

Review Article

Phytochemical and Ethno-Pharmacological Review of the Genus *Araucaria* – Review

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Abstract

Distribution, traditional uses, isolated chemical constituents and pharmacological activities of some common species of the genus *Araucaria* are reviewed in this paper. Almost 19 species belong to the genus, *Araucaria*. It is indigenous to North America. Biflavanoid, diterpene, phenyl propanoid and lignans are abundant in the genus. The most common pharmacological activity of *Araucaria* in modern medicines is anti-inflammatory. It also possesses other pharmacological activities such as anti-ulcer, antiviral, neuro-protective, anti-depressant and anti-coagulant. The aim of the present paper is to present an extensive review of the plants in this genus including their traditional uses, chemical constituents and pharmacology.

Keywords: *Araucaria*, Ethnopharmacology, Phytochemistry, Biflavanoids, Diterpene

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INTRODUCTION

Medicinal plants are of huge value to mankind, for example, some ornamental species are of huge medicinal importance such as isolated constituents of catharanthus roseus used in cancer therapy. This review on the genus *Araucaria* covers its traditional uses, phytochemistry and the pharmacological activities of its different species. Various retrieval systems were accessed for the compilation of the data presented.

Botany

Araucaria belong to the genus of evergreen coniferous trees (Araucariaceae). The genus *Araucaria* is represented by 19

species, several of which are used for ornamental and timber purposes. Some species are used for medicinal purposes such as *Araucaria angustifolia*, *Araucaria araucana*, *Araucaria bidwillii*, *Araucaria cunninghamii* and *Araucaria heterophylla*. It is highly distributed throughout New Guinea, New Caledonia, eastern Australia, Norfolk Island, Chile, southern Brazil and Argentina. *Araucaria bidwillii* Hook, *Araucaria cunninghamii* and *Araucaria heterophylla* have been introduced in China while *Araucaria columnaris* and *Araucaria cunninghamii* exist in Pakistan. In Pakistan, it is widely used as decorative plant in urban cities. Major species with synonyms and their distribution are listed in Table 1.

Traditional uses of *Araucaria*

Araucaria belongs to the genus that has been used for different purposes. Different species have different functions, for example, the leaves of *Araucaria angustifolia* are used against respiratory infection. It is also used as emollient, antiseptic and for rheumatism [1]. The resin of *Araucaria araucana* is used to treat contusions, ulcers, as well as to help cicatrization and is also applied to wounds [2,3]. One of the species (*Araucaria*

bidwillii) exists in South Africa and the bark is used for treatment of amenorrhoea. The bark is grated and one tablespoonful is poured into approximately 750 ml of cold water and left for a day. This is taken orally once a day, four tablespoon at a time. It is also an application for body wash and steam wash [4]. *Araucaria cunninghamii* is interestingly used in rituals for the people of yali (New Guinea) [5]. *Araucaria heterophylla* has been traditionally used for toothache [6]

Table 1: Major *Araucaria* species, synonyms and their distribution

Species	Synonym	Distribution
<i>Araucaria angustifolia</i>	<i>Columbea angustifolia</i> Bertol.	Bolivia , Brazil ,Ecuador, El Salvador, Honduras Paraguay
<i>Araucaria araucana</i>	<i>Pinus araucana</i> Molina; <i>Abies araucana</i> (Molina) Poir ; <i>Dombeya araucana</i> (Molina) Raeusch.	Chile and Venezuela
<i>Araucaria bidwillii</i>	<i>Mary wildea bidwillii</i> (Hook.) A.V. Bobrov & Melikyan	Australia, China, El Salvador, Guatemala, Honduras, Nicaragua, Venezuela
<i>Araucaria brasiliana</i>	<i>Columbea brasiliana</i> (A. Rich.) Carrière	Brazil
<i>Araucaria chilensis</i>	<i>Dombeya chilensis</i> Lam.	-
<i>Araucaria columnaris</i>	<i>Cupressus columnaris</i> J.R. Forst.	New Caledonia, Peshawar
<i>Araucaria excelsa</i>	<i>Dombeya excelsa</i> Lamb. <i>Columbea excelsa</i> (Lamb.) Spreng. ; <i>Eutacta excelsa</i> (Lamb.) Link	Australia, Bolivia, Guatemala, Panama.
<i>Araucaria heterophylla</i>	<i>Eutassa heterophylla</i> Salisb.	Belize, China, Ecuador, El Salvador, Honduras, Venezuela.

