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Review Article

Phytochemistry and Pharmacological Activities of *Lepisanthes* Genus: A Review

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ABSTRACT

The genus *Lepisanthes* belonging to the family Sapindaceae consists of trees and shrubs native to tropical Africa, Madagascar, South and Southeast Asia, and northwestern Australia. Herein, we reported a comprehensive review on phytochemical constituents and biological activities of *Lepisanthes* species from year 1999 to 2021. All the available information and reported studies concerning *Lepisanthes* plants were summarized from library and digital databases (e.g., Google Scholar, Sci-finder, PubMed, Springer, Elsevier, MDPI, Web of Science, etc.). Approximately 96 chemical constituents have been isolated and reported from *Lepisanthes* species, such as flavonoids, tannins, saponin triterpenoids, lupane and hopane triterpenes as well as glycosides. Biological activities including anticancer, antimicrobial, antiacetylcholinesterase, antioxidant, antidiabetic, antihyperglycemic and antidiarrheal were demonstrated. This is the first review which highlights the phytochemical and pharmacological studies of different *Lepisanthes* species. The presented data can be beneficial for any future study.

Key words: Lepisanthes, Sapindaceae, Phytochemical, Bioactivity, Saponin.

Introduction

The genus *Lepisanthes* belonging to Sapindaceae family, comprises of 26 species and 2 subspecies of trees and shrubs.[1] They are widely distributed in tropical region from Africa to Madagascar, South to Southeast Asia and from northwestern Australia to New Guinea. The distribution of plants according to species are summarized in Table 1. The trees of *Lepisanthes* genus are commonly found in a coastal forest or on islands, or in the transition zone between mangrove and dry land. It can also grow in lowland forest, wastelands, by streams, or in secondary forest up to 500 m altitude. Plants from the genus *Lepisanthes* are discriminated based on their micro-morphological characters such as cuticular striation, stomata structure, type of waxes, trichome [2] as well as vessels, parenchyma, rays and fiber morphology.[3]

Traditionally, plants from this genus are used to cure headache, fever,[4] chest pain and nosebleed.[5] Aside from medicinal uses, it is also utilized as food preservatives and as sleep-inducing food.[6] The timbers are used for house building, manufactured as tool handles, crafted as kitchen utensil and chopped as firewood.[7] Unripe fruits are green in color and when the fruits are ripe, the color change from yellow to orange to red. Some species are planted for their fruits.[8-10] Due to its colorful fruits, *Lepisanthes alata* is used as decorative plant among local in Malaysia.[11] The fruits are 3 to 4 cm long obovoid berries borne in clusters, and can be eaten fresh, as it is sweet when ripe. This species is widely planted due to the sweetness of the fruits. The phytochemical screening of this genus has shown the presence of alkaloids, flavonoids, tannins, saponin triterpenoids, phenolics and glycosides.[6,12-13] Pharmacological studies of the extracts showed the presence of anticancer, antimicrobial, antiacetylcholinesterase, antioxidant, antidiabetic, antihyperglycemic and antidiarrheal activities. Both pharmacological and phytochemical of *Lepisanthes* species are summarized in Table 2 and 3. This review presented phytochemical and pharmacological results of *Lepisanthes* species in the period of 1999 to 2021. Based on this review, it was found that limited studies have been conducted on this genus, hence this review can be used as a starting point for researchers to discover other promising bioactive compounds from unexplored species of the genus *Lepisanthes*.

Traditional uses

Several *Lepisanthes* species are widely utilized as folk medicine, for example the leaves of *L. rubiginosa* are used for treating headache, fever, and act as tranquilizer. It is also processed into tonics and taken as cough medicine,[22] to induce sleep, remedy for nausea and vomitting [23] and also as food preservatives.[6] The uses are agreeable with *L. tetraphylla* whereby it also has the capability in reducing fever [24] and as cough remedy [24] The plant is also used as medicated shampoo to treat dandruff problem among Indian,[19] and to cure those with diarrhea in Bangladesh.[20] The Dayak's tribe from Kalimantan Indonesia use the leaves of *L. amoena* to treat facial skin problem by rubbing the foam formed after crumbling the shoots onto the affected skin.[25] In addition, various ethnic groups in Borneo use this plant as one of the ingredients in formulation of facial cleanser, soap, shampoo and face powder.[26-27] The decoction from the leaves of *L. senegalensis* helps to cure pain, inflammation, body fatigue,[28] fever,[29] while the fruits are eaten for treatment of diarrhea and dysentery.[30] On the other hand, the roots are used in the treatment of malaria, vertigo, chest pain and nosebleed.[31] There is also a report on its uses in the treatment of pleuropneumonia.[32] Previous study describes the roots of *L. fruticose* are used as poultice to relieve itching and to lower the body temperature during fever.[4,33] The natives in Sarawak make use of the decoction from the roots to rehabilitate rheumatism, backache and infertility.[34]

Pharmacological activities

Plant extracts from the genus *Lepisanthes* produce a wide spectrum of bioactivities including antibacterial, antioxidant, antidiabetic, antimalarial, and antiacetylcholinesterase activities. Until Jun 2021, only six species from this genus were screened over selected

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bioactivities. The bioactivity of *Lepisanthes* crudes were summarized in Table 2.

