



## *Sapindus emarginatus*: Phytochemistry & Various Biological Activities

Bharti Arora<sup>a\*</sup>, Preeti Bhadauria<sup>b</sup>, Deepak Tripathi<sup>c</sup>, Alok Sharma<sup>d</sup>

<sup>a</sup> Department of Pharmaceutical Chemistry, A.P.I.T.C.E, Agra(Uttar Pradesh), India

<sup>b</sup> Department of Pharmaceutical Sciences, A.P.I.T.C.E, Agra(Uttar Pradesh), India

<sup>c</sup> Department of Pharmaceutics, Sir Madanlal Institute of Pharmacy, Etawah, India

<sup>d</sup> Department of Pharmaceutics, IIMT College of Medical Sciences, India

Address for Correspondance: [preeti.ibs14@gmail.com](mailto:preeti.ibs14@gmail.com)

**ABSTRACT:** *Sapindus emarginatus* is important indigenous plant with lots of traditional importance belongs to family sapindaceae. It is commonly called as Soap nut tree which is found in most of the hilly regions of India. Each and every part of the plant is used traditionally in various ailments. Trees of genus *Sapindus* are cultivated in many parts of India. The secondary metabolites present in *Sapindus emarginatus* were found to be alkaloids, carbohydrates, phenols, flavonoids, saponins fixed oils & fats. It possesses various activities such as surfactant, mild detergent, anti-inflammatory, antipruritic, antihyperlipidemic, antimicrobial, CNS, emetic, hair tonic, nasal insufflations. Therefore the aim of the present review is to summarize the taxonomy, chemical constituents and various studies on the biological activities of the plant *Sapindus emarginatus*. © 2011 IGJPS. All rights reserved.

**KEYWORDS:** *Sapindus emarginatus*; Secondary metabolites; Phytochemicals; Biological activity.

### INTRODUCTION

Medicinal plants are gifts of nature which are used in curement of various human ailments. *Sapindus emarginatus* Vahl belongs to family sapindaceae and genus *Sapindus* is a medium sized deciduous tree found in south India[1]. The Tree is about 8m to 10 m tall and has branches. *Sapindus emarginatus* is an economically significant tropical tree species meagerly distributed in diverse geographical provinces like Gangetic Plains, Western Ghats, and Deccan Plateau in India[2].

It is commonly called as Soapnut tree and is the south Indian species of genus *Sapindus*. The fruit is known for saponins which constitutes upto 56.5% of the drupe. Members of the genus are commonly known as soapberries or soapnuts because the fruit pulp is used to make soap. Investigation of the contraceptive capability of plant Saponins have shown some spermicidal capacity[3].

*Scientific classification*[4]

<u>Kingdom</u>	Plantae
<u>Phylum</u>	Spermatophyta
<u>Sub phylum</u>	Angiospermae
<u>Class</u>	Magnoliopsida

<u>Order</u>	Sapindales
<u>Family</u>	Sapindaceae
<u>Subfamily</u>	Sapindoideae
<u>Genus</u>	Sapindus

#### *Morphology*[4]

*Sapindus emarginatus* is a deciduous tree. The trunk of the tree is straight and cylindrical, approximately 4-5 m in height.

Leaves- 5-10 pairs of leaves, solitary alternate, 15–40 cm (5.9–16 in) long, pinnate, with 14-30 leaflets, the terminal leaflet often absent.

Flowers- The flowers form in large panicles and each flower is small and creamy white in colour. It flowers during summer.

Fruits- The fruit is small leathery-skinned drupe which is 1–2 cm (0.39–0.79 in) in diameter, which is yellow and turn blackish when ripen, containing one to three seeds.

### **PHYTOCHEMICALS & ISOLATED CHEMICAL COMPOUNDS**

Several constituents were isolated from the plant including secondary metabolites. Plant *Sapindus emarginatus* found to consists of various compounds i.e. Phytochemicals such as flavonoids, Triterpenoids, glycosides, carbohydrates, fatty acids, phenols, fixed oil, and saponins<sup>5</sup>. Pericarps of the plant found to contain large percentage of saponin. Kaempferol, Quercetin and  $\beta$ - sitosterol are also found to be present in the nuts[6].

