## *Original Research Article*

## Antifungal properties and phytochemical composition of *Ficus platyphylla* stem bark and leaves extracts.

### ABSTRACT

*Ficus platyphylla* is a plant species used in traditional medicine to treat microbial diseases. Leaves and stem bark are the most used parts of this plant.

**Objective**: The current work aims to study alternative treatments based on plants for mycoses in Togo.

**Method**: Hydroethanolic and aqueous extracts of *F. platyphylla* stem bark and leaves were tested on five reference strains (*Candida albicans* ATCC90028, *Candida krusei* ATCC6258, *Candida parapsilosis* ATCC 22019, *Trichophyton mentagrophytes* ATCC 9533 and *Aspergillus fumigatus* ATCC 13073), and two clinical strains (*Trichophyton rubrum* and *Microsporum canis),* using the broth microdilution method.

**Results**: Hydroethanolic extracts were more active. Dermatophyte strains were more sensitive, with MICs ranging from 0.31 to 2.5 mg/mL. Phytochemical tests revealed the presence of saponins, flavonoids, alkaloids, sterols, polyphenols and tannins, justifying the antifungal properties observed.

**Conclusion**: Hydroethanolic extract of *F. platyphylla* leaves has a significant antifungal potential and should be explored in further studies, particularly in therapeutic studies.

*Key words: Ficus platyphylla, stem bark, leaves, antifungal properties, phytochemicals*.

### INTRODUCTION

The distribution of mycoses is influenced by factors such as climate, geography and socio-economic conditions (Berrached *et al.*, 2022). Changes in human habits lead to the emergence of new pathogens and new clinical forms (Wiederhold, 2017). In many countries with limited resources, mycoses are diagnosed clinically without mycological confirmation, leading to empirical or preventive treatments based on conventional drugs (Perlin *et al.*, 2022). The leaves and stems of *F. platyphylla* are used to treat certain diseases, in particular opportunistic mycoses in AIDS patients (Gbogbo KA et *al.,* 2013; Koné *et al.,* 2012). This study aims to find alternatives to conventional antifungal chemotherapy using traditional African plant-based medicine.

### METHODS

#### Materials

#### Fungal material

Fungal strains used were: *C. albicans* ATCC 90028, *C. parapsilosis* ATCC 22019; *C. krusei* (presently known as *Pichia kudriavzevii*) ATCC 6258; *T. mentagrophytes* ATCC 9533, *A. fumigatus* ATCC 13073, *T. rubrum*, and *M. canis*.

Yeast strains were obtained from the laboratory of Hôpital Pitié Salpêtrière, Paris, and filamentous strains from the laboratory of Strasbourg University Hospital, France. *T. rubrum* and *M. canis* (clinical strains) were isolated from a nail sample and a scalp ringworm sample respectively, from Mycology Laboratory of CHU Campus, Lomé.

#### Plant material

The plant species used is *F. platyphylla*. Stem bark and leaves were harvested for the use in the current study.

#### Methods

#### Sample collection and drying

Stem bark and leaves were collected in Kovié locality, situated about 40 km from Lomé, the capital town of Togo (N: 6°36'56.8''; W: 1°09'43.5''). The plant species was identified at the herbarium of "Botany and Plant Ecology Laboratory" where herbarium samples were deposited in Faculty of Science, University of Lomé, Togo.

#### Extract preparation

Stem bark and leaves were shade-dried at 25°C for at least two weeks, then ground and powdered using an electric mill. One hundred grams of *F. platyphylla* stem bark or leaf powder were macerated in hydroethanolic solution (70°) or in distilled water, in stoppered jars and with stirring, for 48 to 72 hours. The resulting solutions are filtered, then the filtrates were evaporated at 40°C under vacuum using a Rotavapor®. The extracted compounds depend on the extraction solvent used: it is either a hydroethanol extract, or an aqueous extract containing the active compounds. Recovered extracts were stored in steril plastic tubes at 4°C in the refrigerator for the use in antifungal tests.