Table 2: *Araucaria* species - common names and traditional uses

Species	Common name	Plant part	Traditional uses	Reference
<i>Araucaria angustifolia</i>	Pinheiro-do-parana (Barazilian)	Leaves	Emollient, antiseptic and for respiratory infections and rheumatism	[1]
<i>Araucaria araucana</i>	Pehuen (Argentina)	Whole Plant	The resin was used to treat contusions, ulcers, to help cicatrization and was also applied to wounds	[2,3]
<i>Araucaria bidwillii</i>	abaNqonqozi (South africa)	Bark	A treatment for amenorrhoea and body wash and steam wash	[4]
<i>Araucaria cunninghamii</i>	Sin	Whole plant	Bark used for thatching; Ritual application	[5]
<i>Araucaria heterophylla</i>	Pino (Peru)	Aerial Part	Toothache, Extracting teeth	[6]

Chemical constituents isolated from the genus *Araucaria*

Extensive work has been done in *Araucaria angustifolia*. It comprises N-acetyl-D-glucosamine-specific lectin from the seed of plant [7]; biflavanoid such as 7,4',7"-tri-O-Methyl amentoflavone (**5a**), 7,4',4"-tri-O-Methyl amentoflavone (**5b**), 4',4""-di-O-Methyl amentoflavone (**5c**), ginkgetin (**12**), Bilobetin (**13**), 11-7-O-methyl-robustafavone (**14**), cupressuflavone (**15**) [8,9,10,18,20,22]; isoflavanoids such as Cabreuvin (**6**) [8], Irisolidone (**7**); Phenylpropanoid like Octadecyl (E)-p-coumarate (**1**), Octadecyl (Z)-p-coumarate (**2**), Octadecyl (E)-ferulate (**3**), Octadecyl (Z)-ferulate (**4**) [8]; Lignans such as (+)-Pinoresinol (**8**), (+)-Eudesmin (**9**), (+)-Lariciresinol (**10**), secoisolariciresinol (**16**), isolariciresinol (**17**), isolariciresinol-4'-methyl ether, Secoisolariciresinol monomethyl ether, lariciresinol-4-methyl ether and terpenes like trans-Communic acid (**11**) [8,11,12]. Similarly, *Araucaria araucana*, which belongs to the same genus, contain biflavanoid such as 7-O-methylagathisflavone (**27**), 7"-O-methylamentoflavone (**28**), 7,7"-di-O-methylcupressuflavone, di-O-methylagathisflavone (**29**), di-O-methylamentoflavone (**30**), tri-O-methylagathisflavone, tri-O-methylamentoflavone and tri-O-cupressuflavone [18] and terpenes like Trachylobane (**18**) [14], 15,19-diacetoxylabd-8(17)-en [15], geraniolene (**19**), limonene (**20**), (+)- γ -cadinene (**21**), (-)- α -cadinol (**22**), (+)-hibaene (**23**), (-)-kaurene (**24**), (-)-atisirene (**25**), isokaurene/isoatisirene [16], Labdane (**26**) [17], junicedric acid (**31**) [19].

Araucaria bidwillii contains 7-O-methylcupressuflavone, 7,7"-di-O-methylagathisflavone (**29**), 7-O-methylagathisflavone (**27**), 4""-7-di-O-methylagathisflavone, 7,7"-di-O-methylcupressuflavone, bilobetin (**13**) [20], arabinogalactan from their exudate (**32**) [21], Labda-8(20),13-dien-15-oic acid (**33**), Labda-8(20), 13-dien-15,19-dioic acid (**34**), Kolavenic acid [22] (**35**).

