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A Review on Taxonomy, Ethnobotanical Uses, Phytochemistry and Pharmacological Activities of *Caesalpinia mimosoides* Lam. (Caesalpiniaceae)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Caesalpinia mimosoides Lam. has been widely studied, although it still has the potential to be explored, because it comprises a variety of chemical compounds which have diverse biological activities. The species have, variety of chemical compounds that are present, emphasizing the importance of quality control to distinguish the species. The phytochemicals have importance for their effects on inflammation, anti-microbial, anti-diabetic, anti-oxidant activity especially the Alzheimer's Disease. In addition, other pharmacological efficacious, such as epilepsy, dizziness, cardiovascular diseases demonstrated a great potential for using *Caesalpinia mimosoides* Lam. in therapeutics.

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Keywords: Caesalpinia mimosoides Lam; ethnobotany; pharmacological activities; review.

1. INTRODUCTION

Caesalpinia mimosoides Lam. is a one-meter-tall upright or climbing shrub with thickly pocked thorns on all surfaces. In Northern and North-Eastern Thailand, the plant may be found in ancient clearings, scrub regions, and mixed deciduous forests. Cassane diterpene and diterpene dimer, homoisoflavonoid, sesquiterpene, stilbene, gallic acid and its derivatives with other useful chemical substances have all been reported from *C. mimosoides* Lam. The plant young shoot and leaves are used as a fresh dietary vegetable in India [1,2].The plant is also used by folklore practitioners (Table 2) in their practices [3,4]. Therapeutic characteristics and a wide range of phytochemicals found in *C. mimosoides* Lam. indicate the plant's potential utility as a source for pharmaceutical drug development. It has some therapeutic properties and has historically been used as a carminative to relieve stomach discomfort. In many parts of the world, the plant has been employed for its diverse pharmacological characteristics [5].

2. STUDY PURPOSE

The primary objective of this review is to document the medicinal uses of *Caesalpinia mimosoides* Lam. to treat disease, raise people's awareness of what it is and how it affects them and compile all the research data regarding these species.

3. A METHOD OF REVIEWING THE LITERATURE

The following is a review of information pertaining to the species. From the review of the plant, its ethnobotanical potential has been estimated. The literature retrieved for this scholarly works found on NCBI, Google Scholar and PubMed. Web of Science, publications of the ACS and various other online sources articles (e-newspapers), etc. The majority of the published works were cited from other journal publications that had been subjected to peer review.

4. TAXONOMIC STATUS

Caesalpinia mimosoides described by Lamarck in (1785), in the Encyclopedie Methodique. It was a gifted specimen by Mr. Sonnerat who was a French colonial administrator, explorer, and naturalist. The specimen was collected by Mr. Sonnerat from the Malay peninsula [6]. Lamarck (1785), mentioned in his protologue that, it is a small downy leguminous plant. The stem was covered with aculeate prickles, oblong obtuse leaflets, used *Mimosa malabarica* as a synonym [7]. He mentioned in Flora of British India that *Caesalpinia mimosoides* is a distinct species belonging to subgenus *Eucaesalpininia* and treated as *Caesalpinia simora* Buch.-Ham. ex Roxb., *Caesalpinia resupinata* Roxb. *Caesalpinia horiida* Herb. Madr. ex Wall, C. armata Graham, and *Biancaea mimosoides* (Lam.) Tod. as synonyms of *Caesalpinia mimosoides* Lam [8], studied molecular systematics of the *Caesalpinia* group and proposed the new monotypic genus *Haltholia* with species *mimosoides* based on the basionym *Caesalpinia mimosoides* Lam. and the synonym *Biancaea mimosoides* (Lam.) Tod. The detailed classification of the *Caesalpinia mimosoides* Lam. is given in Table 1.

Table 1. Classification of *Caesalpinia mimosoides* Lam

Bentham & Hooker		APG IV	
Kingdom	Plantae	Domain	Eukaryota
Phylum	Magnoliophyta	Regnum	Plantae
Division	Magnoliopsida	Cladus	Angiosperms
Class	Angiospermae	Cladus	Rosids
Order	Fabales	Order	Fabales
Family	Fabaceae/ Caesalpiniaceae	Familia	Fabaceae
Genus	*Caesalpinia*	Subfamilia	Caesalpinioideae
Species	*mimosoides* Lam	Tribus	Caesalpinieae
		Genus	*Caesalpinia*
		Species	*Mimosoides Lam.*

4.1 Morphology

It is a thorny shrub. Branches are armed with copious irregular small prickles. Leaves are long. Leaflets sessile, oblong, apiculate, membranous, sensitive, glabrous. Flowers terminal, across bright yellow. Pedicels 2-3 times the length of the calyx. Calyx more or less downy. Five petals, orbicular. Filaments densely woolly in the lower half. Pod under 2 in. long, more turgid than in the other species, half an inch thick, narrowed to the base, hard, sub indehiscent, clothed with minute deciduous bristles, truncate at the end with a short recurved beak, the sutures not at all thickened [7].

4.2 Chromosome Number

2n = 24 [9]

4.3 Synonyms

Caesalpinia resupinata Roxb*., Caesalpinia simora* Roxb*.*

Vernacular names are listed below.

