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Review Article

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A Comprehensive Ethno-Phyto-Pharmacological Review on Novel Indian Medicinal Plants Used In Polyherbal Formulations

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Abstract

Almost 15% out of the 20,000 medicinal plants in Indian sub continent has a tremendous potential and advantage in the emerging field of herbal medicines. Medicinal plants are the main sources of chemical substances with potential therapeutic effects. A lot of compounds were characterized from plants which are now using in the treatment of many diseases. Since ancient times, plants have been an exemplary source of medicine. Ayurveda and other Indian literature mentioned the use of plants in treatment of various human ailments. Medical plants play an important role in the management of different clinical problems especially in developing countries where resources are meager The present paper reviews the literature on recent ethno medicinal uses with pharmacological screeing of every plant part of different five medicinal plants, i.e *Cassia Auriculata Linn*, *Cinnamomum tamala*, *Ficus benghalensis*, *Trichosynthes dioica* and *Mangifera indica* and their phytochemical properties used for the treatment of various ailments in human civilization as well as used in folk medicine as a remedy. The name and parts of the plant studied, the spectrum of activity, and methods used are discussed in this review paper.

Keywords: Medicinal Plants, Ethanomedical Use, Phytochemistry, Pharmacological Sereening.

Introduction

Over the centuries, the use of medicinal herbs has become an important part of daily life despite the progress in modern medical and pharmaceuticals research. Approximately 3000 plants species are known to have medicinal properties in India [1].The Rigveda (3700 B.C.), mentions the use of medicinal plants. Our traditional systems of medicines, viz., Ayurveda, Yunani, Siddha and Homeopathy etc. use herbs for treatment. It is estimated that 40% of the world populations depends directly on plant based medicine for their health care [2]. According to WHO more than one million people rely on herbal medicines to some extants and also listed 21,000 plants for medicinal uses around the world. India has rich medicinal plant flora of some 25,000 species of these 150 species is commercially used for extracting medicines or drug formulation. In India the medicines the use of medicinal herbs is as old as 1500 BC, underline the medical culture of India both folk traditions as well as codified knowledge system is a deep understandings of the medicinal value of the plants starting with the references in the Atharveda. We have textual evidence of a tradition of use of medicinal plants that is more than 3000 years old. Over the last few years, researchers have aimed at identifying and validating plants derived substances for the treatment of various diseases. Interestingly, it is estimated that more than 25% of modern medicines are directly or indirectly derived from plants. In this context, it worth mentioning that Indian plants are considered a vast source of several pharmacologically active principles and compounds that are commonly used in home remedies against multiple ailments [3,4]. Indian medicinal plants are widely used by all sections of the population and it has been estimated that over 7500 species of plants are used by several ethnic communities.

The focus of this review is to provide information's on the phytochemicals, ethnomedicinal uses and pharmacological activities of five medicinal plants (*Cassia Auriculata Linn*, *Cinnamomum tamala*, *Ficus benghalensis*, *Trichosynthes dioica* and *Mangifera indica*) commonly used in Indian traditional medicine. These plants are known to contain various active principles of therapeutic value and to possess biological activity against a number of diseases.

No comprehensive accounts on together of these plants are available as a review. NCBI (Pubmed) and Medbioworld databases were used for the collection of pharmacological activities. As well as, ethnomedicinal information was extracted from the book on Dictionary of Indian Folk Medicine and Ethnobotany and some related publications which are published on the ethnobotanical aspects. The medicinal properties and plant characteristics were collected from the published books on Indian Medicinal Plants and Indian Materia Medica.

Cinnamomum Tamala

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Cinnamomum tamala Fr. Nees., belonging to family Lauraceae, is also known as Indian Cassia, Indian cassia bark, Tamala cassia and the leaves are commonly called as bay leaves or Tejpat (Trade name Tamalpatra). Lauraceae is an economically important family consisting mostly of trees or tree-like shrubs. The genus *Cinnamomum* is represented by about 350 species worldwide.

Vernacular names

Sanskrit:	Tamalpatra
Hindi:	Tejpatta
Assamese:	Tejpat
Marathi:	Tamalpatra
Tamil:	Talishappattiri
Malayalam:	Tamalapatram
Telugu:	Talisapatri,
Kannada:	Patraka
Bengali:	Tejpat

Taxonomic Classification

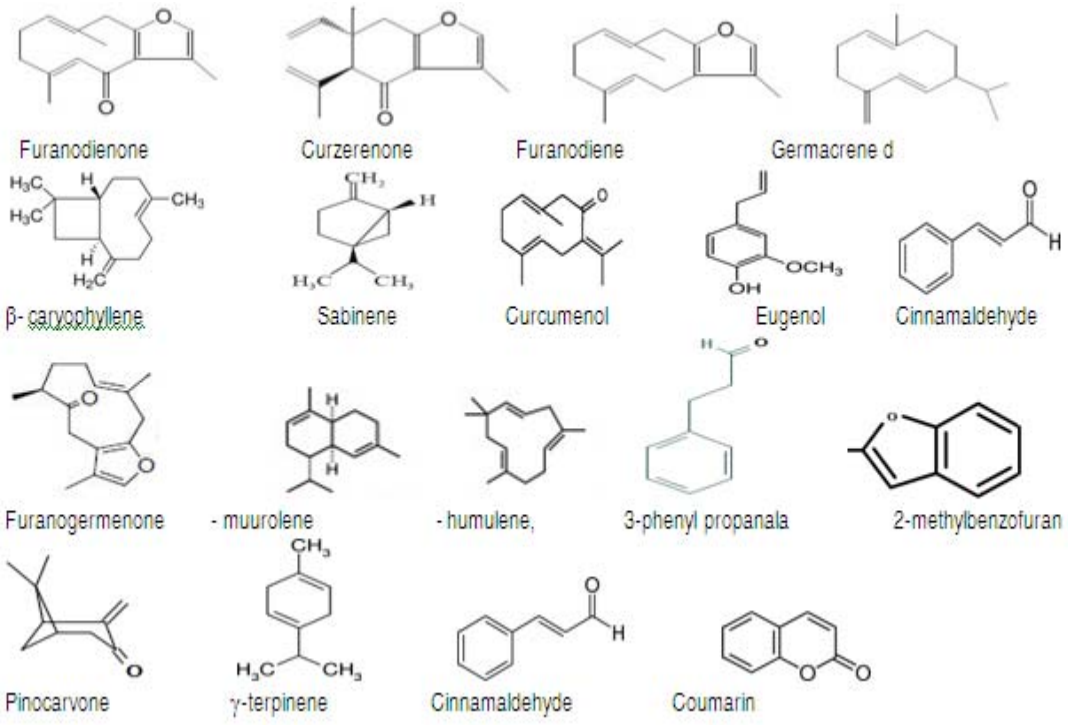
Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Magnoliidae
Order	Laurales
Family	Lauraceae
Genus	Cinnamomum Schaeff
Species	*Cinnamomumtamala* (Buch.-Ham.) T. Nees & Eberm.

Ethanomedicinal review

It is used in Indian system of traditional medicines since long time. The leaves of this tree have a clove like taste and a faintly papper like odor [5]. Leaves and bark have aromatic, astringent, stimulant and carminative qualities and used in rheumatism, colic, diarrhea, nausea and vomiting. Ancient literature has revealed that in the first century A.D., dried leaves and bark of this plant were prescribed for fever, anemia and body odor. Its seeds were crushed and mixed with honey or sugar and administered to children for dysentery or cough [6]. The leaves of *C. tamala* have been used extensively as spice in the food industry because of its special aroma and pepper like odour [7]. It is also used in industries as fragrance component in soaps, detergents, cosmetics and perfumes, and toothpastes. It is used as food, fodder, medicine, and timber in Uttarakhand Himalayan region [8]. Parts of *C.Tamala* are used in many ayurvedic preaparations e.g. sudarshan choorna and chandraprabhavati. The leaves extract are used as clarifiers in dyeing procedures with myrobalans or kamala. Traditionally green dye has been extracted from its leaves [9].

