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A REVIEW ON THE ETHNOBOTANY, PHYTOCHEMISTRY AND PHARMACOLOGICAL ACTIVITIES OF *CAESALPINIA DECAPETALA* (ROTH) ALSTON

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ABSTRACT

Caesalpinia decapetala (Roth) Alston is an understudied plant with significant ethnobotanical promise. The species is grown as a hedge plant, because of its attractive yellow-coloured inflorescences. Now days the plant has been naturalised around the globe, where it is now considered a noxious weed in certain areas. In order to search the scientific literature, we used databases such as PubMed, Research gate, Scopus and Science. It has been discovered through various studies that the plant contains numerous biologically active chemical compounds with cassane diterpenoids, which exhibits anti-microbial, anti-fertility, anti-diabetic, anti-viral activities as well as having potent cytotoxic and hepatoprotective properties. The high antioxidant capacity of the plant material may make it a possible food preservative and packaging material in the future, and the high fibre quality should make it a suitable raw material for the paper manufacturing industry. As a result, the species has enormous potential in the future for pharmacological and industrial uses and there is need of doing adequate research on the biological activity of numerous chemical substances.

KEYWORDS: Biological activities, *Caesalpinia decapetala*, Ethnobotany, Phytochemical compounds, Reviews.

INTRODUCTION

Caesalpinia decapetala (Roth) Alston is a showy yellow flowered, an adaptable, vigorous, scrambling shrub or thorny climber (cabi.org). It is traditionally used for variety of therapeutic purposes.[1,2] It is commonly known as "Roth" and founds throughout tropical regions of the world. *C. decapetala* (Roth) Alston widely occurs in the Indian subcontinent and is very common in sub-Himalayan tracts in the wild and is also cultivated as a hedge in gardens because of its beautiful, long, blazing, yellow colored inflorescence.[3,4] In South Africa, *C. decapetala* (Roth) Alston has now been categorized as a noxious weed.[5] In Vietnamese traditional medicine, it is used as an immunomodulator and as an anti-inflammatory.[6] Herbal medicine is made up of all parts of the plant, including the root, bark, leaves, flowers and seeds. It has been utilised in traditional oriental medicine since ancient times.[7,8] The major chemical constituents found in plants are terpenoids and flavonoids, many of which has antitumor activity, plant has plenty of tannins.[6] Cassane diterpenoids, astragalin, lupeol, spathulenol, resveratrol, quercetin, sitosterol and stigmasterol compounds were isolated by chemical characterization.[7-9] *C. decapetala* (Roth) Alston extract has analgesic, antioxidant, anticancer, and anti-fertility properties. As a result, the plant may be used both as an aesthetic and a pharmaceutical.[8,10,11]

General botanical information of the plant

Morphology

A plant is scandent, small tree or scrambling shrub. The leaves are bipinnately compound with caducous stipule. Rachis is long with 8 -10 pairs of pinnae. The inflorescence is supra-axillary to terminal. Flowers are bright yellow colored frequently with red veins. Calyx is fulvous hairy, 10 ribbed with 5 golden hairy sepals. Petals are 5, obovate or sub-orbicular. Androecium possess 10 free stamens. The filaments are 1.5 cm long, flattened, and densely woolly at the bottom with versatile anthers. Pods are flat, oblong to falcate-oblong, smooth, brown, slightly pubescent, sharply hooked, dehiscent. Each pod contains 4-8 dull black, elliptical seeds.[12]

Geographical distribution

Caesalpinia decapetala (Roth) Alston referred as thorny climber shrub which was considered as pantropical genus, but now widely naturalized and cultivated in gardens as a hedge throughout the world. It's a hermaphrodite species that's pollinated by insects and flourishes in light, well-drained soil.[13] It's native to tropical Asia, India and China and now distributed

in Bhutan, South Korea, Laos, Malaysia, Myanmar, Nepal, Sri Lanka, Pakistan, Thailand, and Vietnam.[11] It is perennial and found in tropical and subtropical lowland rainforests and mountain slopes. The plant prefer the habitats that are open and bushy with hedges and river banks.[12] The plant is widely spread throughout warmer areas of India.[14] *C. decapetala* (Roth) Alston is a tropical Asian species that was introduced in India and has now become naturalised.[15]

Taxonomic status

Caesalpinia decapetala syn: *Biancaea decapetala* (Roth) O. Deg. accepted by Govaerts, R. in 1999 in their World Checklist of Seed Plants.[16] Alston in 1931 create a new combination that is *Caesalpinia. decapetala* (Roth) Alston based on *Reichardia decapetala* Roth. Roth in 1821 when *Reichardia decapetala* was described, he was also doubtful due to the that he wrote, "*Richardia* ? *decapetala* in his protologue.[17]" Steenis (1996) in the Flora of Malesiana treated *Caesalpinia decapetala* is a distinct species and, given the type information, Heyne *s.n.* (K iso), India and *C. sepiaria* are synonyms under it.[18] C. *sepiaria Roxb. (*1814*),* which was a *nomen nudum* because it was not a validly published name till 1814, and Wallich (1828) also used the same epithet (*C. sepiaria Wall.*).[19]

Synonyms

Biancaea sepiaria (Roxb.) Tod., *Biancaea decapetala* (Roth) O. Deg., *Caesalpinia sepiaria* Roxb., *Reichardia decapetala* Roth., *Mezoneuron benguetense* (Elmer) Elmer. Some common vernacular names are listed in Table 1.

Table 1- Synonyms in vernacular languages[5, 12, 14, 20]

Language	Synonyms
English	Mysore thorn, Mauritius thorn, cat's claw
Bangla	Kander, Relan
Chinese	Yun shi, Ma tou, Yan wang ci,
French	liane sappan, sappan, Bois sappan
Hawaiian	Popoki, puakelekino
Oromo	Yeferenj kitikita, Gom riya
Japanese	Jaketsu-ibara
Nepali	Lata, Arile kanda, Arille, Ulte kanda, Karanga, Lata kanda
Malagasy	Roinombilahy, Roimainty, Tsiafakomby
Isizulu	Mauritiusdoring, Kaffer-wag-n-bietjie, Kraaldoring, Lunakha
Pashto	Jara
Marathi	Chiller, Chillhari, Chillati
Hindi	Ralan, Alia, Arlu, Kingan
Gujrati	Kirmich chilar

Urdu	Kander Relan
Sanskrit	Kantaki karanja
Kannada	Gajalige, Hotasige, Hunnula, Kurudu, Gejjuga, Kurutugajjika
Malayalam	Inna
Telugu	Gaddakorinda
Tamil	Puli-tatukki

RESULT AND DISCUSSION

Ethnobotanical Uses

Ethnobotany refers to a completely organic and traditional relationship between people and the plant. *C. decapetala* (Roth) Alston naturalised over a large area and subsequently cultivated in gardens it is popular herbal plant that is known all over the world. Almost all plant parts are used medicinally, especially in Chinese medicine. Jaundice, diarrhoea, bronchitis and roots in malarial fever are effectively used. Some ethnobotanical uses are listed below in Table 2.

Table 2 - Ethnobotanical uses of *Caesalpinia decapetala* (Roth) Alston.

Sr. No.	Plant part used	Application/ uses	Places/Tribes/ Community/ Country	References
I	Whole Plant	A bath containing a *C. decapetala* decoction is effective for treating jaundice	NR	[21,22]
II	Root	Treat Nauralgia	Kagoshima, Japan	[23,24]
		As an antimalarial agent, it is used to cure bronchitis, prevent colds.	China	[11]
		Crushed the seed as used a twice a day oral doses for purgative	Darmai vally and Shahgram valley, Swat District, Pakistan	[25,26]
		Inner root bark used for diarrhoea	Parinche valley, Pune, Maharashtra	[27]
		Relieve fever	Kweichow province	[28]
		To cure dysmenorrhoea, the roots are cooked and the liquid consumed.	Lwamondo area, Limpopo province, South Africa	[29]
		Root juice or decoction used to cure sprain, and muscular swelling	Ayurveda and Siddha	[30,31,32]
		Traditionally used to cure as a bronchitis treatment, cold prevention, and malaria treatment.	Guizhou Province, China	[11]
		Boil for ten minutes, then take one tin cup of 300 ml of the extract orally three times a day for a week for sexually transmitted infections.	Blouberg, South Africa	[33]
		For the treatment of Gonorrhoea	Blouberg municipality, Capricorn District,	[33]
III	Bark	Poisonous to fish and being used as a fish	West Nepal	[14,34,35]

		poison		
		Decoction is abortifacient	Ayurveda and Siddha	[30,31,32]
		Tannins isolation	Maharashtra and South India	[36]
IV	Leaves	Burns, biliousness, and stomach ailments are treated with the leaves.	NR	[10,21,22]
		Sore in the mouth	Ayurveda and Siddha	[31]
		Antibacterial activity	NR	[37]
V	Flowers	Infusion in brochities, asthma and malerial fever	Ayurveda and Siddha	[31,32]
VI	Seeds	Women manufacture and wear necklaces out of *Caesalpinia decapetala* (Roth.) Alston seeds to avoid false perception.	Ethiopia	[13, 38]
		Anti-diarrheal and febrifuge for malarial fever	Oriental Medicine, China	[39,40]
		One tablespoon of the powdered seeds is taken orally two to three times per week after being dissolved in 200 to 250 mL of water or a cup of tea. The powdered seeds are preserved in airtight jars. (should be manually pounded rather than mechanically)	Parinche valley, Pune, Maharashtra	[41]
		Paste is used to eliminate freckles from the face as a cosmetic. Used to treat a variety of skin ailments, including scabies and eczema.	Abbotabad	[42]
VII	Leaves and Root	Purgative and emmenagogue properties	----	[10,21,22,31,43]
		They are used in traditional medicine to treat bronchitis, diarrhoea, diabetes, malaria, paediatric infantile malnutrition, as well as to ward off cold symptoms.	China	[44]
VIII	Seeds and Root	Insecticidal, veterinary medicine	Ayurveda and Siddha	[31]
IX	Root, Stem, Fruits	The seeds are extremely toxic, and the root is used to treat colds and rheumatic pain.	Miao people of Jijiezi, Yunnan, China	[45,31]
X	Plant part not mentioned	Laxative, tonic, carminative and antipyretic	----	[10,46,21,22]
		Anti-diabetic	----	[47]
		Lotion is applied for treating headache with ecthyma	Chinese medicine	[48]
		Used in eye drop treating trachoma caused by *Chlamydia trachomatis*	Chinese medicine	
		A paste for the treatment of venomous snake bites	Chinese medicine	
		Utilised for treating scaled and burn	Chinese medicine	
		Sexually Transmitted Diseases (STD's) are treated using extract.	----	
		Used to treat closed bone fractures with	----	