#### Extraction yield calculation

The extraction yield (Yd) was calculated by dividing the mass of extract obtained by the mass of plant powder used to carry out the extraction. Yd is expressed as a percentage. In practice, it was determined by the formula 1.

Yd (%) = (m x 100)/M (1)

Where: m: mass in grams of dry extract, M: mass in grams of extract powder).

#### Antifungal test preparation

#### Solubility test for extracts

A dilution of 4 mg/mL of each extract is made in the base solvent to ensure the solubility of each extract.

#### Antifungal tests

These tests were carried out using the broth microdilution method (Pfaller and Diekema, 2012)with a few modifications.

Starting with stock extract solution with a concentration of 100 mg/mL, a dilution in Sabouraud broth resulted in a concentration of 80 mg/mL in the first wells, followed by a series of dilutions in constant dilution factor of 2 to obtain a final concentration range in the wells between 80.00 and 0.04 mg/mL. Spore suspensions obtained from subcultures in Petri dishes, 24 hours and eight (8) days old respectively for yeasts and filamentous fungi, were calibrated using the Malassez cell at a concentration of 4.105 CFU/mL for yeasts and 4.104 CFU/mL for filamentous fungi.

One hundred (100) µL of spore suspension was added to all wells according to the fungus tested, inducing final extract concentrations in the wells of 40.00 to 0.02 mg/mL**.** Negative controls without extracts or conventional antifungals, and positive controls with conventional antifungals were used as follows: Nystatin (100 µg/mL) for yeasts, and Griseofulvin (20 µg/mL) for filamentous fungi under the same conditions as the extracts.

#### Fungicide and fungistatic activity assessment

These activities of the extract on each susceptible strain were determined as follow. In practice, 50 µL were taken from the last wells where no growth was observed (total inhibition), and were introduced into 950 µL of Sabouraud broth, then the mixture was incubated at 30 ± 2°C for 72 hours (*A. fumigatus*) to 8 days for *T. mentagrophytes, T. rubrum* and *M. canis*. The same treatment was done for the control wells in the same conditions as above. The resumption of growth indicates a fungistatic effect, and the absence of growth means a fungicidal effect. In addition, the Minimum Fungicide Concentration/Minimum Inhibitory Concentration (MFC/MIC) ratio is also used to determine whether the compound had a fungistatic (MFC/MIC ≤ 4) or fungicidal (MFC/MIC ≥ 4) effect (Banothu *et al*., 2017; Siddiqui *et al.*, 2013).

#### Phytochemical analyses

#### Phytochemical screening (qualitative)

This qualitative phytochemical analysis was done to detect the presence or absence of specific chemical molecules in an extract, using suitable reagents for each molecule (Harborne, 1998). So, major chemical groups such as: polyphenols, alkaloids, terpenes, sterols, saponosides, flavonoids and tannins, were investigated in hydroethanolic and aqueous extracts of *F. platyphylla*.

#### Identification of polyphenols

Two (2) mL of methanol and a few drops of iron perchloride (FeCl3: 1%) were respectively added to 2 mL of each extract. The presence of a blue-black color indicates the presence of phenolic compounds in the extracts analyzed (Harborne, 1998).

#### Detection of alkaloids

A few drops of Dragendorff’s reagent were added to 1 mL of each extract. The appearance of an orange-red precipitate confirms the presence of alkaloids in the extracts analyzed (Harborne, 1998).

#### Identification of triterpenes and sterols

The use of 1.6 mL of chloroform, followed by 3 drops of concentrated sulfuric acid, were added to 4 mL of each aqueous extract solution. The appearance of a red-brown ring between the light and dark phases indicates a positive test (Harborne, 1998).

#### Detection of saponosides

Two (2) mL of each aqueous extract solution were taken in a test tube and shaken vigorously for 1 minute. Persistent foam formation for 15 minutes indicates the presence of saponins in the extracts (Harborne, 1998).

#### Detection of flavonoids

Two (2) mL of methanol were added to 2 mL of each extract solution, followed by a few drops of sodium hydroxide 10% solution. The appearance of yellow-orange coloration characterized the presence of flavonoids in the extracts analyzed (Harborne, 1998).