Phytochemical Review

The major constituents of the leaf essential oils of these species contain furanosesquiterpenoids as principal constituents. Furanogermenone (59.5%) was found to be the major compound in the leaf essential oil is β- caryophyllene (6.6%), sabinene (4.8%), germacrene D (4.6%) and curcumenol (2.3%). The leaf oil was characterized by a high content of sesquiterpenoids (96.8%), dominated mainly by furanosesquiterpenoids (79.3%) viz. furanodienone (46.6%), curzerenone (17.6%), furanodiene (1.8%) and curzerene (1.2%). Cinnamon *leaf* oil contains a variety of constituents including eugenol and cinnamaldehyde, which is a local mucous and dermal membrane irritant [10]. Analysis of a steamdistilled volatile oil from cinnamon fruit stalks yielded 27 compounds with cinnamyl acetate (36.59%) and caryophyllene (22.36%) being the major components [11]. Apart from that, Leaf oil or Tejpat oil mainly contains -lenalool (60.73%), -pinene (10.54%), β-pinene (10.42 %), limonene (3.21%) and camphene (3.06%). Eugenol and cinnamaldehyde were found in minute quantity [12], β-caryophyllene (25.3%), linalool (13.4%), caryophyllene oxide (10.3%), p-cymene, geraniol etc. Benzaldehyde, 1,8-cineole, Salicylaldehyde, γ-terpinene, acetophenone, cis-sabinene hydrate, trans-sabinene hydrate, 3-phenyl propanala, Pinocarvone, borneol, 2-methylbenzofuran, tepinen-4-ol, p-cymen-8-ol, -terpineol, cinnamaldehyde, carvone, cinnamaldehyde, bornyl acetate, cinnamyl alcohol, hydrocinnamyl acetate, cinnamyl acetate, β-caryophyllene, cinnamic acid, coumarin, cinnamyl acetate, -humulene, nerolidol, spathulenol, β-copaen-4a –ol, Monoterpenoid Hydrocarbons, Oxygenated Monoterpenes, Sesquiterpens Hydrocarbons, Oxygenated Sesquiterpens, Phenylpropanoids also reported in some extent quantity [13,14]. Minor compounds included - humulene, - muurolene. The volatile oil of the buds contains more monoterpene and sesquiterpene compounds than oils from the flowers and fruits,



Pharmacological Review

Pharmacological activity	Plant Parts	Extract used	Screening models	Reference
Antidiabetic activity	Bark	Methanol and successive water extract	Amylase inhibition assay	Roux GF *et al.*,(2008)[17] Usha C. *et al*,. (2010)[18]. Shradha Bisht *et al*, (2011)[19].
	Leaves	Methanol extract. Ethanol extract	Stz-Treated Diabetic Rats	Rahul Gupta *et al*,. (2009)[20], Palanisamy P *et al.* (2011)[21].
Antibacterial activity	Stem- bark Leaves	Alcohol extract Alcohol extract	Agar well diffusion assay Disc Diffusion Assay (DDA)	Prabuseenivasan S. *et al.*, (2006)[22]. Jamiuddin A. *et al.*, (2013)[23].
Antioxidant activity	Oil and oleoresin		Peroxide, *p*- anisidine, Thiobarbituric acid and total carbonyl value.	Osawa T *et al.*, (1983)[24].
	Whole plant	Pet. ether, chloroform, ethyl acetate methanol/ n-butanol	Linoleic acid system and Scavenging effect on DPPH DPPH• radical scavenging, phosphomolybdate and ferric thiocyanate (FTC) methods	Miller NJ *et al.*, (1997)[25].
	Leaves	Methanol extract	Free radical scavenging acility (FRSA), CAT, SOD, Glutathione peroxydase.	Durre Shahwar *et al.*, (2010)[26]. Palanisamy. P *et al.*(2011)[21].
	Leaves	Methanol extract	Rat brain synaptosomes	Devi. SL *et al.*,(2007)[27].
Anti-ulcer activity	Leaves	Hydro alcoholic extract	Chemical, stress, and physically induced ulcers	Lima ZP *et al.*, (2010)[28].
Antimicrobial activity	Leaves	Volatile oil	Inverted patri-plate method,	Vardar Unlu G *et al.* (2003)[29].
	Leaves	Volatile oil	Food poisoned method Micro dilution methods	Manindra Mohan *et al.*, (2012)[30].

	Leaves	Ethanol extract	Disc diffusion assay	Hemayet, *et al.* (2012)[31].
Anthelmintic activity	Leaves	Methanol extract		Jamiuddin A. *et al* (2013)[23].
Cytotoxic activity	Leaves Leaves	Methanol extract Acetone and ethanol extracts	Brine shrimp lethality bioassay Ehrlich Ascites Carcinoma (EAC) in mice	Jamiuddin A. *et al*, (2013)[23]. Hemayet, *et al.* (2012)[31]. Manmeet S Saluja *et al* (2010)[32].
Anti-inflammatory activity	Leaves	Ethanol extract Methanol extract	Carrageenan and histamine-induced rat paw edema test	Hemayet Hossain *et al.,* (2008)[31], Gambhire MN *et al.*, (2009) [33], Thamizhselvam *et al.*(2012)[34].
Acaricidal activity	Leaves and bark	Aqueous extracts		G.V. Manjunatha R. *et al,.*(2009)[35].
Anti fungal activity	Fruits Leaf oil	Acetone, Methanol, Benzene, Ethyl acetate and Chloroform	MIC and MFC MIC	Ritu Singh *et al.*, (2013)[36] Bhawana Srivastava *et al*, (2011)[37].
Antihyperlipidemic activity	Leaves	Aqueous and ethanol extracts	Serum total cholesterol, triglyceride HDL-C	V. Dhulasavant *et al,*. (2010)[38].
Analgesic activity	Leaves	Methanol extract	Hot plate method, acetic acid induced writhing movement and tail flick test.	Thamizhselvam *et al.* (2012)[34].
Antipyretic activity	Leaves	Methanol extract	Brewer's yeast.	Thamizhselvam *et al.*(2012) [34].
Antidiarrhoeal activity	Leaves	Ethanol extract	Castor oil induced diarrhea in mice	Hemayet, *et al.*(2012)[39]. Chandana V. Rao *et al.*,(2008)[40]. Rao CV *et al.,* (2008)[41].
Antiaflatoxigenic Activity	Leaf oil		Aflatoxin B_1 secretion by the toxigenic strain (SK 3NSt) of *A. flavus*	Bhawana Srivastava *et al*, (2011)[37].
Lipid Lowering Activity	Leaves	Methanol extract	Lipid profile test	Al-Mamun R *et al.*, (2011)[42].
Gastroprotective activity	Leaves		Experimental gastric ulcers in rats	Eswaran MB *et al.,* (2010)[43].

whereas the concentration of *trans* – cinnamyl acetate is much higher in the volatile oils from flowers and fruit than from the buds. A study of cinnamon essential oil indicated that the major constituent was *trans* - cinnamaldehyde (41.3%) [15]. Outer bark on distillation yields an essential oil similar to cinnamon oil with 70-85% cinnamaldehyde. Root contains oil which has eugenol, safrole, benzaldehyde and terpine[16].