Chemical Constituents

Phytochemical study of *Lepisanthes* species has shown the presence of several classes of compounds, such as pentacyclic triterpenes, triterpenoid saponins, flavonoids, tannins, phenolic compounds and glycosides (Table 3).

Terpenes

The pentacyclic triterpenes were found to give hopane and lupane skeleton which can be seen from structure **1** until **10** (Figure 1). The caffeates substituent are attached to C-3 of hopane while coumarates are connected to lupane skeletons. On the other hand, triterpenoid saponins were isolated to give eight known compounds (**11-21**). These compounds usually form a glycosidic bond to its glycine namely glucose, arabinose, rhamnose and xylose. Terpenoids acquired from *L. rubiginosa* were sesquiterpenoids which formed together with rhamnose, arabinose and glucose (**22-23**) (Figure 2).

Flavonoids

Flavonoids are the largest group of phenolic compounds. To date, 49 flavonoids were recorded from *L. fruticosa* and *L. alata* with different skeletons such as flavanol, flavanonol, flavanone, flavonol, flavone, isoflavone and anthocyanin. Anthocyanin is the glycosylated form of anthocyanidin which provides 18 compounds in *Lepisanthes* genus (**24-72**) (Figure 3-5).

Phenolic compounds

Four phenolic acids were found in *L. alata* with two different skeletons. Caffeic acid-4-*O*-glucoside and ferulic acid-4-*O*-glucoside provides hydroxycinnamic molecular structure while hydroxybenzoic found in vanillic acid-4-*O*-glucoside (**73-76**). Besides phenolic acids, other compounds were identified. with various skeletons such as stilbene which contribute to structure **81** while mangiferin and mangiferdiol arises from xanthone skeletons (**77-84**) (Figure 6).

Tannin

Tannin found in this genus were hydrolysable condensed tannins. *L. fruticosa* has led to the isolation of condensed tannin which are procyanidin B1 and B2 as well as arecatannin A1 and A2 (**85-89**) (Figure 7). Structure **89** provides hydrolysable tannin due to presence of benzenetriol carrying hydroxy groups at positions 1, 2 and 3.

Other compounds

The rest of compounds belong to this category, which have different skeletons and sometimes attached to sugar ring like glucose, galactopyranosyl and hexoseside-pentoside (**90-96**) (Figure 8).

Table 1: Distribution of *Lepisanthes* Species

Species	Region			Ref.
	Africa to Madagascar	South to Southeast Asia	Northwestern Australia to New Guinea	
L. alata (Blume) Leenh		✓		11,14
L. amoena (Hassk.) Leenh		✓		2, 15-16
L. basicardia Radlk.		✓		17
L. browniana Hiern		✓		17
L. cauliflora var. *cauliflora*		✓		17
L. cauliflora var. *glabriflora* S. L. Mo & X. X. Lee		✓		17
L. fruticose (Roxb.) Leenh.		✓		11,18
L. hainanensis H.S.Lo		✓		17
L. oligophylla (Merr. & Chun) N. H. Xia & Gadek		✓		17
L.senegalensis (Poir.) Leenh.	✓	✓	✓	17
L. rubiginosa (Roxb.) Leenh		✓	✓	17
L. tetraphylla (Vahl.) Radlk		✓		19-21
L. unilocularis Leenh.		✓		17

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Table 2: Pharmacological Activities of the Genus *Lepisanthes*

Species	Plant Parts	Extracts	Bioactivities
L. alata (Blume) Leenh	All parts	EtOH, MeOH, H_2O	Antioxidant,[35-36] Antibacterial,[36] Antidiabetic,[37] Cyototoxic[35]
L. amoena (Hassk.) Leenh	Leaves, fruits & seeds	EtOH	Antibacterial,[38] Antioxidant[15,27,38]
L. fruticose (Roxb.) Leenh.	Leaves, fruits & stems	MeOH, H_2O	Antibacterial,[40] Antioxidant,[39,41-43] Antiacetylcholinesterase[33]
L.senegalensis (Poir.) Leenh.	Leaves & roots	EtOH, MeOH	Antibacterial,[28] Antimalarial,[31] Cytotoxic[28]
L. rubiginosa (Roxb.) Leenh	Leaves & barks	EtOH, MeOH	Antibacterial,[6] Antioxidant,[44] Antihyperglycemic,[6] Antipuretic,[6] Antidiarrheal,[6] Neuropharmacological[6]
L. tetraphylla (Vahl.) Radlk	Leaves & Stems	MeOH, CH_2Cl_2	Antibacterial,[45] Nematicidal[21]