		blood stasis.		
		Treatment of rabies	----	

PHYTOCHEMISTRY

Chemical compounds

Ogawa *et al*., separated chemical compounds from roots of *Caesalpinia decapetala var. japonica* using dried plant material in methanolic extract and isolated cassane diterpenoid caesaljapin and two tritrepenoids as lup-20(29)-en-3β-ol, betulinic acid with five phenolics as sappanchalcone, 3-deoxysappanchalcone, catechin, methyl gallate, 3-hydroxy-1-(4-hydroxy-3-methoxyphenyl)-1-propanone.[24] Van *et al*., isolated cassane diterpenoid caesaldecan, 4,5, epoxy- 8(14) – caryophyllene, spathulenol, lupeol, squalene, trans-reveratol, quercetin, astragalin, stigmasterol etc. from leaves of *C. decapetala* (Roth) Alston and drawn their structures using combination of 2D NMR techniques, namely, $^{1}H–^{1}H$ COSY, HMQC, HMBC, and ROESY.[6] Zhang isolated chemical compounds from the stem of *C. decapetala* (Roth) Alston in an ethanolic extract, and chemicals were discovered like 6'-hydroxy-3,4-(1''-hydroxy-epoxy- propane)-2', 3'-(1'' β-hydroxy-2'''-carbonyl-cyclobutane)-1, 1'-diphenyl, octacosyl 3, 5-dihydroxycinnamate, 2', 4, 4'-trihydroxychalocone, bonducellin,7, 3', 5'-trihydroxyflavanone, daucosterin, β –sitosterol.[49] Powar *et al.*, optimised the conditions for isolation of gallic acid as the best Gallic acid extraction requirements were found to be extraction at 65-70º C for 48 hours and 70:30 ethanol: water composition. The greatest yield of gallic acid achieved at this optimal extraction is 17.85%.[10] Miyazawa *et al.*, in 2012, Used flowering twigs, gas chromatography olfactory (GC-O) and aroma extract dilution analysis (AEDA) to identify, define and examine the unique odour. Aroma chemicals that have been isolated α-pinene, β-myrcene, α-phellandrene, limonene, (Z)-β-ocimene, (E)-β-ocimene, linalool, nonanal, α-terpineol, geraniol, β-caryophyllene, α-humelene, (E)-nerolidol.[50]

Wei *et al*., isolated the fourteen compounds from roots of *C. decapetala* (Roth) Alston the compounds are like andrographolide, quercetin, β- sitosterol, bergenin, rutin, emodin, botulin, stigmasterol, baicalein, polydatin, salicin, apigenin, epicatechin, cinnamic acid etc. and studied their anticancer activity against human gastric carcinoma cell.[7] Wei *et al*., isolated one new cassane diterpenoid from seeds of *C. decapetala* (Roth) Alston. They used air dried powder in ethanolic extracts to isolate phanginin Q a new unusual O bridge between C-19 and C-20, as well as three new cassane diterpenoids as caesaljapin, caesaldekarin A, and caesaldekarin B.[51] In 2015 Kamikawa, identified and elicited the structures of chemical

substances. They extracted furanano diterpenoids like caesaljaponins A and B from seed using a methanolic extract.[40] Hua *et al*., yielded five cassane type diterpenoids specifically caesaldecapes C, caesaldecapes D, caesalmin C, caesalmin E, and bounducellpin A from the seeds of *C. decapetala* (Roth) Alston.[52] Qiao *et al*., (2016), isolated diterpenoid compounds from the root of *C. decapetala* (Roth) Alston. The compounds, namely 3β-hydroxyphanginin H, 7β-acetoxyphanginin H, 3β-acetoxyphanginin H, 7β-hydroxyphanginin H, 4-epi-3β-acetoxycaesalpinilinn, 4-epi-3β-hydroxycaesalpinilinn, tomocin E, 20-acetoxytaepeenin D, caesaljapin C, caesalacetal, caesalpinista B, henrilabdane C, 11E-labdadien-19-oic acid, trans-communic acid, 3-hydroxy-4-methoxycinnamaladehyde, ozoroalide and intricatinol, 4-hydroxy-3-methoxypropiophenone. They looked at their anticancer properties as well.[44] Xu *et al.*, (2016), characterized diterpenoid compounds from seeds of *C. decapetala* (Roth) Alston the isolated compounds are decapetpene A, decapetpene B, decapetpene C, caesalpinin ML, neocaesalpin S, neocaesalpin AB, 14(17)-dehydrocaesalpin F, caesalpinin MJ, caesalmin C, caesalmin D, caesalmin F, caesalpinin E, and caesalpinin U and They study their anti-TMV activity.[53] Chemical analysis of *C. decapetala* (Roth) Alston was carried out by Qiao *et al.*, This study resulted in the isolation and identification of a 1:1 combination of two C-20 epimeric cassane type furanoditerpenoids, as caesaldecins A and B, as well as a novel labdane-type diterpenoid known as 8(17),11(Z),13(E)- trien-15,19-dioic acid. By comparing their estimated and experimental ECD's and considering their biosynthesis pathways with analogous diterpenoids, the stereochemistry of compounds was explained and their *in-vitro* cytotoxic and antibacterial properties were disclosed in this paper.[54] Akihara *et al*., isolated compounds and investigated their HPLC profiles and spectroscopic analyses. caesaljapanin A, caesaljaponin B, caesalacetal, caesaljapin, caesalsauteolide, 2- hydrooxy caesaljapin, 2,7-dihydroxycaesaljapin, 2-hydroxycaesalacetal, caesalsauterol, 6-acetylcaesalsauterol, norcaesalsauterol compounds isolated and analyzed.[55] Isolated fifty nine compounds form bark and leaves of the plant in methanolic and infusion. The names and structures of the isolated compounds are listed in the following table. The bioactivity of *C. decapetala* (Roth) Alston leaves and bark extract was assessed using a variety of traditional *in-vitro* bioassays.[56] In addition to the chemicals reported in Table 3 and their chemical structures are redrawn in Table 4. Some additional compounds viz. Caesalpinin Q, Neocaesalpin N, Caesalpinol, 4'-methoxy-4,6-dihydroxyisoquirtigenin, 1-deacteoxy-1-oxocaesalmin C, Neocaaesaloin N, 3,4,3,5'-tetrahydroxydistyrene, Protohematoxylin B, 3-deoxy-hematoxylin chalcone, Protosappanoside A, Isoprotosappanoside A, Protosappanoside

B, Isoprotosappanoside B, Protosappanoside C, Isoprotosappanoside C, Quinoyl-glucogallic acid are also reported in *C. decapetala* (Roth) Alston.

Table 3: Chemical compounds found in *Caesalpinia decapetala* (Roth) Alston.

Sr. No.	Part of Plant	Name of the compound	Molecular Formula	References
1.	Root Var. *japonica*	Caesaljapin	$C_{21}H_{28}O_5$	[24]
2.		Lup-20(29)-en-3ß-ol	$C_{30}H_{50}O$	
3.		Betulinic acid	$C_{30}H_{48}O_3$	
4.		3-deoxysappanchalcone	$C_{16}H_{14}O_4$	
5.		Sappanchalcone	$C_{16}H_{14}O_5$	
6.		Catechin	$C_{15}H_{14}O_6$	
7.		Methyl gallate	$C_8H_8O_5$	
8.		3-hydroxy-l-(4-hydroxy-3-methoxyphenyl)-l-propanone	$C_{10}H_{12}O_4$	
9.	Entire plant	Lupeol acetate	$C_{32}H_{52}O_2$	[9]
10.		Lupeol	$C_{30}H_{50}O$	
11.		Oleanoic acid	$C_{30}H_{48}O_3$	
12.		Pentacosanoic acid 2,3 – dihydroxypropyl ester	$C_{27}H_{52}O_4$	
13.		1- (26-hydroxyhexacosanoyl)- glycerol	$C_{29}H_{58}O_5$	
14.		Stigmasterol	$C_{29}H_{48}O$	
15.		β- Sitosterol	$C_{29}H_{50}O$	
16.	Leaves	Caesaldecan	$C_{25}H_{38}O_5Na$	[6]
17.		Spathulenol	$C_{15}H_{24}O$	
18.		4,5, epoxy-8(14)-caryophyllene	$C_{15}H_{24}O_2$	
19.		Squalene	$C_{30}H_{50}$	
20.		Lupeol	$C_{30}H_{50}O$	
21.		Trans-resveratrol	$C_{14}H_{12}O_3$	
22.		Quercetin	$C_{15}H_{10}O_7$	
23.		Astragalin	$C_{21}H_{20}O_{11}$	
24.		Stigmasterol	$C_{29}H_{48}O$	
25.	Stem	6’-hydroxy-3,4-(1’’-hydroxy-epoxy-propane)-2’, 3’-(1’’ β-hydroxy-2’’’-carbonyl-cyclobutane)-1, 1’-diphenyl	$C_{15}H_{10}O_5$	[49]
26.		Octacosyl 3, 5-dihydroxycinnamate	$C_{37}H_{64}O_4$	
27.		2’, 4, 4’-trihydroxychalocone	$C_{25}H_{12}O_4$	
28.		Bonducellin	$C_{17}H_{14}O_4$	
29.		7, 3’, 5’-trihydroxyflavanone	$C_{15}H_{12}O_5$	
30.		Daucosterin	$C_{35}H_{60}O_6$	
31.		β -sitosterol	$C_{29}H_{50}O$	
32.	Leaves	α-Phellandrene	$C_{10}H_{16}$	[57]
33.		Caryphyllene	$C_{15}H_{24}$	
34.		**α**-pinene	$C_{10}H_{16}$	
35.		β-pinene	$C_{10}H_{16}$	
36.		β-ocimene	$C_{10}H_{16}$	
37.		Geraniol	$C_{10}H_{18}O$	
38.	Flowering	α-pinene	$C_{10}H_{16}$	[50]