Cassia Auriculata Linn

Cassia auriculata commonly known as tanner's cassia is a shrub belonging to the Caesalpiniaceae family. The shrub is especially famous for its attractive yellow flowers which are used in the treatment of skin disorders and body odour.

Vernicular name

English: Tanner's Cassia
Hindi: Tarwar
Marathi: Tarwad
Kannada: Tangedi
Telugu: Tagedu
Tamil: Avaram
Gujarati: Awala
Malayalam: Avaram

Taxonomic Classification

Kingdom Plantae
Subkingdom Tracheobionta
Superdivision Spermatophyta
Division Magnoliophyta
Class Magnoliopsida
Subclass Rosidae
Order Fabales
Family Fabaceae
Genus Cassia L
Species *Cassia auriculata* L.

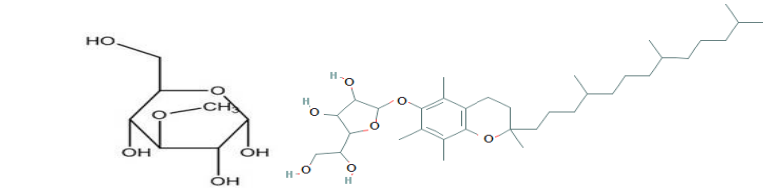
Ethnomedicinal Review

It is widely used in traditional medicine for rheumatism, conjunctivitis and diabetes [44]. The tea prepared from the leaves is used in chronic fever and fruits, barks and leaves are used as anthelmintic[45]. Tribals of Eastern Ghats, make pills from ground leaves and fruits, for the treatment of leucorrhoea[46]. Southern Indian tribals prepare paste from leaves in vinegar, which applied

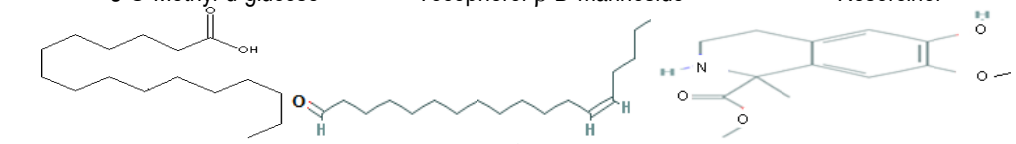
on skin for various skin diseases [47,48] and also some of them dropped the juice of fresh macerated leaves into ears in case of scorpion bite [49]. It was also found that the tenders of leaves mixed with lime and is given once a day for treatment of stomachache[50]. Leaves and flowers are used for treatment of diabetes and for religious function[51]. Flowers are used for spermatorrhoea. The dried powder of flowers mixed with goat milk taken orally to prevent white discharge by indigenous tribes[52]. The flowers are also uses as food stuff [53] and also in preventive medicine for cattle in heat disease[54]. According to Ayurveda, roots are useful in urinary discharges and cures tumours, skin diseases and asthma. Powder of bark is uses for fixing teeth and decoction for chronic dysentery. Decorticated seeds in fine powder and paste are valued local applications to purulent opthalmia and conjunctivitis[55]. Various Indigenous communities used it for treatment of skin diseases, asthma, conjunctivitis and renal disorders, Leucorrhoea, body heat and cuts, even as a purgative for cattle[56].

Phytochemical review

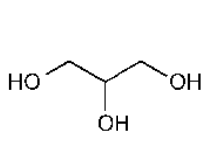
Cassia auriculata contains several active constituents such as flavonoids, β- sitosterol-β-D-glucoside, polysaccharides, anthracene, dimeric procyanidins and myristyl alcohol etc[57]. The leaves of *Cassia auriculata* contains 29 compounds where the main constituents are 3-O-Methyl-dglucose (48.50%), -Tocopherol-β-D-mannoside (14.22%), Resorcinol (11.80%), n-Hexadecanoic acid (3.21%), 13-Octadecenal, (Z)- (2.18%) and 1,2,3,4-Tetrahydroisoquinolin-6-ol-1-carboxylic acid (1.98%). Apart from that other compounds are found like Glycerin, Thymine, 1-Butanol,3Methyl-, formate, 4H-Pyran-4-one,2,3-dihydro-3,5-dihydroxy- 6- methyl, Benzaldehyde,4 methyl. 2-Propenoic acid, 4-methylpentyl ester, Resorcinol, Sucrose, 1,6,Anhydro-β-D-glucopyranose (levoglucosan), 18.43 β-D-Glucopyranoside, methyl, 3-O-Methyl-d-glucose, 1,2-Benzenedicarboxylic acid,bis (2-methylpropyl)ester, Benzenamine,2,3,4,5,6-pentamethyl, n-Hexadecanoic acid, Hexadecanoic acid, ethyl ester, 1-Tridecyne, 13-Oxabicyclo[10.1.0] tridecane, Phytol, 1-E,11,Z-13-Octadecatriene, 13-Octadecenal,(Z), 1 Octadecanoic acid, 1,2,3,4-Tetrahydroisoquinolin-6-ol-1- carboxylic acid, -Tocopherol, N-Acetltyramine, - Tocopherol-β-D-mannoside[58]. *C. auriculata* seeds also contains numerous phytochemicals like β.- Ethoxypropionaldehyde diethyl acetal, 2,3-dihydro-3,5-dihydroxy-6-methyl-4hpyran-4-one, Ethyl caprylate, Benzoic acid, 2-hydroxy-,methyl ester, Resorcinol, 2-methoxy-4-vinylphenol, Capric acid ethyl ester, Glycine, N- (trifluoroacetyl)-, 1- methylbutyl ester, Dodecanoic acid, 3',5'-Dimethoxyacetophenone, n-Hexadecanoic acid, Grape seed oil (Linoleic acid, Oleic acid), 9-Octadecenoic acid, (E)-, Stearic acid, Palmitic acid.beta.-monoglyceride, E,Z-1,3,12-Nonadecatriene, dl-. .-Tocopherol, Stigmasta-5,23-dien-3-ol, (3.β.)[64] Most recently it revealed the occurrence of active principles as kaempferol 3-O-rutinoside, luteolin, quercetin and kaempferol. All of these compounds along with rutin, a minor constituent, which was previously isolated from this plant[59].

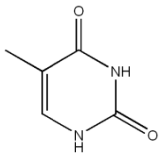


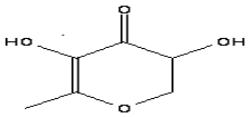
3-O-Methyl-d-glucose - Tocopherol-β-D-mannoside Resorcinol

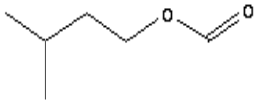


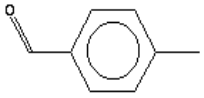
n-Hexadecanoic acid/ Palmitic Acid 13-Octadecenal 1,2,3,4-Tetrahydroisoquinolin-6-ol-1-carboxylic acid

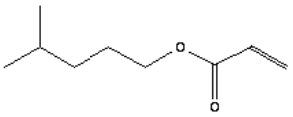

Glycerin

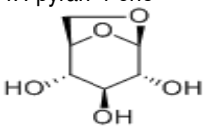

Thymine

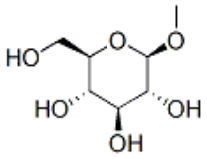

2,3-dihydro-3,5-dihydroxy -6-methyl-4H-pyran-4-one

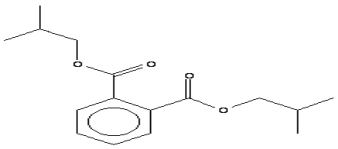

1-Butanol,3Methyl-formate


4 methyl- Benzaldehyde,

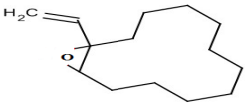

2-Propenoic acid, 4-methylpentyl ester

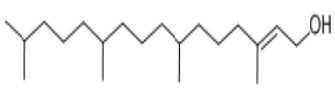

1,6,Anhydro-β-D glucopyranose (levoglucosan)