#### Identification of tannins

Two (2) mL of distilled water followed by three (3) drops of iron perchloride (FeCl3: 1%) were added to 2 mL of each extract. After two (2) minutes of incubation, the presence of gallic tannins in the extracts was revealed by blue, dark-blue or black coloration. In addition, green to dark green coloration indicated the presence of catechic tannins in the extracts analyzed (Harborne, 1998).

#### Quantitative phytochemical analysis

#### Determination of total phenols

Total phenols were determined spectrophotometrically, using the colorimetric Folin-Ciocalteu reagent (Singleton VL., 1999). This assay was based on quantification of the total concentration of hydroxyl groups present in the extracts.

In glass hemolysis tubes, a volume of 200 μL of each extract (1 mg/mL) was added to a mixture of 1 mL of 10-fold diluted Folin-Ciocalteu reagent and 800 μL of 7.5% sodium carbonate solution. Tubes were vortexed and stored away from light for 30 min. Absorbance was read at 765 nm using a MACY(UV-1800) UV-Visible spectrophotometer. A calibration curve was run in parallel under the same operating conditions, using gallic acid at different concentrations (0 to 1000 μg/mL). Phenolic content was expressed as mg of gallic acid equivalent per a gram of dried extract (GAE/g DE).

#### Determination of total flavonoids

Flavonoids were quantified using a process based on the formation of a highly stable complex between aluminum chloride and the oxygen atoms present in flavonoid on the carbon atoms, number 4 and number 5 (Lagnika, 2005).

The protocol applied was described by Kim *et al.,* 2003 but with a few modifications (Kim et al., 2003).

In a glass hemolysis tube, 400 μL of extract, or standard, or distilled water for the control, were added to 120 μL of NaNO2 (5%). After 5 minutes, 120 μL of AlCl3 (10%) was added, and the medium was mixed vigorously. After six (6) minutes, 800 μL of NaOH (1 M) was added to the medium. Absorbance was read immediately at 510 nm against the control. A methanolic solution of quercetin as standard was prepared. Dilute solutions prepared from the stock solution at different concentrations ranging from 0 to 1 000 μg/mL, were used to plot calibration curve. Condensed flavonoid content was expressed as mg Quercetin equivalent per gram of dry extract **(QUE)/g DE)**.

#### Total tannin determination

The vanillin application method with HCl was used as described in literature (Makkar, 2013). This method depends on the reaction of vanillin with the terminal flavonoid group of condensed tannins (TCs) and the formation of red complexes (Makkar, 2013), which is explained by the property of tannins to transform into red-colored anthocyanidols by reaction with vanillin..

A volume of 50 μL of each extract was added to 1500 μL of 4% vanillin/methanol solution, then mixed vigorously. A volume of 750 μL of concentrated HCl was then added. The resulting mixture was incubated at room temperature for 20 minutes. Absorbance was measured at 550 nm against a blank. Different concentrations in the range 0 to 1000 μg/mL, prepared from a catechin stock solution, were used to plot the calibration curve. The results were expressed as mg catechin equivalent per gram of dry extract **(CAE)/g DE)**

#### Data analysis

Data were analyzed by Microsoft Excel 2016 software using descriptive statistical parameters. Results of quantitative phytochemical analyses were expressed as mean ± standard deviation over three consecutive measurements for each sample.

### RESULTS

### Extraction yields

Extraction yields for *F. platyphylla* stem bark and leaves are shown in Table 1. According to the results, extraction yields depend not only on the plant part used, but also on the type of extraction solvent. For the stem bark, the extraction yield of the aqueous extract was 4.8%, while that of the hydroethanolic extract was 18.1 %. Extraction yields for aqueous and hydroethanolic extracts of the leaves were respectively 5.0 % and 13.6 %.

