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Review

Bioactive Compounds, Therapeutic Activities, and Applications of *Ficus pumila* L.

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Abstract: *Ficus pumila* L. has been used as a functional plant for a long time in East Asia, especially its fruits, as a dietary component in Japan and parts of China. A series of bioactive compounds, including phenolic acids, flavonoids, terpenoids, alcohols, and steroids, have been extracted from the stems, leaves, flowers, and fruits of *Ficus pumila* L. Accumulated studies have demonstrated that *Ficus pumila* L. has multiple therapeutic activities, including antioxidant, anti-inflammatory, antibacterial, antitumor, hypoglycemic, and cardiovascular protective effects. Moreover, *Ficus pumila* L. has extensive applications, such as in the food industry and ecological city construction. Herein, we summarize the latest knowledge about the bioactive compounds and therapeutic activities of *Ficus pumila* L., and its applications in the food industry and ecological city construction are also discussed. We hope that this comprehensive review can attract more attention to *Ficus pumila* L. and be helpful for its further applications.

Keywords: *Ficus pumila* L.; bioactive compounds; therapeutic activities; applications

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1. Introduction

Ficus plants have a long history of human cultivation. Many *Ficus* species are popular foliage plants [1], and some species are commonly used in traditional medicine [2,3]. *Ficus pumila* L. is a creeping fig in the mulberry family (Figure 1). It is widely grown in Japan and the south of China. Plant-based natural products have been reported to have multiple biological functions that might be beneficial for human health [4–11]. The bioactive compounds, pharmacological activities, and applications of several *Ficus* plants, such as *Ficus hispida* L. [12], *Ficus racemose* [13], *Ficus sycomorus* [14], *Ficus religiosa* [15], and *Ficus carica* L. [16,17], have been discussed recently. *Ficus pumila* L. also exhibits many therapeutic activities, including antioxidant [18], anti-inflammatory [19], antibacterial [20], anti-cancer [21], blood sugar lowering [22], gastrointestinal protection [23], hepatorenal protection [24], and cardiovascular protection [25]. The biological functions of *Ficus pumila* L. are mainly attributed to the bioactive compounds in different parts of *Ficus pumila* L. The bioactive compounds found in *Ficus pumila* L. include different types, especially flavonoids, terpenes, alcohols, steroids, and phenolic acids. In order to better understand *Ficus pumila* L., we thoroughly summarized the latest knowledge about *Ficus pumila* L., including its bioactive compounds, therapeutic activities, and potential applications in the food industry and ecological restoration.

Figure 1. Stems, leaves, and fruits of *Ficus pumila* L.

2. Bioactive Compounds in *Ficus pumila* L.

2.1. Flavonoids

So far, thirty-seven flavonoids (Table 1) have been identified in *Ficus pumila* L. The leaves and inflorescences of *Ficus pumila* L. have the highest flavonoid contents. In addition, the contents of flavonoids in leaves are significantly higher than those in stems and seeds [26].

Table 1. Flavonoid compounds found in *Ficus pumila* L.

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
1	5,7,2′,5′-Tetrahydroxyflavanone	$C_{15}H_{10}O_6$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	NMR	[27]
2	5,7,2′-Trihydroxy-4′-methoxyisoflavone	$C_{16}H_{12}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
3	5,7,4′-Trimethoxy flavane-3-ol	$C_{18}H_{20}O_5$	Aboveground parts except fruit	75% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, EI-MS	[29]
4	5,7,4′-Trihydroxy-3′-(2-hydroxy-3-methyl-3-butenyl)-isoflavone	$C_{20}H_{18}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
5	5,7,4′-Trihydroxy-3′-(3-hydroxy-3-methylbutyl)isoflavone	$C_{20}H_{20}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
6	5,7,4′-Trihydroxyisoflavone	$C_{15}H_{10}O_5$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
7	5,7-Dihydroxy chromone	$C_9H_6O_4$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
8	7,4′-Dimethoxy-5-hydroxyisoflavone	$C_{17}H_{14}O_5$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	^{1}H-and ^{13}C-NMR	[27]
9	Alpinum isoflavone	$C_{20}H_{16}O_5$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]

Table 1. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
10	Apigenin	$C_{15}H_{10}O_5$	Stem, leaf, and above ground parts except fruit	80% Ethanol, 75% Ethanol, $CHCl_3$/Methanol 9:1	Liquid extraction	^{1}H-and ^{13}C-NMR	[27–29]
11	Apigenin 6-neohesperidose	$C_{27}H_{30}O_{14}$	Leaf	Methanol	Liquid extraction	HPLC, NMR	[30]
12	Astragalin	$C_{21}H_{20}O_{11}$	Inflorescence receptacle, fresh leaves	Methanol, 75% industrial ethanol	Liquid extraction	HPLC, NMR	[31–33]
13	Catechin	$C_{15}H_{14}O_6$	Stem, above ground parts except fruit	80% Ethanol, 75% industrial ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, ESI-MS	[28,29,34]
14	Chrysin	$C_{15}H_{10}O_4$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	NMR	[27]
15	Chrysoeriol	$C_{16}H_{12}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
16	Derrone	$C_{20}H_{16}O_5$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
17	Dihydrokaempferol 5-*O*-*β*-D-glucopyranoside	$C_{21}H_{22}O_{11}$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
18	Dihydrokaempferol 7-*O*-*β*-D-glucopyranoside	$C_{21}H_{22}O_{11}$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
19	Epicatechin	$C_{15}H_{14}O_6$	Above ground parts except fruit	75% industrial ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[29]
20	Eriodictyol	$C_{15}H_{12}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
21	Ficuisoflavone	$C_{20}H_{16}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
22	Genistein	$C_{15}H_{10}O_5$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	NMR	[27]
23	Hesperitin	$C_{16}H_{14}O_6$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	NMR	[27]
24	Isoquercitrin	$C_{21}H_{20}O_{12}$	Inflorescence receptacle, fresh leaves	Methanol, 75% industrial ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[31,32,35]

