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SAPINDUS TRIFOLIATUS: A REVIEW

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### Abstract:

The objective of this review is to inform a short compilation of Phytochemical Screening, Pharmacological activity and other uses of Sapindus trifoliatus plant. It is one of the oldest cultivated medicinal plants in the world. It is commonly called as soap nut and has been widely used as surfactant and fir cleaning hair. The famous benefit is keeping the hair long and healthy and also useful in the treatment of Lices and dandruff. A review article based on the Phytochemical and pharmacological screening of Sapindus trifoliatus is not so far reported. The main phytoconstituents isolated and identified from different parts of this plant are saponins, sugars, fatty acids, trifoliosides, genins, phenolic acids, steroids, carbohydrates and tri terpenoids. Many research studies have been conducted to prove the plants potential as Spermicidal, Anti-inflammatory, Anthelmintic, Anti ulcer, Anti cancer activity etc. This review focuses on the Phytochemistry and Pharmacological actions of Sapindus trifoliatus.

**Key words:** Anti cancer activity, Antihelmintic, Soap nuts, Sapindus, Saponins, Spermicidal.

*Sapindus trifoliatus* L., (Family: Sapindaceae) is one of the oldest cultivated medicinal plants in the world. In fact Botanist traced it to the period of the Vedas about 5000 years ago. It is a medium sized deciduous tree growing wild in South India. *Sapindus trifoliatus* is belonging to the family Sapindaceae, are rich in saponins<sup>(1,2)</sup>.

*Sapindus* is a genus of about of five to twelve species of shrubs and small trees in the Lychee family, Sapindaceae, native to warm temperate to tropical regions. The genus includes both deciduous and evergreen species. Members of the genus are commonly known as soapberries or Soap nuts, because the fruit pulp is used to make soap. The generic name is derived from the Latin words Saponins, meaning “Soap”, and Indicus meaning “of India”.



### Botanical description:

It is a native species grown in Indo-Gangetic plains, Shivaliks and Sub-Himalayan tracts in India at altitudes ranges from 200m to 1500m<sup>(3)</sup>. It is known locally as soap nut in English, Ritha in Bengali and Ponnangottai in Tamil <sup>(4)</sup>.

This tree flourishes well in deep clay loamy soil with an annual rain fall of 200mm. It can reach a height of 25m. The leaves are alternate, 15-40cm long, pinnate, with 14 - 30 leaflets, the terminal leaflet often absent. The leaflets are elliptic-lance shaped, smooth with tipped points and slightly oblique based. They are often found in pairs of 2 or 3 and are 8 to 18cm long and 5 to 7.5cm wide. The flowers form in large panicles, each flower smell, creamy white. The flowers are small greenish white in color. They can be seen in the months of November, December and January. The fruit is a small leathery-skinned drupe 1-2 cm in diameter. The fruits are solitary globose appears in the month of July-August. The fruit is velvety when young and turns hard and smooth on maturing. The fruit contains an active principle saponin which ranges from 6-10 % of mass weight <sup>(5)</sup>. The plant has been reported for its high content of Saponins and Sugars. The Saponin moiety is characterized as the hederagenin group of glycoside <sup>(6)</sup>. The fruits and seeds are slightly smaller than the North Indian soap nuts. The shell is of a red color and become darker after they are harvested and dried. Vernacular names:

Sanskrit : Arishtak, Phenila, Aristam

Hindi : Ritha

Bengali	:	Rithe, Reetha
English	:	Soap nut tree of south India
Kannada	:	Kookatakayi
Malayalam	:	Uruangi
Marathi	:	Aritha
Oriya	:	Ritha
Tamil	:	Manipungan maram
Telugu	:	Kunkudu kayalu Kunkudu chettu

**Taxonomical classification:**

Kingdom	:	Plantae
Sub kingdom	:	Tracheobiota
Division	:	Magnoliphyta
Super division:		Spermatophyta
Class	:	Magnolipside
Sub class	:	Rosidae
Family	:	Sapindaceae
Genus	:	Sapindus
Species	:	S. trifoliatus
Parts used	:	fruits, soap nut shells.
Habitat	:	grows wild in south India.