**Table 1: Extraction yields of stem bark and leaves of F. platyphylla**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameters | Aqueous extracts | | Hydroethanolic extracts | | |  |
| Stem bark | Leaves | | Stem bark | Leaves | |
| Quantity of powder (g) | 200 | 200 | | 200 | 200 | |
| Quantity of extracts (g) | 9.6 | 10.0 | | 36.1 | 27.2 | |
| Yield of extraction (%) | 4.8 | 5.0 | | 18.1 | 13.6 | |

### Microbiological analysis

Minimum Fungicide Concentration/Minimum Inhibitory Concentration (MFC)/MIC

The results of antifungal properties of hydroethanolic and aqueous extracts of the stem bark and leaves of *F. platyphylla* are shown in table 2. The MIC values obtained confirm that all of the extracts had antifungal effects against the various fungal species studied. However, the best MIC values (*i.e* the lowest) were obtained with hydroethanolic extracts, notably against dermatophyte strains. These were a reference strain of *T. mentagrophytes* ATCC 9533 with *F. platyphylla* leaves (MIC= 0.31 mg/mL), clinical strains of *T. rubrum* and *M. canis* with *F. platyphylla* stem bark (MIC= 0.63 mg/mL each). The hydroethanolic extract also showed the lowest MIFs against clinical strains of *T. rubrum* and *M. canis*, with MIF values of 2.5 and 1.25 mg/mL respectively for *F. platyphylla* stem bark.

Microbiological analysis on the reference strain of *T. mentagrophytes*, gave a CMF of 2.5 mg/mL with hydroethanolic extracts of *F. platyphylla* leaves. The antifungal effects observed were either fungistatic or fungicidal, depending on the fungal species and extract used.

**Table 2: MICs and MFCs** **microorganisms by aqueous extracts of the stem bark and leaves**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Microorganisms** | Stem bark | | | EF[[1]](#footnote-1)a | Leaves | | | EF |
| MICs | MFCs | MICs/MFCs | MICs | MFCs | MICs/MFCs |
| ***C. albicans*** ATCC 90028 | ˃40 | ˃40 | ˃ 1 | FC[[2]](#footnote-2) | 10 | 40 | 1 | FC |
| ***C. parapsilosis*** ATCC 22019 | ˃40 | ˃40 | ˃ 1 | FC | 10 | 40 | 1 | FC |
| ***C. krusei*** ATCC 6258 | ˃40 | ˃40 | ˃ 1 | FC | 10 | 40 | 1 | FC |
| ***T. mentagrophytes*** ATCC 9533 | 20 | ˃40 | ˃ 2 | FC | 20 | ˃ 40 | ˃ 2 | FC |
| ***A. fumigatus*** ATCC 13073 | 20 | ˃40 | ˃ 2 | FC | ˃ 40 | ˃ 40 | ˃ 1 | FC |
| ***T. rubrum*** | 2.5 | 10 | 4 | FS[[3]](#footnote-3) | 10 | 20 | 2 | FC |
| ***M. canis*** | 10 | 40 | 4 | FS | 10 | 40 | 4 | FS |

**Table 3: MICs and MFCs of microorganisms by hydroethanolic extracts of the stem bark and leaves**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Microorganisms | Stem bark | | | EF | Leaves | | | EF |
| MICs | MFCs | MICs/MFCs | MICs | MFCs | MICs/MFCs |
| ***C. albicans*** ATCC 90028 | ˃40 | ˃40 | ˃ 1 | FC | ˃40 | ˃40 | ˃ 1 | FC |
| ***C. parapsilosis*** ATCC 22019 | ˃40 | ˃40 | ˃ 1 | FC | ˃40 | ˃40 | ˃ 1 | FC |
| ***C. krusei*** ATCC 6258 | ˃40 | ˃40 | ˃ 1 | FC | ˃40 | ˃40 | ˃ 1 | FC |
| ***T. mentagrophytes ATCC 9533*** | 10 | 40 | 4 | F | 0.31 | 2.5 | 8.06 | FS |
| ***A. fumigatus*** ATCC 13073 | 20 | ˃40 | ˃ 2 | FC | 10 | ˃ 40 | ˃ 4 | FS |
| ***T. rubrum*** | 0.63 | 2.5 | 4 | **FS** | **2.5** | **10** | 4 | FS |
| ***M. canis*** | 0.63 | 1.25 | 2 | **FC** | **2.5** | **5** | 2 | FC |

### Qualitative phytochemical profiles of extracts

The phytochemical constituents revealed in the aqueous and hydroethanolic extracts of *F. platyphylla* stem bark and leaves are presented in Table 4.