*EtOH: ethanol; MeOH: methanol; H_2O: water; CH_2Cl_2: dichloromethane

Table 3: Phytochemicals Isolated from the Genus *Lepisanthes*

Name of Compounds	Species (plant parts)	Structure
LUPANE		
28-*O*-acetyl-3*β*-*O*-*trans*-caffeoylbetulin	*L. senegalensis* (st) [46]	**1**
3-*O*-*trans*-caffeoylbetulin	*L. senegalensis* (st & r) [46]	**2**
3-*O*-*trans* –caffeoylbetulinic acid	*L. senegalensis* (st) [46]	**3**
Betulin	*L. senegalensis* (st) [46]	**4**
Betulinic acid	*L. senegalensis* (st) [46]	**5**
Lupeol	*L. senegalensis* (st & r) [46]	**6**
3-*O*-*trans* -caffeoyllupeol	*L. senegalensis* (r) [46]	**7**
HOPANE		
3*α*-*O*-*trans* -*p*-coumaroyl-22-hydroxyhopane.	*L. senegalensis* (r) [46]	**8**
3*α*-*O*-*cis*-*p*-coumaroyl-22-hydroxyhopane	*L. senegalensis* (r) [46]	**9**
3*α*-*O*-*trans* -caffeoyl-22-hydroxyhopane	*L. senegalensis* (r) [46]	**10**
TRITERPENOID SAPONIN		
stigmasterol-3*β*-*O*-D-glucoside	*L. rubiginosa* (b) [47]	**11**
3-*O*-*α*-L-arabinopyranosyl hederagenin	*L. rubiginosa* (b) [47]	**12**
3-*O*-*α*-L-rhamnopyranosyl(1-2)-*α*-L-arabinopyranosyl hederagenin	*L. rubiginosa* (b) [47]	**13**
3-*O*-*β*-D-xylopyranosyl(1-3)-*α*-L-rhamnopyrosyl(1-2)-*α*-L-arabinopyranosyl hederagenin	*L. rubiginosa* (b) [47]	**14**
3-*O*-*α*-L-arabinopyranosyl(1-3)-*α*-L-rhamnopyrosyl(1-2)-*α*-L-arabinopyranosyl hederagenin	*L. rubiginosa* (b) [47]	**15**
3-*O*-*β*-D-glucopyranosyl(1-3)-*α*-L-rhamnopyrosyl(1-2)-*α*-L-arabinopyranosyl hederagenin	*L. rubiginosa* (b) [47]	**16**
3-*O*-*α*-L-rhamnopyranosyl(1-2)-*α*-L-arabinopyranosyl hederagenin 28-*O*-*β*-D-glucopyranosyl(1-2)-*β*-D-glucopyranosyl ester	*L. rubiginosa* (b) [47]	**17**
3-*O*-*β*-D-xylopyranosyl(1-3)-*α*-L-rhamnopyrosyl(1-2)-α-L-arabinopyranosyl hederagenin 28-*O*-*β*-D-glucopyranosyl(1-2)-*β*-D-glucopyranosyl ester	*L. rubiginosa* (b) [47]	**18**
Lepisantheside A	*L. rubiginosa* (b) [22]	**19**
Acutoside A	*L. rubiginosa* (b) [22]	**20**
3-*O*-[b-D-xylopyranosyl-(1!3)-b-D- glucopyranosyl-]-oleanolic acid	*L. rubiginosa* (b) [22]	**21**
SESQUITERPENOID SAPONIN		
Lepisantheside B	*L. rubiginosa* (b) [22]	**22**
Rubiginoside	*L. rubiginosa* (b) [47]	**23**