Abietanes is present in *Araucaria columnaris*, *Araucaria cunninghamii* and *Araucaria montana* [22]. *Araucaria excelsa* contains 7"-O-Methylamentoflavone (**28**), 7,7"-di-O-methylamentoflavone, 4' or 4""-7-di-O-methylcupressuflavone, 7,7""-tri-O-methyl agathisflavone, 7,4',7"-tri-O-methylamentoflavone (**5a**), 7,7"-di-O-

methylagathisflavone (**29**), 7,4',7",4""-tetra-O-methylamentoflavone (**5d**), 7,4',7",4""-tetra-O-methyl-cupressuflavone whereas *Araucaria heterophylla* contains Labda-8(17), 14-diene, 13-epicupressic acid (**37**), 13-O-acetyl-13-epicupressic acid [23][24]. 3-O-methylrhamnose (**38**) [25] is the only constituents found in *Araucaria resinous*. All the chemical constituents present in the genus are listed in Table 3

Pharmacological activities

Gastroprotective activity was afforded by the ethanol extract of *Araucaria araucana* in mice in the dose range of 25 – 800 mg [26]. *Araucaria angustifolia* owns anti-depressant activity because it possess isolated lecithin from the seeds of the plant. Saline was used as negative control. Pentylene-tetrazole and strychnine-induced seizure models were used to induce depression in rats [27]. *Araucaria angustifolia* also possesses antiviral activity and in this regard, different fractions (hydroethanol, petroleum ether, dichloromethane, ethyl acetate, and n-butanol) were used [28]. It also possesses anti-inflammatory activity when tested with the rat paw edema model [29]. Ethyl acetate fraction of *Araucaria bidwillii* possesses neuroprotective activity using vitamin E as positive control [30]. Other activities that have been reported include free radical scavenging capacity, as well as anti-pyretic activity, anti-coagulant and anti-inflammatory activities [31-33]. The ethanol extract of *Araucaria bidwillii* has anti-pyretic and anti-inflammatory activity [31-33]. The genus' pharmacological activities are detailed in Table 5.

