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**A POTENTIAL REVIEW: PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF SWEET LIME (MOSAMBI FRUIT)**

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**Abstract:**

Mosambi citrus looks very much like a lime with an underlying yellow base and is about 7 centimeters in diameter. Some fruits will exhibit more yellow colouring and even the occasional orange hue. A nice, ripe Mosambi will be heavy for its size. The skin is full of essential oils; the surface of the peel will release an intense aroma. Mosambi, or sweet lime as it is called, is a fruit with great benefits for the health. Being as a seasonal fruit, Mosambi is available mostly in summers and hence both the fruit and its naturally sweet and tangy juice can make feel refreshed and energized in an instant. Grown mostly in the tropical climate of South-East Asia. Apart from its delightful taste, the fruit is also rich in: vitamin C, copper, zinc, iron, calcium, potassium etc. It is low in fat and has several therapeutic qualities. Apart from being consumed as a juice, Mosambi is also consumed extensively in the form of jams, pickles, sorbets and as a meat marinade. Indeed, it is a versatile fruit with many benefits. The most potential therapeutic activity of Mosambi fruit are: helps in digestion, prevents gum and teeth diseases, recovers immune system promotes bone health, good for eyes, skin and hair, good in pregnancy, aids weight control, helps nervous system, antioxidant, good for respiratory health, maintains sugar levels, aids liver functioning, boosts blood circulation etc. This study is focused on highlighting the phytochemical investigations, traditional uses and clinical applications of Citrus limetta as well as its chief constituent-limonene, which provides approval for further pharmacological and clinical investigations.

**Key Words:** Mosambi; essential oils; antioxidant; phytochemical; limonene etc.

## **INTRODUCTION**

Citrus limetta, alternatively considered to be a Citrus limon, C. limon 'Limetta' is a species of citrus, commonly known as mousambi, musambi, sweet lime, sweet lemon, and sweet limetta, it is a member of the sweet lemons [1]. It is native to southern regions of Iran [2] and also cultivated in the Mediterranean Basin. In North India, it is commonly called mousambi, mosambi, or musambi [3]. In East India, and Malayalam, Bathayi in Telugu, and sathukudi or sathukodi in Tamil. In Nepali, it is called Mausam.

## **Plant description**

C. limetta is a small tree up to 8 m (26 ft) in height, with irregular branches and relatively smooth, brownish-grey bark. It has numerous thorns, 1.5–7.5 cm (0.59–2.95 in) long. The petioles are narrowly but distinctly winged, and are 8–29 mm (0.31–1.14 in) long. Leaves are compound, with acuminate leaflets 5–17 cm (2.0–6.7 in) long and 2.8–8 cm (1.1–3.1 in) wide. Flowers are white, 2–3 cm (0.79–1.18 in) wide. Fruits are oval and green, ripening to yellow, with greenish pulp. The pith is white and about 5 mm (0.20 in) thick. Despite the name sweet lime, the fruit is more similar to a greenish orange in appearance. C. limetta grows in tropical and subtropical climates. It begins bearing fruit at 5 to 7 years old, with peak production at 10 to 20 years. It is propagated by seed.



**Fig-1: Sweet Lemon Plant**

### Scientific classification

Kingdom:	Plantae
(unranked):	Angiosperms
(unranked):	Eudicots
(unranked):	Rosids
Order:	Sapindales
Family:	Rutaceae
Genus:	<i>Citrus</i>
Species:	<i>C. limetta</i>
<b>Binomial name</b>	
<i>Citrus limetta</i>	

### PHYTOCHEMISTRY

#### Sweet Lime (Mosambi Fruit) [4]

It is the citrus fruit commonly found almost throughout the year. Although mosambi is similar in appearance to lemon, it tastes sweeter. There are many benefits of mosambi and hence widely consumed by people of all ages. The mosambi plants grow abundantly in South-East Asia. Mosambi fruits are small in size, green or yellow colored fruits. The shape of the mosambi ranges from round to oval. The taste of mosambi is similar to that of an orange. The refreshing mosambi juice is both delicious and healthy. Mosambi is commonly called as sweet lime because it has a sweet taste and resembles lime in its appearance. The color of the mosambi can range from shades of yellow to green, with light green as the most common shade. Since the temperatures are very hot in summer, it is recommended to consume a fresh glass of mosambi juice at regular intervals to protect from dizziness and weakness.



