Vol. 14(3), pp. 118-128, March, 2020
DOI: 10.5897/JMPR2019.6874
Article Number: 5652D3B63323
ISSN 1996-0875

http://www.academicjournals.org/JMPR

ACADEMIC JOURNALS
expand your knowledge

**Journal of Medicinal Plants Research**

*Full Length Research Paper*

# Evaluation of the biological activities of leaf and bark extracts of *Ficus platiphylla* Delile, a medicinal plant used in Mali

**Mamadou Abdoulaye Konaré[1*], Nouhoum Diarra[1], Cheickna Cissé[1], Daouda Abdoul Karim Traoré[1,2,3], Issiaka Togola[1], Adounigna Kassogué[4], Rokia Sanogo[5,6] and Aboubacar Sidiki Ouattara[7]**

[1]Laboratory of Plant and Food Biochemistry and Biotechnologies (LBVA_B), Faculty of Sciences and Techniques (FST), University of Sciences, Techniques and Technologies of Bamako (USTTB), Mali –BPE 3206.
[2]Faculty of Natural Sciences, School of Life Sciences, Keele University, Staffordshire ST5 5BG, United Kingdom.
[3]Life Sciences Group, Institute Laue Langevin, 71 avenue des Martyrs, Grenoble Cedex 9, France.
[4]Microbiology and Microbial Biotechnology Laboratory (LaBoREM-Biotech), Faculty of Sciences and Techniques (FST), University of Sciences, Techniques and Technologies of Bamako (USTTB), BPE 3206, Mali.
[5]Department of Traditional Medicine (DMT), National Institute of Research in Public Health (INSRP), B.P 1746 Bamako, Mali.
[6]Department of Pharmaceutical Sciences, Faculty of Pharmacy, University of Sciences, Techniques and Technologies of Bamako (USTTB), BPE 3206 Mali.
[7]Research Centre for Biological Food and Nutritional Sciences (CRSBAN), University Joseph Ki-Zerbo, 03 BP 7131 Ouagadougou 03, Burkina Faso.

Received 2 November, 2019; Accepted 14 February, 2020

**Leaves and barks of *Ficus platiphylla* are used in traditional medicine in western Africa for treating bacterial infections. The aim of this work was to screen the biological activities of extracts of the plant. Three common bacterial strains were used in this study. The antiradical and antibacterial activities were assessed respectively by spectrophotometric and agar diffusion methods. The bark and leaves are very rich in dry matter, ash and as well as proteins and carbohydrates. Ethyl acetate was the best solvent to extract polyphenols (4.77-5.01 g/100 g) and flavonoids (1.97-3.32 g/100 g). Similarly, ethyl acetate extracts showed the best anti-free radical activity with $IC_{50}$ = 5.10 and 5.22 µg/ml for bark and leaves respectively. The aqueous and methanolic leaf extracts displayed the highest antibacterial activity on the *Escherichia coli*, with an inhibition diameter (ID) of 11.50 ± 0.50 mm. On *Salmonella typhi*, the most active antibacterial agents were found in leaf ethyl acetate extracts with ID = 15.33 ± 0.58 mm. These extracts have the same efficacy as the commercial antibiotic ciprofloxacin (positive control) which displayed an ID of 15.33 ± 0.76 mm. Finally, *S. aureus* was highly sensitive to ethyl acetate extracts of the barks: ID = 15.50 ± 1.32 mm (p-value = 4.10E-6 < 0.05). The richness in secondary metabolites associated with the antiradical and antibacterial activities justify use of *F. platiphylla* in traditional medicine. This study shows that *F. platiphylla* could be a valuable medicinal plant for the management of common bacterial infections.**

**Key words:** *Ficus platiphylla* extracts, phytochemical screening, antiradical activity, antibacterial activity.

## INTRODUCTION

The use of natural products for primary needs, particularly for health care, has always been part of human practice.

The treatment of common diseases and conditions caused by pathogens is increasingly unaffordable for people in developing due to the high cost combined with the low efficacy of some allopathic drugs (Shahzad et al., 2016; Traoré et al., 2019). There is therefore a great need to find alternative sources of bioactive chemicals, in particular of plant origin which can readily be used though undergoing an extensible manufacturing process (Biyiti et al., 2004). In recent years, many plants have been investigated as alternative sources of bioactive drugs and in particular antimicrobial agents (Sanogo, 2014; Haidara et al., 2016; Akhtar et al., 2018; Bagayoko et al., 2018; Haidara, 2018; Keita et al., 2018; Mihin et al., 2019). Traditional plant-based medicine remains the first option for treatment in low-income countries. This is not only due to the historical considerations but more importantly, the lower-cost and access these medicines (Kpadonou et al., 2019; Traoré et al., 2019). The WHO estimates that up to 80% of the world's population uses traditional medicine for primary care (WHO, 2018). It is therefore important to extend investigations on medicinal plants using modern tools in order to acquire a better knowledge of their therapeutic virtues. These discoveries could yield to unknown bioactive molecules that could be useful for the treatment of diseases and the standardisation of therapeutic compositions (Haidara, 2018).

In Mali, the National Institute of Research in Public Health (INRSP) through its Department of Traditional Medicine (DMT), a structure specializing in the exploration and development of phytomedicines, has carried out numerous studies to this end (Diallo et al., 2003; Willcox et al., 2007; Togola et al., 2008; Sanogo et al., 2012; Sanogo et al., 2014; Haidara et al., 2016; Traoré et al., 2019; Denou et al., 2019). However, many other plant species commonly used by local populations have not yet been explored. That is the reason why we initiated studies on a widely used plant by the population of Banamba (Northwest Mali) for its therapeutic virtues: *Ficus platiphylla* Delile. *F. platiphylla* Delile is a deciduous fig tree widely distributed in the African Savannahs particularly in Mali where it is called "N'Gaba Bilé" in the local language Bamanankan. The various parts of this plant, including leaves and trunk bark, are used for the prevention and treatment of various diseases. Several studies have been conducted worldwide on the evaluation of antimicrobial activities in Ficus species (Saleh et al., 2015; Shahzad et al., 2016; Bhawana et al., 2018). Some studies have shown that they are promising candidates for the development and formulation of new antimicrobial drugs (Truchan et al., 2015; Milala et al., 2015).

Studies on *F. platiphylla* Delile, have shown that it has anti-nociceptive, anti-inflammatory, gastrointestinal antispasmodic and effects on the central nervous system (Diawara, 2010; Ugwah-Oguejiofor et al., 2011; Ben et al., 2015; Chindo et al., 2016). The main purpose of this work was to evaluate the antibacterial activity of the plant towards few of the most common infectious bacterial agents found in Mali. We also present the phytochemical composition and antiradical activities of leaf and bark extracts of *F. platiphylla* Delile. The motivation comes from the extensive use of this plant by traditional health practitioners in Banamba in the treatment of bacterial infections. If such use is justified, this plant may be an avenue for the discovery of sustainable alternatives in the fight towards antibiotic resistance.