Saponins contain the saponin hederagenin[6,7]. One known sweet acyclic sesquiterpene glycoside, mukurozioside IIb has also been isolated and characterized. Flavonoids have also been isolated from *Sapindus emarginatus*[8].

#### *Pericarps*

(i) Two piscidal Triterpenoid saponins, 3-O-[[ $\beta$ -D-xylopyranosyl-(1 $\rightarrow$ 3)- $\alpha$ -L-rhamnopyranosyl (1 $\rightarrow$ 2)- $\alpha$ -L-arabinopyranosyl] hederagenin & 3-O-[[ $\alpha$ -L-arabinopyranosyl(1 $\rightarrow$ 3)- $\alpha$ -L-rhamnopyranosyl(1 $\rightarrow$ 2)- $\alpha$ -L-arabinopyranosyl] hederagenin and  $\beta$ - sitosterol were isolated and characterized from the pericarps of *Sapindus emarginatus*. Due to the presence of these saponins *Sapindus emarginatus* pericarps shows good piscidal activity[6,9].

(ii) Three new acetylated triterpene saponins were also isolated and characterized. The structures of new compounds were elucidated as hederagenin 3- O-(2-O-acetyl- $\beta$  -D-xylopyranosyl)-(1 $\rightarrow$ 3)- $\alpha$ -L-rhamnopyranosyl-(1 $\rightarrow$ 2)- $\alpha$ -L-arabinopyranoside, 23-O-acetyl-hederagenin 3-O-(4-O-acetyl- $\beta$  -D xylopyranosyl)-(1 $\rightarrow$ 3)- $\alpha$ -L-rhamnopyranosyl-(1 $\rightarrow$ 2)- $\alpha$ -L-arabinopyranoside and oleanolic acid 3- O-(4-O-acetyl- $\beta$  -D-xylopyranosyl)-(1 $\rightarrow$ 3)- $\alpha$ -L-rhamnopyranosyl-(1 $\rightarrow$ 2)- $\alpha$ -L-arabinopyranoside by chemical and spectroscopic data[6,10].

#### *Fruits*

Hederagenin-3-O-  $\beta$ -d-galactopyranosyl-(1 $\rightarrow$ 2)- $\beta$ -D-glucopyranosyl, hederagenin-3-O- $\beta$ -D glucuronopyranosyl-(1 $\rightarrow$ 2)- $\beta$ -D-galactopyranoside[6,10].

*Phytochemical screening*

The preliminary phytochemical studies were performed for testing different chemical groups present in extracts[11,12].

Alkaloids

i. Mayer's test

To 2 ml of Ethanolic extract few drops of the Mayer's reagent was added. Formation of white or pale yellow precipitate indicates the presence of alkaloids.

ii. Wagner's test

2 mg of Ethanolic extract was acidified with 1.5 per cent v/v of hydrochloric acid and a few drops of Wagner's reagent were added. Formation of yellow or brown precipitate indicates the presence of alkaloids.

iii. Hager's test

To 2 mg of the Ethanolic extract taken in a test tube, a few drops of Hager's reagent were added. Formation of yellow precipitate confirms the presence of alkaloids.

iv. Dragendorff's test

To 2 mg of the Ethanolic extract 5 ml of distilled water was added, 2M Hydrochloric acid was added until an acid reaction occurs. To above solution 1 ml of Dragendorff's reagent was added. Formation of orange or orange red precipitate indicated the presence of alkaloids.

