**Abstract**

This review aims to gather information on chemical compounds, biological activities and patents concerning parts of *Ficus* species, in order to contribute to the design of future studies. Systematic research was carried out on databases over the last five years. A total of 103 papers and 11 patents were found. Several species were investigated considering their chemical composition and biological properties. Organic acids, phenolic compounds, flavonoids, and terpenes were identified. *Ficus carica* was the most investigated species of the genus. Antioxidant, antimicrobial, anti-hyperglycemic, antidiabetes, anticancer and cytotoxic were the main reported activities, revealing their natural supplementary potential in contemporary diseases. Some of their chemical constituents presented pharmacological properties. These results suggest the potential of extracts and essential oil of *Ficus* genus in pharmacological industry. More studies still need to identify the compounds related to each property. Patents concerning parts of *Ficus* spp. involve different application areas, mainly cosmetics, food and pharmacology. This review may inspire investigations considering the development of new drugs, as well as new scientific and technological research using different parts of the *Ficus* genus.

**Keywords:** *Ficus carica*; Antioxidant; Chemical composition; Phenolic compounds; Patents.

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**Ficus spp.: Phytochemical composition and medicinal potential**

**Ficus spp.: Composição fitoquímica e potencial medicinal**

**Ficus spp.: Composición fitoquímica y potencial medicinal**

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investigações considerando o desenvolvimento de novos fármacos, bem como novas pesquisas científicas e tecnológicas utilizando diferentes partes do gênero *Ficus*.

**Palavras-chave:** *Ficus carica*; Antioxidante; Composição química; Compuestos fenólicos; Patentes.

**Resumen**
Esta revisión tiene como objetivo recopilar información sobre compuestos químicos, actividades biológicas y patentes referentes a partes de especies de *Ficus*, con el objetivo de contribuir al diseño de futuros estudios. Se llevó a cabo una investigación sistemática en bases de datos durante los últimos cinco años. Se encontraron un total de 103 artículos y 11 patentes. Se investigaron varias especies considerando su composición química y propiedades biológicas. Se identificaronácidos orgánicos, compuestos fenólicos, flavonoides y terpenos. *Ficus carica* fue la especie más investigada del género. Las principales actividades reportadas fueron antioxidantes, antimicrobianas, antihiper glucemiantes, antidiabéticas, anticancerígenas y citotóxicas, lo que revela su potencial suplementario natural en las enfermedades contemporáneas. Algunos de sus constituyentes químicos presentaron propiedades farmacológicas. Estos resultados sugieren el potencial de los extractos y aceites esenciales del género *Ficus* en la industria farmacológica. Todavía se necesitan más estudios para identificar los compuestos relacionados con cada propiedad. Patentes relativas a partes de *Ficus* spp. implican diferentes áreas de aplicación, principalmente cosmética, alimentaria y farmacológica. Esta revisión puede inspirar investigaciones que consideren el desarrollo de nuevos medicamentos, así como nuevas investigaciones científicas y tecnológicas que utilicen diferentes partes del género *Ficus*.

**Palabras clave:** *Ficus carica*; Antioxidante; Composición química; Compuestos fenólicos; Patentes.

1. **Introduction**

The Moraceae family is constituted of more than 60 genera and approximately 1,500 species among trees, shrubs, and vines. The genus *Ficus* comprises more than 1,000 species distributed in several continents with tropical and subtropical climates. Figure 1 presents a geographic distribution of the *Ficus* genus. Interest in this genus has increased due to its beneficial properties to human health as a result of several researches, which identified different classes of compounds such as alkaloids, flavonoids, glycosides, saponins, steroids, tanins and terpenes (Akomolafe et al., 2016; El-Beltagi et al., 2019; Shaheen & Ahmad, 2021).

**Figure 1.** Geographic distribution of the *Ficus* genus at the Global Biodiversity Information Center.

Source: https://www.gbif.org/
The scientific evidences described in this review confirmed chemical, biological and pharmacological activities, such as antioxidant, antimicrobial, anti-inflammatory, healing, anticancer, anti-hyperglycemic, and diabetes and antiobesity (Chen et al., 2017; Sadasivan Nair et al., 2020; Tian et al., 2020). Health-related properties are generally attributed to the high content of bioactive phenolic compounds such as flavonoids (Ghazi et al., 2012). Most activities were tested in vitro and some in vivo using rats or mice (Manjuprasanna et al., 2020; Sadasivan Nair et al., 2020; Tian et al., 2020).

We previously reviewed the chemical composition, properties and products of Ficus spp (Cruz et al., 2022). In the present review we aim at the scientific contribution on the other plant parts of Ficus spp. to facilitate the understanding of the importance of the genus, direct future studies from its chemical constituents and biological activities, as well as enhance the development of new products from the macro view the use of its patented products.

2. Search Methodology

This review was searched in Scopus, ScienceDirect, Capes Periodicals and Google Scholar databases. Search was performed using term “Ficus” together with “biological activity”, “properties”, “biological potential”, “medicinal”, “phytochemical”, “chemical compounds” and “composition”, considering published papers from 2016 to 2021. The review in patent databases such as INPI, SPACENET, USTPO, PATENTSCOPE also pointed, considering the last five years, to species of the Ficus genus, as well as the use of their specific Boolean. The method addressed the use of chemical compounds and proven properties in different areas of application using plant parts of Ficus species.

3. Chemistry of the Ficus genus

3.1 Phytochemical content

Different classes of compounds were identified in bark, roots and aerial parts of the species from the Ficus genus, predominantly alkaloids, flavonoids, glycosides, saponins, steroids, tanins and terpenes. The variety of phytochemicals is essential for the development of new products, so it is described in Table 1.

3.2 Phenolic compounds

Phenolic compounds were identified in all parts of Ficus, as shown in Table 2. The ellagic acid was found in the leaves of F. capensis, F. palmata and F. sycomorus (Akomolafe et al., 2016; El-Beltagi et al., 2019; Shaheen & Ahmad, 2021). Phenolic acids were also identified, especially in aqueous, hydroalcoholic or alcoholic extract of Ficus leaves, as chlorogenic, gallic, vanillic, caffeic, p-coumaric and ferulic acids (Abraham et al., 2018; Akomolafe et al., 2016; Alcántara et al., 2020; El-Beltagi et al., 2019; El-hawary et al., 2019; Petruccelli et al., 2018; Rjeibi et al., 2017; Shaheen & Ahmad, 2021; Suliman et al., 2021; Sumi et al., 2016; Taviano et al., 2018).

The caffeic acid was also reported in roots of F. microcarpa, F. dubia, F. beecheyana (Rjeibi et al., 2017; Suttisansanee et al., 2021; Yen et al., 2018), and in latex of F. carica, F. dubia and F. sycomorus (Abdel-Aty et al., 2019; Suttisansanee et al., 2021). The p-hydroxybenzoic acid was identified in roots of F. hirta and F. beecheyana (Cheng, Yi, Chen, et al., 2017; Yen et al., 2018), in stem bark of F. glumosa (G. V. Awolola et al., 2019) and in F. sycomorus latex (Abdel-Aty et al., 2019).
Table 1. Phytochemical content of *Ficus* spp.

| Specie         | Part            | Extract        | Al | AA | An | At | Ca | Cu | Fl | Gl | PC | Qu | Sa | St | Su | Ta | Te | Reference                              |
|----------------|-----------------|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------------------------------------|
| *F. asperifolia*| Leaf            | EtOH           | +  |    | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | +  | (Pwaniyibo et al., 2020)               |
| *F. auriculata*| Leaf            | EtOH:H₂O       | +  |    | +  |    |    | +  | +  |    |    |    |    |    |    |    | (El-hawary et al., 2019)              |
| *F. beecheyana*| Root            | H₂O, EtOH      | +  |    |    |    |    |    |    |    |    |    |    |    |    |    | (Yen et al., 2018)                   |
| *F. benghalensis*| Bark           | EtOH           |    | +  | +  | +  | +  | +  | +  | +  |    |    |    |    |    |    | (Khanal & Patil, 2020)               |
| *F. bengalensis*| Bark            | EtOH           |    |    |    |    |    |    |    |    |    |    |    |    |    |    | (Moe et al., 2018)                  |
| *F. benghalensis*| Stem bark      | MeOH           | –  |    | +  | +  | +  | +  | –  | +  | +  | +  |    |    |    |    | (Raheel et al., 2017)               |
| *F. benjamina* | Leaf            | EtOH           |    | +  |    |    |    |    |    |    |    |    |    |    |    |    |    | (A. Ashraf et al., 2020)            |
| *F. carica*    | Fruit latex    | MeOH, fractions (Hex, Hex-AcOEt, MeOH) | + |    |    |    |    |    |    |    |    |    |    |    |    |    | (Paşayeva et al., 2020)             |
| *F. carica*    | Leaf            | EtOH           | –  |    | +  | –  | +  | +  | +  | +  |    |    |    |    |    |    | (Desta et al., 2020)                |
| *F. carica*    | Leaf, stem bark| AcOEt, EtOH, H₂O | + |    | +  |    |    |    |    |    |    |    |    |    |    |    | (Mopuri et al., 2018)              |
| *F. carica*    | Leaf            | Acetone        | +  |    |    |    |    |    |    |    |    |    |    |    |    |    | (Mustafa et al., 2021)             |
| *F. carica*    | Latex           | EtOH:H₂O      |    |    |    |    |    |    |    |    |    |    |    |    |    |    | (Shahinuzaman et al., 2020)         |
| *F. carica*    | Leaf            | AcOEt of MeOH  | +  |    | +  | +  | +  | +  | +  | +  |    |    |    |    |    |    | (Dureshahwar et al., 2019)         |
| *F. carica*    | Leaf            | MeOH           | +  |    | +  | +  | +  | +  |    |    |    |    |    |    |    |    | (Purnamasari et al., 2019)         |
| *F. carica*    | Leaf            | MeOH:H₂O      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | (Petruccelli et al., 2020)         |
| Species          | Part            | Solvent(s)                  | Al  | AA  | An   | At   | Ca   | Cu  | Fl  | Gl  | PC  | Qu  | Sa  | St  | Su  | Ta  | Te  | Source                      |
|------------------|-----------------|-----------------------------|-----|-----|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----------------------------|
| *F. deltoidea*   | Leaf            | Crude                       | +   | +   |      |      |      |     |     |     |     |     |     |     |     |     | et al., 2018                |
| *F. deltoidea*   | Leaf            | AcOEt, MeOH, Hex, H₂O       | +   | +   |      |      |      |     |     |     |     |     |     |     |     |     | Abolmaesoomi et al., 2019   |
| *F. exasperata*  | Leaf            | MeOH                        | –   | –   | +    | +    | +    | +   | +   | +   | +   |     |     |     |     |     | (Mikail et al., 2019)        |
| *F. mucoso*      | Root bark       | MeOH, fractions (CH₂Cl₂, AcOEt, MeOH) | +   |     | +    | +    | +    |     |     |     |     |     |     |     |     |     | (Oyebode et al., 2019)       |
| *F. mysorensis*  | Leaf            | EtOH:H₂O                    | +   | +   |      |      |      |     |     |     |     |     |     |     |     |     | (El-hawary et al., 2019)     |
| *F. pyriformis*  | Leaf            | EtOH:H₂O                    | +   | +   |      |      |      |     |     |     |     |     |     |     |     |     |     | (Bagyalakshmi et al., 2019)  |
| *F. racemosa*    | Leaf            | EtOH, AcOEt, Toluene        | +   | +   | +    | –    | –    | –   | +   | +   |     |     |     |     |     |     |     | (Singh et al., 2020)         |
| *F. religiosa*   | Aerial parts    | EtOH:H₂O                    | +   | +   | +    | +    | –    | +   | +   | +   |     |     |     |     |     |     |     | (Saloufou et al., 2018)      |
| *F. spragueana*  | Leaf            | EtOH:H₂O                    | +   | +   |      |      |      |     |     |     |     |     |     |     |     |     |     | (El-hawary et al., 2019)     |
| *F. sur*         | Bark, Leaf and Root | EtOH                      | +   | +   | +    | –    | +    | +   |     |     |     |     |     |     |     |     |     | (El-hawary et al., 2019)     |
| *F. trigonata*   | Leaf            | EtOH:H₂O                    | +   | +   |      |      |      |     |     |     |     |     |     |     |     |     |     | (El-hawary et al., 2019)     |

(+ presence of compound class; (-) absence of compound class. Al = alkaloids; AA = amino acids; An = anthocyanins; At = Anthraquinones; Ca = Carotenoids; Cu = cumarin; Fl = flavonoids; Gl = glycosides; PC = Phenolic Compounds; Qu = quinones; Sa = saponins; St = steroids; Su = sugars; Ta = tanins; Te = terpenes. Source: Authors.)
Table 2. Main phenolics compounds of different parts of Ficus spp.