Table 1. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
25	Isoquercitrin 6-C a-L-rhamnopyranosyl-(1→2)-β-D-glucopyranoside	$C_{33}H_{41}O_{20}$	Leaf	Methanol	Liquid extraction	NMR	[32]
26	Isorhamnetin-3-*O*-glucoside	$C_{22}H_{22}O_{12}$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	NMR	[27]
27	Kaempferol 3-*O*-a-L-rhamnopyranosyl (1→6)-β-D-glucopyranoside	$C_{27}H_{30}O_{15}$	Inflorescence receptacle, leaf, and fruit	Ethanol and methanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[30,32,35,36]
28	Kaempferol 3-robinobioside	$C_{27}H_{30}O_{15}$	Leaf	Methanol	Liquid extraction	HPLC, NMR	[30,32]
29	Lupin isoflavone C	$C_{20}H_{18}O_6$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
30	Luteolin	$C_{15}H_{10}O_6$	Stem and leaf	$CHCl_3$/Methanol 9:1	Liquid extraction	NMR	[27]
31	Maesopsin 6-*O*-β-D-glucopyranoside	$C_{21}H_{22}O_{11}$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
32	Naringenin	$C_{15}H_{12}O_5$	Above ground parts except fruit, stem, and leaf	80% Ethanol, 75% industrial ethanol, $CHCl_3$/methanol 9:1	Liquid extraction	^{1}H-and ^{13}C-NMR	[27–29]
33	Quercetin	$C_{15}H_{10}O_7$	Above ground parts except fruit	75% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[18,29,37]
34	Quercitrin	$C_{21}H_{20}O_{11}$	Fruit, stem, and leaf	95% Ethanol, petroleum ether, ethyl acetate, and N-butanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[27,31]
35	Rutin	$C_{27}H_{30}O_{16}$	Leaf, stem, fruit, inflo-rescence receptacle	Methanol, ethanol, $CHCl_3$/methanol 9:1	Liquid extraction	^{1}H-and ^{13}C-NMR	[19,30,31,33,35,38]
36	Taxifolin	$C_{15}H_{12}O_7$	Stem and leaf	$CHCl_3$/methanol 9:1	Liquid extraction	NMR	[27]
37	Tricetin	$C_{15}H_{10}O_7$	Stem and leaf	$CHCl_3$/methanol 9:1	Liquid extraction	NMR	[27]

Abbreviations: NMR, nuclear magnetic resonance spectroscopy; HPLC, high performance liquid chromatography; ESI-MS, electrospray ionization-mass spectrometry; ODS, octadecylsilyl.

2.2. Phenolic Acids and Their Derivatives

There have been 12 phenolic acids (Table 2) isolated from *Ficus pumila* L., four of which are phenylpropanoid compounds (9–12). Most of the phenolic acids and their derivatives are found in the inflorescence and receptacle of *Ficus pumila* L.

Table 2. Phenolic acids and their derivatives found in *Ficus pumila* L.

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
1	4-Acetonyl-3,5-dimethoxy-*p*-quinol	$C_{11}H_{14}O_5$	Inflorescence receptacle	95% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[35]
2	5-*O*-Caffeoyl quinic acid butyl ester	$C_{20}H_{26}O_9$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
3	5-*O*-Caffeoyl quinic acid methyl ester	$C_{17}H_{20}O_9$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
4	Bergapten	$C_{12}H_8O_4$	Stem, leaf	80% Ethanol, $CHCl_3$/methanol 9:1	Liquid extraction	^{1}H-and ^{13}C-NMR	[28,36,38,39]
5	Caffeic acid	$C_9H_8O_4$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
6	Chlorogenic acid	$C_{16}H_{18}O_9$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
7	Oxypeucedanin hydrate	$C_{17}H_{18}O_6$	Leaf	Ethanol	Liquid extraction	NMR	[39]
8	Protocatechuic acid	$C_7H_6O_4$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
9	Psoralene	$C_{11}H_6O_3$	Fruit	Methanol	Liquid extraction	FAB-MS,^{1}H-,^{13}C- and ^{13}C-^{1}H COSY NMR	[36,38]
10	*p*-Hydroxybenzoic acid	$C_7H_6O_3$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]

Table 2. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
11	Seco-isolariciresinol 9-*O*-*β*-D-glucopyranoside	$C_{26}H_{34}O_{11}$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
12	Vanillic acid	$C_8H_8O_4$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]

Abbreviations: ODS, octadecylsilyl; HPLC, high performance liquid chromatography; NMR, nuclear magnetic resonance spectroscopy; COSY, correlated spectroscopy.

2.3. Terpenoids

Triterpenoids have multiple pharmacological effects, such as immunoregulatory, anti-tumor, liver protection, and blood lipid-lowering effects. At present, 54 terpenoids (Table 3), mainly triterpenes and sesquiterpenes, have been isolated from *Ficus pumila* L., of which 25 are sesquiterpenes, mainly distributed in the stems, leaves, and fruits. In addition, there are 29 triterpenoids found in *Ficus pumila* L., which can be divided into oleanane type, ursane type, lupane type, dammarane type, lanostane, and cyclortane according to their skeleton structure [36].

Table 3. Terpenoids found in *Ficus pumila* L.

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
1	(1′S, 6′R)-8′-Hydroxyabscisic acid *β*-D-glucoside	$C_{21}H_{30}O_{10}$	Inflorescence receptacle, fruit	95%Ethanol, methanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, preparative HPLC column, chromatographies	[32,35,36]
2	(1S,4S,5R,6R,7S,10S)-1,4,6-Trihydroxy eucalyptane6-*O*-*β*-D-glucopyranoside	$C_{21}H_{38}O_8$	Fruit	Methanol	Liquid extraction	FAB-MS,^{1}H-,^{13}C- and ^{13}C-^{1}H COSY NMR	[36,38]
3	(1S,4S,5S,6R,7R,10S)-1,4-Trihydroxyolane1-*O*-*β*-D-glucopyranoside	$C_{21}H_{38}O_7$	Fruit	Methanol	Liquid extraction	FAB-MS,^{1}H-,^{13}C- and ^{13}C-^{1}H COSY NMR	[36,38]
4	(23Z)-3*β*-Acetoxycycloart-23-en-25-ol	$C_{32}H_{52}O_3$	Fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[36]
5	(23Z)-3*β*-Acetoxyeupha-7,23-dien-25-ol	$C_{32}H_{52}O_3$	Fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[36]
6	(23Z)-Cycloart-23-ene-3*β*,25-diol	$C_{30}H_{50}O_2$	Fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[36]
7	(24R)-6*β*-Hydroxy-24-ethylcholest-4-en-3-one	$C_{29}H_{48}O_2$	Leaf	80%Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[40]