Carbohydrates

i. Molisch's test

To 2 ml of aqueous extract, 2 drops of freshly prepared 20 %alcoholic solution of  $\alpha$ - naphthol was added in a test tube. 2 ml of conc. sulphuric acid was added along the sides of test tube. Purple or violet coloured ring appeared, indicating the presence of carbohydrates which disappeared on the addition of excess of alkali.

ii. Benedict's test

To 0.5 ml of aqueous extract, 5 ml of Benedict's solution was added in a test tube and boiled for 5 min. Formation of brick red coloured precipitate indicated the presence of carbohydrates.

iii. Fehling's test

To 2 ml of aqueous extract, 1 ml mixture of equal parts of Fehling's solution A and B were added and boiled for few minutes. Formation of red or brick red coloured precipitate indicated the presence of reducing sugar.

Flavonoids

i. Shinoda's test

To 0.5 ml of the Ethanolic extract in test tube magnesium turnings were added followed by dil. HCl. Formation of pink, reddish or reddish-brown colour indicated the presence of flavonoids.

ii. Alkaline reagent test

To 2 ml of test extract few ml. of sodium hydroxide solution was added. At first intense tallow colour was appeared which turned colourless on addition of dil. HCl indicated the presence of Flavonoids

### Glycosides

#### Borntrager's test.

The 5 ml of extract was boiled with equal amount of dilute sulphuric acid in a test tube with for 5 min. while hot it was filtered and cooled. The filtrate was shaken with equal volume of chloroform. The lower layer of chloroform was separated. The layer was stunned with half of its volume of dilute ammonia. Appearance of rose pink to red colour indicated the presence of glycoside.

### Triterpenoids

#### Liebermann - Burchard's test

2 mg of dry extract was dissolved in acetic anhydride, heated to boiling, cooled and then 1 ml of concentrated sulphuric acid was added along the sides of the test tube. Formation of a violet coloured ring indicated the presence of Triterpenoid.

### Proteins

#### i. Warming test

2 ml of extract was taken in test tube and heated in boiling water bath. Coagulation of protein occurs.

#### ii. Millon's test

1 ml of aqueous extract was dissolved in 1ml of distilled water in a test tube and 5 to 6 drops of Millon's reagent were added. Formation of white precipitate which turns red on heating indicated the presence of proteins.

### Saponins

#### Froth formation test

2 ml of an Ethanolic extract was shaken vigorously with water in a test tube and left for 3 min. Formation of constant froth indicated the presence of saponins.

### Steroids and Triterpenoids

#### i. Liebermann-Burchard's test

2 mg of dry extract was dissolved in acetic anhydride, heated to boiling, cooled and then 1 ml of concentrated sulphuric acid was added along the sides of the test tube. Formation of green colour indicated the presence of steroids.

#### ii. Salkowski reaction

Test extract was shaken with chloroform, to the chloroform layer sulphuric acid was added slowly by the sides of test tube. Red colour indicated the presence of steroids.

### Tannins

#### i. Ferric chloride test

To 1-2 ml of the Ethanolic extract, few drops of 5 % w/v FeCl<sub>3</sub> solution were added. Appearance of green colour indicated the presence of gallotannins, while brown colour indicated the presence of pseudotannins.

#### ii. Gelatin test

To 2 ml of extract, 1% gelatin solution containing 10 % sodium chloride was added. Precipitate formation indicated the presence of tannins

### Starch

0.01g of Iodine and 0.075 g of potassium iodide were dissolved in 5 ml of distilled water and 2 to 3 ml of an Ethanolic extract was added. Formation of blue colour indicated the presence of starch.

## **TRADITIONAL USES**

The members of genus *Sapindus* are well known for their medicinal values. For thousands of years it has been used for various purposes. *Sapindus emarginatus* is known as Ritha, reetha, aritha, kanma etc. Due to the presence of saponins, they are known for their surfactant & detergent properties. The fruits of *Sapindus emarginatus* are commonly used for hair problems and also in preparation of shampoos[13]. Traditionally it used as anti-inflammatory and antipyretic. The seed is intoxicant and the fruit rind has oxytropic action. Nut powder is used as Nasal Insufflations. Seeds of *Sapindus emarginatus* contain anti-inflammatory oil which is traditionally used to purify the blood[14]. Historically it has been used in folk remedies as a mucolytic agent, emetic, paralysis of limbs, treatment of chlorosis. Soapnuts are also used as effective aid for the treatment of skin problems like eczema, itching and psoriasis. Its fruits are natural substitute for chemical soaps and hair dyes. Effect on reproductive organs also has been reported<sup>15</sup>. Pericarp contains triterpene saponins, commonly used as antifertility, antipruritic and anti-inflammatory agents in traditional Indian and Thai medicines. The roots are used as expectorant and demulcent and also are used for cure of hysteria and epilepsy.