39.	twig	β--myrcene	$C_{10}H_{16}$	
40.		α -phellandrene	$C_{10}H_{16}$	
41.		Limonene	$C_{10}H_{16}$	
42.		(Z)-β-ocimene	$C_{10}H_{16}$	
43.		(E)-β-ocimene	$C_{10}H_{16}$	
44.		Linalol	$C_{10}H_{18}O$	
45.		Nonanal	$C_9H_{18}O$	
46.		α -terpineol	$C_{10}H_{18}O$	
47.		Geraniol	$C_{10}H_{18}O$	
48.		β-caryophyllene	$C_{15}H_{24}$	
49.		α -humelene	$C_{15}H2_4$	
50.		(E)-nerolidol	$C_{15}H_{26}O$	
51.	Roots	Andrographolide	$C_{20}H_{30}O_5$	[7]
52.		Quercetin	$C_{15}H_{10}O_7$	
53.		β-sitosterol	$C_{29}H_{50}O$	
54.		Bergenin	$C_{14}H_{16}O_9$	
55.		Rutin	$C_{27}H_{30}O_{16}$	
56.		Emodin	$C_{15}H_{10}O_5$	
57.		Betulin	$C_{30}H_{50}O_2$	
58.		Stigmasterol	$C_{29}H_{48}O$	
59.		Baicalein	$C_{15}H_{10}O_5$	
60.		Polydatin	$C_{20}H_{22}O_8$	
61.		Salicin	$C_{13}H_{18}O_7$	
62.		Apigenin	$C_{15}H_{10}O_5$	
63.		Epicatechin	$C_{15}H_{14}O_6$	
64.		Cinnamic acid	$C_9H_8O_2$	
65.	Seeds	Phanginin Q	$C_{21}H_{26}O_6Na$	[51]
66.		Caesaljapin	$C_{21}H_{28}O_5$	
67.		Caesaldekarin A	$C_{22}H_{32}O_4$	
68.		Caesaldekarin B	$C_{20}H_{30}O_3$	
69.	Seed *var. japonica*	Caesaljaponin A	$C_{25}H_{34}O_8$	[40]
70.		Caesaljaponin B	$C_{25}H_{34}O_8$	
71.	Roots var. *japonica*	Caesalacetal	$C_{21}H_{28}O_5$	[40]
72.		Caesalpinetate	$C_{23}H_{32}O_5$	
73.		Caesalpinone	$C_{19}H_{26}O_2$	
74.		Caesaljapin	$C_{21}H_{28}O_5$	
75.		(E)-15-oxolabda-8(17),13-diene-19-oic acid	$C_{20}H_{30}O_3$	
76.		(Z)-15-oxolabda- 8(17),13-diene-19-oic acid	$C_{20}H_{30}O_3$	
77.		Mimosol c	$C_{20}H_{34}O_2$	
78.		Isocupressic acid	$C_{20}H_{32}O_3$	
79.		Isopimaradien 3b-18-diol	$C_{20}H_{32}O$	
80.		Agathic acid	$C_{20}H_{30}O_4$	
81.	Roots	3β-hydroxyphanginin H	$C_{21}H_{28}O_5$	[44]
82.		3β-acetoxyphanginin H	$C_{23}H_{30}O_6$	
83.		7β-acetoxyphanginin H	$C_{23}H_{30}O_6$	
84.		7β-hydroxyphanginin H	$C_{21}H_{28}O_5$	

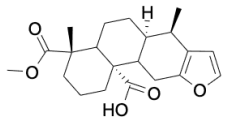
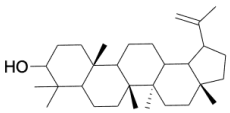
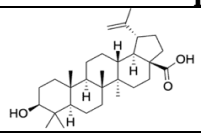
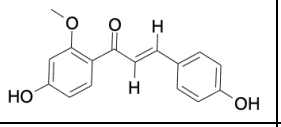
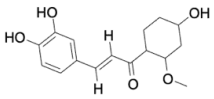
85.		4-epi-3β-hydroxycaesalpinilinn	$C_{21}H_{26}O_6$	
86.		4-epi-3β-acetoxycaesalpinilinn	$C_{23}H_{28}O_7$	
87.		20-acetoxytaepeenin D	$C_{25}H_{30}O_7$	
88.		Tomocin E	$C_{24}H_{34}O_8$	
89.		Caesaljapin C	$C_{23}H_{30}O_7$	
90.		Caesalacetal	$C_{21}H_{28}O_5$	
91.		Caesalpinista B	$C_{23}H_{32}O_6$	
92.		11E-labdadien-19-oic acid	$C_{17}H_{21}O_3$	
93.		Henrilabdane C	$C_{20}H_{30}O_4$	
94.		Trans-communic acid	$C_{20}H_{30}O_2$	
95.		Ozoroalide	$C_{17}H_{24}O_4$	
96.		3-hydroxy-4-methoxycinnamaladehyde	$C_{10}H_{10}O_3$	
97.		4-hydroxy-3-methoxypropiophenone	$C_{10}H_{12}O_3$	
98.		Intricatinol	$C_{17}H_{14}O_5$	
99.	Seed	Caesaldecapes A	$C_{19}H_{26}O_5$	[45]
100.		Caesaldecapes B	$C_{27}H_{38}O_{11}$	
101.	Seeds	Caesaldecapes C	$C_{25}H_{34}O_{10}$	[52]
102.		Caesaldecapes D	$C_{27}H_{36}O_{11}$	
103.		Caesalmin C	$C_{26}H_{34}O_8$	
104.		Caesalmin E	$C_{26}H_{36}O_9$	
105.		Bounduceellpin A	$C_{25}H_{34}O_9$	
106.	cotyledon	Caesalpinista B	$C_{23}H_{32}O_6$	[58]
107.		Deoxycaesaljaponin A	$C_{25}H_{34}O_7$	
108.	Seeds	Decapetpene A	$C_{25}H_{34}O_8$	[53]
109.		Decapetpene B	$C_{24}H_{36}O_5$	
110.		Decapetpene C	$C_{24}H_{38}O_8$	
111.		Caesalpinin ML	$C_{20}H_{30}O_2$	
112.		Neocaesalpin S	$C_{22}H_{32}O_6$	
113.		Neocaesalpin AB	$C_{22}H_{32}O_7$	
114.		14(17)-dehydrocaesalpin f	$C_{26}H_{34}O_8$	
115.		Caesalpinin MJ	$C_{24}H_{31}O_6$	
116.		Caesalmin C	$C_{26}H_{34}O_8$	
117.		Caesalmin D	$C_{26}H_{36}O_9$	
118.		Caesalmin F	$C_{27}H_{37}O_9$	
119.		Caesalpinin E	$C_{25}H_{34}O_8$	
120.		Caesalpinin U	$C_{27}H_{42}O_{12}$	
121.		Caesalmin F	$C_{27}H_{38}O_9$	
122.		**α**- caesalpin	$C_{24}H_{32}O_8$	
123.	Leaves	Catechin	$C_{15}H_{14}O_6$	[8]
124.		Quercetin	$C_{15}H_{10}O_7$	
125.		Gallic acid	$C_7H_6O_5$	
126.		4-hydroxybenzoic acid	$C_7H_6O_3$	
127.		p- coumaric	$C_9H_8O_3$	
128.	Leaves	Apigenin-7-rhamnoside	$C_{21}H_{20}O_9$	[59]
129.		4-O-Methyl episappanol	$C_{17}H_{18}O_6$	
130.		Daucosterol	$C_{35}H_{60}O_6$	
131.		Astragalin	$C_{21}H_{20}O_{11}$	

132.		6-hydroxy kaempferol	$C_{15}H_{10}O_7$	
133.		Quercetin	$C_{15}H_{10}O_7$	
134.		Narengin	$C_{27}H_{32}O_{14}$	
135.	Flower	Bufadienolides	$C_{24}H_{34}O_2$	[60]
136.		Furanolactone	$C_{21}H_{26}O_8$	
137.		Enone	C_4H_6O	
138.		Androsterone	$C_{19}H_{30}O_2$	
139.	Leaves	Caesaldecins A	$C_{21}H_{26}O_6$	[54]
140.		Caesaldecins B	$C_{21}H_{26}O_6$	
141.		8(17),11(Z),13(E)-trien-15,18-dioic acid	$C_{20}H_{28}O_4$	
142.	Infected Seed	Caesaljaponin A	$C_{24}H_{34}O_8$	[55]
143.		Caesaljaponin B	$C_{25}H_{34}O_8$	
144.		Caesalacetal	$C_{21}H_{28}O_5$	
145.		Caesaljapin	$C_{21}H_{28}O_5$	
146.		Caesalsauteolide	$C_{21}H_{26}O_7$	
147.		2-hydroxycaesaljapin	$C_{21}H_{28}O_6$	
148.		2,7-dihydroxycaesaljapin	$C_{21}H_{28}O_7$	
149.		2-hydroxycaesalacetal	$C_{21}H_{28}O_6$	
150.		Caesalsauterol	$C_{21}H_{28}O_6$	
151.		6-acetylcaesalsauterol	$C_{23}H_{30}O_7$	
152.		Norcaesalsauterol	$C_{20}H_{26}O_7$	
153.		Caesalpinista A	$C_{21}H_{30}O_5$	
154.	Leaves, Flower Bark	Lupeol	$C_{30}H_{50}O$	[61]
155.		Betulinic acid	$C_{30}H_{48}O_3$	
156.		Stigmasterol	$C_{29}H_{48}O$	
157.		Stigmasterol-3-O- β -D-glucopyranoside	$C_{21}H_{28}O_5$	
158.		Caesaljapin	$C_{21}H_{28}O_5$	
159.		Caesaldecan	$C_{25}H_{38}O_5Na$	
160.		Methoxy inocitol	$C_7H_{16}O_6$	
161.		Quercetin	$C_{15}H_{10}O_7$	
162.	Seed	1 α,6 α,7ß-triacetoxy-14 α -methoxy-Vouacapen-5 α -ol	$C_{25}H_{38}O_9$	[62]
163.		Caesalmin F	$C_{27}H_{38}O_9$	
164.		Neocaaesalpin MP	$C_{27}H_{38}O_{10}$	
165.		Neocaesaloin AA	$C_{25}H_{36}O_9$	
166.		Bonducellpin C	$C_{23}H_{32}O_7$	
167.		Bonducellpin E	$C_{23}H_{30}O_8$	
168.	Entire Plant	Methyl 2,3,5-trihydroxybenzoate	$C_8H_8O_5$	[63]
169.		Protocatechuic acid methyl ester	$C_8H_8O_4$	
170.		N-trans-feruloyl tyramine	$C_{18}H_{19}NO_4$	
171.		Trichostachine	$C_{16}H_{17}NO_3$	
172.		Cinnamylpiperidine	$C_{14}H_{19}N$	
173.		Gallic acid	$C_7H_6O_5$	
174.		Methyl 3,4,5-trihydroxybenzoate	$C_8H_8O_5$	
175.		Ethyl 3,4,5 Trihydroxybenzoate	$C_{21}H_{16}O_6$	
176.		Resveratrol	$C_{14}H_{12}O_3$	