**Phytochemistry**

The plant contains tetra cyclic tri terpenoid saponins, bacosides A and B, hersaponin, alkaloids viz herperstine and brahmine and flavonoides<sup>(7, 8)</sup>. All parts of the *Sapindus trifoliatus* contain phenolic acids such as protocatechuic acid, cis-p-coumaric acid, p-hydrobenzoic acid and Cinnamic acid<sup>(9)</sup>. *Sapindus trifoliatus* L. was studied by Kasai et al.,<sup>(10)</sup> they isolated two unknown saponins and a new cyclic Sesqui terpenic Oligoglycoside, called trifolioside II

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from the methanol extract of *S. trifoliatus*. Its structure was elucidated by enzyme hydrolysis of the cellulose- isolated compound in acetate for 7 days at 37°C by <sup>13</sup>C NMR analyses of compounds.

The major constituents of the fruits are Saponins (10-11.5%), Sugars (10%) and Mucilage. The saponin can be extracted by simple chemical extraction method <sup>(11)</sup>. The Pericarp of the fruits contains Genins, Methylhedragenate and Methyl Oleanlate <sup>(12)</sup>. High content of saponins and sugars have been reported in the pericarp <sup>(13)</sup>. The saponin moiety is characterized as Hederagenin group of glycosides <sup>(14)</sup>.

The saponin glycoside hederagin 3-o (3-o-acetyl-D-Xylose) was isolated from Pericarp of *Sapindus trifoliatus* <sup>(15)</sup>. Seeds contain 11.5% Saponins, 45 % Fixed oil and 10 % Glucose. The preliminary Phytochemical analysis of methanolic and aqueous seed extracts of *Sapindus trifoliatus* indicated the presence of steroids, carbohydrates, flavonoids, triterpenoids and saponins. The Seeds contain Fatty acid. The Fatty acids are Ofrachidic acid, Behenic, Linoleic , Oleic, Palmitic, Stearic, Oleanolic acid and Sapindic acid. They also contain Trifolioside A, Sapindiside C, D, E, Glucopyanosides of Stigmasterol, Kaempferol, quercetin, B-sitosterol, Hederagenin, Protein, Carbohydrate and Starch <sup>(16)</sup>.

### **Medicinal uses**

The plant is very commonly used in Indian Ayurvedic healing system. It is also used in Unani and Tibetan indigenous medicine. For asthma and cough, it is given as expectorant. It is an effective ingredient in Ayurvedic shampoos and cleansers. In folklore practice, some of the tribes of Orissa, India use the decoction of the aerial parts of the plant for the treatment of diabetes mellitus. ST has been used for many decades to relieve symptoms from fever caused by infection, inflammation and prescribed in the mixture of traditional medicine for treating various malignancies <sup>(17)</sup>. The plant is reported Vasoconstrictor and Anti inflammatory activity <sup>(7)</sup>. It is an excellent herb for skin problems like Eczema and Psoriasis.

Soap nut powder is a very good Anti bacterial and Antifungal agent. It is mostly used in the Cosmetic and Contraceptive creams. Powdered seeds are used for the treatment of Arthritis, Common cold, Constipation, Nausea and Dental caries <sup>(18)</sup>. The poultice of soap nut is prepared and it is applied on the affected portions of joints for the relief from joint pains <sup>(19)</sup>. *Sapindus trifoliatus* have historically been used in folk remedies as a mucolytic agent, Emetic, Contraceptive and for the treatment of excessive salivation, Epilepsy and to treat Chlorosis. The pericarp of

the fruit of this plant is reported for its various medicinal properties like tonic, stomachic, spermicidal and also used in the treatment of hemicranias, Migraine, Hysteria etc<sup>(20)</sup>. The thick watery solution of the pericarp is used for the relief of Hemi crania, Hysteria or Epilepsy<sup>(21)</sup>. Saponins obtained from the fruits of Soap nut have shown Spermicidal activity<sup>(22, 23)</sup>.

Saponin from soap nut is also widely used in the Native medicine<sup>(24)</sup>, Pharmaceutical Industries<sup>(25, 26)</sup> used as Detergents<sup>(27)</sup> used for Environmental remediation<sup>(28)</sup>. Saponins A and C and Sapindosides A and B extracted from the rind of the fruit showed Anti fungal activity. The pericarp is reported for various medicinal properties. It is reported to possess Emetic, Tonic, Astringent and used in the treatment of Asthma, Colic due to indigestion, Diarrhea and Paralysis of limbs, a thick watery solution of the pulpy mesocarp is introduced in to the nose of the patients for the relief of Hemi crania and for restoring conscious ness during Epileptic and Hysterical fits<sup>(29)</sup>. ST has been reported for its anti Spermatogenic, Anti androgenic activities and Anti rheumatic activities<sup>(30)</sup>. The fruits possess Tonic and Astringent properties. Fruit possess Emetic, Tonic, Astringent and Antihelminthic properties and are used in treatment of Asthma. Roots and barks are employed as a mild expectorant and demulcent. Leaves of *S. trifoliatum* can be used as Expectorant, Eczema, Aphrodisiac, Abortifacient, Migraine, Psoriasis and freckles, Inflammation<sup>(31)</sup>.