**Fig-2-A: Mosambi fruits.**



**Fig-2-B: Mosambi fruits**

### **Nutritional value of Mosambi**

Sweet lime has great nutritional value and hence beneficial for the health of an individual. Eating a mosambi will help in meeting the Vitamin C requirement for the body of an individual. Sweet lime is an extremely versatile fruit with both a sweet and sour taste. The fruit can be consumed in many forms such as jams, drinks, snacks, candies, pickles, drinks, etc. Mosambi is the right choice for people who are looking forward to a low-calorie diet. Sweet lime contains about 43 calories and 0.3gms of fat. Sweet lime is a citrus fruit and hence a very rich source of Vitamin C. It is found to be rich in Potassium almost 490mg in a serving. Smaller amounts of copper, calcium, phosphorus, and iron are found in mosambi.

Till now about 12 nutritional chemicals and 30 compounds have been identified in various studies. Limonene is the main component of the citrus peel oils and it ranges from 40-95% in concentration in citrus fruits.

**Table-1: Nutritional compositions [4]**

Sweet Lime	
Nutritional value per 100 g (3.5 oz)	
Energy	180 kJ (43 kcal)
Carbohydrates	9.3 g
Sugars	1.7g
Dietary fiber	0.5 g
Fat	0.3 g
Protein	0.7-0.8 g
Vitamins	Quantity %DV <sup>†</sup>
Vitamin C	60%, 50 mg
Minerals	Quantity %DV <sup>†</sup>
Calcium	4%, 40 mg
Iron	5%., 0.7 mg
Phosphorus	4%, 30 mg
Potassium	10%, 490 mg
Other constituents	Quantity
Water	88 g

**Table-2: Chemical composition of the Citrus limetta peel as analyzed by GCMS [5]**

S. No	Retention time	Active constituents	Quantity (%)
1	11.32	d-limonene	78.3
2	14.59	Bergamol	6.21
3	9.14	$\beta$ -pinene	5.6
4	14.51	Linalool	5.15
5	7.54	$\alpha$ -pinene	1.58
6	11.51	1,8 cineole	0.76
7	14.60	$\alpha$ -terpineol	0.51
8	21.50	Neral	0.28
9	22.31	Geranial	0.21
10	31.72	$\beta$ -Bisabolol	0.10
11	30.03	$\beta$ -Bisabolene	0.10
12	9.78	$\beta$ -Myrcene	0.08
13	10.30	Sabinene	0.08
14	16.95	Citronellal	0.07
15	15.06	$\alpha$ -Terpineol acetate	0.06
16	8.07	Camphene	0.06
17	31.72	$\alpha$ -Bisabolol	0.05
18	31.80	Bicyclogermacrene	0.03
19	20.97	Farnesol	0.03
20	51.07	Terpinen-4-ol	0.03
21	14.59	Trans-nerodilol	0.03
22	53.01	$\beta$ Farnesene	0.03
23	10.29	Nonanal	0.01
24	44.30	Phytol	0.01
25	34.07	Hinesol	0.01
26	10.11	$\alpha$ -phellandrene	0.01
27	17.57	Borneol	0.01
28	42.10	Myrcenil acetate	0.01
29	27.09	$\beta$ -Santalene	0.01

## PHARMACOLOGICAL PROFILE OF MOSAMBI FRUIT



**Fig-3: Health benefits of sweet lime**

### **1. Gallstone dissolution**

In an in vitro study performed on d-limonene, it was observed that it could dissolve human gallstones within two hours. In animals, infusion of d-limonene into the gallbladder dissolved and disintegrated gallstones, which were excreted through the common bile duct. In patients post gallstone surgery, infusion of 20 mL d-limonene every other day dissolved gallstones overlooked during surgery. In some patients gallstone dissolution occurred after only three infusions [6].

