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Wood apple (*Kaith*): A nutritious underutilized fruit

Wood apple (*Feronia limonia* syn. *Limonia acidissima*), an underutilized arid zone fruit of the Rutaceae family, is valued for its nutritional richness, medicinal properties, and diverse uses. Native to India, it thrives in tropical and subtropical climates, tolerating drought and poor soils. The pulp is high in pectin, carbohydrates, proteins, vitamins (A, B-complex, C), minerals, and fiber, supporting gastrointestinal health and various culinary applications. It remains underutilized despite its potential for income generation, climate-resilient farming, systematic cultivation, varietal enhancement, and improved post-harvest management. Promoting wood apple through crop diversification programs can enhance rural livelihoods, food security, and sustainability under changing climate conditions.

WOOD apple (*Kaith*, *Feronia limonia* syn. *Limonia acidissima*) is an arid-zone fruit native to India, found growing throughout the country except in higher hills. *Kaith* is a slow-growing deciduous tree belonging to the family Rutaceae. The trees are medium to large in size.

Kaith is a multipurpose tree species valued for its edible fruits, gum, wood, alkaloids, and numerous medicinal properties. It has been used in India since prehistoric times. The pulp of the wood apple is sweet–sour in taste and contains many small seeds. It is rich in nutrients and possesses several medicinal properties. The pulp contains high amounts of pectin, carbohydrates, protein, fat, and fiber. It is also a good source of vitamin A, B_1, B_2, B_3, C, iron, calcium, phosphorus, zinc, and manganese.

Both unripe and ripe fruits are used in the preparation of jam, jelly, sherbet, chutney, chocolates, and other products. Sherbet and chutney made from *kaith* are popular in central and southern India. *Kaith* is considered highly beneficial for gastrointestinal disorders. The gum obtained from *kaith* is used as an adulterant for gum arabic and in the manufacture of inks, dyes, varnishes, and artistic colors. wood apple tree also serves as fodder for livestock.

Nutritional value of wood apple fruits (per 100 g edible portion)

Nutrients	Quantity	Nutrients	Quantity
Moisture	69.5 g	Niacin	8 mg
Carbohydrate	15.5 g	Vitamin C	2.0 mg
Protein	7.3 g	Calcium	130 mg
Fat	3.7 g	Phosphorus	11 mg
Fibre	5.2 g	Magnesium	18 mg
Vitamin A (carotene)	61IU	Iron	6 mg
Thiamine	0.04 mg	Zinc	10mg
Riboflavin	170 mg	Energy	134 Kcal

WOOD APPLE (*KAITH*)

Area and distribution

In India, wood apple is grown in Maharashtra, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Karnataka, Telangana, and certain regions of Rajasthan and Gujarat. It is also found in Bangladesh, certain parts of Sri Lanka, Pakistan, Thailand, Malaysia, Cambodia, and other countries of Southeast Asia.

The exact area and production of wood apple are not documented, and there are no specific commercial orchards dedicated to its cultivation. It is believed that Maharashtra is the largest producer of *kaith* in India. The tree commonly grows on barren lands, along field bunds, and in forest areas. Fruits are collected from these trees and sold in local markets. They are available from October to March, and sometimes even until May.

Soil and climate

Kaith thrives in tropical and subtropical regions, from sea level up to 1,400 m above mean sea level. It is a drought-resistant plant and performs well in dry regions, requiring arid conditions with some rainfall.

It can grow in a wide variety of soils, but the best yields are obtained in well-drained sandy loam soils with an acidic to neutral pH. Adding farmyard manure improves plant growth, fruit size, and quality. The tree is susceptible to waterlogging, so low-lying areas should be avoided for planting.

Varieties and genetic variability

There are no officially released varieties of *kaith*. Two main types are commonly found across growing areas:

1. Large-fruited types with sweeter taste.
2. Smaller-fruited types with more acidic pulp.

Efforts to collect genetic diversity have been made in different regions:

- At the ICAR-Indian Institute of Horticultural Research (IIHR), Bangalore, over 30 collections were made. Two collections were found superior–high-yielding, regular bearing, large-fruited, with high total soluble solids (>18 °Brix), brown pulp, and a sweet–sour taste.
- At BCKV, Kalyani, superior types were identified with high yield, large fruits, high pulp recovery, total soluble solids (15–18.4 °Brix), and total sugars (5.1–14.3%).
- At CHES, Godara, 30 collections were assessed. Fruit weight ranged from 156.45 g to 432.93 g; total soluble solids from 11.07 °Brix to 19.36 °Brix; acidity from 3.23% to 6.86%; and pectin content from 1.39% to 1.65%.

Propagation

Wood apple is propagated both by seeds and vegetative methods. The seeds are small, brown, and non-dormant, germinating rapidly within 15–20 days. However, seedling growth is slow, and establishment rates are low. Seedling trees bear fruit only after 10–15 years and show high genetic variability.