## MATERIALS AND METHODS

The plant material used in this study was derived from the leaves and bark of *F. platiphylla* Delile. These were harvested in Banamba, 150 km Northwest of Bamako (Mali), between January and February 2019. The nature of the plant was confirmed at the Department of Traditional Medicine (DMT) in Bamako where a herbarium is registered under number 1814. Bacterial strains *Escherichia coli, Salmonella typhi* and *Staphylococcus aureus* were provided by the Laboratory of Microbiology and Microbial Biotechnology (LaBoREM - Biotech) located at the University of Sciences, Techniques and Technologies of Bamako (USTTB).

### Preparation of extracts

Ten grams of sample powder are dissolved in 100 mL of solvent under magnetic agitation for 24 hand filtered. The solvent is evaporated dry (if organic) and the extract is redisolved in 50 ml of water for lyophilisation and stored cold at 0°C (Keïta et al., 2019). The extraction yields are calculated using the following formula:

$$\text{Extraction yield (\%)} = \frac{(P1-P0)}{Pe} \times 100$$

P0 = Mass of the empty storage tank (g)
P1 = Mass of the flask containing the lyophilized extract (g)
Pe = Mass of test sample (g)

### Phytochemical screening

These extracts were screened for the presence of alkaloids, anthraquinones, tannins, saponins, flavonoids using standard protocol (Haidara, 2018; Keita et al., 2018). Alkaloids were characterized by Mayer and Dragendorff reagents, tannins by reaction with ferric chloride (FeCl3), saponosides by persistent foam, flavonoids by reaction with cyanidine and anthocyanins by acidification and alkalinisation of the extract. The sterols and triterpenes were characterized with the Liebermann-Burchard reaction. The appearance or not of UV fluorescence at λ = 366 nm was used to search for coumarins (Haidara, 2018; Keita et al., 2018). Metabolites were searched for in aqueous, methanolic and ethyl acetate extracts from leaves and bark.

*Corresponding author. E-mail: konaresucces@gmail.com.

**Dry matter**

The dry matter content was obtained by weight dosage. Ten grams (test intake) of leaf or bark powder was introduced into a previously tared porcelain crucible. The crucible containing the powder is weighed before being introduced into the oven at 105°C for 24 h. At the exit of the furnace and after cooling in a desiccator, the dry matter is weighed again. The result is expressed as a percentage of dry matter, calculated according to the following formula (Haidara, 2018):

$$\text{Dry matter (\%)} = \frac{\text{Dry matter mass (g)}}{\text{Test intake (g)}} \times 100$$

**Total ash content**

The ash content of samples (barks and leaves) was also obtained by weight dosage the white ash obtained by calcining in a furnace. A test intake of 10 g of sample powder was placed in a previously tared porcelain crucible and introduced into the furnace set at 550°C for 6 h. At the exit of the furnace and after cooling in desiccator, the ash mass is measured. The percentage of total ash is calculated according to the following formula (Haidara, 2018):

$$\text{Total ash (\%)} = \frac{\text{Mass of ash (g)}}{\text{Test take (g)}} \times 100$$

**Metabolite assay**

Total proteins were determined by the Kjeldhal method and total carbohydrates by the spectrophotometric method described by Doukani et al. (2013). Total polyphenols and flavonoids were quantified by the spectrophotometric method according to the protocol described by Fofié et al. (2017). The levels of polyphenols and flavonoids are expressed in equivalent grams, respectively of gallic acid and quercetin per 100 g of raw products.

**Determination of antiradical activity**

Antiradical activity was evaluated by two methods: phosphomolybdate and DPPH tests as described below:

**Phosphomolybdate test or total antioxidant capacity (TAC)**

This colorimetric assay is based on the redox reaction of molybdenum Mo (VI) present in the mixture as $MoO^{2-}$ to Mo (V) $MoO^{2+}$ molybdate ions. In the presence of the extract, a green phosphate/ Mo (V) complex is formed at acidic pH (Prieto et al., 1999). A volume of 100 µL of the extract is mixed with 900 µl of reagent solution (0.6 M sulphuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate). The tubes containing the mixture are sealed and incubated at 95°C for 90 min. After cooling, the absorbance of the solutions is measured at 695 nm with a spectrophotometer (Suzi 40/10) against the blank which contains 900 µl of the reagent solution and 100 µl of methanol and is incubated under the same conditions as the sample. The total antioxidant capacity is expressed in equivalent milligrams of quercetin per gram of raw product (Prieto et al., 1999).

**DPPH method**

Trapping of the free radical 2.2'-diphenyl-1-picryl hydrazyl (DPPH) was used to determine the anti-radical activity of the extracts (Mihin et al., 2019). From a solution of 100 µg/ml of extract, a calibration range is performed. 50 µl of each extract at different concentrations are added to 1.95 ml of DPPH methanolic solution (0.024 g/L). At the same time, a negative control is prepared by mixing 50 µl of methanol with 1.95 ml of the methanol solution of DPPH. The absorbance is read with a spectrophotometer (Suzi 40/10) against a blank prepared for each concentration at 515 nm after 30 min of incubation in darkness and room temperature (30-35°C). Controls using standard antioxidants: ascorbic acid, quercetin and rutin are included in the experiment.

The results are expressed in $IC_{50}$ (concentration of the tested sample required to reduce 50% of the DPPH radical) which is inversely proportional to the antiradical activity. The $IC_{50}$ are determined by linear regression from the inhibition percentages as a function of different concentrations of the extracts tested. The free radical inhibition percentages are calculated using the following formula:

$$\text{Percentage of inhibition (\%)} = \left[1 - \frac{\text{Absorbance of the sample}}{\text{Absorbance of the negative control}}\right] \times 100$$

**Antibacterial activities**

***Disk preparation***

A concentration of 4 mg/ml of bark or leaf extract diluted in 1% DMSO was used. Blank discs (from Liofilchem S.R.L.) with a diameter of 5 mm were impregnated with the extract solution. The commercial antibiotic discs of amoxycycline (30 µg/disk), doxycycline (30 µg/disk) and ciprofloxacin (5 µg/disk) were used as positive controls and a 1% DMSO solution (10 µl/disk) as negative control.

***Preparation of the inoculum***

A physiological solution of pure isolates of clinical strains of *E. coli, S. typhi* and *S. aureus* was prepared. The turbidity is then adjusted to the McFarland 0.5 standard with a spectrophotometer (Suzi 40/10), which corresponds to $1\text{-}2\times10^8$ colony forming units in millimeters (CFU/ml) for bacteria (Beddu, 2015).