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FLAVANOL		
Gallocatechin	*L. fruticosa* (s) [33]	**24**
Epicatechin	*L. fruticosa* (s) [33], *L. alata* (f) [33]	**25**
FLAVANONOL		
Dihydrokaempferol-5-*O*-*β*-D-glucopyranoside	*L. fruticosa* (s) [33]	**26**
2,5,7-trihydroxyflavanone-4'-*O*-*β*-D-glucoside	*L. fruticosa* (s) [33]	**27**
Neoastilbin	*L. fruticosa* (s) [33]	**28**
Taxifolin-3-*O*-hexoside	*L. alata* (f) [48]	**29**
FLAVANONE		
Eriodictyol-7-*O*-rutinoside	*L. alata* (f) [48]	**30**
Eriodictyol-*O*-hexoside I, II, III	*L.alata* (f) [48]	**31**
FLAVONOL		
Quercetin-3,7-*O*-*β*-D-diglucopyranoside	*L. fruticosa* (s) [33]	**32**
Quercetin-3-*O*-*β*-D-galactopyranoside	*L. fruticosa* (s) [33]	**33**
Kaempferol-3,7-diglucoside	*L. fruticosa* (s) [33]	**34**
Quercetin-3-galactoside-7-glucoside	*L. fruticosa* (s) [33]	**35**
Quercetin-3-*O*-*β*-D-galactopyranoside	*L. fruticosa* (s) [33]	**36**
Rutin	*L. fruticosa* (s) [33]	**37**
Quercetin-3-sulphate	*L. fruticosa* (s) [33]	**38**
Buddlenoid A	*L. fruticosa* (s) [33]	**39**
Hibiscetin-3-*O*-glucoside	*L. fruticosa* (s) [33]	**40**
Myricetin-3-*O*-rutinoside	*L. alata* (f) [48]	**41**
Quercetin-3-*O*-rutinoside	*L. alata* (f) [48]	**42**
Quercetin-3-*O*-glucoside	*L. alata* (f) [48]	**43**
Kaempferol-3-*O*-rutinoside	*L. alata* (f) [48]	**44**
Isorhamnetin-3-*O*-rutinoside	*L. alata* (f) [48]	**45**
Quercetin-3-*O*-rhamnoside	*L. alata* (f) [48]	**46**
Quercetin	*L. alata* (f) [48]	**47**
Quercetin-4'-*O*-galactoside	*L. alata* (f) [48]	**48**
FLAVONE		
5,2'-dihydroxy-6,7,8-trimethoxyflavone-2'-*O*-*β*-D-glucoside	*L. fruticosa* (s) [33]	**49**
Luteolin-7-*O*-hexoside	*L. alata* (f) [48]	**50**
ISOFLAVONE		
Genistein-7,4'-di-*O*-*β*-D-glucoside	*L. fruticosa* (s) [33]	**51**
Neobavaisoflavone	*L. alata* (f) [48]	**52**
Daidzein	*L. alata* (s) [49]	**53**
Genistein	*L. alata* (f) [49]	**54**
ANTHOCYANIN		
Luteolinidin	*L. fruticosa* (s) [33]	**55**
Cyanidin-3-*O*-sophoroside	*L. alata* (f) [48]	**56**
Cyanidin-3-*O*-glucosylrutinoside	*L. alata* (f) [48]	**57**
Cyanidin-3,5-*O*-diglucoside	*L. alata* (f) [48]	**58**
Cyanidin-3-*O*-rutinoside-5-O-glucoside	*L. alata* (f) [48]	**59**
Delphinidin-3-*O*-neohesperidoside	*L. alata* (f) [48]	**60**
Cyanidin-3-*O*-glucoside	*L. alata* (f) [48]	**61**
Cyanidin-3-*O*-rutinoside	*L. alata* (f) [48]	**62**

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Peonidin-3-*O*-glucoside	*L. alata* (f) [48]	**63**
Cyanidin-3-*O*-pentoside	*L. alata* (f) [48]	**64**
Cyanidin-3-*O*-(2'''-acetylrutinoside)	*L. alata* (f) [48]	**65**
Cyanidin-3-*O*-(6"-acetylglucoside)	*L. alata* (f) [48]	**66**
Delphinidin-3,5-*O*-diglucoside	*L. alata* (f) [48]	**67**
Delphinidin-3-*O*-(6"-coumaroylglucoside)	*L. alata* (f) [48]	**68**
Delphinidin-3-*O*-rutinoside	*L. alata* (f) [48]	**69**
Cyanidin-3-*O*-glucoside-5-Opentoside	*L. alata* (f) [48]	**70**
Cyanidin-3-*O*-glucoside-7-Orhamnoside	*L. alata* (f) [48]	**71**
Petunidin-3-*O*-rutinoside	*L. alata* (f) [48]	**72**
PHENOLIC ACID		
Caffeic acid-4-*O*-glucoside	*L. alata* (f) [48]	**73**
Vanillic acid-4-*O*-glucoside	*L. alata* (f) [48]	**74**
Ferulic acid-4-*O*-glucoside	*L. alata* (f) [48]	**75**
(2Z)-6-[5-(b-D-Glucopyranosyloxy)-4-hydroxy-2-methylphenyl]-2-methyl-2-heptenoic acid	*L. alata* (f) [48]	**76**
OTHER COMPOUNDS		
Mangiferin	*L. fruticosa* (s) [33]	**77**
6-gingerol	*L. fruticosa* (s) [33]	**78**
Ellagic acid	*L. fruticosa* (s) [33]	**79**
Mangiferdiol	*L. alata* (f) [48]	**80**
3-Isopentadienyl-3',4,5'-trihydroxystilbene	*L. alata* (f) [48]	**81**
Verbasoside	*L. alata* (f) [48]	**82**
Primulaverin	*L. alata* (f) [48]	**83**
Astringin	*L. alata* (f) [48]	**84**
TANNIN		
Procyanidin B2	*L. fruticosa* (s) [33]	**85**
Procyanidin B3	*L. fruticosa* (s) [33]	**86**
Arecatannin A1	*L. fruticosa* (s) [33]	**87**
Arecatannin A2	*L. fruticosa* (s) [33]	**88**
1,2,6-tri-*O*-galloyl-*β*-D-glucopyranoside	*L. fruticosa* (s) [33]	**89**
Methyl 4-*O*-galactopyranosyl-2,3-di-*O*-methyl-galactopyranoside	*L. alata* (f) [48]	**90**
Benzyl alcohol-hexosidepentoside I, II	*L. alata* (f) [48]	**91**
Primeveroside	*L. alata* (f) [48]	**92**
Jasminoside R	*L. alata* (f) [48]	**93**
Pinellic acid	*L. alata* (f) [48]	**94**
2,6-dimethoxy-1,4-benzoquinone	*L. senegalensis* (b) [46]	**95**
Equol	*L. alata* (s & f) [49]	**96**