177.		Protosappanin A	$C_{15}H_{12}O_5$	
178.	NR	Catechin	$C_{15}H_{14}O_6$	[64]
179.		Epicatechin	$C_{15}H_{14}O_6$	
180.		Ethyl gallate	$C_9H_{10}O_5$	
181.		Quercetin	$C_{15}H_{10}O_7$	
182.		Luteolin	$C_{15}H_{10}O_6$	
183.		Isoliquiritigenin	$C_{15}H_{12}O_4$	
184.		Linoleic acid	$C_{18}H_{32}O_2$	
185.		Brevifolin carboxylic acid	$C_{13}H_8O_8$	
186.		Epicatechin gallate	$C_{22}H_{18}O_{10}$	
187.		Resveratrol	$C_{14}H_{12}O_3$	
188.		Hematoxylin	$C_{16}H_{14}O_6$	
189.	Leaves and Bark var.japonca	Quinic acid	$C_7H_{12}O_6$	[56]
190.		Isocitric acid	$C_6H_8O_7$	
191.		Galloyl glucose	$C_{13}H_{16}O_{10}$	
192.		Shikimic acid	$C_7H_{10}O_5$	
193.		Gallic acid	$C_7H_6O_5$	
194.		5-O-Galloylquinic acid	$C_{14}H_{16}O_{10}$	
195.		5-O-Galloylquinic acid derivative	$C_{16}H_{18}O_{10}$	
196.		Galloylsucrose	$C_{19}H_{26}O_{15}$	
197.		Galloylshikimic acid isomer 1	$C_{14}H_{14}O_9$	
198.		Naringenin derivative	$C_{17}H_{24}O_{13}$	
199.		3,4-Dihydroxybenzoic acid	$C_7H_6O_4$	
200.		Gallic acid derivative	$C_{15}H_{20}O_{11}$	
201.		4-Glucogallic acid	$C_{13}H_{16}O_{10}$	
202.		2-Isopropylmalic acid	$C_7H_{12}O_5$	
203.		Galloylshikimic acid isomer 2	$C_{14}H_{14}O_9$	
204.		Caffeoylglucose	$C_{15}H_{18}O_9$	
205.		Dihydroxybenzoic acid pentoside	$C_{12}H_{14}O_8$	
206.		Gallic acid acetylrhamnoside	$C_{15}H_{18}O_{10}$	
207.		Di-O-galloyl kinic acid	$C_{21}H_{20}O_{14}$	
208.		Methyl gallate	$C_8H_8O_5$	
209.		Galloyl pentose	$C_{12}H_{14}O_9$	
210.		Coumaroylquinic acid	$C_{16}H_{18}O_8$	
211.		Dihydrobenzoic acid hexoside derivative	$C_{13}H_{18}O_8$	
212.		5-O-(digalloyl)quinic acid	$C_{21}H_{20}O_{14}$	
213.		3,5-di-O-galloylquinic acid	$C_{21}H_{20}O_{14}$	
214.		4-O-Caffeoylquinic acid	$C_{16}H_{18}O_9$	
215.		Digallic acid	$C_{14}H_{10}O_9$	
216.		Digalloylshikimic acid isomer 1	$C_{21}H_{18}O_{13}$	
217.		Ethyl gallate	$C_9H_{10}O_5$	
218.		Quinic acid rhamnoside	$C_{13}H_{22}O_{10}$	
219.		Digalloylshikimic acid isomer 2	$C_{21}H_{18}O_{13}$	
220.		3,4,5-Tri-O-galloylquinic acid	$C_{28}H_{24}O_{18}$	
221.		Myricetin-O-(O-galloyl)- hexoside	$C_{28}H_{24}O_{17}$	
222.		Digallic acid methyl ester isomer 1	$C_{15}H_{12}O_9$	
223.		Galloyl-4-O-Caffeoylquinic acid	$C_{23}H_{22}O_{13}$	

224.		Quercetin-O-(O-galloyl)- hexoside	$C_{28}H_{24}O_{16}$	
225.		Digallic acid methyl ester isomer 2	$C_{15}H_{12}O_9$	
226.		Digallic acid methyl ester isomer 3	$C_{15}H_{12}O_9$	
227.		Galloyl-astragalin	$C_{28}H_{24}O_{15}$	
228.		Di-galloyl-rhamnosyl-kinic acid	$C_{27}H_{30}O_{18}$	
229.		Galloyl-caffeoyl-hydroxytetramethoxyflavone	$C_{35}H_{28}O_{14}$	
230.		Quercetin dihexoside	$C_{30}H_{26}O_{15}$	
231.		Galloyl-ethylgallate	$C_{16}H_{13}O_9$	
232.		Di-galloyl-methylgallate	$C_{22}H_{16}O_{13}$	
233.		Caffeoyl-astragalin	$C_{30}H_{26}O_{14}$	
234.		Tetrahydroxyflavone 3'-O-rhamnoglucoside	$C_{27}H_{30}O_{15}$	
235.		Quercetin	$C_{15}H_{10}O_7$	