English: Mimosa thorn, Prickly brasiletto
Thai: Phi-puya, Cha-rueat
Marathi: Lajri, Narkati
Kokani: Kenchiki, Lajri
Sanskrit: Ritubana, Shwetamula, Vaishakhama
Kannada: Eejimullu, Ganajilu, kenchige, Komme, Mulluarishina
Malayalam: Chingamullu, Kathaavaadi, Kooramullu, Kumullu, Theemulu
Tulu: Cheemullu, Theemullu
Tamil: Pulinagakondrai, Pananjimullu [10]

5. GEOGRAPHICAL DISTRIBUTION

Caesalpinia mimosoides Lam. is a spiny and woody climbing tropical shrub that seems to be native to Southeast Asia mainly in Northern and North Eastern parts of Thailand and distributed in old clearings, scrub areas, and mixed deciduous forest [11,12]. The species is distributed in the Indian subcontinent like South China and countries like India, Burma, Vietnam, Sri Lanka, Laos, Xishuangbanna, Bangladesh and Myanmar. In India, it is distributed throughout the Southern and Northern parts of Peninsular India. The plant is observed frequently in West coast and Western Ghats which grows along forest edges. It is rare in moist and dry deciduous forest [13-16].

6. ETHNOBOTANICAL USES

The *C. mimosoides* Lam. possesses a tremendous amount of potential in terms of the traditional medical systems that were utilised by the local peoples. Ethnobotanical uses of *C. mimosoides* Lam. are listed in Table 2.

7. PHYTOCHEMISTRY

7.1 Nutritional and Antinutritional Composition

C. mimosoides Lam. contains high amount of vitamin C [17]. The leaves, roots, fruits, and flowers of *C. mimosoides* Lam. contain variety of major and minor elements [18].

7.2 Chemical Compounds

From the plant, numerous chemical compounds have been reported, enlisted in Table 3. Bioassay-guided separation of *C. mimosoides* Lam. crude extract in dichloromethane and acetone identified a total of seven new compounds as four diterpenes named as minosol A, minosol B, minosol C, minosol D, one dimer *i.e.* minosol E, two dibenzo (b, d) furans *i.e.* minosol F and minosol G. Eleven known compounds containing four diterpenes *i.e.* taepeenin A, taepeenin D, nortaepeenin A and taepeenin L, three homoisoflavones *i.e.* (E)-7-hydroxy-3-(4-methoxybenzyl)chroman-4-one, (E)-7,8-dihydroxy-3-(4-methoxybenzyl)chroman-4-one and (E)-7-hydroxy-8-methoxy-3-(4-methoxybenzyl)chroman-4-one, three phenylpropanols like tetracosyl caffeate, resveratrol, bergenin and a sequiterpene (+)-pterocarpol have reported from plant [19].

The presence of amino acids, alkenes, nitrates, ethers, organic halogen compounds and carbohydrates reported from the leaves of *C. mimosoides* [20].

Seventeen different compounds were characterized and analyzed by using spectroscopy from the twigs of *C. mimosoides* Lam. These compounds are 10-methoxyprotosappanin B, 10-methoxyisoprotosappanin B, eucomin, intricatinol, 8-methoxybonducellin, quercetin, quercetin-3-O-glucoside, sulfuretin, bergenin 11-O-(E)- ferulate, bergenin, butein, coniferaldehyde, ethyl gallate, friedelin, isoliquiritigenin and sitoindoside I [11].

Table 2. Ethnobotanical uses of *Caesalpinia mimosoides* Lam

Sr. No.	Plant part used	Application/ uses	Places/tribes/ community/ country	References
1.	Whole plant	Relief form migraine.	Palakkad, Kerala	[39]
		The stems and branches with sesame oil are boiled and administered in two split dosages to alleviate discomfort in the joints. *('Vata'* disorder).	Kaddor & Nadoor , Karnataka	[3,40]
2.	Root	Fleshy Roots, in conjunction with ginger paste are used as anti-helminthic.	Mullu Kuruma , Kerala	[41,42]
		Ulcers and wounds are treated with this herb by folklore practitioners. This plant's root is massaged with water and taken once a day internally and three to four times a day externally.	Udapi, Karnataka	[3,18]
3.	Shoot	Shoot tips are consumed as digestive tonic.	Thailand	[33]
		Shoot tips are used as an appetizer, anti – vertigo and improves blood quality.	Thailand	[26]
		Externally, a paste made by crushing young shoots of the plant in water is applied to the inflamed area to suppurate and burst the boils. Following the drainage of all purulent materials, the same paste is used to repair ruptures, treat skin ailments, and cleanse the blood.	Uttar Kannada, Karnataka	[4]
		Young sprouts are used as carminative & cure dizziness, fainting etc.	Thailand	[24,33]
4.	Leaves	Tender leaves combined with *Ricinus*, *Acorus* are used for epilepsy therapy.	Mullu Kurma , Kerala	[18,43-45]
		Oral decoction is used to improve blood circulation and cure cardiovascular disease.	Adiyan Wayanad, Karnataka	[45]
		Used to cure boil with 100 % fidelity of local peoples.	Coastal Part , Karnataka	[46]
		Young leaves are used for making chatany.	Kurumbas Western nilgiri, Tamil Nadu	[47]
5.	Leaves and stems	Plant parts in combination with other ethnomedicinally important plants, are used for antiarthritic benefits of these medicinal herbs have been well documented in reviews.	Aneguli-Maradavalli , Central Western Ghat, Karnataka	[48]

C. mimosoides contains the important cassane diterpenoids, which was considered to be a distinguishing trait of the *Caesalpinia* genus. Two novel cassane diterpenoid lactams *i.e.* caesmimotam A , and caesmimotam B along with these eight previously known compounds *i.e.* 11-o-(e)-ferulate, syringaresinol, ethyl gallate, gallic acid, 3-Hydroxy-4-methoxybenzaldehyde, Lupeol, 5α,8α,-epidioxy-(22E,24R)-ergosta-6,22-dien-3β-ol, Sitoindoside I [21].