## **RECENT RESEARCH STUDIES ON THE BIOLOGICAL ACTIVITIES OF SAPINDUS EMARGINATUS**

### *Antifertility and antiandrogenic activity*

Fruit extract of *Sapindus emarginatus* was found to produce potent antifertility and antiandrogenic activity. The extract shows the activity almost certainly by selective androgen deprivation to epididymis, thus affecting sperm motility and metabolism. The androgen deprived effect of the extracts is evident by the significant increase in the testicular cholesterol content by this treatment. It is further substantiated by significant fall in levels of seminal vesicle fructose in these animals[15].

### *Antihyperlipidemic activity*

Hyperlipidemia is a condition in which increase in plasma cholesterol and triglycerides occur mostly from the increase secretion of VLDL secretion by the liver accompanied by strong decrease of VLDL and LDL breakdown[16]. *Sapindus emarginatus* fruit extract has been used for Antihyperlipidemic activity. The saponins from *Sapindus emarginatus* fruit extract found to have significant Antihyperlipidemic activity. Methanolic extract at a dose of 100 and 200 mg/kg significantly lowered both plasma glycerides and cholesterol levels. The cholesterol lowering activity of the fruit extract result from the breakdown of LDL cholesterol by enhancing enzymatic action. The active ingredients present in the extract recover the disorders in lipid metabolism occurring in hyperlipidemic state. The Antihyperlipidemic activity of plant *Sapindus emarginatus* could be attributed to the presence of valuable saponins and flavonoids[17].

#### *CNS activity*

Methanolic extract of fruit of *Sapindus emarginatus* found to produce CNS depressant activity. The methanolic extract of Pericarps of *Sapindus emarginatus* at 100 and 200 mg/kg caused a significant reduction in the spontaneous activity, significant decrease in exploratory behavioral pattern, reduction in muscle relaxant activity, inhibition of cocaine induced hyperactivity and also extensively potentiated phenobarbitone sodium-induced sleeping time. A different dose of methanol extract produced a considerable increase in the hypnotic effect induced by the phenobarbitone, in a dose dependent manner, suggesting a profile sedative activity[18]. Various scientific research reports showed that Triterpenoids produced CNS depressant action[19]. The presence of these active constituents in the methanol extract of *S. emarginatus* may be responsible for the CNS depressant activity.

#### *Anti-mosquito activity or Larvicidal activity*

*Sapindus emarginatus* fruit extract shows the presence of saponins which demonstrated larvicidal activity against the larvae of mosquito *Aedes aegypti*, which is a vector for dengue and chikungunya[20]. Investigations with kernels from the soapnut *Sapindus emarginatus* revealed it as a new source of botanical biocide with potent antimosquito activity, which is proved from the ability of the aqueous extract of kernel to kill all the developmental stages of three important vector mosquito species, *Aedes aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus*. Later studies were also conducted which resulted that exposure of the kernel extract produces changes in total proteins, and esterases, phosphatases resulting in metabolic disturbances. The extract shows its anti-mosquito activity by multiple modes of action as clear from several adverse changes noticed in three main enzymes, namely, Acetylcholinesterase,  $\beta$ -carboxyl esterase and acid phosphatases of larvae of *A. aegypti*[21,22].