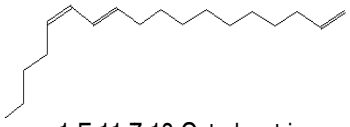

Methyl β-D-Glucopyranoside

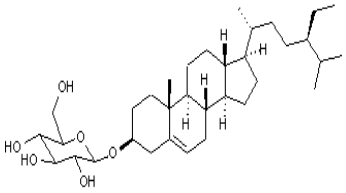

1,2-Benzenedicarboxylic acid, bis (2- methylpropyl)ester

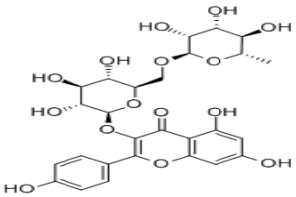

1-Tridecyne

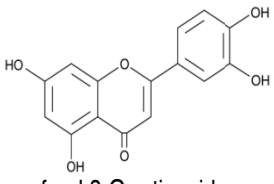

13-Oxabicyclo[10.1.0] tridecane

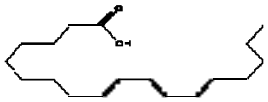

Phytol

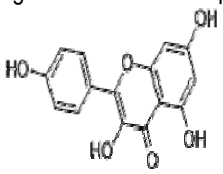

1-E,11,Z-13-Octadecatriene

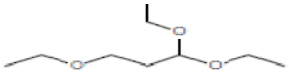

β- sitosterol-β-D-glucoside

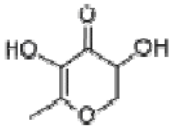

kaempferol

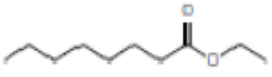

kaempferol 3-O-rutinoside

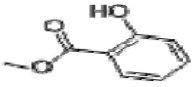

1 Octadecanoic acid

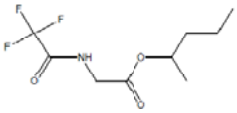

Luteolin

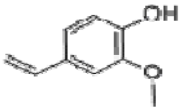

β.-Ethoxypropionaldehyde diethyl acetal


2,3-dihydro-3,5- dihydroxy-6-methyl-4hpyran-4-one

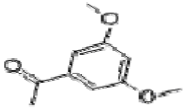

Ethyl caprylate


Benzoic acid, 2-hydroxy-methyl ester Glycine,


N-(trifluoroacetyl)-, 1-methylbutyl ester


2-methoxy-4-vinylphenol

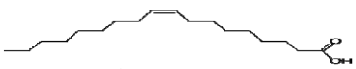

Capric acid ethyl ester


3',5'- Dimethoxyacetophenone

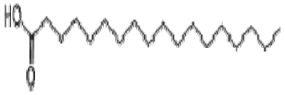

Dodecanoic acid


n-Hexadecanoic acid


Linoleic acid

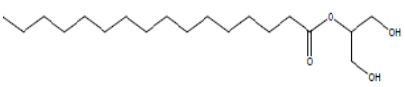

Oleic acid

9-Octadecenoic acid, (E)-

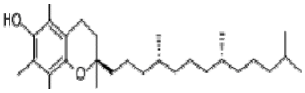


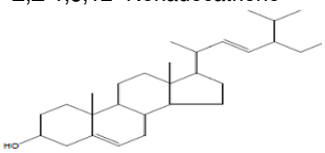
Stearic acid

E,Z-1,3,12- Nonadecatriene



Palmitic acid .beta.- monoglyceride dl-. .-Tocopherol





Stigmasta-5,23-dien-3-ol, (3.β.)-

Pharmacological review

Pharmacological activity	Plant Parts used	Extract used (solvents)	Screening models	Reference
Anti diabetic Activity	Flower Bark	Aqueous extract Methanol extract	Streptozotocin induced Diabetic Rats	L Pari *et al* (2002)60. Mahendra Shiradkarg *et al* (2011)[61].
Hepatoprotective activity	Leaf and flowers	Alcoholic	Alcohol induced liver injury in albino rats	Jeeva Jothi Dhanasekaran *et al.,* (2011)[62].
Anti bacterial activity	Dry flower Leaves Flower	Ethanol, methanol and aqueous Hexane, chloroform, ethyl acetate, acetone and methanol Aqueous methanol extract	 Agar disc diffusion method In vitro antibacterial activity, MIC.	S.Maneemegalai *et al.,*(2010)[63] C. Anushi *et al*,.(2009)[64] Gaurav M. Doshi *et al*,.(2011)[65]
Antipyretic Activity	Leaves Flower	 Aqueous extract	 Brewer's yeast.	L Pari *et al* (2002)[60], Vedavathy, S. *et al* (1991)[66].
Antioxidant Activity	Flower	Ethanol and methanol extracts	(ABTS) and (DPPH) radical scavenging method	A. Kumaran. *et al* (2007)[67], C. Anushia *et al* (2009)[64], PS Kumar *et al* (2008)[68].
Anthelmintic Activity	Leaves	Aqueous extract Petroleum ether, Ethyl acetate, Ethanol and Aqueous extracts	Anthelmintic potential against earthworms, tapeworms and roundworms. Against earthworms (Eisenia foetida)	Satish B. Kosalge *et al* (2009)[69], P. Salvekar *et al*., (2011)[70] Sushma Kainsa *et al* (2011)[71].
Hapatoprotective activity	Leaves	Ethanol extract	Alcoholic liver injury studies in rats	Senthil Kumar *et al*, (2003)[72].
Antiulcer Activity	Leaves	Ethanol extract	Pylorous ligation induced gastric ulcer	Ahmed M *et al*, (2010)[73].
Antimutagenic activity	Bark	Methanol extract	Mutagenicity assay	Mahendra Shiradkarg *et al* (2011)[61].
Antifertility Activity	Bark	Methanol extract	Antiimplantation and early abortifacient activity	Mahendra Shiradkarg *et al* (2011)[61].
Laxative activity	Pods	Ethanol extract	Charcoal meal test (Intestinal transit rate) and Faecal output.	H. M. Suresh *et al* (2007)[74]

Ficus Bengalensis Linn

Ficus bengalensis Linn. syn. *Ficus banyana* Oken. (Family-Moraceae). It is a member of four sacred trees *Nalpamara* (*Ksirivrksas*) meant to be planted around the home and temples

Varnecular names

English:	Banyan tree
Bengali:	Bar
Gujarati:	Vad
Hindi:	Bargad
Kanarese:	Ala
Malyalam:	Ala, Vatam
Marathi:	Vada
Sanskrit:	Bahupada
Tamil:	Al
Telugu:	Peddamarri

Taxonomical classification

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Hamamelididae
Order	Urticales
Family	Moraceae
Genus	Ficus L.
Species	*Ficus benghalensis* L.