Six novel cassane diterpenes reported and characterized from the plant *i.e.* caesmimosin A, caesmimosin B, caesmimosin C, caesmimosin D, caesmimosin E, caesmimosin F from the fruits of *C. mimosoides* Lam. All of these compounds were evaluated for cytotoxicity against the human tumor cell lines HL-60 (acute leukemia), SMMC-7721 (liver cancer), A-549 (lung cancer), MCF-7 (mammary cancer) and SW-480 (colon cancer) [22].

Eighteen diterpenoids were isolated from *C. mimosoides* Lam seeds. Thirteen compounds containing entirely novel structures were isolated *i.e.* caesmimo A1, caesmimo A2, caesmimo A3, caesmimo A4, caesmimo A5, caesmimo A6, caesmimo A7, caesmimo A8, caesmimo A9,

caesmimo A10, caesmimo A11, caesmimo A12, caesmimo A13. Five known compounds were also isolated *i.e.* caesmimosins G1/G2, methyl vinhaticoate, pteroloterins, caesamimosin E, neocaesalpin-1- methyl ester. This combination yields four cassane diterpenoids, which are exceedingly rare in nature. Both caesmimo A7 and caesmimo A8 are cassane diterpenoids fused with a ketone carboxyl at the C4 position, representing the first examples of cassane diterpenoids fused with a ketone carboxyl and a ternary oxygen ring, respectively. The compound caesmimo A9 and caesmimo A10 include a five-member ring, which is uncommon in cassane diterpens. Based on this, the author concluded that extreme levels in the plant secondary metabolites demonstrated development of the plant secondary metabolism and the author predicted a probable evolutionary link between them and hypothesised intermediates in the plant secondary metabolism [23]. A characteristic esterase from the seeds of *C. mimosoides* Lam was isolated and purified and the kinetics of this enzyme was studied in response to pH and temperature [24]. The following chemical compounds were isolated from *Caesalpinia mimosoides* Lam. and their molecular structures are also redrawn in Table 3, which is given below.

8. PHARMACOLOGICAL ACTIVITIES

8.1 Wound-Healing Activity

The plant is utilized in traditional system of medicine to heal the wounds and skin problems in the Uttar Kannada district. The presence of bioactive compounds *viz.* ethyl gallate and gallic acid results in the plant's effectiveness as an antibacterial, wound healing and antioxidant agent [4].

8.2 Antimicrobial and Antifungal Activity

Antimicrobial activity of the several extracts against eight human pathogenic bacteria, one yeast and five filamentous fungal strains were studied by disc diffusion method. Aqueous extract exhibited inhibitory activity against all the pathogens *e.g. Aspergillus sp., Candida albicans, Enterococcus faecalis, Escherichia coli, Fusarium sp., Klebsiella pneumoniae, Microsporum gypseum, Penicillium sp., Psedomonas aeruginosa, Salmonella typhi, Staphylococcus aureus, Staphylococcus epidermidis, Trichophyton rubrum, Vibrio cholerae.* while ethanolic extract also showed high level of activity against all the microorganisms except *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Chloroform extract displayed lower activity against *Vibrio cholerae*, *Staphylococcus aureus*, *Staphylococcus epidermidis* and acetone extract showed moderate activity against *Vibrio cholerae*, gram positive bacteria and dermatophytic fungi. This study concluded that an active antimicrobial substance, *i.e.* gallic acid, with MIC values of 2500 μg/ml and 1250 μg/ml indicated effectiveness against the *S. typhi* and *S. aureus* respectively [2].

Ethanolic extracts of *C. mimosoides* Lam. demonstrated considerable inhibition effects against fungi *i.e. Microsporum gypseum* and *Trichophyton rubrum*. The major ingredient of the extract was discovered to be gallic acid [25].

Caesalpinia mimosoides Lam. has the highest phenolic content (246.6 ± 0.6 mg GAE/g dry weight) and has significant antibacterial activity against *Escherichia coli*, *Salmonella typhimurium* and *Staphylococcus aureus* [26].

The fruit and leaf extracts suppress Gram-positive pathogenic microorganisms *e.g. Psedomonas aeruginosa, Staphylococcus aureus,* and are least effective against Gram negative bacteria *Klebsiella pneumoniae*. Phytopathogenic fungi are like *Alternaria sp*., *Aspergillus flavus, Colletotrichum capsica, Helminthosporium sp* and *Sclerotium rolfsii* are inhibited by root and fruit extracts [17].

Natural gallic acid from was isolated from shoot and leaves of *C. mimosoides* Lam. The MIC of obtained natural gallic acid was effective against foodborne *Salmonella spp*. and *Plesiomonas shigelloides* [27].

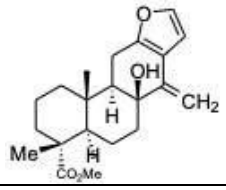
C. mimosoides Lam. leaf extracts AgNPs films had much more antimicrobial activity against *Escherichia* coli than *Listeria monocytogenes*. Active food packaging will benefit from this since it will improve the safety and shelf life of packaged foods [27].