Table 4: Chemical structure of above mentioned compounds according to the serial number.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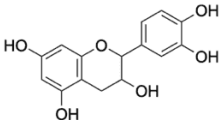	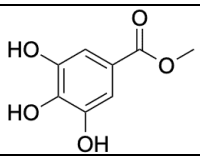	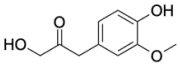	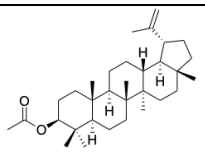	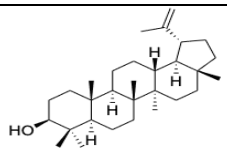
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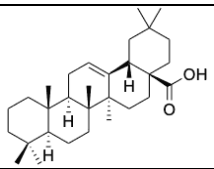			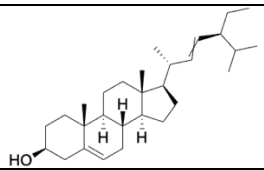	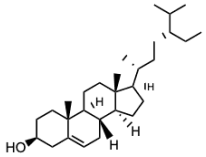
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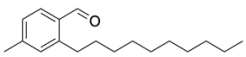	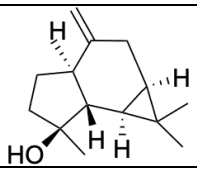	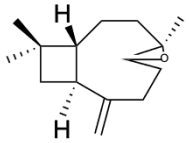	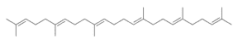	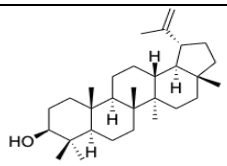
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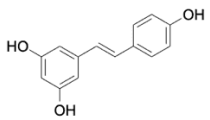	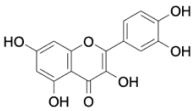	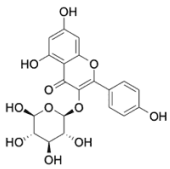	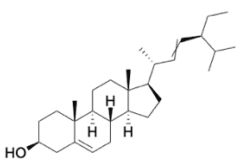	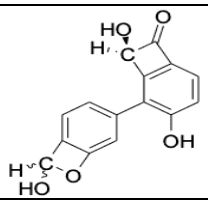
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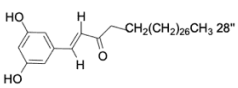	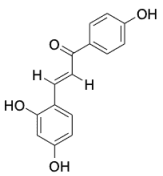	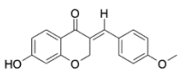	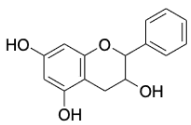	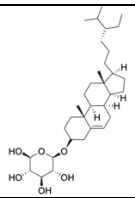
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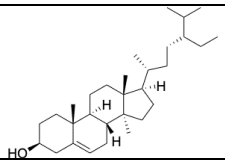	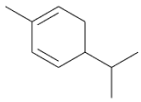	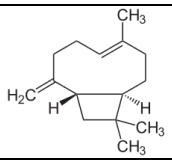	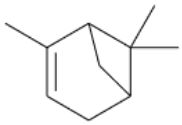	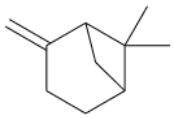
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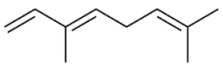	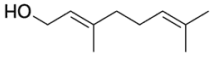	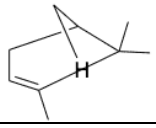	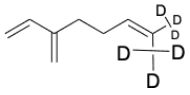	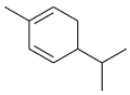
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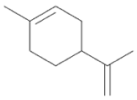	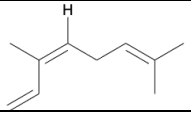	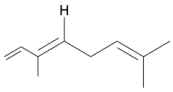	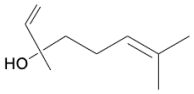	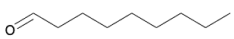
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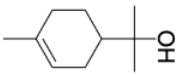	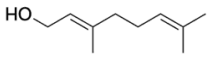	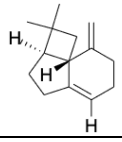	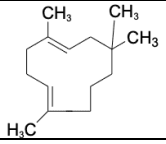	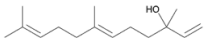
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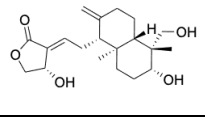	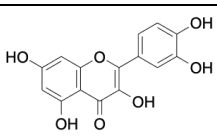	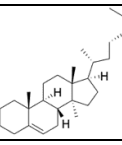	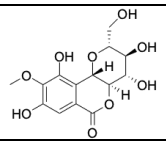	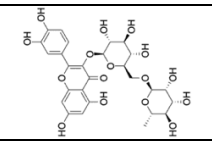
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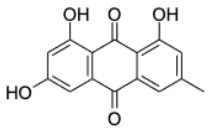	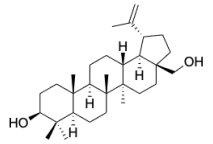	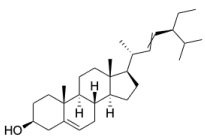	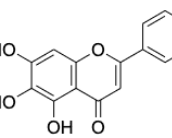	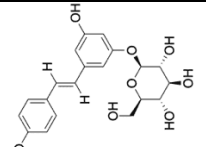
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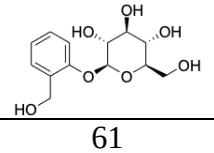	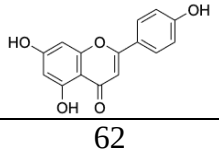	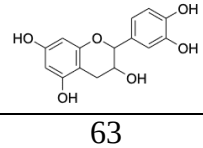	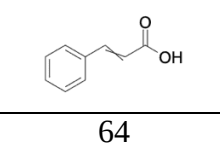	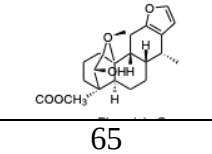
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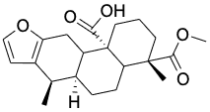	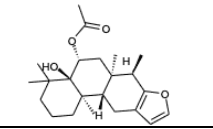	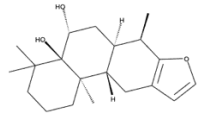	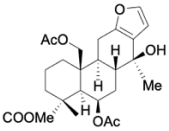	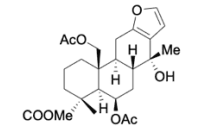
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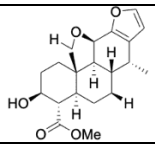	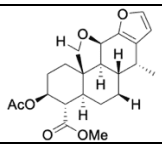	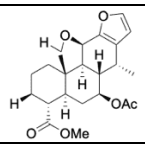	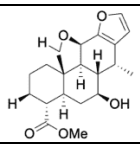	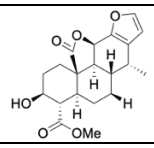
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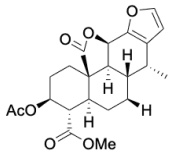	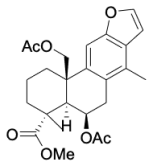	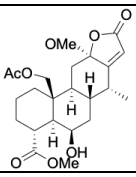	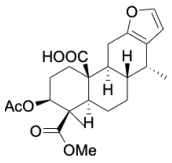	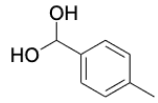
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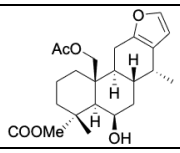	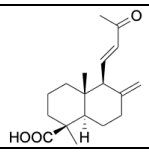	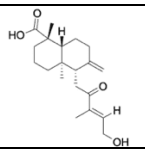	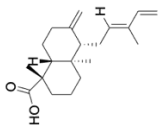	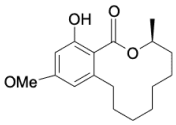
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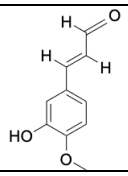	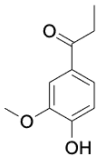	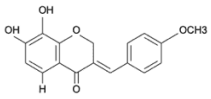	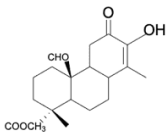	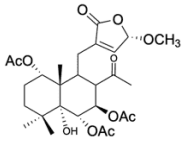
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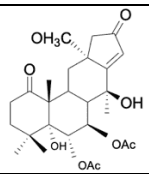	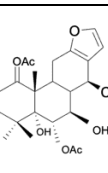	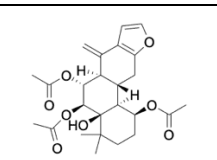	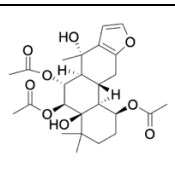	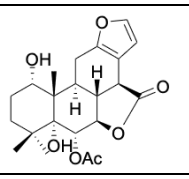
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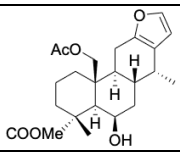	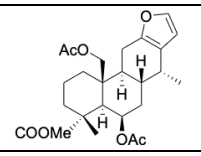	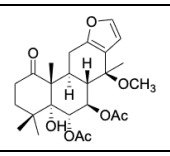	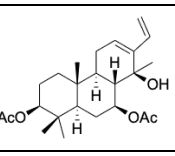	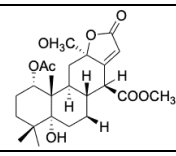
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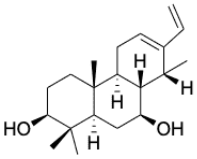	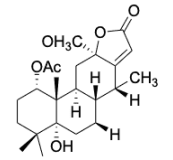	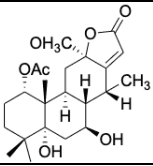	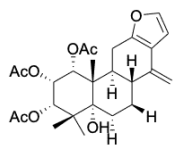	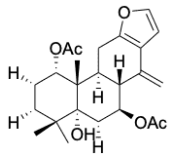
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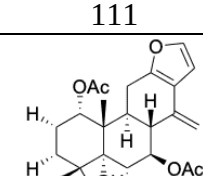	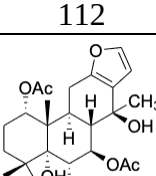	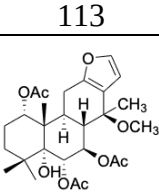	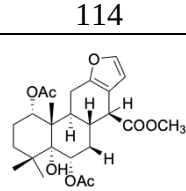	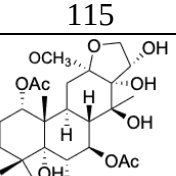
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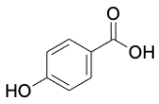	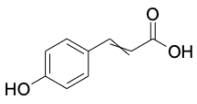	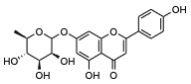	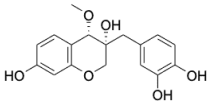	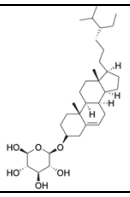
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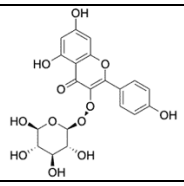	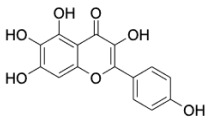	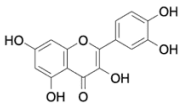	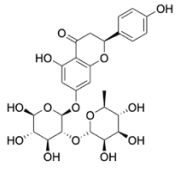	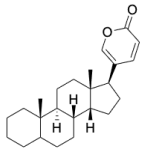
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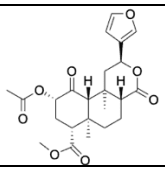	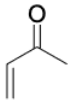	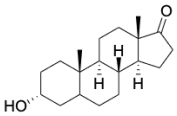	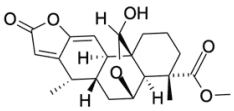	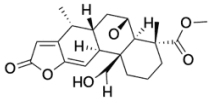
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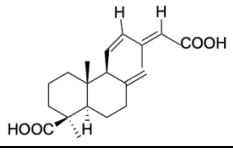	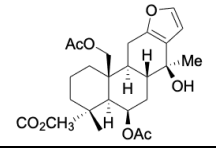	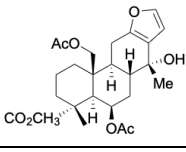	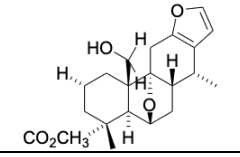	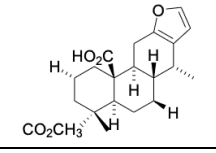
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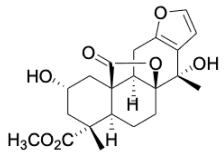	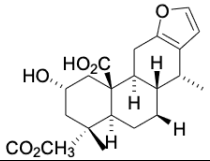	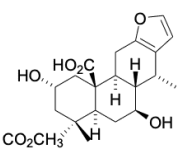	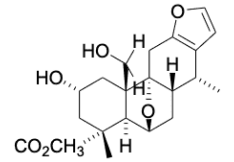	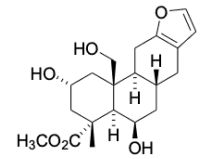
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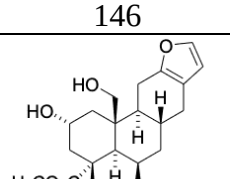	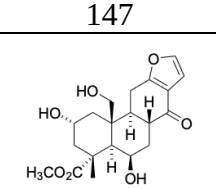	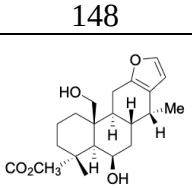	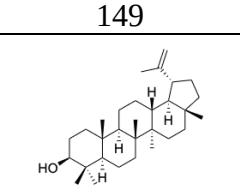	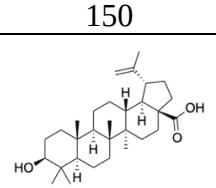
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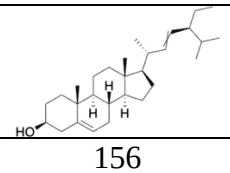	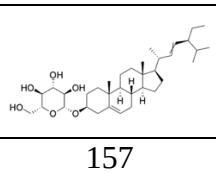	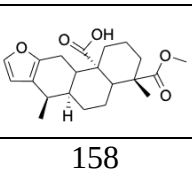	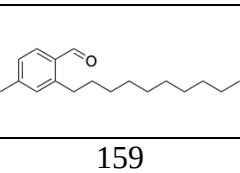	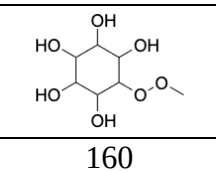
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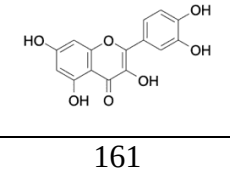	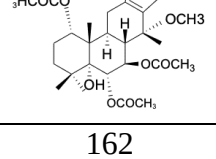	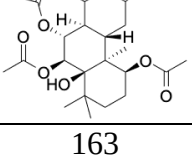	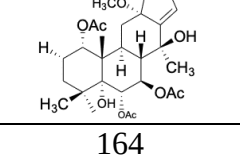	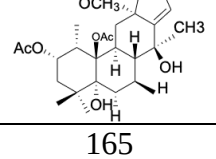
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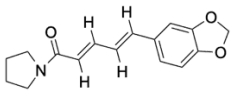	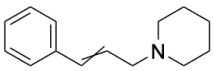	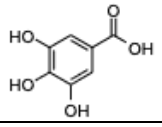	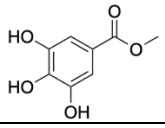	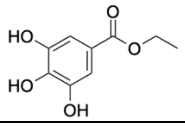
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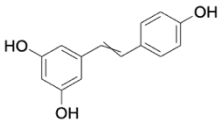	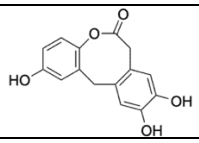	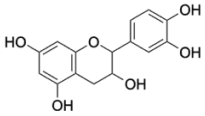	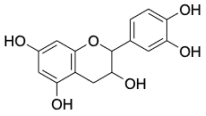	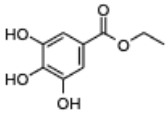
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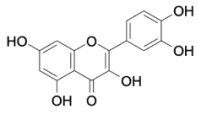	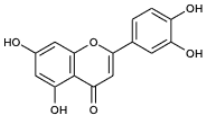	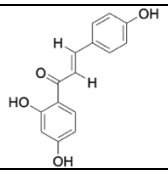	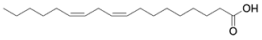	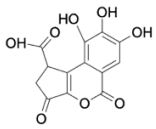
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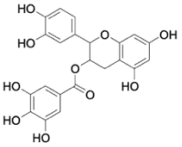	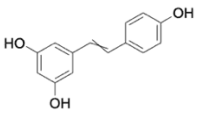	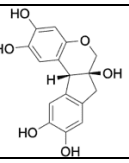	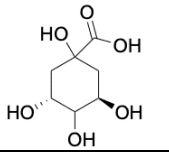	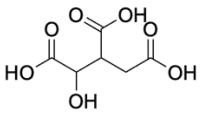
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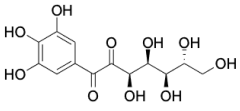	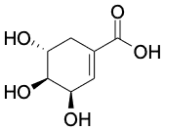	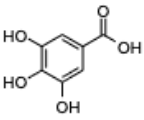	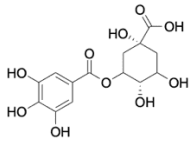	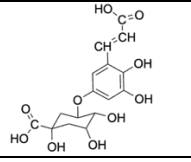
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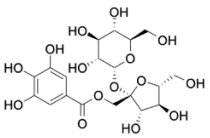	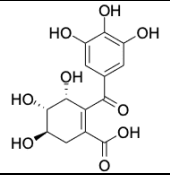	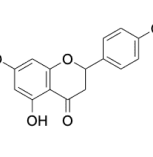	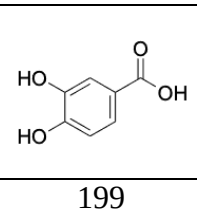	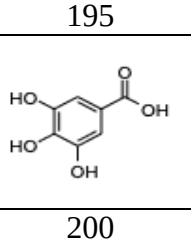
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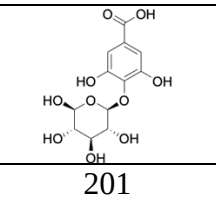	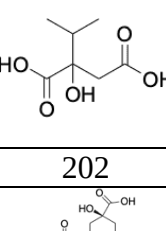	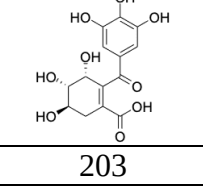	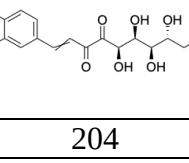	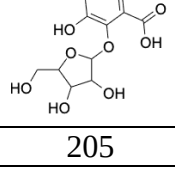
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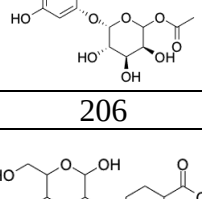	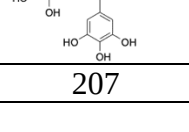	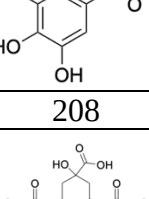	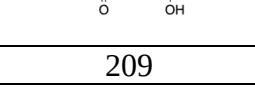	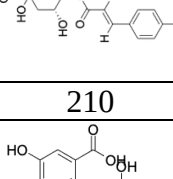
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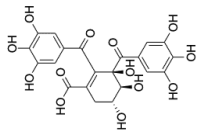	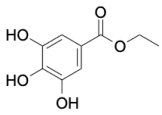	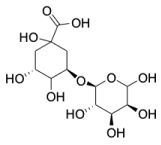	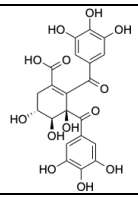	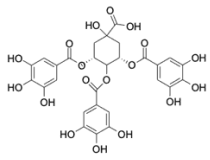
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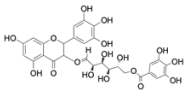	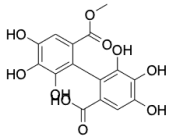	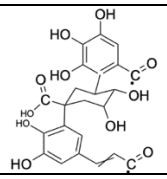	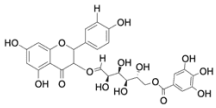	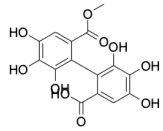
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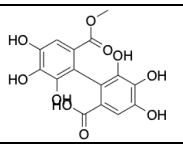	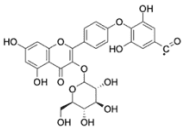	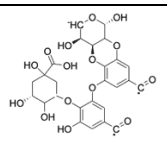	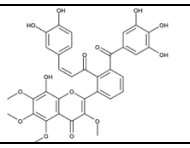	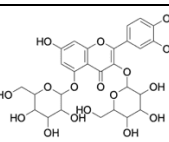
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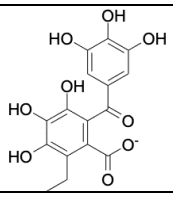	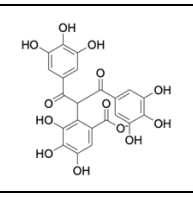	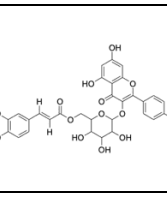	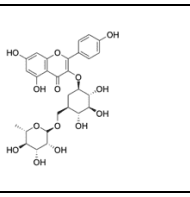	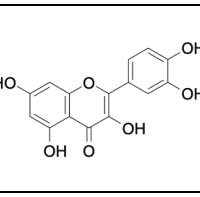
231	232	233	234	235

