

**ADHATHODAI CHOORANAM : SIDDHA MEDICINE INDICATED
FOR IYA ERAIPPU NOI (BRONCHIAL ASTHMA) – A REVIEW**

Vetha Merlin Kumari. H*, **Nalini Sofia. H***, **Manickavasakam. K****, **Mohan. S*****
Karthikeyan. Karu****

*Lecturer, **Guide & Director(Rtd), *** Director(i/c), National Institute of Siddha,
****Medical superintendent, NIS, Chennai, Tamil Nadu, India.

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***Correspondence for
Author**

**Dr. Vetha Merlin
Kumari . H**

Lecturer, NIS, Chennai,
Tamil Nadu, India.

ABSTRACT

Siddha is a very vast and elaborate medicinal science, containing a huge amount of medical knowledge. In siddha system of Medicine 4448 types of diseases are explained by Siddhars. The disease Iya eraippu noi can be correlated to Bronchial Asthma in Modern science. Bronchial asthma is a common respiratory disorder affecting approximately 35% of the population. Bronchial asthma is a chronic inflammatory disorder of the airway in susceptible individuals. Inflammatory symptoms are usually associated with widespread but variable airflow obstruction and an increase in airway response to a variety of stimuli. Obstruction is often reversible either spontaneously

with treatment. Many new drugs are under development and yet there is no cure for asthma. Herbal medicine is the third most popular choice of both adults (11%) and children (6%) suffering from asthma. Siddha, an ancient system of Indian Medicine has recommended a number of drugs for indigenous plant sources for the treatment of Bronchial Asthma and allergic disorder. One among them is Siddha sastric preparation Adhathodai chooranam, a poly herbal formulation. It is the safe and efficacious medicine used traditionally for the treatment of Respiratory illness. This review describes the chemical constituents and pharmacological properties of its individual ingredients.

KEYWORDS: Siddha, Iya Eraippu noi, Adhathodai chooranam, Bronchial Asthma.

INTRODUCTION

The prevalence of Bronchial Asthma, a major public health problem world wide. Bronchial Asthma is a common respiratory disorder affecting approximately 3-5 percent of the

population. In a country like India with different socio cultural diversities and beliefs, the treatment of Asthma varies and the existence of different systems of Medicine in our country complicates the treatment issues. Over the past decade, herbal and siddha drugs have become a subject of world importance with both Medicinal and economical implications. A regular and widespread use of herbs throughout the world has increased serious concerns over their quality, safety and efficacy. In siddha classical text, Adhathodai chooranam is specially indicated for Bronchial Asthma which comprises 17 ingredients such as *Alpinia galanga* Wild, *Alpinia officinarum* Hance, *Justicia adhatoda* Linn, *Tragia involucrata* Linn, *Piper longum* Linn, *Styrax benzoin* Dryand, *Curcuma longa* Linn, *Costus speciosus* (Koen.) sm, *Embelia ribes* Burm.f, *Clerodendrum serratum* (Linn.) Moon, *Cyperus rotundus* Linn, *Ficus tsiela* Roxb, *Woodfordia fruticosa* Kurz, *Solanum trilobatum* Linn, *Solanum surattense* Burm.f, *Piper nigrum* Linn. This review mainly evaluates and documents the in-vivo, in-vitro and therapeutic potential of the herbs of Adhathodai chooranam to support the clinical application in managing Bronchial Asthma.

***Alpinia galanga* Wild.**

Family: Zingiberaceae

Tamil name: Perarathai

Part used: Rhizome

Chemical constituents

The root contained Galangin and 3-methyl galangin.^[1] Essential oil was obtained from the rhizome yield of 0.04 per cent.^[2] The chloroform extract of the rhizome yielded two new phenolic constituents, p-hydroxycinnamaldehyde and di-(p-hydroxy-cis-stryl)methane.^[3] α pinene, β pinene, limonene, terpinen-4-ol, α terpinol, linalool, methyl eugenol, eugenol, 1,8 cineole are the major chemical constituents. Quercetin, kaempferol, isorhamnetin, kampferide, 1-acetoxychavicol acetate, 1-acetoxyeugenol acetate, galangal A & B, galanolacton.^[4] Myrcene 94.51, z- β -imene, 2.05.^[5]

In a study 1's'-1' hydrox chavicol acetate, trans-p-hydrox cinnamaldehyde, trans acetate and trans p-coumaryl diacetate have been isolated from rhizomes. The pungent principal compound 1's'-1' acetoxychavicol acetate has been reported to possess various biological activities such as anti inflammatory, anti oxidative and xanthineoxidase inhibitory activity.^[6] The GC-MS analysis showed that the main compounds of galangal extract are 1,8-cieole, β -bisabolone and β -selinene. Whereas α -selinene, farnesene, 1,2 -benzenedicarboxylic acid,

germacrene β and pentadecane are the minor components. 1,8-cineole is an oxygenated monoterpene, while β -Caryophyllene is a sesquiterpene. In addition β -bisabolene and β -selinene are terpenes.^[7] Unique aroma components i.e hydroxyl-1,8-cineole β -D-glucopyranosides, (1R,2R,4S) and (1S,2S,4R)-trans-2-hydroxy-1,8-cineole β -D-glucopyranoside and (1R,3S,4S)-trans-3-hydroxy-1,8-cineole β -D-glucopyranoside which are precursors of acetoxy-1,8-cineoles have been isolated from the rhizomes of greater galangal.^[8] Three new 8-9 linked neolignans, galanganal, galanganols A and B and a sesqueneolignan, galanganol C have also been isolated.^[9]

Pharmacological studies

Anti allergic activity

Alpinia galangal was found to be effective in treatment of allergy. Isolated compounds, 1'-1'-acetoxychavicol acetate from aqueous extract of rhizome have shown to inhibit release of β -hexosaminidase and the antigen-IgE mediated TNF- α and IL-4 production in passive cutaneous anaphylaxis reaction in mice.^[10]

Antioxidant activity

A lot of scientific works have revealed that *Alpinia galangal* and its isolates possess significant antioxidant activity. Essential oil of *Alpinia galangal* has been reported to possess stronger antioxidant activity with IC 50 value of 550 μ g/ml. Zaoung *et al* have reported significant free radical scavenging activity against 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical in methanolic and water extracts and volatile oils.^[12]

Antioxidant activity at natural pH was higher than at acidic pH ranges. Ethanolic extract of galangal has been reported to possess strong superoxide anion scavenging activity. Fe²⁺ chelating activity and reducing power in a concentration-dependent manner. However it also possess lipoxygenase inhibitor activity.^[13] Dose dependent antioxidant activity has been reported in Dichloromethane (DCM) and methanol extract of rhizome of *Alpinia galangal*.^[14] The acetone extract of the rhizome exhibited strong antioxidant activity.^[15]

Immunostimulating effect: A study conducted by Bendjeddou *et al*, revealed that a polysaccharide extract of *Alpinia galangal* rhizome possesses a marked stimulating effect on the reticuloendothelial system and increased the number of peritoneal exudates cells and spleen cells of mice.^[15]

Antiinflammatory activity: *A. galanga* and five other plants used under the name rasna were tested for comparative anti-inflammatory activity against formalin –induced arthritis and carrageenin-induced acute rat paw oedema. The water soluble fraction of the alcoholic extract of the plant was found to be active in chronic arthritis in albino rats. Its antiinflammatory activity was similar to that of Betamethasone.^[16] Isolated p-coumaryl alcohol - γ -o-methyl ether having phenylpropanoid structure, which selectively and substantially suppressed IFN γ production in CD4+TH cells.^[17] Isolated chavicol analogues viz, acetoxychavicol acetate and hydroxychavicol acetate have been comparably examined. In which Acetoxychavicol acetate exhibited potent antioxidant activity, increased cell apoptosis and decreased cytokine production by TH cells, whereas, Acetoxychavicol acetate suppressed T-bet expression and might act as a beneficial therapeutics for treating inflammatory immune disorder caused by extravagant activation.^[10]

Antimicrobial activity: The essential oil obtained from the rhizome in a preliminary biological screening revealed antibacterial activity against *Staphylococcus aureus*.^[18] antibacterial activity against *Staphylococcus aureus* and *Streptococcus pyogenes*. 1,8-cineole has been reported to have an antibacterial activity against *Staphylococcus aureus*.^[20] In a study performed by using both dilution method, ethanol extract of galangal showed the strongest inhibitory effect against *Staphylococcus aureus*.^[21] Aqueous extract showed significant activity against *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pyogenes* except *Staphylococcus epidermidis*.^[22] Essential oil had showed significant activity against *Staphylococcus aureus*, *Streptococcus suis*, *P. aeruginosa* with the maximum inhibitory dilution-higher potential in antimicrobial activities was supposed to be due to the composition 1,8-cineole 4-allylphenyl acetate and α -bisabolene.^[23] The acetone extract of the rhizome exhibited strong antioxidant activity.^[5]

Alpinia officinarum Hance

Family: Zingiberaceae

Tamil name: Chittarathai

Part used: Rhizome

Chemical constituents: The rhizome was reported to contain tannins, phlobaphenes in the alcoholic extract while chloroform extract showed the presence of flavones such as kaempferide, galangin and alpinin. 24 Five diarylheptanoides were obtained and their structures were identified as 5-ethoxyl-7-(4-hydroxy-3-methoxy-phenyl)-1-phenyl-3-heptanone, 5-

hydroxy-1,7-diphenyl-3-heptanone,5-hydroxy-7-(4-hydroxyl-3-methoxyphenyl)—1-phenyl-3-heptanone, 5-methoxy-7-(4-hydroxy-3-methoxyphenyl)-1-phenyl-3-heptanone,and(E)-7-(4-hydroxy-3-methoxyphenyl)-1-phenylhept-4-en-3-one.25GC-MS revealed that the major constituents of essential oil were eucalyptol 28.11%, terpineol 9.17%, muurolene 7.88%, farnesene 5.73%, caryophyllene 4.6%, bergamotene 4.18% and gurjunene 3.63%.26The alcoholic extract of rhizome showed the presence of various flavanoid which include quercetin, kaemferol, quercetin-3-methyl ether, isorhamnetin, kaemferide, galangin and galangin -3-methyl ether. 27 Two flavanoides, i.e., rhamnocitrin and 7-hydroxy-3,5-dimethoxyflavone have also been isolated from the plant.Various compounds have also been reported to be present in the oil, which include, 1,8-cineole, α -pinene, β -pinene,methyl isovalerate, camphene, limonene, p-cymene, camphor trans- α -bergamotene, β -elemene, terpinen-4-ol . 28Moreover, the roots of the plants have been noted to contain quercetin-3 methyl ether, galangin 3-methyl ether, kamfero 7-methyl ether and 7-OH-3,5-DIO-o methyl flavanone and pungent principle like 5-OH-7(4-OH-3-OMe-ph-1-ph-3-heptanone).^[29]

