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A comprehensive review on *Salacia oblonga*: Its bioactive compounds and therapeutic applications

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Abstract
Salacia oblonga, commonly known as Saptrangi, is a tropical evergreen plant native to Sri Lanka and widely distributed in Asia. Belonging to the Celastracea family, it has been used in traditional Ayurvedic medicine to manage inflammatory and metabolic disorders. The plant's bioactive chemicals, including salacinol and mangiferin, are concentrated in its roots, which exhibit extensive pharmacological activities. These include anti-diabetic, anti-hyperglycemic, anti-inflammatory, antimicrobial, and antioxidant properties. *Salacia oblonga* has shown potential in treating various diseases, such as diabetes, renal fibrosis, and cardiac hypertrophy. Its phytochemicals have beneficial effects on hepatic steatosis, postprandial hyperlipidemia, and nephroprotection. With its rich chemical composition and diverse pharmacological effects, *Salacia oblonga* is a valuable plant in the treatment of various metabolic and inflammatory disorders. Further research is needed to explore its therapeutic potential and develop effective treatments.

Keywords: *Salacia oblonga*, Saptrangi, Celastracea, Chemical constituents, Pharmacological activity

Introduction
The Indian traditional medicine system is dependent on Ayurveda, Siddha, Unani, and Homoeopathy. Over the past few decades, plants have been used for medicinal purposes. These plants are useful for treatment due to their chemical constituents. These phytochemicals are beneficial due to their physiological activities in the body. The *Salacia* genus is one of these plant genera that is useful due to its medicinal activities. There are around 407 species and around 108 genera of this genus. This genus consists of species like *Salacia oblonga*, *S. accedens*, *S. accuminatissima*, *S. adolphi-friderici*, *S. affinis*, *S. africana*, and *S. alata*, *S. alternifolia*, *S. alveolata*, *S. amazonica*, *S. acreana*, *S. brachypoda*, *S. brasiliensis*, *S. buddinghii*, *S. bullata*, *S. chinensis*, *S. chloratha*, *S. congolensis*, *S. chlorian*, *S.devredii*, *S. dewevrei*, *S. erecta*, *S. erythrocarpa*, *S. forsteniana*, *S. fredericqii*, *S. gracilis*, *S. grandiflora*, *S. hamputensis*, *S. hippocrateoides*, *S. induta*, *S. insignis*, *S. johannis-albrechti*, *S. juruana*, *S. kabweensis*, *S. kalahiensis*, *S. lucida*, *S. luebbertii*, *S. maburensis*, *S. macrantha*, *S. nitidissima*, *S. noronhioides*, *S.oblongifolia*, *S. obovata*, *S. pyriformioides*, *S. pyriformis*, *S. quadrangulata*, *S. racemosa*, *S. radula*, *S. sulfur*, *S. sylvestris*, *S. talbotii*, *S. tenuicula*, *S. unguiculata*, *S. uragoensis*, *S. vahliana*, *S. velutina*, *S. wrayi*, *S. wrightii*, *S. zenkeri*, *S. zeyherii*.[1]
Salacia oblonga Wall. Belonging to the Celastracea family. It was a traditional medicine from Ayurveda. This woody climbing plant is found in the Western Ghats, from Konkan southwards to Kerala's rainforest, in India and Sri Lanka. It contains yellow roots, ovoid leaves, orange to reddish fruits, and yellow-green flowers. This plant extract contains three active ingredients: salacinol, kotalanol, and mangiferin. [2,3]
This scrub remains green throughout the year and grows vertically up to 8m. Its leaves are elliptically oblong with sharp blades. The flowering season is between March and May, and the fruit grows between May and August.[4]

Vernacular names
- Latin - *Salacia oblonga*
- English- salacia
- India- saptrangi
- Sanskrit-vairi, pitika
- Tamil- ponkoranti, chundan
- Malayalam- ponkoranti, koranti

- Kannada- ekanayakam
- Telugu- anukudu cettu
- Sinhalese- himbutu, kothalahimbutu[1]

