



## PHYTOCHEMICAL AND PHARMACOLOGICAL CHARACTERISTICS OF LIMONIA ACIDISSIMA LINN: A COMPREHENSIVE REVIEW

**Sampat Singh Meena** Department of Botany Government College, Tonk (Raj.). E-mail: [sampatgothara@gmail.com](mailto:sampatgothara@gmail.com);

### Abstract

Kaitha is a subtropical fruit that has high nutritional value and it is cultivated for its fruits as Kaitha fruit has nutritional value age main source of vitamin A and C, Antioxidant (beta carotene) minerals (Iron, Phosphorus, Zink, Calcium) and high amount Fiber and high amount of protein and essential fatty acid and oils.

Kaitha helps to protect against macular degeneration, antioxidant, enhance skin complexion, antimicrobial activity against bacteria and fungi, anti-inflammatory, antiviral, anti-cancer, anti-diabetic, cardio protective, gastro protective and hepatoprotective and use in traditional medicine for various elements.

This review is based on the form of pharmacological, phytochemical and nutritional use of Kaitha. Flavonoids, alkaloids, phenolics, terpenoid, tannin, glycoside, steroids, saponins, fats present in Kaitha plants. Leaves of Kaitha plant contain psoralen, stigmaterol, orientin, bergapten, vitedin, tannins, and essential oils,(Patel et al., 2021; Sharma1 and Tenguria2, 2021a) Fruits of Kaitha contain flavonoids, glycosides, saponins, tannins, coumarins, alkaloids, lignin, triterpene, and sterols. Stem bark contains flavanone, alkaloid, coumarins, lignin, triterpene, and sterols.(Patel et al., 2021; Sharma1 and Tenguria2, 2021a)

This review is helpful to summarizes recent pharacognostical, various nutritional, bioactive, phytochemical and pharmacological applications of this fruit, This review will be helpful to create interest toward the lesser-known facts and less documented work done on *L. acidissima*.(Srivastava et al., 2019)

### Keywords

Kaitha, Nutritional Value, Antioxidant, Ethnomedicinal

### 1.Introduction

Kaitha (*Limonia acidissima* Linn) is a deciduous, erect, slow-growing tree, with a few upward-reaching branches bending outwards near the summit where they are subdivided into slender branchlets drooping at the tips. Its fruit is spherical in shape with 5–12.5-cm diameter. Kaitha (*L.acidissima*) is a moderate (Sharma1 and Tenguria2, 2021) e to large size

of tree which is associated with the family Rutaceae (Citrus family), that grows up to 30 ft tall, plant bark is rough and spiny. (Sharma1 and Tenguria2, 2021a) According to Morton, 1987 *L. acidissima* is native and common in dry plains of India and Ceylon. It is distributed throughout India. (Pandavadra and Chanda, 2014; Sharma1 and Tenguria2, 2021a) But it is cultivated, similarly found in forests, and known as a border plant.(Singh et al., 2007)

Kaitha plant (*Limonia acidissima* L.) is known as barriers vernacular name in different reason such as wood apple and elephant apple in English Kaitha in Hindi and Marathi, beil in Hindi kotha in Gujarati, Kadu nimbe in Kannada, kattunarakam in Malayalam, Vilankai in Malayalam, Vilaa in Tamil, Kapitthamu in Telugu, Parupovelaga in Telugu. (Pandavadra and Chanda, 2014; Patel et al., 2021a)



Figure 2 Kaitha Plant



Figure 1 Fruit

Cultivated for its fruits, Kaitha is a subtropical fruit with a high nutritional value. The fruit known as Kaitha



is very nutritious and the primary source of antioxidants (beta carotene), iron, phosphorus, zinc, and calcium), vitamins A and C, high levels of fiber, high levels of protein, and vital fatty acids and essential oils. (Patel et al., 2021; Sharma1 and Tenguria2, 2021a)

Plants have been used for thousands of years as a source of traditional medicines, with their low side effects and increasing popularity in pharmaceuticals and cosmetics. They contain various phytochemicals, essential oils, and essential oils used in various industries. The fruit wood apple, found in India, Pakistan, Bangladesh, Sri Lanka, and Southeast Asia, has a sour and funky taste and is used as a remedy for cancer, diabetes, diarrhoea, ulcers, and blood pressure.

In traditional medicine, Kaitha is used for a variety of purposes. It is an antioxidant, improves skin tone, anti-bacteria and fungus, reduces inflammation, has antiviral, anti-cancer, anti-diabetic, cardioprotective, gastroprotective, and hepatoprotective properties.