CONCLUSION

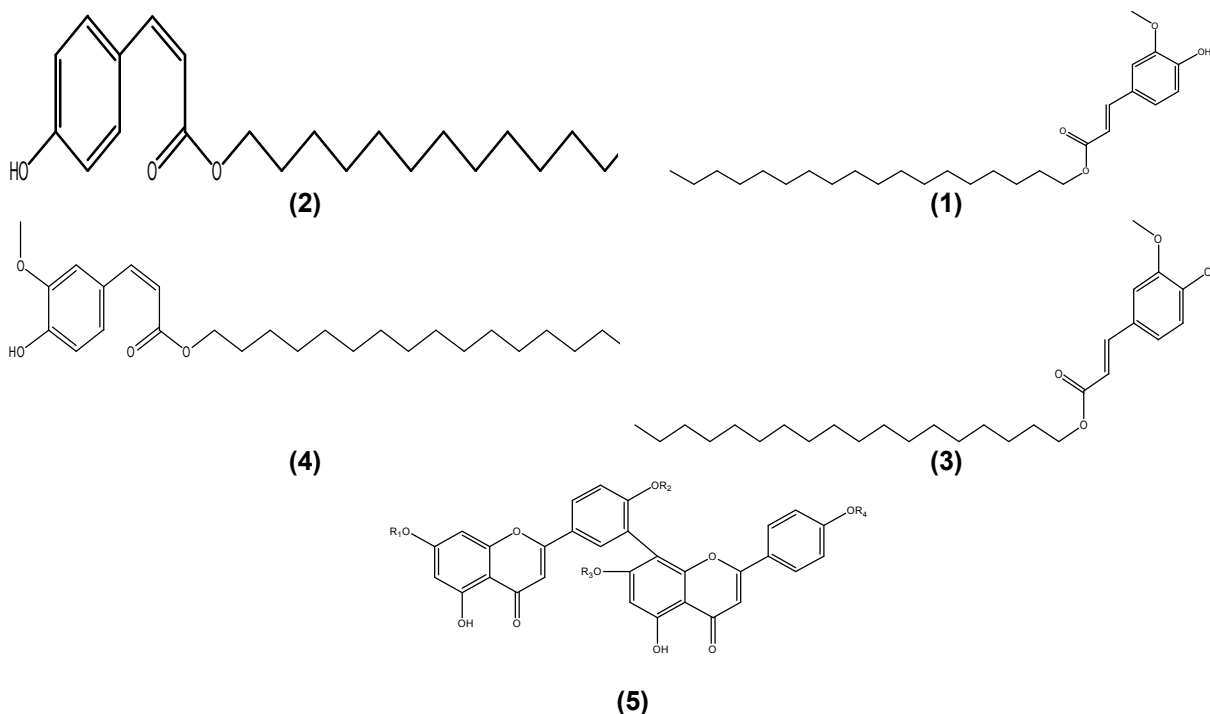
Araucaria species are abundant in South America, particularly Bolivia, Brazil, Ecuador, El Salvador, Honduras and Paraguay. They are traditionally used for ethnomedicinal and ornamental purposes. Some of the species may have medicinal value such as gastroprotective, antiviral and anti-inflammatory activity. *Araucaria angustifolia* and *Araucaria excelsa* are rich in biflavonoids while *Araucaria araucana* are rich in terpenes.

Table 3: Chemical constituents of the genus *Araucaria*

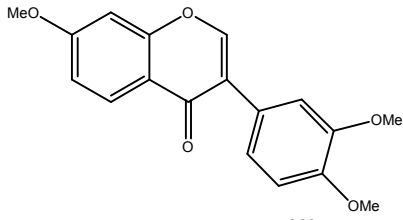
Species	Chemical constituent	Reference
<i>Araucaria angustifolia</i>	N-acetyl-D-glucosamine-specific lectin, Octadecyl (E)-p-coumarate(1) ; Octadecyl (Z)-p-coumarate(2) ; Octadecyl (E)-ferulate(3) ; Octadecyl (Z)-ferulate(4); 7,4',7''-tri-O-Methyl amentoflavone(5a); 7,4',4''-tri-O-Methyl amentoflavone(5b) ; 4',4'''-di-O-Methyl amentoflavone(5c); Cabreuvine(6) ; Irisolidone(7); (+)-Pinoresinol(8) ; (+)-Eudesmin(9) ; (+)-Lariciresinol(10) ; trans-Communic acid(11) ; ginkgetin(12) ; Bilobetin(13) ; 11-7-O-methyl-robustaflavone(14); cupressuflavone(15) ; secoisolariciresinol(16) ; isolariciresinol(17); isolariciresinol-4'-methyl ether ; Secoisolariciresinolmonomethyl ether ; lariciresinol-4-methyl ether ; Arabinogalactan-proteins.	[7][8][9][10] [11][12][13]
<i>Araucaria araucana</i>	Trachylobane(18) ; 15,19-diacetoxylabd-8(17)-en ; geraniolene(19);limonene (20) ; (+)- γ -cadinene(21); (-)- α -cadinol(22) ; (+)-hibaene(23) ; (-)-kaurene(24) ; (-)-atisirene(25) ; isokaurene/isoatisirene ; Labdane(26) ; 7-O-methylagathisflavone (27);7''-O-methylamentoflavone (28) ; 7,7''-di-O-methylcupressuflavone ; di-O-methylagathisflavone(29) ; di-O-methylamentoflavone(30) ; tri-O-methylagathisflavone, tri-O-methylamentoflavone and tri-O-cupressuflavone ; junicedric acid(31).	[14][15][16] [17][18][19]
<i>Araucaria bidwillii</i>	7-O-methylcupressuflavone ; 7,7''-di-O-methylagathisflavone(29) ; 7-O-methylagathisflavone(27) ; 4''',7-di-O-methylagathisflavone ; 7,7''-di-O-methylcupressuflavone ;bilobetin(13) ; arabinogalactan from their exudate(32) ; Labda-8(20),13-dien-15-oic acid (33) ; Labda-8(20), 13-dien-15, 19-dioic acid(34); Kolavenic acid(35)	[20][21][22]
<i>Araucaria columnaris</i>	Abietanes(36)	[22]
<i>Araucaria cunninghamii</i>	Abietanes(36)	[22]
<i>Araucaria excelsa</i>	7''-O-Methylamento-flavone (28) ; 7,7''-di-O-methylamento-flavone ; 4' or 4''', 7-di-O-methylcupressuflavone ; 7,7'',4''-tri-O-methyl agathisflavone ; 7,4',7''-tri-O-methylamento-flavone(5a); 7,7''-di-O-methylagathisflavone(29) ; 7,4',7'',4''-tetra-O-methylamento-flavone(5d) ; 7,4',7'',4''-tetra-O-methylcupressuflavone.	[23]
<i>Araucaria heterophylla</i>	Labda-8(17), 14-diene ; 13-epicupressic acid (37) ; 13-O-acetyl-13-epicupressic acid	[24]
<i>Araucaria montana</i>	Abietanes(36)	[21]
<i>Araucaria resinosa</i>	3-O-methylrhamnose(38)	[25]