Pharmacological studies

Antimicrobial activity: The ethyl alcohol extract of the rhizome revealed anti microbial activity against *Staphylococcus aureus*,*Bacilus subtilis*,*Escherichia coli*,*Candida albicans*.^[30,31]Antibacterial activity of galangin was investigated against 17 strains of 4-quinolone resistant *Staphylococcus aureus* using an agar dilution assay.The strain which possessed an aminoacid alteration in the Gr1B subunit of topoisomerase IV had increased susceptibility to galangin. The topoisomerase IV enzyme may therefore be implicated in the antibacterial mechanism of action of galangin.Antimicrobial activity of galangin against 16 camphylobacter jejuni clinical isolates and several Gram-positive and Gram-negative human pathogens were investigated. Galangin showed highest percentage of sensitivity among camphylobacter jejuni strains. Aggregatory effect of galangin on bacterial cell was investigated.In preparatory time-kill assays, galangin was found to reduce colony counts of *Staphylococcus aureus*.Light microscopy study showed significant increases in the number of large clusters of bacterial cells in populations treated with the flavanol.The bioactivity of the flavanoids galangin 3-methyl ether was investigated in vitro against amastigote stages of *Leishmanis amazonensis* and found to have significant activity.A number of mechanisms are involved in the antimicrobial effects of herbs, including inhibition of beta-lactamase, which was found in the herbal phytoconstituents galangin.^[16]

Antioxidant activity: *In vitro* and *in vivo* antioxidant activity indicate that galangin has anti-oxidative and free radical scavenging activity and is capable of modulating enzyme activity and suppressing the genotoxicity of chemicals. Liposomes containing flavanoids (galangenin) was evaluated for their antioxidant activity and found to have significant antioxidant activity and is dependent on concentration and chemical structure of active compound. Antioxidant activity of galangin was measured and found to show significant DPPH radical scavenging activity.^[32]

A comparison of alizarin red and fluorescein as target molecules in oxygen radical absorbance capacity-like methods is reported and showed that galangin decreased alizarin red initial consumption rate. Galangin was found to have significant antioxidant potential. Antioxidant activity of various components of propolis was investigated and found that galangin possessed significant antioxidant activity. Mitochondria are important intracellular sources and targets of ROS. Antioxidant activity of galangin on Fe²⁺/citrate – mediated membrane lipid peroxidation in isolated rat liver mitochondria was investigated. Results suggest that 2,3-double bond in conjugation with the 4-oxo function in the flavanoid structure are major determinants of the antioxidant activity of flavanoids in mitochondria. The modulatory effect of galangin on rabbit PMN oxidative metabolism, specifically stimulated via Fc gamma R, CR or both classes of receptors, was evaluated by luminal- and lucigenin-dependent chemiluminescence assay.^[16]

Anti-inflammatory activity

Topical anti-inflammatory activity of selected flavanoids commonly found in propolis was investigated. The reduction in croton oil-induced oedema in a mouse model, after topical application of galangin for 3h, was more than 50%, while after 6h of treatment the reduction was less than 50%. Various fractions obtained from parthenium hysterophorus showed anti-inflammatory activity and contain galangin as active constituent.^[16]

***Cyperus rotundus* Linn**

Family: Cyperaceae

Tamil name: Koraikizhangu

Part used: Rhizome

Chemical constituents: 4 α , 5 α oxidoeudesm-11-en-3 α -ol, cyperene-1 (a tricyclic sesquiterpene), cyperene-2 (a bicyclic sesquiterpene hydrocarbon), β -selinene, cyperenone, α

cyperone. 27 compounds from the essential oil including copadiene, epoxyguaiene rotundone, cyperenol, cyperolone, eugenol, cyperol, isocyperol, α & β rotunol, kobusone, isokobusone.^[32] Terpinoidal and flavanoidal constituents like: sitosterol, oleanolic acid-3-O-neohesperidoside, a flavanol glycoside characterized as rhamnetine 3-O-rhamnosyl rhamnopyranoside, caryophyllene, caryophyllene-6,7-oxide, caryophylla-6-one and unidentified terpenoids. saponins, steroids, glucosides, sugars, starch, sterols and flavanoids in tuber.^[34] Cyperene I and II, Cyperol and cyperone, mustakone, copadiene, (+)-epoxyguaiene, (-) rotundone, cyperolone, isopatchoulone, pinene and patchoulone were reported from the essential oil.

The mineral element composition of the plant was reported to be Ca, 0.395; Cd, 0.0011; Cu, 0.195; Fe, 2.170; K, 9.29; Mg, 0.433; Mn, 0.0173; Na, 0.90; Ni, 0.065 and Zn, 0.0093 mg/g dry material.^[35]

The mineral composition of plant was reported as organic carbon, 46.60; total nitrogen, 1.6; total phosphorus, 1.12; total potassium, 1.10; calcium, 1.68; magnesium, 1.08; sodium, 0.28 and sulphur, 0.53. The micronutrients present in the plant were iron (182.3 ppm), zinc (37.1 ppm) and copper (10.4 ppm), the organic constituents present were soluble carbohydrates (37.10%), hemicelluloses (13.35%), cellulose (16.29%), lignin (9.80%) and crude protein (11.00%).^[36] Different phytochemical studies on *C. rotundus* revealed the presence of alkaloids, flavonoids, tannins, starch, glycosides, furochromones, monoterpenes, sesquiterpenes, sitosterol and fatty oil containing a neutral waxy substance, glycerol, linolenic, myristic and stearic acids.^[37, 38, 39]

The major compounds isolated from essential oil and the extracts of *C. rotundus* rhizome are Alpha-cyperone, Alpha-rotunol, Beta-cyperone, Beta-pinene, Beta-rotunol, Beta-selinene, Calcium, Camphene, Copaene, Cyperene, Cyperenone, Cyperol, Cyperolone, Cyperotundone, D-copadiene, D-epoxyguaiene, D-fructose, D-glucose, Flavonoids, Gamma-cymene, Isocyperol, Isokobusone, Kobusone, Limonene, Linoleic-acid, Linolenic-acid, Magnesium, Manganese, C. rotunduskone, Myristic-acid, Oleanolic-acid, Oleanolic-acid-3-o-neohesperidoside, Oleic-acid, P-cymol, Patchoulone, Pectin, Polyphenols, Rotundene, Rotundenol, Rotundone, Selinatriene, Sitosterol, Stearic-acid, Sugeonol, Sugetriol.^[40, 41] *C. rotundus* contains an essential oil that provides for the characteristic odour and taste of the herb, comprised mostly sesquiterpene hydrocarbons, epoxides, ketones, monoterpenes and aliphatic alcohols. Sesquiterpenes include selinene, isocurcumenol, nootkatone, aristolone, isorotundene, cypera-2,4(15)-diene, and norrotundene, as well as the sesquiterpene alkaloids

rotundines A-C. Other constituents include the ketone cyperadione, and the monoterpenes cineole, camphene and limonene. *C.rotundus* has also been shown to contain miscellaneous triterpenes including oleanolic acid and sitosterol, as well as flavonoids, sugars and minerals.^[42, 43, 44]

The oil and the fractional distillates from the tubers of the Madras variety *viz.*, Cyperene I, cyperene II, cypeol and cyperone were tested against *Staphylococcus aureus*, *Escheria coli*, *E.typhosum*, *Vibrio cholera*, *Shigae*, *Schmitz* and *sonnei* strains of *Shigella*. The oil inhibited the growth of only *Staphylococcus aureus* and was ineffective against the other organisms. Among the fractions, cyperene I and II were more potent than the oil and cyperol while cyperone was inert.^[48]

Spasmolytic activity : Ethanolic extract of *C. rotundus* produced relaxation of rabbit ileum and spasmolytic effect against contractions induced by acetylcholine, barium chloride and 5-hydroxitriptamine, showing a direct relaxant action on the smooth muscle.^[49]

Antioxidant activity : A combination of spices (*Piper nigrum*, *Piper longum* and *Zingiber officinale*), herbs (*Cyperus rotundus* Linn. and *Plumbago zeylanica*) and salts make up Amrita Bindu. The study was focused to evaluate the antioxidant property of individual ingredients in Amrita Bindu against the free radical 2,2'-azinobis-(3-ethylbenzothiazoline-6sulphonicacid) (ABTS). The analysis revealed the antioxidant potential of the ingredients in the following order: *Piper nigrum* > *Piper longum* > *Cyperus rotundus* > *Plumbago zeylanca* > *Zingiber officinale*. These results reveal that Amrita Bindu, a salt-spice-herbal mixture containing *C. rotundus* Linn. exerts a promising antioxidant potential against free radical induced oxidative damage.^[50]

Anti Inflammatory Activity: B-sitosterol, isolated from the plant, in a dose of 320 mg/kg i.p. and p.o. showed significant anti-inflammatory activity against carrageenin-induced oedema in rats. The petroleum ether, chloroform and methanol extract of the tubers in doses of 10 mg/kg showed significant anti-inflammatory activity against carrageenin induced oedema in rats. The petroleum ether extract was found to be most potent showing 75% inhibition. The five substances (A, B, C and E) isolated from the fraction IVB of the petroleum ether extract were found to possess potent anti-inflammatory activity.^[34] The drug is rich in Cu, Fe, Mg and Ni. The drug is rich in Cu, Fe, Mg and Ni. B-Sitosterol isolated from the tubers exhibits significant anti-inflammatory activity against carrageenan and cotton pellet induced oedema

in rats. The activity is comparable to hydrocortisone and phenylbutazone, when administered intraperitoneally.^[45]