The pharmacological, phytochemical, and nutritional uses of Kaitha form the basis of this review. Kaitha contains flavonoids, alkaloids, phenolics, terpenoids, tannins, steroids, saponins, and essential oils. (Saima et al., 2000)

Kaitha (*Limonia acidissima L.*) is a moderate (1) to large size (4) of tree which is associated with the family Rutaceae, that grows up to 30 ft tall, plant bark is rough and spiny. (4) (Sharma1 and Tenguria2, 2021a)

The leaves are alternate, imparipinnate compound leaves with an entire margin, with five to seven with surface appearance and texture glabrous. (Bhavsar et al., n.d.; Pandavadra and Chanda, 2014)

The flowers are white and have five petals with terminal and lateral panicles inflorescence (Pandavadra and Chanda, 2014)

*Limonia acidissima*, also known as Wood Apple or Elephant Apple, produces edible fruit. It looks greenish-brown on the outside and the sticky brown pulp has several white tiny seeds that are imbedded in it. (Pandavadra and Chanda, 2014; Srivastava et al., 2019)

The fruit is a berry that is 1.9-3.5 inches in diameter, with a hard, woody epicarp (shell) and a sour, pulpy interior. However, it's important to note that the fruit is quite sour and may require sweetening. The fruit is rich in vitamins, minerals, and antioxidants, making it a nutritious and versatile food source. The pulp and juice of the fruit are edible and are used in various ways, such as: Making juice, squash, or syrup, preparing chutneys, jams, and preserves, adding flavour to salads and desserts, Making face creams and skincare products (in Myanmar)

*L. acidissima* fruit's epicarp is cracked using a hammer and is dark, mealy, fragrant, resinous, acidic, or sweetish. Fruit used in a variety of products for human consumption due to highly nutritious source. (Srivastava et al., 2019) Fruits of *L. acidissima* are mostly used in food products as Murabba, pudding, and juice but unripe fruit is eaten as chitin, but it has a sour taste so requires sweetening. (Srivastava et al., 2019)

## 2. Aim of study

Aim of review is to provide a comprehensive overview, summarize and synthesize existing phytochemical, pharmacological therapeutic, potential toxicity, bioactive compounds traditional and folk uses and safety profiles of wood apple uses, and benefits. By reviewing the literature, researchers can gain a deeper understanding of *Limonia acidissima*'s value and potential and guide further studies to unlock its full potential.

## 3. Nutritional profile of Kaitha

Table 1. Biochemical composition of *L. acidissima*

Nutrients	Pandey et al. (2014) (Pandey et al., 2014a)	Sharma et al (2014)	Jyotsana et al (2015)



Moisture (%)	6.4	76.33	72.4
Protein (%)	13.8	2	7.2
Fat (%)	4.3	3.78	2.07
Carbohydrates (%)	70	-	15.13
Ash (%)	5.28	1.32	3.2
dietary Fiber (%)	1.7	-	-
Ascorbic acid (mg/100g)	-	7.1	-
<b>Vitamins (<math>\mu\text{g/g}</math>)</b>			
Vitamin C	180	-	66.4
Riboflavin(B2)	0.23		
Thiamine(B1)	0.31		
Beta-carotene	0.04		
PH		3.5	3.4
Acidity	-	2.92	3.18
Total sugar%	-	1.6	
Reducing sugar %	-	1.1	
Pectin content%	-	2.05	
<b>Minerals (<math>\mu\text{g/g}</math>)</b>			
P	1137.35	-	98.8
Mg	852.5		
Ca	711.8	-	88.8
Fe	23		
Zn	23.84		
Cu	6.67		
Mn	3.64		
Sb	0.626		
As	ND		
Be	ND		
Cd	ND		

Cr	1.543		
Co	ND		
Pb	0.163		
Li	0.241		
Mo	0.263		
Ni	0.819		
Se	0.768		
Sr	ND		
Tl	1.93		
Ti	0.257		
Sn	0.474		

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dietary Fiber (%)	1.7	-	-
Ascorbic acid (mg/100g)	-	7.1	-
<b>Vitamins (<math>\mu\text{g/g}</math>)</b>			
Vitamin C	180	-	66.4
Riboflavin(B2)	0.23		
Thiamine(B1)	0.31		
Beta-carotene	0.04		
PH		3.5	3.4
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Total sugar%	-	1.6	
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**Table 2:** Phytochemical constituents of Kaith (dried pulp) (Pandey et al., 2014a)

Components	Pulp	Rind
Alkaloids (g/100 g DM)	36	13.27
Saponins (g/100 g DM)	0.16	0.5
Total phenols (µg GAE/mg)	35.72	33.8
Flavonoids (µg CE/mg)	35.51	39.51