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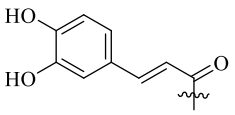
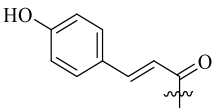
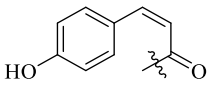


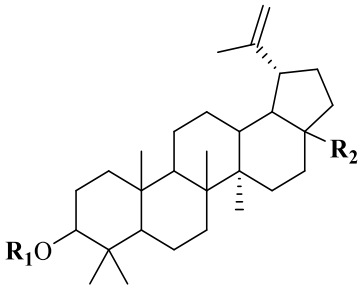
trans-caffeoyl



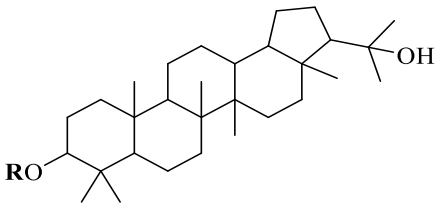
trans-coumaroyl



cis-coumaroyl

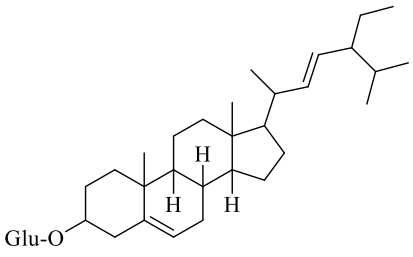


	R_1	R_2
1	*trans*-caffeoyl	CH_2OAc
2	*trans*-caffeoyl	CH_2OH
3	*trans*-caffeoyl	COOH
4	H	CH_2OH
5	H	COOH
6	H	CH_3
7	*trans*-caffeoyl	CH_3



	R
8	*trans*-coumaroyl
9	*cis*-coumaroyl
10	*trans*-caffeoyl

Figure 1: Compounds **1-10**



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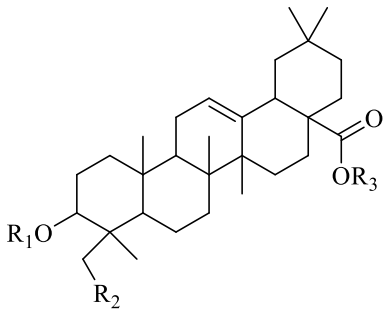
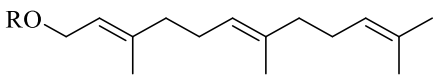


	R_1	R_2	R_3
12	Ara	OH	H
13	Rha(1-2)Ara	OH	H
14	Xyl(1-3)Rha(1-2)Ara	OH	H
15	Ara(1-3)Rha(1-2)Ara	OH	H
16	Glc(1-3)Rha(1-2)Ara	OH	H
17	Rha(1-2)Ara	OH	Glc(1-2)Glc ester
18	Xyl(1-3)Rha(1-2)Ara	OH	Glc(1-2)Glc ester
19	Glc(1-2)Xyl(1-3)Glu	H	H
20	Glc(1-2)Glc	H	H
21	Xyl(1-3)Glc	H	H



	R
22	Rha(1-6)Rha(1-2)Ara(1-3)Glc
23	Rha(1-6)Rha(1-2)Ara(1-3)Ara(1-3)Glc

Figure 2: Compounds **11-23**

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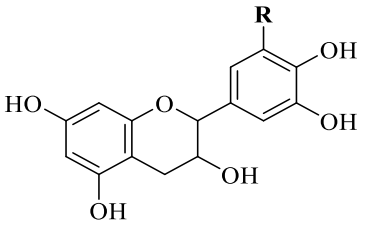
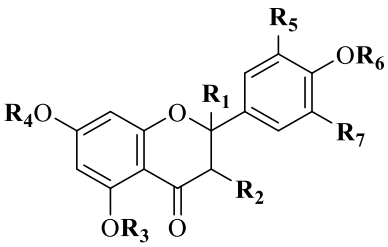
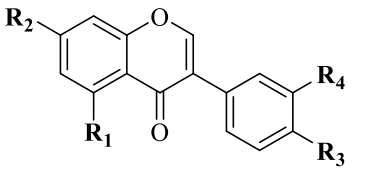