| Compound | Specie          | Part       | Sample     | Analytical method       | Reference                                      |
|----------|-----------------|------------|------------|-------------------------|------------------------------------------------|
| Phenol, R, R₁ = H | *F. carica* | Leaf       | H₂O, MeOH  | GC-MS                   | (Ergül et al., 2019)                           |
| Phenol, 2,4-bis(1,1-dimethylethyl)-, R, R₁ = 1,1-dimethylethyl | *F. palmata* | Leaf       | H₂O:EtOH   | HPLC and GC–MS          | (Shaheen & Ahmad, 2021)                        |
| Catechol, R, R₁ = H | *F. carica* | Leaf       | MeOH       | GC-MS                   | (Ergül et al., 2019)                           |
| 3-methoxycatechol, R = OCH₃, R₁ = H | *F. sycomorus* | Leaf       | EtOH       | GC-MS, HPLC             | (El-Beltagi et al., 2019)                      |
| 4-methoxycatechol, R, R₁ = OCH₃ | *F. bizanae* | Stem bark  | Hex, CH₂Cl₂ | CC, IR, MS, ¹H and ¹³C NMR | (G. V. Awolola et al., 2018)                   |
| Pyrogallol, R = OH, R₁ = H | *F. sycomorus* | Leaf       | EtOH       | GC-MS, HPLC             | (El-Beltagi et al., 2019)                      |
| Resorcinol | *F. palmata* | Leaf       | H₂O:EtOH   | HPLC and GC–MS          | (Shaheen & Ahmad, 2021)                        |
| 1,5-naphthalenediol | *F. sycomorus* | Leaf       | EtOH       | GC-MS, HPLC             | (El-Beltagi et al., 2019)                      |
| Arbutin, R = H, R₁ = Glu | *F. racemosa* | Leaf       | MeOH       | HPLC                    | (Sumi et al., 2016)                            |
| Markhamioside F, R = OCH₃, R₁ = Glu-Apifuranosyl | *F. hirta* | Roots      | EtOH       | HPLC, UV, IR, HRESIMS, ¹H and ¹³C NMR | (Ye et al., 2020)                             |
| Compound Description                                                                 | Plant Species | Sample Part | Solvent | Detection Method          | References                  |
|-------------------------------------------------------------------------------------|--------------|-------------|---------|---------------------------|-----------------------------|
| Benzoic acid, 2-hydroxy-, methyl ester, R = OH, R₁ = H                               | *F. carica*  | Latex       | MeOH    | GC-MS                     | (Abdel-Aty et al., 2019)    |
| Benzoic acid, 3-hydroxy-, methyl ester, R = H, R₁ = OH                              | *F. carica*  | Leaf        | H₂O     | GC-MS                     | (Ergül et al., 2019)        |
| Ficusidal                                                              | *F. hirta*   | Roots       | EtOH    | CC, OBS, MPLC, HPLC, IR,  | HR-ESI-MS, ¹H and ¹³C NMR   |
| 4-(2-hydroxypropoxy)-3, 5-dimethyl-phenol                                          | *F. glomerata* | Leaves     | CHCl₃   | LC-MS                     | (Shaikh et al., 2020)       |
| 4-(3′-hydroxypropyl)-2,6-dimethoxyphnol-3′-O-β-D-glcoside                          | *F. hirta*   | Roots       | EtOH    | HPLC, UV, IR, HRESIMS, ¹H | and ¹³C NMR                 |
| 4-allyl-2,6-dimethoxyphenol                                                        | *F. sycomorus* | Leaf       | EtOH    | GC-MS, HPLC               | (El-Beltagi et al., 2019)   |
| Compound                                                                 | Plant Part | Solvent | Analytical Methods                  | Reference                                      |
|--------------------------------------------------------------------------|------------|---------|-------------------------------------|-----------------------------------------------|
| 3'-hydroxy-4'-metoxy-trans- cinnamaldehyde                               | *F. hirta* | Roots   | EtOH, HPLC, $^1$H and $^{13}$C NMR | (Cheng, Yi, Wang, et al., 2017)               |
| 4-hydroxy-3-methoxbenzoic acid, methyl ester, R = CH$_3$, R$_1$ = OCH$_3$, R$_2$ = OH | *F. carica* | Latex   | MeOH, GC-MS                         | (Abdel-Aty et al., 2019)                       |
| 4-hydroxybenzoic acid 4-O-glucoside, R = H, R$_1$ = H, R$_2$ = OGlu      | *F. carica* | Leaf    | H$_2$O, TOF-LC-MS-MS               | (Alcántara et al., 2020)                       |
| 5-O-caffeoylquinic acid                                                  | *F. exasperata* | Leaf and Stem bark | H$_2$O lyophilized, HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018)                           |
| 4-O-caffeoylquinic acid                                                  | *F. exasperata* | Leaf and Stem bark | H$_2$O lyophilized, HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018)                           |
### Apigenin, R, R₂ = H, R₁ = OH

Apigenin 6-C-glucoside (isorvitexin), R = Glu, R₂ = H, R₁ = OH

**F. carica** Leaf Acetone HPLC (Mustafa et al., 2021)

**F. microcarpa** Leaf MeOH HPLC-DAD and FT-IR (Rjeibi et al., 2017)

**F. sycomorus** Latex MeOH HPLC (Abdel-Aty et al., 2019)

Apigenin 6-C-glucoside 8-C-arabinoside, R = Glu, R₁ = OH, R₂ = Arab

**F. deltoidea** Leaf H₂O UHPLC, UV-Vis (Abrahim et al., 2018)

**F. vasta** Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

**F. exasperata** Leaf, Stem bark H₂O lyophilized HPLC–DAD–ESI/MS, UP–LC–ESI–QTOF–MS, HPLC–UV (Mouho et al., 2018)

### Apigenin-8-C-glucoside (vitrex), R = H, R₁ = OH, R₂ = Glu

Apigenin-6-C-hexoside-8-C-pentoside, R = Hex, R₁ = OH, R₂ = Pent

**F. deltoidea** Leaf H₂O TOF-LC-MS-MS (Alcántara et al., 2020)

**F. vasta** Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

**F. exasperata** Leaf, Stem bark H₂O lyophilized HPLC–DAD–ESI/MS, UP–LC–ESI–QTOF–MS, HPLC–UV (Mouho et al., 2018)

Apigenin-6-C-pentoside-8-C-hexoside, R = Pent, R₁ = OH, R₂ = Hex

**F. deltoidea** Leaf H₂O TOF-LC-MS-MS (Alcántara et al., 2020)

**F. vasta** Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

**F. exasperata** Leaf, Stem bark H₂O lyophilized HPLC–DAD–ESI/MS, UP–LC–ESI–QTOF–MS, HPLC–UV (Mouho et al., 2018)

Apigenin-6-C-arabinoside, R = Arab

**F. deltoidea** Leaf H₂O TOF-LC-MS-MS (Alcántara et al., 2020)

**F. vasta** Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

**F. exasperata** Leaf, Stem bark H₂O lyophilized HPLC–DAD–ESI/MS, UP–LC–ESI–QTOF–MS, HPLC–UV (Mouho et al., 2018)

### Apigenin-8-C-arabinoside, R = Rham, R₁ = OH

Apigenin-7-O-ketorhamnoside-8-C-hexoside, R = H, R₁ = OH, R₂ = Glu

**F. benghalensis** Leaf MeOH HPLC-PDA/ESI-MS (Hassan et al., 2020)

**F. carica** Leaf H₂O TOF-LC-MS-MS (Alcántara et al., 2020)

Apigenin 7-O-neohesperidoside (Rhoifolin), R = H, R₁ = neohesp, R₂ = H

**F. benghalensis** Leaf MeOH LC-HR–ESI-MS (Hassan et al., 2020)

**F. carica** Leaf H₂O TOF-LC-MS-MS (Alcántara et al., 2020)

8-C-(2′′-O-β-D-apiofuransosyl)-β-D-glucopyranosyl apigenin (Ficuflavoside), R = H, R₁ = OH, R₂ = Apiofur-Glu

**F. benghalensis** Leaf MeOH LC-HR–ESI-MS (Hassan et al., 2020)

**F. carica** Leaf H₂O TOF-LC-MS-MS (Alcántara et al., 2020)
(1→2)-β-D-galactopyranoside, \( R = \text{OH}, R_1 = \text{Rham-Gal} \), \( R_2 = \text{H} \)

| Compound | Plant | Part | Solvent | Technique | Reference |
|----------|-------|------|---------|-----------|-----------|
| Schaftoside, \( R = \text{Glu}, R_1 = \text{Arab} \) | *F. carica* | Leaf | \( \text{H}_2\text{O}:\text{MeOH} \) | HPLC-DAD-TOF-MS | (Petruchelli et al., 2018) |
| Isoschaftoside, \( R = \text{Arab}, R_1 = \text{Glu} \) | *F. carica* | Leaf | \( \text{H}_2\text{O}:\text{MeOH} \) | HPLC-DAD-TOF-MS | (Petruchelli et al., 2018) |
| Luteolin, \( R, R_1 = \text{H} \) | *F. carica* | Leaf | Acetone | HPLC | (Mustafa et al., 2021) |
| | *F. microcarpa* | Root | MeOH | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| | *F. vasta* | Leaf | MeOH | HPLC-PDA/ESI-MS | (Taviano et al., 2018) |
| Luteolin-6,8-di-C-hexoside, \( R, R_1 = \text{hex} \) | *F. exasperata* | Leaf | H$_2$O lyophilized | HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |
| Luteolin-8-C-(3/4-ketorhamnoside)hexoside, \( R = \text{H}, R_1 = \text{kotorham-hex} \) | *F. sur* | Leaf | MeOH solution from EtOH | HPLC-ESI’-QTOF-HRMS | (Saloufou et al., 2018) |

5,7,3’6’-tetrahydroxy-6,8,2’-trimethoxyflavone
| Plant Species | Part | Solvent | Method | Reference |
|---------------|------|---------|--------|-----------|
| *F. capensis* | Leaf | H₂O     | HPLC–DAD | (Akomolafe et al., 2016) |
| *F. carica*   | Leaf | Acetone | HPLC   | (Mustafa et al., 2021) |
| *F. microcarpa* | Leaf | MeOH    | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| *F. microcarpa* | Root | MeOH    | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| *F. vasta*    | Leaf | MeOH    | HPLC-PDA/ESI-MS | (Taviano et al., 2018) |
| *F. exasperata* | Leaf and Stem bark | H₂O lyophilized | HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |
| *F. bizanæ*   | Leaf | Hex, CH₂Cl₂ | CC, IR, MS, ¹H and ¹³C NMR | (G. V. Awolola et al., 2018) |
| *F. glumosa*  | Leaf | MeOH    | GC-MS, CC, VCC, TLC, FT-IR, ¹H and ¹³C NMR | (G. V. Awolola et al., 2019) |
| *F. carica*   | Leaf | H₂O:MeOH | HPLC-DAD-TOF-MS | (Petrucelli et al., 2018) |
| *F. vasta*    | Leaf | MeOH    | HPLC–PDA/ESI-MS | (Taviano et al., 2018) |
| *F. capensis* | Leaf | H₂O     | HPLC–DAD | (Akomolafe et al., 2016) |
| *F. glumosa*  | Leaf | MeOH    | GC-MS, CC, VCC, TLC, FT-IR, ¹H and ¹³C NMR | (G. V. Awolola et al., 2019) |
| *F. vasta*    | Leaf | MeOH    | HPLC–PDA/ESI-MS | (Taviano et al., 2018) |
| *F. auriculata* | Leaf | H₂O:EtOH | HPLC | (El-hawary et al., 2019) |
| *F. beecheyana* | Roots | EtOH    | HPLC | (Yen et al., 2018) |
| *F. capensis* | Leaf | H₂O     | HPLC–DAD | (Akomolafe et al., 2016) |
| *F. carica*   | Latex | MeOH    | HPLC | (Abdel-Aty et al., 2019) |
| Species          | Part       | Solvent      | Method                | Ref.                      |
|------------------|------------|--------------|-----------------------|---------------------------|
| *F. carica*      | Leaf       | Acetone      | HPLC                  | (Mustafa et al., 2021)    |
| *F. carica*      | Leaf       | H₂O:MeOH     | HPLC-DAD-TOF-MS       | (Petruccelli et al., 2018) |
| *F. microcarpa*  | Root       | MeOH         | HPLC-DAD and FT-IR    | (Rjeibi et al., 2017)     |
| *F. myrsinensis* | Leaf       | H₂O:EtOH     | HPLC                  | (El-hawary et al., 2019)  |
| *F. pyrifórmis*  | Leaf       | H₂O:EtOH     | HPLC                  | (El-hawary et al., 2019)  |
| *F. spragueana*  | Leaf       | H₂O:EtOH     | HPLC                  | (El-hawary et al., 2019)  |
| *F. sycomorus*   | Leaf       | EtOH         | GC-MS, HPLC           | (El-Beltagi et al., 2019) |
| *F. trigonata*   | Leaf       | H₂O:EtOH     | HPLC                  | (El-hawary et al., 2019)  |
| *F. vasta*       | Leaf       | MeOH         | HPLC-PDA/ESI-MS       | (Taviano et al., 2018)    |
| *F. carica*      | Leaf       | H₂O          | TOF-LC-MS-MS          | (Alcántara et al., 2020)  |
| *F. capensis*    | Leaf       | H₂O          | HPLC–DAD              | (Akomolafe et al., 2016)  |
| *F. microcarpa*  | Root       | MeOH         | HPLC-DAD and FT-IR    | (Rjeibi et al., 2017)     |
| *F. sycomorus*   | Leaf       | EtOH         | GC-MS, HPLC           | (El-Beltagi et al., 2019) |
| *F. exasperata*  | Leaf       | H₂O lyophilized | HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |
| *F. capensis*    | Leaf       | H₂O          | HPLC–DAD              | (Akomolafe et al., 2016)  |
| *F. microcarpa*  | Root       | MeOH         | HPLC-DAD and FT-IR    | (Rjeibi et al., 2017)     |
| *F. sycomorus*   | Leaf       | EtOH         | GC-MS, HPLC           | (El-Beltagi et al., 2019) |
| *F. exasperata*  | Leaf       | H₂O lyophilized | HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |

