

# Wood Apple (*Limonia Acidissima* L.): A Multipurpose Herb In Cosmetics

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**Abstract:** In today's era herbs play vital role in every industry due to their different properties. This article mainly shows the importance of *Limonia Acidissima* L. in cosmetics. This article also shows its Pharmacological activities and Medicinal uses. *Limonia Acidissima* L. also known as Wood Apple belonging to family Rutaceae. Different parts of *Limonia Acidissima* L. shows different properties like essential oil obtained from the leaves of *Limonia Acidissima* L. shows anti-bacterial activity because of carvacrol and cyclodecandine constituents. Shell shows anti-fungal activity against gram positive and gram negative bacteria because of Psoralene. Pulp of the *Limonia Acidissima* L is good for skin because of its higher moisture content. The other main constituents of *Limonia Acidissima* L are saponins, flavonoids, amino acids, beta carotene, tannins, carbohydrates, vitamin B, triterpene. These constituents are responsible for some cosmetic properties hence *Limonia Acidissima* L. can be used in cosmetic products.

**Keywords:** *Limonia Acidissima* L., Antifungal, Exfoliation, Shell, Cosmetic uses, Antibacterial

## I. INTRODUCTION:

There are number of herbs which are used for their medicinal and cosmetics properties, *Limonia Acidissima* L. is one of them. Different parts of *Limonia Acidissima* L. are responsible for different medicinal as well as cosmetics properties. Fruit of *Limonia Acidissima* L. is used as a substitute for bael in diarrhea and dysentery <sup>[1]</sup>. Fruit is much used in India as a liver and cardiac tonic and when unripe, as a means of halting diarrhea and dysentery and for effective treatment for high cough, sore throat and disease of the gums. Leaves and stem bark of wood apple have been studied for anti-tumor and antimicrobial activity and pulp has anti-inflammatory, antipyretic activity <sup>[2]</sup>. The fruit contains flavonoids which gives anti-oxidant property, saponins which are responsible for foaming and anti-fungal property. Glycosides, tannins, some coumarins and tyramine derivatives have also been isolated from the fruits of *Limonia*. The fruit shells of *Limonia Acidissima* contain anti-fungal compounds, namely, psoralene, xanthotoxin, 2, 6-dimethoxybenzoquinone and ostheno <sup>[3]</sup>. The shell of the fruit can be also used for skin exfoliation purpose.



Fig. 1 *Limonia Acidissima* fruit, shell,



Fig.2 *Limonia Acidissima* fruit pulp <sup>[5]</sup>

Leaves <sup>[4]</sup>

## II. DISTRIBUTION:

*Limonia Acidissima* L. is globally reported from India, Sri Lanka, Pakistan, Java and Malaysia. In India, it is found to occur in the dry regions. It is reported from the states of Punjab, Delhi, Rajasthan, Madhya Pradesh, West Bengal, Arunachal Pradesh, Maharashtra, Goa, Karnataka, Tamil Nadu and Andhra Pradesh. This species is globally distributed in Indo-Malesia. Within India, it is cultivated for its fruits throughout the plains of India, especially in the drier zones <sup>[6]</sup>.

Table 1 - Botanical description of *Limonia Acidissima* L.

Kingdom	Plantae
Sub-Kingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Sub-Class	Rosidae
Order	Sapindales
Family	Rutaceae
Genus	<i>Limonia</i> L.
Species	<i>L. acidissima</i>
Synonyms	<i>Feroniaele phantum</i> Correa, <i>Feronia limonia</i> (L.) Swingle, <i>Schinus limonia</i> L.

Table 1 "[7]"

Table 2 – Different names of *Limonia Acidissima* L.

Sr. No.	State	Names
1	English	Elephant apple, Wood apple
2	Hindi	Barnahi billan, Barnasi, Beli
3	Kannada	Aranamullu, Aruna mullu
4	Malayalam	Cerukattunarakam, Cherrukatnarragam,
5	Marathi	Kauth, Kavath, Kaveet, Kovit, Sit-ranlimbi
6	Sanskrit	Kapithah, Akshasasya, Atha,
7	Tamil	Narivila, Nilavila, Vilaa, Vilanga,
8	Telugu	Kapithhamu, Parupuvelaga, Pulivelaga,
9	Arabic	Kabit
10	Persian	Kabit
11	Urdu	Kaitha
12	Tibetan	Ka bi ta, Kapita

Table 2 "[7]"

### III. MORPHOLOGICAL CHARACTERISTICS:

The tree of *Limonia Acidissima* L. is a moderate sized, deciduous, erect tree with a few upward reaching branches bending outward near the summit where they are subdivided into slender, branchlets drooping at the tips throughout India "[8]". It is a slow growing tree up to 9m tall, grows all over India in dry and warm areas up to 450m elevation. Often tree with rough, spiny bark. The spines are axillary, short, straight, 2-5 cm long on some of the zigzag twigs "[9]".