Phytochemical, antibacterial and cytoprotective characteristics in leaf extract *C. mimosoides* Lam. were examined and reported the presence of flavonoids, glycosides, saponins, reducing sugar, tannins, phenols, phytosterols, resins, anthraquinones and alkaloids. They also noticed an antibacterial and antifungal activities and found that antibacterial activities were more effective than antifungal activity [5].

Table 3. Chemical compounds from *Caesalpinia mimosoides* Lam

Sr. No.	Part of plant	Name of the compound	Molecular formula	References
1.	Roots	Mimosol A	$C_{21}H_{28}O_4$	[19]
2.		Mimosol B	$C_{20}H_{32}O$	
3.		Mimosol C	$C_{20}H_{34}O_2$	
4.		Mimosol D	$C_{24}H_{38}O_4$	
5.		Taepeenin A	$C_{21}H_{26}O_3$	
6.		Taepeenin D	$C_{23}H_{28}O_5$	
7.		Nortaepeenin A	$C_{20}H_{26}O_4$	
8.		Taepeenin L	$C_{20}H_{34}O$	
9.		Mimosol E	$C_{42}H_{54}O_6$	
10.		Mimosol F	$C_{17}H_{16}O_5$	
11.		Mimosol G	$C_{18}H_{18}O_5$	
12.		(E)-7-hydroxy-3-(4-methoxybenzyl)chroman-4-one	$C_{17}H_{14}O_4$	
13.		(E)-7,8-dihydroxy-3-(4-methoxybenzyl)chroman-4-one	$C_{17}H_{14}O_5$	
14.		(E)-7-hydroxy-8-methoxy-3-(4-methoxybenzyl) chroman-4-one	$C_{18}H_{32}O_7$	
15.		Tetracosyl caffeate	$C_{33}H_{56}O_4$	
16.		Resveratrol	$C_{14}H_{12}O_3$	
17.		Bergenin	$C_{14}H_{16}O_9$	
18.		(+)-Pteerocarpol	$C_{15}H_{26}O_2$	
19.	Fruits	Caesmimotam A	$C_{21}H_{27}O_3N$	[21]
20.		Caesmimotam B	$C_{23}H_{31}NO_4$	
21.		11-o-(e)-ferulate	$C_{24}H_{24}O_{12}$	
22.		Syringaresinol	$C_{22}H_{26}O_8$	
23.		Ethyl gallate	$C_9H_{10}O_5$	
24.		Gallic acid	$C_7H_6O_5$	
25.		3-Hydroxy-4-methoxybenzaldehyde	$C_8H_8O_3$	
26.		Lupeol	$C_{30}H_{50}O$	
27.		5α,8α-epidioxy-(22E,24R)-ergosta-6,22-dien-3β-ol	$C_{28}H_{44}O_3$	
28.		Sitoindoside I	$C_{51}H_{90}O_7$	
29.	Fruits	Caesmimosin A	$C_{23}H_{34}O_6$	[22]
30.		Caesmimosin B	$C_{21}H_{30}O_6$	
31.		Caesmimosin C	$C_{23}H_{34}O_6$	
32.		Caesmimosin D	$C_{23}H_{32}O_8$	
33.		Caesmimosin E	$C_{21}H_{30}O_5$	
34.		Caesmimosin F	$C_{25}H_{36}O_7$	
35.	Twig	10-methoxyprotosappanin B	$C_{17}H_{18}O_6$	[11]
36.		10-methoxyisoprotosappanin B	$C_{17}H_{18}O_6$	
37.		Eucomin	$C_{17}H_{14}O_5$	
38.		Intricatinol	$C_{17}H_{14}O_5$	
39.		8-methoxybonducellin	$C_{18}H_{16}O_5$	
40.		Quercetin	$C_{15}H_{10}O_7$	
41.		Quercetin-3- O-glucoside	$C_{21}H_{20}O$	
42.		Sulfuretin	$C_{15}H_{10}O_5$	
43.		Isoliquiritigenin	$C_{15}H_{12}O_4$	
44.		Butein	$C_{15}H_{12}O_5$	
45.		Bergenin	$C_{14}H_{16}O_9$	
46.		Bergenin 11-O-(E)- ferulate	$C_{24}H_{24}O_{12}$	
47.		Sitoindoside I	$C_{51}H_{90}O_7$	
48.		Friedelin	$C_{30}H_{50}O$	
49.		Coniferaldehyde	$C_{10}H_{10}O_3$	
50.		Ethyl gallate	$C_9H_{10}O_5$	
51.		Gallic acid	$C_7H_6O_5$	