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Quercetin 3-O-glucosyl-rhamnosyl-glucoside,
R = Glu-Rham-Glu, R₁, R₂, R₃ = H

Quercetin 3-O-malonyl-glucoside, R = Mal-Glu, R₁, R₂, R₃ = H

Quercetin 7,3’,4’-trimethoxy, R = H, R₁, R₂, R₃ = CH₃

Quercetin-3-(6-rhamnoside)glucoside, R = Rham-Glu, R₁, R₂, R₃ = H

Quercetin-3,7-di-hexoside, R₁ = hex, R₂, R₃ = H

Quercetin-3-hexoside-7-ketorhamnoside, R = hex, R₁ = ketorham, R₂, R₃ = H

Kaempferol, R = H

Kaempferol 3-O-glucoside, R = Glu

Kaempferol 3-O-rhamnoside, R = Rham

Kaempferol 3-O-rutinoside, R = Rut

Kaempferol 3-O-xyllosyl-glucoside, R = Xyl-Glu

Kaempferol 3-O-xyllosyl-rutinoside, R = Xyl-Rut

Kaempferol-3-(2-rhamnoside)hexoside, R = Rham-Hex
Myricetin

4',5,7-trihydroxyflavan-3-ol

Catechin

(+)-catechin hydrate, xH₂O

Catechin or epicatechin

epicatechin

F. sycomorus Leaf EtOH UPLC–ESI–QTOF–MS, HPLC–UV (El-Beltagi et al., 2019)

F. sur Bark MeOH solution from EtOH HPLC-ESI’-QTOF-HRMS (Saloufou et al., 2018)

F. sur Leaf MeOH solution from EtOH HPLC-ESI’-QTOF-HRMS (Saloufou et al., 2018)

F. capensis Leaf H₂O HPLC– DAD (Akomolafe et al., 2016)

F. carica Latex MeOH HPLC (Abdel-Aty et al., 2019)

F. deltoidea Leaf H₂O UHPLC, UV-Vis (Abraham et al., 2018)

F. microcarpa Leaf MeOH HPLC-DAD and FT-IR (Rjeibi et al., 2017)

F. microcarpa Root MeOH HPLC-DAD and FT-IR (Rjeibi et al., 2017)

F. sycomorus Stem bark CH₂Cl₂:EtOH LC/MS (Suliman et al., 2021)

F. vasta Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

F. virens – H₂O HPLC-DAD-ESI-MS/MS, MALDI-TOF MS (Chen et al., 2017)

F. vogeliana Bark H₂O LC-MS/MS (Misso et al., 2020)

F. racemosa Leaf MeOH HPLC (Sumi et al., 2016)

F. sur Bark and Leaf MeOH solution from EtOH HPLC-ESI’-QTOF-HRMS (Saloufou et al., 2018)

F. beecheyana Roots EtOH HPLC (Yen et al., 2018)

F. capensis Leaf H₂O HPLC– DAD (Akomolafe et al., 2016)
| Plant            | Tissue  | solvent | Methodology                               | Reference                  |
|------------------|---------|---------|-------------------------------------------|----------------------------|
| F. microcarpa    | Leaf    | MeOH    | HPLC-DAD and FT-IR                        | (Rjeibi et al., 2017)     |
|                  | Root    |         |                                           |                            |
| F. racemosa      | Leaf    | MeOH    | HPLC                                      | (Sumi et al., 2016)       |
| F. sycomorus     | Stem bark | CH2Cl2:EtOH | LC/MS                                    | (Suliman et al., 2021)   |
| F. virens        | –       | H2O     | HPLC-DAD-ESI-MS/MS, MALDI-TOF MS          | (Chen et al., 2017)       |
| F. vogeliana     | Bark    | H2O     | LC-MS/MS                                  | (Misso et al., 2020)      |
| F. virens        | –       | H2O     | HPLC-DAD-ESI-MS/MS, MALDI-TOF MS          | (Chen et al., 2017)       |

Epiafzelechin, R = H, R1 = H, R2 = H, R3 = H, R4 = H
epiafzelechin adducts,
R = H, R1 = H, R2 = 4→8, R3 = 6→4, R4 = 8→4
epicatechin adducts,
R = OH, R1 = H, R2 = 4→8, R3 = 6→4, R4 = 8→4
epigallocatechin adducts,
R = OH, R1 = OH, R2 = 4→8, R3 = 6→4, R4 = 8→4

Cyanidin, R = H
Cyanidin 3-O-(6-succinyl-glucoside), R = 6-Suc-Glu

F. dubia Latex H2O HPLC (Suttisansanee et al., 2021)
F. carica Leaf H2O TOF-LC-MS-MS (Alcántara et al., 2020)
5-pyranopelargonidin-3-O-glucoside

F. carica Fruit latex MeOH LC–MS/MS (Paşayeva et al., 2020)

F. vogeliana Bark H$_2$O LC–MS/MS (Misso et al., 2020)

F. sycomorus Stem bark CH$_2$Cl$_2$:EtOH LC/MS (Suliman et al., 2021)

Procyanidin trimer, R = cyanidin unit

F. sycomorus Stem bark CH$_2$Cl$_2$:EtOH LC/MS (Suliman et al., 2021)

Procyanidin B, R = H

F. vasta Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

F. sycomorus Leaf EtOH GC-MS, HPLC (El-Beltagi et al., 2019)

Naringenin, R = H

Naringin, R = Rham-Glu

F. vasta Leaf MeOH HPLC-PDA/ESI-MS (Taviano et al., 2018)

F. carica Leaf H$_2$O TOF-LC-MS-MS (Alcántara et al., 2020)
| Compound                        | Source                      | Extraction Method | Identification Method     | Authors                  |
|--------------------------------|-----------------------------|-------------------|---------------------------|--------------------------|
| Didymin, R = Rutinoside         | *F. benghalensis* Leaf      | MeOH              | LC-HR-ESI-MS              | Hassan et al., 2020      |
| Steppogenin                    |                             |                   |                           |                          |
| F. carica                      | Leaf                        | H~2~O             | TOF-LC-MS-MS              | Alcántara et al., 2020   |
| F. benghalensis                | Leaf                        | MeOH              | VLC, MS, ¹H and ¹³C NMR   | Hassan et al., 2020      |
| Chrysoeriol                    |                             |                   |                           |                          |
| Carpachromene                  | *F. benghalensis* Leaf      | MeOH              |                           | Hassan et al., 2020      |
| Gallic acid                    | *F. beecheyana* Roots       | EtOH, H~2~O       | HPLC                      | Yen et al., 2018         |
| *F. capensis*                  | Leaf                        | H~2~O             | HPLC–DAD                  | Akomolafe et al., 2016   |
| *F. carica*                    | Leaf                        | Acetone           | HPLC                      | Mustafa et al., 2021     |
| *F. deltoidea*                 | Leaf                        | H~2~O             | UHPLC, UV-Vis             | Abraham et al., 2018     |
| *F. microcarpa*                | Root                        | MeOH              | HPLC-DAD and FT-IR        | Rjeibi et al., 2017      |
| *F. palmata*                   | Leaf                        | H~2~O:EtOH        | HPLC and GC–MS            | Shaheen & Ahmad, 2021    |
| *F. racemosa*                  | Leaf                        | MeOH              | HPLC                      | Sumi et al., 2016        |
| *F. spragueana*                | Leaf                        | H~2~O:EtOH        | HPLC                      | El-hawary et al., 2019   |
| *F. sycomorus*                 | Leaf                        | EtOH              | GC-MS, HPLC               | El-Beltagi et al., 2019  |
| *F. trigonata*                 | Leaf                        | H~2~O:EtOH        | HPLC                      | El-hawary et al., 2019   |
| *F. vasta*                     | Leaf                        | MeOH              | HPLC-PDA/ESI-MS           | Taviano et al., 2018     |
| Gentisic acid, $R = H$ | $F. vogueiana$ | Bark | H$_2$O | LC-MS/MS | (Misso et al., 2020) |
|-----------------------|------------------|------|--------|----------|---------------------|
| Gentisic acid 5-O-β-D-xyloside, $R = Xyl$ | $F. hirta$ | Roots | EtOH | HPLC, UV, IR, HRESIMS, $^1$H and $^{13}$C NMR | (Ye et al., 2020) |
| Caffeic acid, $R, R_1 = OH, R_2 = H$ | $F. beecheiana$ | Roots | EtOH | HPLC | (Yen et al., 2018) |
| $F. capensis$ | Leaf | H$_2$O | HPLC-DAD | (Akomolafe et al., 2016) |
| $F. carica$ | Leaf | MeOH | HPLC | (Sumi et al., 2016) |
| $F. dubia$ | Latex | H$_2$O | HPLC | (Suttisananee et al., 2021) |
| $F. microcarpa$ | Root | EtOH | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| $F. racemosa$ | Leaf | MeOH | HPLC | (El-hawary et al., 2019) |
| $F. spragueana$ | Leaf | H$_2$O:EtOH | HPLC | (Abdel-Aty et al., 2019) |
| $F. sycomorus$ | Leaf | EtOH | GC-MS, HPLC | (El-Beltagi et al., 2019) |
| Caffeoylmalic acid, $R, R_1 = OH, R_2 = $ malic acid | $F. carica$ | Leaf | H$_2$O:MeOH | HPLC-DAD-TOF-MS | (Petrucelli et al., 2018) |
| Caffeoyl malic acid dimer, $R, R_1 = OH, R_2 = $ malic acid | $F. exasperata$ | Leaf | H$_2$O lyophilized | HPLC-DAD-ESI/MS, UPLC-ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |
| Cinnamic acid, $R, R_1 = H, R_2 = H$ | $F. microcarpa$ | Leaf, Root | MeOH | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| $F. sycomorus$ | Leaf | MeOH | HPLC | (Abdel-Aty et al., 2019) |
| $F. sycomorus$ | Leaf | EtOH | GC-MS, HPLC | (El-Beltagi et al., 2019) |
| $F. carica$ | Leaf | H$_2$O | TOF-LC-MS-MS | (Alcántara et al., 2020) |
| $F. racemosa$ | Leaf | MeOH | HPLC | (Sumi et al., 2016) |
| $F. sycomorus$ | Leaf | EtOH | GC-MS, HPLC | (El-Beltagi et al., 2019) |
| $F. exasperata$ | Leaf | H$_2$O lyophilized | HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |
| Ferulic acid, $R – OCH_3, R_1 = OH, R_2 = H$ | $F. microcarpa$ | Leaf, Root | MeOH | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| $F. sycomorus$ | Leaf | MeOH | HPLC | (Abdel-Aty et al., 2019) |
| $F. sycomorus$ | Leaf | EtOH | GC-MS, HPLC | (El-Beltagi et al., 2019) |
| $F. carica$ | Leaf | H$_2$O | TOF-LC-MS-MS | (Alcántara et al., 2020) |
| Feruloyl malic acid dimer, $R = OH, R_1 = OCH_3, R_2 = $ malic acid | $F. exasperata$ | Leaf | H$_2$O lyophilized | HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV | (Mouho et al., 2018) |
| Feruloyl sinapic acid, $R = OH, R_1 = OCH_3, R_2 = $ sinapic acid | $F. carica$ | Leaf | H$_2$O | TOF-LC-MS-MS | (Alcántara et al., 2020) |
| Plant | Part | Method | Detection | References |
|-------|------|--------|-----------|------------|
| p-coumaric acid, \( R = OH, R_1 = H, R_2 = H \) | *F. microcarpa* | Leaf, Root | MeOH | HPLC-DAD and FT-IR | (Rjeibi et al., 2017) |
| | *F. beecheyana* | Roots | EtOH, H₂O | HPLC | (Yen et al., 2018) |
| | *F. deltoidea* | Leaf | H₂O | UHPLC, UV-Vis | (Abraham et al., 2018) |
| | *F. sycomorus* | Latex | MeOH | HPLC | (Abdel-Aty et al., 2019) |
| | *F. sycomorus* | Leaf | EtOH | HPLC | (El-Beltagi et al., 2019) |
| | *F. hirta* | Roots | EtOH | CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, \(^1\)H and \(^{13}\)C NMR | (Cheng, Yi, Chen, et al., 2017) |
| p-coumaroyl malic acid, \( R = OH, R_1 = H, R_2 = \text{malic acid} \) | *F. carica* | Leaf | H₂O | TOF-LC-MS-MS | (Alcántara et al., 2020) |
| | *F. carica* | Leaf | H₂O:MeOH | HPLC-DAD-TOF-MS | (Petruccelli et al., 2018) |
| p-coumaroylquinic acid, \( R = OH, R_1 = H, R_2 = \text{quinic acid} \) | *F. carica* | Leaf | H₂O:MeOH | HPLC-DAD-TOF-MS | (Petruccelli et al., 2018) |
| | *F. carica* | Leaf | H₂O | TOF-LC-MS-MS | (Alcántara et al., 2020) |
| Dihydrocaffeic acid, \( R = OH \) | *F. bizanae* | Stem bark | Hex, CH₂Cl₂ | CC, IR, MS, \(^1\)H and \(^{13}\)C NMR | (G. V. Awolola et al., 2018) |
| Dihydroferulic acid, \( R = \text{OCH}_3 \) | *F. auriculata* | Leaf | H₂O:EtOH | HPLC | (El-hawary et al., 2019) |
| | *F. beecheeyana* | Roots | EtOH | HPLC | (Yen et al., 2018) |
| | *F. carica* | Leaf | H₂O | HPLC- DAD | (Akomolafe et al., 2016) |
| | *F. carica* | Latex | MeOH | HPLC | (Abdel-Aty et al., 2019) |
| | *F. exasperata* | Leaf | H₂O:MeOH | HPLC-DAD-TOF-MS | (Petruccelli et al., 2018) |
| | *F. exasperata* | Leaf | H₂O lyophilized | HPLC-DAD-ESI/MS, UPLC-ESI-QTOF-MS, HPLC-UV | (Mouho et al., 2018) |
| Chlorogenic acid | *F. mysorensis* | Leaf | H₂O:EtOH | HPLC | (El-hawary et al., 2019) |
| | *F. palmata* | Leaf | H₂O:EtOH | HPLC and GC–MS | (Shaheen & Ahmad, 2021) |
| | *F. pyriformis* | Leaf | H₂O:EtOH | HPLC | (El-hawary et al., 2019) |
| | *F. spragueana* | Leaf | H₂O:EtOH | HPLC | (El-hawary et al., 2019) |
| | *F. sycomorus* | Latex | MeOH | HPLC | (Abdel-Aty et al., 2019) |
| | *F. sycomorus* | Leaf | EtOH | GC-MS, HPLC | (El-Beltagi et al., 2019) |
| | *F. sycomorus* | Leaf | CH₂Cl₂:EtOH | LC/MS | (Suliman et al., 2021) |
| Plant         | Part          | Solvent       | Method                | Reference                        |
|--------------|---------------|---------------|-----------------------|----------------------------------|
| *F. trigonata*| Leaf          | H₂O:EtOH      | HPLC                  | (El-hawary et al., 2019)         |
| *F. vasta*   | Leaf          | MeOH          | HPLC-PDA/ESI-MS       | (Taviano et al., 2018)           |
| *F. capensis*| Leaf          | H₂O           | HPLC–DAD              | (Akomolafe et al., 2016)         |
| *F. palmata* | Leaf          | H₂O:EtOH      | HPLC and GC–MS        | (Shaheen & Ahmad, 2021)          |
| *F. sycomorus*| Leaf          | EtOH          | GC-MS, HPLC           | (El-Beltagi et al., 2019)        |