The alcoholic extract (70% alcohol) possessed anti-inflammatory activity against carrageenan induced oedema and also found effective against formaldehyde induced arthritis in albino rats.^[51] In another study the petroleum ether extract of the rhizomes showed anti-inflammatory activity against carrageenan induced oedema in albino rats. The triterpenoid obtained by chromatographic separation from petroleum ether extract revealed a high potent anti-inflammatory activity. This terpenoid was also found to possess significant antipyretic and analgesic effects similar to acetyl salicylic acid. *C. rotundus* has also reported as protective in inflammatory bowel disease. In addition, the extract suppressed the production of O₂- by phorbol ester stimulated RAW 264.7 cells in dose- and time-dependent manners. Collectively, these results suggest that the methanol extract of rhizomes of *C. rotundus* could be developed as anti-inflammatory candidate for the treatment of inflammatory diseases mediated by overproduction of NO and O₂.^[52] Another study on alcoholic extract of *C. rotundus* showed highly significant ($P < 0.001$) anti-inflammatory activity against the exudative and proliferative phases of inflammation in two animal models (carrageenan induced oedema and formaldehyde induced arthritis in rats). Its anti-inflammatory relative effect was higher than that of hydrocortisone (75.9% versus 47.3% in carrageenan-induced oedema model; 55.1% versus 35.6% in formaldehyde induced arthritis model).^[53,54,55,56]

Antibacterial activity: The alcoholic extract of the root tuber showed antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* whereas aqueous extract was found to be inactive against both the organisms.^[46] The ethanol extract of the root and bulb showed activity against *Escheria coli*, *pseudomonas aeruginosa*, *Bacillus subtilis*.^[47] The oil and the fractional distillates from the tubers of the Madras variety viz., *Cyperene I*, *cyperene II*, *cyperol* and *cyperone* were tested against *Staphylococcus aureus*, *Escheria coli*, *E. typhosum*, *Vibrio cholera*, *Shigae*, *Schmitz* and *sonnei* strains of *Shigella*. The oil inhibited the growth of only *Staphylococcus aureus* and was ineffective against the other organisms. Among the fractions, *cyperene I* and *II* were more potent than the oil and *cyperol* while *cyperone* was inert.^[48] In-vitro antimicrobial activity by agar disc diffusion and agar well diffusion method was evaluated for aqueous and ethanolic extracts. The ethanolic extract was active against all the investigated bacterial strains, while aqueous extract was inactive. In another study acetone and ethanol extracts showed significant broad spectrum antibacterial activity in disc diffusion

method.^[57] Antimicrobial activity tests were carried out on human pathogens bacteria (gram negative and gm positive) and ungi viz. *C.albicans* and *A. niger*. The highest percentage of inhibition was observed against *K.pneumoniae* (133.33%). Amoxicillin 20µg/ml and ethanol (as fungicide) 70% were used as positive control. Moderate inhibition was observed in case of *A. niger* and *S. aureus* (90and 70% respectively). No zone of inhibition was observed in *Acinto bacter* and *Candida*. The oil of *C.rotundus* showed a remarkable activity against gram-positive bacteria, *Staphylococcus aureus* and *Enterococcus faecalis*.^[58]

***Clerodendrum serratum*(Linn.) Moon**

Family:Verbenaceae

Tamil name:Siruthekku

Parts used:Root

Chemical constituents: D-Mannitol, γ -Sitosterol. Hydrolysis of crude saponin fraction gives oleanolic acid, queretaroic acid, serratagenic acid. The minerals reported in the plant were: Na, Mg, Al, Ca, V, Cr, Mn, Fe, Co, Ni.^[59] Preliminary studies of root reported the presence of flavonoids, glycosides, saponins, sterols and absence of alkaloids and terpenoids. The major groups of chemical constituents present in the *Clerodendrum* genus are carbohydrates, phenolics, flavonoids, terpenoids and steroids. Generally, D-mannitol have been found in the roots of the plant.^[60] Flavonoids are further sub-grouped into catechins, ucoanthocyanidins, flavanones, flavanonols, flavones, anthocyanidins, flavanols, chalcones, auronones and isoflavones. These isolated flavonoids like hispidulin and cleroflavone possess potent anti-oxidant, anti-microbial, anti-asthmatic, anti-tumor and CNS-binding activities. Other flavonoids isolated from plants are apigenin, 7-hydroxy flavanone, scutellarein and pectolinarigenin.^[61] Steroids are terpenes based on the cyclopentane perhydroxy phenanthrene ring. Chiefly, γ -sitosterol, β -sitosterol, cholestanol, clerosterol, campesterol and 24-ethyl cholesterol were reported to be isolated from the plant.^[62] The phenolic compounds in the genus *Clerodendrum* are found in both free as well as bound to sugar moieties. Some of the phenolic compounds isolated were serratagenic acid, acteoside, indolizino and verbascoside which possess biologically activities such as anti-oxidant, anti-microbial, anti-proliferative, antihypertensive and anti-cancer activities.^[60] Terpenoids are generally found to be bound to sugar moieties by a glycoside linkage. Usually they are present as glycosides in their β -D-glucosidic form.^[61] Terpenes isolated from plant like betulin, oleanolic acid, clerodermic

acid, betulinic acid, friedelin and monomelittoside had weak CNS activity, strong molluscicidal and fungitoxic activities.^[63]

Antioxidant activity: In DPPH radical scavenging assay, *Clerodendrum serratum* root at various concentrations (50, 100, 150, 200, 250 µg/ml) and ascorbic acid (50, 100, 150, 200, 250 µg/ml) showed the significant inhibitory activity with IC₅₀ value 175 and 137 respectively. In reducing power assay, a linear increase in reducing power was observed over the concentration range 20-120 µg/ml sample, equivalent to 20 -120 µg/ml ascorbic acid. The inhibition of $73.32 \pm 0.002\%$, and $64.49 \pm 0.242\%$ was observed for ascorbic acid (standard) and ethanolic extract of root (test) The ethanol extract of roots of the plant have been respectively at maximum concentrations.^[64]

Antibacterial activity: The ethanol extract of roots of the plant have been screened for their antibacterial activity. The extract (7.5 mg/disc) showed broad-spectrum antibacterial activity against gram positive and gram negative bacteria. The results were compared with the standard drug streptomycin (10 µg/disc). The zone inhibition was found to be increased with the increase in concentration of the extract and thus exhibiting concentration dependent activity.^[65]

Anti-inflammatory activity: The ethanolic root extract of *C. serratum* showed significant anti-inflammatory activity in carrageenan-induced oedema in rats, and also in the cotton pellet model in experimental mice, rats and rabbits at concentrations of 50, 100 and 200 mg/kg.^[66]

Antiallergic activity: Icosahydronic acid (IHPA), a new pentacyclic triterpenoid saponin was first time isolated from the roots of *Clerodendrum serratum* (L) Moon. IHPA, at the dose of 100mg/kg, showed significant protection of mast cell degeneration (59.62%) as compared to standard sodium cromoglycate (64.48%). The compound also revealed significant inhibitory activity on histamine induced gout tracheal chain preparation.^[67]

Anti-inflammatory and anti allergic activity: Anti inflammatory action in rats was assessed by Granuloma pouch method. The anti allergic activity was evaluated by milk induced leucocytosis in mice and bronchial hyper reactivity in Guinea pigs sensitized with egg albumin. (6 groups, n=6). This study shows that Low Dose (LD) of Bharangi root and High Dose (HD) of stem show anti-inflammatory (23%) and anti allergic activity (21%) equivalent

to Dexamethasone (21%). But the high dose of Bharangi root has promising anti-inflammatory (44%) and anti-allergic activity 35%. Anti-allergic activity is minimal (8.6%) for LD of stem. This study indicates that Bharangi root is more effective than stem and its HD would be useful in anti-allergic and anti-inflammatory activity in diseases like asthma, which needs to be further confirmed.^[68]

Anti histaminic activity: Aqueous extract of the root blocked histamine induced contractions in isolated guinea pig ileum and trachea and inhibited compound 48/80 induced release of histamine. Saponin isolated from the drug did not show any antihistaminic activity. Ethanol extract of the root produced antinociceptive anti-inflammatory and antipyretic activities.^[69]

***Embelia ribes* Burm. F.**

Family: Myrsinaceae

Tamil name: Vaivilangam

Part used: Seeds

Chemical constituents: Uinones: The fruit contains embelin (embelic acid), which is considered to be the major active principle, and vilangin. Alkaloid; Christembin.^[70] Fatty acids; Seed oil contains palmitic, oleic and linoleic acids.^[71] The main active principle of *E. ribes* viz., embelin (2,5-dihydroxy-3-undecyl-1,4-benzoquinone) was reported as early as 1929.^[72] The fruits were reported to contain 2.5 to 3.1 per cent of embelin.

Pharmacological studies

Antimicrobial activity: Embelin showed antibacterial activity at 800 µg/ml against *Staphylococcus aureus*, *S. albus* and *S. citreus*.^[70]

Anti-inflammatory activity: Embelin and its 2,5-isobutylamine salts possess anti-inflammatory activity in carrageenan induced paw oedema and cotton pellet granuloma formation. In another study anthralite derivatives of embelin using the carrageenan-induced edema in the hind paw of rats at a dose of 50 mg/kg were found to be more active than phenylbutazone when tested for their anti-inflammatory activity.