### **2. Anticancer activity**

Animal studies have set the stage for further investigation into the chemoprotective activity of d-limonene for several types of cancer. Several studies suggested that inhibition of chemically-induced mammary cancer in rodents administered either orange peel oil or pure d-limonene [7-10] caused inhibition in either the initiation or

promotion phases, depending on the chemically-induced medium used [11-13]. Other experimental studies demonstrated that d-limonene inhibited development of liver cancer, pulmonary adenoma, and for stomach tumors [14-16].

### **3. Gastroesophageal reflux**

d-limonene has been shown to be effective in relieving occasional heartburn and gastroesophageal reflux disorder (GERD [17].

**4. Antibacterial and antifungal effects:** The peel oil extract when applied against different food borne pathogens including bacteria (*Staphylococcus aureus* ATCC 25923, *Bacillus subtilis* ATCC 6633, *Bacillus cereus* ATCC 14579, *Lactobacillus acidophilus* ATCC 4356, *E. coli* ATCC 25922, *Salmonella typhimurium* ATCC 14028 and fungi (*Aspergillus niger* ATCC 16404, *Aspergillus flavus* ATCC 204304, *Aspergillus fumigatus* KM 8001, *Aspergillus ficuum* ATCC 66876, *Aspergillus oryzae* ATCC 10124, *Fusarium oxysporum* ATCC 48122, *Penicillium digitatum* ATCC 201167, *Fusarium miniformes* MAY 3629, *Fusarium saloni* MAY 3636, *Candida utilis* ATCC 9950). It was found that peel oil exhibited maximum zone of inhibition against *B. cereus* ATCC 6633 (26 mm) followed by *S. aureus* ATCC25923 (21 mm) after 48 hours of incubation at 370 C, whereas the minimum zone of inhibition was shown by *F. oxysporum* ATCC 48122 (11 mm) after 48 hours of incubation at 250 C in comparison with streptomycin/fluconazole at 20 µl per disc. However, *A. niger* ATCC 16404, *A. flavis* ATCC 204304, *A. fumigates* KM 8001, *A. ficuum* ATCC 66876, *C. utilis* ATCC 9950, *P digitatum* ATCC201167, *E. coli* ATCC 25922, *L. acidophilus* ATCC 4356, *S. typhimurium* 14028 and *E. aerogenes* ATCC 13048 gave 22,19,14,12,13, 18, 13, 18, 17 mm of zone of inhibition [18].

**5. Antioxidant activity:** Antiradical activity was evaluated by measuring the scavenging activity of the examined *C. limetta* oil on the 2, 2-diphenyl-1-picrylhydrazil (DPPH) radical. The DPPH assay was performed as described by [19]. The samples (100 µl each) were mixed by 3 ml of DPPH solution. The absorbance of the resulting solution and the blank (with only DPPH and no sample) were recorded after an incubation time of 30 min at room temperature against ascorbic acid as a positive control. For each sample, three replicates were recorded. The disappearance of DPPH was measured spectrophotometrically at 517 nm. The percentage of radical scavenging activity was calculated. It is the ability of essential oils to act as a donor for hydrogen atoms or electrons in the transformation of DPPH-H (which is measured spectrophotometrically)



gives them antioxidant activity characteristic. The results of DPPH scavenging activity of C. limetta oil compared with ascorbic acid as a reference standard indicating that it has slightly lower antioxidant activity comparative to reference standard, ascorbic acid, being a strong antioxidant reagent.

**6. Antihyperglycaemic activity:** Citrus limetta fruit peel contain the flavonoids hesperidin and naringin. Hesperidin and naringin both are proven to be potent hypoglycaemic agents and their hypoglycaemic activity is postulated to be partly mediated by hepatic glucose regulations enzymes in C57BL/KsJ-db/db mice. Dietary hesperidin also exerts hypoglycemic and hypolipidemic effects in streptozotocin-induced diabetic rats [20]. Naringin provided a significant amelioration of hypoglycaemic and antioxidant activity in STZ-induced diabetic rats [21]. Therefore, it can be postulated that the presence of flavonoids in the extract might be the reason of the antihyperglycemic action.