Table 3. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
8	(24RS)-3*β*-Acetoxycycloart-25-en-24-ol	$C_{32}H_{52}O_3$	Fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[36]
9	(24RS)-Cycloart-25-en-3*β*,24-diol	$C_{30}H_{50}O_2$	Fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[36]
10	(6R,7E)-4,7-Megastigmadien-3,9-dione	$C_{11}H_{18}O_2$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, HR-ESI-MS	[28]
11	(6R,7E,9R)-9-Hydroxy-4,7-megastigmadien-3-one	$C_{13}H_{20}O_2$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, HR-ESI-MS	[28,41]
12	(6S*,7E,9Z)-6,10-Dihydroxy-7,9-pentadienyl-4-cyclohexen-3-one	$C_{14}H_{20}O_3$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, HR-ESI-MS	[28]
13	(6S,7E)-6-Hydroxy-4,7-megastigmadien-3,9-dione	$C_{13}H_{18}O_3$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, HR-ESI-MS	[28,41]
14	(E,4R)-4-Hydroxy-4,5,5-trimethyl-3-(3-oxobut-1-enyl)cyclohex-2-en-one	$C_{14}H_{20}O_2$	Stem	Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28,41]
15	10*α*,11-Hydroxy juniper-4-ene11-*O*-*β*-D-glucopyranoside	$C_{21}H_{38}O_7$	Fruit	Methanol	Liquid extraction	FAB-MS,^{1}H-,^{13}C-and ^{13}C-^{1}H COSY NMR	[36,38]
16	11*α*-Hydroxy-*β*-amyrin	$C_{30}H_{50}O_2$	Stem and leaf	$CHCl_3$/methanol 9:1	Liquid extraction	NMR	[27]
17	2*α*,3*β*-Dihydroxyurs-12-en-28-oic acid	$C_{38}H_{48}O_4$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC	[31]
18	3,9-Dihydroxy-5,7-megastigmadien-4-one	$C_{13}H_{19}O_3$	Leaf	Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[42]
19	3-Oxo-*α*-ionone	$C_{13}H_{18}O_2$	Stem	Ethanol	Liquid extraction	NMR	[41]
20	3*α*-Hydroxy-5,6-epoxy-7-megastimen-9-one	$C_{13}H_{20}O_3$	Leaf	Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[42]
21	3*α*-Hydroxy-isohop-22(29)-en-24-oic acid	$C_{30}H_{48}O_3$	Leaf	Methanol	Liquid extraction	Sephadex LH-20 (Methanol) column chromatography	[32]
22	3*β*,28-Dihydroxylup-20(29)-ene	$C_{30}H_{50}O_2$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC	[32]
23	3*β*,28-Dihydroxyolean-12-ene	$C_{30}H_{50}O_2$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC	[32]
24	3*β*,28-Dihydroxyurs-12-ene	$C_{30}H_{50}O_2$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC	[32]
25	3*β*-Acetoxy-(20R, 22E, 24RS)-20,24-dimethoxydammarane-22-ene-25-alcohol	$C_{34}H_{58}O_5$	Fruit	Methanol	Liquid extraction	EI-MS, NMR	[36]

Table 3. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
26	3β-Acetoxy-(20S, 22E, 24RS)-20,24-dimethoxydammarane-22-ene-25-alcohol	$C_{34}H_{58}O_5$	Fruit	Methanol	Liquid extraction	EI-MS, NMR	[36]
27	3β-Acetoxy-20,21,22,23,24,25,26,27-Octamethyldammarane-17β-alcohol	$C_{24}H_{40}O_3$	Fruit	Methanol	Liquid extraction	EI-MS, NMR	[36]
28	3β-Acetoxy-22,23,24,25,26,27-hexamethyldammarane-20-one	$C_{26}H_{42}O_3$	Fruit	Methanol	Liquid extraction	EI-MS, COSY NMR	[36]
29	3β-Acetoxycycloartan-24-al	$C_{29}H_{46}O_3$	Leaf	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[40]
30	3β-Hydroxy-urs-12-en-28-oic acid	$C_{30}H_{50}O_3$	Leaf	70% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[32,43]
31	4-Megastigment-3,9-dione	$C_{13}H_{20}O_2$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28,41]
32	8,9-Dihydro-8,9-dihydroxy-megastigmatrienone	$C_{13}H_{20}O_3$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28,41]
33	9,10-Dihydroxy-4,7-megastigmadien-3-one	$C_{13}H_{20}O_3$	Leaf	Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[42]
34	Betulin	$C_{30}H_{50}O_2$	Stem and leaf, leaf	70% Ethanol and petroleum ether, methanol	Liquid extraction	^{1}H-and ^{13}C-NMR, ESI-MS	[32,43]
35	Betulinic acid	$C_{30}H_{48}O_3$	Above ground parts except fruit, stem, and leaf	70% Ethanol and petroleum ether, methanol	Liquid extraction	^{1}H-and ^{13}C-NMR, ESI-MS	[22,29,32]
36	*cis,trans*-Abscisic acid	$C_{15}H_{20}O_4$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28]
37	Glutinol	$C_{30}H_{50}O$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC	[32]
38	Lupenyl acetate	$C_{32}H_{52}O_2$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC, FAB-MS, ^{1}H-and ^{13}C-NMR	[32,36]
39	Lupeol	$C_{30}H_{50}O$	Above ground parts except fruit, stem, and leaf	70% Ethanol and ethyl acetate, methanol	Liquid extraction	^{1}H-and ^{13}C-NMR, ESI-MS	[29,32,36,43]
40	Neohopane	$C_{30}H_{50}O_2$	Leaf	Ethanol	Liquid extraction	NMR	[44]
41	Phaseic acid	$C_{15}H_{20}O_5$	Inflorescence receptacle	95% Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, preparative HPLC column chromatographies	[35]