Figure.1: Detailed structure of chemical compounds found in C. decapetala (Roth) Alston (Chemical structure redrawn from: Chemdraw and pubchem.ncbi.nlm.nih.gov)

PHARMACOLOGICAL ACTIVITIES

Anagenic activity

Anagenic activity from the leaves of *C. decapetala* (Roth) Alston studied by Parveen *et al.*, For the experiment, the authors utilized leaves that were air dried in the shade at room temperature for 15 to 20 days. The leaf powder was extracted using n-hexane and 70% aqueous methanolic solvents. They employed twenty swiss albino mice (20 to 30 gm) for the experiment and separated them into four separate sections like control, aqueous methanolic, n-hexane and standard. Acetic acid writhing mice obtained with an aqueous methanolic extract of *C. decapetala* (Roth) Alston (18.4 ± 0.53) showed little action when compared to control mice (22.6 ± 0.51). The licking of paw mice was induced by formalin. *C. decapetala* (Roth) Alston aqueous methanolic extract (275 ± 4.18) demonstrated more pronounced action than n-hexane extract (293.8 ± 1.20). Carrageenan-induced paw edema was investigated for action against inflammation at a dosage of 100 mg/kg of extract, and the aqueous methanolic extract of *C. decapetala* (Roth) Alston was found to have little difference (0.66 ± 0.06) up to two hours, which was nearly equal to standard drugs and n-hexane extracts. In the mice that were examined, there was no acute toxicity. As a conclusion *C. decapetala* (Roth) Alston

aqueous methanolic extract has analgesic, anti-inflammatory, and antipyretic action without toxicity.[3]

Antioxidant activity

Powar *et al*., investigated the antioxidant activities from wood and pericarp of *C. decapetala* (Roth) Alston. They examined the ability of DPPH scavenging, superoxide radicles, and nitric oxide radicles to reduce lipid peroxidation. The total polyphenol content of wood and pericarp is 13.28 ± 0.0057 and 12.68 ± 0.005 respectively as mg gallic acid/g. Total flavonoids in wood and pericarp are 3.93 ± 0.005 and 5.26 ± 0.005 respectively as mg quercetin/g, and the wood and pericarp have an action similar to that of a nitric oxide scavenger like 60.67% and 69.65 % and the DPPH radicle scavenging activity is 51.65% and 56.59 %, respectively as compared with 1500 µg/ml of ascorbic acid as standard.[4] Extracted gallic acid from the wood of *C. decapetala* (Roth) Alston, and an extract was prepared in ethanol: water (65: 35) isolated gallic acid has free radicle scavenging action at concentration 20 µg/ml, with suppression of free radicals of 61.45 ± 0.44% and 52.94 ± 0.67% for the ABTS and DPPH assays, respectively. Using a concentration of 50 µg/ml, the ABTS and DPPH assays showed 95.22 ± 0.71% and 91.99 ± 0.59% suppression of free radicals, respectively.[21] Gallego *et al*., stated *C. decapetala* (Roth) Alston extract might be capable as a source of natural antioxidants for meat produces. Including this herb extract as an component in burger patties might be an effective way to boost nutritional value and safety. The addition of this extract at 0.5% was the most effective antioxidant. This concentration constrained formation of TBARS plus volatile compounds more efficiently than the synthetic antioxidant BHT Throughout a period of 11 days.[11] Gallego *et al*., (2016,a), estimated a total phenolic content of 63.8 ± 2.1mg GAE/g dry plant in a 50 % ethanolic extract, and remarked that the plant possesses a rich source of phenolic compounds with significant radicle scavenging action hence the stability and increase of specific polyphenolic chemicals, these extracts were reported to protect against lipid oxidation of O/W emulsions.[65] Evaluated antioxidant activity on ground beef patties coated with gelatin-based packaging, particularly those made with 1% *C. decapetala* (Roth) Alston ethanolic leaf extract. Studied various properties like water-vapor permeability, light permeability and color properties. The antioxidant activity as phenol content was found to be ranging from 61 toward 191 mg GAE/g film, ORAC plus TEAC assay was 0.32 mol TE/g for the concentration of 1 % and 0.02 ± 0.001 mol TE/g film Throughout the course of of 12 days, biodegradable gelatin films incorporating *C. decapetala* (Roth) Alston offer high potential for use in food packaging.[66]