**Ellagic acid**

**Armillarisin A or isomer**

**Emodin, R = H**

Emodin-6-O-β-D-glucopyranoside, R = Glu

**Evofolin-B**

**El-Hawary et al., 2019**

**Taviano et al., 2018**

**Akomolafe et al., 2016**

**Shaheen & Ahmad, 2021**

**El-Beltagi et al., 2019**

**Saloufou et al., 2018**

**Mbougnia et al., 2021**

**Cheng, Yi, Wang, et al., 2017**
| Plant          | Part            | Solvent | Extraction Method | Reference                                      |
|---------------|-----------------|---------|-------------------|------------------------------------------------|
| *F. carica*   | Leaf            | MeOH    | GC-MS             | (Ergül et al., 2019)                           |
| *F. carica*   | Fruit latex     | Hex:AcOEt fraction | LC-MS/MS         | (Paşayeva et al., 2020)                        |
| *F. sycomorus*| Leaf            | CH₂Cl₂:EtOH | LC/MS            | (Suliman et al., 2021)                        |
| *F. beecheyana* | Roots      | EtOH, H₂O | HPLC             | (Yen et al., 2018)                             |
| *F. glumosa*  | Leaf            | MeOH    | GC-MS, CC, VCC, TLC, FT-IR, \(^1\)H and \(^13\)C NMR | (G. V. Awolola et al., 2019)                    |
| *F. glumosa*  | Stem bark       | AcOEt fraction | GC-MS, CC, VCC, TLC, FT-IR, \(^1\)H and \(^13\)C NMR | (G. V. Awolola et al., 2019)                    |
| *F. hirta*    | Roots           | EtOH    | CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, \(^1\)H and \(^13\)C NMR | (Cheng, Yi, Chen, et al., 2017)                 |
| *F. sycomorus*| Latex           | MeOH    | HPLC              | (Abdel-Aty et al., 2019)                       |
| *F. sycomorus*| Leaf            | EtOH    | GC-MS, HPLC       | (El-Beltagi et al., 2019)                      |
| *F. beecheyana* | Roots      | H₂O     | HPLC              | (Yen et al., 2018)                             |
| *F. carica*   | Latex           | MeOH    | HPLC              | (Abdel-Aty et al., 2019)                       |
| *F. glumosa*  | Stem bark       | AcOEt fraction, MeOH | GC-MS, CC, VCC, TLC, FT-IR, \(^1\)H and \(^13\)C NMR | (G. V. Awolola et al., 2019)                    |
| *F. vogeliana*| Bark            | H₂O     | LC-MS/MS          | (Misso et al., 2020)                           |
| Compound                          | Species         | Part                  | Solvent | Instrument                  | Reference                        |
|----------------------------------|-----------------|-----------------------|---------|-----------------------------|----------------------------------|
| Protocatechuic acid 4-O-glucoside, R = Glu | *F. carica*     | Leaf                  | H$_2$O  | TOF-LC-MS-MS               | (Alcántara et al., 2020)         |
| Resveratrol                      | *F. carica*     | Leaf                  | H$_2$O  | TOF-LC-MS-MS               | (Alcántara et al., 2020)         |
| Rosmarinic acid                  | *F. carica*     | Fruit latex           | MeOH    | LC-MS/MS                    | (Paşayeva et al., 2020)          |
|                                  | *F. sycomorus*  | Leaf                  | EtOH    | GC-MS, HPLC                | (El-Beltagi et al., 2019)        |
| Rosmadial                        | *F. carica*     | Leaf                  | H$_2$O  | TOF-LC-MS-MS               | (Alcántara et al., 2020)         |
| Salicylic acid                   | *F. microcarpa* | Leaf, Root            | MeOH    | HPLC-DAD and FT-IR         | (Rjeibi et al., 2017)            |
|                                  | *F. sycomorus*  | Leaf                  | EtOH    | GC-MS, HPLC                | (El-Beltagi et al., 2019)        |
|                                  | *F. carica*     | Latex                 | MeOH    | HPLC                        | (Abdel-Aty et al., 2019)         |
Sinapic acid, R = H
Sinapoyl glucose, R = Glu
3-sinapoylquinic acid, R = quinic acid

F. sycomorus  Latex  MeOH  HPLC  (Abdel-Aty et al., 2019)
F. carica  Leaf  H₂O  TOF-LC-MS-MS  (Alcántara et al., 2020)
F. carica  Leaf  H₂O  TOF-LC-MS-MS  (Alcántara et al., 2020)

Syringaresinol, R, R₁ = OCH₃
(-)-pinoresinol, R, R₁ = H

F. hirta  Roots  EtOH  CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, ¹H and ¹³C NMR  (Cheng, Yi, Chen, et al., 2017)
F. hirta  Roots  EtOH  HPLC, ¹H and ¹³C NMR  (Cheng, Yi, Wang, et al., 2017)
F. sycomorus  Leaf  EtOH  GC-MS, HPLC  (El-Beltagi et al., 2019)

Syringic acid

F. palmata  Leaf  H₂O:EtOH  HPLC and GC–MS  (Shaheen & Ahmad, 2021)

Tannic acid

F. carica  Fruit latex  MeOH  LC–MS/MS  (Paşayeva et al., 2020)
| **Source** | **Vanillyl acid, R = OH** | **Vanillin, R = H** | **β-hydroxypropiovanillole, R = CH2CH2OH** |
|------------|-------------------------|-------------------|---------------------------------------------|
|            | **F. hirta** Roots      | **F. carica** Latex | **F. hirta** Roots | **F. microcarpa** Leaf | **F. microcarpa** Root | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf | **F. palmata** Leaf | **F. racemosa** Leaf | **F. sycomorus** Leaf |
|            | EtOH                    | MeOH              | MeOH            | MeOH                   | MeOH                   | H2O:EtOH            | MeOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  | EtOH                  |
|            | HPLC, \(^1^H\text{and}\(^{13}\text{C NMR}) |                  |                |                        |                        | HPLC and GC–MS       |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |
|            | (Cheng, Yi, Wang, et al., 2017) |                  |                |                        |                        | (Shaheen & Ahmad, 2021) |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        |

**Source:** Authors.
Flavonoids such as rutin, quercetin, catechin and epicatechin extracted by water and alcohol from *F. auriculata*, *F. capensis*, *F. carica*, *F. deltoidea*, *F. microcarpa*, *F. mysorensis*, *F. racemosa*, *F. spragueana*, *F. sycomorus*, *F. trigonata* and *F. vasta* were found mainly in leaves (Abraham et al., 2018; Akomolafe et al., 2016; El-Beltagi et al., 2019; El-hawary et al., 2019; Mustafa et al., 2021; Rjeibi et al., 2017; Sumi et al., 2016; Taviano et al., 2018). The catechin and epicatechin were also identified in roots (Rjeibi et al., 2017; Yen et al., 2018), and bark (Misso et al., 2020; Suliman et al., 2021). Vitexin (Abraham et al., 2018; Taviano et al., 2018), apigenin (Abdel-Aty et al., 2019; Mustafa et al., 2021; Rjeibi et al., 2017), luteolin (Mustafa et al., 2021; Rjeibi et al., 2017; Taviano et al., 2018), kaempferol and derivatives (Akomolafe et al., 2016; El-Beltagi et al., 2019; Petruccelli et al., 2018; Rjeibi et al., 2017) were also identified.

Among the identified coumarins, psoralen was found in *F. bizanae*, *F. carica*, *F. hirta* and *F. sycomorus* (Abdel-Aty et al., 2019; G. V. Awolola et al., 2018; Cheng, Yi, Wang, et al., 2017; El-Beltagi et al., 2019; Petruccelli et al., 2018), bergapten in leaves of *F. carica* (Ergül et al., 2019; Petruccelli et al., 2018), and in stem bark of *F. exasperate* (Mouho et al., 2018), 7-methoxy coumarin in stem bark of *F. bizanae* (G. V. Awolola et al., 2018), and 4-hydroxycoumarin in leaves of *F. carica* (Alcántara et al., 2020).

### 3.3 Terpenes, steroids and fatty acids

A mixture of linear aliphatic alkanes (the steroids β-sitosterol and sitosteryl 3-O-β-D-glucopyranoside and other constituents) was identified in the raw chloroformic/ethanolic extract of the wood from aerial roots of *F. elastica* (J. M. E. Teinkela, Noundou, et al., 2016). In the essential oils of the leaves of *F. capensis* were identified mainly fatty acids and alkanes (Lawal et al., 2016). In the latex of *F. carica* a mixture of saturated and unsaturated fatty acids was reported (Ghanbari et al., 2019).

The steroid β-sitosterol was identified in different parts of *F. carica*, *F. crocata*, *F. elastica*, *F. natalensis*, *F. racemosa* and *F. sycomorus* (Bopage et al., 2018; Cruz-Concepción et al., 2021; El-Beltagi et al., 2019; Mbougnia et al., 2021; Mustafa et al., 2021; Sánchez-Valdeolivar et al., 2020; J. M. E. Teinkela, Noundou, et al., 2016). The stigmasterol and campesterol phytosterols were identified in the leaves of *F. crocata* (Sánchez-Valdeolivar et al., 2020), and *F. sycomorus* (El-Beltagi et al., 2019).