***Disk distribution***

The agar diffusion method of discs was used to assess the sensitivity of bacterial strains to extracts (Truchan et al., 2015). Blank discs, impregnated with 10 µl of extract or 1% DMSO solution, are deposited on the surface of a Mueller-Hinton agar medium in a petri dish (3 discs/petri dish) previously seeded on the surface with 1 mL bacterial suspension ($10^8$ CFU/ml) for 10-15 min(Mihin et al., 2019). The boxes are left at room temperature for 1 hour and then incubated at 37°C for 18-24 h. After incubation, the diameter of the inhibition zones is measured in millimeters (mm). The diameters of the inhibition zones (ID) were classified according to the scale proposed by (Mihin et al., 2019): if ID < 8 mm, the strain is considered not sensitive to the extract tested, if 8 ≤ ID < 14 mm, sensitive strain, if 14 ≤ ID < 20 mm, very sensitive strain and if ID ≥ 20 mm, extremely sensitive strain.

**Data analysis**

The data were collected on Excel version 2013 and analysed with

**Table 1.** Phytochemical screening of leaf and bark extracts of *F. platiphylla* Delile.

| Chemical groups | Leaves | | | Bark | | |
|---|---|---|---|---|---|---|
| | Aq | Ac E | Meth | Aq | Ac E | Meth |
| Alkaloids | + | + | + | - | - | - |
| Tannins | + | + | + | + | + | + |
| Flavonoids | + | + | + | + | + | + |
| Coumarins | + | + | + | + | + | + |
| Saponins | - | - | - | - | - | - |
| Sterols and Triterpenes | + | + | + | + | + | + |
| Free anthraquinones | + | + | + | + | + | + |

*Aq: Aqueous extract; Ac E: Ethyl acetate extract; Meth: Methanolic extract.

**Table 2.** Dry matter content (%), total ash (%), total protein and carbohydrates (g/100 g).

| Organs | Dry matter (%) | Total ash (%) | Total proteins (g/100 g) | Total carbohydrates (g/100 g) |
|---|---|---|---|---|
| Bark | $92.22 \pm 1.15^{a}$ | $9.61 \pm 0.10^{b}$ | $1.08 \pm 0.12^{d}$ | $21.95 \pm 1.51^{e}$ |
| Leaves | $93.00 \pm 0.33^{a}$ | $17.47 \pm 2.27^{c}$ | $1.01 \pm 0.03^{d}$ | $15.51 \pm 0.41^{f}$ |

*For each parameter, the averages that do not share any letters are significantly different at the 0.05 threshold; the same goes for the carbohydrate averages.

Minitab 18.1 software. Analysis of variance (ANOVA) was used to compare the means of the three trials in each case to the 5% probability threshold. The averages are considered significantly different when p-value < 0.05.

## RESULTS

### Phytochemical screening

We performed a phytochemical screening of *F. platiphylla.* The results of the screening are presented in Table 1.. These results suggest the presence of several major chemical groups such as alkaloids, tannins, flavonoids, coumarins, sterols, triterpenes, free anthraquinones and terpenoids in both leaves and bark. However, the presence of saponins was not revealed in the samples extracts of bark and leaves as well as alkaloids in the bark extracts (Table 1).

### Dry matter, total ash, total protein and total carbohydrate composition

In order to assess the physicochemical composition of *F. platiphylla*, we determined the total dry matter, the total amount proteins and carbohydrates. These results are presented in Table 2. Interestingly, the dry matter and total protein found in the bark and the leaves are identical. However, bark extracts are richer in carbohydrates than leaf extracts. The highest total ash content was found in the leaves. The dry matter and protein contents of the bark and leaves are identical. However, bark extracts is richer in carbohydrates than leaf extracts. The highest total ash content was found in the leaves (Table 2).

### Extraction yields

Figure 1 shows the extraction yields. This figure shows that methanol is the best solvent to extract soluble compounds from both leaves and bark.

### Determination of total polyphenols and flavonoids

Figure 2 shows the levels of total polyphenols and flavonoids as a function of the organs and the extraction solvent. The highest levels of polyphenols and flavonoids are found in ethyl acetate extracts from bark and leaves. So ethyl acetate is the best extractive solvent for polyphenols and flavonoids in both organs.

### Antiradical activity

To assess the antiradical activity of the plant, we performed two independent tests: Phosphomolybdate test or Total Antioxidant Capacity (TAC) and the DPPH test. Both methods revealed that ethyl acetate and methanol extracts from bark and leaves present the highest total antioxidant capacities and the lowest $IC_{50}$ (Figure 4.). Although, the antiradical activities are weaker than those of the positive controls (ascorbic acid, Quercetin, Rutin) (Figure 4.).

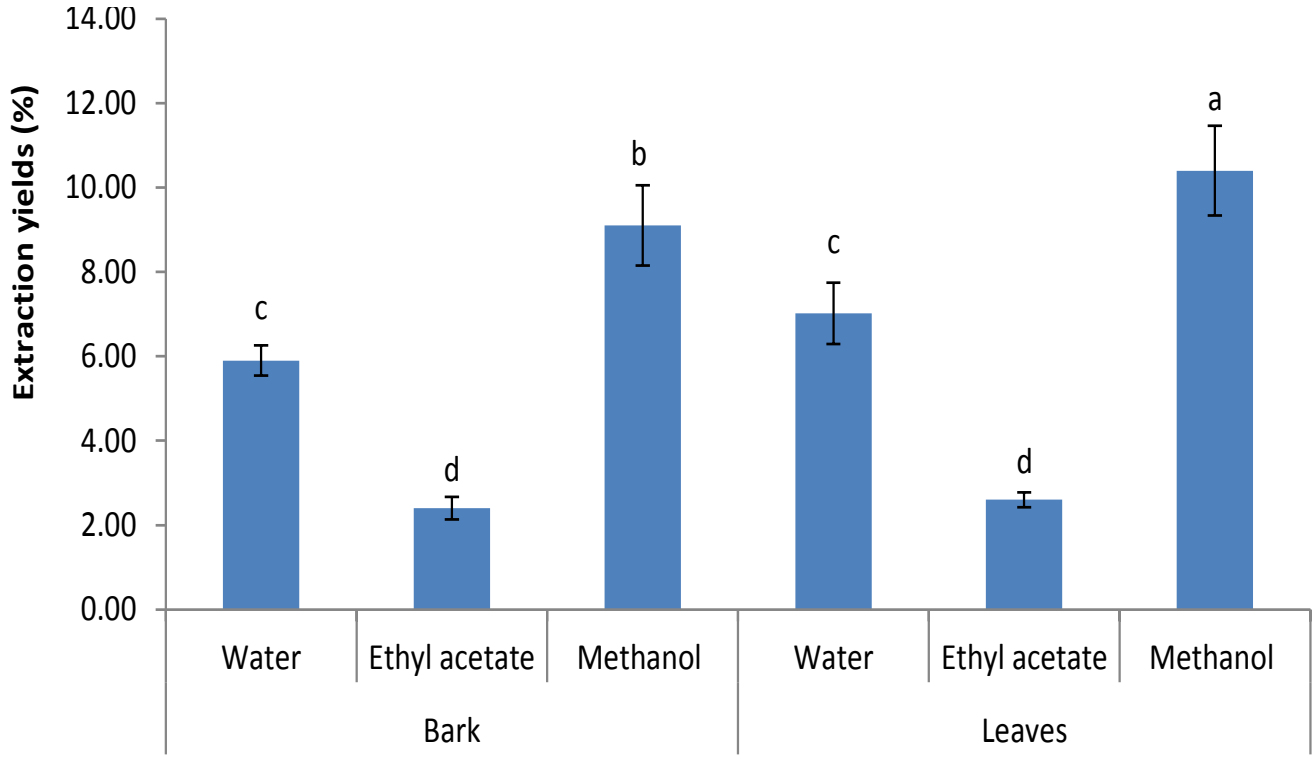


**Figure 1.** Extraction yields per organ and per extraction solvent.
* The average extraction yields that do not share any letters are significantly different at the 0.05 threshold.