Table 4: Chemical class of compounds isolated from *Araucaria* species

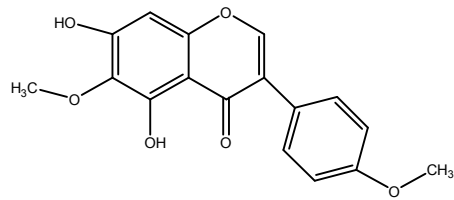
Chemical class	Typical compounds
Biflavanoid	7,4',7''-tri-O-Methyl amentoflavone(5a); 7,4',4''-tri-O-Methyl amentoflavone(5b) ; 4',4'''-di-O-Methyl amentoflavone(5c);ginkgetin(12); Bilobetin (13); Il-7-O-methyl-robustaflavone(14);cupressuflavone(15); 7,7''-di-O-methylcupressuflavone ; di-O-methylagathisflavone(29) ; di-O-methylamentoflavone(30) ; tri-O-methylagathisflavone ; tri-O-methylamentoflavoneand tri-O-cupressuflavone ; 7-O-methylcupressuflavone
Isoflavanoid	Cabreuvin(6) ;Irisolidone(7)
Phenylpropanoid	Octadecyl (E)-p-coumarate(1) ; Octadecyl (Z)-p-coumarate(2) ; Octadecyl (E)-ferulate(3) ; Octadecyl (Z)-ferulate(4) ;
Furans; lignans	(+)-Pinoresinol(8); (+)-Eudesmin(9); (+)-Lariciresinol(10); secoisolariciresinol(16) ; isolariciresinol (17); isolariciresinol-4'-methyl ether ; Secoisolariciresinolmonomethyl ether ; lariciresinol-4-methyl ether
Protein	Arabinogalactan-proteins
Terpenes	trans-Communic acid(11); Trachylobane (18); 15,19-diacetoxylabd-8(17)-en; geraniolene (19) ; limonene (20) ;(+)- γ -cadinene(21) ; (-)- α -cadinol(22) ; (+)-hibaene (23) ; (-)-kaurene (24) ; (-)-atisirene (25) ; isokaurene/isoatisirene; Labdane (26); Junicedric acid(31) ; Labda-8(20),13-dien-15-oic acid (33) ; Labda-8(20), 13-dien-15, 19-dioic acid (34); Kolavenic acid (35) ; Abietanes (36); Labda-8(17), 14-diene; 13-epicupressic acid (37) ; 13-O-acetyl-13-epicupressic acid
Polysaccharides	3-O-methylrhamnose (38)