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Table 3. Quality phytochemical analysis (Secondary metabolites) of kaitha

Components	(Sharma1 and Tenguria2, 2021)		(Pandavadra and Chanda, 2014)		Methanol plant extrate (Patel et al., 2021)			(Thomas and Ponnammal, 2005)		
	Leaf	Stem	Leaf	Stem	Leaf	Fruit pulp	Fruit rind	Leaf	Bark	Pulp
Alkaloids	+	+	+	+	-	-	-	+	+	+

Saponins	+	+	-	-	-	-	+	+	+	+
Tannins	+	-	+	-	-	-	+	+	+	+
Flavonoids	+	+	+	+	+	-	-	-	+	+
Glycosides			+	+				+	+	+
Terpenoids	-	+	+	+	-	-	-	+	+	+
Gum and mucilage								-	+	+
Phenols								+	+	-

‘+’ symbol for positive and ‘-’ symbol for negative

**Table 4:** Biochemical composition of Wood Apple (Thomas and Ponnammal, 2005)

Plant Parts	Protein (mg/g)	Carbohydrate (mg/g)	Amino acid (mg/g)
Bark	10.53 ± 0.09	3.23 ± 0.09	9.10 ± 0.29
Leaf	14.80 ± 0.16	6.40 ± 0.08	10.86 ± 0.09
Pulp	19.33 ± 0.12	9.38 ± 0.21	10.44 ± 0.08

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Pulp	19.33 ± 0.12	9.38 ± 0.21	10.44 ± 0.08

### Nutritional constituents of Kaitha (dried pulp)

According to Pandey et al., 2014 Kaitha fruit pulp is very good source of nutrients like carbohydrates (70.14%), protein (13.8%), fat (4.3%) and dietary fiber (1.7%), vitamins like Vitamin C (180µg/ g) Riboflavin(B2) (0.23µg/ g) Thiamine(B1) (0.31µg/ g) Beta-carotene (0.04µg/ g) and minerals like calcium, magnesium, iron etc. Presence of low amount of fat (4.3%), and high amounts of zinc are also reported in this fruit.

According to Campous et al., 2009 the presence of iron in fruit indicates effectiveness use against anaemia, tuberculosis and other disorders and effectiveness role of phosphorus and calcium in bone formation, blood clotting and more other metabolic processes

Fruit pulp contains phytochemicals like Alkaloids (g/100 g DM) 36 Saponins (g/100 g DM) 0.16 Total phenols (µg GAE/mg) 35.72, Flavonoids (µg CE/mg) 35.51 polyphenols, vitamins, saponins, coumarins, amino acids, tri-terpenoids, phytosterols and tannins (Phytochemical analysis of *Limonia acidissima* ripe fruits indicates presence of flavonoids, steroids, glycosides and various acidic compounds. The major chemical compounds in leaf are acidissimin and acidissiminol. Presence of alkaloids, phenol, resins, gum and mucilage, fixed oils and fats are also noted in leaves.

#### 3.1 Protein and amino acids

The seeds and fruits of the Kaitha tree contain fatty acids Palmitic acid, Stearic acid, Oleic acid, Linoleic acid, Stigmasterol (found in unripe fruit) and pulp of fruit contain 13.8% of protein.

**3.2 Fats** The fruit also contains low amounts of fat (4.3) %, which is ideal for weight management.

#### 3.3 Vitamins

Kaitha fruit contains numerous amounts of vitamins vitamin c content like Vitamin C (180µg/g) which promotes the synthesis of collagen passed in bond healing and enhance the absorption of iron from food. Thiamine(B1) (0.31µg/g) help to maintain heart and nerve function. Riboflavin(B2) (0.23µg/g), Beta-carotene is also present. (Pandey et al. (2014))

### 3.4 Carbohydrates

Kaitha fruit contain 70.14% of carbohydrates,1.6 %total sugar and 1.1%reducing Sugar. According to Vijayvargia et al. (2013) observed high amount in stem (52±0.81mg/gdw),that is primary organic source of high energy for all living organism and a significant amount of dietary fiber with 1.7% contain soluble fiber.(Vijayvargia et al. (2013)

### 3.5 Minerals

Kaitha fruit contains a significant amount of minerals it helps in mounting synthesis along with the smooth flow of blood such as calcium 711.8(µg/g), magnesium 852.5(µg/g) iron23(µg/g) zinc 23.84(µg/g) copper 6.67(µg/g) Phosphorus 1137.35 (µg/g).According to Campous et al., 2009 the presence of iron in fruit indicates effectiveness against anaemia, tuberculosis and other disorders and the effectiveness of phosphorus and calcium in bone formation, blood clotting and more other metabolic processes.