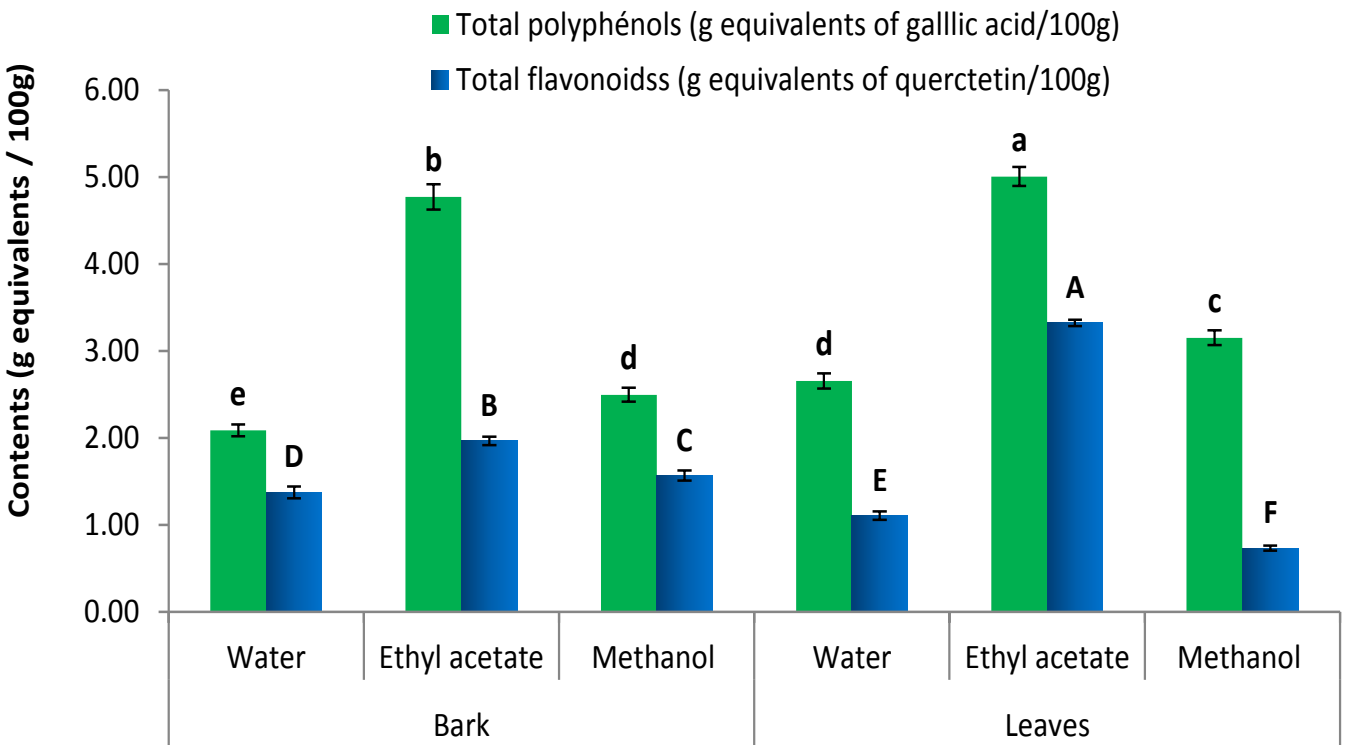


**Figure 2.** Levels of total polyphenols and flavonoids as a function of the organs and the extraction solvent. *The averages of polyphenols that do not share any lower-case letters are significantly different at the 0.05 threshold; the same applies to flavonoids averages that do not share any upper-case letters.

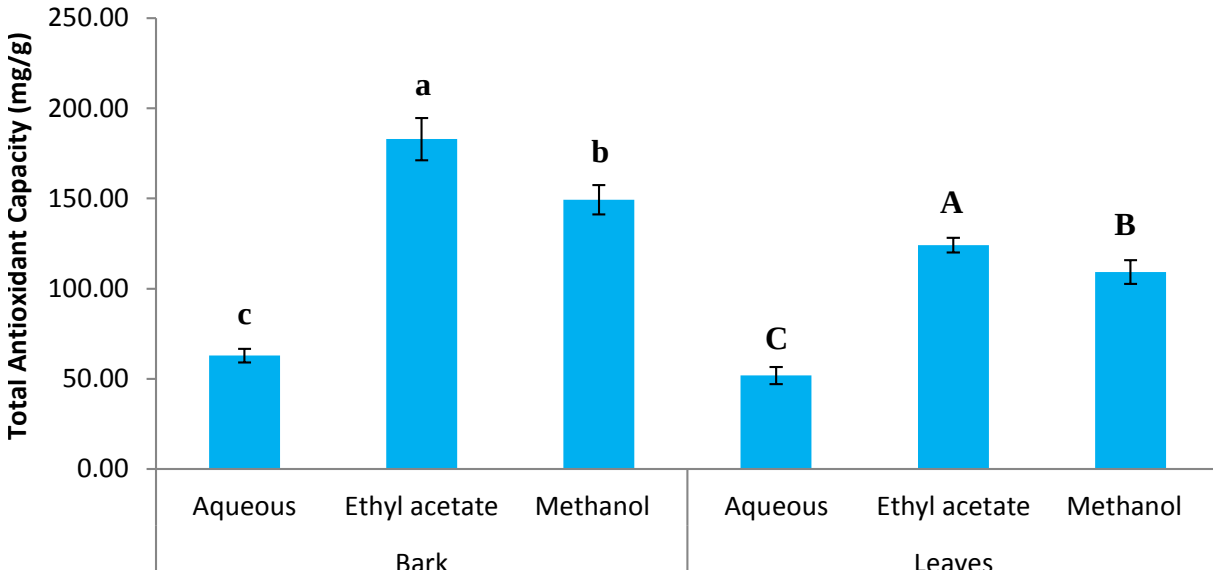


**Figure 3.** Total antioxidant capacity (mg/g) as a function of organs and extraction solvent. *The averages of bark extracts that do not share any lower-case letters are significantly different at the 0.05 threshold; the same applies to leaf extract averages that do not share any upper-case letters.