Vegetative propagation methods such as air layering, patch budding, and root cuttings have been tested with varying success in different regions. At ICAR-IIHR, Bangalore, cleft grafting in September and October achieved about 80% success, performing better than in March or July. Grafting was found to be more successful than budding Cleft Gafting in Ferronia. However, large-scale use of vegetative propagation has not yet been adopted, so seedlings are still predominantly used for planting.

Planting

Kaith plants require good sunlight and should not be planted in shaded areas. The planting distance depends on soil type, land slope, and plant type (seedlings or grafts). Usually, seedlings are planted at an 8 × 8 m spacing, whereas grafted plants can be planted at 6 × 6 m. The rainy season is the best time for planting; however, planting can also be done in spring if irrigation facilities are available.

Pits of 1 cubic meter size should be dug at least 25–30 days prior to planting. These pits should be filled with topsoil and 10–15 kg of farmyard manure 20–25 days after opening. Planting is generally done in July–August. One- to one-and-a-half-year-old plants are ideal for planting, as the establishment rate for older plants (2–3 years) is lower. After planting, young plants should be irrigated, basins should be made around them, and gentle irrigation should be provided. Mulching with dry leaves is recommended to conserve soil moisture.

Manure and fertilizer

Kaith is a slow-growing tree, often thriving in barren and unfertile land. No specific recommended fertilizer dose has been established so far, and manure/fertilizer use is generally negligible. If required, 50 g of fertilizer (10:20:20 NPK) can be applied to young plants, and 100 g to mature trees annually.

Training and pruning

Kaith trees grow slowly but produce many thorny branches near the main stem in their initial years. These branches should be pruned during the first 2–3 years to develop a single main stem. Later, the tree exhibits apical dominance, but training is required at this stage to reduce upright growth. *Kaith* trees can be trained to a modified central leader system. Once mature, they require minimal pruning–mainly the removal of dead or diseased twigs/branches–once a year, after fruit harvest and before flowering initiation (February–March).

Irrigation and weed management

Kaith has deep root systems, allowing it to tolerate drought for extended periods, so mature trees generally do not require irrigation. However, young plants should be watered regularly in summer and at one-month intervals in winter to promote rapid vegetative growth and establishment.

Weed control during the initial years is essential for better growth. Creeping weeds often cover the tree during the rainy season, making their removal important. Intercropping with legumes during the rainy season can also be practiced.

Flowering, fruiting, and yield

Seedling trees of *kaith* start flowering after 10–15 years. In South India, flowering generally occurs in March–April, though staggered flowering up to June is observed, with a low percentage of late blooms. Flowers are small (1.5–2.0 cm) and white, opening in the morning. Pollination is primarily carried out by bees and other insects.

Fruits take 10–12 months to mature. They are initially green, later turning whitish-grey, and finally blackish-grey at maturity. Fruit maturity occurs from October to March, with some extending to June depending on the region. Fruit weight ranges from 100–300 g. A mature tree can yield 400–500 fruits, with elite trees producing over 1,000. Trees are generally regular bearers, though heavy-bearing years are often followed by lighter yields.

Insects and diseases

Kaith trees are generally not severely affected by insects and diseases. However, termites can damage the trees. Stem rot and fruit rot are observed in high-rainfall regions. During storage, fruits may be affected by *Aspergillus* rot. Although the fruits appear healthy externally, the pulp may rot inside, making them unsuitable for long-term storage at room temperature.

Uses

Kaith fruit has a sweet-sour taste and is generally not consumed fresh. The pulp is eaten with jaggery or used to prepare sherbet, jam, jelly, chutney, and other products.

Sherbet

Kaith sherbet is sweet, sour, astringent, and has a cooling effect. Fresh ripe pulp is used for preparation. The pulp is extracted and macerated with jaggery or sugar,

then the seeds are removed by filtering through a muslin cloth. The filtered extract is diluted with water, and black pepper or small cardamom powder may be added to taste.

Jelly

Kaith pulp is rich in pectin, making it excellent for jelly preparation. *Kaith* jelly is sweet and slightly astringent. Ripe fruits are used to prepare jelly. The pulp is extracted, boiled with water until soft, and then filtered through a muslin cloth. The filtrate is boiled with sugar (750 g per 1 kg of pulp) and citric acid until the desired consistency is reached. After cooling, the jelly is stored in bottles. It can also be cut into small pieces after cooling and packed like chocolates.

Chutneys

Kaith chutney is a popular preparation. The pulp of unripe or ripe fruit is extracted, and seeds are separated. The pulp is then macerated and mixed with a spice blend made from roasted and powdered mustard seeds, fenugreek seeds, red chilli, asafoetida, green chilli, and salt.

Marketing

Kaith fruits have good market demand, especially during summer. They sell for 5–10 per fruit, and a mature, good-yielding tree can generate 1,500–2,000 annually. Some innovative *kaith* growers earn more than 10,000 per plant.

CONCLUSION

Kaith has been used in India since prehistoric times for its high nutritional value, culinary applications, and medicinal properties. Despite its potential, limited research has been conducted on *Kaith*. Its nutritional and medicinal benefits, coupled with its drought tolerance, make it a promising crop for diversification programs aimed at combating climate change.

For further interaction, please contact:
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