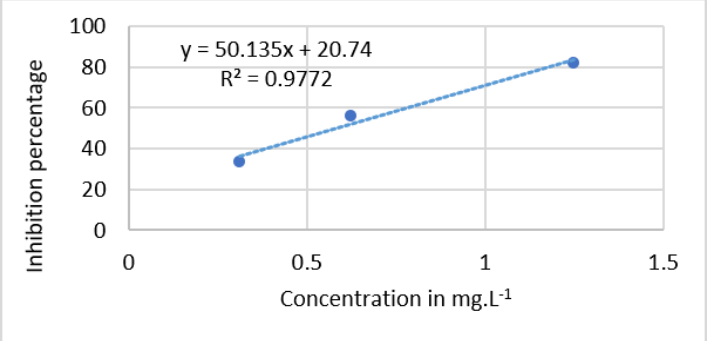

Figure 2 : Determination of the 50% inhibition percentage for *Ficus sycomorus L.* leaves

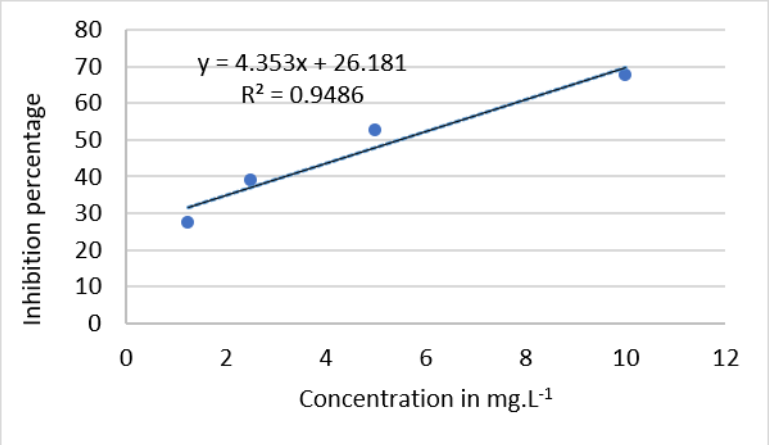

Figure 3 : Determination of the 50% inhibition percentage of *Ficus sycomorus L.* bark

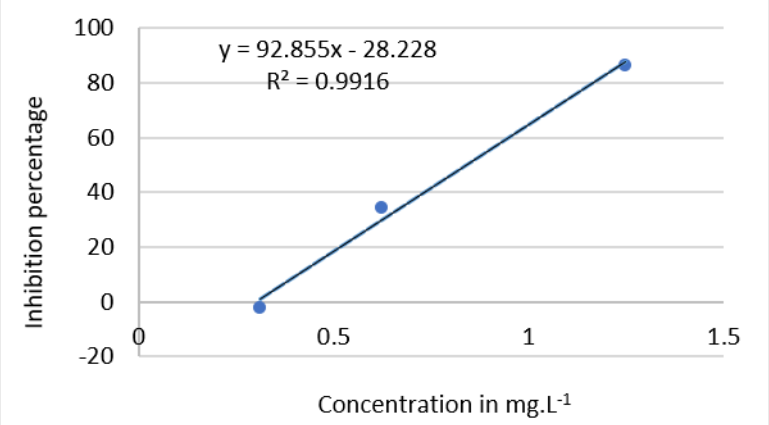

Figure 4 : Determination of the 50% inhibition percentage of ascorbic acid (positive control)

Table 4 : In vitro antioxidant activity of the ethanolic extract of *Ficus sycomorus L.* bark

Concentration (mg.mL⁻¹)	Average absorbance and standar deviations	PI (%)
10	0,176 ± 0,003	74,69
5	0,226 ± 0,015	67,51
2,5	0,330 ± 0,017	52,48
1,25	0,425 ± 0,021	38,89
0,625	0,504 ± 0,059	27,46

The data presented in Table 3 demonstrate remarkable antioxidant activity of the leaf extract, reaching a maximum inhibition percentage of 82.03% at 1.25 mg·mL⁻¹, which exceeds the maximum inhibition obtained by the bark extract. The leaf extract exhibited generally dose-dependent activity between 0.3125 and 1.25 mg/mL, with inhibition percentages of 33.64% (0.3125 mg·mL⁻¹), 56.22% (0.625 mg·mL⁻¹), and 82.03% (1.25 mg·mL⁻¹). However, a slight decrease in the IP was observed at the highest concentration tested (79.65% at 2.5 mg·mL⁻¹), which was lower than the value obtained at 1.25 mg·mL⁻¹.

Using the regression equation for the leaves (y = 50.135x + 20.74), the estimated IC_{50} value is approximately 0.58 mg·mL⁻¹.

Table 4 shows dose-dependent antioxidant activity for the bark extract, with inhibition percentages decreasing from 74.69% at the highest concentration (10 mg·mL⁻¹) to 27.46% at 0.625 mg·mL⁻¹. Using the regression equation for the bark (y = 4.353x + 26.181), the bark extract demonstrated an estimated IC_{50} value in the range of 2 to 2.5 mg·mL⁻¹, consistent with direct interpolation of the data in Table 4 (≈ 2.27 mg/mL between 1.25 and 2.5 mg·mL⁻¹).

Positive Control (Ascorbic Acid)

To validate the DPPH assay and provide a reference point for the antioxidant potency of the extracts, ascorbic acid was tested under the same experimental conditions as a positive control. The results are presented in Table 5.