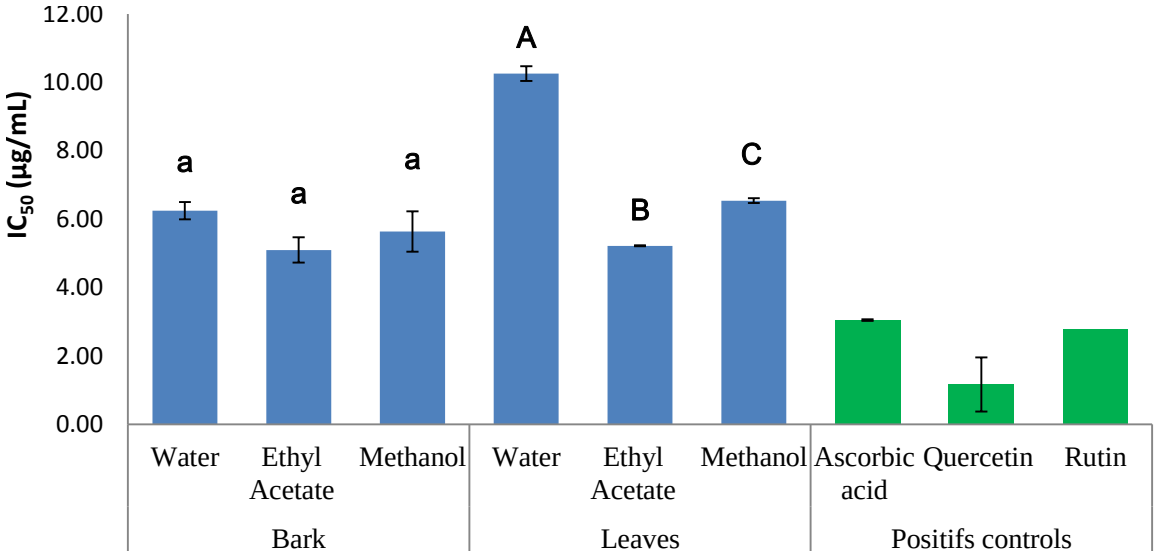


**Figure 4.** $IC_{50}$ (µg/ml) variations according to organs and extraction solvent. *The $IC_{50}$ averages of bark extracts that do not share any lowercase letters are significantly different at the 0.05 threshold; the same goes for the $IC_{50}$ averages of leaf extracts that do not share any uppercase letters.

**Phosphomolybdate test or total antioxidant capacity (TAC)**

Figure 4 shows the results of the phosphomolybdate test.

**DPPH method**

Figure 4. shows the 50% inhibitory concentrations ($IC_{50}$) of extracts and standards.

**Antibacterial activities**

We tested the antibacterial activities on the major bacterial strains: *E. coli*, *S. typhi* and *S. aureus*. A typical antibiogram is presented in Figure 5. With the positive control (Ciprofloxacin), the inhibition zone is clearly visible

**Positive control on *S. typhi*** **Negative control on *S. typhi*** **Leaf extract on *S. typhi***

**Figure 5.** Photos of *S. typhi* cultivated in the presence of controls (positive and negative) and extracts.

**Table 3.** Diameter of inhibition zones (mm) of extracts tested on *E. coli*.

| Organ | Extracts type | *E. coli* | Strain sensitivity |
|---|---|---|---|
| Bark | Aqueous | 9.83 ± 0.76[b] | Sensitive |
| | Ethylic | 8.50 ± 0.50[c] | Sensitive |
| | Methanolic | 6.33 ± 0.58[d] | Not Sensitive |
| Leaves | Aqueous | 11.50 ± 0.50[a] | Sensitive |
| | Ethylic | 7.83 ± 0.29[c] | Not Sensitive |
| | Methanolic | 11.50 ± 0.50[a] | Sensitive |
| Positives controls | Amoxicilline | - | Not Sensitive |
| | Ciprofloxacin | 16.00 ± 1.00[f] | Very Sensitive |
| | Doxycycline | 18.17 ± 1.04[e] | Very Sensitive |

*The averages of inhibition zone diameters that do not share any letters are significantly different at the 0.05 threshold.

**Table 4.** Diameter of inhibition zones (mm) of extracts tested on *S. typhi.*

| Organ | Extracts type | *Salmonella typhi* | Strain sensitivity |
|---|---|---|---|
| Bark | Aqueous | 11.33 ± 0.58[b] | Sensitive |
| | Ethylic | 12.33 ± 0.58[b] | Sensitive |
| | Methanolic | 12.00 ± 1.00[b] | Sensitive |
| Leaves | Aqueous | 6.50 ± 0.50[c] | Not sensitive |
| | Ethylic | 15.33 ± 0.58[a] | Very sensitive |
| | Methanolic | 11.17 ± 0.76[b] | Sensitive |
| Positives controls | Amoxicilline | - | Not sensitive |
| | Ciprofloxacin | 15.33 ± 0.76[a] | Very sensitive |
| | Doxycycline | - | Not sensitive |

*****The averages of inhibition zone diameters that do not share any letters are significantly different at the 0.05 threshold.

when the bacterial culture is challenged with the antibiotic. The negative control displays no inhibition zone and the experiment with the leaf extract display some inhibition. The inhibition diameters were measured for each extract and the results are summarized in Tables 3 to 5. Figure 5 shows some images of the strains of S.

**Table 5.** Diameter of inhibition zones (mm) of extracts tested on *S. aureus.*

| Organ | Extracts type | *S. aureus* | Strain sensitivity |
|---|---|---|---|
| Bark | Aqueous | 8.50 ± 0.50$^{d}$ | Sensitive |
| | Ethylic | 15.50 ± 1.32$^{a}$ | Very sensitive |
| | Methanolic | 11.00 ± 1.00$^{b}$ | Sensitive |
| Leaves | Aqueous | 10.33 ± 0.58$^{bc}$ | Sensitive |
| | Ethylic | 9.67 ± 0.58$^{bcd}$ | Sensitive |
| | Methanolic | 9.17 ± 0.76$^{cd}$ | Sensitive |
| Positives controls | Amoxicilline | 18.67 ± 1.15$^{f}$ | Very sensitive |
| | Ciprofloxacin | 18.33 ± 0.58$^{f}$ | Very sensitive |
| | Doxycycline | 22.33 ± 0.58$^{e}$ | Extremely sensitive |

*The averages of inhibition zone diameters that do not share any letters are significantly different at the 0.05 threshold.

typhi cultivated in the presence of extracts.

The following Tables 3 to 5 present the diameters of the inhibition zones (ID) of the extracts tested on the three bacterial strains. The results from Table 3. indicate that methanolic and aqueous leaf extracts have good inhibition on the growth of *E. coli* strains. On the other hand, ethyl acetate extract from leaves shows good inhibition of *S. typhi* growth (Table 4). As for *S. aureus*, its growth is strongly inhibited by ethyl acetate extracts from bark.