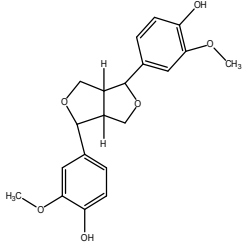
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5a	Me	Me	Me	H
5b	Me	Me	H	Me
5c	H	Me	H	Me
5d	Me	Me	Me	Me



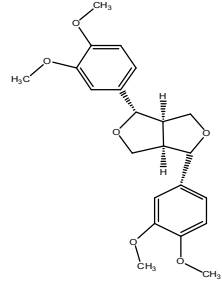
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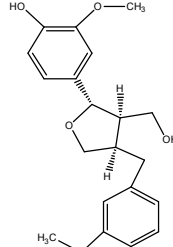
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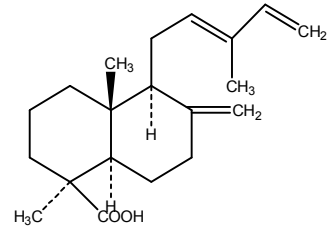
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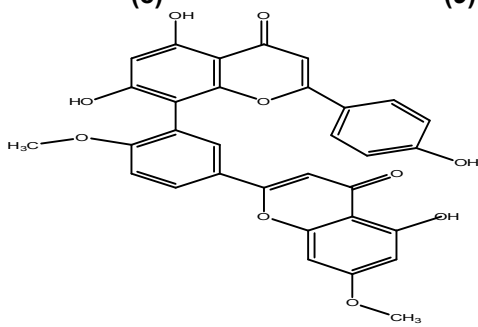
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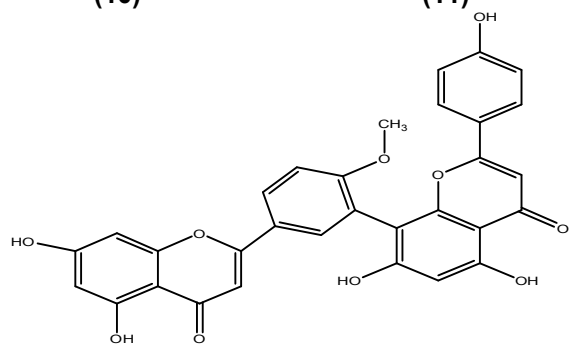
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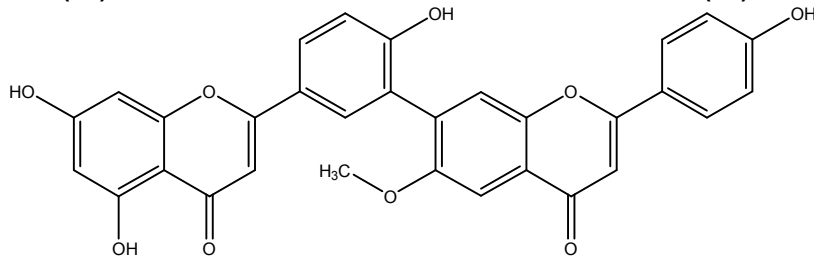