Sharma *et al.*, reported the leaf extracts contained alkaloids, phenols, flavonoids, anthraquinone, anthocyanin, tannins, and steroids, according to the findings. The composition of these compounds changes depending on the proportion. The DPPH radical scavenging action in methanolic extract of *C. decapetala* (Roth) Alston leaves is dose-dependent. The ability of methanol extract to remove free radicals from leaf was found to be 82.63 % at a level of concentration 100 µg/ml. Despite the fact that the extracts DPPH radical scavenging powers were much lower than the level of ascorbic acid 91.62 % at 100 g µg/ml, the investigation revealed that the extracts had proton donating skills and might operate as free radical inhibitors or as scavengers, perhaps serving as major antioxidants. During the fourteen day observation period, oral a single course of administration of 2000 mg/kg dosage of *C. decapetala* (Roth) Alston methanol leaf extract to five mice produced no evidence of toxicity or death in the treated animals.[67] Eight compounds isolated using open column chromatography. These compounds are five rare flavonoids like apigenin-7-rhamnoside, 4-O-methyl episappanol, caesalpinol, daucosterol, astragalin, one benzoxecin as kaempferol, one phytosterol as quercitrin and one sappanol as naringin. the author evaluated the antioxidant potential and α - glucosidase inhibition activity. All partitions had considerable DPPH activity, according to the findings. Ethyl acetate and n-butanol demonstrated the highest inhibition percentages at 100 µg, 78.56 % and 88.50 %, respectively. comparatively TLC analysis revealed that n-butanol contained more compounds, it was chosen for further separation. Among the isolated compounds, *C. decapetala* (Roth) Alston quercetin has a substantial radical scavenging activity of 93.39 ± 1.18 µM, which is lower than that of standard allopurinol 92.54 ± 0.69 µM. They also tested α - glucosidase capacity, finding that apigenin-7-rhamnoside 213 ± 1.0 ±. µM, astragalin 311.8 ± 0.00 µm, kaempferol 231.6 ± 8.7 µM, and quercitrin 233.0 ± 032 µM in comparison to the positive control acarbose IC_{50} 127.9 ± 2.0 µM. The PTP1B inhibitory action of 4-O-methyl episappanol was shown with an IC_{50} of 43.4 ± 1.7 µM when compared to the positive control ursolic acid, which had an IC_{50} of 0.8 ± 1.4 µM. All extracted compounds from *C. decapetala* (Roth) Alston were evaluated against α -glucosidase inhibition in our quest for a possible glucosidase inhibitor, and flavonoids derivatives performed well. At a dosage of 250 µM, the flavonoid compounds isolated from *C. decapetala* (Roth) Alston exhibited action as an order apignin-7-rhmanoside > quercitrin > 6-hydroxy-kaempferol > astragalin > naringin.[59] Gallego *et al.*,investigated the oxidative stability of oil-in-water emulsions using a fifty percent ethanolic extract and noticed total polyphenols 31.58 mg gallic acid/g dehydrated plant, flavonoids 1.96 mg catechin/g dry plant, TEAC 360, ORAC 700, FRAP 200, DPPH 300 µmol Trodox/g dry

plant. They also looked at the chemicals in *C. decapetala* (Roth) Alston extract and discovered quercetin, catechin, gallic acid, 4-hydroxybenzoic acid, and p-coumaric acid in the sample. Ethanolic *C. decapetala* (Roth) Alston extracts were more efficient than Trolox in improving the stability of oil-in-water emulsions, particularly at the 0.2 % concentration. The extract was high in polyphenols and showed high antioxidant activity. The finding might lead to their usage in the food sector as an substitute to synthetic preservatives, particularly as an antioxidant for fat preservation.[8]

Antimicrobial activity

Antibacterial activity of both essential oils and crude extracts of petroleum ether, dimethyl ether, ethanol and methanol were studied. Isolated essential oils as caryphyllene (7.5%), geraniol (5.9%), α and β-pinene (25.5 and 8.4%), β-ocymene (31.6%) and α-phellandrene (4.5%). The antibacterial activity of several organic crude extracts against the growth of *Escherichia coli, Listeria innocua, Salmonella typhimurium,,* and *Staphylococcus aureus* revealed that only methanol crude extract is effective against *Salmonella typhimurium* and *Staphylococcus aureus*. The antibacterial action of this active extract was shown to be due to tannins. Mahizi noted that the essential oil isolated from *C. decapetala* (Roth) Alston leaves were hazardous to every microorganisms tested in this investigation.[57] Kalsi *et al*., used a schematic extraction procedure from dried leaf powder to test the antibacterial capabilities of *C. decapetala* (Roth) Alston. They utilized fungus such as *Aspergillus fumigatus* and *Candida albicans,* as well as gram positive and gram negative bacteria such as *Staphylococcus aureus, Streptococcus pyogenes* and *Escherichia coli, Pseudomonas aeruginosa* respectively. They found that the methanolic extract had dose-dependent antibacterial activity in vitro, and that it was especially effective against *Staphylococcus aureus* (Gram + ve bacterium) and *Staphylococcus aeruginosa* (Gram -ve bacteria).[68] Isolated compounds and evaluated against four bacterial strains, including *Escherichia coli, Psedomonas aeruginosa, Salmonella enterica subsp. enterica,* and *Staphylococcus aureus subsp. aureus* with penicillin G and ceftazidime serving as positive controls at 50 µg/g ml^{-1}, compound 8(17),11(Z),13(E)- trien-15,19-dioic acid inhibited the growth of *Staphylococcus aureus subsp. aureus* with an inhibition ratio of 77.745 ± 1.704, and the MIC_{50} value was determined to be 5.99µg/ml^{-1}.[54] The biological activities of *C. decapetala* (Roth) Alston against pathogenic bacteria like *Bacillus subtilis, Escherichia coli, Klebsiella aerogenes, Staphylococcus albus* Fungi like *Aspergillus niger, Peniicillium chrysogenum.* An antibacterial and antifungal compound derived from *C. decapetala* (Roth) Alston leaves

extract may provide protection against a variety of ailments, according to this investigation traditional medicine relies heavily on the usage of leaves because of the unique biological properties they possess an alternative to commercially accessible synthetic antibiotic.[48]

Antifertility activity

Aerial parts of plant harvested during blossoming, dried them and extracted dried flowering twig with 90% ethanol at room temperature. From these extracts, ethanolic extract given at a dosage 500 mg/kg one to eight days, after coitum 70% of hamsters pregnancy was avoided.[69]

Antidiabetic Activity

Antidiabetic activity studied in diabetic induced rabbits, the lipid profile, renal and hepatic functions improved as a result of treatment compared to glibenclamide's 183.8 mg/dL, oral extracts at 300 and 500 mg/kg reduced average levels of blood glucose from 250.6 to 204.2 and 188.2 mg/dL, respectively, over a 14-day period. Polyphenols and flavonoids, which possess the ability to fight free radicals and in particular efficient in reducing oxidative damage and preserving beta cells of the pancreas, may be responsible for the anti-diabetic actions of the aqueous methanolic extract of *C. decapetala* (Roth) Alston. The extract dramatically reduced increased blood urea with serum creatinine levels, indicating that it may serve as a critical trigger for the kidneys to return to normal metabolic homeostasis. With regards to blood sugar and cholesterol reduction, as well as liver and kidney protection, *C. decapetala* (Roth) Alston has shown remarkable potential, indicating the safety connected with the use of raw medication.[70]

Anaphylactic activity

Ogawa, reported caesaljapin, inhibited anaphylactic contraction in Guinea pig taenia coli sensitized by anti-egg albumin rabbit IgG by Schultz- Dale method at 50 µM, 26 %.[24]

Anti-cancer Activity

All extracted compounds is tested for anticancer activity by using MTT assay against MGC-803 cell lines. Mitochondrial Succinate Dehydrogenase (MSD) is the enzyme responsible for the reduction of yellow 3-(4,5-dimethythiazol-2-yl)-2,5-diphenyletrazolium bromide (MTT). DMSO was utilized as a negative control, whereas ADM was employed as a positive control in the experiment. Cells were treated for 72 hours with 20 µmol/L of each chemical to determine their inhibitory percentage**.** The greatest anticancer action was found in baicalein