Sr. No.	Part of plant	Name of the compound	Molecular formula	References
52.	Seeds	Caesmimo A1	$C_{20}H_{32}O$	[23]
53.		Caesmimo A2	$C_{21}H_{32}O_2$	
54.		Caesmimo A3	$C_{22}H_{32}O_5$	
55.		Caesmimo A4	$C_{22}H_{34}O_5$	
56.		Caesmimo A5	$C_{22}H_{32}O_5$	
57.		Caesmimo A6	$C_{22}H_{30}O_5$	
58.		Caesmimo A7	$C_{20}H_{30}O_3$	
59.		Caesmimo A8	$C_{21}H_{32}O_3$	
60.		Caesmimo A9	$C_{21}H_{30}O_6$	
61.		Caesmimo A10	$C_{19}H_{28}O_3$	
62.		Caesmimosins G1/G2	$C_{20}H_{34}O_7$	
63.		Methyl vinhaticoate	$C_{21}H_{22}O_3$	
64.		Caesmimo A11	$C_{20}H_{30}O_4$	
65.		Pteroloterins	$C_{22}H_{26}O_5$	
66.		Caesamimosin E	$C_{21}H_{30}O_5$	
67.		Caesmimo A12	$C_{22}H_{32}O_5$	
68.		Caesmimo A13	$C_{22}H_{30}O_5$	
69.		Neocaesalpin-1- methyl ester	$C_{21}H_{28}O_4$	



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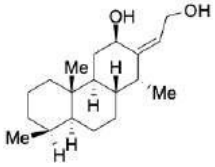

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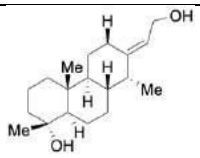

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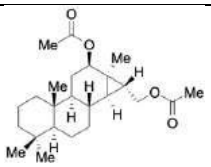

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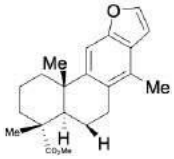

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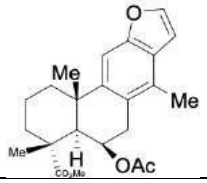

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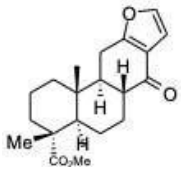

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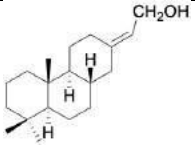

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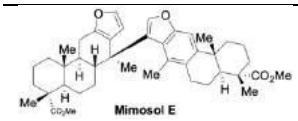

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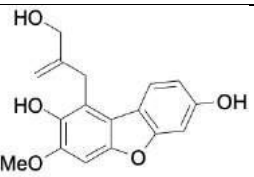

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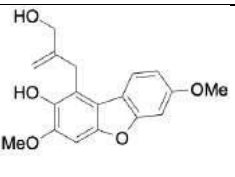

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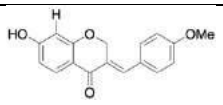

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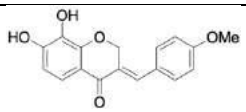

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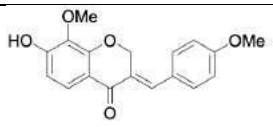

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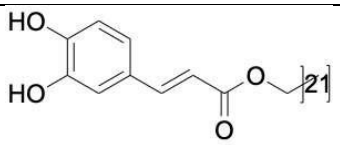

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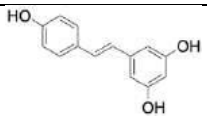

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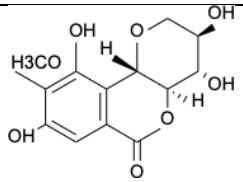

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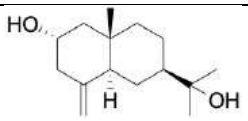

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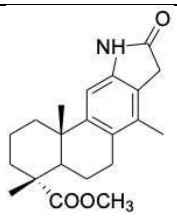

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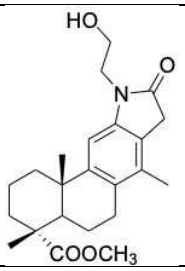