Taxonomical classification

- **Kingdom:** Plantae,
- **Phylum:** Magnoliophyta,
- **Class:** Magnoliopsida,
- **Order:** Celastrales,
- **Family:** Celastracea,
- **Genus:** Salacia,
- **Species:** *Salacia oblonga*[5]

Fig 1: *Salacia oblonga* [1]

Fig 2: Root of S. oblonga

Geographical distribution

This species is widely present in southern to western India. The *Salacia oblonga* is available in Indian states like Goa, Karnataka, Kerala, Maharashtra, and Tamil Nadu. This is mainly found in Sri Lankan regions like Fringing Forest, semi-evergreen forests, and Undergrowth Forest with a plateau border. This species is also found in Indonesia, China, Vietnam, Thailand, Malaysia and other Asian countries. This is also found in tropical and subtropical regions of North Africa, East Asia, and South America.[1,6,7]

Macroscopy and microscopy

Macroscopy

a. Stem

The stem of the *S. oblonga* is cylindrical in shape, with 23 to 34cm and 2 to 5 cm. The stem's surface can be divided into inner and outer parts. The inner surface is a pale yellowed colour with well-defined cambium rings. It is hard to break, and if broken, forms sharp, elongated pieces or splinters. The outer surface is ash-grey colored. Moss and lichen can be found on the outer surface. Fracture is fibrous. The maximum length can go up to 8m. [4,8]

b. Root

The root of the plant is also cylindrical, with 33 to 35cm and 7 to 9cm. Its surface can also be divided into two parts: Inner and outer. The inner surface colour ranges from pale yellow to pink. Fine lines, grooves, or ridges running parallel to the length of the surface can be found on the root, known as longitudinally striate. The fracture is hard. The outer surface is yellowish-brown in colour. If scraped, it is greenish yellow. The fracture is fibrous. The randomly placed lenticels can be found on a primary root. The texture of the root's outer surface is rough. [4,8]

c. Leaf

The young leaf is green, whereas the mature leaf is dark green. The leaf has an elliptic-oblong shape. The size of the leaf ranges from 7-12.5 x 2.5-3.6cm. The margin is serrate or entire. The leaf is placed at the opposite or sub-opposite petiole. The petiole length is 2.2cm.[4,6]

d. Flower

The inflorescence is an axial raceme. The flower is greenish-yellow in colour with a campanulate shape. The calyx lobe is orbicular ciliate. The disk is conical and pale green colored. Three stamens are present, which are inserted in the disk. Three-celled ovary is fixed into the disk.[4,6,9]

e. Fruit

The colour of the fruit changes from dark green to orange with maturity. The diameter is 2 - 5 cm, the highest among all the species. The fruit and its apex are shaped. The surface is smooth, rarely uneven or tuberculate. The mesocarp is white. The endocarp is mucilaginous. 2 - 8 seeds can be found in one fruit, which is angularly located. [4,6]

Microscopy

a. Stem

The sections of the stem are circular. The circumference comprises 4 to 7-layered, thick-walled, continuous rectangular cork cells. The cortex comprises 5 to 20 thin-walled, rectangular, or polygon parenchymatous cells. Most of these contain oval simple or 2 - 3-celled starch compounds. It includes circular or oval, thick-walled lignified simple stone cells. Irregular patches of phloem are found, and phloem fibres contain blunt ends. [8]

b. Root

The sections of the root are circular. The circumference comprises 2 to 3-layered, thick-walled, discontinuous rectangular cork cells. Up to 10-celled thin-walled, rectangular, or polygon parenchymatous cells make up the cortex. They are filled with oval, simple starch grains. The cortex is made up of uniformly distributed lignified simple stone cells. Phloem is widely spread with irregular patches; phloem fibres are blunt or pointed-ended with highly thick-walled, but very thin, narrow lumen.[8]