### IV. DESCRIPTION OF DIFFERENT PARTS OF LIMONIA ACIDISSIMA L. :

The leaves of *Limonia Acidissima* L. are deciduous, alternate, dark-green, leathery, 3 to 5 inch long. Often minutely toothed, blunt or notched a dull- red or greenish, born in small, loose, terminal or lateral panicles.

The fruit is round to oval 5-12.5 cm wide with a woody, amazingly hard rind which can be difficult to crack. The fruit is greyish - white, it has a scurfy rind about 6 mm thick.

The pulp of *Limonia Acidissima* L. is sticky, brown, and aromatic. It is odorous, resinous, astringent, acid or sweetish, with numerous small, white seeds scattered through it. There are two forms, one with large, sweet fruits and the other with small, acid fruits. *Limonia Acidissima* L. is an aromatic plant.

The rind is greyish-white in colour and 6 mm thick. It has woody and extremely hard outer shell (called as rind) which is very difficult to crack open. Hammer is used to crack the hard rind of wood-apple fruit "[9]".

Table 3 - Chemical constituents of different parts of Limonia Acidissima L. "[1, 3, 8, 10,11,12,13,14 ,15]"

Sr. No.	Parts	Constituents
1	Fruit	Flavonoids, glycosides, saponins and tannins and some coumarins, tyramine derivatives "[3]"  Acidissimin, acidissiminol "[12]"
2	Leaves	<b>Alkaloids</b> - Psoralen, bergapten. <b>Flavones</b> - Orientin, vitexin <b>Saponins</b> <b>Essential oils</b> "[15]"  Eudesma-4 (14). 11-diene (46.3%), carvacrol (29.6%) and 1,5-cyclodecandine (13.4%) these are the major constituents extracted from essential oil of leaves of limonia acidissima (Anti-bacterial activity). Other constituents are $\alpha$ -Thujene, $\alpha$ -Pinene, Linalool 0.1, 1,5-Cyclodecandine, Caryophyllene 1.3, cis-Anethole, Elemicin 0.9, Aromadendrene, Germacrene-D, 3,4-Dimethyl cinnamic alcohol, Veratraldehyde, Caryophyllene oxide "[11]"  Stigmasterol, orientin, vitedin, saponarin, tannins "[1]"  Carbohydrate, amino acid, protein, lipid, tannins, alkaloids, steroids "[13]"
3	Shell	Psoralene, xanthotoxin, 2, 6-dimethoxybenzoquinone, ostenol (anti-fungal) "[3]" <u>Amino acid, total amino acid</u> "[14]"
4	Seed	Fixed oil, carbohydrates, proteins and amino acids.
5	Unripe Fruit	Stigmasterol "[1]"
6	Bark	<b>Coumarins</b> - Marmesin, bergapten, psoralen, luvangetin, xanthotoxin, scopoletin, isoimperatorin, osthol and 6,7-dimethoxycoumarin "feronolide and feronone "[1]"  <b>Alkaloids</b> <b>Steroids</b> - Sitosterol and sitosterol-o-beta-d-glucoside. <b>Terpenoids</b> - Lupeol and limonin <b>Flavones</b> - 5, 7-dihydroxy-3', 4'-dimethoxy-6,8-di (3-methylbut-2-enyl) stigmasterol, sitosterol-3-O- $\beta$ -D-glucopyranoside "[42]"  The bark of the plant has yielded (-)(2S)-5,3'-dihydroxy-4'-methoxy-6",6"dimethyl chromeno-(7,8,2",3")-flavanone along with several known compounds, five coumarins, a flavanone, a lignan, (antimicrobial) "[3]"  Carbohydrate, amino acid, protein, lipid tannins "[13]"  Phenols "[14]"
7	Pulp	<b>Flavone glycoside</b> - 5,4-dihydroxy-3-(3-methyl-but-2-enyl) 3,5,6-trimethoxyflavone-7-O-b-D-glucopyranoside "[15]"  Citric acid and other fruit acids, mucilage and minerals, alkaloids, coumarins, fatty acids, sterols, umbelliferone, dictamnine, xanthotoxol, scoparone, xanthotoxin, isopimpinellin, isoimperatorin and marmin "[1]"  Rich source of Beta carotene, a precursor of vitamin-A which also contains significant amount of vitamin B such as riboflavin and thiamine and it had small quantities of ascorbic acid content "[8]"  Carbohydrate, amino acid, protein, lipid, tannins "[13]"  Resins "[14]"
8	Root	<b>Lactones</b> - Feronia lactone, geranylumbelliferone, frenolin. <b>Coumarin</b> - Aurapten, marmesin, bergapten, xanthotoxin, osthol, xanthyletin, 6-methoxy-7-geranyloxycoumarin, ostenol. <b>Quinolone alkaloid</b> - 1-methyl-4-methoxy-2-quinolone "[15]"