The composition of chemical groups is the same for all of four extracts, except for saponin which is only found in the hydroethanolic extract of the leaves. The phytochemical groups found are: alkaloids, polyphenols, flavonoids, tannins, triterpenes and sterols.

**Table 4: Phytochemical composition of our extracts according to extraction solvents and plant organs used**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Chemical groups** | **Aqueous extract** | | **Hydroethanolic extract** | |
| Stem bark | Leaves | Stem bark | Leaves |
| Saponins | **-[[4]](#footnote-4)** | **-** | **-** | **+** |
| Alkaloids | **+[[5]](#footnote-5)** | **+** | **+** | **+** |
| Polyphenols | **+** | **+** | **+** | **+** |
| Flavonoids | **+** | **+** | **+** | **+** |
| Tannins | **+** | **+** | **+** | **+** |
| Triterpenes and sterols | **+** | **+** | **+** | **+** |

### Quantitative phytochemical profiles of the extracts

The contents of the major phytochemical groups in the extracts varie according to the parts of the plant and the type of solvent used.

### Total polyphenol contents

The total polyphenol contents of hydroethanolic and aqueous extracts of the stem bark and leaves of *F. platyphylla* are presented in Table 5. The results are reproducible, since all the absorbances were closely correlated with the concentration of gallic acid used in the standard range, with a correlation coefficient squared R² = 0.989 (Table 5).

The aqueous extract of *F. platyphylla* stem bark contains more total polyphenols than the hydroethanolic extract, respectively 111.11 mg GAE/ g DE and 101.25 mg GAE/ g DE. As for the aqueous extract of *F. platyphylla* leaves, it contains almost 2.30 times more total polyphenols than the hydroethanolic extract, i.e. 185.48 mg GAE/ g DE *versus* 80.65 mg GAE/ g DE.

**Table 5: Total polyphenol content in F. platyphylla extracts**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Plant material** | Total polyphenol contents (mg GA[[6]](#footnote-6)E[[7]](#footnote-7)/ g DE[[8]](#footnote-8)) | | Curve equation | R² |
| Aqueous extract | Hydroethanol extract |
| Stem bark | 111.11 ± 20.53 | 101.25 ± 4.11 | *y* = 0.372*x* | 0.989 |
| Leaves | 185.48 ± 12.32 | 80.65 ± 18.82 |

### Total flavonoid contents

The total flavonoid contents of aqueous and hydroethanolic extracts are shown in Table 6. The quantitative determination of flavonoids (Quercetin is used as a standard) shows a good correlation between flavonoid variation (0 to 1 mg/mL) and absorbance. with a correlation coefficient squared R² = 0.998 (Table 6).

The results show that the hydroethanolic extracts contain more flavonoids than the aqueous extracts. The hydroethanolic extract of *F. platyphylla* stem bark contains 1.8 times more flavonoids than its aqueous extract; the hydroethanolic extract of *F. platyphylla* leaves contains 4.8 times more flavonoids than its aqueous extract.

**Table 6: Total flavonoid content in *F. platyphylla* extracts**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Plant material** | Total flavonoid contents (mg QU[[9]](#footnote-9)E/g DE) | | Curve equation | **R²** |
| Aqueous extract | Hydroethanol extract |
| Stem bark | 149.12 ± 3.87 | 272.42 ± 3.51 | *y* = 2.052*x* | 0.998 |
| Leaves | 93.40 ± 8.61 | 448.99 ± 32.64 |

### Total tannin contents

The total tannin contents of aqueous and hydroethanolic extracts of *F. platyphylla* stem bark and leaves are presented in Table 7. Quantitative evaluation of total tannins shows a positive correlation between the variation in this tannin (0 to 1 mg/mL) and absorbance, with a coefficient squared R² = 0.991.