**7. Antitumor potential of Citrus limetta peel:** Methanolic extract of Citrus limetta peel at the dose level of 200 and 400 mg/kg body weight increased the life span, non-viable tumor cell count and decreased the cell count compared to the Ehrlich ascites carcinoma (EAC) control mice [22].

**8. Antagonizing the hypertensive effect of angiotensin II:** In a study reported acute response of blood pressure to angiotensin II administration was measured in mice. Also, the acute oral toxicity profiles were determined. Investigations showed that different concentrations of the aqueous extract prevented the raise of systolic blood pressure, diastolic blood pressure and mean blood pressure with a dose dependent effect for diastolic pressures at 125-500 mg/kg dosages. The 500 and 1000mg/kg doses inhibited the action of Ang II in similar extent to telmisartan. Toxic signs or deaths were not observed in mice treated at 2000mg/kg of Citruslimetta extract. All doses of C. limetta aqueous extract, used in this assay, were safe and effective [23].

**9. Larvicidal activity:** Citrus limetta peel extracts were prepared using hexane and petroleum ether as the solvents and it was assessed against dengue fever vector, *Aedesaegypti* and malarial vector, *Anopheles stephensi*. Toxicity effects were evaluated on early fourth instars. Both the extracts were found effective against both the species. Evaluation results revealed that the hexane extracts possessed 1.9 fold more larvicidal potential against *A. stephensi* as compared to the extracts obtained using petroleum ether as solvent [24].

## **10. Traditional uses of Citrus limetta**

**10.1. In the treatment of scurvy:** This disease is caused by vitamin C deficiency characterized by swollen gums, frequent bouts of flu, clod and cracked lip corners. Being rich in vitamin C, mosambi is effective in curing scurvy.

**10.2. As digestive aid:** Due to its sweet fragrance, mosambi juice facilitates the release of saliva from the salivary glands which assists in quick digestion. The flavonoids present in lime juice enhance the digestive process by stimulating the secretion of bile, digestive juices and acids. Thus, drinking mosambi juice frequently throughout the day can ward off stomach problems, indigestion, nausea and dizziness. The acids present in mosambi juice help in the removal of toxins from the bowel tracts, thus easing constipation. Sweet mosambi juice with a pinch of salt can provide immediate relief. Additionally, it is effective in case of stomach upsets, dysentery, diarrhea and loose motions as it is rich in potassium. Due to its tasty flavor, it helps in avoiding vomiting and nausea. It also helps in curing bloody amoebic dysentery.

**10.3. Antidiabetic benefits:** Mosambi juice is beneficial for diabetes patients. To treat diabetes, you can mix 2 teaspoons mosambi juice, 4 teaspoons amla juice and 1 teaspoon honey and take this on an empty stomach every morning for best results.

**10.4. Antiulcer effects:** Peptic ulcers are open sores that occur on the inner lining of your esophagus, stomach or upper intestine and cause a lot of abdominal pain. The acids in lime juice provide relief against peptic ulcers by causing an alkaline reaction in the system, thus reducing gastric acidity. For best results, you can drink a mixture of mosambi and lemon Juices. Drinking mosambi juice in warm water treats mouth ulcers and bad breath.

**10.5. Immunity booster:** Regular consumption of mosambi juice ensures proper blood circulation by improving the function of the heart. This results in a much healthier immune system.

**10.6. Weight reduction:** Being low in fat and calories, mosambi juice helps in reducing weight. You can drink a mixture of mosambi juice and honey to burn extra calories.

**10.7. Beneficial in pregnancy:** Pregnant women are often advised to drink mosambi juice as it provides a lot of calcium that benefits both the growing fetus and the mother to be.