Anti histaminic activity: In the isolated goat tracheal chain preparation, histamine produced dose dependent contraction of goat tracheal chain preparation while there was rightside shift

of dose response curve of histamine in the presence of *Embellia ribes* indicating antihistaminic activity.^[73]

In the present study, anti histaminic drug chlorpheniramine maleate and *Embellia ribes* significantly protected the guinea pigs against histamine induced bronchospasm. *E.ribes* has significantly prolonged the latent period of convulsions as compared to control following the exposure to histamine aerosol. This indicates the utility of the *E.ribes* in the treatment of Asthma and bronchitis by virtue of its H1 –receptor blocking or bronchodilating activity. This *E.ribes* have anti-histaminic by blocking H1-receptor or bronchodilating activity which suggestive of its potential in prophylaxis and management of Asthma.^[74]

Antimicrobial activity

The highest activity (diameter of zone of inhibition 27mm) was demonstrated by the ethanolic extract of *Embellia ribes* fruits against *Pseudomonas aeruginosa* while the lowest activity (diameter of zone of inhibition 2mm) was demonstrated by the water extract against *Escherichia coli*. The aqueous extract generally showed lower activity against the test organisms compared to the ethanolic extract. The result showed that *Streptococcus faecalis* had the highest MIC (16 mg/ml) and MBC (18.5 mg/ml), while the lowest MIC of 6 mg/ml was shown by *Pseudomonas aeruginosa*.^[75] Embelin showed bactericidal activity (MIC index is 4 or less than 4) against gram positive organisms, whereas against gram negative organisms it showed bacteriostatic activity (MIC index values greater than 4 and less than 32).^[76]

Clinical study

A clinical study was conducted on 69 of bronchial asthma with sisanal tablets containing 200 mg of berries (two tablets thrice daily in adults). In the case of bronchial asthma patients the response of 29 cases was classified as very good, the attacks almost completely disappeared with one month's treatment. In 22 cases the response was good, the attacks disappeared during the first course of treatment of 2 months. In 11 cases, the response was Fair while in 7 cases there was no response.^[70]

Justicia adhatoda Linn.

Family: Acanthaceae

Tamil name: Adhathodai

Part used: Flowers, root bark

Chemical constituents: Alkaloids: The chief alkaloid vasicine is reported in all parts of the plant, highest being in inflorescence.⁵ Vasicine, a quinazoline alkaloid, is the major alkaloid. The leaves also contain vasicinone, 7-methoxyvasicinone, vasicinol, adhatodine, adhatonine, adhava sinone, anistone, 3-hydroxyanisotine, desmethoxyaniflorine, vasicoline and vasicolinone.^[77] The root contains vasicinol, vasicinolone, vasicinone, adhatonine and vasicol.^[78,79] Phytosterol and triterpenes: Dauco sterol, α -amyrine and epitaraxerol.^[80] Flavanoids: Apigenin, astragalin, kaempferol, quercetin, vitexin, isovitexin, violanthin, 2''-O-xylosylvitexin, rhamnosylvitexin, 2'-hydroxy-4-glucosyloxychalcone are present in the leaf and flower.^[81] Both leaves and flowers contained the flavones, luteolin.^[82] Essential oil: The flower volatile oil contains a ketone identified as 4-heptanone as the major compound, together with at least 36 other components including 3-methylheptanone.^[81] Fatty acids and hydrocarbons: The leaf oil is a complex mixture of over 50 compounds, the major component being decane, together with the hydroxyalkanes 37-hydroxyhexatetracont-1-en-15-one and 29-methyltriacontan-1-ol and linolenic, arachidonic, linoleic, palmitic and oleic acids.^[83] The petroleum ether extract of the flowers contained a number of non-nitrogenous compounds viz., triacontane, β -sitosterol-D-glucoside; the ether extract yielded kaempferol and quercetin; the ethyl acetate and n-butanol extracts afforded kaempferol-3-B-D-glucoside and kaempferol-3-sophoroside.^[84] The young inflorescence yielded (\pm)-vasicinone.^[85] Flowers in addition yielded a fat containing traces of tridecanoic and pentadecanoic acids and a new glucoside identified as 2, 4-dihydroxychalcone 4-glucoside.^[81] The structure of vasicinol isolated from the root was established as 6-hydroxypeganine.^[86] The mass fragmentation of the alkaloids vasicine, vasicinol as well as its methyl ether was also studied.^[87] The other alkaloids isolated were 9-acetamido-3,4-dihydroperido-(3,4-b)-indole, O-ethyl- α -D-galactoside, 1,2,3,9-tetrahydropyrrolo(2,1-b)quinazolin-9 (IH)-one, sitosterol B-D-glucoside, D-galactose and deoxyvasicinone.⁸⁸ Vasicol (1,2,3,4,9,11-hexahydropyrrolo (2,1-b)quinazolin-3,11-diol), vasiinone, adhatonine and vasicinolone.^[89] The total and reducing sugars present in the root and the bark were also estimated. The leaves had good amount of raffinose and glucose, while the root had xylose. Besides sugars, vitamin B and C were found in the leaves and root, while the bark contained only vitamin C.^[90] The root showed the presence of saponins, while the leaves had alkaloids and glycosides.^[91]

Clinical studies: *A. zeylanica* is one of the constituents of a herbomineral preparation 'svasa kuthararasa' and an Ayurvedic preparation 'shreeshadi kashaya' (*Albizia lebbek*, *Solanum xanthocarpum*, *Glycyrrhiza glabra* and *A. zeylanica*) which have been reported to be useful

in patients suffering from bronchial asthma in study at S.S.Hospital, Banaras Hindu University, Varanasi.^[92]

Pharmacological studies

Antitussive activity: The antitussive activity of the plant was evaluated in anaesthetised guinea pigs and rabbits and in unanaesthetized guinea pigs. When administered intravenously, the extract was 1/20-1/40 as active as codeine on mechanically and electrically-induced coughing in rabbits and guinea pigs. On oral administration to the guinea pigs, the antitussive activity of the extract was similar to codeine against coughing induced by irritant aerosols.^[93]

Expectorant activity: The petroleum ether extract of the leaves 50 mg/kg bw i.p. and i.v was given after atropinization in rabbits. The expectorant action of the petroleum ether extract was compared with that of ammonium chloride and eucalyptol. Of the three, only the petroleum ether extract showed any stimulation of respiratory tract fluid. The comparative increase in the production of RTF by two standard respiratory stimulants and 'vasaka' was found to be ammonium chloride (0.4g/kg bw) 47 percent; eucalyptol (0.184g/kg bw) 36 percent and petroleum ether extract 78.5 percent, respectively.^[94]

Bronchodilatory and antiasthmatic activity: Vasicine showed bronchodilatory activity in both in vivo and in vitro experimental studies, its activity being comparable to theophylline. However, vasicinone showed bronchodilatory activity in vitro and bronchoconstriction in invivo studies. The two alkaloids in combination showed more bronchodilatory activity both in vivo and in vitro.^[95] Vasicinone isolated from the leaves had a bronchodilator action on the normal lungs and powerful bronchodilator action against the histamine induced bronchoconstriction in guinea pig's lungs and tracheal chain, but its action was weaker than that of adrenaline. l-vasicinone, was, however, stronger in action than the dl-form. Vasicinone produced a slight and transient fall in the blood pressure of dog. On isolated perfused hearts of guinea pig and rabbit, vasicinone had a positive inotropic action and increased the flow in the coronary vessels. Both l-and dl-forms of vasicine displayed a bronchoconstrictor action, had a negative inotropic action on heart and also reduced the flow in the coronary vessels.⁹⁶ Vasicinone was found to have a potent bronchodilatory activity in both in vitro and in vivo studies. In isolated tracheal chain of guinea pig, vasicinone (100-800 µg/ml) produced a dose dependent relaxation of tracheal smooth muscles. The bronchoconstrictions induced by histamine and carbachol were also inhibited by vasicinone (2.5 to 20 mg/kg i.v). It was as

potent as theophylline while 4-5 thousand times less potent than isoprenaline. At effective bronchodilator concentrations vasicinone showed very weak cardiac stimulant action. Vasicinone in small doses (25 or 50 µg/ml) markedly potentiated the effects of isoprenaline. The additive effect of vasicinone and theophylline and marked potentiation of isoprenaline effects suggested that it may be acting like phosphodiesterase (PDE) inhibitor. It possessed antianaphylactic activity in both in vitro and in vivo studies in rats as was evidenced by its inhibitory activity on the release of histamine.^[97] On comparing with vasicine, it was found that vasicinone was a bronchodilator, weak cardiac stimulant and a potent antianaphylactic agent while vasicine was a bronchoconstrictor, cardiac depressant and devoid of antianaphylactic activity. The study also revealed that a minor change in the structure of vasicine induced vast changes in its pharmacological properties.^[98] The bronchodilator activity of pure samples of vasicinone was investigated and compared with those of isoprenaline and aminophylline. Acute toxicity in mice and absorption pattern in dogs of the aqueous solution administered by different routes confirmed the bronchodilator activity and safety of vasicinone. A combination of vasicinone with aminophylline might prove useful as indicated by its additive effect on bronchodilator activity.^[99] Adhatoda vasica reduced ovalbumin and PAF-induced allergic reactions. A fraction containing the minor alkaloid vasicinol and about 20% vasicine inhibited ovalbumin-induced allergic reactions by about 37% at a concentration of 5 mg.^[100]

Antibacterial activity: A methanolic extract of the leaves was investigated for antibacterial activity using the paper disc and dilution methods. The in vitro screening showed a strong activity of the alkaloid fraction against *Pseudomonas aeruginosa* (MIC=164 µg/ml). Significant antibacterial activity against the Gram-positive bacteria *Streptococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis* and the Gram-negative *E. coli* was also noted.^[101]

Antioxidant and anti microbial activity: In the present study antioxidant and antimicrobial activity of aqueous and methanolic extracts of *Adhatoda vasica* were evaluated against the bacteria isolated from the sputum samples of asthmatic patients. From antioxidant study the Assay of superoxide Dismutase activity was observed to maximum in methanolic extract as compared to aqueous extract of *Adhatoda vasica*. Among the two extracts of *Adhatoda vasica*, the highest activity of catalase was observed in aqueous extract and lowest activity in methanolic extract. *Adhatoda vasica* showed a broad spectrum of antibacterial activities against Gram-positive (*Staphylococcus aureus* and *Streptococcus pneumoniae*) bacterial

species in comparison to the Gram-negative (*E. coli* and *Klebsiella pneumoniae*) bacterial species. On the basis of the results obtained in the present study, we concluded that the aqueous and methanolic extract of *Adhatoda vasica* has significant amounts of anti oxidants and anti microbial agents.^[102]