#### *Antihyperglycemic and antidiabetic activity*

Diabetes mellitus is a chronic disorder, with a worldwide incidence of 5% in local population. Type I diabetes is treated with exogenous insulin and type II is with oral hypoglycemic agents[23]. Since time immemorial, patients with non-insulin dependent Diabetes have been treated orally in folk medicines. A number of medicinal plants are reported in literature and *Sapindus emarginatus* is one of them. In 2009 S. Jeyabalan et al studied the Antihyperglycemic effect of leaves extract of *Sapindus emarginatus* in the glucose overloaded hyperglycemic rats. Various extract of leaves of plant *Sapindus emarginatus* at different doses exhibited a significant hypoglycemic activity and the activity shown was dose dependent. The study also revealed that total haemoglobin level, Glycosylated haemoglobin level, serum creatinine, serum urea and lipid profiles measured showed the antidiabetic activity[24].

#### *Antimicrobial activity*

Leaf extracts of *Sapindus emarginatus* was reported antimicrobial activity against bacteria. Both methanolic and aqueous extract showed varying degree of inhibitory potential against *Escherichia coli* and *Pseudomonas aeruginosa*. Methanolic extract of leaves also showed the antifungal activity against the tested fungus *Aspergillus niger*. *S. emarginatus* showed strong antibacterial activity against *M. flavus*, *S. epidermidis* and *P. morgani*<sup>25</sup>. Another investigation was also reported on the leaf extract of *Sapindus emarginatus* against six bacterial strains, *Pseudomonas testosteroni*, *Staphylococcus epidermis*, *Klebsiella pneumonia*, *Bacillus subtilis* and *Proteus morgani* and showed most potent antibacterial activity[14].

#### *Antioxidant activity*

The antioxidants play important role in protecting human beings from the dangerous effects of pollutants which enhance production of reactive oxygen species thereby increasing oxidative stress in the body. The human body has various mechanism to counteract these oxidative stress by producing antioxidants either naturally produced antioxidants either endogenous antioxidants or exogenous antioxidants[26]. Leaves of plant *Sapindus emarginatus* were found to exhibit moderate antioxidant activity which was strongly dose dependent. The antioxidant activity increases with the increase in extract dose and further descend with continuous increase in dose. Phytochemicals mainly plant phenolics constitute a major group of compounds that act as primary antioxidants. Phytochemical investigation revealed the presence of phenols and flavones in the leaves which contributed the antioxidant activity of the plant. The antioxidant activity may be due to proton donating capability of the leaf extract[27]. Thus the plant *Sapindus emarginatus* can be used in manufacturing of cosmetics, herbal products for skin as antiageing agents, anticancer agents.

### **CONCLUSION**

The main objective of this review is to present the exploration of the uses and activities of the plant *Sapindus emarginatus* with its classification, Phytochemicals and specially to present the whole research work carried out with species *Sapindus emarginatus* belongs to genus *Sapindus*, in order to organize the result produced. Various research works were done on the plant and reports the presence of various bioactive novel compounds like saponins, flavonoids, Triterpenoids, Phenolic acid etc. Various literature reports that many biological and pharmacological activities were shown by the presence of Phytochemicals or secondary metabolites and the isolated compounds. *S. emarginatus* showed good antibacterial activity and CNS activity so this plant can be used to discover bioactive natural products. *S. emarginatus* could be used as sources to isolate active compounds to produce valuable mosquito larvicidal agents to control mosquito vectors.

Traditionally the plant *Sapindus emarginatus* is used in various ailments like as emetic, blood purifier, antipruritic, paralysis of limbs, as hair tonic, expectorant and anti-inflammatory agent. But scientific research has not yet done on the particular species or on the specific component responsible for the particular biological activity. Furthermore, the chemically unknown species present in the crude extracts become a better source of novel drug or novel drug template. Therefore need of study of detail chemical analysis arises to spot the targeted bio active compound and isolate them and trace their pharmacological activities. Thus it can be concluded that the plant *Sapindus emarginatus* need more focus and further study in order to get more medicinal value in near future. This plant can be used to find out bioactive natural products that may serve as leads for the development of new pharmaceuticals to unmet remedial needs. Screening of various natural organic compounds and identifying the specific active agents present is becoming the need of the hour in today's time, because successful prediction of lead fragment and drug like properties at the beginning of drug discovery will pay off later in drug development.

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