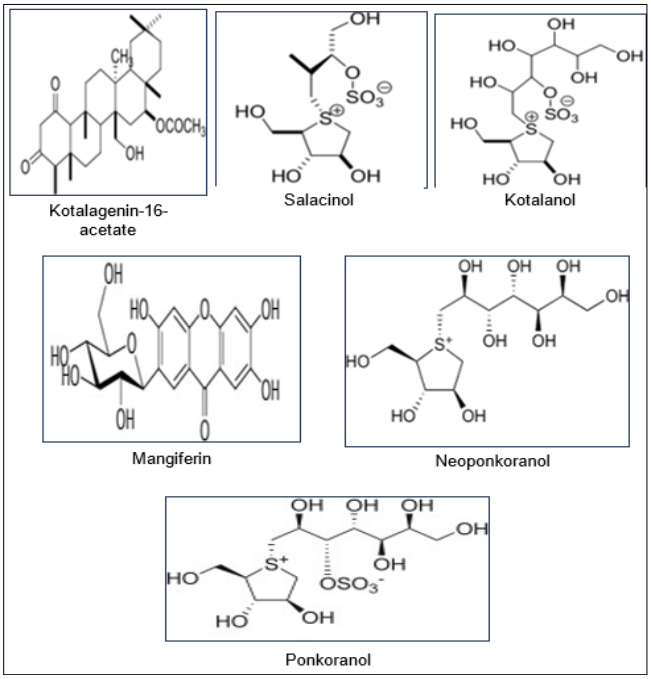

Fig 3: Chemical constituents [1,10]

Chemical constituents

Table 1: Chemical extracts and their pharmacological activity

Activity	Extract	Reference
Anti-diabetic	Aqueous, Aqueous methanolic, Isolated salacinol, kotalanol and mangiferin	[5]
Antihyperglycemic activity and cardiac fibrosis inhibition	Aqueous	
Postprandial glycemic, insulinemic, and breath hydrogen responses	480 mL of study beverage (14 g fat, 82 g carbohydrate, and 20 g protein) with SO extract.	
Postprandial hyperlipidemia in diabetes and obesity	Water extract from the root	
Hepatic steatosis in diabetes and obesity	Water extract from the root	
Inhibition of diabetic-induced renal fibrosis	Aqueous	
Anti-mutagenic and anti-oxidant	Rootbark extract	
Nephroprotective and antioxidant	Ethanol extract	
Hypolipidemic	Powder extract	
Anti-microbial	Root, stem, and leaf powder	
Anti-bacterial	Stem, leaves, and roots extracts	
Anti-inflammatory	Rootbark powder	
Hypoglycemic	Rootbark extract	
Anti-oxidant	Rootbark extract	
Antihypertriglyceridemic	Root extract	
Obesity and diabetes-associated cardiac hypertrophy	Aqueous extract	

Pharmacological activity

a. Antidiabetic activity

For antidiabetic activity, the methanolic air-dried root extract was used. This extract provides activity due to ingredients like salacinol and kotalanol. For this, female albino Wistar rats were used. This study was used for Type 2 DM. TIIDM was induced by intraperitoneal injection of 100mg nicotinamide in 0.9% NaCl, followed by 60mg/kg streptozotocin in sodium citrate buffer. To prevent hypoglycemia after feeding, a 10% dextrose solution was given after 1 hr. and 4 hr. After 72 hours, TIIDM was induced. This extract gives antidiabetic activity through two methods: α-glucoside and α-amylase inhibition. α-glucoside inhibition was found at a minimum dose of 50µg/ml, increasing if 100 - 250µg/ml was administered. α-Amylase inhibition activity is observed at 50 - 250µg/ml doses. No acute toxic activity was found even when a 2000mg/kg dose was used.[11]

b. Antihyperglycemic activity and cardiac fibrosis inhibition

For cardiac fibrosis inhibition activity, dried root material was used with three times hot aqueous extraction. For this study, lean and obese Zucker rats were used. After sacrificing the rat, the left ventricle was fixed with 10% formalin to induce cardiac fibrosis. When a 100mg/kg dose was given, it was observed that it helped in fibrosis by improving cardiac fibrosis via normalising excessive fibrosis, suppressing the overexpression of transforming growth factor (TGF)-β1 and TGF-β3 mRNAs, which are responsible for collagen synthesis and fibrosis development. It also helped with diabetic conditions by strongly suppressing α-glucosidase activity. This activity was due to mangiferin.[12]