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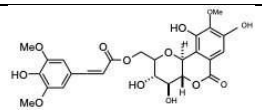	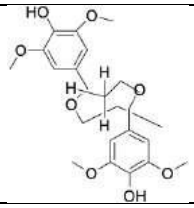	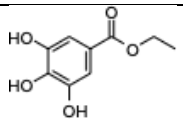	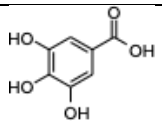
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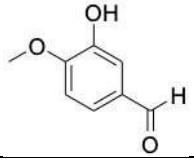	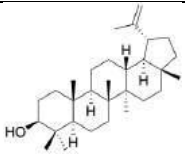	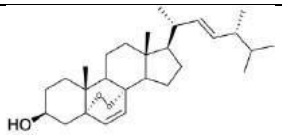	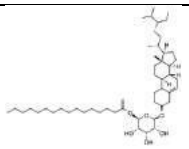
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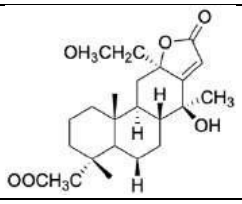	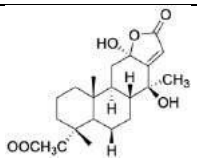	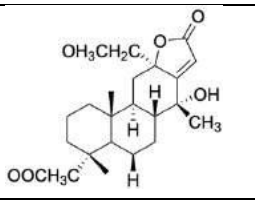	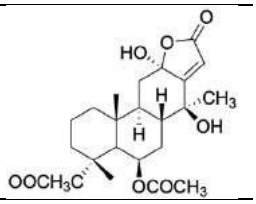
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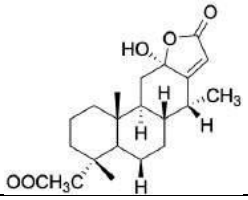	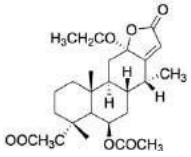	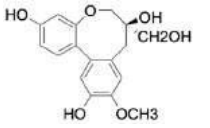	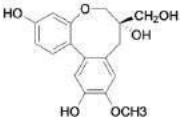
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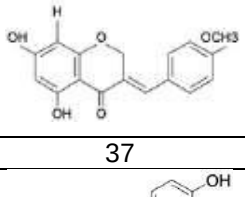	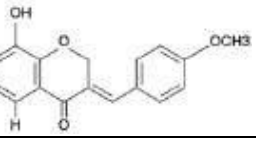	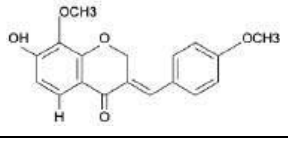	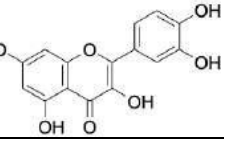
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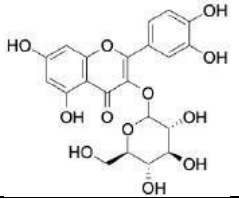	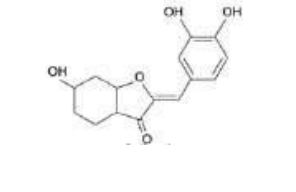	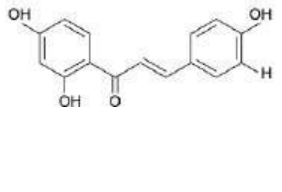	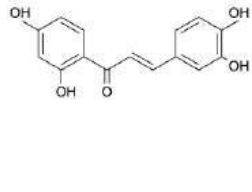
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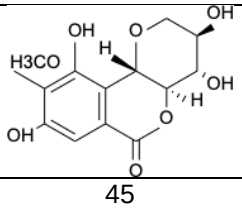	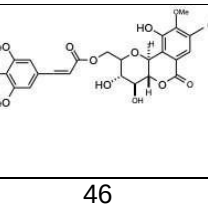	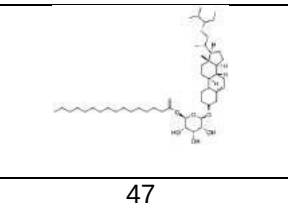	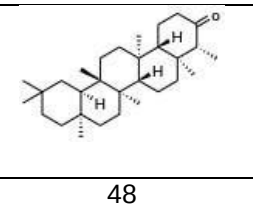
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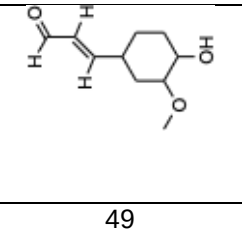	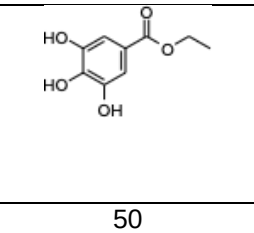	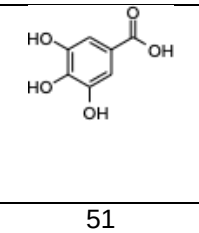	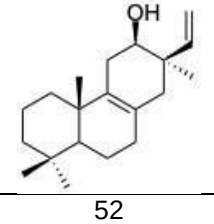
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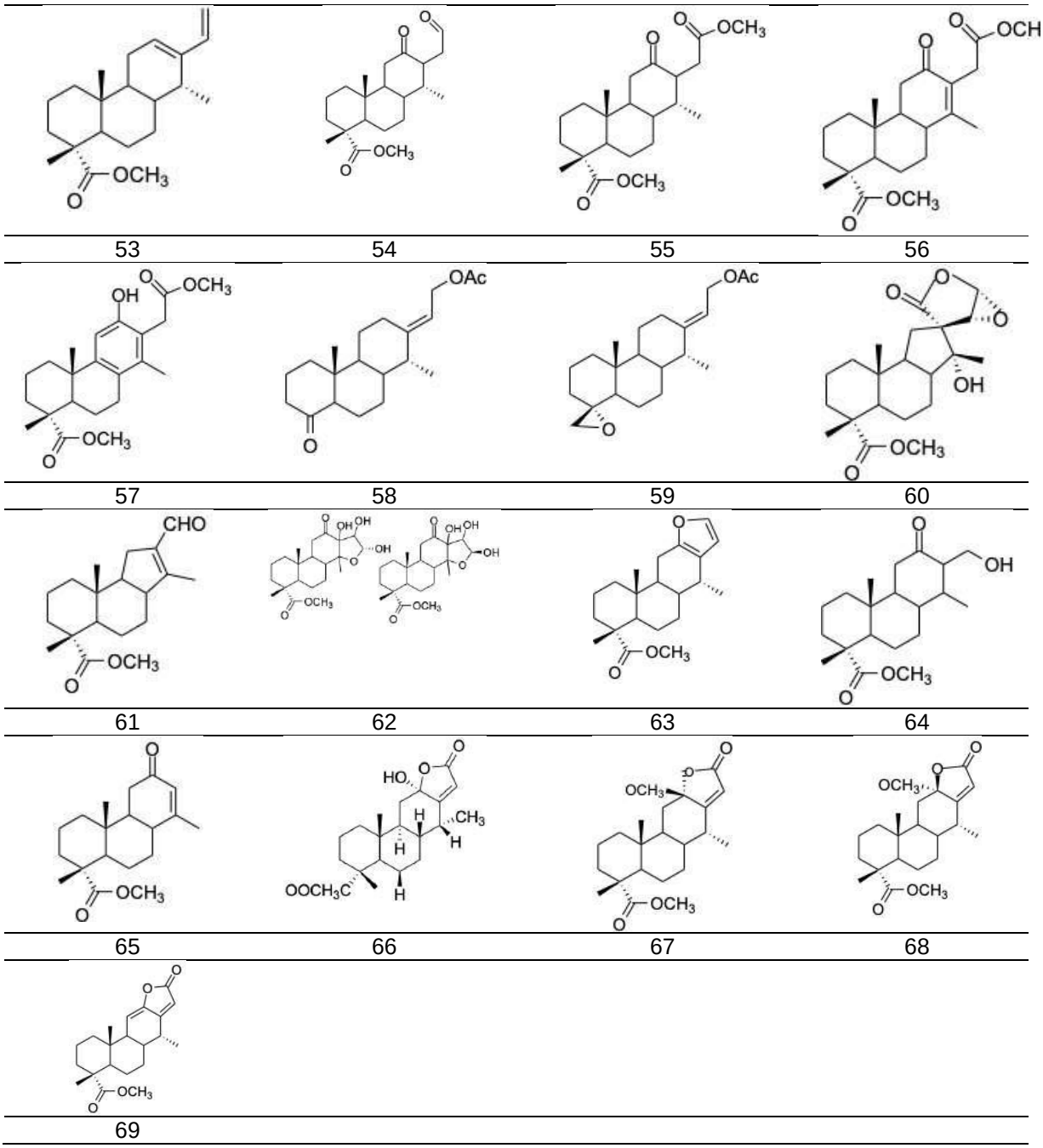