The alkaloids, vasicine and vasicinone are reported to have smooth muscle relaxant action. Some unknown alkaloids present in the plant showed significant protection against allergen induced bronchial obstruction in guineapigs.(10mg/ml aerosol).^[5]

***Piper nigrum* Linn.**

Family: Piperaceae

Tamil name: Milagu

Part used: Fruits

Chemical constituents: Volatile oil: The dried fruits contain 1.2-2.6% of volatile oil mainly composed of sabinene (15-25%), Caryophyllene, α -pinene, β -pinene, β -ocimene, **delta**-cadinol, guaiacol, 1-phellandrene, 1,8 cineole, p-cymene, carvone, citronellol, α -thujene, α -terpinene, bisabolene, dl-limonene, dihydrocarveol, camphene and piperonal.^[103] Alkaloids and amides: These are the main pungent principles and include piperine, piperlylin, piperolein A and B, Cumaperine, piperanine, piperamides, pipericide, guineensine and sarmentine. Other alkaloids include Chavicine, piperidine and piperettine, methyl caffeic acid, piperidide, β -methyl pyrroline, and a series of vinyl homologues of piperine and their stereoisomers.^[104]

Aminoacids: The dried fruits are rich in β -alanine, arginine, serine, threonine, histidine, lysine, cystine, asparagines and glutamic acid in combination with γ -aminobutyric acid and pipercolic acid.^[70]

Miscellaneous compounds: Eugenol, methyl eugenol, myristicin, safrole, benzaldehyde, trans-anethole, piperonal, m-methyl aceto-phenone, p- methyl acetophenone, n-butyrophenone, benzoic acid, phenyl acetic acid, cinnamic acid and piperonic acid are some of the aromatic compounds characterized in pepper oil. Methyl heptanoate, methyl octanoate, 2-undecanone, n-nonane, n-tridecane, n-nonadecane and piperidine are the other compounds identified.¹⁰⁵

Antioxidant activity: Studied the antioxidant efficacy of black pepper and piperine in rats with high-fat diet-induced oxidative stress. Thirty male rats (95-115g) were divided into five groups. They were fed standard pellet diet, high-fat diet (20% coconut oil, 2% cholesterol and

0.125% bile salts), high-fat diet plus black pepper (0.25 g or 0.5g/kg body weight) or high fat diet plus piperine (0.02g/kg body weight) for a period of 10 weeks. Significantly elevated levels of thio-barbituric acid reactive substances (TBARS), conjugated dienes (CD) and significantly lowered activities of superoxide dismutase (SOD), Catalase (CAT), Glutathione peroxidase (GPx), glutathione-s-transferase (GST) in the liver, heart, kidney, intestine and aorta were observed in rats fed the high-fat diet as compared with the control rats. Simultaneous supplementation with black pepper or piperine lowered TBARS and CD levels and maintained SOD, CAT, GPx, GST and GSH levels to near those of the control rats. The data indicate that supplementation with black pepper or the active principle of black pepper, piperine, can reduce high-fat-diet-induced oxidative stress.^[106] Pepper is rich in phenolicamides and possess antioxidant effects that are more potent than α -tocopherol and equivalent to the synthetic antioxidants butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT).^[107]

Anti-inflammatory activity: Piperine exhibited activity by depressing both the acute inflammatory process and chronic granulative changes using carrageenan-induced rat paw oedema, cotton pellet and croton oil-induced granuloma pouch models. It was through the stimulation of the pituitary adrenal axis.^[108]

Antimicrobial activity: Black pepper extracts inhibited aflatoxin production, via the β -glucuronidase reporter gene under the control of the aflatoxin biosynthesis gene promoter in the fungus *Aspergillus parasiticus*.^[109] Using the agar diffusion method, both the ethanol and aqueous extracts of the dried fruits were found to have significant activity against a penicillin G-resistant strain of *Staphylococcus aureus*.^[110] An extract was toxic to the culture of *Escherichia coli*, *Staphylococcus faecalis*, *Staph. aureus*, *Staph. albus*, *Corynebacterium diphtheriae*, *Salmonella dysenteriae* and *S. sonnei*.^[111]

The volatile oil also exhibited a high degree of antimicrobial activity against various types of organisms including animal pathogens, organisms involved in food poisoning and other spoilage bacteria and fungi.^[112] Piperine showed mild to moderate antibacterial activity against selected Gram positive and Gram negative bacteria.^[113]

Bio-enhancing ability: The effect of piperine on the bioavailability and pharmacokinetics of propranolol and theophylline has been examined clinically.^[114]

Woodfordia fruticosa kurz

Family: Lythraceae

Tamil: Kattathippoo

Parts used: Flowers

Chemical constituents: Tannins: The flowers contain the hydrolysable tannins oenothain A and B, woodfordins A-I and isoschimawalin A.^[115] Flavanones and anthocyanins. The flowers contain pelargonidin-3,5, diglucoside, and the leaves contain numerous Quercetin and myricetin glycosides.^[116]

Phytosterols and hydrocarbons: The flowers contain octacosanol and β -sitosterol.^[117]

Anthraquinone: Chrysphanol-8-O- β -D-glucopyranoside has been isolated from the flowers.^[117] Polyphenol, epigallocatechin gallate.^[118] Ellagic acid, naringenin 7-glucoside kaempferol-3-glucoside, hecogenin, mesoinositol, norbergenin.^[119]

Pharmacology

Anti-inflammatory and antipyretic activity: A water extract of the flowers exhibited anti-inflammatory activity against cotton pellet-induced granuloma in rats. Tissue granuloma formation was prevented but no effect on adrenal ascorbic acid was observed. The ethanolic extract also showed significant anti-inflammatory and antipyretic activity, at a dose of 500 mg/kg.^[120]

Immunomodulatory activity: The contribution of *Woodfordia fruticosa* flowers to the immunomodulatory activity of the Ayurvedic drug Nimba arishta was investigated and the preparation was found to inhibit both human complement activity and chemiluminescence generated by Zymosan-stimulated human polymorphonuclear leucocytes. It was established that the increased biological activity was not due to microbial interference, but to immunoactive constituents released from the *Woodfordia* flowers.^[121]

Piper longum Linn.

Family: Piperaceae

Tamil name: Arisi thippili

Part used: Fruit

Chemical constituents: Alkaloids and amides: The fruit contains a large number of alkaloids and related compounds, the most abundant of which is piperine, together with methyl piperine, pipernonaline, piperettine, asarinine, pellitorine, piperundecalidine, piperlongumine,

piperlonguminine, retrofractamide A, pergumidiene, brachystamide-B, a dimer of desmethoxy piperlonguminine, N- isobutyl-decadienamide, brachyamide-A, brachystine, piperlonguminine, piperderidine, longamide, dehydropiperlonguminine piperidine and tetrahydropiperine.^[122] Methyl-3,4,5 trimethoxycinnamate.^[123]

Lignans: Sesamin, pulvatiol, fargesin and others have been isolated from the fruits.^[124]

Esters: The fruits contain tridecyl-dihydro-p-coumarate, eicosanyl-(E)-P-coumarate and Z-12-octadecenoic-glycerol-monoester.^[125]

Volatile oil: The essential oil of the fruit is a complex mixture, the three major components of which are (excluding the volatile piperine) carryophyllene and pentadecane (both about 17.8%) and bisabolone (11%). Others include thujone, terpinolene, zingiberone, p-cymene, p-methoxyacetophenone and dihydrocarveol.^[126]

Essential oil consisting of n-hexadecane, n-heptadecane, n-octadecane, n-nonadecane, n-sicosane, n-hencosane. L tyrosine, L cysteine hydrochloride DL serine, L-aspartic acid are free amino acids in fruits. Seeds contain sylvatine, diodesmin, palmitic, hexadecenoic, stearic, linoleic, oleic, linolenic higher saturated acids.^[127]

Pharmacological activity

Immunomodulatory activity: Tests such as haemagglutination titre (HA), macrophage migration index (MMI) and phagocytic index (PI) in mice have demonstrated the immunomodulatory action of Piper longum fruits to be both specific and non specific. The effect was more prominent at lower doses (225 mg/kg) and was marginally reduced when the dose was increased.¹²⁸ In another study, it was found to offer protection against externally induced stress.¹²⁹ Extract of Piper longum and piperine was found to increase the circulating antibody titre and antibody forming cells indicating its stimulatory effect on humoral arm of immune system. Administration of this drug could also significantly inhibit the growth of solid tumour induced by Dalton's lymphoma ascites cells and Ehrlich ascites carcinoma cells. Immunomodulatory activity of P. longum and piperine may be due to the combined action of humoral and cell-mediated immune responses. Immunomodulation by piperine may be clearly attributed to its multi faceted activities such as anti-oxidative, anti-apoptotic and restorative ability against cell proliferative mitogenic response, splenic B- and T-cell population and cytokine release. Immunoregulatory potential of P. longum and piperinic acid, one of its active constituent, in Balb/C mice (in vivo) and human PBMCs (in vitro) models was also observed. Piperinic acid moderated the proinflammatory mediators and cytokines. At doses of 10, 20, 40 and 80 mg/kg p.o. PL showed a dose dependent decrease of lymphocytes

(CD4 + and CD8+T-cells) and cytokine levels in sensitized Balb/C mice with a marked inhibition at 40 mg/kg. At an in vitro doses of 20 µg/ml of PL and 5µg/ml of piperinic acid, there was asignificant inhibition of mitogen induced human PBMC proliferation, Mrna transcripts of IL-2 (Con A) and TNFα, IL-1β and Inos(LPS) respectively under stimulated conditions in time dependent (6 h,12h and 24h respectively) expression studies.In parallel, induced nitric oxide production was also reduced by stimulated macrophages.^[70]

Antiasthmatic activity

Studies have been carried out to validate the traditional claims of Ayurveda for antiasthmatic activity of Piper longum.An extract of the fruits in milk reduced passive cutaneous anaphylaxis in rats and protected guinea pigs against antigen-induced bronchospasm.^[130]

Anti-inflammatory activity

A marked antiinflammtory activity of a decoction of P.longum fruits has been reported using carrageenan-induced rat oedema.^[131]

Antibacterial activity

The essential oil of P.longum showed antibacterial action against a number of bacterial strains.^[131,132] *Piper longuminine* was found to have potent activity against *Bacillus subtilis* while piperine was more effective against *Staphylococcus aureus*.^[133]

Bioavailability enhancement

Piperine has been shown to enhance the bio-availability of structurally and therapeutically diverse drugs, possibly by modulating membrane dynamics, due to its easy partitioning and increasing permeability.^[134] The effect of Trikatu a compound Ayurvedic preparation containing Piper longum as one of the major ingredients, was tested in combination with other drugs.The study reported that Trikatu increased their bio-availability either by promoting rapid absorption from the gastrointestinal tract or by protecting the drug from being metabolized during its first passage through the liver after being absorbed, or by combination of both mechanisms.^[135]

The fruits proved to be very effective in childhood Asthma, the total dose for a child under five years being 9.35 g and for a child over five years being 15.75 g over a period of five years.^[136]

Curcuma longa Linn.

