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Ficus spp.: Phytochemical composition and medicinal potential

Ficus spp.: Composição fitoquímica e potencial medicinal

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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.

Resumo
Esta revisão tem como objetivo reunir informações acerca dos compostos químicos, atividades biológicas e patentes referentes às partes das espécies de *Ficus*, visando a contribuição para delineamento de estudos futuros. A pesquisa sistemática foi realizada em bases de dados nos últimos cinco anos. Um total de 103 artigos e 11 patentes foram encontrados. Diversas espécies foram investigadas considerando sua composição química e propriedades biológicas. Ácidos orgânicos, compostos fenólicos, flavonóides e terpenos foram identificados. *Ficus carica* foi a espécie mais investigada do gênero. Antioxidante, antimicrobiana, anti-hiperglicêmica, antidiabetes, anticancerígena e citotóxica foram as principais atividades relatadas, revelando seu potencial suplementar natural nas doenças contemporâneas. Alguns de seus constituintes químicos apresentaram propriedades farmacológicas. Esses resultados sugerem o potencial de extratos e óleo essencial do gênero *Ficus* na indústria farmacológica. Mais estudos ainda precisam identificar os compostos relacionados a cada propriedade. Patentes relativas a partes de *Ficus* spp. envolvem diferentes áreas de aplicação, principalmente cosméticos, alimentos e farmacologia. Esta revisão pode inspirar

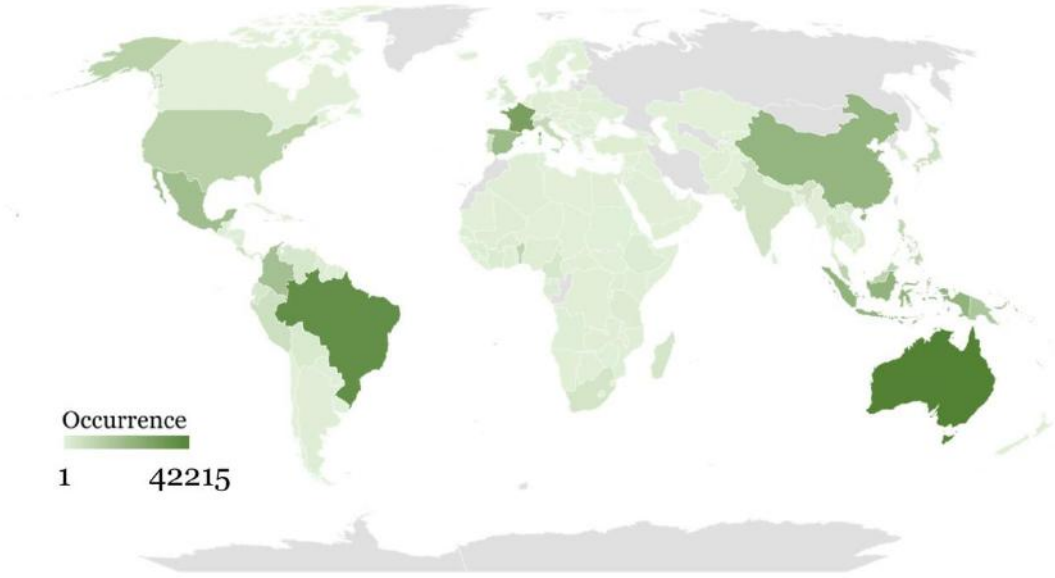
investigações considerando o desenvolvimento de novos fármacos, bem como novas pesquisas científicas e tecnológicas utilizando diferentes partes do gênero *Ficus*.
Palavras-chave: *Ficus carica*; Antioxidante; Composição química; Compostos fenólicos; Patentes.

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 identificaron ácidos orgánicos, compuestos fenólicos, flavonoides y terpenos. *Ficus carica* fue la especie más investigada del género. Las principales actividades reportadas fueron antioxidantes, antimicrobianas, antihiperglucemiantes, 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, andiabetes and antiobesogenic (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 Schoolar 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 Booleans. 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 (Abrahim 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* látex (Abdel-Aty et al., 2019).

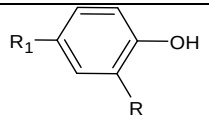
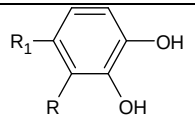
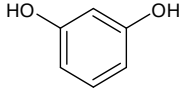
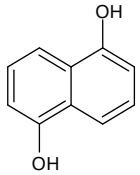
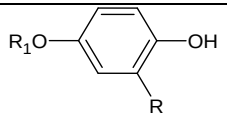
Table 1. Phytochemical content of *Ficus* spp.

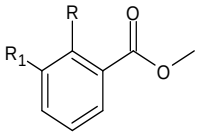
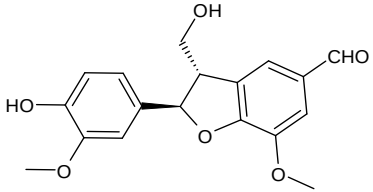
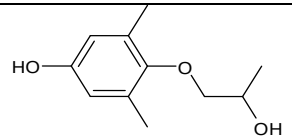
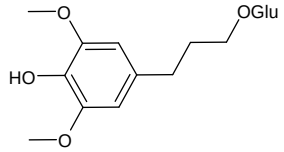
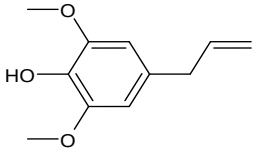
Specie	Part	Extract	Al	AA	An	At	Ca	Cu	Fl	Gl	PC	Qu	Sa	St	Su	Ta	Te	Reference
F. asperifolia	Leaf	EtOH	+				+		+	+			+	+		+	+	(Pwaniyibo et al., 2020)
F. auriculata	Leaf	EtOH:H_2O							+		+							(El-hawary et al., 2019)
F. beecheyana	Root	H_2O, EtOH									+							(Yen et al., 2018)
F. benghalensis	Bark	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, H_2O							+		+							(Mopuri et al., 2018)
F. carica	Leaf	Acetone							+		+							(Mustafa et al., 2021)
F. carica	Latex	EtOH:H_2O									+							(Shahinuzzaman 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:H_2O									+							(Petruccelli

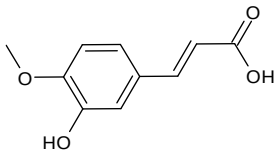
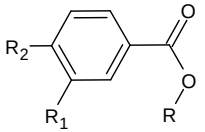
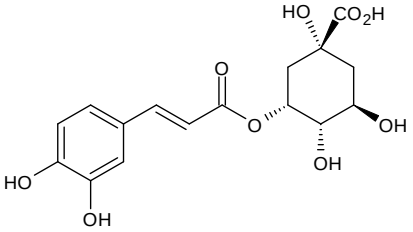
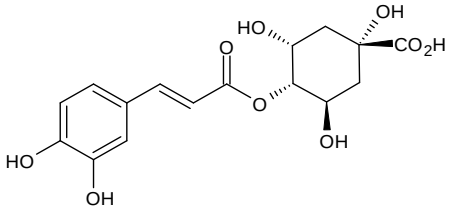
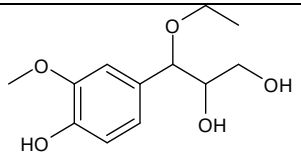
																		et al., 2018)
F. deltoidea	Leaf	Crude					+		+									(Abrahim et al., 2018)
F. deltoidea	Leaf	AcOEt, MeOH, Hex, H_2O					+		+									(Abolmaesoomi et al., 2019)
F. exasperata	Leaf	MeOH	–			–	+		+		+	+	+	+	+			(Mikail et al., 2019)
F. mucoso	Root bark	MeOH, fractions (CH_2Cl_2, AcOEt, MeOH)	+				+		+		+			+				(Oyebode et al., 2019)
F. mysorensis	Leaf	EtOH:H_2O					+		+									(El-hawary et al., 2019)
F. pyriformis	Leaf	EtOH:H_2O					+		+									
F. racemosa	Leaf	EtOH	+				+		+		+	–		+				(Bagyalakshmi et al., 2019)
		AcOEt	+				+		+		–	–		+				
		Tolueno	+				+		+		–	+		+				
F. racemosa	Leaf	MeOH					+		+					+				(Sumi et al., 2016)
F. religiosa	Aerial parts	EtOH:H_2O	+	+			+	+	+		–	+	+	+	+			(Singh et al., 2020)
F. sprageana	Leaf	EtOH:H_2O					+		+									(El-hawary et al., 2019)
F. sur	Bark, Leaf and Root	EtOH	+		+		+	+		–	+	+		+	+			(Saloufou et al., 2018)
F. trigonata	Leaf	EtOH:H_2O					+		+									(El-hawary et al., 2019)