**Table 7: Total Tannin content in F. platyphylla extracts**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Plant material** | Total tannin contents (mg CA[[10]](#footnote-10)E**/**g DE) | | Curve equation | R² |
| Aqueous extract | Hydroethanol extract |
| Stem bark | 209.50 ± 27.93 | 212.84 ± 24.90 | *y* = 0.093*x* | 0.991 |
| Leaves | 173.91 ± 25.28 | 247.58 ± 32.64 |

Overall. hydroethanolic extracts contain is richer in tannins than aqueous extracts.

Aqueous and hydroethanolic extracts of *F. platyphylla* stem bark contain respectively (209.50 and 212.84 mg CE/g DE); *F. platyphylla* leaves (173.91 and 274.58 mg CE/g DE).

### DISCUSSION

The current study revealed the antifungal activity of *F. platyphylla* leaves and stem bark extracts. Dependently, the phytochemical analyses of the extracts revealed the presence of various secondary metabolites, and among them, some were at the source of the fungal activities highlighted.

In this work, hydroethanolic extraction obtained yields were 18.1± Δ % and 13.6 ± Δ %, respectively for *F. platyphylla* stem bark and leaves, compared with 4.8 ± Δ % and 5.0 ± Δ % for aqueous extracts. The best extraction yields were obtained with hydroethanolic extracts. The type of extraction applied in our current study is called solid-liquid extraction, which involves the transfer of the solute contained in a solid (powder) to a liquid known as a solvent. Therefore, the solvent is one of the parameters influencing the nature and kinetics of the solute transfer (Isidore et al., 2019). The higher the solubility of the compounds to be extracted in the extraction solvent, the higher the extraction yield. Compared with water alone, ethanol (70%) has certainly allowed the extraction of both alcohol-soluble molecules and water-soluble small polar molecules, which justifies its higher yield achieved here. Moreover, the polarity-modifying the role of alcohols is known, improving extraction yields (Kowalczyk et al., 2013).

According to some authors(Koné et al., 2012), extraction yield can be influenced by several parameters, including solvent volume ratio, grind mass, percentage of ethanol in the hydroethanolic solvent, grind particle size and maceration time, all of which may explain the diversity of results.

Several studies on *F. platyphylla* (Koné et al., 2012; Milala et al., 2015) have revealed its antifungal potential. Our results showed that all extracts had effects on the growth of the fungal species tested according to a dose-effect relationship. However, the best activity was observed on dermatophyte strains, especially with hydroethanol extracts. MICs ranged from 0.31 to 2.5 mg/mL, and more precisely 0.31 mg/mL for *F. platyphylla* leaves on *T. mentagrophytes* ATCC 9533; 0.63 mg/mL for *F. platyphylla* stem bark on *T. rubrum*; 0.63 mg/mL for *F. platyphylla* stem bark on *M. canis*.

Furthermore, depending on the parts used, *F. platyphylla* stem bark appeared to be more active on clinical strains of *T. rubrum* and *M. canis* than the leaves, with MICs of 0.63 mg/mL, corroborating the work of Gbogbo *et al*., 2013 (Gbogbo KA et al., 2013).

In fact, in their study of *F. platyphylla* stem bark extracts on *T. mentagrophytes*, Gbogbo *et al*. (Gbogbo KA et al., 2013)found MICs of 1 mg/mL for the hydroethanolic extract and 2 mg/mL for the aqueous extract with fungicidal effects. Our results show MICs of 10 and 20 mg/mL respectively for the hydro-ethanolic and aqueous extracts, with fungistatic effects for the hydroethanolic extract and fungicidal effects for the aqueous extract. The MICs we found here are 10 times higher than those of Gbogbo *et al*.,2013. In a study aimed at the seasonal assessment of secondary metabolite content, the authors concluded that plant stress linked to the absence, insufficiency or predominance of one or more exogenous abiotic factors (water, light, temperature, chemical substances, etc.) or biotic factors (as attacks by parasites) have effects on the secondary metabolite contents of plants (Milala *et al*., 2015).