Table 3. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
42	Pumilaside A	$C_{21}H_{38}O_8$	Fruit	Methanol	Liquid extraction	FAB-MS,^{1}H-and ^{13}C-NMR	[36]
43	Pumilaside B	$C_{21}H_{36}O_7$	Fruit	Methanol	Liquid extraction	FAB-MS,^{1}H-,^{13}C-and ^{13}C-^{1}H COSY NMR	[36]
44	Pumilaside C	$C_{21}H_{36}O_7$	Fruit	Methanol	Liquid extraction	^{1}H-,^{13}C-and ^{13}C-^{1}H COSY NMR, HMBC	[36]
45	Rhoiptelenol	$C_{30}H_{50}O$	Leaf	Methanol	Liquid extraction	ESI-MS, HPLC	[32]
46	Taraxerol	$C_{30}H_{50}O$	Leaf	Methanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[32]
47	Taraxeryl acetate	$C_{32}H_{52}O_2$	Stem and leaf	Ethanol	Liquid extraction	Mixed melting point detection	[40,45]
48	Uvaol	$C_{30}H_{50}O_2$	Stem and leaf	70% Ethanol and petroleum ether	Liquid extraction	^{1}H-and ^{13}C-NMR, SI-MS	[27]
49	Vomifoliol	$C_{13}H_{20}O_3$	Stem	Ethanol	Diafiltration extraction	^{1}H-and ^{13}C-NMR, DEPT-135	[28,35,41]
50	Vomifoliol acetate	$C_{15}H_{22}O_4$	Stem	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[28,41]
51	α-Amyrin	$C_{30}H_{50}O$	Leaf, fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[31,36]
52	α-Amyrin acetate	$C_{32}H_{52}O_2$	Leaf, fruit	Methanol	Liquid extraction	ESI-MS, HPLC	[32,36]
53	β-Amyrin	$C_{30}H_{50}O$	Stem and leaf, fruit	Ethanol, methanol	Liquid extraction	^{1}H-and ^{13}C-NMR, MS	[27,32,36,45]
54	β-Amyrin acetate	$C_{32}H_{52}O_2$	Stem, leaf, fruit, inflo-rescence receptacle	methanol, 95% Ethanol, petroleum ether, ethyl acetate, N-butanol	Diafiltration extraction, liquid extraction	Silica gel, Sephadex LH-20, ODS, preparative HPLC column Chromatographies, MS	[22,32,35,36,46,47]

Abbreviations: ODS, octadecylsilyl; FAB-MS, fast atom bombardment mass spectrometry; COSY, correlated spectroscopy; NMR, nuclear magnetic resonance spectroscopy; HR-ESI-MS, high resolution electrospray ionization-mass spectrometry; ESI-MS, electrospray ionization-mass spectrometry; HMBC, heteronuclear multiple bond correlation; MS, mass spectrometry.

2.4. Alcohol Compounds

Several alcohol compounds have been isolated from the ethanol or methanol extract of *Ficus pumila* L. up to now, such as meso-inositol, *n*-octacosanol, *n*-nonacosanoic acid, *n*-tetracosanol, *n*-hexadecanol, and norepinephrine 3,9-dihydroxy dihydro actinidiolide [12,17,25].

2.5. Steroids

Seventeen steroids (Table 4) have been isolated from *Ficus pumila* L. These steroid compounds are widely distributed in different parts of *Ficus pumila* L., including leaf, steam, fruit, inflorescence, and receptacle.

2.6. Other Compounds

Other compounds have also been isolated from the *Ficus pumila* L. Kitajima et al. (1998) isolated α-tocopherol and VE-FPL (3α-acetyl-2,3,5-trimethyl-7α-hydroxy-5-(4,8,12-trimethyl-tridecanyl)-1,3α,5,6,7,7α-hexahydro-4-oxainden-1-one) from the leaves of *Ficus pumila* L. [32]. In addition, β-D-glucopyranoside and (E)-2-methyl-2-butenyl were isolated from the fruits of *Ficus pumila* L. [36]. Fan et al. (2005) isolated ethyl-β-D-glucopyranoside from the fruit-removing part of *Ficus pumila* L. by using 75% ethanol [29]. Wei et al. (2014) isolated 1-methyl-1, 2, 3, 4-tetrahydro-β-carboline-3-carboxylic acid, an alkaloid, from dried inflorescence of *Ficus pumila* L. by using 95% ethanol [35]. Trinh et al. (2018) isolated a new benzofuran derivative, pumiloside, from the ethanol extract of *Ficus pumila* L. [31]. Moreover, Xiao et al. (2015) isolated a new compound from *Ficus pumila* L., named 5-aldehyde-4′-hydroxy-2,2′-dimethoxybiphenyl [28]. Cai et al. (2017) isolated *trans* ethyl *p*-hydroxycinnamate, pubinernoid A, and oxindole [40]. Bai et al. (2019) isolated blumenol A, (6R, 9R)-3-oxo-ationol-onolglucopyranoside, roseoside (rosmarinin), and (E)-4-[3′-(β-D-glucopyranosyloxy)butylidene]-3,5,5-trimethyl-2-cyclohexen-l-one from *Ficus pumila* L. [42].

Table 4. Steroid compounds found in *Ficus pumila* L.