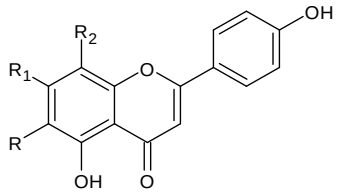
(+) presence of compound class; (-) absence of compound class. Al = alkaloids; AA = amino acids; An = anthocyanins; At = Anthraquinones; Ca = Carotenoids; Cu = cumarin; Fl = flavonoids; Gl = glycosides; PC = Phenolic Compounds; Qu = quinones; Sa = saponins; St = steroids; Su = sugars; Ta = tanins; Te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

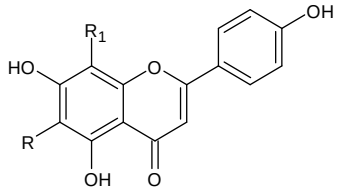
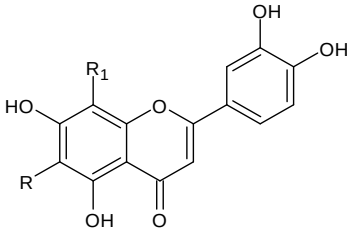
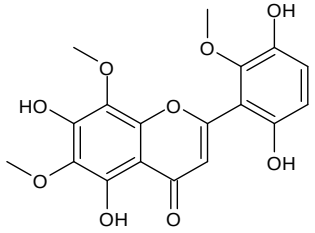
Table 2. Main phenolics compounds of different parts of *Ficus* spp.

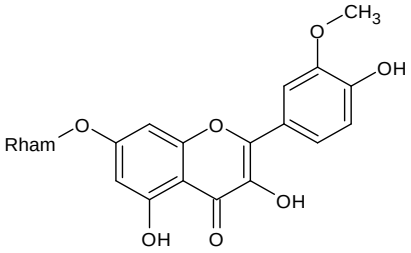
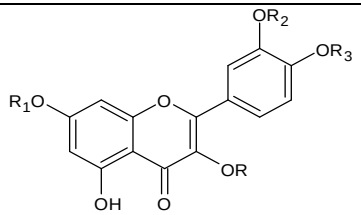
Compound	Specie	Part	Sample	Analytical method	Reference
	*F. carica*	Leaf	H_2O, MeOH	GC-MS	(Ergül et al., 2019)
	F. palmata	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
Phenol, R, R_1 = H					
Phenol, 2,4-*bis*(1,1-dimethylethyl)-, R, R_1 = 1,1-dimethylethyl	*F. carica*	Leaf	MeOH	GC-MS	(Ergül et al., 2019)
	*F. sycomorus*	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
	F. religiosa	Fresh leaf	H_2O	GC-MS	(Suriyakalaa et al., 2021)
Catechol, R, R_1 = H					
3-methoxycatechol, R = OCH_3, R_1 = H	*F. glomerata*	Leaves	$CHCl_3$	LC-MS	(Shaikh et al., 2020)
4-methoxycatechol, R, R_1 = OCH_3	*F. bizanae*	Stem bark	Hex, CH_2Cl_2	CC, IR, MS, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2018)
Pyrogallol, R = OH, R_1 = H	*F. sycomorus*	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
	*F. palmata*	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
Resorcinol					
	*F. sycomorus*	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
1,5-naphthalenediol					
	*F. racemosa*	Leaf	MeOH	HPLC	(Sumi et al., 2016)
Arbutin, R = H, R_1 = Glu					
Markhamioside F, R = OCH_3, R_1 = Glu-Apifuranosyl	*F. hirta*	Roots	EtOH	HPLC, UV, IR, HRESIMS, ^1H and ^{13}C NMR	(Ye et al., 2020)

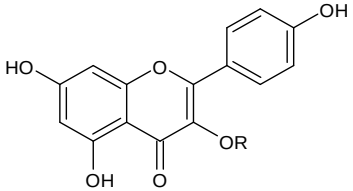
	*F. carica*	Latex	MeOH	GC-MS	(Abdel-Aty et al., 2019)
Benzoic acid, 2-hydroxy-, methyl ester, R = OH, R_1 = H					
Benzoic acid, 3-hydroxy-, methyl ester, R = H, R_1 = OH	*F. carica*	Leaf	H_2O	GC-MS	(Ergül et al., 2019)
	*F. hirta*	Roots	EtOH	CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, ^{1}H and ^{13}C NMR	(Cheng, Yi, Chen, et al., 2017)
ficusal					
	*F. glomerata*	Leaves	$CHCl_3$	LC-MS	(Shaikh et al., 2020)
4-(2-hydroxypropoxy)-3, 5-dimethyl-phenol					
	*F. hirta*	Roots	EtOH	HPLC, UV, IR, HRESIMS, ^{1}H and ^{13}C NMR	(Ye et al., 2020)
4-(3′-hydroxypropyl)-2,6-dimethoxyphnol-3′-*O*-β-D-glcoside					
	*F. sycomorus*	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
4-allyl-2,6-dimethoxyphenol					

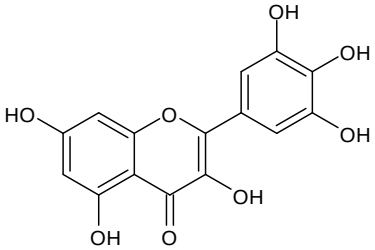
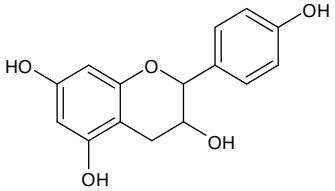
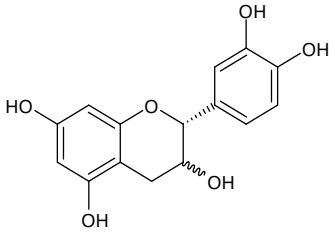
 3'-hydroxy-4'-metoxy-*trans*- cinnamaldehyde	*F. hirta*	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)
 4-hydroxy-3-methoxbenzoic acid, methyl ester, R = CH_3, R_1 = OCH_3, R_2 = OH	*F. carica*	Latex	MeOH	GC-MS	(Abdel-Aty et al., 2019)
4-hydroxybenzoic acid 4-*O*-glucoside, R = H, R_1 = H, R_2 = OGlu	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 5-*O*-caffeoylquinic acid	*F. exasperata*	Leaf Stem bark	H_2O 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_2O lyophilized	HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV	(Mouho et al., 2018)
	*F. hirta*	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)