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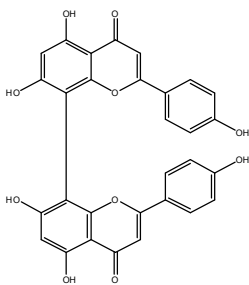
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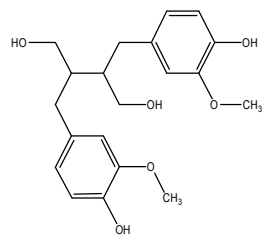
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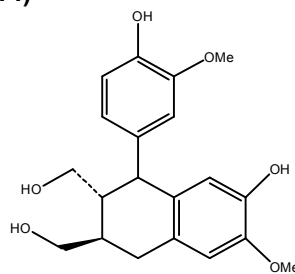
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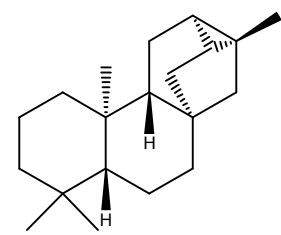
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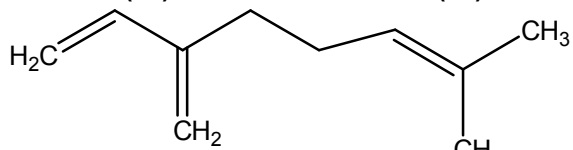
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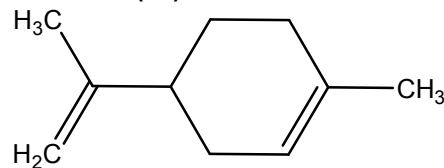
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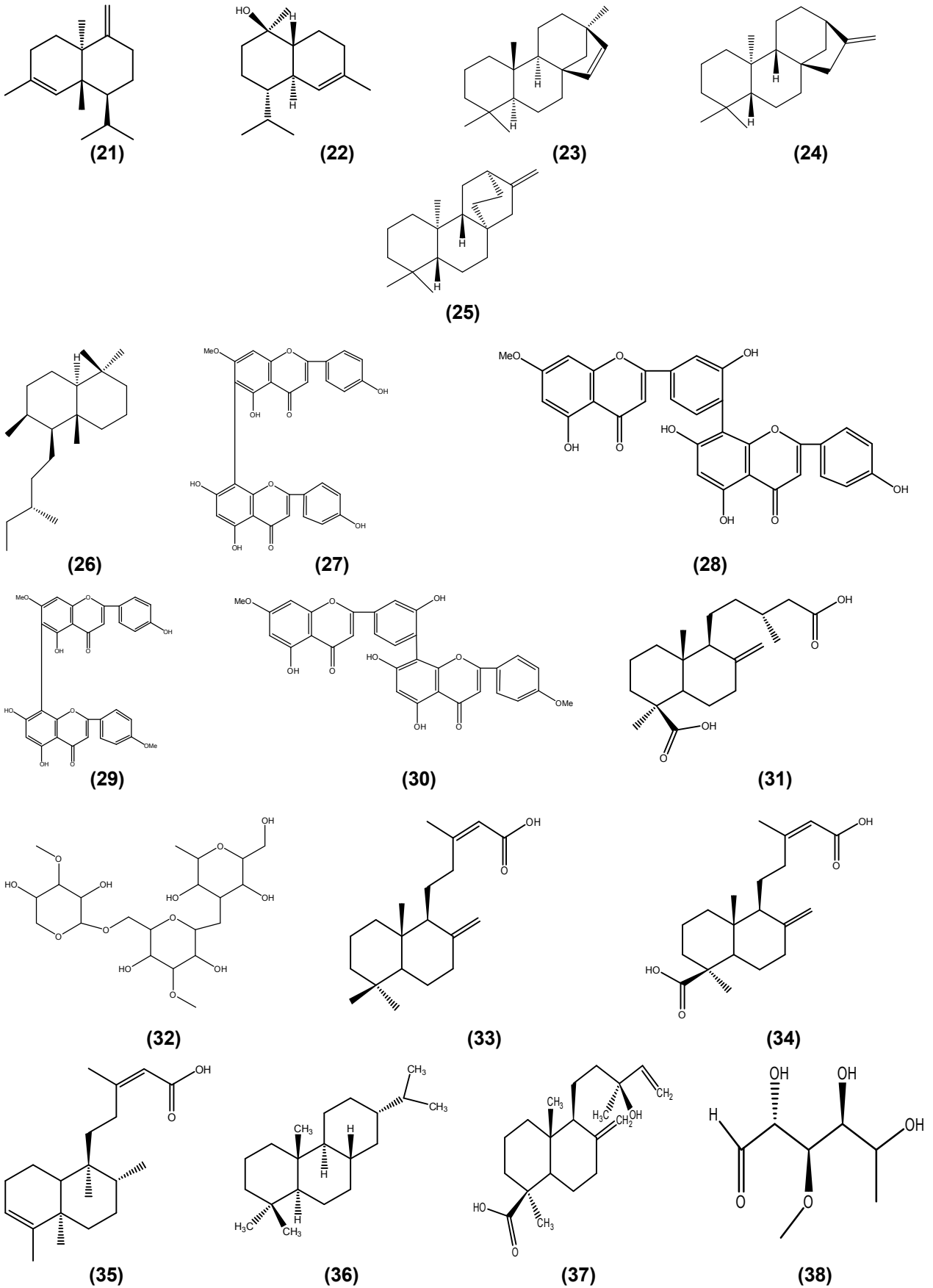