#### Other uses

It has a number of health benefits. The health benefit is keeping the hair long and healthy and also useful in the treatment of lice's and dandruff. It is also used as detergent, bio-surfactant and remedial for organic soil pollution in the modern medicine. The roots and stem bark are considered as a mild expectorant and demulcent. Soap nuts are being considered for commercial use in cosmetics and many other cleaning agents<sup>(32)</sup> which will not cause any toxic effects on human skin and eyes. The soap nut berries soaked in water and the extract is used in cleaning teeth, polishing jewellery, cleaning glass, paintwork and even washing the car. The jewelers in India use this plant extract to bring back the lost brightness of ornaments made of precious metals like gold, silver etc<sup>(33, 34)</sup>. The kernel contains 25 to 30 % of fatty acid, approximately 85 % of triglycerides and sterol. The oil extracted from the kernel is used as a bio-fuel<sup>(35)</sup>. The fruit is used as fish poison<sup>(36)</sup>.

## Pharmacological activities

### Anti inflammatory activity:

DK Arulmozhi et al <sup>(37)</sup> investigated the effect of lyophilized aqueous extract of pericarps of *Sapindus trifoliatus* (ST) in various in vitro and in vivo inflammatory models. ST was studied for its in vitro inhibitory activity against 5-lipoxygenase (5-LO), Cyclooxygenase (COX), Leukotriene B4 (LTB4) and Nitric oxide synthase (NOS). At doses 20 and 100mg/kg, I.P, ST was evaluated in acute pedal inflammation induced by carrageenan, histamine, serotonin and zymosan in rats and mice. ST extract inhibited the inflammation from the first hour, acting on both the early as well as the late phases. ST extract also effectively inhibited the inflammation produced by histamine and serotonin, which suggests that the anti-inflammatory activity of ST is possibly mediated by inhibiting the action of these mediators. Zymosan, an insoluble fraction of yeast cell wall produces an inflammatory response through multiple factors which include generation of anaphylotoxins that induce histamine release from mast cells, biosynthesis of eicosanoids by neutrophil macrophages and generation and release of platelet activating factors, oxygen free radicals and lysosomal enzymes. ST at 100mg/kg dose significantly inhibited the zymosan-induced paw inflammation in mice, suggesting that ST could involve inhibition of one or more of the above mentioned inflammatory mediators. It was concluded that ST, a phytomedicine traditionally used in the treatment of hemicrania (neurovascular disorder due to neurogenic inflammation and vasoactive peptides) exhibited anti-inflammatory activity in various in vitro and in vivo models of inflammation. Then results suggest that cyclo-oxygenase and Lipoxygenase pathways could be involved in the anti inflammatory activity of ST like feverfew (*Tanacetum parthenium*), a well known prophylactic anti migraine herb. Saponins, particularly the hederagenin type are known to have anti-inflammatory, anti nociceptive and anti rheumatic activities. It is therefore probable that the saponin component of the extract may contribute in part for the observed pharmacological activities.

Arul et al <sup>(38)</sup> studied the anti-inflammatory action of an ethanol extract of *S. trifoliatus* seeds by paw-edema induction and pleurisy methods caused carrageenan and granuloma formulation. The extract produced decreases in paw edema and in pleural sweating volume and had an inhibitory effect on leukocyte migration. A decrease in granuloma weight was also reported.

**Anti cancer effect:**

D. Pradhan et al<sup>(39)</sup> evaluated the anticancer effect of *Sapindus trifoliatus* on human breast cancer cell lines, SKBR3 and MDA-MB435. SKBR3 is human breast cancer cell line with over expression of HER2/neu receptor, absence of ER receptor where as MDA-MB435 breast cancer cell line is absent ER receptor and also HER2/neu expression. To determine the cell cycle,  $1 \times 10^6$  cells were seeded in each tissue culture dish and treated with herb extracts at a final concentration of 80 and 160  $\mu\text{g/ml}$  for SKBR3. For MDA-M435, cells were treated with herb extracts at a final concentration of 60 and 120  $\mu\text{g/ml}$ . 1 % DMSO (Di methyl sulfoxide) was added to the control group. After treatment for 48 h, cells were collected and incubated with reagents as described in the protocol of the cycle TEST™ PLUS DNA reagent kit. The DNA content of cell was measured by flow cytometry.