c. Postprandial glycemic, insulinemic, and This activity was found due to the α-glucosidase inhibitory activity of the plant. When root extract was used. When root extract was given, it produced its α-glucosidase inhibition. For this, a 1000mg dose was given, and it reduced by around 25% postprandial glucose and serum insulin levels by around 35%. As α-glucosidase was inhibited, carbohydrate malabsorption led to an increase in breath hydrogen AUC of 0 - 480 min by 60% produced by unabsorbed carbohydrate fragments by colon bacteria. [13]

d. Postprandial hyperlipidemia in diabetes and obesity

An aqueous extract of the root of *Salacia oblonga* produces the postprandial anti-hyperlipidemic activity. To assess this activity, two types of Zucker rats were used: Zucker diabetic fatty (ZDF) rats and Zucker lean (ZL) rats. When a 100mg/kg dose was given to both rats, this extract reduced plasma triglyceride and total cholesterol (TC) levels, and increased plasma high-density lipoprotein levels in ZDF rats, but did not produce any activity in ZL. Thus, it helped to improve postprandial hyperlipidemia.[14]

e. Hepatic steatosis in diabetes and obesity

An aqueous extract of the root of *Salacia oblonga* produces the postprandial anti-hyperlipidemic activity. To assess this activity, two types of Zucker rats were used: Zucker diabetic fatty (ZDF) rats and Zucker lean (ZL) rats. When a 100mg/kg dose was given to both rats, this extract reduced the liver contents of triglyceride, non-esterified fatty acids (NEFA), and the ratio of fatty droplets to total tissue in ZDF rats. Still, it did not produce any activity in ZL. Thus, it helped to reduce hepatic steatosis in diabetics and obesity.[14]

f. Inhibition of diabetic-induced renal fibrosis

This activity was tested on Zucker diabetic fatty (ZDF) rats, and for this aqueous root extract was used. This extract was given orally at 100mg/kg for six weeks. This reduced salt-soluble, insoluble, and acid-soluble collagens' reabsorption and normalised blood urea nitrogen and hypoalbuminemia.

This extract contains mangiferin, which stimulates angiotensin II's proliferation and increases mRNA expression and activities of collagen I, collagen IV, fibronectin,
Angiotensin II type I receptors, transforming growth factor (TGF)—β1, and plasminogen activator inhibitor—1 reduce renal fibrosis.[15]

g. Anti-mutagenic activity
A hydrochloric extract of the root was taken to evaluate the antimutagenic activity. This experiment used a Wistar rat, which was divided into three groups.

- Group 1(control group): normal saline 0.5 ml/kg is given to control the condition.
- Group 2(challenge group): 2 mg/kg mitomycin-cis given orally, which causes toxicity in the testicular tissue and also causes sperm abnormalities.
- Group 3(treatment group): To treat that condition, *Salacia oblonga* is given orally, two doses are given 0.5 and 1 gm/kg dose for 7 days, and observation is taken 48 and 72 hours after providing the *Salacia oblonga* extract significant improvement in symptoms and decrease in testicular damage and improvement the sperm abnormalities.[16]

h. Nephroprotective activity
This activity was tested on rats. An ethanolic extract was used. Acetaminophen was administered to induce nephrotoxicity. Here, two different doses were administered: 250mg/kg and 500mg/kg. This restored glutathione levels, which were altered due to nephrotoxicity.[17]

i. Hypolipidemic activity
This activity was tested on female albino Wistar rats using powder extract. Aluminium chloride induced toxicity in rats. When the oral doses of 200mg/kg and 400mg/kg were given to check activity, day 14 of the study showed a significant decrease in levels of alkaline phosphate, aminotransferase, urea, bilirubin, and creatinine. No acute toxicity was observed.[18]