Fig. 1. Chemical strucure of above chemical compounds
(Chemical structure redrawn from: Chemdraw and pubchem.ncbi.nlm.nih.gov)

Antibacterial activity of the butanolic extract of seeds of *C. mimosoides* Lam. has been tested and protease inhibitors present in the seeds were found effective against many bacterial strains. On the basis of these results they mentioned the use of *C. mimosoides* Lam. in agricultural, culinary and pharmaceutical industries might all benefit from direct application from this extract [13].

8.3 Anti-Inflammatory Activity

The bioassay-guided separation of extracted *C. mimosoides* Lam. dried powder of roots in chloromethanide and acetone exhibited anti-inflammatory activity. All the compounds analysed in the RAW 264.7 macrophage cell lines of inhibitory activity revealed against lipopolysaccharide-induced nitric oxide

production, which would be a marker of inflammation. Minosol D, taepeenin D, taepeenin L, (E)-7-hydroxy-3-(4-methoxybenzyl)chroman-4-one,(E)-7,8-dihydroxy-3-(4-methoxybenzyl) chroman-4-one and (E)-7-hydroxy-8-methoxy-3-(4- methoxy benzyl) chroman -4-one showed considerable NO inhibitory activity, from this Minosol D has strong inhibitory action for NO production and tumor necrosis factor alpha (TNF-α) with IC50 values of 3.0 and 6.5μM respectively [19].

C. mimosoides Lam. aerial parts were investigated for anti-inflammatory potential. For *in-vivo* testing, either sex Wister albino rats and observed that the ethyl acetate extract of *C. mimosoides* Lam. prevented protein denaturation better than petroleum ether and chloroform. After the third hour of ingesting the ethanolic extract of *C. mimosoides* Lam., the efficacy of the extract decreased inflammation significantly 51.39 % inhibition as compared to 75 mg/kg of conventional Diclofenac (73.61%). The extracts of *C. mimosoides* Lam. revealed no cytotoxic activity up to 2000 mg/kg body weight and found to be safe [29].

8.4 Alzheimer's Disease

The isolation of quercetin from the plant was reported. Quercetin has now been shown to be an anti-cholinesterase as well as a substantial neuroprotective agent, making it a very effective treatment for Alzheimer's disease and other neurodegenerative illnesses [30].

Rangsinth, stated that the methanol extract of *C. mimosoides* Lam. leaves stimulated neurite outgrowth in wild type and Amyloid Precursor Protein (APP) overexpressing cells. During the subsequent analysis of different concentrations of methanolic extracts on Neuro2a and Neuro2a/APPswe cells, it was discovered that when given a dosage of 10 µg/mL (94.08 $\pm$4.98% and 93.78 $\pm$ 5.56%, respectively) showed low toxicity and high efficacy, observations suggested that *C. mimosoides* Lam. extract promotes neurite outgrowth and inhibits BACE1 activity in APP overexpressing neurons. Hence, this plant species may serve as a source of drugs for Alzheimer's Disease (AD) treatment [12].

8.5 Anti-Cancer Activity

A study conducted on the shoots and leaves of *C. mimosoides* Lam. The active fractions from *C. mimosoides* Lam. in methanolic extraction were found to enhance the killing of high-risk HPV-positive and HPV-negative cells. It was discovered that it only inhibited the growth of cancer cell lines [31].

Natural gallic acid has both anticancer and antimicrobial activity. M213 and M214 cell lines were tested for effects of natural gallic acid and commercial gallic acid. Natural gallic acid has an IC 50 value of 120 μm, 124 μm, and commercial gallic acid has an IC 50 value of 119 μm and 147 μm, respectively [27].