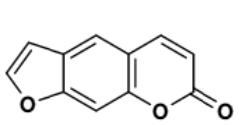
Ethanomedicinal Review [75-81]

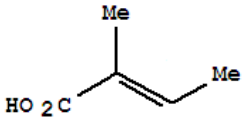
According to Ayurveda, it is astringent to bowels and very useful in treatment of biliousness, vaginal complains, fever, ulcers, erysipelas, vomiting, inflammations, diabetis and leprosy. According to Unani system of medicine, latex is maturant, lessens inflammations, aphrodisiac, tonic, vulernary and is useful in piles, nose-diseases, gonorrhea etc. The aerial root is styptic and is useful in syphilis, biliousness, dysentery and inflammation of liver. It acts as an astringent, antidiarrheal, antidysenteric, hemostatic and antihemorrhoidal and its leavs are used for fodder.

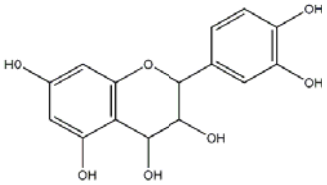
Phytochemical review

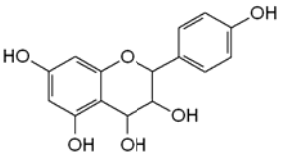
Preliminary phytochemical investigation reported the presence of carbohydrates, flavonoids, amino acids/proteins, steroids, saponins and tannins in roots of ficus bengalensis[82].

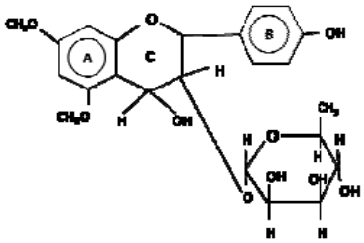
The bark of *F. bengalensis* yields 5,7 Dimethyl ether of leucopelargonidin-3-0- -L rhamnoside and 5,3 dimethyl ether of leucocynidin 3-0- -D galactosyl cellobioside, beta glucoside, glucoside,20-tetratriaconthene-2-one,6- heptatriacontene-10 one, pentatriacontan-5-one, beta sitosterol-alpha-Dglucose and meso-inositol[83-87], Leucodelphinidin derivative[88], bengalenoside[89], Leucopelargonin, a glycoside which has antidiabetic effects[90-92], leucocynidin derivative[93], have also been isolated from the bark of the *F. bengalensis.* Three ketones 20-tetratriacontene-2-one, 6-heptatriacontene-10-one, pentatriacontan-5-one were isolated from stem bark[94]. Coumarins (furocoumarins) have been identified from *F. bengalensis* Psoralen, Bergapten (5-methoxypsoralen) occurs naturally in the seeds of *F. bengalensis*. The tiglic acid ester of ψ-traxasterol has been isolated from the heartwood of *F. bengalensis.* Recently three new esters were isolated and characterized from methanolic extract of the bark of *F. bengalensis* along with linolyl glucoside and oleiyl glucoside. These esters are Keto-n-cosanyl stearate, Hydroxypentacosanyl palmitate and Phenyl tetradecanyl oleiate[95]. The leaves contain, crude protein, crude fibres, CaO, phosphorous, rutin, friedelin, taraxosterol, lupeol, β-amyrin along with psoralen, bergapten and β-sisterol, quercetin-3-galactoside[96], Leucodelphinidin derivative[97], bengalenoside, Aglucoside[94], Leucopelargonin and leucocynidin derivatives. The latex contains caoytchoue, resin, albumin, cerin, sugar, and malic acid and a serine protease was purified to homogeneity from the latex of medicinal plant *F. bengalensis* [98].

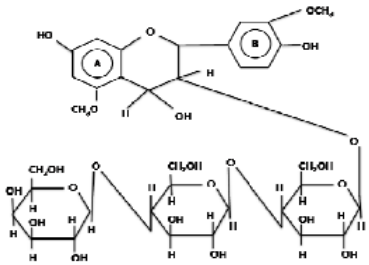

Furocoumarin

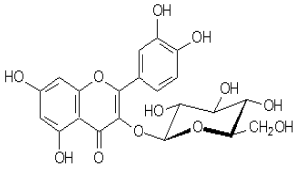

Tiglic acid ester

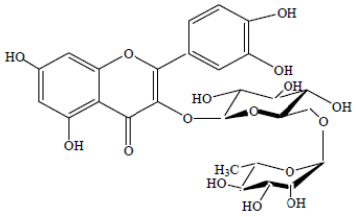

Leucocynidin

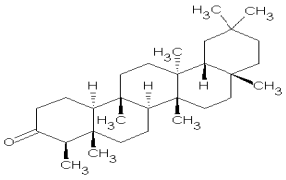

Leucopelargonin

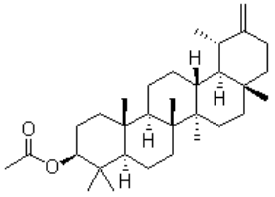

5,7 Dimethyl ether of leucopelargonidin -3-0- -L rhamnoside

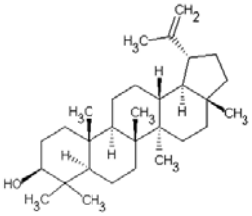

5,3 dimethyl ether of leucocynidin 3-0- -D galactosyl cellobioside

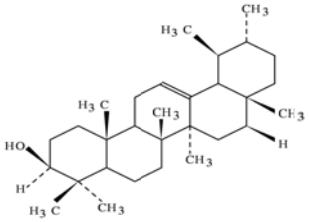

Quercetin-3-galactoside / isoquercitrin

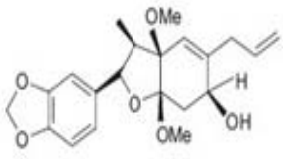

Rutin


Friedelin


Taraxosterol


Lupeol


β-amyrin Q


Uercitin

Pharmacological Review

Pharmacological activity	Plant Parts used	Extract used (solvents)	Screening models	Reference
Antioxidant activity	Bark Aerial root	Aqueous extract Methanol and 70% acetone (acetone: water, 70:30)	Hypercholesterolemia rabbits. Hyperlipidemic rats	Rimi Shukla *et al*,. (2004)[82] Daniel, R.S *et al*,(1998)[96]
Antiatherogenic activity	Bark	Alcoholic	Alloxan diabetic dogs	Daniel RS *et al*,. (2003)[87].
Antitumor activity	Fruit	Alcoholic	Potato disc bioassay	Mousa O *et al*, (1994)[97].
Anthelmintic activity	Root	Methanolic, chloroform, and pet. ether extracts		Aswar M *et al*,. (2008)[99].

Anti-inflammatory	Bark	Methanol, Ethanol and petroleum ether extracts	Carrageenan-induced hind paw edema in rats. Acetic acid induced vascular permeability and cotton pellet induced granuloma	Patil V.V *et al*, (2009)[100] Vishnu N Thakare *et al*, (2010)[101].
Analgesic activity	Bark	Aqueous, ethanol, chloroform and petroleum ether extracts Methanol extract	Hot-plate and tail-immersion method Acetic acid induced writhing	Vikas VP *et al.* (2010)[92]. Vishnu N Thakare *et al*, (2010)[101].
Antipyretic activity	Bark	Aqueous, ethanol, chloroform and petroleum ether extracts	Brewer's yeast-induced pyrexia in rats	Vikas VP *et al.* (2010)[102].
Anti stress and antiallergic activity	Bark	Aqueous, ethanol, and ethyl acetate extracts	Milk-induced leucocytosis and milkinduced eosinophilia.	DJ Taur *et al*, (2007)[103].
Antidiarrhoeal activity	Hanging root	Ethanol extract		Pulok K. Mukherjee *et al*, (1998)[104]
Antidiabetic activity	Bark	Aqueous extract	Histological studies Streptozotocin induced diabetic rats.	Mahalingam G *et al*, (2008)[105]. Joglekar, J.C *et al*, (1963)[106], Vohra, S.B *et al*,(1970)[107], Augusti KT *et al*, (1975)[89], Babu, B.V *et al*, (1985)[108], Kumar R.V *et al*, (1989)[109], Sheeja Cherian *et al*, (1992)[84], Cherian S *et al*, (1993)[110], Geetha BS *et al*, (1994)[88], Augusti KT *et al*, (1994)[111], Shukla, R *et al*, (1994)[112], Shukla, R *et al*, (1995)[113]
Hypolipidemic activity	Bark	Aqueous extract	Alloxan diabetic rabbits, rats and in humans.	Agrawal V *et al*, (1988)[114]
Immunomodulatory activity	Aerial roots	Methanol and water extracts	Percentage phagocytosis in vivo studies	Gabhe S.Y. *et al*, (1988)[115]
Wound healing activity	Leaf Bark	Ethanol and aqueous extract	Excision, incision, dead space wound Excision, incision wounds	Biswas TK *et al.*,(2003)[116], Ayyanar M *et al*,. (2009)[117], Vipin K G., *et al* (2011)[118]
Growth promoting activity	Young prop roots	Alcohol and aqueous	one-month-old immature female rats	Nidhiya SR *et al*,. (2009)[119]