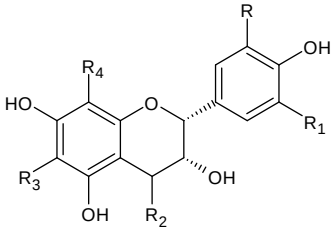
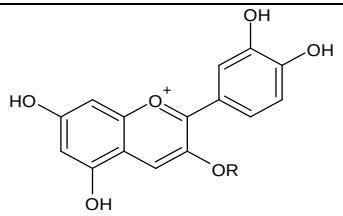
7-*O*-ethylguaiacylglycerol					
	*F. carica*	Leaf	Acetone	HPLC	(Mustafa et al., 2021)
	F. microcarpa	Leaf Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. sycomorus	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
Apigenin, R, R_2 = H, R_1 = OH					
Apigenin 6-*C*-glucoside (isovitexin), R = Glu, R_2 = H, R_1 = OH	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
Apigenin 6-*C*-glucoside 8-*C*-arabinoside, R = Glu, R_1 = OH, R_2 = Arab					
Apigenin-8-*C*-glucoside (vitexin), R = H, R_1 = OH, R_2 = Glu	*F. deltoidea*	Leaf	H_2O	UHPLC, UV-Vis	(Abrahim et al., 2018)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
	F. exasperata	Leaf, Stem bark	H_2O lyophilized	HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV	(Mouho et al., 2018)
Apigenin-6-*C*-hexoside-8-*C*-pentoside, R = Hex, R_1 = OH, R_2 = Pent					
Apigenin-6-*C*-pentoside-8-*C*-hexoside, R = Pent, R_1 = OH, R_2 = Hex					
Apigenin-7-*O*-ketorhamnoside-8-*C*-hexoside, R = H, R_1 = OH, R_2 = Glu					
Apigenin-6-*C*-pentoside-8-*C*-(3,4-ketorhamnoside)hexoside R = Pent, R_1 = OH, R_2 = Glu		Leaf			
Apigenin-6-*C*-rhamnoside-8-*C*-hexoside, R = Rham, R_1 = OH, R_2 = Hex					
Apigenin-8-*C*-(3,4-ketorhamnoside)hexoside, R = H, R_1 = OH, R_2 = ketorham-hex		Stem bark			
Apigenin 7-O-neohesperidoside (Rhoifolin), R = H, R_1 = neohesp, R_2 = H	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
8-*C*-(2″-*O*-β-D-apiofuranosyl)-β-D-glucopyranosyl apigenin (Ficuflavoside), R = H, R_1 = OH, R_2 = Apiofur-Glu	*F. benghalensis*	Leaf	MeOH	LC-HR- ESI-MS	(Hassan et al., 2020)
4',5,6,7-tetrahydroxyflavone 6-*O*-[α-L-rhamnopyranosyl-	*F. benghalensis*	Leaf	MeOH	LC-HR- ESI-MS	(Hassan et al., 2020)

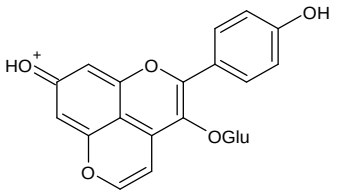
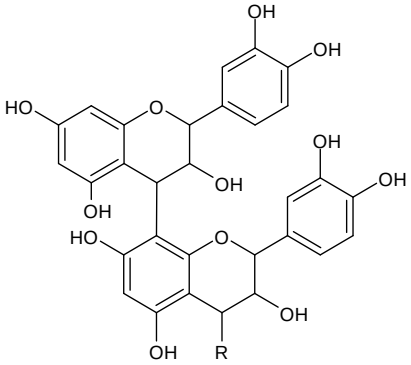
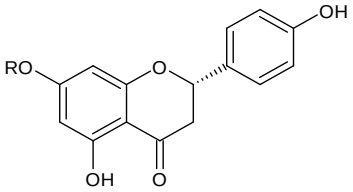
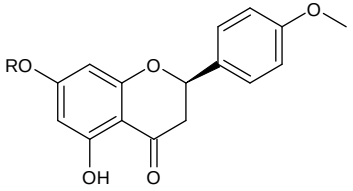
(1→2)- β-D-galactopyranoside], R = OH, R_1 = Rham-Gal, R_2 = H					
	*F. carica*	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
Schaftoside, R = Glu, R_1 = Arab					
Isoschaftoside, R = Arab, R_1 = Glu	*F. carica*	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
	*F. carica*	Leaf	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, R, R_1 = H					
Luteolin-6,8-di-*C*-hexoside, R, R_1 = hex	*F. exasperata*	Leaf	H_2O lyophilized	HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV	(Mouho et al., 2018)
Luteolin-8-*C*-(3/4-ketorhamnoside)hexoside, R = H, R_1 = ketorham-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					

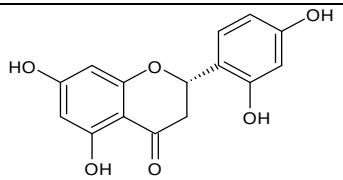
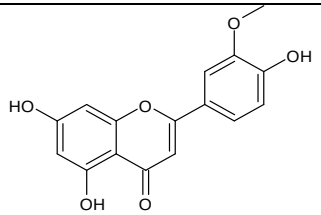
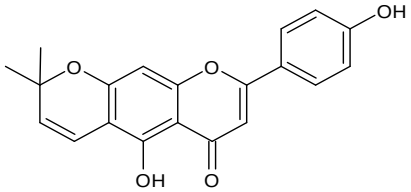
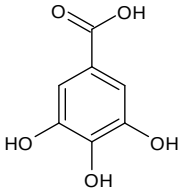
 Isorhamnetin 7-*O*-rhamnoside	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 Quercetin, R, R_1 = H	*F. capensis*	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. carica	Leaf	Acetone	HPLC	(Mustafa et al., 2021)
	F. microcarpa	Leaf	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. microcarpa	Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
Quercetin-3-*O*-β-D-glucopyranoside (isoquercetrin) R = Glu, R_1, R_2, R_3 = H	*F. exasperata*	Leaf and Stem bark	H_2O lyophilized	HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV	(Mouho et al., 2018)
	F. bizanae	Leaf	Hex, CH_2Cl_2	CC, IR, MS, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2018)
	F. glumosa	Leaf	MeOH	GC-MS, CC, VCC, TLC, FT-IR, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2019)
	F. carica	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
Quercitrin, R = Rham, R_1, R_2, R_3 = H	*F. capensis*	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
Quercetin-3-*O*-β-D-galactopyranoside, R = Gal, R_1, R_2, R_3 = H	*F. glumosa*	Leaf	MeOH	GC-MS, CC, VCC, TLC, FT-IR, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2019)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
Quercetin 3-rutinoside (rutin), R = Rut, R_1, R_2, R_3 = H	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
	F. auriculata	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. beecheyana	Roots	EtOH	HPLC	(Yen et al., 2018)
	F. capensis	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. carica	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)

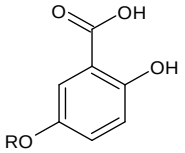
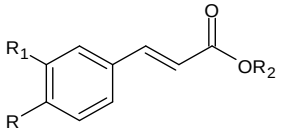
	F. carica	Leaf	Acetone	HPLC	(Mustafa et al., 2021)
	F. carica	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
	F. microcarpa	Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. mysorensis	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. pyriformis	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	*F. sprague*ana	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
	F. trigonata	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
quercetin 3-*O*-glucosyl-rhamnosyl-glucoside, R = Glu-Rham-Glu, R_1, R_2, R_3 = H	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
quercetin 3-*O*-malonyl-glucoside, R = Mal-Glu, R_1, R_2, R_3 = H	*F. carica*	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
Quercetin 7,3',4'-trimethoxy, R = H, R_1, R_2, R_3 = CH_3	*F. sycomorus*	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
Quercetin-3-(6-rhamnoside)glucoside, R = Rham-Glu, R_1, R_2, R_3 = H	*F. exasperata*	Leaf	H_2O lyophilized	HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV	(Mouho et al., 2018)
Quercetin-3,7-di-hexoside, R, R_1 = hex, R_2, R_3 = H		Leaf			
Quercetin-3-hexoside-7-ketorhamnoside, R = hex, R_1 = ketorham, R_2, R_3 = H		Leaf and Stem bark			
 Kaempferol, R = H	*F. capensis*	Leaf	H_2O	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)
kaempferol 3-*O*-glucoside, R = Glu	*F. carica*	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
Kaempferol 3-*O*-rhamnoside, R = Rham kaempferol 3-*O*-rutinoside, R = Rut Kaempferol 3-*O*-xylosyl-glucoside, R = Xyl-Glu Kaempferol 3-*O*-xylosyl-rutinoside, R = Xyl-Rut	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
Kaempferol-3-(2-rhamnoside)hexoside, R = Rham-Hex	*F. exasperata*	Leaf	H_2O lyophilized	HPLC–DAD–ESI/MS,	(Mouho et al., 2018)