Family:Zingiberaceae

Tamil name:Karimanjal

Part used: Finger Rhizome

Chemical constituents: Phenylpropanoids:Curcumin,the main active principle, is present as 2-5% dry weight in the rhizome.Curcumenone, curcumenone, bis-desmethoxycurcumin, bis-(para-hydroxy-cinnamoyl) methane, L- α -curcumenone, cyclocurcumin, curcumenol, curdione, curzerenone, dehydroturmerone, dihydrocurcumin, eugenol, turmerin, turmerone, turmeronol and others are present.^[137] Monoterpenes:More than 20 components have been identified from the leaf oil of *Curcuma longa*,of which the major monoterpenes are α -phellandrene, 1,8-cineole, p-cymene and β -pinene.^[138] Others are α -terpinene, γ -terpinene and terpinolene.^[70] Glycans:Ukonans A, B,C and D Sesquiterpenes: Zingiberene, bisabolol, germacrone, sabinene and others.^[138,139] Arabinose, ascorbic acid, α and γ -atlantone, ortho and p-coumaric acid, phytosterols.^[137]Curcumin (diferuloylmethane) comprises Curcumin I (curcumin), Curcumin II (demethoxycurcumin) and Curcumin III (bisdemethoxycurcumin).^[114,140] The essential oil 5.8% obtained by steam distillation of rhizome has α -phellandrene 1%, sabinene 0.6%, cineol 1%, borneol 0.5%, zingiberene 25% and sesquiterpenes 53%.Two new sesquiterpene ketoalcohols-turmeronol A and turmeronol B-have also been reported from the dried rhizome .Five sesquiterpenes, e.g germacrone-13-al, 4-hydroxybisabolol-2, 10-diene-9-one,4-methoxy-5-hydroxybisabolol-2, 10-diene -9-one,2-5- dihydroxybisabolol-3,10-diene and procurcumadiol, have been isolated and identified by NMR(H andC) spectroscopy. The study indicates more of bisabolene-type sesquiterpenes in turmeric.^[141,142]

Antioxidant activity: Various extracts of the rhizome are active as antioxidants and the curcuminoids are the main active compounds.^[137] Curcumin was the most potent when tested against air oxidation of linoleic acid and showed better activity than dl-alpha-tocopherol at the same concentration.^[143] Another antioxidant principle is a heat-stable protein isolated from the water extract; it has an approximate molecular weight of 24000 Da.^[144] Three curcuminoids from turmeric, namely curcumin, demethoxy curcumin and bisdemethoxycurcumin, were found to protect PC 12 rat pheochromocytoma and normal human umbilical vein endothelial cells from beta-amyloid (1-42) insult, as measured by the 3-(4,5-dimethylthiazole-2-yl)-2,5-diphenyltetrazolium bromide reduction assay.^[145] Oxidative stress induced by beta-amyloid is a well-established pathway of neuronal cell death in Alzheimer's disease.^[70] -Curcumin has also been most abundant and most active antioxidant

in the methanolic extract of turmeric. Its antioxidant activity is found to be stronger than vit E & Tocopherol and is about the same as the synthetic antioxidants, Butylated hydroxyanisole(BHA) and Butylated hydroxytoluene(BHT)-Central Food technological research Institute, Mysore has isolated a water soluble peptide (0.1% of dry wt) from turmeric having antioxidant activity.^[146] An invitro study on the comparison of the antioxidant activity of curcuminoids and tetrahydrocurcumin using rabbit erythrocyte membrane showed highest activity with tetrahydrocurcumin.^[147] The three forms of the pigment have dual prolonged antioxidant activity, e.g. preventing the formation of free radicals, as well as intervening in their propagation . In fact, the antioxidant activity has been attributed to its unique conjugated structure, which includes two methoxy phenols and an enol form of β -diketone, with the typical radical trapping ability as a chain breaking antioxidant.¹⁴⁸

Anti spasmodic activity: Curcumin exhibited antispasmodic action.^[149] Ukonans A,B,C and D, glycans isolated rom a hot water extract of *c.longa*, exhibited reticuloendothelial system-potentiating activity in a carbon clearance test.^[150] Another immunostimulant polysaccharide, similar to bacterial lipopolysaccharide, has also been isolated.^[151]

Antiasthmatic activity: Oral administration of the volatile oil was found to be clinically effective in cases of bronchial asthma.^[152] A protective effect by curcumin (200 mg/kg for 7 days) on rat lung, against toxicity induced by cyclophosphamide, has been observed.^[153]

Antimicrobial activity: The essential oil showed activity against Gram-negative bacteria and pathogenic fungi at a dilution of 1: 32.^[154] The alcocholic extract and curcumin inhibited the growth of Gram-positive bacteria in several in vitro studies.Curcumin at concentrations of 2.5-50.0 mg/100ml inhibited in vitro growth of *Staphylococcus aureus*.^[155] Methicillin-resistant *Staphylococcus aureus* (MRSA) has been emerging worldwide as one of the most important hospital and community pathogens. The present study investigated the antimicrobial activity of ethyl acetate, methanol and water extracts of *Curcuma longa* L. (*C. longa*) against MRSA. The ethyl acetate extract of *C. longa* demonstrated a higher antibacterial activity than the methanol extract or water extract. Since the ethyl acetate extract was more active than the other extracts, the study examined whether the ethyl acetate extract could restore the antibacterial activity of beta-lactams and alter the MRSA invasion of human mucosal fibroblasts (HMFs). In the checkerboard test, the ethyl acetate extract of *C. longa* markedly lowered the MICs of ampicillin and oxacillin against MRSA. In the bacterial invasion assay, MRSA intracellular invasion was significantly decreased in the presence of

0.125-2 mg/mL of *C. longa* extract compared with the control group. These results suggest that the ethyl acetate extract of *C. longa* may have antibacterial activity and the potential to restore the effectiveness of beta-lactams against MRSA, and inhibit the MRSA invasion of HMFs.^[156] The study suggests that essential oil fraction from turmeric possesses significant ($P < 0.001$) antibacterial activity at very low concentration (20 µg/disc) on pathogenic Gram-positive *S. aureus* (CI) bacteria.^[157]

Turmeric in respiratory diseases: Turmeric is anti-inflammatory and anti-purulent in nature. It is reported that volatile oil of turmeric as oral drug in a clinical trial was found very effective in the treatment of bronchial asthma. Fresh rhizome proved effective against whooping cough and other coughs and in dyspnea. In catarrh and coryza, the inhalation of burning turmeric fumes causes copious mucous discharge and gives instant relief. The root, parched and powdered, is given in bronchitis. A report of clinical trials in respiratory diseases such as bronchial asthma, bronchitis, bronchiectasis, and tropical eosinophilia revealed that turmeric could play a vital role as an adjuvant in improving the airway resistance. Anti-asthmatic property of Curcumin had been tested in guinea pig model.^[158]

Anti-inflammatory activity: Anti-inflammatory activity has been exhibited by several fractions.^[159] In carrageenan-induced rat paw oedema, the volatile oil at a dose of 1.6 ml/kg exhibited activity comparable to that of phenylbutazone at 100 mg/kg.^[160] Isolated curcumin also showed significant activity in carrageenan-induced rat paw oedema, equivalent to phenylbutazone; however, it was only half as potent in chronic models.^[161] Clinically, patients suffering from rheumatoid arthritis were subjected to a short-term double-blind trial where curcumin was compared with phenylbutazone. A significant improvement in symptoms was observed with curcumin, although phenylbutazone was more potent, probably because it also has analgesic action.^[162] In a postoperative inflammation model for evaluating anti-inflammatory activity, curcumin was found to have greater activity than phenylbutazone or placebo in a double blind clinical trial.^[162]

Turmeric possesses anti-inflammatory property comparable to Aspirin, Ibuprofen, etc. A vanishing cream-base prepared with turmeric and red sandal wood (*Pterocarpus santalinus* Linn) showed anti-inflammatory activity by inhibiting 95.46% carrageenan induced hind paw oedema in rats. In experimental animals, petroleum ether extract of the rhizome showed significant anti-inflammatory activity without producing any toxicity or side effects. The activity of the extract has been attributed to curcumin and its analogues. Curcumin in vivo

animal models acts as an anti-inflammatory by inhibiting 5-lipoxygenase activity in rat peritoneal neutrophils as well as the 12 lipogenase and cyclo oxygenase activities in human platelets. It is found effective in both acute and chronic models of inflammation and its potency is approximately equal to phenylbutazone. Curcumin also potentiates the anti-inflammatory and analgesic activities of drugs in rats. The anti-inflammatory activity of curcumin analogue, feruloyl 4-hydroxy cinnamoyl methane (FHM) is found to be more than that of sodium curcumenate and phenylbutazone.^[163] Turmeric fried ground and given with milk, proved efficacious in patients suffering from cough and dyspnoea.^[164]

Costus speciosus (koen.)