Mangifera Indica

Mangifera indica L. is a large evergreen tree, long living, 10-45 m high with a strong trunk and heavy crown. Native from tropical Asia, it has been introduced wherever the climate is sufficiently warm and damp and is now completely naturalized in many parts of tropics and subtropics[120].

Vernacular names

Sanskrit: Ambrah
English: Mango
Hindi: Aam
Tamil: Ambiram
Punjabi: Amb, Wawashi
Gujarati: Ambo
Kashmiri: Amb
Malayalam: Amram, Manga
Marathi: Amchur, Amba
Bangali: Aam

Taxonomical classification

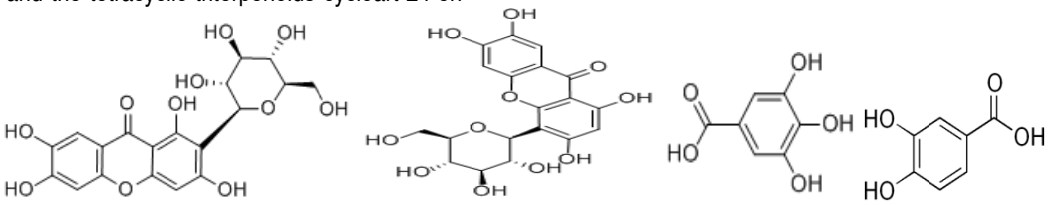
Kingdom Plantae
Subkingdom Tracheobionta
Superdivision Spermatophyta
Division Magnoliophyta
Class Magnoliopsida
Subclass Rosidae
Order Sapindales
Family Anacardiaceae
Genus Mangifera L.
Species *Mangifera indica* L.

Ethanmedicinal Review

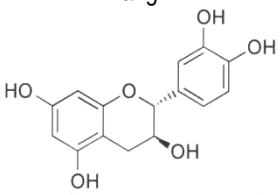
The root, bark, leaves, flowers; unripe and ripe fruit are acrid, cooling and astringent to the bowels and have been employed to cure "vata", "pitta", and "kapha". The parts of *M. indica* mentioned above have also been employed traditionally for treatment of leucorrhoea, bad blood; dysentery, piles, bronchitis, biliousness, urinary discharges, throat troubles, vaginal troubles, hiccough, ophthalmic, eruption, asthma and labouring under habitual constipation. It is also used as aphrodisiac, tonic, appetizer, beautifier of complexion, hiccough, laxative, diuretic, stomachic, antisyphilitic and for tanning purposes in various parts of the world[121]. The widely available leaves of *M. indica* traditionally known to be useful for the treatment of wide panel of disease like throat infection, burns, scalds[122], antidiabetic[123], antioxidant[124], antimicrobial[125], antiviral[126] and antibacterial[127].

Phytochemical Review

Different chemical constituents like polyphenolics, flavonoids, triterpenoids etc hes been isolated from *Mangifera indica*. Mangiferin, a xanthone glycoside, found as major bio-active constituent, isomangiferin, tannins & gallic acid derivatives also present. The bark is reported to contain protocatechic acid, catechin, mangiferin, alanine, glycine, γ-aminobutyric acid, kinic acid, shikimic acid and the tetracyclic triterpenoids cycloart-24-en-3β,26diol, 3-ketodammar-24 (*E*)-en-20S,26-diol, C-24 epimers of cycloart-25 en 3β,24,27-triol and cycloartan-3β,24,27-triol[128]. Stem Triterpenoids (29-hydroxymangiferonic acid, Mangiferonic acid, Mangiferolic acid, Hydroxymangiferolic acid, 3 -22ξ-dihydroxycycloart-24E-en-26-oic acid), Sitosterol arachidate, Friedelin, Friedelan-3β-ol, β-sitosterol, Epi-Ψ-taraxastane-3β ,20-diol, The mixture of 6β-hydroxystigmast-4-en-3-one, 6β hydroxycampest-4-en-3-one and 6β-hydroxystigmasta-4 ,22-dien-3-one, 5 -stigrnastane-3β, 6 -diol, Cycloartane-3β ,24,25-triol, Phenolic acids (gallic acid, 3,4-dihydroxy benzoic acid, gallic acid methyl ester, mangiferin, (+)-catechin, (-)-epicatechin[129-134]. Benzoic acid, benzoic acid propyl ester, Saponins (indicoside A, indicoside B), Triterpenoids (25 (R)-3-oxo-methylene cycloartan-26-ol, Ψ-taraxastanonol, cycloart-24-ene-3β ,26-diol, C-24 epimers of cycloart-25-ene-3β, 24 ,27-triol, the C-24 epimers of cycloartane-3β ,24,25-trio1, 3-ketodammar-24E-ene-2OS, 26diol, hopane-lβ, 3β ,22-triol) , manghopanal, mangoleanone, mangsterol, manglupenone, mangocoumarin, n-tetacosane, n-heneicosane, n-triacontane , Mangostin, An unusual fatty acid, cis-9, cis-15-octadecadienoic acid was isolated from the pulp lipids of mango. Phenolic Antioxidants, Free Sugars and Polyols isolated and analyzed from Stem Bark[135]. 5 - [12 (Z)-heptadecenyl] resorcinol / Mangol II was found in milk of this tree.Fruit contains Gallotannins (penta-, hexa-, and hepta-O-galloylglucose[136]. The flower yielded alkyl gallates such as gallic acid, ethyl gallate, methyl gallate, n-propyl gallate, n-pentyl gallate, n-octyl gallate, 4-phenyl gallate, 6-phenyl-n-hexyl gallate and dihydrogallic acid[137]. Root of mango contains Friedelin, chromones, 3-hydroxy-2-(4'-methylbenzoyl)-chromone and 3-methoxy-2-(4'-methyl benzoyl)-chromone. Leaves also contains Friedelin, Taraxerol, Taraxerone, Lupeol The leaf and flower yield an essential oil containing humulene, elemene, ocimene, linalool, nerol and many others. The fruit pulp contains vitamins A and C, β-carotene and xanthophylls the presence of a phenolic compound from leaves which was named as homomangifirin[138]. 5-Alkyl- and 5-alkenylresorcinols, as well as their hydroxylated derivatives, extracted from peels [139] the bioactive marker compound mangiferin in the stem bark & leaves. Friedelin, Friedelan -3β-ol, Cycloartenol, - amyrin, β-amyrin, Mangiferonic acid, Mangiferolic acid was isolated from root bark. Steam bark also contains Cycloartenol [140] .The volatile composition of *M. indica* a total of 19 different compounds were identified. Sesquiterpene hydrocarbons were shown to be the main group of constituents of all taxa. The main constituents of the oil were -gurjunene (24.0%), β-selinene (24.0%), β-caryophyllene (11.2%), -humulene (7.2%), caryophyllene oxide (5.5%) and humulene epoxide (2.4%).