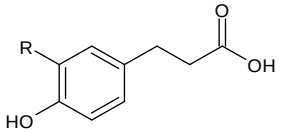
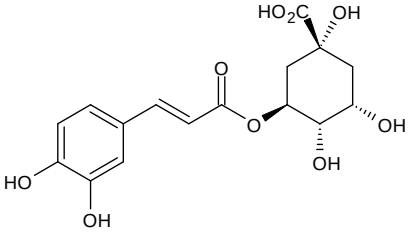
				UPLC–ESI–QTOF–MS, HPLC–UV	
 Myricetin	*F. sycomorus*	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
 4',5,7-trihydroxyflavan-3-ol	*F. sur*	Bark	MeOH solution from EtOH	HPLC-ESI$^+$-QTOF-HRMS	(Saloufou et al., 2018)
	F. sur	Leaf	MeOH solution from EtOH	HPLC-ESI$^+$-QTOF-HRMS	(Saloufou et al., 2018)
 Catechin	*F. capensis*	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. carica	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
	F. deltoidea	Leaf	H_2O	UHPLC, UV-Vis	(Abrahim 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	CH_2Cl_2:EtOH	LC/MS	(Suliman et al., 2021)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
	F. virens	–	H_2O	HPLC-DAD-ESI-MS/MS, MALDI-TOF MS	(Chen et al., 2017)
	F. vogeliana	Bark	H_2O	LC-MS/MS	(Misso et al., 2020)
(+)-catechin hydrate, xH_2O	*F. racemosa*	Leaf	MeOH	HPLC	(Sumi et al., 2016)
Catechin or epicatechin	*F. sur*	Bark and Leaf	MeOH solution from EtOH	HPLC-ESI$^+$-QTOF-HRMS	(Saloufou et al., 2018)
epicatechin	*F. beecheyana*	Roots	EtOH	HPLC	(Yen et al., 2018)
	F. capensis	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)

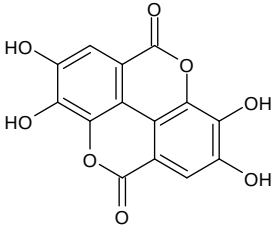
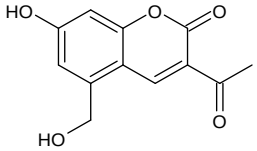
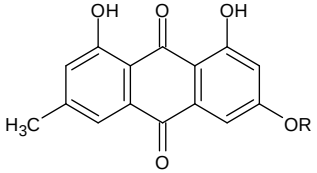
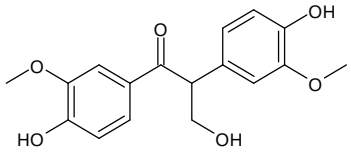
	F. microcarpa	Leaf Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. racemosa	Leaf	MeOH	HPLC	(Sumi et al., 2016)
	F. sycomorus	Stem bark	CH_2Cl_2:EtOH	LC/MS	(Suliman et al., 2021)
	F. virens	–	H_2O	HPLC-DAD-ESI-MS/MS, MALDI-TOF MS	(Chen et al., 2017)
	F. vogeliana	Bark	H_2O	LC-MS/MS	(Misso et al., 2020)
 Epiafzelechin, R = H, R_1 = H, R_2 = H, R_3 = H, R_4 = H epiafzelechin adducts, R = H, R_1 = H, R_2 = 4→8, R_3 = 6→4, R_4 = 8→4 epicatechin adducts, R = OH, R_1 = H, R_2 = 4→8, R_3 = 6→4, R_4 = 8→4 epigallocatechin adducts, R = OH, R_1 = OH, R_2 = 4→8, R_3 = 6→4, R_4 = 8→4	*F. virens*	–	H_2O	HPLC-DAD-ESI-MS/MS, MALDI-TOF MS	(Chen et al., 2017)
 Cyanidin, R = H	*F. dubia*	Latex Root	H_2O H_2O, EtOH	HPLC	(Suttisansanee et al., 2021)
Cyanidin 3-*O*-(6-succinyl-glucoside), R = 6-Suc-Glu	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)

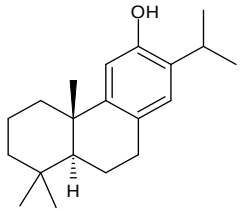
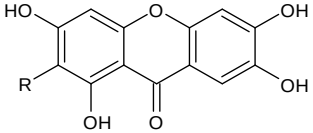
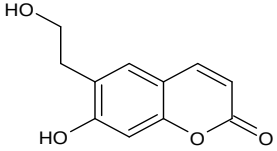
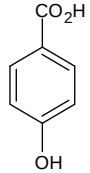
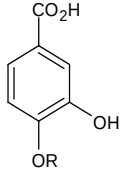
	*F. carica*	Fruit latex	MeOH	LC–MS/MS	(Paşayeva et al., 2020)
5-pyranopelargonidin-3-*O*-glucoside					
	*F. vogeliana*	Bark	H_2O	LC-MS/MS	(Misso et al., 2020)
	F. sycomorus	Stem bark	CH_2Cl_2:EtOH	LC/MS	(Suliman et al., 2021)
Procyanidin B, R = H					
Procyanidin trimer, R = cyanidin unit	*F. sycomorus*	Stem bark	CH_2Cl_2:EtOH	LC/MS	(Suliman et al., 2021)
	*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_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)

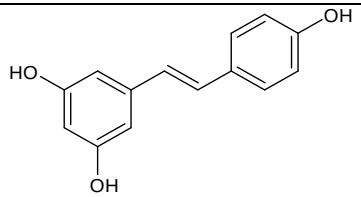
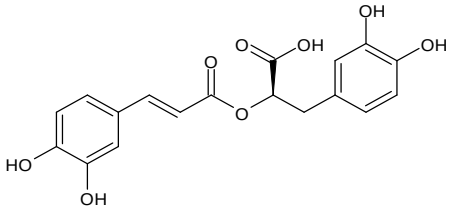
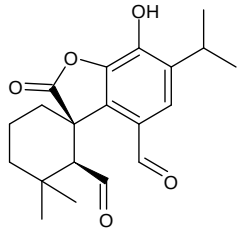
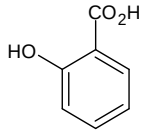
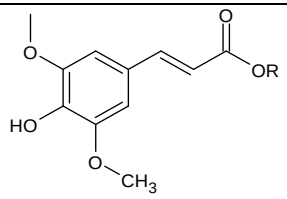
Didymin, R = Rutinoside					
 Steppogenin	*F. benghalensis*	Leaf	MeOH	LC-HR- ESI-MS	(Hassan et al., 2020)
 Chrysoeriol	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 Carpachromene	*F. benghalensis*	Leaf	MeOH	VLC, MS, ^{1}H and ^{13}C NMR	(Hassan et al., 2020)
 Gallic acid	*F. beecheyana*	Roots	EtOH, H_2O	HPLC	(Yen et al., 2018)
	F. capensis	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. carica	Leaf	Acetone	HPLC	(Mustafa et al., 2021)
	F. deltoidea	Leaf	H_2O	UHPLC, UV-Vis	(Abrahim et al., 2018)
	F. microcarpa	Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. palmata	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
	F. racemosa	Leaf	MeOH	HPLC	(Sumi et al., 2016)
	F. spragueana	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
	F. trigonata	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)