Table 3 "[1, 3, 8, 10,11,12,13,14 ,15]"

Table 4 – Essential oil from Leaves of *Limonia Acidissima* L. <sup>“[15]”</sup>

Sr. No.	Constituent	Composition
1	Caryophyllene oxide	1.7%
2	Veratraldehyde	0.3%
3	3,4-Dimethyl cinnamic alcohol	0.1%
4	Germacrene-D	1.2%
5	Aromadendrene	0.1%
6	Elemicin	0.9%
7	Eudesma-4(14)11-diene	46.3%
8	cis-Anethole	2.8%
9	Caryophyllene	1.3%
10	Carvacrol	29.6%
11	1,5-Cyclodecandine	13.4%
12	Linalool	0.1%
13	$\alpha$ -Pinene	0.2%
14	$\alpha$ -Thujene	0.4%

Table – 4 <sup>“[15]”</sup>Table 5 – Essential oil from fruit pulp of *Limonia Acidissima* L. <sup>“[15]”</sup>

Sr. No.	Constituent	Composition
1	Thymol	52.22%
2	Dodecanoic acid	19.34%
3	$\alpha$ -Pinene	4.02%
4	Carvacrol	3.86%
5	Camphoric acid	3.25%
6	Caryophyllene oxide	3.06%

Table 5 <sup>“[15]”</sup>

## V. MEDICINAL USES:

- *Limonia Acidissima* L. is widely used as a liver and cardiac tonic in India. The pulp is poultice onto bites and stings of venomous insects.
- *Limonia Acidissima* L. is used to treat diarrhoea and dysentery, in effective treatment for Hiccough, in sore throat and diseases of the gums.
- Traditionally, the constituents (in paste form) from the stem bark of *Limonia acidissima* is mixed with water and applied mainly to the face (Yoganarasimhan, 2000). It is believed that the regular application on the skin helps to keep skin cool, smooth, fair and well-textured complexion (Patra, Mishra and Chaudhuri, 1988). It is also known to be protecting against skin cancer by blocking UV rays.
- ‘Thanaka’, a root paste made from the pulp of *L. acidissima*, is a facial cosmetic to remove small spots and lesions on the skin (Bandara et al., 1988) <sup>“[16]”</sup>

## VI. PHARMACOLOGICAL ACTIVITY:

### Wound Healing-

Albino rates of either sex were used to check the wound healing activity by screening with methanol extract of fruit pulp of *Limonia Acidissima* L. In the excision wound model, the wound contracted progressively when treated with the extracts and required a mean period of  $16.0 \pm 0.8$  days for optimum healing. Incision wound model showed increased wound breaking strength and decreased epithelisation period when treated with MELO (Methanol extract of fruit pulp). Different extracts of *Limonia Acidissima* L. possesses significant dose dependent wound healing activity. <sup>“[17]”</sup>

### Antioxidant Activity-

The crude methanol extract of the stem bark of *Limonia acidissima* L. was screened for antioxidant activities <sup>“[18]”</sup>. The antioxidant (free radical scavenging) activity of the partitionates on the stable radical 1,1-diphenyl-2picrylhydrazyl (DPPH) was determined. The chloroform soluble fraction (CL) of crude methanol extract showed the highest free radical scavenging activity. At the same time the pet ether soluble fraction (PE) also exhibited strong antioxidant potential. The methanol extract of *Limonia Acidissima* L. fruit was also screened for their free radical scavenging properties by Ferric reducing antioxidant power (FRAP) assay and DPPH radical scavenging assay <sup>“[19]”</sup>. In vitro antioxidant activity of different extracts from leaves of *Limonia acidissima* L. has been done and documented <sup>“[20]”, “[21]”</sup>