Family: Costaceae

Tamil name: Kostum

Part used: Root

Chemical constituents: The rhizome contain tigogenin, tetradecyl -13-methylpentadecanoate, tetradecyl 11-methyltridecanoate and 14 oxotricosanoic, 14-oxoheptacosanoic, 15-oxo octacosanoic and triacontanoic acids, triacontanol, sitosterol, 5 α stigmasterol-9(11)-en-3 β -ol, curcumin, 24-hydroxyhentriacontan-27-one, 24-hydroxytriacontan-26-one, 8-hydroxytriacontan 25 -one, methyltriacontanoate, 31-norcycloartanone, methyl triotriacontanoate, acetates of cycloartanyl, cycloartenyl and cycloaudenyl and a mixture of 4 alkaloids. The alkaloids show papaverine like smooth muscle relaxant activity cardiotonic activity like that of digitalis and antispasmodic, CNS depressant, diuretic and hydrocholeretic activities. A mixture of saponins from rhizomes show significant anti-inflammatory activity.^[170] The rhizome showed presence of two growth inhibitory substances abscisic acid and bis(2-ethylhexyl) phthalate.^[171] Curcumin was extracted from the rhizome and yield estimated as 3.21 percent based on a colorimetric method.^[172] β -Sitosterol- β -D-glucoside, prosapogenin B of dioscin, prosapogenin A of dioscin, dioscin, gracillin.^[173] In a preliminary screening the rhizome showed the presence of alkaloids and saponins and absence of alkaloids and flavanoids.^[174,175]

Pharmacology

Anti-inflammatory activity: The total saponin mixture obtained from the rhizome exhibited significant anti-inflammatory activity against carrageenan-, formalin-, croton oil-, cotton pellet- and pleural exudation-induced inflammation in rats at 10 mg/100 g bw. The activity was comparable to betamethasone (25 μ g/100 g bw).^[176] In another study, the aqueous

solution of alkaloid mixture obtained from 95 percent ethanoic extract of rhizome at a dose of 10 mg/kg i.p. did not show anti-inflammatory activity against carrageenan-and turpentine-induced inflammation.^[177] The ethanolic extract of the rhizome of *Costus speciosus* possesses anti inflammatory property, which was studied in carrageenan induced paw oedema and cotton pellet induced granuloma formation. Significant anti inflammatory effect was found against carrageenan induced oedema formation in rats at a dose of 800mg/kg and against cotton pellet granuloma formation in rats at doses of 400 mg/kg and 800mg/kg.^[178]

Spasmolytic activity: The aqueous solution of the mixture of alkaloids isolated from 95 percent ethanolic extract of rhizome showed a non-specific spasmolytic activity against the different spasmogens in isolated ileum of rabbit, guinea pig, rat and tracheal chain of dog. Dihydroergotamine and propranolol were used as to compare the effects of alkaloids. The mixture of alkaloids also decreased the rhythmic contractions of isolated muteri of rat ang guinea pig at 0.2-2 mg/ml.^[177]

Anti-oxidant activity: Nehate *et al* 2010 has tried to evaluate in vitro antioxidant activity of different extracts of this plant by DPPH scavenging activity total antioxidant capacity, nitroxide scavenging activity, ion chelating activity, hydroxyl radical scavenging activity and its correlation with total phenolic content. Among all the extracts analysed, a significant phenolic content and antioxidant activity were found for benzene extract which predicted that the antioxidant activity may be due to the total phenolic content in the plant.^[179]

Costus speciosus has an antioxidant activity which may be due to plant derived antioxidant such as tannins, lignans, stilbanes, coumarins. Quinines, xanthones, phenolic acid, flavones, Flavanones, catechins, anthocyanins and protection for living organism from damage caused by controlled production of reactive oxygen specis and the concomitant lipid peroxidation, protein damage and Dna stand breeding.^[180]

Antibacterial activity: Antibacterial activity was studied by Ariharan *et al.*, 2012. Where high antibacterial activity of rhizome extract was seen against Gram positive (*Staphylococcus aureus*, *Staphylococcus epidermidis*) and Gram-ve bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*) which may be due to the presence of diosgenin, a precursor for the synthesis of steroidal hormones. This shows that the plant has disease resistance ability, which may be due to the presence of phenolics and alkaloid substances.^[181]

Tragia involucrata Linn

Family:Euphorbiaceae

Tamil name:Poonaikanchori

Part used:Root

Chemical constituents: Presence of various chemical constituents such as alkaloids, flavonoids, lipids, phenolic compounds, proteins, saponins and triterpenoids have been reported. Major components identified from volatile oil were 1-methoxypropane, (Z)-3-hexen-1-ol, 3-methoxyphenyl acetate, acetophenone, 4-vinylguaiacol, isophytol, and phytol. The major headspace components are ethylbenzene, o-xylene, limonene. *Tragia* saponins ABC and D, triterpens oligo glycosydes, together with beta vulgarosides and spinacosidec from fresh areal parts. Its leaves are known for being rich in kerotene and vitamine-A. Anthocyanins are glycosylate from anthocyanidins, all anthocyanidins are composed of 2 or 3 parts. The basic structure which is a glycon (anthocyanidine), sugars and remaining substances and frequently an acyl group. The most common order of sugar frequency is glucose rhamnose, xylose, galactose, arabinose and fructose. However in some cases anthocyanidine can be glycosylated. The glycosylation can occur in positions 3,5,7 as the most common once are linked to hydroxyls in positions 3 and 5 and the least common to hydroxyl. chromatography (TIC, HPLC) with beta cyanin standards. ^[182]

Pharmacology

Anti inflammatory activity: It was observed that the *root* extracts of *T.involucrata* had significantly inhibited carrageenan- induced paw oedema in rats. It may be assumed that the anti-inflammatory effect of these extracts might be due to their possible inhibition of lipoxygenase pathway. Carrageenan induced paw edema model in rats is known to be sensitive to cyclooxygenase inhibitors and has been used to evaluate the effect of nonsteroidal anti-inflammatory type of agents which primarily inhibit the enzyme cyclooxygenase in prostaglandin synthesis. Based on these reports it can be inferred that the inhibitory effect of *T.involucrata* extracts on carrageenan- induced inflammation in rats could be due to the inhibition of the enzyme cyclooxygenase leading to inhibition of prostaglandin synthesis. The root extracts of *T.involucrata* also exhibited analgesic activity in rodents. ^[183]

Antioxidant activity: For antioxidant studies aqueous ethanolic extract of *Tragia Involucrata* was administered orally for 28 days at a dose of 250 and 500mg/kg body wt to Streptozotocin-Nicotinamide induced wistar rats. All the animals were sacrificed on the 29 th day and the

levels of LPO, SOD, CAT, GPX and GSH in kidney and liver of control and experimental rats were studied. The aqueous ethanolic extract of *Tragia involucrata* exhibited significant antioxidant activity showing increased levels of superoxide dismutase, catalase, Glutathione peroxidase, reduced glutathione, and decreased level of lipid peroxidation.^[184]

Antibacterial activity

In vitro antibacterial properties of different compounds including vinyl hexylether, shellsol, 2-4 dimethyl hexane, 2-methylnonane and 2,6-dimethyl heptanes were isolated from the leaf of *Tragia involucrata* studied against *Escherichia coli*, *proteus vulgaris* and *Staphylococcus aureus* using the disc diffusion method at 50 µg/ml concentration. The compound vinyl hexylether showed a broad spectrum of activity. The highest activity was found in Shellsol(50µg/ml) against *Proteus vulgaris* and *Staphylococcus aureus*. Minimum inhibitory concentrations were determined for the effective compounds (MICS 2.5-40µg/ml) Shellsol and vinyl hexylether showed inhibitory action at the lowest dilution.(10µg/ml) than 2-methylnanone, Shellsol inhibited the growth of *Staphylococcus aureus* effectively than the other compounds. These compounds showed bacterial effects against all the tested bacteria (MBC, 12.25µg/ml).^[185]

Styrax benzoin Dryand

Family:Styraceae

Tamil name:Sambirani

Part used:Resin

Chemical constituents

Benzoic, cinmamic acid, benzyl benzoate, benzoic aldehyde, vanillin and coniferyl benzoate, pinoresinol, cinnamon acid ester, styrol, styracin, phenyl-propyl cinnamate benzaldehyde.

Pharmacology

Anti allergic activity: Suzuki and Shimada. 2006 studied and described that *Styrax benzoin* lowers production of IL4 by 58%, when used in a concentration of 33% microgram/ml, by T cells in the presence of antigen presenting cells (like allergens).^[186] Sumatra benzoin obtained from *styrax benzoin* is an ingredient of inhalations which are used in the treatment of the upper respiratory catarrh.^[187]

***Solanum surrattense* Burm. f**

Family :Solanaceae

Tamil name:Kandangathari

Part used:Whole plant

Chemical constituents: Steroidal alkaloid solasodine 0.2%, Steroidal alkaloids: solamargine, β -solamargine, sterols, cycloartenol, norcarpesterol, cholesterol and their derivatives. Flavones, phenolics and coumarins: Apigenin, scopoletin, esculetin, coumarin, methyl caffeate, caffeic acid.