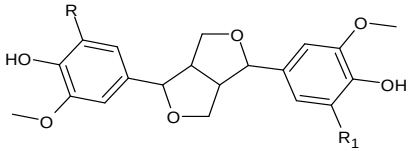
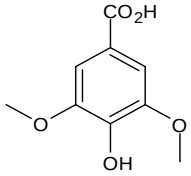
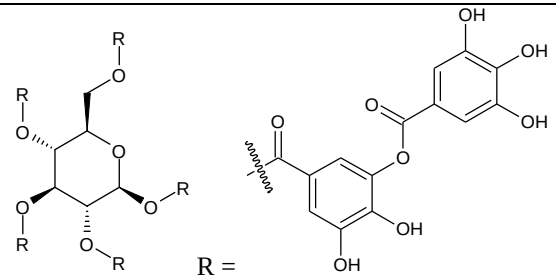
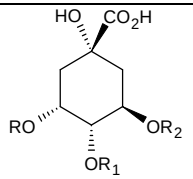
 Gentisic acid, R = H	*F. vogeliana*	Bark	H_2O	LC-MS/MS	(Misso et al., 2020)
Gentisic acid 5-*O*-β-D-xyloside, R = Xyl	*F. hirta*	Roots	EtOH	HPLC, UV, IR, HRESIMS, ^1H and ^{13}C NMR	(Ye et al., 2020)
 Caffeic acid, R, R_1 = OH, R_2 = H	*F. beecheyana*	Roots	EtOH H_2O	HPLC	(Yen et al., 2018)
	F. capensis	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. carica	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
	F. dubia	Latex	H_2O	HPLC	(Suttisansanee et al., 2021)
		Root	H_2O, EtOH		
	F. microcarpa	Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. racemosa	Leaf	MeOH	HPLC	(Sumi et al., 2016)
	*F. sprague*ana	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. sycomorus	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
		Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
Caffeoylmalic acid, R, R_1 = OH, R_2 = malic acid	*F. carica*	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
Caffeoyl malic acid dimer, R, R_1 = OH, R_2 = malic acid	*F. exasperata*	Leaf Stem bark	H_2O 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	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
Ferulic acid, R – OCH_3, R_1 = OH, R_2 = H	*F. carica*	Leaf	H_2O	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)
Feruloyl malic acid dimer, R = OH, R_1 = OCH_3, R_2 = malic acid Feruloyl sinapic acid, R = OH, R_1 = OCH_3, R_2 = sinapic acid	*F. exasperata*	Leaf	H_2O lyophilized	HPLC–DAD–ESI/MS, UPLC–ESI–QTOF–MS, HPLC–UV	(Mouho et al., 2018)
3-feruloylquinic acid, R = OH, R_1 = OCH_3, R_2 = quinic acid	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)

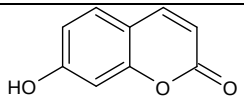
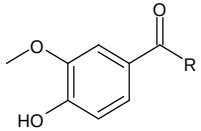
p-coumaric acid, R = OH, R_1 = H, R_2 = H	*F. microcarpa*	Leaf, Root	MeOH	HPLC-DAD and FT-IR	(Rjeibi et al., 2017)
	F. beecheyana	Roots	EtOH, H_2O	HPLC	(Yen et al., 2018)
	F. deltoidea	Leaf	H_2O	UHPLC, UV-Vis	(Abrahim et al., 2018)
	F. sycomorus	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
	F. sycomorus	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 = malic acid	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
	F. carica	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
p-coumaroylquinic acid, R = OH, R_1 = H, R_2 = quinic acid	*F. carica*	Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
 Dihydrocaffeic acid, R = OH	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
Dihydroferulic acid, R = OCH_3	*F. bizanae*	Stem bark	Hex, CH_2Cl_2	CC, IR, MS, ^{1}H and ^{13}C NMR	(G. V. Awolola et al., 2018)
 Chlorogenic acid	*F. auriculata*	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. beecheyana	Roots	EtOH	HPLC	(Yen et al., 2018)
			H_2O		
	F. capensis	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. carica	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
		Leaf	H_2O:MeOH	HPLC-DAD-TOF-MS	(Petruccelli et al., 2018)
	F. exasperata	Leaf	H_2O lyophilized	HPLC–DAD–ESI/MS,	(Mouho et al., 2018)
		Stem bark		UPLC–ESI–QTOF–MS, HPLC–UV	
	F. mysorensis	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. palmata	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
	F. pyriformis	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. spragueana	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. sycomorus	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
		Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
		Leaf	CH_2Cl_2:EtOH	LC/MS	(Suliman et al., 2021)

		Stem bark			
	F. trigonata	Leaf	H_2O:EtOH	HPLC	(El-hawary et al., 2019)
	F. vasta	Leaf	MeOH	HPLC-PDA/ESI-MS	(Taviano et al., 2018)
 Ellagic acid	*F. capensis*	Leaf	H_2O	HPLC– DAD	(Akomolafe et al., 2016)
	F. palmata	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
 Armillarisin A or isomer	*F. sur*	Leaf	MeOH solution from EtOH	HPLC-ESI$^+$-QTOF-HRMS	(Saloufou et al., 2018)
 Emodin, R = H Emodin-6-*O*-β-D-glucopyranoside, R = Glu	*F. natalensis*	Stem bark	CH_2Cl_2 and EtOAc soluble fractions from MeOH	CC, TLC, ^{1}H and ^{13}C NMR	(Mbougnia et al., 2021)
 Evofolin-B	*F. hirta*	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)

 Ferruginol	*F. carica*	Leaf	MeOH	GC-MS	(Ergül et al., 2019)
 Mangiferin, R = Glu	*F. carica*	Fruit latex	Hex:AcOEt fraction	LC–MS/MS	(Paşayeva et al., 2020)
 Phellodenol A	*F. sycomorus*	Leaf	CH_2Cl_2:EtOH	LC/MS	(Suliman et al., 2021)
 *p*-hydroxybenzoic acid	*F. beecheyana*	Roots	EtOH, H_2O	HPLC	(Yen et al., 2018)
	F. glumosa	Leaf	MeOH	GC-MS, CC, VCC, TLC, FT-IR, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2019)
	F. glumosa	Stem bark	AcOEt fraction	GC-MS, CC, VCC, TLC, FT-IR, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2019)
	F. hirta	Roots	EtOH	CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, ^1H 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)
 Protocatechuic acid, R = H	*F. beecheyana*	Roots	H_2O	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, ^1H and ^{13}C NMR	(G. V. Awolola et al., 2019)
	F. vogeliana	Bark	H_2O	LC-MS/MS	(Misso et al., 2020)

Protocatechuic acid 4-*O*-glucoside, R = Glu	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 Resveratrol	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 Rosmarinic acid	*F. carica* *F. sycomorus*	Fruit latex Leaf	MeOH EtOH	LC–MS/MS GC-MS, HPLC	(Paşayeva et al., 2020) (El-Beltagi et al., 2019)
 Rosmadial	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 Salicylic acid	*F. microcarpa* *F. sycomorus*	Leaf, Root Leaf	MeOH EtOH	HPLC-DAD and FT-IR GC-MS, HPLC	(Rjeibi et al., 2017) (El-Beltagi et al., 2019)
	*F. carica*	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)

Sinapic acid, R = H	*F. sycomorus*	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
Sinapoyl glucose, R = Glu	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
3-sinapoylquinic acid, R = quinic acid	*F. carica*	Leaf	H_2O	TOF-LC-MS-MS	(Alcántara et al., 2020)
 Syringaresinol, R, $R_1 = OCH_3$	*F. hirta*	Roots	EtOH	CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, ^1H and ^{13}C NMR	(Cheng, Yi, Chen, et al., 2017)
(-)-pinoresinol, R, R_1 = H	*F. hirta*	Roots	EtOH	HPLC, ^1H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)
 Syringic acid	*F. hirta*	Roots	EtOH	CC, OBS, MPLC, HPLC, IR, HR-ESI-MS, ^1H and ^{13}C NMR	(Cheng, Yi, Chen, et al., 2017)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
 Tannic acid	*F. palmata*	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
 Trigalloylquinic acid, R, R_1, R_2 = Galloyl	*F. carica*	Fruit latex	MeOH	LC–MS/MS	(Paşayeva et al., 2020)

 Umbelliferon	*F. hirta*	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)
 Vanillic acid, R = OH	*F. carica*	Latex	MeOH	HPLC	(Abdel-Aty et al., 2019)
	F. glumosa	Stem bark	EtOAc fraction, MeOH	GC-MS, CC, VCC, TLC, FT-IR, ^{1}H and ^{13}C NMR	(G. V. Awolola et al., 2019)
	F. hirta	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)
	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. palmata	Leaf	H_2O:EtOH	HPLC and GC–MS	(Shaheen & Ahmad, 2021)
	F. racemosa	Leaf	MeOH	HPLC	(Sumi et al., 2016)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
Vanillin, R = H	*F. hirta*	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)
	F. racemosa	Leaf	MeOH	HPLC	(Sumi et al., 2016)
	F. sycomorus	Leaf	EtOH	GC-MS, HPLC	(El-Beltagi et al., 2019)
β-hydroxypropiovanillone, R = CH_2CH_2OH	*F. hirta*	Roots	EtOH	HPLC, ^{1}H and ^{13}C NMR	(Cheng, Yi, Wang, et al., 2017)

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 (Abrahim 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 (Abrahim 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-Valdeolívar 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-Valdeolívar 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-Valdeolívar et al., 2020), squalene (Cruz-Concepción et al., 2021; Knothe et al., 2019; Sánchez-Valdeolívar 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-Valdeolívar et al., 2020).