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
1	(24S)-Stigmast-5-ene-3β,24-diol	$C_{29}H_{50}O_2$	Fruit	Methanol	Liquid extraction	NMR	[46]
2	(24S)-24-Hydroxystigmast-4-en-3-one	$C_{29}H_{48}O_2$	Fruit	Methanol	Liquid extraction	NMR	[46]
3	3β-Hydroxysitost-5-en-7-one	$C_{29}H_{48}O_2$	Stem	80% Ethanol	Liquid extraction	HPLC	[28]
4	5α-Stigmastan-2,6-dione	$C_{29}H_{48}O_2$	Leaf and stem	70% Ethanol and petroleum ether	Liquid extraction	ESI-MS	[43]
5	6α-Hydroxystigmast-4-en-3-one	$C_{29}H_{48}O_2$	Stem	80% Ethanol	Liquid extraction	HPLC	[28]
6	6β-Hydroxystigmast-4-en-3-one	$C_{29}H_{48}O_2$	Stem	80% Ethanol	Liquid extraction	HPLC	[28]
7	7-Keto-β-sitosterol	$C_{29}H_{48}O_2$	Leaf	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[40]
8	Campesterol	$C_{28}H_{48}O$	Fruit	Methanol	Liquid extraction	NMR	[46]
9	Cholesterol	$C_{27}H_{46}O$	Fruit	Methanol	Liquid extraction	NMR	[46]
10	Daucosterol	$C_{35}H_{60}O_6$	Leaf and stem, inflorescence receptacle, and above-ground parts except fruit	70% Ethanol and ethyl acetate, methanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies; TLC	[29,32,35,43]
11	Dihydrodehydrodiconiferyl alcohol	$C_{20}H_{24}O_6$	Leaf	80% Ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR	[40]
12	Stigmast-4-en-3-one	$C_{29}H_{48}O$	Fruit	Methanol	Liquid extraction	NMR	[46]
13	Stigmast-5,24(28)-dien-3-ol	$C_{29}H_{48}O$	Leaf and stem	70% Ethanol and petroleum ether	Liquid extraction	^{1}H-and ^{13}C-NMR, ESI-MS	[43]

Table 4. *Cont.*

No.	Compounds	Molecular Formula	Plant Parts	Extraction Solvents	Extraction Methods	Detection Methods	Ref.
14	Stigmasterol	$C_{29}H_{48}O$	Leaf and stem	70% Ethanol and ethyl acetate	Liquid extraction	^{1}H-and ^{13}C-NMR, ESI-MS	[43]
15	*β*-Daucosterol	$C_{35}H_{60}O_6$	Inflorescence receptacle	Ethanol	Diafiltration extraction	Silica gel, Sephadex LH-20, ODS, and preparative HPLC column chromatographies	[35]
16	*β*-Sitosterol	$C_{29}H_{50}O$	Leaf, stem, fruit, inflorescence receptacle	70% Ethanol and petroleum ether, methanol, $CHCl_3$/methanol 9:1	Liquid extraction	Mixed melting point detection, Silica gel column chromatography, Sephadex LH-20 column chromatography, TLC, ESI-MS	[27–29,32,43,45,46]
17	*β*-Sitosterol-3-*O*-*β*-D-glucopyranoside-6′-pentadecanoate	$C_{50}H_{90}O_7$	Aboveground parts except fruit	75% Industrial ethanol	Liquid extraction	^{1}H-and ^{13}C-NMR, EI-MS	[29]

Abbreviations: NMR, nuclear magnetic resonance spectroscopy; HPLC, high performance liquid chromatography; ESI-MS, electrospray ionization; ODS, octadecylsilyl; TLC, thin-layer chromatography; SI-MS, secondary ion mass spectroscopy; ESI-MS, electron impact-mass spectrometry.

3. Therapeutic Activities of *Ficus pumila* L.

Quite a few plant-derived bioactive compounds and extracts have received much attention because of their potential health benefits [48–55]. Some *Ficus* plants have been used in traditional medicine for a long time, and their pharmacological activities have been summarized in recent reviews [12–17]. Accumulating studies have demonstrated that *Ficus pumila* L.-derived bioactive compounds and extracts possess multiple therapeutic activities, which are discussed as follows.

3.1. Antioxidant Effects

Several studies have reported the antioxidant effects of bioactive compounds or extracts from the root, stem, leaf, and fruit of *Ficus pumila* L. Flavonoid glycosides such as rutin, kaempferol 3-rutinoside, kaempferol 3-robinobioside, and apigenin 6-neohesperidose isolated from the leaves of *Ficus pumila* L. showed strong antioxidant activities in superoxide radical inhibition assay and 1,1-diphenyl-2-picrilhydrazyl (DPPH) radical scavenging assay [30]. Moreover, the total phenolic content may contribute to the antioxidant ability of *Ficus pumila* L. Wang et al. (2009) evaluated the antioxidant ability of various concentrations of ethanol extracts from the fruit of *Ficus pumila* L. by multiple in vitro assays including DPPH assay, ferric reducing antioxidant power (FRAP) assay, trolox equivalent antioxidant capacity (TEAC) assay, and reducing power assay, and the results showed that the 80% ethanol extract had the highest total phenolic content and exhibited the strongest antioxidant activities [56]. Tang et al. (2012) investigated the antioxidant activities of different solvents and water extracts from *Ficus pumila* L. stem and leaves and found that the total phenolic content was correlated with the antioxidant capacity [57]. In addition, Noronha, et al. (2014) determined the antioxidant activities of hydroethanolic extracts from dried and fresh root, stem, leaf, and fruit of *Ficus pumila* L., and found fresh stem exhibited the strongest antioxidant capacity by DPPH assay [18].

3.2. Anti-Inflammatory Effect

It has been reported that *Ficus pumila* L. exhibits quite evident anti-inflammatory properties in well-recognized animal inflammatory models of xylene-induced ear swelling, carrageenan-induced toe swelling, and glacial acetic acid-induced celiac capillary permeability. The extracts from different parts of *Ficus pumila* L. could stimulate the celiac capillary permeability and inhibit ear and toe swelling in bilateral adrenalectomy mice compare to the blank controls, which indicated a hypothalamus–pituitary–adrenal axis-independent anti-inflammatory effect of *Ficus pumila* L. [58].

The systematic solvent method was applied to separate the chemical composition of *Ficus pumila* L. by Mao et al. (2011); three fractions were obtained, namely water extract, ethyl acetate extract, and butanol extract, which were then used to evaluate the anti-inflammatory activities [59]. The results showed that the water and ethyl acetate extracts were the effective parts that significantly inhibited the xylene-induced auricular inflammation in rats and carrageenan-induced footpad inflammation in mice, while they increased the celiac capillary permeability of mice as well [59]. In another study, they investigated the anti-inflammatory effects of water and different solvents extractions including ethanol, ethyl acetate, petroleum ether, and butanol of *Ficus pumila* L. by using the ear swelling mouse model and acetic acid capillary permeability assay, and the results showed that all the groups exhibited active anti-inflammatory effects except for the petroleum ether extraction [60].