8.6 Anti–Renal Activity

Eighteen diterpenoids were isolated from *C. mimosoides* Lam seeds. All of these isolated compounds were examined for anti-renal fibrosis activity using the NRK-52E cell model, which was triggered by TGF- β1. qRT-PCR was used to determine the mRNA levels of fibrosis markers such as α-SMA, E-cadherin, and Collagen I. The results revealed that compounds caesmimo A6 and caesmimo A9 exhibited the most potent anti-renal fibrosis activity [23].

8.7 Anti-Diabetic Activity in Relation to Anti-Oxidant Property

C. mimosoides Lam. crude extract contains large amounts of the total phenolic compounds (445 ± 59 mg GAE/g). They exhibited a low IC 50 (the half maximal inhibitory concentration) of 0.18 ± 0.03 mg/ml for alpha-glucosidase inhibition when compared with the standard acarbose is an anti-diabetic medication.IC50 of 1.58±0.08 mg/ml [32].

8.8 Antioxidant Activity

C. mimosoides Lam. was investigated for antioxidant components and revealed the presence of tannins (484 ± 0.13 mg %) and total phenolics (1924 ± 0.31mg %) [33].

C. mimosoides Lam. extract is prohibited oral cavity cell line proliferation, therefore it could be a source of natural antioxidants for pharmaceutics [26].

C. mimosoides Lam. was examined for its mineral content, antibacterial activity, and radial scavenging activity [18]. As per the findings, major elements calcium in leaves (8381.35 ppm) and potassium in fruits (6145.50 ppm) were

detected in the greatest concentrations, while minor elements iron in root (1515.8 ppm). Using the DPPH radial scavenging test, the antioxidant radical scavenging capability of different extracts was assessed. The fruit extract scavenging activity was revealed to be the most effective of all extracts. According to preliminary phytochemical examination, all of the extracts showed the presence of steroids, flavonoids, glycosides, and tannins.

In-vitro antioxidant activity of aerial part extracts of *C. mimosoides* Lam. by using iron chelating method and NO method were evaluated. The nitric oxide scavenging ability of ethyl acetate extract was found to be 61.77µg/ml which is comparable to that of ascorbic acid (32.37µg/ml). In an iron chelating assay, the IC50 value of the standard ascorbic acid was 49.20 µg/ml compared with that of the EAE IC50 58.32 µg/ml and it showed significant antioxidant potential [1].

C. *mimosoides* Lam extract for total phenolic content and free radicle scavenging activity, noted the presence of phenolic acid content (GAE) 234.92 mg/g extract, DPPH assay is 97.20 ±0.8 % and TEAC (mg/g sample) 196.15 mg/g [34].

Extracted aqueous leaf extracts of Thai edible and folk medicine plants for the observation of antioxidant properties and analyzed DPPH and FRAP assay, in *C*. *mimosoides* Lam. and noted highest total phenolic content in this plant (377.47 ± 7.37 mg GAE/g) and also the highest antioxidant capacity was 72.57 ± 5.76 TE/100 g and 363.03 ± 6.82 FeSO4/100g DPPH and FRAP, respectively. On the other hand, *C*. *mimosoides* Lam. indicates cell toxicity, therefore its neuroprotective activities will not be tested further [35].

Studied *in vivo* antioxidant activities of *C. mimosoides* Lam. showed that the overall phenolic content of methanol was the maximum (460.25 ± 3.08 mg GAE/g dry weight extract) it was observed that methanol with minimal toxicity increased the lifespan of *C. elegans* through reducing oxidative stress suggesting its potential use as a dietary supplement and alternative medicine to defend against oxidative stress and ageing [36].

The highest rate of DPPH scavenging activity in *C. mimosoides* Lam. (92.36 mmol TE/g), the highest antioxidant activity (192.36 mmol TE/g), and total phenolic content (221.65 mg GE/g), In nutritional composition, the highest protein content (27.86 g/100g dry weight) and nitrogen content were observed [37].

8.9 Phytotoxic Activity

The phytotoxic activity of leaves and stem of *C. mimosoides* Lam. was investigated and found that the methanolic extracts of *C*. *mimosoides* Lam. inhibited the growth of cress, *Alfa alfa*, lettuce, foxtail fescue, timothy and barnyard grass [38].

9. SUMMARY AND CONCLUSION

In 1785, the species was established by Lamarck, but till now there are taxonomic conflicts about species. Gagnon in 2016, studied the molecular systematics of the species and created the monophyletic genera *Haltholia mimosoides* (Lam.). The plant is used by traditional folkcare practitioners to cure a wide variety of health issues. *Caesalpinia mimosoides* Lam. is a fresh dietary vegetable that is being utilized to demonstrate the potential safety of its future uses in food and therapeutics. *C. mimosoides* Lam. show the presence of various chemical compounds in its plant parts. These chemical compounds have various activity. Many biological activities such as wound healing activity, antimicrobial activity, antifungal activity, anti-inflammatory activity, anticancer activity, anti-renal activity, anti-diabetic activity, phytotoxic activity are greatly exhibited by the plant. Along with these the plant significantly possess antioxidant activity and promotes neurite outgrowths and may be served as source of drugs for Alzheimer's disease treatment. From the above review it is clear that the plant C. mimosoides Lam. has many active principles with great potential in the field of ethnobotany. Further studies with respect to above aspects are needed which will enlighten the focus on the significance of the plant in the biological field.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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