4. Chemical, Biological and Phamacological 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* (Suttisansanee 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	IC_{50}, $DPPH^{\cdot}$ (5.06 ± 0.35 µg/mL), $NO^{\cdot}$ (169.65 ± 1.53 µg/mL).	(Wong et al., 2020)
F. beecheyana	Roots	EtOH and H_2O	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	$DPPH^{\cdot}$ (48.85 ± 1.27%), $NO^{\cdot}$ (76.05 ± 4.42%), $O_2^{\cdot}$ (79.08 ± 4.62%).	(Moe et al., 2018)
	Bark	H_2O:EtOH	IC_{50}, $ABTS^{+\cdot}$ (45.73 ± 1.17 µg/mL), $DPPH^{\cdot}$ (73.99 ± 2.22 µg/mL), TAC (51.45 ± 1.23 µg/mL), $NO^{\cdot}$ (69.02 ± 2.57 µg/mL), H_2O_2 (50.67 ± 1.77 µg/mL), CUPRAC (55.51 ± 0.54 µg/mL), metal chelating (55.95 ± 0.92 µg/mL).	(Khanal & Patil, 2020)
	Leaf	MeOH and AcOEt fraction	H_2O_2 (IC_{50}178.2 ± 1.750 and 603.1 ± 6.573 µg/mL).	(Hassan et al., 2020)
	Stem bark	MeOH	$DPPH^{\cdot}$ (71.77 ± 0.514 to 82.6 ± 2.395% at 0.125 and 4 mg/mL).	(Raheel et al., 2017)
F. benjamina	Leaf	EtOH	$DPPH^{\cdot}$ (68.27 ±1.08 µg/mL).	(A. Ashraf et al., 2020)
F. capensis	Leaf	H_2O	IC_{50}, $NO^{\cdot}$ (0.12 ± 0.01 mg/mL), $OH^{\cdot}$ (0.53 ± 0.00 mg/mL), Fe^{2+} chelation (0.16 ± 0.00 mg/mL).	(Akomolafe et al., 2016)
F. carica	Fruit latex	MeOH and fractions (Hex, Hex-AcOEt and MeOH).	$ABTS^{+\cdot}$ (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	$DPPH^{\cdot}$ (13.60 ± 1.20 µg GAE/mL) and $ABTS^{+\cdot}$ (4.50 ± 0.72 µg GAE/mL).	(Abdel-Aty et al., 2019)
	Latex	MeOH, EtOH (100%, 75%), AcOEt and Hex	$DPPH^{\cdot}$ (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)
	Leaf	AcOEt fraction from MeOH	$DPPH^{\cdot}$ (IC_{50}, 5.508 µM).	(Dureshahwar et al., 2019)
	Leaf	EtOH and MeOH	IC_{50}, $DPPH^{\cdot}$ (101.76 ± 1.15 and 93.12 ± 1.17 and µg/mL).	(Javaid et al., 2021)
	Leaf	H_2O and H_2O:EtOH	TEAC (≈ 1.75 and 0.5 mmol Trolox/g).	(Alcántara et al., 2020)
	Leaf	H_2O and MeOH (1000 µg/mL)	$DPPH^{\cdot}$ (≈ 30 and 25%), $ABTS^{+\cdot}$ (≈ 50 and 50%), FRAP (≈ 0.4 and 0.6 mM $FeSO_4$ equivalent), iron chelating (≈ 70 and 40).	(Ergül et al., 2019)
	Leaf	H_2O:MeOH	$DPPH^{\cdot}$ (EC_{50}, 0.48 ± 0.07 to 6.68 ± 0.06 mg DW/mL)	(Petruccelli et al.,

			and ORAC· (6.33 ± 0.5 to 49.19 ± 0.6).	2018)
	Leaf	Hex, AcOEt, EtOH and H_2O	IC_{50}, DPPH· (1233 ± 40.764, 899.55 ± 109.737, 175.857 ± 8.932 and 322.110 ± 12.970 µg/mL).	(Mopuri et al., 2018)
	Leaf	MeOH (1000 µg/mL)	DPPH· (80%).	(Purnamasari et al., 2019)
	Stem bark	Hex, AcOEt, EtOH and H_2O	IC_{50}, 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	IC_{50}, DPPH· (107.05 ± 2.61 µg/mL), $ABTS^{+\cdot}$ (1.47 ± 1.21 µg/mL).	(Cruz-Concepción et al., 2021)
F. deltoidea	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).	(Abrahim et al., 2018)
	Leaf	H_2O	FIC (EC_{50}, 1289.00 ± 22.63 to 1572.83 ± 234.71 µg/mL).	(Abolmaesoomi et al., 2019)
	Leaf	Hex, AcOEt, MeOH and H_2O	EC_{50}, 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 H_2O	$ABTS^{+\cdot}$ (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 H_2O	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 Fe^{2+}/g).	(Abolmaesoomi et al., 2019)
	Leaf	Hex, AcOEt, MeOH and H_2O	Cellular Antioxidant Assay (CAA, EC_{50}, 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)
	Leaf	MeOH	DPPH· (IC_{50}, 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 H_2O	EC_{50}, O_2· (592.27 ± 57.72 and 204.53 ± 39.23 to 1001.43 ± 99.90 µg/mL).	(Abolmaesoomi et al., 2019)
	Leaf	MeOH, $CHCl_3$, AcOEt and BuOH.	DPPH· (≈ 80, 60, 70 and 40%, 200 µg/mL).	(K. Ashraf et al., 2020)
	Leaf	MeOH, $CHCl_3$, 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· (SC_{50}, 579.67 ± 15.03 µg/mL), $ABTS^{+\cdot}$ (SC_{50}, 87.09 ± 0.89 µg/mL), FRAP (461 ± 34.67 µmol TE/g extract) and ORAC (7,976 ± 70 µmol TE/g extract).	(Suttisansanee et al., 2021)
	Roots	EtOH, H_2O and H_2O hot	SC_{50}, DPPH· (250.31 ± 102.66, 611.30 ± 36.92 and 460,55 ± 18.08 µg/mL).	(Suttisansanee et al., 2021)
	Roots	EtOH, H_2O and H_2O hot	SC_{50}, $ABTS^{+\cdot}$ (43.39 ± 0.38, 56.51 ± 2.24 and 38.76 ± 3.26 µg/mL).	(Suttisansanee et al., 2021)
	Roots	EtOH, H_2O and H_2O hot	FRAP (830 ± 22.75, 515 ± 37.90 and 601 ± 21.10 µmol TE/g extract).	(Suttisansanee et al., 2021)
	Roots	EtOH, H_2O and H_2O hot	ORAC (2,671 ± 85, 1,678 ± 94 and 2,059 ± 170 µmol TE/g extract).	(Suttisansanee et al., 2021)
F. exasperata	Leaf and	H_2O	IC_{50}, DPPH· (222.50 ± 8.00 and 621.10 ± 38.98 µg/mL), NO· (510.00 ± 77.47 and 866.00 ± 32.36	(Mouho et al., 2018)