The presence of terpenes was also identified, among them the lupeol triterpenes (Cruz-Concepción et al., 2021; El-Beltagi et al., 2019; Knothe et al., 2019; Mbougnia et al., 2021; Sánchez-Valdeolivar et al., 2020), squalene (Cruz-Concepción et al., 2021; Knothe et al., 2019; Sánchez-Valdeolivar et al., 2020; Tian et al., 2020), lanosterol (El-Beltagi et al., 2019), diterpene phytol (Cruz-Concepción et al., 2021; El-Beltagi et al., 2019; Lawal et al., 2016), monoterpene linalool, and the sesquiterpene β-caryophyllene (Lawal et al., 2016; Soltana et al., 2017; Tian et al., 2020), mainly identified in leaves (*F. asperifolia*, *F. carica*, *F. crocata*, *F. sycomorus*) and seeds (*F. nota*, *F. septica*, *F. ulmifolia*).

### 3.4 Other compounds

The hydromethanolic extract of the *F. carica* bark stem contains, in large quantities, α-D-glucopyranose, an oligomer isolated from the oligosaccharide rich fraction (Raafat & Wurglics, 2019). Organic acids such as oxalic, aconitic, citric, tartaric, malic, quinic and fumaric acids were identified in the aqueous extracts of *F. exasperata* leaves and bark (Mouho et al., 2018). Vitamin E was identified in the acetone extracts of the *F. crocata* leaves (α-tocopherol) (Cruz-Concepción et al., 2021; Sánchez-Valdeolivar et al., 2020).
4. Chemical, Biological and Pharmacological Properties of *Ficus*

4.1 Antioxidant activity

Among the species from the *Ficus* genus, antioxidant activity was reported by alcoholic, aqueous, hydroalcoholic, hexane and chloroform, ethyl acetate, dichloromethane and petroleum ether extracts from different parts, such as leaves, bark, branches, stem and roots, mainly by *in vitro* assays, as presented in Table 3. In general, polar extracts (such as alcoholic and hydroalcoholic) revealed compounds responsible for antioxidant activity. Hot water is a good solvent strategy, as it has improved the extraction of antioxidant compounds in roots from *F. dubia* (Suttisansane et al., 2021).

**Table 3. In vitro antioxidant activity of extracts from the *Ficus* genus.**

| Specie          | Part                 | Extraction solvent | Assay              | Reference                           |
|-----------------|----------------------|--------------------|--------------------|-------------------------------------|
| *F. auriculata* | Leaf                 | EtOH               | IC₅₀, DPPH⁻ (5.06 ± 0.35 μg/mL), NO⁻ (169.65 ± 1.53 μg/mL). | (Wong et al., 2020)                |
| *F. beecheyana* | Roots                | EtOH and H₂O       | ORAC (45.0 ± 2.0 and 33.3 ± 1.4 Trolox µmole/g), TEAC (38.9 ± 1.9 and 17.3 ± 1.8 Trolox µmole/g). | (Yen et al., 2018)                |
| *F. benghalensis*| Bark                 | EtOH               | DPPH⁻ (48.85 ± 1.27%), NO⁻ (76.05 ± 4.42%), O₂⁻ (79.08 ± 4.62%). | (Moe et al., 2018)                |
|                 | Bark                 | H₂O:EtOH           | IC₅₀, ABTS⁺⁺⁺ (45.73 ± 1.17 µg/mL), DPPH⁻ (73.99 ± 2.22 µg/mL), TAC (51.45 ± 1.23 µg/mL), NO⁻ (69.02 ± 2.57 µg/mL), H₂O₂ (50.67 ± 1.77 µg/mL), CUPRAC (55.51 ± 0.54 µg/mL), metal chelating (55.95 ± 0.92 µg/mL). | (Khanal & Patil, 2020)            |
| *F. auriculata* | Stem                 | MeOH and AcOEt fraction | H₂O₂ (IC₅₀ 178.2 ± 1.750 and 603.1 ± 6.573 µg/mL). | (Hasan et al., 2020)              |
|                 | Leaf                 | AcOEt fraction from MeOH | DPPH⁻ (71.77 ± 0.514 to 82.6 ± 2.395% at 0.125 and 4 mg/mL). | (Raheel et al., 2017)             |
| *F. benjamina*  | Leaf                 | EtOH               | DPPH⁻ (68.27 ± 1.08 µg/mL). | (A. Ashraf et al., 2020)           |
| *F. capensis*   | Leaf                 | H₂O                 | IC₅₀, NO⁻ (0.12 ± 0.01 mg/mL), OH⁻ (0.53 ± 0.00 mg/mL), Fe²⁺ chelation (0.16 ± 0.00 mg/mL). | (Akomolafe et al., 2016)          |
| *F. carica*     | Fruit                | MeOH and fractions (Hex, Hex-AcOEt and MeOH). | ABTS⁺⁺⁺ (0.105 ± 0.007, 0.074 ± 0.011, 0.086 ± 0.005 and 0.180 ± 0.058 µM Trolox/g extract). | (Paşayeva et al., 2020)           |
|                 | Latex                | MeOH               | DPPH⁻ (13.60 ± 1.20 µg GAE/mL) and ABTS⁺⁺⁺ (4.50 ± 0.72 µg GAE/mL). | (Abdel-Aty et al., 2019)          |
|                 | Latex                | MeOH, EtOH (100%, 75%), AcOEt and Hex | DPPH⁻ (66.67 ± 1.30, 52.72 ± 0.96, 63.76 ± 1.48, 22.52 ± 0.35 and 11.90 ± 0.20%). | (Shahinuzzaman et al., 2020)      |
| *F. auriculata* | Leaf                 | AcOEt fraction from MeOH | DPPH⁻ (IC₅₀, 5.508 µM). | (Dureshahwar et al., 2019)          |
| *F. auriculata* | Leaf                 | EtOH and MeOH      | IC₅₀, DPPH⁻ (101.76 ± 1.15 and 93.12 ± 1.17 and μg/mL). | (Javaid et al., 2021)             |
| *F. auriculata* | Leaf                 | H₂O and H₂O:EtOH   | TEAC (= 1.75 and 0.5 mmol Trolox/g). | (Alcántara et al., 2020)           |
|                 | Leaf                 | H₂O and MeOH (1000 µg/mL) | DPPH⁻ (≈ 30 and 25%), ABTS⁺⁺⁺ (≈ 50 and 50%), FRAP (≈ 0.4 and 0.6 mM FeSO₄ equivalent), iron chelating (≈ 70 and 40). | (Ergül et al., 2019)              |
| *F. auriculata* | Leaf                 | H₂O:MeOH           | DPPH⁻ (EC₅₀, 0.48 ± 0.07 to 6.68 ± 0.06 mg DW/mL) | (Petruccelli et al., 2021)         |
| Plant Species | Leaf | Methods | Results |
|---------------|------|---------|---------|
| *F. dubia*    | Hex, AcOEt, EtOH and H₂O | IC₅₀, DPPH⁻ (1233 ± 40.76, 899.55 ± 109.737, 175.857 ± 8.932 and 322.110 ± 12.970 µg/mL). | (Mopuri et al., 2018) |
|               | MeOH (1000 µg/mL) | DPPH⁻ (80%). | (Purnamasari et al., 2019) |
| *F. deltoidea*| Stem Hex, AcOEt, bark EtOH and H₂O | IC₅₀, DPPH⁻ (736.395 ± 37.441, 507.584 ± 55.794, 171.479 ± 19.354 and 376.055 ± 33.931 µg/mL). | (Mopuri et al., 2018) |
|               | Leaf Acetone | IC₅₀, DPPH⁻ (107.05 ± 2.61 µg/mL), ABTS⁺⁻ (1.47 ± 1.21 µg/mL). | (Cruz-Concepción et al., 2021) |
|               | Leaf Crude extract | DPPH⁻ (15 to 50%, 0.4 mg/mL), TBARS (15 to 50%, 2 mg/mL), CUPRAC (0.3 to 1 Abs 450nm, 1 mg/mL), FIC (60 to 75%, 0.4 mg/mL) and ferricyanide (0.3 to 0.5 Abs 700 nm, 1 mg/mL). | (Abraham et al., 2018) |
| *F. deltoidea*| Leaf H₂O | FIC (EC₅₀, 1289.00 ± 22.63 to 1572.83 ± 234.71 µg/mL). | (Abolmaesoomi et al., 2019) |
|               | Leaf Hex, AcOEt, MeOH and H₂O | EC₅₀, DPPH⁻ (978.40 ± 6.87, 337.83 ± 8.20 to 1882.34 ± 13.02, 213.33 ± 2.88 to 409.42 ± 13.97 and 229.43 ± 2.05 to 1161.38 ± 15.52 µg/mL). | (Abolmaesoomi et al., 2019) |
|               | Leaf Hex, AcOEt, MeOH and H₂O | ABTS⁺⁻ (0.52 ± 0.03 to 0.96 ± 0.05, 1.04 ± 0.09 to 2.17 ± 0.05, 2.05 ± 0.05 to 2.51 ± 0.01 and 2.10 ± 0.10 to 2.56 ± 0.02 mmol TE/g). | (Abolmaesoomi et al., 2019) |
|               | Leaf Hex, AcOEt, MeOH and H₂O | FRAP (1.86 ± 0.03 to 4.02 ± 0.03, 1.02 ± 0.15 to 3.92 ± 0.04, 4.71 ± 0.14 to 6.54 ± 0.38 and 1.90 ± 0.13 to 4.46 ± 0.01 mmol Fe²⁺/g). | (Abolmaesoomi et al., 2019) |
|               | Leaf Hex, AcOEt, MeOH and H₂O | Cellular Antioxidant Assay (CAA, EC₅₀, 23.17 ± 0.79 to 1343.84 ± 148.88, 9.49 ± 0.16 to 289.27 ± 9.74, 146.90 ± 11.88 to 868.24 ± 8.80 and 323.61 ± 39.10 µg/mL). | (Abolmaesoomi et al., 2019) |
| *F. dubia*    | Leaf MeOH | DPPH⁻ (IC₅₀, 66.81 ± 4.32 to 288.04 ± 11.43 µg/mL), Reducing Power (0.04 ± 0.00 to 0.24 ± 0.24 mg AAE/g). | (Dom et al., 2020) |
|               | Leaf MeOH and H₂O | EC₅₀, O₂⁻ (592.27 ± 57.72 and 204.53 ± 39.23 to 1001.43 ± 99.90 µg/mL). | (Abolmaesoomi et al., 2019) |
|               | Leaf MeOH, CHCl₃, AcOEt and BuOH | DPPH⁻ (80, 60, 70 and 40%, 200 µg/mL). | (K. Ashraf et al., 2020) |
| *F. exasperata*| Leaf MeOH, CHCl₃, AcOEt, BuOH | Ferric Reducing (0.75, 0.45, 0.5 and 0.45 Abs 700 nm, 1000 µg/mL). | (K. Ashraf et al., 2020) |
| *F. dubia*    | Latex – | DPPH⁻ (SC₅₀, 579.67 ± 15.03 µg/mL), ABTS⁺⁻ (SC₅₀, 87.09 ± 0.89 µg/mL), FRAP (461 ± 34.67 µmol TE/g extract) and ORAC (7.976 ± 70 µmol TE/g extract). | (Sutittsananee et al., 2021) |
| *F. exasperata*| Roots EtOH, H₂O and H₂O hot | SC₅₀, DPPH⁻ (250.31 ± 102.66, 611.30 ± 36.92 and 460.55 ± 18.08 µg/mL). | (Sutittsananee et al., 2021) |
|               | Roots EtOH, H₂O and H₂O hot | SC₅₀, ABTS⁺⁻ (43.39 ± 0.38, 56.51 ± 2.24 and 38.76 ± 3.26 µg/mL). | (Sutittsananee et al., 2021) |
|               | Roots EtOH, H₂O and H₂O hot | FRAP (830 ± 22.75, 515 ± 37.90 and 601 ± 21.10 µmol TE/g extract). | (Sutittsananee et al., 2021) |
|               | Roots EtOH, H₂O and H₂O hot | ORAC (2.671 ± 85, 1.678 ± 94 and 2.059 ± 170 µmol TE/g extract). | (Sutittsananee et al., 2021) |
| *F. exasperata*| Leaf H₂O | IC₅₀, DPPH⁻ (222.50 ± 8.00 and 621.10 ± 38.98 µg/mL), NO⁻ (510.00 ± 77.47 and 866.00 ± 32.36 µmol TE/g extract). | (Mouho et al., 2018) |
stem bark μg/mL and O₂⁻ (50.00 ± 3.00 and 561.00 ± 51.78 μg/mL).