	R
24	OH
25	H

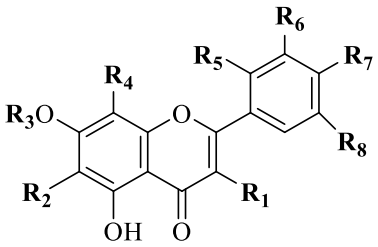


	R_1	R_2	R_3	R_4	R_5	R_6	R_7
26	H	OH	Glu	H	H	H	H
27	OH	H	H	H	H	Glu	H
28	H	O-Rha	H	H	H	H	OH
29	H	O-Hex	H	H	H	H	OH
30	H	H	H	Rut	OH	H	H
31	H	H	H	Hex	OH	H	H



	R_1	R_2	R_3	R_4
51	OH	O-Glu	O-Glu	H
52	H	OH	OH	Prenyl
53	H	OH	OH	H
54	OH	OH	H	OH

Figure 3: Compounds **24-31, 51-54**



	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8
32	O-Glu	H	Glu	H	H	H	OH	OH
33	O-Glu	H	H	H	H	H	OH	OH
34	O-Glu	H	Glu	H	H	H	OH	H
35	O-Gal	H	Glu	H	H	H	OH	OH
36	O-Gal	H	H	H	H	H	OH	OH
37	O-Rha(1-6)Glu	H	H	H	H	H	OH	OH
38	O-SO_3H	H	H	H	H	H	OH	OH
39	OH	H	O-Cou-Glu	H	H	H	OH	H
40	O-Glu	H	H	OH	H	OH	OH	OH
41	O-Rut	H	H	H	H	OH	OH	OH
42	O-Rut	H	H	H	H	OH	OH	H
43	O-Glu	H	H	H	H	OH	OH	H
44	O-Rut	H	H	H	H	H	OH	H
45	O-Rut	H	H	H	H	OCH_3	OH	H
46	O-Rha	H	H	H	H	OH	OH	H
47	OH	H	H	H	H	OH	OH	H
48	OH	H	H	H	H	OH	O-Gal	H
49	H	OCH_3	CH_3	OCH_3	O-Glu	H	H	H
50	H	H	Hex	H	H	OH	OH	H

Figure 4: Compounds **32-50**

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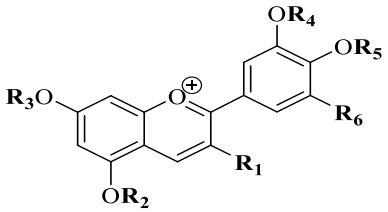
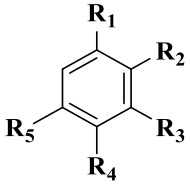
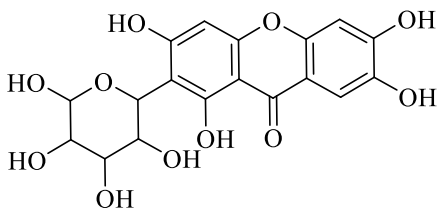


	R_1	R_2	R_3	R_4	R_5	R_6
55	H	H	H	H	H	H
56	O-Sop	OH	OH	OH	OH	H
57	O-Glu-Rut	OH	OH	OH	OH	H
58	O-Glu	O-Glu	OH	OH	OH	H
59	O-Rut	O-Glu	OH	OH	OH	H
60	O-Neo	OH	OH	OH	OH	OH
61	O-Glu	OH	OH	OH	OH	H
62	O-Rut	O-Glu	OH	OH	OH	H
63	O-Glu	OH	OH	OCH_3	OH	H
64	O-Pen	OH	OH	OH	OH	H
65	O-ac-Rut	OH	OH	OH	OH	H
66	O-ac-Glu	OH	OH	OH	OH	H
67	O-Glu	O-Glu	OH	OH	OH	OH
68	O-cou-Glu	OH	OH	OH	OH	OH
69	O-Rut	OH	OH	OH	OH	OH
70	O-Glu	O-Pen	OH	OH	OH	H
71	O-Glu	OH	O-Rha	OH	OH	H
72	O-Rut	OH	OH	OH	OH	OCH_3

Figure 5: Compounds **55-72**



	R_1	R_2	R_3	R_4	R_5
73	Acrylic acid	H	OH	O-Glu	H
74	Formic acid	H	OCH_3	O-Glu	H
75	Acrylic acid	H	OCH_3	O-Glu	H
76	Heptenoic acid	CH_3	H	OH	O-Glu



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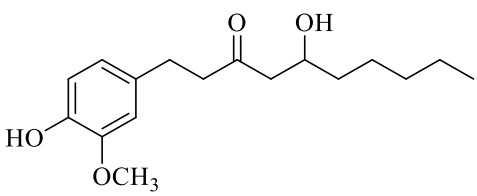