Other studies have shown the effect of climatic conditions, geographical location and harvesting period on the content of these secondary metabolites (Deci et al., 1999). So in their study, Gbogbo *et al.*, 2013 have used plants harvested in Bassar, a locality situated at north of Togo, about 450 km from Lomé. This area has a semi-arid Sudanian climate, characterized by two seasons: rainy from April to November, and dry from December to March (André Kouassi Ablom Johnson, 2017). Whereas in our study, the plant was harvested in Kovié, a place located in southern Togo, around 40 km from Lomé, characterized by a sub-equatorial climate with two dry seasons and two rainy seasons of unequal duration (André Kouassi Ablom Johnson, 2017). The difference between our results could lie in the impact of these different factors on the plant species studied.

In the current study, the clinical strains appear to be more sensitive to the plant extracts tested than the reference strains, but this finding was not consistent with the literature on reference microbial strains and clinical strains. It could be concluded that there is no significant difference between the sensitivity of these two types of strains (Abe *et al.*, 2010).

Phytochemical analysis of the different extracts revealed the presence of alkaloids, polyphenols, flavonoids, tannins, triterpenes, sterols and saponins in the hydroethanolic extract. The hydroethanolic extract of *F. platyphylla* stem bark contains all the chemical compounds studied, except saponin. Several studies have focused on the chemical constituents of *F. platyphylla* (Gbogbo KA *et al*., 2013; Milala *et al*., 2015)*.* The presence of these major chemical groups in these plants’ extracts could confer antifungal properties (Isidore *et al.*, 2019). In their study, these authors reported that the phytochemical study is carried out to scientifically evaluate the claim of a plant's therapeutic potential, which meets the objectives of most phytochemical studies and antimicrobial properties.

Quantitative phytochemical analysis of our plant showed a content of total flavonoids, total polyphenols and total tannins dependent on extraction solvent, plant organ used. For some authors, the secondary metabolite contents of plant species could be linked to important factors such as vegetation diversity, climate and soil type (Hadjer, 2023; Lefebvre and Gallet, 2018). Hydro-ethanolic extracts have overall higher contents of total chemical groups than aqueous extracts except aqueous extract of *F. platyphylla* leaves, which has almost double the value of its total polyphenol content in the hydroethanolic extract (185.48 ±12.32 and 80.65 ±18.82). Water and ethanol being the best solvent for polyphenol extraction (ALI Z. *et al.*, 2021), a potentiation of these extraction actions with respect to *F. platyphylla* leaves could justify this result.

### CONCLUSION

The study of the antifungal properties of *F. platyphylla* leaves and stem bark extracts on fungal species commonly found in superficial mycoses, namely *C. albicans*, *C. parapsilosis*, *C. krusei*, *T. mentagrophytes*, *T. rubrum*, *M. canis* and *A. fumigatus* confirmed the existence of dose-dependent antifungal activities. Activities were best on dermatophyte species, especially with *rubrum*, *M. canis* and *A. fumigatus* with hydroethanolic extracts. The presence of chemical groups in the phytochemical analysis confirms and justifies the use of these plant species in traditional medicine.

As the MICs obtained are higher than those of conventional molecules, there is a need to work on the purification of these extracts in order to improve their activity and pursue further *in-vitro* anti-fungal susceptibility tests.

**CONSENT AND ETHICAL APPROVAL**

It is not applicable.

**ARTIFICIAL *INTELLIGENCE***

*Author(s) here by declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.*

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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1. a EF= Effect [↑](#footnote-ref-1)
2. FC= Fungicid [↑](#footnote-ref-2)
3. FS= Fungistatic [↑](#footnote-ref-3)
4. **- =** Absent [↑](#footnote-ref-4)
5. += Present [↑](#footnote-ref-5)
6. GA= Gallic Acid [↑](#footnote-ref-6)
7. E= Equivalent [↑](#footnote-ref-7)
8. DE= Dry extract [↑](#footnote-ref-8)
9. QU= Quercetin [↑](#footnote-ref-9)
10. CA= Catechin [↑](#footnote-ref-10)