F. glomerata Leaf CHCl₃ Reduced oxidative stress in diabetic rats.

F. hirta Roots EtOH and AcOEt fraction IC₅₀, DPPH⁻ (79.91 ± 4.79 and 64.71 ± 0.82 μmol/L), PMS/NADH-NBT (>300 and 281.00 ± 4.63 μmol/L).

F. lyrata Bark gum H₂O (2.5 mg/mL) DPPH⁻ (≈ 70%).

F. maclellandii Branch EtOH IC₅₀, DPPH⁻ (183 ± 4 μg).

F. natalensis Bark PeEt, CHCl₃, MeOH and H₂O. ABTS⁺⁺ (7.183 ± 0.241, 1.583 ± 0.085, 7.436 ± 0.264 and 7.956 ± 0.526 mM TE), Metal Chelating (61.5 ± 0.5, 49.73 ± 0.2867, 30.08 ± 0.102 and 41.01 ± 0.42% bound iron).

F. relicosa Leaf AcOEt DPPH⁻ and ABTS⁺⁺.

F. sur Bark, leaf and roots EtOH DPPH⁻ (≈ 56, 30 and 50 μg QE/mg of dry extract) and FRAP (≈ 104, 52 and 48 μmol FeSO₄ Eq/mg of dry extract).

F. sycomorus Latex MeOH DPPH⁻ (7.00 ± 0.30 μg GAE/mL) and ABTS⁺⁺ (6.40 ± 0.32 μg GAE/mL).

Leaf EtOH, AcOEt DPPH⁻ (IC₅₀, 18.443 and 33.348 μg/mL), reducing power (22.53 ± 0.37 and 16.19 ± 0.18 μg gallic acid /100g DW).

Leaf H₂O, acetone, CHCl₃, EtOH and MeOH DPPH⁻ (1 ± 2.55, 33 ± 3.38, 42 ± 0.13, 18 ± 0.13 and 47 ± 2.17%).

Leaf Hex and CH₂Cl₂:EtOH DPPH⁻ (6.79 ± 0.88 mg TE/g), ABTS⁺⁺ (9.67 ± 1.46 and 27.45 ± 1.38 mg TE/g), Phosphomolybdenum (1.09 ± 0.07 and 2.65 ± 0.10 mmol TE/ g), CUPRAC (55.47 ± 1.04 and 147.97 ± 5.32 mg TE/g), FRAP (23.35 ± 0.88 and 37.46 ± 0.52 mg TE/g), ferrous chelating (27.93 ± 1.04 and 58.27 ± 0.39 mg EDTAE/g).

Stem Hex and bark CH₂Cl₂:EtOH DPPH⁻ (5.43 ± 1.56 and 32.87 ± 0.71 mg TE/g), ABTS⁺⁺ (11.26 ± 1.57 and 40.81 ± 1.15 mg TE/g), Phosphomolybdenum (0.75 ± 0.13 and 2.10 ± 0.04
mmol TE/g), CUPRAC (51.66 ± 1.70 and 128.78 ± 2.50 mg TE/g), FRAP (19.75 ± 0.89 and 56.72 ± 0.41), ferrous chelating (13.72 ± 0.54 and 47.56 ± 3.49 mg EDTAE/g).

| Species       | Part          | Extractant       | IC_{50}, DPPH' (µg/mL) | Source                                    |
|---------------|---------------|------------------|------------------------|-------------------------------------------|
| *F. variegata*| Branch EtOH   | IC_{50}, DPPH'   | (195 ± 2)              | (Raza et al., 2016)                       |
|               | Leaf EtOH     | IC_{50}, DPPH'   | (173 ± 2 and 191 ± 3)  |                                           |
| *F. vasta*    | Leaf H$_2$O:MeOH | DPPH'           | 0.0672 ± 0.0038        | (Taviano et al., 2018)                    |
|               |               | reducing power   | 3.65 ± 0.48 ASE/mL     |                                           |
| *F. vogeliana*| Bark H$_2$O   | DPPH'           | 4.60 ± 0.15 µg/mL      | (Misso et al., 2020)                      |
|               |               | phosphomolybdenum (VtCE, 87.37 ± 0.60; BHTE, 358.70 ± 2.87; QE, 53.78 ± 0.46 mg/g of dry plant extract) | |

Source: Authors.

Some reports compared the extraction of phenolic compounds and antioxidant activity by conventional and ultrasound-assisted methods. The best antioxidant activity was observed in leaf extracts (Alcántara et al., 2020), and látex (Shahinuzzaman et al., 2020) of *F. carica* obtained from conventional method.

The acetone extract from the leaves of *F. crocata* showed antioxidant activity (IC$_{50}$: 107.05 ± 2.61 µg/mL by DPPH’ and 1.47 ± 1.21 µg/mL by ABTS+) higher than ascorbic acid (IC$_{50}$: 118.82 ± 2.48 µg/mL by DPPH’ and 2.22 ± 0.80 µg/mL by ABTS+) (Cruz-Concepción et al., 2021).

The methanol extract of *F. racemosa* leaves showed antioxidant activity through radical scavenging (DPPH’, O$_2^-$ and OH’) and Reducing Power Assay similar to the fruit extract (Sumi et al., 2016). On the other hand, extracts from ethanol, toluene e ethyl acetate of the fruits presented antioxidant activity superior to the leaves. For both parts, the toluene extract showed the best results, with IC$_{50}$ of (0.75 ± 0.01) µg/mL for fruits and (2.35 ± 0.41) µg/mL for leaves (Bagyalakshmi et al., 2019).

Methanol and chloroform extracts from *F. sycomorus* leaves showed statistically similar percentages of inhibition of DPPH’ radicals of 47 ± 2.17 and 42 ± 0.13, respectively. However, the fruit extracts were more active (Ozdenefe et al., 2020). On the other hand, the ethyl acetate extracts from the leaves were slightly higher in antioxidant potential than the fruits (El-Beltagi et al., 2019).

The CH$_2$Cl$_2$:EtOH extract of *F. sycomorus* bark showed better antioxidant activity when compared to the same leaf extract and hexane extracts from leaves and stem bark. In the ABTS and DPPH’ assays, its activity was 40.81 ± 1.15 and 32.87 ± 0.71 mg TE/g, respectively (Suliman et al., 2021). The aqueous extract of *F. vogeliana* bark also showed good antioxidant potential, with IC$_{50}$ of 4.60 ± 0.15 µg/mL and antioxidant activity index (AAI) of 10.88 ± 0.36 in DPPH’ tests, which were statistically similar to vitamin C (Misso et al., 2020).

The antioxidant activity has a great influence on the variety studied. The methanol extract of *F. deltoidea* leaves changed the IC$_{50}$ from 66.81 ± 4.32 to 288.04 ± 11.43 µg/mL in the DPPH’ assay, while for ascorbic acid and quercetin, the IC$_{50}$ was 1.3 ± 0.74 and 4.98 ± 1.58 µg/mL, respectively (Dom et al., 2020). In the aqueous extract of the same species the variation was observed from 229.43 ± 2.05 to 1161.38 ± 15.52 µg/mL (Abolmaesoomi et al., 2019). For the hydromethanolic
extract (80:20, v/v) of *F. carica* leaves, the variation was observed from 0.48 ± 0.07 to 6.68 ± 0.06 mg/mL (Petruccelli et al., 2018).

Antioxidant activity was also observed in proanthocyanidins isolated from the bark and leaves of *F. virensis* through radical scavenging DPPH· e ABTS+· (Chen et al., 2017). The compounds carpachromene, alpha amyrine acetate, mucusoside and 2-O-a-L-rhamnopyranosyl-hexacosanoate-b-D-glucopyranosyl ester isolated of ethyl acetate fraction of methanol extract from *F. benghalensis* leaves showed antioxidant activity inferior to methanolic extract (IC₅₀, 178.2 ± 1.750 µg/mL) and to ascorbic acid (174.8 ± 12.3 µg/mL) (Hassan et al., 2020).

In vitro assays were predominantly used to measure antioxidant potential. The ethanol extract of *F. carica* leaves caused a reduction of malondialdehyde (MDA) in *in vivo* tests, a marker of oxidative stress (Sukowati et al., 2019). Moreover, the hydroethanol extract (70:30, v/v) of aerial parts of *F. religious* showed potential to normalize the levels of antioxidant enzymes (CAT and SOD) (Singh et al., 2020). Chloroform extract of *F. glomerata* leaves reduced the oxidative stress in diabetic rats (Shaikh et al., 2020).

Research suggests that extracts from different parts of *Ficus* spp. exhibit antioxidant activity, both *in vitro* and in animal model. However, it is suggested for the future, *in vivo* tests also using fractions to guide the isolation of compounds with biological interest.

### 4.2 Antimicrobial activity

The essential oil and extracts from the parts of *Ficus* spp. presented activity against microorganisms, such as *C. albicans*, *B. subtilis*, *S. aureus* and *E. coli* (Table 4) (Lawal et al., 2016; Tian et al., 2020). The essential oil of *F. tikoua* showed good antibacterial activity against gram-positive species, such as *Enterococcus faecalis* (MIC = 3.13 mg/mL, MBC = 3.13 mg/mL), *Staphylococcus aureus* (MIC = 0.20 mg/mL, MBC = 0.20 mg/mL) and *Bacillus subtilis* (MIC = 0.39 mg/mL, MBC = 0.39 mg/mL). The major compound of the essential oil was palmitic acid, which was more active against gram-negative bacteria, such as *Pseudomonas aeruginosa*, *Escherichia coli* and *Proteus vulgaris*, with MIC of 0.63, 0.63 and 1.25 mg/mL, respectively (Tian et al., 2020).

| Specie            | Part   | Extraction solvent | Microorganism                                      | Reference                               |
|-------------------|--------|--------------------|----------------------------------------------------|-----------------------------------------|
| *F. asperifolia*   | Leaf   | Essential oil      | IZD (mm), *B. subtilis* (17.3 ± 1.2), *S. aureus* (23.7 ± 1.5), *E. coli* (20.6 ± 1.8), *Klebsiella spp.* (10.7 ± 1.2), *Proteus spp.* (20.0 ± 1.3), *Pseudomonas spp.* (9.3 ± 0.2), *Salmonella spp.* (13.7 ± 0.6), *P. notatum* (21.0 ± 1.0) and *R. stolonifera* (26.3 ± 5.5). | (Lawal et al., 2016)                     |
| *F. bengalensis*   | Bark   | EtOH               | IZD (mm), *S. aureus* (12), *B. cereus* (11), *E. faecalis* (15), *P. aeruginosa* (13) and *C. albicans* (12).                                      | (Moe et al., 2018)                      |
| *F. benjamina*     | Leaf   | EtOH               | In ovo.                                            | (A. Ashraf et al., 2020)                |
| *F. bizanae*       | Leaf   | CH₂Cl₂, AcOEt and MeOH | IZD (mm), *E. coli* (10, 8 and 8) and *S. aureus* (8, 10 and 10).                                      | (G. V. Awolola et al., 2018)           |
|                    | Leaf   | Hex                | IZD (mm), *E. coli* (8)                                      | (G. V. Awolola et al., 2018)           |
|                    | Stem   | CH₂Cl₂ and Hex     | IZD (mm), *E. coli* (8 and 14) and *S. aureus* (11 and 11).                                      | (G. V. Awolola et al., 2018)           |
| Plant         | Part               | Extraction Solvent | Bioactivity                                      |
|--------------|--------------------|--------------------|--------------------------------------------------|
| *F. bubu*    | Leaf, bark         | MeOH               | MIC (µg/mL), *E. faecalis* (39.1), *S. aureus* (625.0), *
|              |                    |                    | *K. pneumoniae* (156.2) and *S. typhimurium* (625.0). |
| *F. capensis*| Leaf, bark         | MeOH               | MIC (µg/mL), *E. faecalis* (39.1), *S. aureus* (312.5 µg/mL), *
|              |                    |                    | *K. pneumoniae* (9.8), *E. coli* (39.1) and *S. typhimurium* (625.0). |
| *F. carica*  | Leaf, bark         | EtOH, CHCl<sub>3</sub>, MeOH, H<sub>2</sub>O | MIC (µg/mL), *E. coli* (11.87 ± 0.11), *S. flexneri* (11.73 ± 0.11), *
|              |                    |                    | *R. solanacearum* (8.07 ± 0.11), *A. niger* (8.53 ± 0.0, 9.83 ± 0.0, 9.47 ± 0.11), *
|              |                    |                    | *P. aeruginosa* (MIC 37.5% and MBC 50%). |
| *F. deltoidea* | Leaf, bark         | CHCl<sub>3</sub>, MeOH, H<sub>2</sub>O | MIC (mg/mL), *E. coli* (0.625 and 2.5), *S. aureus* (0.156 and 0.625), *
|              |                    |                    | *C. albicans* (2.5 and 2.5). To *P. aeruginosa*, *E. faecalis*, *
|              |                    |                    | *K. pneumoniae* MIC > 2.5 mg/mL. |
| *F. elastica* | Root, wood         | MeOH               | MIC (µg/mL), *E. coli* (9.1), *P. vulgaris* (39.1), *
|              |                    |                    | *P. stuartii* (1250.0), *P. aeruginosa* (39.1), *S. aureus* (39.1) and *C. albicans* (39.1). |
| *F. fistulosa* | Leaf, fractions  | EtOH, fractions (But, CHCl<sub>3</sub>) | Hepatitis C Virus. |
| *F. lyrata*  | Bark, gum          | CHCl<sub>3</sub>   | IZD, *Bacillus* sp (2, 4 and 5 mm, in 4, 6 and 8 mg/mL). |
| *F. natalensis* | Bark              | PeEt, CHCl<sub>3</sub>, MeOH, H<sub>2</sub>O | IZD (mm), *E. coli* (30 ± 0.57, 27 ± 0.72, 23 ± 1, 26 ± 0.97), *
|              |                    |                    | *P. aeruginosa* (47 ± 0.4, 30.5 ± 1.28, 30.8 ± 0.34, 28 ± 0.76), *
|              |                    |                    | *S. aureus* (55.7 ± 1.15, 50.9 ± 0.9, 25.6 ± 0.63, 23 ± 0.6), *
|              |                    |                    | *B. subtilis* (38 ± 1.52, 29.7 ± 0.3, 20.8 ± 0.72, 26.8 ± 0.4), *
|              |                    |                    | *A. niger* (37 ± 0.57, 25 ± 1.0, 43.7 ± 1.5, 27 ± 1.52) and *A. oryzae* (23.7 ± 0.57, *
|              |                    |                    | 25.2 ± 0.28, 26.7 ± 1.15, 26.2 ± 0.76). |