Steroids and triterpenoids: carpesterol, campesterol, sitosterol, glycoartenol, stigmasterol, cholesterol, lupeol. Steroidal alkaloids, glycoalkaloids: solasodine, diosgenin, tomatidenol, α -solamargine. Fatty acids: Linoleic acid, oleic acid, stearic acid.^[188]

Pharmacology

Anti-inflammatory activity: The water extract of dried fruits of *Solanum xanthocarpum* Schrad and Wendl and dried pulp of *Cassia fistula* Linn was prepared. The anti-inflammatory activity of these extracts was investigated using the carragenan-induced paw edema model in rats individually and in two different combinations. ED₅₀ of both the extracts singly and in combination were calculated by dose-response curves, and this information was then plotted on the isobologram. The interaction index of the extracts was also investigated to determine whether both the extracts in combination show synergistic or antagonistic or additive effects. It was observed that extracts of dried fruits of *Solanum xanthocarpum* showed more anti-inflammatory activity than dried fruits of *Cassia fistula* Linn. Both the extracts showed maximum anti-inflammatory activity at 500 mg/kg dose. Among the different dose combinations of both the extracts, the 1:1 combination at the 500 mg/kg dose showed maximum percentage inhibition of 75%, which was comparable with the positive control, diclofenac sodium, which showed 81% inhibition.^[189]

Stigmasterol, carpesterol and diosgenin showed anti inflammatory effect. Lupeol in *S. xanthocarpum* also acted as multi target agent with immense anti inflammatory potential, targeting key molecular pathways, which involved nuclear factor kappa B, cFLIP, Fas, Kras, Phosphatidylinositol-3-kinase (P130)/Akt and Wnt/ β -catenin in a variety of cells. Lupeol at its effective therapeutic doses exhibited no toxicity to normal cells and tissues. Hence it may serve as a therapeutic and chemopreventive agent for treatment of inflammation.^[188]

Antiasthmatic properties: A pilot study on the clinical efficacy of SX and *Solanum trilobatum* in bronchial asthma were undertaken to prove the significant use of herbs in treatment of asthma. Major literature data supports use of whole plantst .Ethanol extract of SX shown a significant antihistaminic activity in histamine induced contraction in goat tracheal chain preparation. Thus, the significant inhibition of histamine induced contractions produced by ethanol extract of SX flower on isolated goat tracheal chain preparation indicates that the SX flower has antihistaminic (H1-receptor antagonist) action. While screening the all three extracts of flowers of SX, results were indicative that only ethanolic extract of SX at a dose of 50 and 100 mg / kg reduced milkinduced eosinophilia of statistical significance. SX at a dose of (50-100 mg/kg, i.p) showed significant mast cell stabilization as compared to standard drug Disodiumchromoglycate (DSCG).

Clinical study: SX is widely used by practitioners of the Siddha system of medicine in southern India to treat respiratory diseases . The powder of whole dried plant or a decoction is used for this purpose. Treatment with SX improved the pulmonary functions to a significant level in patients suffering from mild to moderate asthma. Subjective relief from asthmatic symptoms was reported by the patients an hour after administration of SX powder. The effect lasted for about 6–8 h. However, responses observed were apparently less when compared to that of deriphilline or salbutamol. A decrease in forced expiration volume and peak expiration flow rates are indicative of both large and small airway obstruction and muscle power. The dose of SX was well tolerated and no untoward effects were reported. SX is asafe medicine in the traditional system and has been used by mankind over many centuries. It was suggested that relief from the symptoms of bronchial asthma produced by SX may be due to:(a) a bronchodilator effect, (b) reduction in the bronchial mucosal edema, and/or (c) reduction in the secretions within the airway lumen.^[190]

Anti allergic activity: Apigenin has shown anti allergic effect of apigenin in ovalbumin induced asthma model mice.OVA-induced mice showed allergic airway reactions and included an increase in number of eosinophils in bronchoalveolar lavage (BAL) fluid,an increase in inflammatory cell infiltration into lung around blood vessels and airways,airway luminal narrowing, and development of airway hyperresponsiveness.Administration of apigenin before last airway OVA challenge resulted in a significant inhibition of all asthmatic reactions.^[188]

Clinical study: Preliminary clinical trials of the drug have shown significant improvement in some respiratory diseases like bronchial asthma and the beneficial effects could be through depletion of histamine level.^[191]

Solanum xanthocarpum and *Solanum trilobatum* increased FEV1 by 65% & 67% respectively at two hours but this effect was less than with conventional drugs. Subjective relief was reported after one hour and this effect was lasted 6-8 hours.^[192]

Solanum trilobatum Linn

Family: Solanaceae

Tamil name: Thoothuvalai

Part used: Leaf

Chemical constituents: The major glycol alkaloid present in the plant is β -salamarine. A crude glycol alkaloid mixture isolated from the plant material contained about 20% β solamarine. The plant gives highest yield of glyco alkaloid in summer (1.60%).^[165] The leaves contain rich amount of calcium, iron, phosphorus, carbohydrates, protein, fat, crude fibre and minerate.^[166]

Pharmacology

Antimicrobial activity: Aqueous methanol and n-butanol extracts of aerial parts of *S. trilobatum* were tested for antimicrobial activity by disc diffusion method. From the results, it was found that extracts from leaves, flowers, stem and fruits revealed antimicrobial activity against Gram positive and Gram negative bacteria. Maximal antibacterial activity was seen against *Klebsilla* with aqueous extract whereas methanol extract of stem showed maximal activity against *Staphylococcus aureus*. Minimum inhibitory concentration exhibited by *S. trilobatum* aqueous extracts against tested organisms ranged between 0.06-0.5mg/ml. Presence of tannins, saponins, flavanoids, phenolic compounds, cardioglycosides and carbohydrates indicates *Solanum trilobatum* is one of the potential medicinal plant for therapeutic use.^[168]

Anti inflammatory activity: The solasodine isolated from *Solanum trilobatum* exerted (5,30 and 75 mg/kg) statistically significant and dose dependent anti-inflammatory activity in carrageenan induced rat paw oedema which was similar to that of indomethacin 10 mg /kg a known anti-inflammatory agent.^[169]

Aqueous and alcoholic extracts of *Solanum trilobatum* exhibited inhibition of mast cell degranulation significantly decreased the release of IL1 and increased the release of IL 8 from the cultured keratinocytes. Oral administration of the aqueous and alcoholic extracts of *Solanum trilobatum* stabilized mast cells in experimental rats.^[193] *Solanum trilobatum* possesses antioxidant activity and hepatoprotective activity. The study has shown the immunomodulatory activity of anticancer plant, *Solanum trilobatum* by potentiating humoral as well as cellular immunity.^[194]

Clinical study: A clinical study was reported that oral administration of 300mg dry powder, thrice a day was found to be very effective in controlling mild and moderate bronchial asthma and moreover the bioactivity is equivalent to that of administration of 200 mg of deriphyllinecer plant, *Solanum trilobatum* by potentiating humoral as well as cellular immunity.^[194]

Ficus tsiela Roxb

Family: Moraceae

Tamil name: Ithippattai

Part used: Stem bark

Chemical constituents

Bioactive chemical constituents reported from bark of the *F.tsiela* include Lup-20(29)-en-3yl acetate, lupeol, Myristic acid, 1,3,4,5-tetra hydroxyl cyclo hexane carboxylic acid, stearic acid, phytol, sitosterol, lanosterol acetate. Preliminary phytochemical screening of *F.amplissima* bark extract of methanol showed the presence of phenolic compounds, alkaloids, flavanoids and tannins.^[195]

Pharmacology

Antibacterial activity: Both aqueous and ethanolic extracts of the bark were screened for antibacterial activity against *Ps aeruginosa*, *Ps testosterone*, *Staph epidermidis*, *Pr mirabilis*, *Pr vulgaris*, *Baccereus*, *citrobacter freundii*, *Ent aerogenes*, *Esch coli*, *Strept faecalis*, *Strept cremoris*, *Strept agalactiae*, *Alcaligenes faecalis*, *Salm typhimurium* and *Staph aureus*. The extracts were active against *Baccereus* and *Staph aureus*. In addition the ethanolic extract was also active against *Ps aeruginosa*, *Pr mirabilis*, *A.faecalis*, *Salm typhimurium*, *Ent aerogenes*, *Staph epidermis* and *Strept agalactiae*.^[196]

Antioxidant activity: *In-vitro* DPPH free radical scavenging activity of the methanolic extract of barks of Ficus Tsiela and Ficus tomentosa were compared with ascorbic acid, quercetin, flavones and rutin (standard used) was observed. At a concentration of 0.1 mg/ml the scavenging activity of the Ficus Tsiela reached 62.34%, Ficus tomentosa have 41.83% activity, while at the same concentration rutin have 44.39% activity. Absorbance of control was 0.603%. The results clearly indicate that extract of Ficus Tsiela having the higher radical scavenging capacity compared with the extract of Ficus tomentosa.^[197] There is a definite role of free radicals in the pathogenesis of wound, the antioxidant activity was also studied. The results for antioxidant potential of F. amplissima bark methanol extract indicate that it possesses potent antioxidant activity by inhibiting lipid peroxidation, reduced glutathione and SOD (10.78 ± 0.20) levels while increasing the CAT (253.12 ± 14.98) activity.

Anti-inflammatory activity: Methanol extract of F. amplissima bark registered profound antiinflammatory activity against cotton pellet-induced granuloma in the experimental rats. The extract exhibited a significant ($p < 0.01$) antiinflammatory effect in a dose dependant manner and the results were comparable to that of standard drug Indomethacin. The methanol extract at the dose of 200 mg kg⁻¹ showed maximum granuloma inhibition (69.37%) which is comparable to that of the standard drug Indomethacin (75.69%). Administration of F. amplissima bark methanol extract on egg albumin induced edema in rats caused a significant ($p < 0.001$) dose dependent anti-inflammatory effect against edema (5.13 ± 0.29). The anti-inflammatory effects are comparable to that of positive control i.e., indomethacin (10 mg kg⁻¹). The methanol extract at doses of 100 and 200 mg kg⁻¹ was capable reducing the oedema formation induced by egg albumin at 4 th h.^[197]

CONCLUSION

All the ingredients of Adhathodai chooranam are simple, effective and easily available herbs. This review distinctly exposes that all ingredients of Adhathodai chooranam have anti inflammatory, antihistaminic, antiasthmatic, antispasmodic, antimicrobial, expectorant, bronchodilator, immunomodulator and antioxidant activities. These properties play a major role in the treatment of Bronchial Asthma. Hence, it could be concluded that the Adhathodai chooranam is one of the best drug of choice for Asthmatic patients since it is scientifically validated.

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