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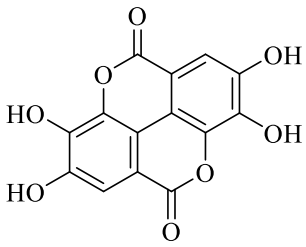

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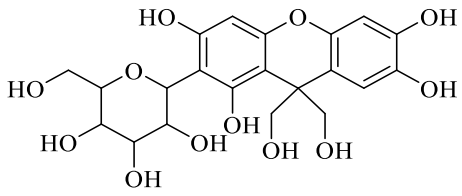

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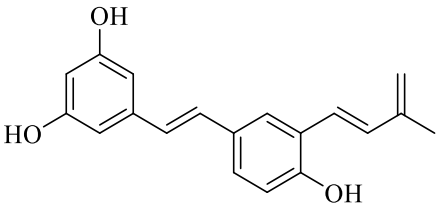

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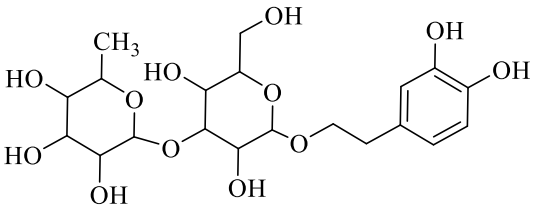

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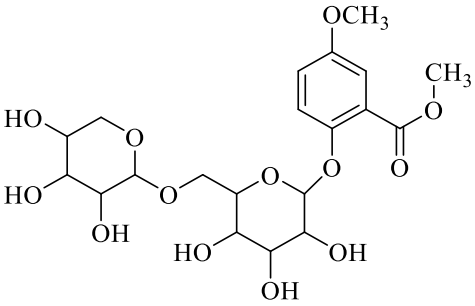

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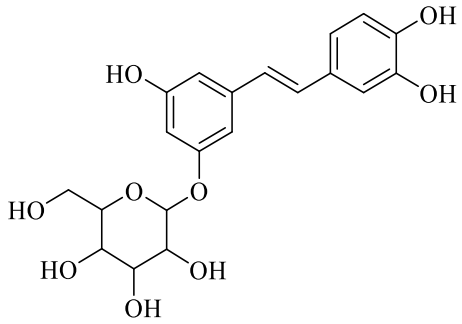

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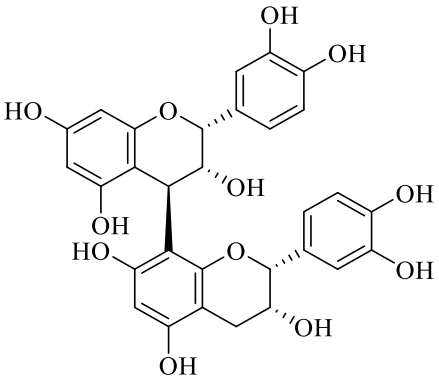
Figure 6: Compounds **73-84**



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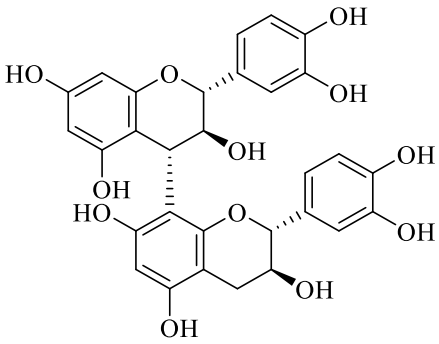

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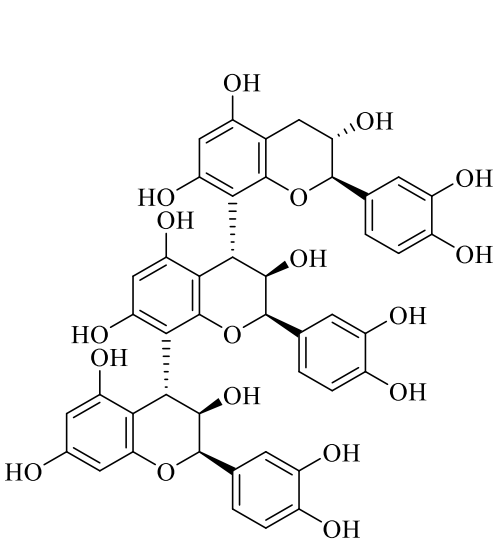