(References: (G. V. Awolola et al., 2018), (J. M. E. Teinkela, 2016), (Lawal et al., 2016), (K. Ashraf et al., 2020), (J. E. M. Teinkela et al., 2017), (Hafid et al., 2018), (Ergül et al., 2017), (Ohashi et al., 2018), (Desta et al., 2020), (Hafid et al., 2016), (Ajaib et al., 2016), (Ajaib et al., 2021).)
**F. racemosa**

| Type | Extract | MIC (mg/mL) | Bacteria/fungi |
|------|---------|-------------|----------------|
| Leaf | EtOH, toluene, AcOEt | E. coli (5.0 ± 0.12, 1.25 ± 0.08, 1.25 ± 0.09), *S. aureus* (2.5 ± 0.09, 0.625 ± 0.02, 5.0 ± 0.11), *Pseudomonas* spp. (5.0 ± 0.12, 1.25 ± 0.11, 2.5 ± 0.14) and *Klebsiella* spp (2.5 ± 0.14, 0.625 ± 0.02, 1.25 ± 0.01). |
| Leaf | MeOH | IZD (mm), *E. coli* (9.61), *S. flexneri* (10.08), *S. boydii* (8.45), *S. epidermidis* (4.23). |
| Bark | EtOAc, MeOH | DCZ (mm), *B. subtilis* (10.44, 9.63), *S. aureus* (10.50, 9.56), *S. cervisiae* (10.69, 10.38), *Saccharomyces* spp. (9.38, 8.94), *C. albicans* (10.69, 9.94). |

**F. religiosa**

| Type | Extract | Bacteria/fungi |
|------|---------|----------------|
| Leaf | AcOEt | *B. subtilis* and *A. fischer*. |

**F. sycomorus**

| Type | Extract | MIC (mg/mL) |
|------|---------|-------------|
| Leaf | Acetone and EtOH | IZD (mm), *C. albicans* (10 and 12). |
| Leaf | Acetone, MeOH and EtOH | IZD (mm), *S. aureus* (11, 10 and 13). |
| Leaf | EtOH, EtOAc | IZD (mm), *E. coli* (17.82 ± 0.51, 14.09 ± 0.16), *S. typhimureum* (19.31 ± 0.11, 15.21 ± 0.52), *S. aureus* (10.46 ± 0.42, 8.11 ± 0.13), *B. cereus* (12.61±0.29, 10.41±0.15), *C. albicans* (13.21 ± 0.16, 9.34 ± 0.41) and *A. niger* (12.60 ± 0.33, 7.32 ± 0.26). |

**F. tikoua**

| Type | Essential oil | MIC (mg/mL), *E. faecalis* (3.13), *S. aureus* (0.20), *B. subtilis* (0.39), *P. aeruginosa* (6.25), *E. coli* (6.25) and *P. vulgaris* (6.25). |

**F. vasta**

| Type | Extract | MIC (μg/mL), B. subtilis (>500), L. monocytogenes (125.0), *S. aureus* (62.5), *S. epidermidis* (62.5), *E. coli* (250.0), *P. aeruginosa* (>500), *S. typhimurium* (250.0), *S. enterica* (250.0) and *C. albicans* (>500). |

IZD, Inhibition Zone Diameter. PI, Percentage of Inhibition. DCZ, Diameter of Clear Zone. Source: Authors.

Significant Inhibition Zone Diameter (IZD) against *B. subtilis*, *A. niger*, *E. coli* e *S. aureus* were presented by leaves and bark extracts of *F. natalensis* (Ajaib et al., 2016). The most important Minimum Inhibitory Concentration (MIC) against *E. coli* and *C. albicans* was 39.1 and 9.8 μg/mL, presented by methanol extract of bark of *F. bubu* (J. M. E. Teinkela, Nguedia, et al., 2016).

Acetone and ethanol extracts of *F. sycomorus* leaves showed lower antibacterial activity when compared to tetracycline control, which presented a diameter of the inhibition zone of 23 mm against *S. aureus*. The same extracts showed a diameter of the inhibition zone of 10 and 12 mm, respectively, against *C. albicans*, while the control nystatin presented a diameter of the inhibition zone of 15 mm (Ozdenefe et al., 2020).

The methanol extract of *F. elastica* roots showed lower antimicrobial activity when compared to gentamycin and fluconazole controls (MIC, 25 μg/mL) against fungi and gram-positive and gram-negative bacteria. However, some isolated compounds showed good antimicrobial activity. Ficusoside B presented a MIC of 4.9 μg/mL against *E. coli*, *P. vulgaris*, *S. aureus* and *C. albicans*, and elastiquinone showed better activity against *P. stuartii* and *P. aeruginosa*, with a MIC of 4.9 μg/mL (J. E. M. Teinkela et al., 2017).

Ficusnotanone and diarylbutanoids (Ficusnotins A-F) extracted from the ethanol extract of the leaves of *F. nota*, showed antibacterial activity against *B. subtilis* (Latayada, Uy, Akihara, Ohta, & Ohta, 2017; Latayada, Uy, Akihara, Ohta, Nehira, et al., 2017). We did not identify work in recent years testing antimicrobial activity in vivo. In addition, there are few
reports where purified compounds were tested for this activity, so this should be the focus of some future studies aimed at the discovery and development of new drugs.

4.3 Anti-hyperglycemic, anti-diabetes and anti-obesogenic activities

Table 5 shows the anti-hyperglycemic, anti-diabetes and anti-obesogenic activities of different extract of *Ficus* genus. These activities were also presented by some compounds isolated from species of this genus. Cycloartenol and 24-methylene-cycloartanol triterpenes isolated from the hexane extract of the stem bark of *F. krishnae* showed anti-hyperglycemic activity in rats (Sadasivan Nair et al., 2020), while four flavonoids, similar to kaempherol, quercetin, naringenin and baicalein, which were isolated from the hydromethanol extract of the stem bark of *F. racemosa*, showed antidiabetic and hypolipidemic activity in diabetic rats (Keshari et al., 2016).

| Specie            | Part       | Extraction solvent | Result                                                                 | Reference                      |
|-------------------|------------|--------------------|------------------------------------------------------------------------|--------------------------------|
| *F. asperifolia*  | Leaf       | EtOH               | Decrease in blood glucose concentration and improved the derangements caused by streptozotocin in diabetic rats. | (Pwaniyibo et al., 2020)       |
| *F. bengalensis*  | Bark       | MeOH               | Antiglycation activity *in vitro*                                      | (Moe et al., 2018)             |
| *F. carica*       | Fruit latex| MeOH, fraction: Hex: AcOEt | Inhibitory effect on α-amylase and α-glucosidase *in vitro*.          | (Paşayeva et al., 2020)        |
| *F. deltoidea*    | Leaf       | MeOH, H$_2$O       | Potential to inhibit pancreatic β-cell apoptosis *in vitro* and *in vivo*. | (Zhang et al., 2020)           |
| *F. dubia*        | Roots      | EtOH               | Higher inhibitory effect against both α-glucosidase and angiotensin-converting enzyme, and low inhibitory activities against acetylcholinesterase. | (Suttisansanee et al., 2021)   |
| *F. exasperata*   | Leaf       | H$_2$O             | Weak effect on α-amylase inhibition and no effect on α-                 | (Mouho et al., 2017)           |

Table 5. Anti-hyperglycemic, anti-diabetes and anti-obesogenic activities of *Ficus* genus. 

*Ficus racemosa,* showed antidiabetic and hypolipidemic activity in diabetic rats (Keshari et al., 2016).
Treatment with chloroform extract from *F. glomerata* leaves (400 mg/kg) reduced blood glucose, plasma urea, uric acid, creatinine, triglycerides and total cholesterol in diabetic rats, presenting results statistically similar to metformin (250 mg/kg) (Shaikh et al., 2020).

*F. asperifolia* showed antidiabetic effects in rats induced by streptozotocin. The ethanol extract of leaves (400 mg/kg body weight) showed statistically similar effects to metglim (3.38 mg/kg body weight) on lipid profile (total cholesterol, high density lipoprotein, low density lipoprotein and triacylglyceride) and body weight diabetic rats (Pwaniyibo et al., 2020). The aqueous extract, in addition to anti-hyperglycemic potential, showed profertility effect in diabetic male rats (Abu Bakar et al., 2020).

The ethanol extract of *F. deltoidea* leaves contributed to suppression of hypercholesterolemic induced in rats (Chuo et al., 2020). Its methanolic extract reduced glucose levels in diabetic rats and prevented diabetic osteoporosis through inhibition of bone oxidative stress (Samsulrizal et al., 2021).

The n-hexane and n-hexane-ethyl acetate fractions from the methanol extract of *F. carica* fruit latex showed an inhibitory effect on α-glucosidase (IC$_{50}$, 12.333 ± 0.153 and 6.920 ± 0.026 µg/mL) based on *in vitro* tests. Only the n-hexane-ethyl acetate fraction showed an inhibitory effect on α-amylase, with IC$_{50}$ of 195.205 ± 0.015 µg/mL. These results were superior to inhibition of α-glucosidase and α-amylase by acarbose, with IC$_{50}$ of 18.903 ± 0.012 and 117.256 ± 0.015, respectively (Paşayeva et al., 2020).

Enzyme inhibitory activity as α-glucosidase and α-amylase was observed in methanolic (64.93 ± 1.09 and 67.32 ± 2.46%) and aqueous (69.56 ± 0.61 and 69.08 ± 6.05%) extracts of *F. carica* leaves (2 mg/mL). Both extracts presented an inhibitory percentage higher than acarbose (57.56 ± 0.52 and 58.40 ± 0.63%) (Ergül et al., 2019). Inhibition of these enzymes involved in carbohydrate metabolism indicates hyperglycemic, antidiabetic and antiobesogenic potential (Akhtar et al., 2018; Mopuri et al., 2018). The potential to inhibit pancreatic β-cell apoptosis *in vivo* and *in vitro* was shown in *F. carica* leaves (Zhang et al., 2020), and in different varieties of *F. deltoidea* there was a significant decrease in the production of advanced glycation end products (AGEs) (Mohd Dom et al., 2020).

### 4.4 Anticancer and cytotoxic activities

The anticancer and cytotoxic activities were reported in extracts and essential oil of the *Ficus* genus (Table 6). Isolated compounds of the *Ficus* genus also showed cytotoxic and anticancer activity. Two alkaloids isolated from the ethanol extract of the bark and leaves of *F. fistulosa* (fistulopsine A and B) showed inhibitory activity against breast and colon carcinoma cell lines (Yap et al., 2016). Tengechlorenine, isolated from the ethanol extract of *F. fistulosa* leaves showed
cytotoxic effect against breast cancer cell lines (Al-Khdhairawi et al., 2017). A homogeneous pectic polysaccharide (FP2) isolated from the ethanol extract of the aerial parts of *F. pandurata* showed anticancer potential (Lv et al., 2020). Proanthocyanidins isolated from the bark and leaves of *F. virens* showed cytotoxic activity against breast cancer cells (Chen et al., 2017).