Flavone and triterpene, such as rutin, luteolin, and apigenin, are the main bioactive components of *Ficus pumila* L. that contribute to its anti-inflammatory effect [19]. The contents of rutin, apigenin, and luteolin in the methanol extract of *Ficus pumila* L. are 24.41 mg/g, 14.11 mg/g, and 2.72 mg/g, respectively [19]. The *Ficus pumila* L. methanol extraction had a similar inhibitory effect as indomethacin on n-carrageenan-induced paw edema in mice, and the anti-inflammatory mechanism may be associated with the decreased levels of inflammatory factors such as interleukin-1β (IL-1β), tumor necrosis factor α (TNF-α), and cyclooxygenase-2 (COX-2), and increased hepatic antioxidant enzyme activities, such as superoxide dismutase (SOD), glutathione peroxidase (GPx), and glutathione reductase (GRd), which causes a reduction of nitric oxide (NO) and malonaldehyde (MDA) levels in the edema paw [19]. Additionally, an analgesic effect of the methanol extract of *Ficus pumila* L. was also demonstrated by recording the writhing response and licking time in mice models of acetic acid writhing and formalin pain, respectively [19].

Recently, an arabinogalactan isolated from *Ficus pumila* L. fruit hulls was found to have immunomodulatory activities [61]. It could promote the nitric oxide generation, phagocytic activity, and cytokine secretion, such as TNF-α, IL-1β, and IL-6, in RAW 264.7 cells [61].

3.3. Antibacterial Effect

Ficus pumila L. has natural antibacterial effects on both Gram-positive and Gram-negative bacteria, especially *Bacillus* and *Staphylococcus*. Studies have shown that sesquiterpenes, triterpenes, and flavonoids are the main bioactive components that contributed to the antibacterial effects of *Ficus pumila* L. The ethyl acetate extract of the stem and leaf of *Ficus pumila* L. showed a 95.83% inhibition rate against *Staphylococcus aureus* [62]. Compounds isolated from an ethyl acetate extract of *Ficus pumila* L. exhibited great antibacterial properties; 8,9-dihydro-8,9-dihydroxy-megastigmatrienone and (E,4R)-4-hydroxy-4,5,5-trimethyl-3-(3-oxobut-enyl)cyclohex-2-enone showed a strong inhibitory activity against *Escherichia coli* with a MIC of 1.25 μg/mL, (E,4R)-4-hydroxy-4,5,5-trimethyl-3-(3-oxobut-enyl)cyclohex-2-enone had a MIC of 2.5 μg/mL for *Staphylococcus albus*, while 8,9-dihydro-8,9-dihydroxy-megastigmatrienone had a weak inhibitory activity with the MIC of 5.0 μg/mL against *Staphylococcus albus*, *Bacillus cereus*, and *Bacillus subtilis* [41]. In addition, the ethanol extract of *Ficus pumila* L.'s stems and leaves had antibacterial effects on *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*, among which the best antibacterial effect was on *Staphylococcus aureus*, and the inhibition rate could reach 100% [62]. Moreover, the fish pathogen *Aeromonas hydrophila* isolated from infected rainbow trout demonstrated the highest susceptibility, with 10–12 mm inhibition zones, to the ethanolic extracts from leaves of *Ficus pumila* L. among the ethanolic leaves extracts from various species of *Ficus* by in vitro antimicrobial susceptibility testing [20].

A dried leaf extract of *Ficus pumila* L., rich in flavonoids, had a quercetin content of 15.30 mg/g, which showed a certain degree of inhibition on *Bacillus subtilis, Bacillus cereus, Enterococcus faecalis, Micrococcus luteus, Proteus mirabili, and Staphylococcus aureus* [18]. It has been found that quercetin plays a role in antibacterial and antiviral infection by regulating the cysteinyl aspartate specific protease-3 (caspase-3) protein-mediated apoptosis [63], which may contributed to the antibacterial effect of *Ficus pumila* L., although the specific compounds in *Ficus pumila* L. extracts still need to be further studied.

3.4. Antitumor Effect

It has been reported that the crude extract of *Ficus pumila* L. showed cytotoxicity in the human leukemia cancer cell line (MT-4) with an IC50 value of 131 μg/mL, while higher cytotoxic activities were found in the chloroform and butanol fractions with IC50 values of 23 μg/mL and 26 μg/mL, respectively [64]. The methyl thiazolyl tetrazolium (MTT) method was used to evaluate the cytotoxic activity of the compounds extracted from the 85% ethanol aqueous solution of *Ficus pumila* L. against Hela, MCF-7, and A549 cell lines [42]. The results showed that the compounds dehydrovomifoliol and (E)-3-oxo-retro-α-ionol performed medium cytotoxic activity, weakened cytotoxicity against Hela, MCF-7, and A549 cells with IC50 values of 32.32 and 33.70 μg/mL, respectively, and the effect of these two compounds in *Ficus pumila* L. against Hela, MCF-7, and A549 target cells activity was greater than that of other compounds, indicating that the carbonyl carbon at C-9 may be essential for the cytotoxic activity of ionone sesquiterpenes [42]. Flavonoids, sesquiterpenes, and other compounds were isolated from the stems of *Ficus pumila* L., and two of the flavonoids, apigenin and alpinum isoflavone, were found to inhibit breast cancer cells (MCF-7) with IC50 values of 32.5 μg/mL and 37.3 μg/mL, respectively [28].

3.5. Hypoglycemic Effect

Both in vitro and in vivo studies supported the hypoglycemic activities of the extracts of *Ficus pumila* L., and the hypoglycemic effects may due to the contents of flavonoids and polysaccharides.

An in vitro study revealed that flavonoids might be the main components that contributed to the hypoglycemic effect of *Ficus pumila* L., as the total flavonoids content was correlated with the α-glucosidase inhibitory activity of the extracts from rhizome of *Ficus pumila* L. [33]. The rhizome extraction contained the highest flavonoid content and displayed the strongest inhibitory activity toward α-glucosidase with an IC50 up to 0.018 g/L, which is better than the effect of acarbose, a clinical hypoglycemic drug, with an IC50 of 1.075 g/L [33]. In addition, the rhizome extracts of *Ficus pumila* L. also showed a high inhibitory effect on acetylcholinesterase with an IC50 up to 0.133 g/L, close to that of tacrine [33].