## DISCUSSION

The objective of this work was to evaluate the biological activities of aqueous, methanolic and ethyl acetate extracts of *F. platiphylla* Delile leaves and bark. To this end, phytochemical screening was performed. The results revealed the presence of many large phytochemical groups (alkaloids, tannins, flavonoids, coumarins, sterols, triterpenes, free and anthraquinones) in all bark and leaf extracts (Table 1). Our study revealed the presence of alkaloids in leaves extracts but not in bark. This is consistent with Kambli et al. (2014) who showed that *Ficus racemosa* Linn, another specie of the same genus, could contain 10 times more alkaloids in leaves than in bark. The absence of alkaloids in the bark could be due to their extremely low levels and therefore not detectable by the test used, which is not very sensitive. Phytochemical screening also showed the absence of saponins in the extracts. The absence of saponins would be a good point for therapeutic use of plant extracts (Xu et al., 1996). These results suggest that *F. platiphylla* is very rich in secondary metabolites.

Our study revealed that leaves were richer in total ash (7.47 ± 2.27%) than bark (9.61 ± 0.10%; p-value = 0.004 < 0.05). These relatively high ash contents show that our samples would be rich in mineral elements (Haidara, 2018). The samples are very rich in dry matter, 92.22 ± 1.15% and 93.00 ± 0.33%, respectively for bark and leaves. These values would indicate ease of preservation with no risk of enzymatic hydrolysis on the one hand (Somboro et al., 2011) and richness in metabolites on the other hand (Diarra et al., 2019). Furthermore, carbohydrates are more concentrated (p-value = 0.435 > 0.05) in the bark (21.95 ± 1.51 g/100 g) than in the leaves (15.51 ± 0.41 g/100g). Protein contents are identical (p-value < 0.05) in bark (1.08 ± 0.12 g/100 g) and leaves (1.01 ± 0.03 g/100 g) (Table 1). In view of these levels, the bark and leaves of Ficus could also be a source of energy nutrients.

Methanol extraction gave the best yields (p-value = 0.2E-7 < 0.05) with 9.10 ± 0.95% and 10.40 ± 1.06% respectively for leaves and bark. It is followed respectively by aqueous extract with 5.90 ± 0.36% for bark and 7.02 ± 0.73% for leaves and ethyl acetate with 2.40 ± 0.26% for bark and 2.60 ± 0.17% for leaves (Figure 1). Ethyl acetate was the best extractive solvent for polyphenols (p-value = 0.28E-12 < 0.05) and flavonoids (p-value = 0.32E-14 < 0.05). The polyphenol contents were 4.77 ± 0.15 g gallic acid equivalents/100 g for bark and 5.01 ± 0.115 g gallic acid equivalents/100 g for leaves. For flavonoids, the contents were 1.97 ± 0.05 g quercetin equivalents/100g for bark and 3.32 ± 0.03 g quercetin equivalents/100g for leaves (Figure 2). These results are consistent with that of Kambli et al. (2014) which showed that leaf extracts contain more phenolic and flavonoid substances than bark. Polyphenols and flavonoids are known for their anti-free radical properties (Kambli et al., 2014; Saleh et al., 2015). According to Badiaga (2011), the richness of plants in flavonoids should play a positive role in the treatment of cardiovascular and neurodegenerative diseases and also in antitumor activity.

As with extraction, the solvent ethyl acetate extracts have shown the best anti-free radical activity. With the

antioxidant capacity method, the bark with a value of 182.89 ± 11.68 mg/g and leaves with a value of 124.10 ± 4.12 mg/g have got the highest total antioxidant capacities (p-value = 0.06E-4 < 0.05) (Figure 2). The lowest activity was recorded with aqueous extracts with 62.84 ± 3.69 mg/g of bark and leaves with 51.83 ± 4.76 mg/g. With the DPPH test, the leaf with a value of $IC_{50}$ = 5.22 ± 0.22 µg/mL and the bark with a value of $IC_{50}$ = 5.10 ± 0.25 µg/ml have shown the best antiradical activities also from ethyl acetate extracts. The ANOVA using the Dunnett Test showed that the antiradical activities of our bark extracts (p-value = 0.004 < 0.05) and leaves (p-value = 0.0001 < 0.05) are all lower than those of the positive controls tested: ascorbic acid with 3.05 ± 0.07 µg/ml, rutin with 2.79 ± 0.79 µg/ml and quercetin with 1.17 ± 0.03 µg/ml (Figure 4.). The high content of polyphenols and flavonoids (Figure 2) in the extracts would be responsible for the anti-free radical activities observed in our extracts; since a direct correlation between antioxidant activity and the reducing power of plant extracts involving phenolic compounds has been reported by many authors (Fatima et al., 2015; Iqbal et al., 2017; Togola et al., 2019; Fofié et al., 2017; Bagewadi et al., 2019). Other secondary metabolites (tannins, terpenes, sterols, etc.) are also thought to be involved in the antioxidant activity of plant extracts (Tabit et al., 2016). Studies have shown that bark extracts are generally richer in phenolic compounds and therefore have more anti-free radical activities than leaves (Nkoulou, 2014).

The bacterial sensitivity test showed that on *E. coli* strain, aqueous (ID = 11.50 ± 0.50 mm) and methanolic (ID = 11.50 ± 0.50 mm) extracts from the leaves showed the largest inhibition diameters (ID) (p-value = 3E-7 < 0.05). This result is consistent with Kambli et al. (2014) who reported that methanolic extracts from Ficus leaves and bark inhibit the growth of *E. coli* (Kambli et al., 2014). The difference of sensitivity observed between methanolic leaf and bark extracts on *E. coli* could be explained by the absence of alkaloids in the bark; since these molecules are indicated to have bactericidal effects (Badiaga, 2011). Numerous studies have shown that the antibacterial activity of plant extracts is also linked to the presence of tannins, polyphenols, flavonoids, terpenes, coumarins and saponins (Deeni and Sadiq, 2003; Agnem et al., 2011; Tabit et al., 2016; Keita et al., 2018).

On *S. typhi*, ethyl acetate extracts from leaves with 15.33 ± 0.58 mm inhibition diameter was the most effective (p-value = 0,10E-6 < 0.05). These extracts have got the same efficacy as ciprofloxacin (positive control) with 15.33 ± 0.76 mm of inhibition diameter (Table 3.). Methanolic extracts from leaves and the three bark extracts have the same efficacy (p-value > 0.05) on *S. typhi* (Table 4). *S. aureus* was more sensitive to bark ethyl extracts (p-value = 4.10E-6 < 0.05) with a ID of 15.50 ± 1.32 mm (Table 5). Saleh et al. (2015) obtained DI of 16.5 ± 0.4 mm and 18.0 ± 0.3 mm respectively with methanolic leaf and bark extracts of *Ficus sycomorus* on the antibiotic-sensitive strain of *S. aureus.* On the multi-resistant *S. aureus* strain, the same authors recorded ID of 15.0 ± 0.2 mm and 16.0 ± 0.0 mm with methanol extracts from respectively leaves and bark of *F. sycomorus*.