Table 5 : In vitro antioxidant activity of ascorbic acid (positive control)

Concentration (mg.mL⁻¹)	Average absorbance and standar deviations	PI (%)
0,25	0,081 ± 0,0014	88,35
0,125	0,2115 ± 0,0262	69,59
0,0625	0,499 ± 0,0184	28,25
0,0312	0,681 ± 0,0297	2,08
0,0156	0,736 ± 0,0467	-5,82

Ascorbic acid exhibited strong, dose-dependent DPPH radical scavenging activity, with inhibition percentages ranging from 88.35 % at 0.25 mg·mL⁻¹ to a negligible effect, close to zero, between 0.0156 and 0.0312 mg·mL⁻¹. Linear regression of this response yielded an estimated IC_{50} of approximately 0.096 mg/mL. This value confirms the sensitivity and validity of the DPPH assay under the conditions used in this study and provides a benchmark against which plant extracts can be compared: the IC_{50} of ascorbic acid (≈ 0.096 mg·mL⁻¹) is approximately 6 times lower than that of the leaf extract (≈ 0.58 mg·mL⁻¹) and approximately 24 times lower than that of the bark extract (≈ 2.27 mg·mL⁻¹), which indicates that, as expected, the pure reference antioxidant is significantly more potent on a mass basis than the crude plant extracts, whose activity reflects a mixture of bioactive and inactive constituents.

The slightly negative PI value observed at the lowest concentration tested (0.0156 mg·mL⁻¹) most likely reflects the analytical background noise inherent in the DPPH assay when the antioxidant concentration becomes very low relative to that of the radical, a phenomenon already discussed in the methodological literature on this assay [15,16], rather than a genuine pro-oxidant effect of ascorbic acid at this dose.

Discussion

The results of this study provide strong scientific evidence supporting the traditional use of Ficus sycomorus L. in West African folk medicine. Both the leaf and bark extracts demonstrated marked antioxidant activity against DPPH free radicals, although with distinctly different potencies and dose-dependent profiles: the leaf extract stands out for its efficacy at much lower concentrations, reflecting superior antioxidant potency per unit mass (see III.3). Compared to ascorbic acid, a well-characterized reference antioxidant (IC_{50} ≈ 0.096 mg·mL⁻¹, see III.4), both extracts proved to be less potent on a mass basis, which is expected for crude plant extracts containing a mixture of active and inactive compounds; nevertheless, the IC_{50} of the leaf extract remains in the same order of magnitude as that of the standard, highlighting its promising antioxidant capacity.

This generally dose-dependent relationship, observed for both extracts, is consistent with classical pharmacological principles and supports the reliability of the methodology used. Such a profile is characteristic of antioxidants: as the concentration increases, more electron-donating groups become available to neutralize DPPH radicals via hydrogen atom transfer or one-electron transfer [17,18], up to a saturation threshold beyond which the effect may stabilize or even decrease slightly, as observed for the leaf extract between 1.25 and 2.5 mg·mL⁻¹.

The high antioxidant capacity of Ficus sycomorus L. is likely due to its phytochemical composition. Previous studies have indeed shown that the plant contains various bioactive molecules: flavonoids, phenolic acids, tannins, and other polyphenolic compounds known for their ability to scavenge free radicals and reduce reactive oxygen species through several complementary mechanisms: hydrogen atom transfer, one-electron transfer, and metal ion chelation [18,19].

The difference in activity observed between leaves and bark is likely due to differences in phytochemical profile and bioactive compound content, consistent with the screening results presented in Section III.2. The absence of detectable flavonoids in the leaves as determined by the Liebermann-Burchard test (Table 2) which contrasts with their antioxidant activity, which is higher than that of the bark warrants a cautious explanation. Several non-mutually exclusive hypotheses can be proposed: (i) the qualitative test used may lack sensitivity for certain classes of glycosylated flavonoids present in low quantities; (ii) the antioxidant activity of the leaves could be based on other compounds not targeted by the screening performed here, such as free phenolic acids or carotenoids; (iii) the chemical nature and bioavailability of antioxidant compounds often have a greater influence on activity than their abundance or diversity alone [16]. At this stage, these hypotheses remain speculative: only quantitative analysis coupled with structural identification (HPLC-DAD or LC-MS, for example) would allow them to be resolved. We recommend this characterization as the next step before drawing any definitive conclusions about the underlying mechanism.

These IC_{50} values also fall within a range consistent with that reported by other studies conducted on Ficus sycomorus L. [3] reported an IC_{50} of 0.237 ± 0.016 mg·mL⁻¹ for a methanolic bark extract, a value intermediate between those obtained here for the leaves and the bark. Other studies report a significantly lower IC_{50} (0.062 mg·mL⁻¹) for a dichloromethane bark extract [6].

These substantial discrepancies, observed for the same plant organ across different studies, illustrate the decisive influence of the extraction solvent and experimental protocol on the measured antioxidant activity, and call for caution when making any direct comparisons between studies based on distinct methodologies.

These results support the pharmacological basis for the traditional use of *Ficus sycomorus L.* in the treatment of conditions related to inflammation and oxidative stress, and suggest promising potential for the development of natural antioxidant products and herbal pharmaceutical formulations. Further research including in vivo studies, toxicity assessments, and investigations into mechanisms of action is nevertheless needed to fully characterize this therapeutic potential and establish its safety for humans.

IV. Conclusion

This phytochemical study confirms that the ethanolic extracts of the leaves and bark of Ficus sycomorus L. exhibit significant antioxidant activity against DPPH free radicals, with the leaf extract proving to be significantly more potent than the bark extract ($IC_{50} \approx 0.58$ mg·mL^{-1}). These results provide scientific evidence supporting the plant's traditional medicinal uses and identify its leaves as a particularly promising source of natural antioxidants, with potential applications in nutraceuticals, dietary supplements, and pharmaceutical development. Further investigations, including in-depth phytochemical characterization, in vivo bioavailability studies, and clinical trials, would help clarify the mechanisms of action and confirm the therapeutic efficacy of the plant in the management of conditions related to oxidative stress.

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