when the concentration was 20 µmol/L, the inhibition rate was 75.7%, and in apigenin at a concentration of 5 µmol/L, with an inhibition rate of 34.1% but andrographolide, bergenin, salicin, and epicatechin had no effect on the proliferation of a cell line of human gastric cancer MGC-803. Emodin, baicalein, and apigenin were found to have significant antitumor capacities against MGC-803 cell lines, IC_{50} values is 15.6, 16.3, and 13.2 µmol/L, respectively. The phytotoxicity of all the identified compounds was investigated using five cancer cell lines SW1990, HepG2, A2780, PancO2, and B16. Gemcitabine and cisplatin were employed as standard controls in the MTT technique. They tested standard and isolated chemicals at concentrations of 1, 2.5, 10, 25, and 50 µm. 3β-Hydroxyphanginin H, 7β-Hydroxyphanginin H, 4-epi-3β-Hydroxycaesalpinilinn, 20-acetoxytaepeenin D, caesalpinista B, inhibited the SW1990 human pancreatic cell line with an IC_{50} value ranging from 2.9 to 8.9 µm.[7] Hua *et al.*, isolate compounds like caesaldecapes C, caesaldecapes D, caesalmin C, caesalmin E, and bounducellpin A from the seeds of *C. decapetala* (Roth) Alston. The MTT method was used to evaluate all of these chemicals against three human cancer cell lines Hela, HT-29, and KB, with doxorubicin acting as a positive control. All chemicals demonstrated a mild or no inhibitory impact against human cancer cell lines in the IC_{50} range of 31.4 to 81.9 µm.[52] The four cancer cell line like liver (HepG2), breast (MCF 7), prostrate (PC-3) and leukaemia (HL60) tested by using a sulphorhodamine B assay. The HL 60 cancer cell was inhibited 50 % by hydro alcoholic extraction flower at very less dosage up to 10 µg/ml, The cytotoxicity declined with increased concentration. The extraction of *C. decapetala* (Roth) Alston flower was profiled through gas mass spectroscopy it contains bufadienolides, diterpenoid furanolactone, polycyclic enone and androsterone.[60] The compounds like Caesaldecins A and B, as well as 8(17),11(Z),13(E)- trien-15,19-dioic acid, were only tested for their *in-vitro* inhibitory activities a comparison with five different human cancer cell lines HL-60, A-549, SMMC-7721, MCF-7 and SW-480 using the MTS method, cis-platinum was used as a positive control in this study, all tested compounds were inactive in cytotoxic activity.[54] The chemicals were extracted from the seed of *C. decapetala* (Roth) Alston tested using Hela, HT-29, and MCF-7 cell lines. Caesaldecapes A and B were extracted and their cytotoxicity activity was evaluated using the MTT technique. With an IC_{50} value of 9.6 µm, caesaldecapes A exhibited specific cytotoxic action against KB cancer cell lines.[45] Zengin *et al*., reported superior bioactivity in terms of antioxidant properties. Its chemical composition was determined by the presence of phenolic acid, flavonoids, their esters and glycosides. The biological potential of galloylation of phenolics has been shown. It's also worth mentioning that butyrylcholinesterase, an enzyme that's gaining favour in the

treatment of Alzheimer's disease, is inhibited by dichloromethane extract from *C. decapetala* (Roth) Alston leaves. The *C. decapetala* (Roth) Alston bark methanol extract had the highest cytotoxicity (CC_{50} 46.08 µg/ml) and selectivity sensitivity index (SI 3.33) towards Hela cells of all the extracts tested, indicating the possibility of more research into the isolates of compounds that cause this activity and to figure out the molecular mechanism behind it.[56]

Antiviral activity

Anti-TMV activity tested for isolated compounds from *C. decapetala* (Roth) Alston by using ribavirin as positive control at concentration of 500 µg/ml. Compound decapetpene B, 14(17)-dehydrocaesalpin F, caesalmin C were more active the value is 35.7%, 30.2% and 31.9 % respectively, which were comparable to positive control ribavirin 39.4%. For protection effect at a concentration of 500 µg/ml compound 14(17)-dehydrocaesalpin F, caesalmin C was more active at 37.6% and 34.0% respectively while positive control ribavirin was at 38.17 %.[53] Zhang *et al.*, prepared an ethanolic extract of dried leaves and twigs of *C. decapetala* (Roth) Alston for their experiment. The nasal cavities of anaesthetized mice were then inoculated with influenza virus. They reported that ethanol extract of *C. decapetala* (Roth) Alston (EEC) suppresses influenza virus multiplication in A549 cells after screening these plant extracts. EEC suppressed infection of A549 cells by the H1N1 influenza virus PR8 strain, with CC_{50} and EC_{50} of 326.4 µg/mL and 9.8 µg/mL, respectively. The suppression of virion production was also investigated, and the findings revealed that EEC suppressed infectious virions generation potently and concentration-dependently. The production of infective influenza virions was under the detection limit as (10 $TCID_{50}$/mL) at concentrations more than 43 µg/mL. EEC has an EC_{50} of 14 µg/mL. To rule out the possibility of EEC having a deleterious impact on viral replication, they employed the indirect immunofluorescence assay (IFA) approach to assess cell viability using DAPI staining and validate the inhibitory effect by looking for M2 protein expression. EEC at 43.2 µg/mL and 14.4 µg/mL totally suppressed viral replication and around 50% inhibited virus replication, respectively, which corresponds to viral generation. Importantly, DAPI staining revealed that EEC is not cytotoxic to A549 cells at these doses, so EEC prevents influenza virus multiplication in A549 cells.[71]

Anthelmintic property

The anthelmintic activity of *C. decapetala* (Roth) Alston leaves and seed extract studied by using different concentrations of hydro-alcoholic extract of the leaves at of 10mg/ml,

20mg/ml, 40mg/ml, 50mg/ml, and 100mg/ml, they exhibited both paralysis and mortality time in 108, 63, 32, 15, 5& 138, 83, 48, 21, 11 mins, correspondingly, then the seed extract at the similar concentrations indicated both paralysis and mortality time in 63, 48, 25, 21, 4 and 87, 62, 32, 26, 9. By, increasing concentration, the impact became stronger. At all dosage, the extract caused paralysis followed by worm death.[72]

Antifeedant Activity

Negi *et al*., performed phytochemical analysis of *C. decapetala* (Roth) Alston. They isolated oils by hydro distillation from leaves, flowers, and bark by Clevenger. They obtained a yield of leaves 0.27 ml (0.24 %), flower 0.4 ml (0.11 %) and bark 0.01 ml (0.01 %) they obtained lupeol, botulinic acid, stigmasterol, stigmasterol-3-Ob-D-glucopyranoside, caesaldecan, methoxy inositol, 4'methoxy-4,6-dihydro liquiritigenin, quercetin. They used the dual choice leaf disc approach to investigate antifeedant activity against *Spodoptera litura* and found that hexane extract had a lesser feeding index of 62.24 ± 3.12, followed by inositol 53.01 ± 5.18 and ethanol extract 51.01 ± 4.28 % Feeding index (PFI at 2.5 µg/cm^2) with essential oils extracted from bark having the highest antifeedant potential of 41.49 ± 2.71. %.[61]

Antimalarial activity

Chu-wei-chang (1945), reported *Caesalpinia sepiaria* Roxb. as an effective antimalarial medication in dosages ranging from 15 to 200 grams of root powder, with no severe side effects.[28]

Hepatoprotective activity

The hepatoprotective efficacy of an ethanolic extract of *C. decapetala* (Roth) Alston on the liver of rabbit was investigated. They took thirty rabbits and divided them into six equal groups. The first to sixth groups were given distilled water, 2000 mg/kg paracetamol, silymarin 100 mg/kg and 2000 mg/kg paracetamol, ethanolic extract of *C. decapetala* (Roth) Alston 150 mg/kg, 300 mg/kg and 500 mg/kg all with 2000 mg/kg paracetamol They investigated biopsy of the liver, and looked at liver enzyme markers, like AST, ALT, and ALK. The levels of liver marker enzymes were shown to be higher in hepatotoxic animals, but they were significantly lower in rabbits given an ethanolic extract of *C. decapetala* (Roth) Alston compared to toxicant rabbits. The extract dosage of 500mg/kg had a stronger hepatoprotective effect. The liver sections of paracetamol-treated rabbits exhibited necrosis and vacuolization whereas the liver sections of silymarin and *C. decapetala* (Roth) Alston

extracts rabbits revealed protective action against paracetamol toxicant and lack of necrosis.[73]

Neuraminidase activity

Kamikawa *et al.*, identified two cassane-type furanoditerpenoids and one diterpenoid from roots of *Caesalpinia decapetala* var. *japonica* also seven additional diterpenoids. Caesalacetal, caesalpinetate, caesalpinone, caesaljapin, (E)-15-oxolabda- 8(17),13-diene-19-oic acid, (Z)-15-oxolabda- 8(17),13-diene-19-oic acid, mimosol C, isocupressic acid, isopimaradien 3B-18-diol, agathic acid. The *in-vitro* neuraminidase inhibitory assessment of the compounds caesalacetal, caesalpinetate, caesalpinone and caesaljapin is evaluated. The IC_{50} values of 93 µM and 24 µM the compounds caesalacetal and caesalpinetate showed modest neuraminidase inhibitory action respectively. At concentrations up to 100 µM, compounds like caesalpinone and caesaljapin were inactive.[40]

CONCLUSION

Caesalpinia decapetala (Roth) Alston is an understudied plant with significant ethnobotanical promise. The species is grown as a hedge plant, because of its attractive yellow-coloured inflorescences. Now days the plant has been naturalised around the globe, where it is now considered a noxious weed in certain areas. It has been discovered through various studies that the plant contains numerous biologically active chemical compounds with cassane diterpenoids, which exhibits anti-microbial, anti-fertility, anti-diabetic, anti-viral activities as well as having potent cytotoxic and hepatoprotective properties. The high antioxidant capacity of the plant material may make it a possible food preservative and packaging material in the future, and the high fibre quality should make it a suitable raw material for the paper manufacturing industry. Veer et al., reported that the hydro-alcoholic plant extracts have wormicidal action, implying that they are beneficial against parasitic infections in humans. In the future, it will be important to discover and isolate the active phytoconstituents responsible for anthelmintic activity, as well as research their pharmacological effects.[72]

The antifeedant potential of plant essential oils was substantial.[61] A novel raw material for the pulp and paper industry, *C. decapetala* (Roth) Alston excellent Kraft pulp output, reasonable strength, and short fiber length all point to its potential as a promising pulp and paper resource.[13] The presence of carbonyl groups, which are essential for the production of antioxidants, may be the reason why isolated Gallic Acid displayed significant ABTS and

DPPH scavenging activity. *C. decapetala* (Roth) Alston shows antioxidant that may help fight illnesses including neurological disorders, inflammation, viral infections and stomach ulcers.[21] Phytochemical screening reveals terpenoids, carbohydrates, flavonoids, resins, alkaloids, proteins, sterols, lipids, oils, phenols, tannins, glycosides and diterpenoids in various parts of *C. decapetala* (Roth) Alston and it has a broad range of biochemical, pharmacological, and industrial applications. As a result, the species has enormous potential in the future for pharmacological and industrial uses and there is need of doing adequate research on the biological activity of numerous chemical substances.

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