**Adsorbent-**

The waste fruit shell of *Limonia acidissima* L. is used as a adsorbent. In this process methylene blue dye was removed from any solution by using *Limonia Acidissima* L. shell as an activated carbon. Effect of agitation time and concentration of dye on adsorption, Effect of adsorbent dose, Effect of temperature plays important role in the adsorptive removal of methylene blue dye "[22]".

The *Limonia acidissima* L. hull (shell) powder is capable of removing chromium ions from aqueous solution up to 67.03% for an initial concentration of chromium 10ppm and at a temperature of 30°C. The chromium adsorption ion performed by *Limonia Acidissima* L. hull powder is strongly affected by parameters such as contact time, initial chromium concentration, pH, adsorbent dosage, adsorbent particle size and temperature "[23]".

The daily chromium requirement for adults is estimated to be 0.5–2 µg of absorbable chromium. Excess amount of chromium ions in body can cause mutagenicity and carcinogenicity activity. Therefore controlled amount of chromium ion in drinking water as well as in human body is important "[24]".

**Anti-bacterial Activity-**

The anti-bacterial activity was evaluated against Gram-negative and Gram-positive bacteria by agar well diffusion method. Methanol extract showed good antibacterial activity with the high inhibition zones while chloroform extract exhibited mild to moderate activity and hexane extract was found to be less active "[25]".

The methanol extracts of *Limonia Acidissima* L. plant parts were tested against *Escherichia coli* and *Staphylococcus aureus* using disc diffusion method. The extracts from different parts showed varying degrees of anti-microbial activity. Generally extracts of all plant parts effectively controlled the growth of both gram negative and gram positive bacteria. Among the 5 components of *L. acidissima* (bark, leaf, shell, pulp, seed) studied, the pulp extract showed greater inhibitory effect on both microorganisms "[26]".

Three gram positive (*Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*) and a gram negative bacterium (*Proteus mirabilis*) were used to evaluate the anti-bacterial activity of dried pulp and rind. The methanol extract of pulp was found to possess highest anti-bacterial activity against *Staphylococcus epidermidis* followed by *Staphylococcus aureus* and *Bacillus subtilis*. The rind of *Limonia Acidissima* L. also revealed antibacterial activity against *Staphylococcus aureus* and *Staphylococcus epidermidis* "[27]".

**Anti-fungal Activity-**

The different extracts (petroleum ether, chloroform, methanol and aqueous) of *limonia Acidissima* L. fruit pulp exhibited antifungal activity against some pathogenic fungus "[28]".

**VII. EFFECT OF ACTIVE CONSTITUENTS:**

- 1) **Flavonoids** - Flavonoids are polyphenolic compounds that are present in nature. Flavonoids are secondary plant metabolites share the chromane ring with tocopherols, these compound show antioxidant activity. In this activity major mechanism is induce direct scavenging of oxygen and nitrogen free radical, inhibition of oxyradical producing enzymes, iron chelation and reduction of leukocyte adhesion to the blood vessel wall during tissue inflammation and reperfusion "[29]".

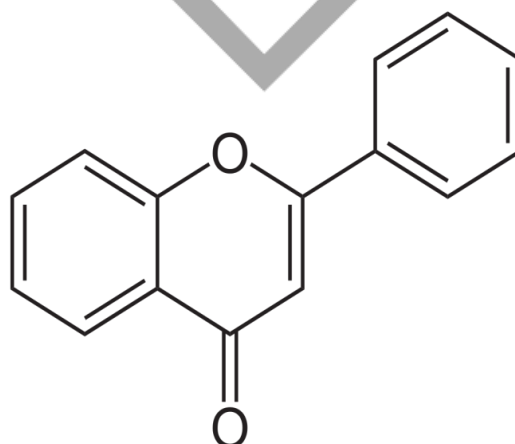
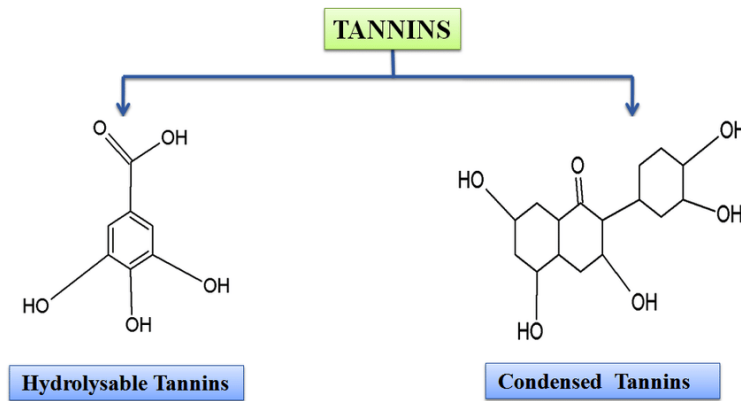