j. Antimicrobial activity
Parts of the plant, like the root, leaves and stem, have antimicrobial activity. Ethyl acetate extract from the plant acts against pathogenic bacteria, which include both gram-positive and gram-negative bacteria. Here zone inhibition test was done for this activity. This extract's zone inhibition ranged from 9.33 ± 0.58mm to 22.33 ± 0.58mm. [19]

h. Antibacterial activity
The anti-bacterial activity was produced by an ethyl acetate root extract of *Salacia oblonga*. This extract will provide the activity against Staphylococcus aureus, Pseudomonas aeruginosa, and Klebsiella pneumonia. To evaluate the anti-bacterial activity zone inhibition technique is used. This technique displayed the inhibition zones of 19.2± mm and 15.12± mm against *S. aureus*,17.8± mm and 18.17± mm against *Pseudomonas aeruginosa*, and19.77± mm and 20.27± mm against *Klebsiella pneumonia*, respectively. That zone inhibition shows anti-bacterial activity.[20]

i. Anti-inflammatory activity
For this study, rootbark powder was used. Male albino rats were used. Chronic inflammation was induced by cotton pellet granuloma. The drug extract was suspended in 2% gum acacia and administered orally for seven days. The maximum activity was observed at a 1000mg/kg dose. This dose decreased transudative, exudative, and proliferative components of chronic inflammation.[21]

j. Hypoglycemic activity
The petroleum ether extract of the root bark of *Salacia oblonga* produces hypoglycemic activity. To evaluate this activity, an experiment was performed on a female albino rat. Streptozotocin (STZ) was given to the rat for drug-induced diabetes. The extract of *Salacia oblonga* was given by oral route 250mg/kg of body weight daily, and this root-bark extract of *Salacia oblonga* shows anti-diabetic activity by inhibiting Hyperglycemia and Hypoinsulinemia-like conditions induced by STZ.[22]

k. Anti-oxidant activity
The petroleum ether extract of the root bark of *Salacia oblonga* produces hypoglycemic activity. An experiment was performed on a female albino rat to evaluate this activity. Streptozotocin (STZ) was given to the rat for overoxidation. Extract of *Salacia oblonga* given by oral route 250mg/kg of the body weight daily, and this root-bark extract of *Salacia oblonga* shows the anti-oxidant activity by increasing the enzymes like superoxide, catalase, dismutase, glutathione reductase (GSSGRase)and glutathione peroxidase (GSHPxase) and decreasing the peroxidation products like hydroperoxides, conjugated dienes and thiobarbituric acid reactive substances**.**[22]

l. Antihypertriglyceridemic activity
The aqueous extract of the root of *Salacia oblonga* produces Antihypertriglyceridemic activity. This activity was performed on groups of animals. For that, animals are divided into 4 groups. 3 groups contain water extract 0%,0.5%, and 1% respectively. The fourth group includes 0.3% fenofibrate (a triglyceride-lowering drug). The comparison of the aqueous root extract shows that antihypertriglyceridemic activity does not affect food intake by reducing the triglyceride level.[23]

m. Obesity and diabetes-associated cardiac hypertrophy
The water extract of *Salacia oblonga* produces anti-obesity and obesity and diabetes-associated cardiac hypertrophy. To evaluate this activity, male Zucker diabetic fatty (ZDF) rats are used. A 100mg/kg dose of extract is given to the rat. This extract inhibits angiotensin-2-stimulated hypertrophy and hyperplasia and also inhibits protein synthesis in heart-derived H9c2, leading to a decrease in collagen accumulation and cardiac hypertrophy that results in a decrease of fatty material in the heart.[24]

Conclusion
Salacia oblonga is a traditional ayurvedic medicine that has a wide range of pharmacological profiles and shows higher potential as a therapeutic agent. It has several chemical compositions like kotalanol, mangiferin, salacinol, etc. Chemical constituents rich in the *Salacia oblonga* plant show pharmacological activities Antidiabetic, Antioxidant, Antibacterial and Anti-inflammatory effects & hyperlipidemia. This plant may emerge as a novel offering, a natural, safe, and effective alternative to conventional therapies.

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