Studies conducted by Milala et al. (2015) on *F. platiphylla* in Nigeria in Borno State revealed resistance of *E. coli*, *S. typhi* and *S. aureus* strains to aqueous and ethanolic extracts from *F. platiphylla* leaves. The difference could be explained by the extremely high concentration (100 µg/ml) of extracts used by these authors. Our ID values are lower than those of Shahzad et al. (2016) who obtained 18.3 ± 0.50 mm of ID on *S. aureus* and 13.9 ± 0.7 mm on *E. coli* with methanol extracts from *Ficus auriculata* leaves. However, the data obtained with aqueous leaf extracts corroborate their results (Shahzad et al., 2016) of 8.9 ± 0.4 mm and 9.1 ± 1.3 mm of ID respectively on *E. coli* and *S. aureus*. To a large extent, the morphological age of the plant, the moisture content of the harvested product, the location and timing of harvesting, and the extraction method are possible sources of variation in the chemical composition and bioactivity of the extracts (Felix, 1982). For plant extracts, these values are very encouraging and would justify the use of this plant in the treatment of certain bacterial infections. Further investigations will be required to better understand the bioactive compound from this plant.

## Conclusion

This study revealed that *F. platiphylla* Delile presents interesting antibacterial activities. All aqueous, methanolic and ethyl acetate extracts from leaves and bark showed promising results in terms of their antiradical properties as well as antibacterial agents on the strains tested. These results highlight the justification for the use of this plant by traditional medical practitioners for the treatment of bacterial infections. However, we noticed that the sensitivity varied across the strains and the type of extract. These differences imply that *F. platiphylla* may contain specific antibacterial substances and could be potential candidates for the formulation of phytomedicines to validate traditional therapeutic properties as a treatment for specific infections. Overall, these data open new avenues of investigation to assess the correlation between the phytochemical composition and the antibacterial activities. On the other hand these extracts should be tested on a wider range of bacterial and fungal agents, some of which remain real plagues.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

**REFERENCES**


Agnem EC, Mebanga SA, Abba A, Nyonbourg E (2011). Evaluation in vitro de l'activité antibactérienne de cinq plantes de la pharmacopée traditionnelle de l'Adamaoua (Cameroun). Cameroon Journal of Experimental Biology 7(1):22-27.

Akhtar N, Ihsan-ul H, Mirza B (2018). Phytochemical analysis and comprehensive evaluation of antimicrobial and antioxidant properties of 61 medicinal plant species. Arabian Journal of Chemistry 11(8).

Badiaga M (2011). Etude ethnobotanique, phytochimique et activités biologiques de Nauclea latifolia Smith, une plante médicinale africaine récoltée au Mali. Thèse de doctorat - Université de Bamako/Mali et Université Blaise Pascal de Clermont-Ferrand/France. Available at: http///tel.archivesouvertes.fr/tel-00719564

Bagayoko MW, Babana AH, Kassogué A, Dembélé D (2018). Antimicrobial Activities of Four Strains of Streptomyces sp Isolated from the Pond of the Village of Demba Tiarki Tara in Mali. International Journal of Microbiology and Biotechnology 3(2):44-50.

Bagewadi Z, Muddapur U, Madiwal S, Mulla S, Khan A (2019). Biochemical and enzyme inhibitory attributes of methanolic leaf extract of Datura inoxia Mill. Environmental Sustainability 2(1):75-87.

Beddu F (2015). Etude phytochimique et activités biologiques de deux plantes médicinales sahariennes *Rumex vesicarius* L. et Anvillea radiata Coss.& Dur. Thèse de doctorat (p.143). Université Abou Bekr Belkaïd - Tlemcen/Algérie.

Ben E, Chindo A, Doris K, Petra T, Axel D, Markus B (2015). Standardized extract of Ficus platiphylla reverses apomorphine-induced changes in prepulse inhibition and locomotor activity in rats. Behavioural Brain Research 293:74-80.

Bhawana R, Kaur J, Vig A, Arora S, Kaur R (2018). Evaluation of antibacterial potential of Ficus species. Journal of Pharmaceutical Sciences and Research 10(5):1251-1255.

Biyiti LF, Meko'o DJL, Tamzc V, Amvam Zollo PH (2004). Recherche de l'activité antibactérienne de quatre plantes médicinales camerounaises. Pharmacopée et Médecine Traditionnelles Africaines 13:11-20.

Chindo BA, Schröder H, Koeberle A, Werz O, Becker A (2016). Analgesic potential of standardized methanol stem bark extract of Ficus platiphylla in mice: Mechanisms of action. Journal of Ethnopharmacology 184:101-106.

Deeni Y, Sadiq N (2003). Antimicrobial properties and phytochemical constituents of leaves of African misteloe (Tapinanthus dodoneifolius (DC) Danser) (Loranceae) and ethno medicinal plant of Hansland, Northern Nigeria. Journal of Ethnopharmacology 83:235-240.

Denou A, Togola A, Tvete Inngjerdingen K, Zhang BZ, Ahmed A, Gwatau Dafam D, Aguiyi JC, Sanogo R, Diallo D, Smestad Paulsen SB (2019). Immunomodulatory activities of polysaccharides isolated from plants used as antimalarial in Mali. Journal of Pharmacognosy and Phytotherapy 11(2):35-42.

Diallo D, Paulsen B, Liljebäck T, Michaelsen T (2003). The Malian medicinal plant Trichilia emetica; studies on polysaccharides with complement fixing ability. Journal of Ethnopharmacology 84(2-3):279-287.

Diarra N, Konaré M. A, Dénou A, Togola I, Diallo D, Ouattara AS, Sanogo R (2019). Biochemical evaluation of five wild food plants used during welding period in southern Mali. International Journal of Advanced Research 7(8):709-716.

Diawara S (2010). Etude de la phytochimie et des activités biologiques de deux Ficus utilisées dans le traitement traditionnel des dysmenorrhées. Thèse de Pharmacie. Faculté de Médecine et d'Odontostomatologie (FMPOS), Université de Bamako.

Doukani K, Tabak S, Gourchala F, Mihoub F, Ounes M, Benbaguara M (2013). Caractérisation physico-chimique du blé fermenté par Stockage Souterrain Caractérisation physico-chimique du blé fermenté par Stockage Souterrain (Matmora). Revue Ecologie-Environnement, 9. Available at: http://fsnv.univ-tiaret.dz/revues.php

Fatima H, Khan K, Zia M, Ur-Rehman T, Mirza B, Haq I (2015). Extraction optimization of medicinally important metabolites from Datura innoxia Mill. : an in biological and phytochemical investigation. BMC Complementary and Alternative Medicine 15(376).

Felix M (1982). Medical Microbiology (Churchill). London, UK.

Fofié BNGY, Kouakou LPMS, Coulibaly K, Sanogo R, Koné-bamba D (2017). Composition en sels minéraux et en métabolites secondaires de Zizyphus mauritiana Lam., une plante antihyperglycémiante. Journal de la Société Ouest-Africaine de Chimie 044:30-35.