**3.4 Starch**(Senthilkumar et al., 2010) Starch Is an important biomolecule in both plants and animals. According to Vijayvargia et al. (2013) Quantitative estimation of starch in stem is significantly higher. (18.4±0.21 mg/gdw)

## 4.Pharmacological Activities of Kaitha

Wood apple is a plant that has been shown various beneficial impacts on the human body both nutritionally and therapeutically. Various studies were carried out in the last years to investigate the pharmacological and dietary benefits of Kaitha.(Kerkar et al., 2020; Senthilkumar et al., 2010; Shermin et al., 2012a; Thomas and Ponnammal, n.d., 2005) Fruit of kaitha is also used as ethnomedicine for folk medicine for the treatment of a variety of ailments.(E. Mohana Priya, 2012; Senthilkumar et al., 2010)

### Analgesic

According to Momin et al., 2013 leaf extract (Tannins, steroid, flavanol, alkaloids) of wood apple has confirmed the analgesic potentiality test justify the traditional uses of this plant for pain management.

Table 5. Pharmacological activities of wood apple

Pharmacological Actions	Plant Parts	Mode of action	References
Anti- tumour	Fruit pulp and stem bark	An acidic heteropolysaccharide has been isolated and a partially carboxymethylated α-(1–4) polygalacturonan backbone structure with 2- and 2,4- <i>O</i> -α-1-rhamnopyranosyl, 2- and 2,3- <i>O</i> -α-1-arabinofuranosyl and 3-, 2,4-and terminal α-d-galactopyranosyl bearing side chains has been tentatively assigned. The murine model showed some significant in vivo Ehrlich ascites carcinoma cell growth inhibition.	(Saima et al., 2000)
Anti- oxidant	Fruit, stem, leaves	The methanolic extract of fruit was also screened for their free radical scavenging properties by FRAP assay and DPPH assay (showed the highest free radicle scavenging activity is shown in crude methanolic extract) and Different extracts from leaves has been	(Ilango and Chitra, 2010; Ilango K Chitra V, 2009; Nanasombat et al., 2022; Patel et al., 2021b; Shermin et al., 2012b)



		reported and methanolic extract of fruit pulp of wood apple (MELA) against carbon tetra chloride (CCl <sub>4</sub> ) induced liver damage in rats.	
Anti- diabetic	Fruit pulp and stem bark	The methanolic extract of fruit pulp and aqueous leaf extract of wood apple	(E. Mohana Priya, 2012)
Cytotoxic	stem bark		(Shermin et al., 2012)
Analgesic	leaves	Analgesic activity of the crude extract was evaluated using acetic acid-induced writhing model of pain in mice.	(Momin et al., 2013)
Anti-diarrhoeal Gastrointestinal motility	leaves	Alcoholic and aqueous extract of bark and Ethanolic extract of plant.	(Momin et al., 2013; Senthilkumar et al., 2010)
Anti-inflammatory	Leaves		Khare et al., 2014)
Anti-bacterial	Leaves, fruit pulp	ethanolic extract of leaves of wood apple	(Pandey et al., 2014b; Thomas and Ponnammal, 2005)
Anti-microbial and antifungal	fruit pulp and leaves	Different extracts of fruit pulp (petroleum ether, chloroform, methanol and aqueous) of plant and essential oil produced by the leaves.	(E. Mohana Priya, 2012; Nanasombat et al., 2022; Patel et al., 2021b)
Hepatoprotective	Fruit pulp	Hepatoprotective and antioxidant activities of methanolic extract of fruit pulp of wood apple (MELA) against carbon tetra chloride (CCl <sub>4</sub> ) induced liver damage in rats.	(Ilango K and Chitra V, 2009)
Wound Healing	fruit pulp	The methanol extract of fruit pulp (MELA) in incision, excision and dead-space wound models.	(Ilango and Chitra, 2010)

**Kaith fruit contain Conclusion**

Kaith fruit contain several physiologically bioactive compounds such as flavonoids, and tannins,alkaloids’ which contribute to its significant role. Moreover, fruit may effectively be utilized in many pharmaceutical applications such as macular degeneration, antioxidant, enhance skin complexion, antimicrobial activity against bacteria and fungi, anti-inflammatory, antiviral, anti-cancer, anti-diabetic, cardio protective, gastro protective and hepatoprotective and fruits of *Limonia acidissima* Linn are used traditionally in India for the treatment of various elements such as tumours, asthma, wounds, cardiac debility and hepatitis.

Kaitha is using at small level to produce many marketable products, including chutneys, sweets, Savory, jam, drinks, juice, and syrup.

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