	stem bark		µg/mL) and $O_2^{\cdot}$ (50.00 ± 3.00 and 561.00 ± 51.78 µg/mL).	
F. glomerata	Leaf	$CHCl_3$	Reduced oxidative stress in diabetic rats.	(Shaikh et al., 2020)
F. hirta	Roots	EtOH and AcOEt fraction	IC_{50}, $DPPH^{\cdot}$ (79.91 ± 4.79 and 64.71 ± 0.82 µmol/L), PMS/NADH-NBT (>300 and 281.00 ± 4.63 µmol/L).	(Cheng, Yi, Wang, et al., 2017)
F. lyrata	Bark gum	H_2O (2.5 mg/mL)	$DPPH^{\cdot}$ (≈ 70%).	(Samrot et al., 2021)
F. maclellandii	Branch	EtOH	IC_{50}, $DPPH^{\cdot}$ (183 ± 4 µg).	(Raza et al., 2016)
	Leaf	EtOH fractions (Hex, $CHCl_3$ and BuOH)	IC_{50}, $DPPH^{\cdot}$ (15 ± 1, 152 ± 3, 159 ± 3 and 73 ± 2 µg).	(Raza et al., 2016)
F. natalensis	Bark	PeEt, $CHCl_3$, MeOH and H_2O.	$ABTS^{+\cdot}$ (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).	(Ajaib et al., 2016)
	Leaf	PeEt, $CHCl_3$, MeOH, H_2O.	$ABTS^{+\cdot}$ (4.81 ± 0.327, 1.2 ± 0.304, 6.44 ± 0.382 and 7.713 ± 0.7 mM TE), Metal Chelating (49.22 ± 0.737, 38.36 ± 0.572, 28.41 ± 0.645 and 74.673 ± 0.302).	(Ajaib et al., 2016)
F. racemosa	Leaf	EtOH, toluene and AcOEt	IC_{50}, $DPPH^{\cdot}$ (10.11 ± 1.02, 2.35 ± 0.41 and 9.71 ± 0.11 µg/mL).	(Bagyalakshmi et al., 2019)
	Leaf	H_2O and MeOH	IC_{50}, $DPPH^{\cdot}$ (23.22 and 5.18 µg/mL).	(Wajiha & Qureshi, 2021)
	Leaf	MeOH	DPPH (≈ 100 %, 512 µg/mL), $O_2^{\cdot}$ (≈ 87 %, 800 µg/mL), $OH^{\cdot}$ (≈ 82 %, 800 µg/mL) and Reducing Power (≈ 80 %, 800 µg/mL).	(Sumi et al., 2016)
F. religiosa	Leaf	AcOEt	$DPPH^{\cdot}$ and $ABTS^{+\cdot}$.	(Gawande & Morlock, 2021)
F. sur	Bark, leaf and roots	EtOH	$DPPH^{\cdot}$ (≈ 56, 30 and 50 µg QE/mg of dry extract) and FRAP (≈ 104, 52 and 48 µmol $FeSO_4$ Eq/mg of dry extract).	(Saloufou et al., 2018)
F. sycomorus	Latex	MeOH	$DPPH^{\cdot}$ (7.00 ± 0.30 µg GAE/mL) and $ABTS^{+\cdot}$ (6.40 ± 0.32 µg GAE/mL).	(Abdel-Aty et al., 2019)
	Leaf	EtOH, AcOEt	$DPPH^{\cdot}$ (IC_{50}, 18.443 and 33.348 µg/mL), reducing power (22.53 ± 0.37 and 16.19 ± 0.18 µg gallic acid /100g DW).	(El-Beltagi et al., 2019)
	Leaf	H_2O, acetone, $CHCl_3$, EtOH and MeOH	$DPPH^{\cdot}$ (1 ± 2.55, 33 ± 3.38, 42 ± 0.13, 18 ± 0.13 and 47 ± 2.17%).	(Ozdenefe et al., 2020)
	Leaf	Hex and CH_2Cl_2:EtOH	$DPPH^{\cdot}$ (6.79 ± 0.88 mg TE/g), $ABTS^{+\cdot}$ (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).	(Suliman et al., 2021)
	Stem bark	Hex and CH_2Cl_2:EtOH	$DPPH^{\cdot}$ (5.43 ± 1.56 and 32.87 ± 0.71 mg TE/g), $ABTS^{+\cdot}$ (11.26 ± 1.57 and 40.81 ± 1.15 mg TE/g), Phosphomolybdenum (0.75 ± 0.13 and 2.10 ± 0.04	(Suliman et al., 2021)

			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).	
F. variegata	Branch	EtOH	IC_{50}, DPPH˙ (195 ± 2 µg).	(Raza et al., 2016)
	Leaf	Fractions of $CHCl_3$ and BuOH from EtOH	IC_{50}, DPPH˙ (173 ± 2 and 191 ± 3 µg).	(Raza et al., 2016)
F. vasta	Leaf	H_2O:MeOH	DPPH˙ (IC_{50}, 0.0672 ± 0.0038 mg/ mL), reducing power (3.65 ± 0.48 ASE/mL) and chelating activity (IC_{50} = 0.801 ± 0.007 mg/mL).	(Taviano et al., 2018)
F. vogeliana	Bark	H_2O.	DPPH˙ (IC_{50}, 4.60 ± 0.15 µg/ mL) and phosphomolybdenum (VtCE, 87.37 ± 0.60; BHTE, 358.70 ± 2.87; QE, 53.78 ± 0.46 mg/g of dry plant extract)	(Misso et al., 2020)

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˙, O2˙ 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 ethanol and ethyl acetate extracts from the leaves were slightly higher in antioxidant potential than the fruits (El-Beltagi et al., 2019).

The CH2Cl2: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. virens* 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 (IC_{50}, 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).

Table 4. Antimicrobial activity of *Ficus* genus.

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), *Kiebsiella 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	CH_2Cl_2, 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 bark	CH_2Cl_2 and Hex	IZD (mm), *E. coli* (8 and 14) and *S. aureus* (11 and 11).	(G. V. Awolola et al., 2018)