Haidara M (2018). Contribution à l'étude de l'activité pharmacologique de Terminalia macroptera Guill. et Perr. (Combretaceae) dans le but de l'élaboration d'un médicament traditionnel amélioré au Mali (Afrique de l'Ouest) (Université Paul Sabatier - Toulouse III). Available at: https://tel.archives-ouvertes.fr/tel-02068818/

Haidara M, Bourdyb G, De Tommasic N, Bracad A, Traoré K, Gianie S, Sanogo R (2016). Medicinal Plants Used in Mali for the Treatment of Malaria and Liver Diseases. Natural Product Communications 11(3):339-352.

Iqbal S, Sivaraj C, Gunasekaran K (2017). Antioxidant and anticancer activities of methanol extract of seeds of *Datura stramonium* L. Free Radical Antioxidants 7:184-189.

Kambli JAY, Patil A, Keshava R (2014). Phytochemical screening and evaluation of antibacterial, antioxidant and cytotoxic activity of Ficus racemosa Linn. Innovare Academic Sciences 6(4):1-5.

Keïta JN, Traore N, Diarra N, Koné D, Mariko B, Pelcouliba D, Poisson JF (2019). Isolation and Identification of Nicotiflorin from the Leaves of Costus spectabilis (Fenzl) K. Schum. Der Chemica Sinica 10(1):782-787.

Keita S, Wélé M, Cisse C, Diarra N, Kirkman L, Baba-moussa L (2018). Antibacterial and Antiplasmodial Activities of Tannins Extracted from Zizyphus mauritiana in Mali. International Journal of Biochemistry Research and Review 24(2):1-8.

Kpadonou D, Kpoviessi S, Bero J, Agbani P, Gbaguidi F, Kpadonou-Kpoviessi B, Sinsin B, Frédérich M, Quetin-Leclercq J (2019). Chemical composition, in vitro antioxidant and antiparasitic properties of the essential oils of three plants used in traditional medicine in Benin. Journal of Medicinal Plants Research 13(16):384-395.

Mihin HB, Somda MK, Kabore D, Sanon S, Akakpo AY, Semde Z, Traore AS (2019). Biopreservation of meat using the essential oil from Hyptis suaveolens Poit. (Lamiaceae) in Burkina Faso. African Journal of Biotechnology 18(29):808-818.

Milala MA, Warabe AM, Ali AA, Gulani IA (2015). Antimicrobial activities of aqueous and ethanolic leaves extracts of Ficus Platiphylla Del. Archives of Applied Sciences Research 7(3):37-42.

Nkoulou CHKK (2014). Screening phytochimique et évaluation in vitro de l'activité anti-oxydante de Syzygium guineense Willd (Myrtaceae). Université de Yaoundé I. Available at: http://www.hsd-fmsb.org/index.php/hsd/thesis/view/176

Prieto P, Pineda M, Aguilar M (1999). Spectrophotometric Quantitation of Antioxidant Capacity through the Formation of a Phosphomolybdenum Complex: Specific Application to the Determination of Vitamin E. Analytical Biochemistry 269:337-341.

Saleh B, Hammoud R, Al-mariri A (2015). Antimicrobial activity of Ficus sycomorus L. (Moraceae) leaf and stem-bark extracts against multidrug resistant human pathogens. Herba Polonica 61(1):39-49.

Sanogo R, Traoré F, Djimdé A, Doumbia L, Maiga A, Diallo D, Doumbo O (2012). Formulation de sirops antipal udiques à base d'extraits de Argemone mexicana. Pharmacopée et Médecine Traditionnelles Africaines, 16. Available at: http://publication.lecames.org/index.php/pharm/article/view/22.

Sanogo R (2014). Pteolopsis suberosa Engl. et Diels (Combretaceae): une plante à activité antiulcère et anti-Helicobacter pylori. Hegel 4(2):148-153.

Shahzad A, Ishtiaq M, Tanveer H, Waheeda M, Amin S, Azhar A, Atiq H (2016). Analysis of antimicrobial potential of some Ficus taxa from district Bhimber Azad Jammu and Kashmir, Pakistan. Applied Ecology and Environmental Research 14(5):159-176.

Somboro AA, Patel K, Diallo D, Sidibe L, Chalchat JC, Figueredo G, Ducki S, Troin Y, Chalard P (2011). An ethnobotanical and phytochemical study of the African medicinal plant Guiera senegalensis J. F. Gmel. Journal of Medicinal Plants Research 5(9):1639-1651.

Tabit FT, Komolafe NT, Tshikalange TE, Nyila MA (2016). Phytochemical Constituents and Antioxidant and Antimicrobial Activity of Selected Plants Used Traditionally as a Source of Food. Journal of Medicinal Food 19(3):324-329.

Togola A, Inngjerdingen M, Diallo D, Barsett H, Rolstad B, Michaelsen

T, Paulsen B (2008). Polysaccharides with complement fixing and macrophage stimulation activity from Opilia celtidifolia, isolation and partial characterisation. Journal of Ethnopharmacology 115(3):423-431.
Togola I, Dembélé AA., Tounkara F, Diarra N, Konaré MA, Karembé M, Maïga SZ, Dembélé D (2019). Evaluation of in vitro Antioxidant Activities of Ethanol Extracts of Datura innoxia Mill. Leaves and Seeds Harvested in Mali. Annual Research and Review in Biology 33(2):1-8.
Traoré K, Haidara M, Dénou A, Kanadjigui F, Sogoba M, Diarra B, Maiga S, Sanogo R (2019). Criblage Phytochimique et Activité Biologiques de Quatre Plantes Utilisées au Mali dans la prise en Charge du Paludisme Chez les Enfants. European Scientific Journal 15(6):212-226.
Truchan M, Buyun L, Osadowski Z, Sosnovsky E (2015). Evaluation of antimicrobial activity of Ficus species leaves extracts against Pseudomonas aeruginosa. Scientific Medical Bulletin 2(2):90-98.
Ugwah-Oguejiofor CJ, Bello SO, Okolo RU, Etuk EU, Ugwah MO, Igbokwe VU (2011). Ficus platyphylla promotes fertility in female Rattus norvegicus Wistar strain : a preliminary study. Reproductive Biology and Endocrinology 9(1):145.
World Health Organization (WHO) (2018). World Malaria. Report, 2018, ISBN 9789.
Willcox M, Graz, B, Falquet J, Sidibé O, Forster M, Diallo D (2007). Argemone mexicana decoction for the treatment of uncomplicated falciparum malaria. Transactions of the Royal Society of Tropical Medicine and Hygiene 101(12):1190-1198.
Xu R, Zhao W, Xu J, Shao B, Qin G (1996). Studies on Bioactive Saponins from Chinese Medicinal Plants. Saponins Used in Traditional and Modern Medicine. Springer, Boston, MA. pp. 371-382.