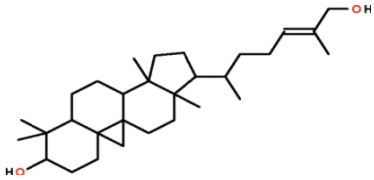


Mangiferin



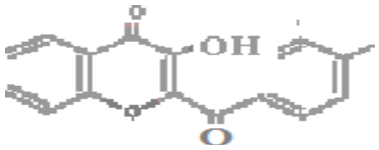
Catechin

Isomangiferin



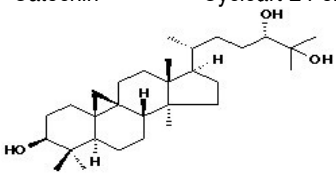
Cycloart-24-en-3β ,26diol

Gallic acid

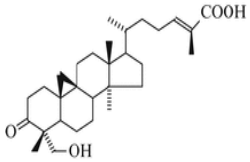


Protocatechuic acid

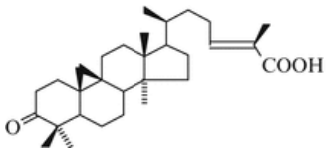
3-methoxy-2-(4'-methyl, benzoyl)-chromone



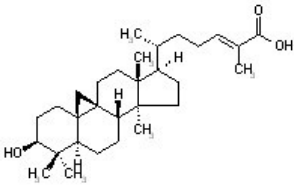
Cycloartan-3β,24,27-triol



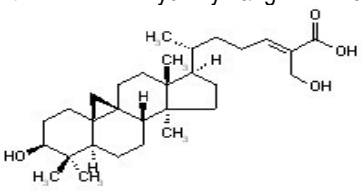
29-hydroxymangiferonic acid



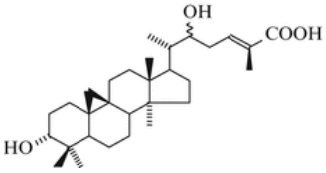
Mangiferonic acid



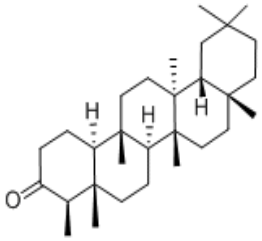
Mangiferolic acid



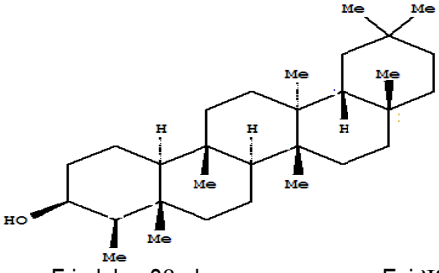
Hydroxymangiferolic acid



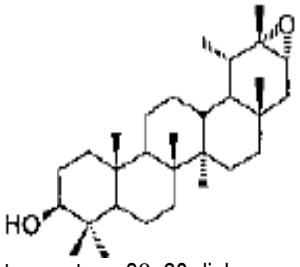
3 -22ξ-dihydroxycycloart -24E-en-26-oic acid