Table 6. Anticancer and cytotoxic activities of *Ficus* genus.

| Specie               | Part            | Extraction solvent | Cell line                                                                 | Reference                                                                                       |
|----------------------|-----------------|--------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| *F. beecheyana*      | Roots           | EtOH               | Human leukemic cells (HL-60)                                              | (Yen et al., 2018)                                                                              |
| *F. benghalensis*    | Barks           | H$_2$O:EtOH        | Chinese hamster ovary e adenocarcinomic human alveolar basal epithelial (A549). | (Khanal & Patil, 2020)                                                                          |
|                      | Stem bark       | MeOH               | Yeast cell model.                                                          | (Raheel et al., 2017)                                                                           |
| *F. bubu*            | Stem bark       | MeOH               | Glioma (U373), lung (A549) and melanoma (SKMEL-28).                       | (J. M. E. Teinkela, Nguedia, et al., 2016)                                                      |
|                      | Leaf Latex      | H$_2$O:EtOH        | Jurkat (human acute T-cell leukemia cells).                               | (Ohashi et al., 2018)                                                                          |
| *F. capensis*        | Leaf Stem-bark  | —                  | Papiloma vírus humano (HPV).                                               | (Ghanbari et al., 2019)                                                                         |
|                      | Latex           | Acetone            | HepG2 (human hepatoblastoma cancer).                                       | (Mustafa et al., 2021)                                                                          |
| *F. carica*          | Leaf Latex      | —                  | MDA-MB-231.                                                               | (AlGhalban et al., 2021)                                                                        |
|                      | Leaf Latex      | MeOH               | Liver cancer (Huh7it) and cause apoptosis in vitro.                       | (Purnamasari et al., 2019)                                                                      |
|                      | Leaf Acetone    | —                  | HeLa and SiHa cervical cancer.                                             | (Cruz-Concepción et al., 2021)                                                                  |
|                      | Leaf Acetone,   | —                  | MDA-MB-231 triple-negative breast cancer.                                 | (Sánchez-Valdeolívar et al., 2020)                                                             |
|                     | CH$_2$Cl$_2$, Hex | —                  |                                                                           |                                                                                                 |
| *F. deltoidea*       | Leaf AcOEt      | —                  | Breast cancer (MCF-7, MDA-MB 231, HCC1937) e colon cancer (HCT 116).      | (Abolmaeoomi et al., 2019)                                                                      |
|                      | Leaf BuOH, CHCl$_3$, AcOEt, MeOH | —                  | Lung adenocarcinoma (A549), hepatocyte carcinoma (HepG2) and breast adenocarcinoma (MCF7). | (K. Ashraf et al., 2020)                                                                        |
| *F. dubia*           | Roots           | EtOH               | SKOV3 (ovarian) and A549 (lung).                                          | (Suttisansanee et al., 2021)                                                                    |
| *F. elastica*        | Aerial root wood| MeOH               | Glioma (U373n Hs683), carcinoma (A549 MCF7) and melanoma (SK-MEL28 B16F10). | (J. M. E. Teinkela, Noundou, et al., 2016)                                                      |
| *F. salicifolia*     | Leaf latexit    | —                  | MDA-MB-231.                                                               | (AlGhalban et al., 2021)                                                                        |
| *F. sycomorus*       | Latex           | MeOH               | Breast (MCF-7), liver (HepG2), colon (HCT116), lung (A549) and acute myeloid leukemia (HL-60) cancers. | (Abdel-Aty et al., 2019)                                                                        |
|                      | Leaf            | EtOH               | Liver (HepG2), colorectal adenocarcinoma (Caco-2) and Breast (MCF-7).     | (El-Beltagi et al., 2019)                                                                      |
4.5 Anti-inflammatory and healing properties

The aqueous and hydroethanolic extract of *F. carica* leaves showed anti-inflammatory activity *in vitro*, which was investigated using the cell-reporter plasmid pNiPty2-SEAP in HT-29 cells (human colon adenocarcinoma). Prominent results were presented by the hydroethanolic extract (Alcántara et al., 2020).

The ethanol extracts of the bark and roots of *F. hirta* and its fractions (CHCl3, AcOEt, BuOH) showed significant anti-inflammatory activity by inhibiting LPS-induced NO production in murine macrophage RAW264.7 (Cheng, Yi, Chen, et al., 2017; Cheng, Yi, Wang, et al., 2017). Phenolic compounds isolated from the CHCl3 fraction of the roots also showed significant inhibition of NO production, including vanillin, (−)-pinoresinol and 30-hydroxy-40-methoxy-trans-cinnamaldehyde, which revealed their anti-inflammatory potential (Cheng et al., 2017).

The ethanolic extract of the bark of *F. hispida* showed anti-inflammatory activity in rats (Howlader et al., 2017). Ficuhismine B, an alkaloid isolated from the ethanol extract of branches and leaves, showed anti-inflammatory activity *in vitro* through the NF-κB pathway luciferase assay (Jia et al., 2020). The ethanolic and hydroethanolic extracts of the stem bark of *F. palmata* presented anti-inflammatory activity *in vitro*, through the inhibition of pro-inflammatory cytokines and by the negative regulation of pro-inflammatory mediators (Khajuria et al., 2018).

Dichloromethane and hexane extracts from the bark of *F. racemosa* showed healing activity *in vitro*, which was evidenced by increased cell migration, mainly attributed to the isolated compounds, lupeol and β-sitosterol (Bopage et al., 2018). The compound drupin, a cysteine protease isolated from the latex of *F. drupacea*, showed activity by accelerating the healing process in mice (Manjuprasanna et al., 2020).

Phenolic glycosides from ethanolic extract of *F. hirta* roots, such as Ficuside A and methyl 2-hydroxybenzoate-2-O-β-D-apiofuran-syl-(1→2)-O-β-D-glucopyranoside were responsible for antineuroinflammatory activity (Ye et al., 2020).

4.6 Other reported activities

The aqueous extract of *Ficus* spp. presented different activities. The aerial roots of *F. benghalensis* showed improvement in memory, anxiolytic activity, muscle relaxant capacity and delay in the onset of seizures in mice. However, no significant effects on the sleep of the animals tested were identified (Panday & Rauniar, 2016). In *F. carica* leaves, cell cultures showed relief from skin damage caused by psychological stress *in vitro* and *in vivo*, suggesting its potential application in skin care products (Dini et al., 2021), a profertilizing effect was observed through the increase in the number of sperm in male diabetic rats (Abu Bakar et al., 2020). Potential to cure polycystic ovary syndrome in rats were observed in the *F. religious* leaves (Suriyakalaa et al., 2021). Oral supplementation of male mice with leaf extract significantly reduced neuromuscular coordination, exploratory behavior and object recognition ability (Akhtar et al., 2020).

Anticoccidial activity through inhibition against *Eimeria* (E. tenella, E. necatrix, E. mitis) were presented by methanolic and aqueous extracts of *F. racemosa* leaves (Wajiha & Qureshi, 2021). The hydromethanolic extract of the stem bark of *F. sycomorus* showed an antidepressant effect in male rats (Foyet et al., 2017).

The methanolic extract of *F. deltoidea* leaves improved the learning ability in rats through its oral administration, being related to the reduction of oxidative stress and, possibly, the reduction of sugar levels in the brain of the animals tested.
The methanolic extract of *F. platyphylla* stem bark presented analgesic potential and neuroleptic effect in mice (Chindo et al., 2016; Sutter et al., 2019). The methanolic extract of *F. dalhousiae* stem bark was shown to be an antihyperlipidemic agent in hyperlipidemic rats induced a high fat diet (Surya et al., 2017). The methanol extract of *F. elastica* root wood demonstrated antitypanosomal property, antimalarial activity and low in vitro cytotoxicity (J. M. E. Teinkela et al., 2018).

The ethanol extract of the stem bark of *F. carica* and its fraction rich in oligosaccharides presented neuroactivity and can significantly control the convulsive disorders induced by strychnine in male mice (Raafat & Wurglics, 2019). Antinociceptive and sedative activity in rats were observed in ethanol extract of the bark of *F. hispida* showed (Howlader et al., 2017).

Immunomodulating property *in vitro* were identified in the methanol extract of the stem bark of *F. glomerata*, which was related to the presence of β-sitosterol and tannins identified in the extract (Heroor et al., 2020). Gastroprotective activity by inhibiting ulcers in rats were showed in the methanol extracts of the stem bark and leaves of *F. glumosa*. Furthermore, the leaves extract showed the most relevant results. This activity was related to isoquercitrin, hyperosid and p-hydroxybenzoic acid isolated in the species (G. V. Awolola et al., 2019).

Hepatoprotective effect were showed by methanol extract of *F. carica* leaves (Dureshahwar et al., 2019), and hydroethanolic extract of the leaves of *F. spragueana* in rats (El-hawy et al., 2019). The hydroethanolic extract of the aerial part of *F. religious* and methanol extract of *F. carica* leaves showed nephroprotective activity in diabetic rats (Dureshahwar et al., 2019; Singh et al., 2020).

### 5. Patents with *Ficus* spp.

The selected patents addressed the use of chemical compounds and properties in different areas of application, using parts of plants of the *Ficus* genus. Among the patents using *Ficus* spp. its use in the preparation of food products is contained, as a meat tenderizer, but in addition to its application for processing, it can also be a source for future patents in the food industry using the potential of bioactive compounds of species of this genus, such as functional teas. Other patents deal with topical and hair care and protection, which points to the potential of this genus in the preparation of cosmetics. Table 7 presents these and other patents using plant parts of the *Ficus* genus.

**Table 7. Patents of *Ficus* spp.**

| Country     | Summary                                                                 | Reference                       |
|-------------|-------------------------------------------------------------------------|---------------------------------|
| China       | Refers to a sunscreen prepared with rich pectin components in *Ficus pumila* seed extract. | (Aihua, 2017)                   |
| United States | Refers to compositions that include combinations of plant extracts (*Ficus tikoua* and others). Used as topical skin compositions, edible compositions, hair care compositions, etc. | (Florence et al., 2017)         |
| China       | Provides a method of processing meat dumplings tenderized with ficin extracted of *Ficus* sp. Latex, belongs to the field of meat products processing technology. | (Jiaxu & Changjun, 2017b)       |
| China       | Provides a processing method of black bean-flavored dried beef. The ficin used in the tenderization solution is extracted from the latex of the *Ficus* sp. And the immature fruit milk. | (Jiaxu & Changjun, 2017a)       |
| China       | Discloses a type of skin care composition of korean ginseng stem cells with extracts from parts of *Ficus pumila* and others. | (Haijia et al., 2018)           |
| Country | Statement | Reference |
|---------|-----------|-----------|
| Korea | Refers to a composition to prevent, improve or treat cognitive impairment, contains *Ficus erecta* extract as active ingredient. | (Jeong et al., 2018) |
| China | Discloses a preparation method and application of a novel isoflavone compound extracted from *Ficus auriculata*. The compound has good effect of inhibiting the proliferation of three tumor cells. | (Changri et al., 2018) |
| China | Belongs to the technical fields of tea, more particularly to a kind of functional tea with parts of the *Ficus tikouae* leaf for the treatment of enteritis. | (Yuanxing, 2018) |
| China | Belong to the field of Chinese medicine, discloses a type of instant particles and its method of preparation for the treatment of renal edema with latex pulp, fruits and roots of *Ficus sarmenosa* and *Ficus pumila*. | (Jie et al., 2018) |
| China | Provides a probiotic and edible medicinal tea drink of traditional Chinese medicine for the prevention of cancer and its method of preparation, the drink comprises parts of *F. carica* and other plants. | (Wei, 2020) |
| China | It relates to a preparation method of freeze-dried powder of a composition with acne removing effect, with traditional Chinese medicine extract, *Ficus pumila* cryptocephala extract and others plants. | (Renpu, 2020) |

Source: Authors.

6. Conclusions and Future Scope

The genus review enabled the macro vision of the state of the art, as well as the use of the *Ficus* genus in different areas such as: cosmetics, sunscreens, food technology, teas, softeners, probiotics, stem cell biotechnology, deficiency pharmacology cognitive impairment, tumor cell growth inhibitors, acne removers and in traditional Chinese medicine. This paper may contribute to the direction of future scientific and technological research using the different parts of the *Ficus* genus.

The results obtained in this review are related to the chemical knowledge of the *Ficus* genus, highlighting phenolic compounds and flavonoids as the main bioactive compounds responsible for most of the activities, such as antioxidants and antimicrobials. The important anticancer, anti-inflammatory and healing properties have been widely described. However, studies are still needed to experimentally relate these reported activities to specific classes of compounds. For this, it is important to fractionate extracts in order to guide the purification and identification of new compounds for the development of new drugs.

Tests were performed mostly *in vitro* and in a smaller number *in vivo* using rats and mice. However, studies in animal models are still quite limited and need to be further explored to enable future clinical trials. It is necessary to understand the mechanisms of action of these natural products for related activities and submit them to toxicity tests in order to obtain information about their possible side effects, generating a more robust report to verify the feasibility of clinical trials.

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