A pectic polysaccharide with a branched-chain of hexenuronic acid methyl ester linking to a linear (1,4)-alpha-D-galacturonic acid was obtained from the fruits of *Ficus pumila* L., and the in vivo study demonstrated that it had a strong hypoglycemic effect in the diabetic model of C57BL/KsJ db/db mice [22]. Results from the study showed that the *Ficus pumila* L. pectic polysaccharide significantly ameliorated hyperglycemia and improved hepatic glycogen metabolism by activating the adenosine monophosphate-activated protein kinase (AMPK)/glycogen synthase kinase-3β (GSK3β)/glycogen synthase (GS) and insulin receptor substrate-1 (IRS-1)/phosphatidylinositol 3-kinase (PI3K)/Akt/GSK3β/GS pathways and regulating the expressions of glucokinase, glucose-6-phosphatase, and phosphoenolpyruvate carboxykinase [22].

Studies have revealed that *Ficus pumila* L. and its bioactive compounds can ameliorate hyperglycemia. Several in vivo studies have demonstrated the antidiabetic activity of flavonoids or extracts from other *Ficus* plants in diabetic animals [65–67]. Therefore, *Ficus pumila* L. might be a good source of natural ingredients for the prevention and management of diabetes.

3.6. Gastrointestinal Protection

The seed surface of *Ficus pumila* L. is rich in pectin, the water extract of which has the property of spontaneous gel-formation at room temperature [68]. Accumulating data have revealed the protective effects of *Ficus pumila* L. pectin on gastrointestinal health. The bioactive compounds of *Ficus pumila* L., especially the pectin, can ameliorate gastrointestinal damages and improve gastrointestinal environments. Capsaicin-induced intestinal discomfort reactions, such as the alteration of intestinal microflora, the reduction of short-chain fatty acids, and the increase of pH and free ammonia levels, were found to be ameliorated by treatment with pectin from *Ficus pumila* L. seeds through both in vitro studies in an intestinal fermentation environment [69] and in vivo studies in capsaicin-induced ovariectomized rats [70]. Further studies demonstrated that *Ficus pumila* L. seeds pectin can decrease cecum free ammonia, and increase cecum short-chain fatty acids, cecum weight, cecum contents, fecal bulk, and the ratio of beneficial bacteria to harmful bacteria, as well as the amount of *Anaerobes*, *Bifidobacterium*, and *Lactobacillus* in ovariectomized rats [71]. Moreover, similar protective effects of *Ficus pumila* L. seed pectin were also found in high-fat diet-fed ovariectomized rats, although there was no effect on high-fat diet-induced hyperlipidemia [72]. Recently, a homogalacturonan-type pectic polysaccharide isolated from the fruits of *Ficus pumila* L. was found to possess beneficial effects on high-fat diet-induced obesity in mice [23]. The results showed that the *Ficus pumila* L. pectic polysaccharide can reduce body weight and ameliorate the high levels of serum total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) by modulating gut microbiota and metabolites [23].

3.7. Hepatorenal Protection

The extracts of *Ficus* plants, including *Ficus pumila* L., have been shown to possess significant protective effects on the liver and kidney [7,73–76]. As mentioned above, *Ficus pumila* L. is rich in various natural antioxidants, and the in vivo antioxidant properties have been reported from the methanol extract of *Ficus pumila* L. by increasing the antioxidant enzyme activities, including SOD, GPx, and GRd, in mice liver [19]. The hepatoprotective effect of *Ficus pumila* L. was then evaluated in the liver damaged model of Sprague–Dawley rats induced by carbon tetrachloride [24]. The results showed that the biochemical indicators of liver damage, such as increased levels of cholesterol and triglyceride, and elevated concentrations of total and indirect bilirubin, were obviously restored by the administration of 50% hydroethanolic leaf extract of *Ficus pumila* L. [24]. Moreover, the nephroprotective effect of *Ficus pumila* L. was demonstrated in a kidney damage model of female Wistar albino rats induced by gentamicin [77]. The data showed that hydroethanolic leaf extract of *Ficus pumila* L. was able to reduce gentamicin nephrotoxicity, which is characterized by changes of biochemical and hematological markers, such as increased levels of serum creatinine, potassium, sodium, urea, and white blood cells, and decreased levels of hemoglobin, mean cell hemoglobin, mean cell volume, and red blood cell [77]. Furthermore, the aqueous extracts of *Ficus pumila* L. fruits were revealed to have the effects on invigorating kidney and strengthened yang, and the extract from syconium fruits of *Ficus pumila* L. showed a better effect than that from the receptacle of inflorescence extract of *Ficus pumila* L. [78]. Thus, *Ficus pumila* L. has the potential to be exploited as a functional food or therapeutic agent against liver and kidney diseases.

3.8. Cardiovascular Protection

A clinical test has been conducted recently to verify the health beneficial effects of the leaf extracts of *Ficus pumila* L. on outpatients with hypertension and dyslipidemia, and the results showed that the *Ficus pumila* L. leaf extracts significantly reduced the body mass index, lowered both systolic and diastolic blood pressure, and improved lipid abnormalities, which indicated the cardiovascular protective effects of *Ficus pumila* L. [25]. Moreover, it was found that four kinds of fatty acid, namely palmatic acid (6.68%), oleic acid (12.67%), linoleic acid (14.42%), and α-linolenic acid (66.23%), are the main constituents of *Ficus pumila* L. seed oil by using supercritical carbon dioxide extraction method to extract oil from *Ficus pumila* L. seeds, of which the content of α-linolenic acid was 10 times than that of ordinary soybean oil [47]. Linoleic acid and α-linolenic acid are the most important essential fatty acids of the human body, which can be combined with cholesterol to prevent and treat cardiovascular diseases [47]. The supplementation of α-linolenic acid was able to improve cardiac function and have a protective effect on ischemic heart failure in a rat model of myocardial infarction by inhibiting the expression of NLR family, pyrin domain containing 3 (NLRP3), and the activity of caspase-1, and by reducing the levels of TNF-a, IL-1β, and IL-6 [79]. Moreover, it has also been found that α-linolenic acid plays a key role in reducing blood sugar and blood lipids in patients with mild to moderate hypertension [80].