	Stem bark	AcOEt and MeOH	IZD (mm), *S. aureus* (13 and 12).	(G. V. Awolola et al., 2018)
F. bubu	Leaf	MeOH	MIC (µg/mL), *E. faecalis* (39.1), *S. aureus* (625.0), *S. saprophyticus* (312.5), *S. epidermididis* (625.0), *T. rubum* (312.5), *C. albicans* (312.5), *E. coli* (312.5), *K. pneumoniae* (156.2) and *S. typhimurium* (625.0).	(J. M. E. Teinkela, Nguedia, et al., 2016)
	Bark	MeOH	MIC (µg/mL), *E. faecalis* (39.1), *S. aureus* (312.5 µg/mL), *S. saprophyticus* (312.5), *S. epidermididis* (312.5), *T. rubum* (312.5), *C. albicans* (9.8), *E. coli* (39.1), *K. pneumoniae* (1250.0) and *S. typhimurium* (625.0).	(J. M. E. Teinkela, Nguedia, et al., 2016)
F. capensis	Leaf	Essential oil	IZD (mm), *B. subtilis* (21.0 ± 1.7), *S. aureus* (28.3 ± 0.6), *E. coli* (25.7 ± 3.1), *Kiebsiella spp.* (8.7 ± 3.1), *Proteus spp.* (19.0 ± 1.7), *Pseudomonas spp.* (17.0 ± 0.6), *Salmonella spp.* (14.7 ± 1.5), *P. notatum* (24.3 ± 3.8) and *R. stolonifer* (27.3 ± 0.6).	(Lawal et al., 2016)
	Leaf and stem bark	H_2O:EtOH	IC_{50} (µg/mL), *T. b. brucei* (159.62 and 36.10) and *L. donovan* (88.9 and 37.0).	(Ohashi et al., 2018)
F. carica	Leaf	EtOH	IZD (mm), *B. subtilis* (11.87 ± 0.11), *S. flexneri* (11.73 ± 0.11), *E. coli* (9.13 ± 0.11), *R. solanacearum* (8.07 ± 0.11), *A. niger* (8.53 ± 0.12) and *P. cyclopium* (8.47 ± 0.1).	(Desta et al., 2020)
	Leaf	$CHCl_3$	IZD (mm), *B. subtilis* (8.07 ± 0.06), *S. flexner* (9.83 ± 0.15), *R. solanacearum* (9.47 ± 0.11) and *P. cyclopium* (10.27 ± 0.12).	(Desta et al., 2020)
	Leaf	EtOH	*E. faecalis* (MIC 37.5% and MBC 50%).	(Nirwana et al., 2018)
	Leaf	MeOH and H_2O	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.	(Ergül et al., 2019)
F. deltoidea	Leaf	$CHCl_3$ and MeOH	PI, *S. aureus* (20% and 16%).	(K. Ashraf et al., 2020)
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).	(J. E. M. Teinkela et al., 2017)
F. fistulosa	Leaf	EtOH, fractions (But, $CHCl_3$)	Hepatitis C Virus.	(Hafid et al., 2016)
F. lyrata	Bark gum	$CHCl_3$	IZD, *Bacillus* sp (2, 4 and 5 mm, in 4, 6 and 8 mg/mL).	(Samrot et al., 2021)
F. natalensis	Bark	PeEt, $CHCl_3$, MeOH, H_2O	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 ± 1.52, 27 ± 1.52) and *A. oryzae* (23.7 ± 0.57, 25.2 ± 0.28, 26.7 ± 1.15, 26.2 ± 0.76).	(Ajaib et al., 2016)
	Leaf	PeEt, $CHCl_3$, MeOH, H_2O	IZD (mm), *E. coli* (44.7 ± 0.57, 27 ± 0.85, 21 ± 1.52, 30.7 ± 0.26), *P. aeruginosa* (33 ± 0.28, 27 ± 0.4, 31 ± 1.52, 21.7 ± 0.57), *S. aureus* (50 ± 0.51, 50 ± 2, 26.7 ± 1.53, 23 ± 2.08), *B. subtilis* (40 ± 0.4, 36 ± 0.9, 16 ± 1, 22.9 ± 0.11), *A. niger* (9 ± 0, 28 ± 1.52, 19 ±1, 29.8 ± 1.04) and *A. oryzae* (23 ± 2.64, 25.2 ± 1.25, 34.8 ± 1.60, 28 ± 1.73).	(Ajaib et al., 2016)

F. racemosa	Leaf	EtOH, toluene, AcOEt.	MIC (mg/mL), *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).	(Bagyalakshmi et al., 2019)
	Leaf	MeOH	IZD (mm), *E. coli* (9.61), *S. flexneri* (10.08), *S. boydii* (8.45), *S. epidermidis* (4.23).	(Sumi et al., 2016)
	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).	(Bopage et al., 2018)
F. religiosa	Leaf	AcOEt	*B. subtilis* and *A. fischer*.	(Gawande & Morlock, 2021)
F. sycomorus	Leaf	Acetone and EtOH	IZD (mm), *C. albicans* (10 and 12).	(Ozdenefe et al., 2020)
	Leaf	Acetone, MeOH and EtOH	IZD (mm), *S. aureus* (11, 10 and 13).	(Ozdenefe et al., 2020)
	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).	(El-Beltagi et al., 2019)
F. tikoua	–	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).	(Tian et al., 2020)
F. vasta	Leaf	MeOH	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).	(Taviano et al., 2018)

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, andiabetes and antiobesogenic activities

Table 5 shows the anti-hyperglycemic, andiabetes and antiobesogenic activities of different extract of *Ficus* genus. These activities were also presented by some compounds isolated from species of this genus. Cycloartenol and 24-methylenecycloartanol 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).

Table 5. Anti-hyperglycemic, antidiabetes and antiobesogenic activities of *Ficus* genus.

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)
	Leaf	Alcohol: H_2O	Potential to inhibit pancreatic β-cell apoptosis *in vitro* and *in vivo*.	(Zhang et al., 2020)
	Leaf	EtOH	Can reduce serum lipid, TNF-α, and malondialdehyde (MDA) in rats fed a high-fat diet.	(Sukowati et al., 2019)
	Leaf Stem bark	EtOH AcOEt, Hex, H_2O	Inhibition of α-amylase, α-glucosidase and pancreatic lipase *in vitro* show their antidiabetic and antiobesogenic potential.	(Mopuri et al., 2018)
	Leaf	AcOEt	It showed a significant effect on carbohydrate metabolism enzymes (glucose-6-phosphatase, fructose-1,6-bisphosphatase and hexokinase) and reduced glucose, cholesterol and triglycerides levels.	(Irudayaraj et al., 2017)
	Leaf	MeOH, H_2O	Inhibition of α-amylase and α-glucosidase *in vitro*.	(Ergül et al., 2019)
	Leaf	H_2O	It show antihyperglycemic effect in diabetic male rats by regulating glucose levels. This effect prevents complications of diabetes on fertility in male rats.	(Abu Bakar et al., 2020)
F. deltoidea	Leaf	EtOH	The treatment caused a reduction in the lipid profile (cholesterol, triglycerídes, HDL and LDL) in hypercholesterolemic-induced rats.	(Chuo et al., 2020)
	Leaf	MeOH	Reduced the levels of glucose in diabetic rats.	(Samsulrizal et al., 2021)
	Leaf	MeOH	Decrease levels of advanced glycation end products (AGEs)	(Mohd Dom 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_2O	Weak effect on α-amylase inhibition and no effect on α-	(Mouho et al.,

	Stem bark		glucosidase *in vitro*.	2018)
F. glomerata	Leaf	$CHCl_3$	The treatment in diabetic rats showed a decrease in blood glucose, triglycerides and cholesterol levels.	(Shaikh et al., 2020)
F. krishnae	Stem bark	Hex	It showed significant glucose-lowering activity in normal glucose-laden rats.	(Sadasivan Nair et al., 2020)
F. microcarpa	Aerial parts	MeOH: $CHCl_3$	α-Glucosidase and α-amylase inhibitory cctivities *in vivo*, which reveals its anti-hyperglycemic potential.	(Akhtar et al., 2018)
F. mucoso	Root bark	MeOH	Inhibition of pore opening, and reduction in levels of malondialdehyde and serum blood glucose. It has therapeutic potential for the treatment of diabetes.	(Oyebode et al., 2019)

Source: Authors.

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_2O: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 Leaf Latex	MeOH	Glioma (U373), lung (A549) and melanoma (SKMEL-28).	(J. M. E. Teinkela, Nguedia, et al., 2016)
F. capensis	Leaf Stem-bark	H_2O:EtOH	Jurkat (human acute T-cell leukemia cells).	(Ohashi et al., 2018)
F. carica	Látex	–	Papiloma vírus humano (HPV).	(Ghanbari et al., 2019)
	Leaf	Acetone	HepG2 (human hepatoblastoma cancer).	(Mustafa et al., 2021)
	Leaf latex	–	MDA-MB-231.	(AlGhalban et al., 2021)
	Leaf	MeOH	Liver cancer (Huh7it) and cause cell apoptosis *in vitro*.	(Purnamasari et al., 2019)
F. crocata	Leaf	Acetone	HeLa and SiHa cervical cancer.	(Cruz-Concepción et al., 2021)
	Leaf	Acetone, CH_2Cl_2, Hex	MDA-MB-231 triple-negative breast cancer.	(Sánchez-Valdeolívar et al., 2020)
F. deltoidea	Leaf	AcOEt	Breast cancer (MCF-7, MDA-MB 231, HCC1937) e colon cancer (HCT 116).	(Abolmaesoomi 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 latex	–	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)

F. tikoua	–	Essential oil	A549, NCI-H1299, PC-3 and K562 tumor cells.	(Tian et al., 2020)
F. vogeliana	Bark	H_2O	DMBA-induced skin cancer in rats.	(Misso et al., 2020)

Source: Authors.

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 pNiFty2-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 ethanol 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

(Nurdiana et al., 2018). 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 antitrypanosomal 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-hawary 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)

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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