Herb extracts from fractions 1 to 4 and also the crude extract were used to determine the ED 50 value (50 % inhibition of cancer cell growth) in two different breast cancer cell lines, SKBR3 and MDA-MB435, with a final concentration ranging from 1 to 500  $\mu\text{g/ml}$ . At 48h, the ED50 values of the fraction 3 were  $56.07 \pm 3.77$  and  $30.61 \pm 1.49 \mu\text{g/ml}$  for SKBR3 and MDA-MB435, respectively. As fraction 3 was found to have an inhibitory growth effect on these cell lines. He concluded that *Sapindus trifoliatus* fraction 3 could inhibit the proliferation of human breast cancer cell lines, SKBR3 and MDA-MB435.

D. Pradhan et al<sup>(40)</sup> investigated the inhibitory growth effect of *S. trifoliatus* in two different breast cancer cell lines SK BR3 and MDA-MB435. He evaluated the fruit of the plant *S. trifoliatus* in Ehrlich Ascited Carcinoma (eac) tumor bearing mice was established. *S. trifoliatus* fruit extract 100mg/kg, 200 mg/kg body weight dose significantly reduced ascetic fluid volume. 300mg/kg, 400mg/kg reduced the percentage of viable ascetic cells to 47 and 48 % respectively in the treated groups as compared to 93 % in the EAC control. 500mg/kg increase the life span of the EAC treated mice by 112% and 100% respectively. All the doses of leaf extracts of the plant *S. trifoliatus* extract increased RBC count and hemoglobin content and decreased WBC count to near normal values, in EAC bearing mice. *S. trifoliatus* extract marginally altered SGOT, SGPT values and significantly increased alkaline phophatase. Increased urea and creatinine content in blood have been observed in 100mg and 200mg/kg body weight dose. The results of the present study clearly demonstrate the tumor inhibitory activity of the plant extract against transplantable murine tumor cell line.

### **Anti migraine activity:**

Arulmozhi et al<sup>(41)</sup> conducted a pharmacological study with the aqueous pericarp extract of fruits of *S. trifoliatus*. The effect of this extract on the central nervous system was investigated for possible anti-migraine characteristics. The results suggested that plant has possible neuroleptic properties.

Arulmozhi et al<sup>(42)</sup> studied the effect of the aqueous pericarp extract of fruits of *S. trifoliatus* in an in vivo migraine hyperalgesic model. The results showed that antagonism to dopamine D2 might underline the mechanism involved in the anti-hyperalgesic activity of the plant.

### **Diabetic neuropathic pain:**

P.K. Sahoo et al<sup>(43)</sup> investigated the ethanolic extract of ST in various in vivo models to study its effect on diabetic neuropathic pain and established the possible mechanism of its traditional use. Concluded that EEST showed significant effectiveness in model of diabetic neuropathic pain and protection produced by adenosine was via stimulation of adenosine A<sub>1</sub>-receptors.

### **Metabolic effects of *Sapindus trifoliatus*:**

D.K. Arulmozhi et al<sup>(44)</sup> evaluated the potential metabolic effects of the aqueous extract of *Sapindus trifoliatus*. ST (at 100mg/kg i.p. dose) was evaluated for its effect on glucose, triglycerides, and total cholesterol in mice and rats. The effect on glucose disposal also carried out in male Wistar rats. ST exhibited a moderate elevation of 18.26 % in plasma glucose levels of mice. However, no difference was found in the triglycerides (TG) and total cholesterol (TC) levels in ST and vehicle treated animals. In rats a significant increase ( $P < 0.05$ ) in the glucose levels were observed ( $95.62 \pm 4.56$  vs.  $157.80 \pm 13.55$ ; mg/dl in vehicle and ST treated group respectively), and no difference was observed in TG and TC levels. Further the hyperglycemic responses during oral glucose tolerance test (OGTT) were significantly greater than the vehicle treated animals. The results of the metabolic studies of ST indicate that, ST has a diabetogenic potential in normal animals.

### **Anti ulcer activity:**

Kishore D.V et al<sup>(45)</sup> investigated the anti-ulcer activity of the extract of *Sapindus trifoliatus* Linn in rats. He found that methanolic and aqueous extracts showed significant reduction in the pylorus ligation induced ulcers in rats.