Figure 1: Structure of chemical constituents isolated from the genus, *Araucaria*

Table 5: Biological and pharmacological activities

Pharmacological activity	Species	Extract/fraction/isolate	Dose tested/route of administration	Bioactive dose	Positive control	Negative control	Animal	Experimental model (<i>in vivo</i> / <i>in vitro</i>)	Reference
Anti-ulcer	<i>Araucaria araucana</i>	Ethanol	25-800mg/kg	100-250mg/kg	-	-	Mice	Gastric ulcer model	[26]
Anti-depressant	<i>Araucaria angustifolia</i>	Isolation of lecithin from <i>Araucaria angustifolia</i>	lectin (0.1, 1, and 10 mg/kg), flumazenil (1 mg/kg), or diazepam (1 mg/kg) intraperitoneally	-	Lectin, Flumazenil, Diazepam	Saline	Mice	Pentylenetetrazole and strychnine-induced seizure models	[27]
Anti-viral	<i>Araucaria angustifolia</i>	Hydroethanolic extract and petroleum ether ; dichloromethane ; ethyl acetate ; n-butanol fractions	-	Ethanol and N-Butanol fractions exhibited the most promising antiviral activity, with Selectivity Index values of 8.19 and 11.04 respectively.	-	-	-	MTT In vitro method	[10]
Anti-inflammatory	<i>Araucaria angustifolia</i>	Isolation of lectin (AaL) from seeds of <i>Araucaria angustifolia</i> were investigated	Intravenous injection of AaL (0.1–1 mg/kg)	-	-	Saline	Mouse	Rat paw edema	[28]
Neuroprotective	<i>Araucaria bidwillii</i>	Ethyl acetate fraction	100 and 200 mg/kg	-	Vitamin E	-	Rat	The ischemia/reperfusion (I/R) was induced by occluding bilateral common carotid arteries (BCCAO) for 30 min, followed by 24 h reperfusion.	[29]
Free radical scavenging	<i>Araucaria bidwillii</i>	Isolation of Bioflavones and tannin	-	-	Quercetin	-	-	In vitro studies	[30]
Anti-pyretic	<i>Araucaria bidwillii</i>	Ethanol extract	30 mg	-	-	-	Rat	Yeast induced hyperthermic test model	[31]
Anti-coagulant	<i>Araucaria bidwillii</i>	Alcoholic and petroleum extract	100-300 mg/kg	-	Aspirin	-	Rat	Pentobarbitone sleeping time	[32]
Anti-inflammatory	<i>Araucaria bidwillii</i>	Ethanol extract	100, 200 and 300 mg/kg	300 mg/kg	Acetylsalicylic acid ; indomethacin	-	Rat	Rat paw edema	[33]

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