Fig. 3 Structure of Flavonoid "[30]"

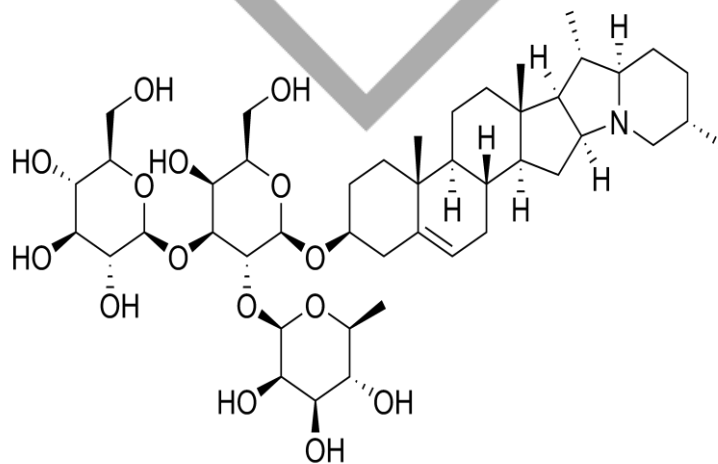


**Cosmetics -**

- Flavonoids are important for skin aging activity. Flavonoids like kaempferol delay skin aging by contrasting enzyme that break down the extracellular matrix, such as collagenase, elastases and hyaluronidases<sup>[29]</sup>.
  - Flavonoids provide the best Antioxidant activity and protect the product from rancidity. The pulp of Limonia Acidissima L. contains ascorbic acid which is responsible for antioxidant activity.
  - Flavonoids also give anti-bacterial, anti-microbial and anti-fungal properties. Quercetin has been reported to completely inhibit the growth of Staphylococcus aureus<sup>[31]</sup>.
- 2) **Tannins** - Tannin are heterogeneous group of high molecular weight polyphenolic compounds with proteins, polysaccharides, alkaloids, nucleic acids and minerals etc<sup>[29]</sup>. Tannins are divided into four group on the basis of its structure- Gallotannins, Ellagitannins, complex tannins, condensed tannins. (Maximilian Nierenstein) studied natural tannins found in different plant species in 1905<sup>[32]</sup>.

Fig. 4 Structure of Tannins<sup>[33]</sup>**Cosmetics-**

- Tannin contain precipitate protein which are used for protection of inflamed surface of skin and treatment of burns<sup>[34]</sup>.
  - Tannins acts as astringent, antioxidant and also provide antibacterial activity<sup>[34]</sup>.
  - Tannins helps to prevent aging of skin
  - Tannins also help to prevent hair loss.
- 3) **Saponins** - Saponins are bioactive compounds produced mainly by plants. Chemically, they occur as glycosides of steroids or polycyclic triterpenes. Because of their lyobipolar properties, they are able to interact with cell membranes and are also able to decrease the surface tension of an aqueous solution. This activity is the reason for the name "saponin", derived from the Latin word "sapo", which refers to the formation of a stable soap-like foam in aqueous solution<sup>[35]</sup>.

Fig. 4 Structure of Saponins<sup>[36]</sup>

**Cosmetics-**

- Saponins are known as natural surfactant, they form stable foam in aqueous solution such as soap.
- They are used in shampoo, liquid detergent and toothpaste as foaming agent.
- Saponins are also used as emulsifier and long lasting foaming agent <sup>[37]</sup>.
- Extract of saponin use as active ingredient in cosmetic for antioxidant, regenerative, and ant aging properties <sup>[38]</sup>.