He indicated that orally administered dose of the 400mg/kg body weight of both methanolic and aqueous extracts of leaves of *Sapindus trifoliatus* showed significant inhibition in ulcer production at 64.82 and 60.13 % respectively. Where as the dose of the 200mg/kg body weight of both methanolic and aqueous extracts of leaves of *Sapindus trifoliatus* showed marked inhibition 52.27, 49.32% respectively as compared to standard drug Ranitidine which showed 71.79% protection. ( $P < 0.01$ ). It appears from the study that methanolic and aqueous extracts containing flavonoids and sterols effectively reduced gastric lesions produced by Ethanol.

G. Surendra et al <sup>(46)</sup> evaluated the anti ulcer activity of methanolic and aqueous seed extracts of *Sapindus trifoliatus* using ethanol induced ulcer model. Sucralfate was used standard anti ulcerogenic agent. In ethanol induced ulcer model, methanolic and aqueous extracts of seeds at 100,200, 400mg/kg body weight produced significant decrease in ulcer index. It was found that maximum ulcer protective activity was shown by aqueous extract when given orally at a dose of 400mg/kg body weight.

#### **Anti epileptic activity:**

T. Jayasree et al <sup>(47)</sup> evaluated the antiepileptic activity of aqueous extract of *Sapindus trifoliatus* (pericarp) in Swiss albino rats. Evaluation was made by electroshock using corneal electrodes after 1hr of administration of extract. Dose dependent effect of graded dose (50,100,200mg/kg, P.O) of extract on MES-induced seizures was seen in rats. Aqueous extract of *Sapindus trifoliatus* at 100mg/kg dose significantly ( $P < 0.01$ ) decreased the duration of tonic extensor phase in MES-induced seizures. The extract also showed a maximum inhibition (100% mortality) against MES-induced seizures.

#### **Anti-diabetic and anti-oxidant activity:**

P.K. Sahoo et al <sup>(48)</sup> described the anti hyperglycemic activity, in vivo anti oxidant potential, effect on glycosylation of hemoglobin and in vitro peripheral utilization of glucose of the ethanolic extract of the aerial parts of *Sapindus trifoliatus*. The extract produced significant decrease in the blood glucose level when compared with the controls in alloxan induced hyperglycemic rats both in the single dose as well as multiple dose experiment at the tested dose level and incomparable with the standard drug Glibenclamide. It was observed that the ethanolic extract reversed the weight loss of the diabetic rats and they returned to near normal. The extract prevented significant elevation of glycosylated hemoglobin in vitro, with IC50 value being 12.5µg/ml that is comparable with the reference drug ∞-

tocopherol. Administration of the extract and Glibenclamide significantly decreased the levels of TBARS, increased the CAT in liver of insulin. Thus, the extract might have insulin like activity and anti hyperglycemic effect of the extract might be due to an increase in peripheral glucose consumption as well as protection against oxidative damage in alloxan induced diabetes. Extract 300mg/kg, as well as standard drug Glibenclamide, 600mg/kg) treated animals showed more significant decrease in peak blood glucose level after 1h. After 2h, the extract treated animals tended to bring the values near normal. Results revealing that the extract produced significant decrease in the blood glucose level when compared with the controls in alloxan induced hyperglycemic rats in the single dose experiment at the tested dose level and are comparable with the standard drug Glibenclamide. In the multiple dose study, the test extract constantly maintained significant reduction of the glucose level in diabetic rats through out the experimental period suggesting that anti hyperglycemic property of the extract. The ethanolic extract of *S. trifoliatum* is reported to be rich in saponins. Saponins are reported to possess anti-diabetic and anti-oxidant activity.

#### **Anthelmintic activity:**

Sravanthi et al<sup>(49)</sup> investigated the Anthelmintic activity of the seeds of *Sapindus trifoliatum*. The Methanolic extract of the crude drug at concentrations of 10mg/ml, 20mg/ml, 30mg/ml, 40mg/ml were tested which involve determination of paralysis time and death time. *Sapindus trifoliate* seed extract was effective at all the concentrations tested against the standard drug Albendazole in causing the death of earth worms.

#### **Discussion:**

*Sapindus trifoliatum* is a common plant available at various places in India. The various parts of this plant like root, the leaves, stem bark, wood and fruit are highly useful to the human beings. The plant is widely used in cosmetic preparation like shampoos and cleansers. The fruit is mainly used for the preparation of hair tonics, cosmetics, skin creams and mainly used for anti spermatic activity. The product obtained from the plant is natural and eco-friendly. So it is very apt to call as multifacetious useful tree. This review will provide a basic idea of most of the phytoconstituents present in *S. trifoliatum*. The pharmacological studies reported in the present review confirm the therapeutic value of this plant.

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