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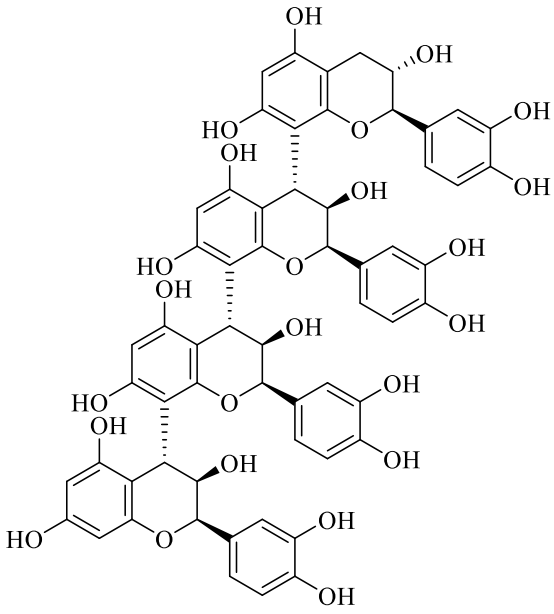

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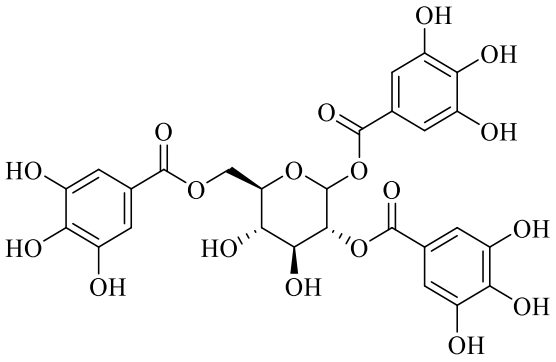

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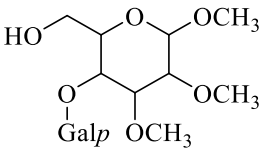
Figure 7: Compounds **85-89**



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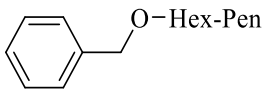

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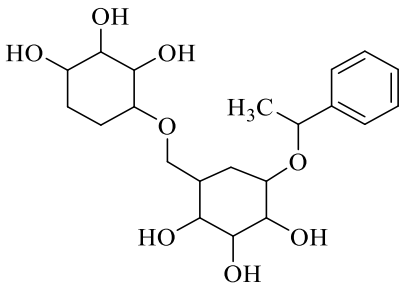

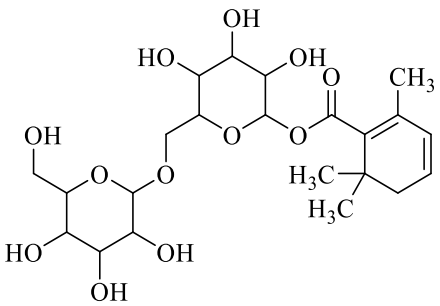

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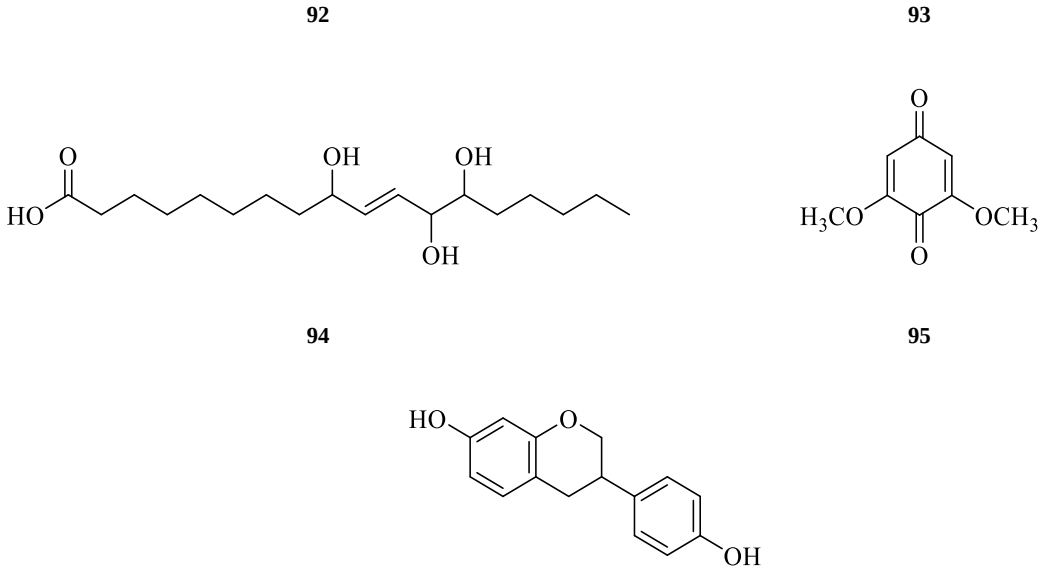

Figure 8: Compounds **90-96**

Conclusion

This review provides a comprehensive summary of phytochemical and pharmacological data of the genus *Lepisanthes*. To date, only six species were investigated for their bioactivities and four species have been phytochemically studied. Considering the limited investigations on the species of this genus, through this latest documented chemical and biological review, future study on other unstudied species will be beneficial and this genus will continue to be a promising source for medicinal natural products and food industrial products.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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