## 4) Alkaloids

The name of alkaloids derives from the “alkaline” and it was used to describe any nitrogen-containing base. They are usually organic bases and form salts with acids and when soluble gives alkaline solutions. Alkaloids are a group of naturally occurring chemical compounds that contains mostly basic nitrogen atoms. This group also includes some related compounds with neutral and even weakly acidic properties <sup>[39]</sup>

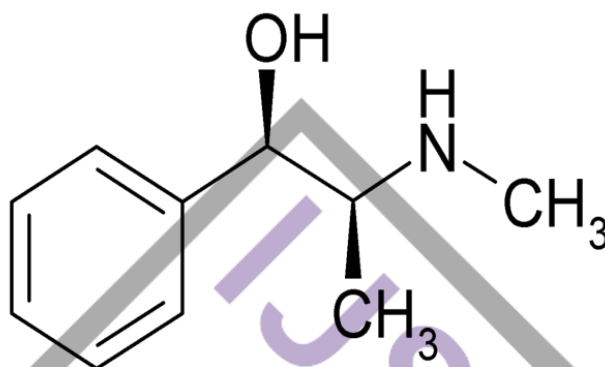


Fig. 5 Structure of Alkaloids <sup>[40]</sup>

**Cosmetics-**

- Alkaloids are responsible for anti-bacterial and anti-fungal activity.
- Pyridine alkaloids have been found to present strong antimicrobial properties and have antioxidant activities due to their ability to act as scavenger of free radicals, hydrogen donation or electron or metal chelating activity <sup>[41]</sup>.
- Alkaloid gives warming effect that can be made use of in foot care for instance.
- Alkaloids fights against wrinkle.
- Alkaloids also helps in Skin-tightening <sup>[42]</sup>.

**VIII. FUTURE SCOPE**

Antibacterial activity is observed from the aqueous extract and ethanol extract of essential oil of Leaves and Fruit pulp of *Limonia Acidissima* L.

A separate study shows the Anti-bacterial activity of leaves essential oil of *Limonia Acidissima* L. by using method hydro distillation with the help of Clevenger apparatus. This study shows the anti-bacterial activity against five gram positive bacteria and six gram negative bacteria. Those bacteria are Gram positive - *Bacillus subtilis*, *Bacillus pumilus*, *Micrococcus luteus*, *Staphylococcus aureus* and *Beta Hemolytic Streptococcus pyogenes*. Gram negative - *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Proteus vul-garis*, *Pseudomonas aeruginosa* and *Salmonella typhimuri-um* <sup>[11]</sup>.

Anti-microbial activity is observed from the aqueous extract of essential oil of Fruit pulp of *Limonia Acidissima* L.

Anti-fungal activity is also observed from the Fruit and Fruit shell of *Limonia Acidissima* L. Responsible constituents for anti-fungal activity are Psoralen, xanthotoxin, 2,6-benzoquinone, sterol.

Anti-oxidant activity is also observed from the methanol extract of stem bark, methanol extract of fruit pulp also shows anti-oxidant activity.

Shell of the *Limonia Acidissima* L. is very tough like a walnut shell so by grinding the shell of *Lomonia Acidissima* L. and by passing them through a sieve we can get small, similar shaped granules. These granules of *Limonia Acidissima* L. shell can be used for exfoliation purpose in skin care cosmetics which help to remove the dead cells from the skin surface.

## CONCLUSION

Limonia Acidissima L. is also known as wood apple and it belongs to family Rutaceae. Wood apple is known for its different properties in different industries. A complete ripe fruit can be directly consumed, it is also famous for its combined sweet and bitter taste and different dishes made from it. Wood apple have different medicinal uses – It is used as tonic for heart and lungs, the unripe fruit is used as anti-diarrhoeal, leaves of wood apple are anti-diabetic, fruit pulp is used in the treatment of sore throat etc. Apart from medicinal properties wood apple also shows various pharmacological activities like – Wound healing, anti-oxidant, adsorbent, and anti-bacterial, anti-fungal all the properties are explained in this article.

The main aspect of this article is to focus on the cosmetic properties of the wood apple. Different parts of wood apple are responsible for different activities and we can use those activities in cosmetics application. Essential oil extract from leaves of wood apple gives anti-bacterial activity, so we can use it in the cosmetic product as needed. We can also use the anti-bacterial extract against five gram positive and six gram negative bacteria which is mentioned in the above topic. Mainly the shell can be used for the exfoliation purpose in skin care cosmetics.

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