3.9. Other Therapeutic Activities

Ficus pumila L. extracts were found to display a significant anti-hyperprolactinemic effect in metoclopramide dihydrochloride-induced hyperprolactinemic rats [81]. Moreover, it has been reported that the pectin from the seeds of *Ficus pumila* L. could increase the cecum area and the contents of short-chain fatty acids in the cecum and decrease the pH of the cecum contents, but it had a negative effect on mineral absorption in ovariectomized rats [82].

4. Study on the Development and Utilization of *Ficus pumila* L.

4.1. Industrial Applications

The quilt, seed, and achene of *Ficus pumila* L. are rich in nutrients. Wu et al. (1999) showed that the pectin content is up to 32.70% and the crude fat content is only 2.67% in *Ficus pumila* L. flowers [83]. The protein content is 39.88% in *Ficus pumila* L. pollen, much higher than that of ordinary plant pollen, and the amino acids content is up to 39.41%, of which 14.56% is the essential amino acids content [83]. *Ficus pumila* L. also contains mineral elements, vitamins, and flavonoids that are beneficial to human health. Yao and Pei (2008) employed supercritical carbon dioxide fluid extraction technology to extract seed oil from *Ficus pumila* L., and the maximum extraction rate could reach 20.93% [47]. In addition, the content of unsaturated fatty acids in *Ficus pumila* L. seed oil is as high as 93.32%, which contains a variety of beneficial fatty acids, and the flavor and quality are extremely high [47]. Therefore, the different parts of *Ficus pumila* L. have been widely used for making food gels, jelly, healthy beverages, or other functional foods [84–86]. Most importantly, it has been reported that *Ficus pumila* L. was non-toxic to mice with a dosage of 231.6 g/kg [87].

In addition to being widely used in the food industry, the high content of pectin in *Ficus pumila* L. is also a great resource to develop thickeners, emulsifiers, and stabilizers. Moreover, the peel milk of *Ficus pumila* L. can be utilized to make rubber, while the vines can be applied to produce paper. Furthermore, *Ficus pumila* L. vines possess good properties of toughness, strength, and wear resistance and can also be used as a raw material for the production of various types of woven handicrafts.

4.2. Ecological City Construction

Ficus pumila L., a vine plant with strong ecological restoration ability, possesses multiple benefits for the urban environment, such as improving urban hydrology, reducing urban air pollution, saving energy, providing habitat for urban wildlife, and beautifying the urban landscape. *Ficus pumila* L. was selected as one of the plant species to construct green roofs to study whether the water quality of the green roofs would be affected by substrates and plant species, and it was found that *Ficus pumila* L. resulted in the lowest concentrations of total phosphorous in both substrate units, suggesting that *Ficus pumila* L. may have the potential to reduce urban water and land pollution of phosphorus [88]. Tian et al. (2014) found that *Ficus pumila* L. has certain effects on water and soil conservation as well as nutrient retention [89]. Li et al. (2008) evaluated the ecological benefits of *Ficus pumila* L. and 11 other plant species with high potential for vertical greening [90]. The results showed that *Ficus pumila* L. displays an admirable performance in ecological benefits, ranking second next to *Thunbergia laurifolia*, and it could release oxygen by 32.52 g.m^{-2}.day^{-1}, absorb carbon dioxide by 44.73 g.m^{-2}.day^{-1}, reduce air temperature by 1.01 °C/1000 m^3, and increase air humidity by 1.13% [90]. Moreover, by using the ion beam irradiation method, Takahashi et al. (2012) produced novel mutants of *Ficus pumila* L. with an enhanced capacity to take up and assimilate atmospheric nitrogen dioxide compared to the wild-type controls, indicating that these mutants of *Ficus pumila* L. have a protective effect on mitigating urban air pollution, especially the atmospheric nitrogen dioxide [91]. In addition, Corlett (2006) demonstrated the importance of the urban fig flora, including *Ficus pumila* L. and other native or exotic *Ficus* species, to the urban wildlife in Hong Kong [92]. *Ficus pumila* L. also showed wide ecological adaptability [93], great vertical greening effect [94], and high tolerance to soil manganese contamination [95]. Furthermore, *Ficus pumila* L. has great ornamental value and is very easy to care for and maintain [1,96,97]. Therefore, *Ficus pumila* L. is considered to be used as a three-dimensional greening plant in the reinforced concrete city or a heavy metal contaminated land restoration plant through artificial breeding [98]. Moreover, tissue culture and other rapidly propagation techniques of *Ficus pumila* L. have been reported [99,100]. Thus, in the future, *Ficus pumila* L. will have broad application prospects, not only to be used as a beautifying plant for decorating home balconies and urban vertical greening of buildings, gardens, roads, and parks, but also applied as an ecological remediation unit for the treatment of soil contamination, water eutrophication, and air pollution, as well as soil-water conservation.

5. Conclusions

Ficus pumila L. is a kind of medicinal and practical plant. *Ficus pumila* L. is rich in nutrients and minerals. The pectin and various fatty acids have been applied in the food industry. It also contains many bioactive components, such as phenolic acids, flavonoids, polysaccharides, terpenoids, alcohols, and steroids. *Ficus pumila* L. extracts and their bioactive compounds exhibit multiple therapeutic activities, including antioxidant, anti-inflammatory, antibacterial, antitumor, hypoglycemic, and cardiovascular protective activities. Generally, *Ficus pumila* L. is non-toxic. Therefore, *Ficus pumila* L. and the contained bioactive components are promising as functional foods for the prevention and treatment of different kinds of diseases. In recent years, with the optimization of extraction techniques and methods, a variety of new compounds has been extracted from *Ficus pumila* L. Therefore, more therapeutic activities of these bioactive compounds from *Ficus pumila* L. should be evaluated, and more studies should be conducted to demonstrate the signaling pathways and mechanisms of action in the future. Moreover, *Ficus pumila* L. has great potential in ecological restoration and vertical greening, and the values of *Ficus pumila* L. in ecological restoration and greening should also attract special attention.

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