**10.8. Treatment of urinary disorders:** Being rich in potassium, mosambi juice helps in treating urinary disorders such as cystitis. Cystitis is an inflammation of urinary

bladder, also known as urinary tract infection (UTI). Mosambi juice boiled in water should be taken within a couple of hours after cooling for immediate relief in cystitis. Potassium facilitates the detoxification process of kidneys and bladder, preventing various types of urinary tract infections.

**10.9. Ophthalmic benefits:** Due to its antioxidant and anti-bacterial properties, this juice protects your eyes from infections and muscular degeneration. Washing your eyes with a few drops of mosambi juice mixed in plain or salt water can help in treating infections like conjunctivitis.

**10.10. Antihyperlipidemic effects:** Drinking mosambi juice reduces cholesterol and lowers blood pressure.

**11. Benefits of Mosambi Juice in various skin diseases:** Mosambi juice has an important role to play in skincare. Being rich in vitamin C, it improves the skin color naturally and is used in several beauty products and alternative medicine supplements and vitamins. Some of its skin benefits are:

**Treatment of Pigmentation, Spots and Blemishes:** Mosambi juice treats various pigmentation issues such as spots, pimples and blemishes. For this purpose, apply fresh mosambi juice on the affected area at bedtime and wash with warm water the next day.

**Prevention of Skin Problems:** Mosambi juice is great for skin health due to the presence of vitamins and minerals. Its antioxidant, antibiotic and disinfectant properties rejuvenate the skin by protecting it from infections. Mosambi juice cleanses your blood, thus providing relief against skin problems.

**12. Treatment of Body Odor and Sweat:** Taking a bath with mosambi juice mixed water helps in tackling body odor and sweat.

**13. Treatment of Cracked Lips:** Rubbing mosambi juice on lips 2-3 times a day can reduce the darkness of lips and also treats chapped lips.

**14. Reduction of Swelling and Pain:** Applying a mixture of mosambi juice and castor oil on the affected area can lessen swelling and pain.

**15. Side-Effects & Allergies of Sweet Lime (Mosambi Fruit):** There can be various side effects of sweet lime juice. They are: GERD or Gastro-Esophageal Reflux Disorder results from acidic and spicy foods. The juice of mosambi can irritate oesophageal lining to trigger GERD. It can exacerbate peptic ulcers and extremely painful sores that lay on the stomach lining. Excessive consumption of sweet lime juice during pregnancy can

harm the fetus. Patients suffering from kidney disorders must avoid it. Mosambi juice is good for health only when consumed in moderation.

### **CONCLUSION**

Rich in flavonoids, its juice stimulates our digestive system and thus increases the secretion of bile, acidic and other digestive juices. The ones who suffer from indigestion are mainly asked to intake sweet lime juice. It helps those who suffer from digestive and gastrointestinal problems along with irregular bowel movement. Its juice simply neutralizes the digestive juices that are acidic in nature, and thus aids in digestion. It helps to flush out the body toxins and waste matter. The compounds present in it aids in peristaltic motion. With the regular consumption of this juice, one can keep vomiting, nausea or diarrhea at bay. Sweet lime, also known as 'Mosambi', is grown in Northeast hills of India and is mostly available between July and August. During summers, it is hard to avoid a cup of pale yellow drink sold by the street vendors called 'Mosambi Juice'. The juice is a hot favorite in India which is consumed not only for its taste but also for an array of health benefits it offers. The rich source of potassium and vitamin C offers medicinal benefits and has a coolant effect on the body. Unlike lemon, the juice of mosambi is not sour and it tastes awesome when sweet. The juice is also used for preparing a variety of dishes. Benefits worth mentioning are; the treatment towards sun strokes, dehydration, motion sickness and gout. The acidic content of mosambi helps to flush out body toxins and waste matter. Being rich in dietary fiber, mosambi acts as a purgative treatment for the ones who suffer from constipation. This refreshing drink is energizing and good for improvement of joint health. It offers a variety of beauty benefits as well.

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