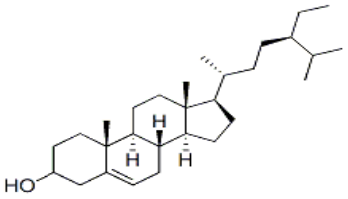
Friedelin



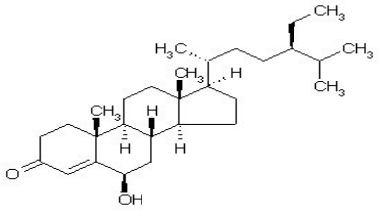
Friedelan-3β-ol



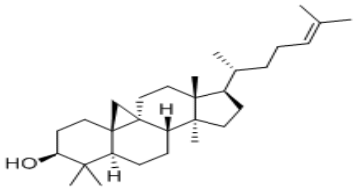
Epi-Ψ-taraxastane-3β ,20-diol



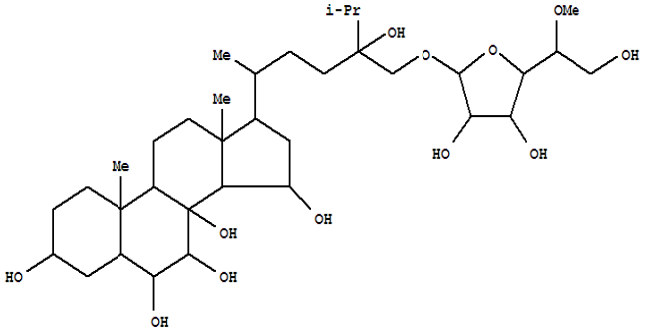
β-sitosterol



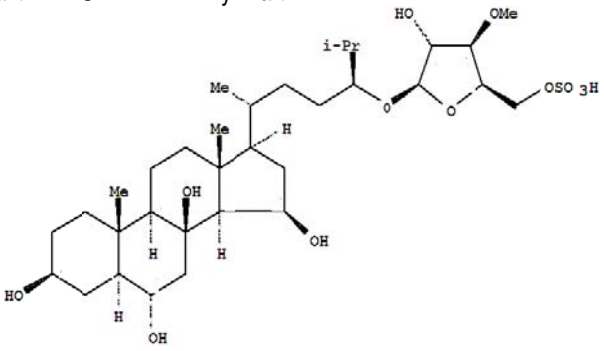
6β-hydroxystigmast-4-en-3-one



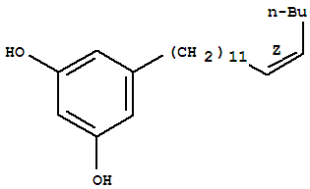
Cycloartenol



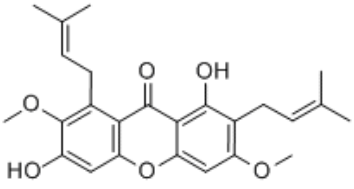
Indicoside A



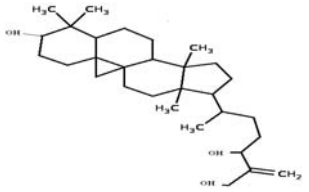
Indicoside B



5 - [12 (Z)-heptadecenyl] resorcinol / Mangol II



3-hydroxy-2-(4'-methylbenzoyl) -chromone



Cycloart-25 en 3β,24,27-triol

Pharmacological review

Pharmacological activity	Plant Parts used	Extract used (solvents)	Screening models	Reference
Anti-oxidant activity	Pulp Stem bark	 Aqueous extract	Total phenolics, carotenoids and ascorbic acid Fe2+-citrate-induced lipoperoxidation	Martinez G *et al*, (2000)[141], Pardo-Andreu GL *et al*, (2006)[142], Rocha Ribeiro SM *et al*, (2007)[143], Gabino G *et al*, (2008)[144], Pardo Andreu G *et al*, (2005)[145]
Anti-diabetic Activity	Leaves Leaves Stem-bark	Ethanol extract Aqueous extract Ethanol extract	Normal and streptozotocin-induced diabetic animals. Blood glucose level in normoglycaemic, glucose - induced hyperglycaemic and streptozotocin (STZ)-induced diabetic Ratsperfusion study	Sharma SR *et al*, (1997)[146] Aderibigbe AO *et al*, (1999)[147], Aderibigbe AO *et al*, (2001)[148], Perpétuo GF *et al*, (2003)[149] Ojewole JA *et al*, (2005)[150], Amrita B *et al*, (2009)[151], Muruganandan S *et al*, (2005)[152], Rolo AP *et al*, (2006)[153]
Antiviral activity		Isolated compound	Against herpes simplex virus type 2 in vitro,	Zhu XM *et al*, (1993)[154], Zheng MS *et al*, (1990)[155], Guha S *et al*, (1996)[156]
Anthelmintic and anti-allergenic activity	Stem bark	Isolated compound		Garcia D *et al*, (2003)[157], Rivera DG *et al*, (2006)[158]
Anti-tumor-anti-HIV activity	Stem bark Arial parts	 Ethanol/water (1:1) extract	Against the breast cancer cell lines MCF 7, MDA-MB-435 and MDA-N, colon cancer cell line (SW-620, renal cancer cell line (786-0). Proliferation of K562 leukemia cells	Muanza DN *et al*, (1995)[159], Aswal BS *et al*,(1984)[160], Peng ZG *et al*,(2004)[161], Yoshimi N *et al*, (2001)[162].
Antibacterial activity		Pet ether, ethyl acetate , ethanolic extract	Against agclinical strains of bacteria S. typhi, B.subtilis, E.coli and K. pneumonia.	Doughari, J. H. *et al*,. (2008)[163]
Anti inflammatory activity	Leaves	Aqueous extract	Carrageenan induced rat paw edema and cotton pellet granuloma.	K.P. Latha *et al*,. (2012)[164]
Hepatoprotective activity	Seed kernels	Isolated compound from ethanolic extract	Against liver injury in rats induced by carbon tetrachloride	Saruth Nithitanakool *et al*., (2009)[165]

Radioprotective effect		Isolatd compound (mangiferin)	Radiation-induced micronuclei formation in cultured human peripheral blood lymphocytes and in DBAxC57BL mice	Jagetia GC *et al.*, (2005)[166]
Lipolytic activity		Isolatd compound (mangiferin)	On rat epididymal fat-derived cultured adipocytes.	Yoshikawa M et ai., (2002)[167]

Trichosanthes dioica roxb.

Trichosanthes, a genus of family Cucurbitaceae is an annual or perennial herb distributed in tropical Asia, Polynesia, & Australia. Over 20 species are recorded in India of which two namely *T. anguina & T. dioica* are cultivated as vegitable.

Vernacular Names

English: Pointed gourd
Hindi: Parwal, Parvar
Bengali: Patol.
Gujrati: Potala, Patal.
Kananda: Kadupodavalu.
Malyalam: Patolam.
Punjabi: Palwal, Parwal.
Tamil: Peyu-padal.
Telegu: Adavi-patola.
Oriya: Patal.

Taxonomical classification

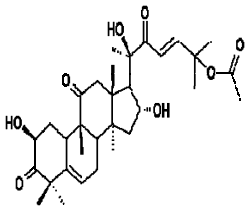
Kingdom Plantae
Division Magnoliophyta
Class Magnoliopsida
Order Cucurbitales
Family Cucurbitaceae
Genus Trichosanthes
Species *Trichosanthes dioica*

Ethnopharmacological Review

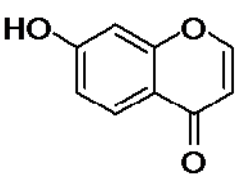
Trichosanthes dioica is known for the important vegetables[168]. The fruits and leaves are the edible parts of the plant which are cooked in various ways either alone or in combination with other vegetables or meats[169]. Juice of leaves of *T. dioica* is used as tonic, febrifuge & in subacute cases of enlargement of liver & spleen[170] In Charaka Samhitha leaves & fruits used for treating alcoholism & jaundice. Leaves are used in odema and alopecia[171]. It is also used as antipyretic, diuretic, cardiotonic & laxative.

Phytochemical review

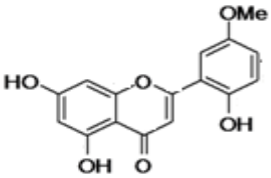
Chemical study reveals that in addition to a number of tetra and pentacyclic triterpenes, the toxic bitter principles cucurbitacins (a group of often highly oxygenated tetracyclic compounds with a unique carbon skeleton and almost a carbonyl group in ring C) may be considered as a taxonomic character of Cucurbitaceae. *T.dioica* is rich in vitamins and contains 9.0 mg Mg, 2.6 mg Na, 83.0 mg K, 1.1 mg Cu, and 17.0 mg S per 100 g edible part[172]. The various chemical constituents present in *T. dioica* are vitamin A, vitamin C, tannins, and saponins. Two main phytosterols present in *T. dioica* are namely, 24 -ethylcholest-7-enol & 24β-ethylcholest-7-enol[173]. Also seeds of *T. dioica* contain lectin, a carbohydrate (specifically galactose) binding protein which is homologous to Type-II ribosome inhibitory proteins (Type-II RIP) [174]. Leaves contain 0.97% hentriacontane, chlorophylls, phytin, resins and anthaquinone derivatives.



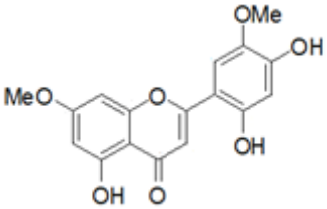
Cucurbitacins



7-Hydroxy-4*H*-5-chromen-4-one.



5,7-dihydroxy-2-(2- hydroxy-5-methoxyphenyl)-4*H*-chromen-4-one.



5-Hydroxy-2-(2,4- dihydroxy-methoxyphenyl)-7-Methoxy 4*H*- chromen-4-one.

Table: Pharmacological Review

Pharmacological activity	Plant Parts used	Extract used (solvents)	Screening models	Reference
Antidiabetic Activity	Leaves, Fruits	Aqueous extract	Normal and streptozotocin (STZ) induced sub- and mild-diabetic rats	Chandrasekhar B *et al.*, (1988)[175], Rai PK *et al*,. (2008)[176], Rai DK *et al*,. (2008)[177],
Hepatopotective Activity	Whole plant	Aqueous and ethanolic extract	Ferrous Sulphate-induced liver injury.	Ghaisas MM *et al.*, (2008)[178].
Cholesterol-Lowering Activity	Fruit	Aqueous extract, alcoholic extract	Normal and streptozotocin diabetic rats	Sharmila *et al.* (2007)[179], Sharma *et al.* (1992)[180]
Anti-Inflammatory Activity		Polyherbal formulation (Jatyadi Ghrita)	Carrageenan induced rat paw edema	Fulzul *et al.* (2001)[181]
Antifungal Activity	Seeds	Fixed oil		Hariti *et al.* (1996)[182]
Antibacterial Activity	Seeds	Fixed oil	Disc diffusion method	Hariti *et al.* (1995)183, Rai PK *et al.* (2010)[184]
Anti-Oxidant Activity	Fruit	Aqueous extract	1, 1 diphenyl-2- picryl hydrazyl, nitric oxide, reducing power assay and hydrogen peroxide radical method.	Shivhare *et al.* (2010)[185]
Wound Healing Activity	Whole plant	Methanolic extract	Burn wound model in rats	Shivhare *et al.* (2010)[186]
Gastric Antiulcer Activity	Leaves	Aqueous extract		Singh KP *et al*, (1985)[187]

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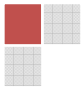

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