



***Citrus macroptera*: A Valuable Wild Citrus Fruit of Northeast India**

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Introduction

Northeastern part of India is considered as one of the richest biodiversity hotspots with vegetation types ranging from tropical rain forest in the foothills to alpine meadows. The region is considered as natural home of many citrus species with wide occurrence of indigenous species like *C. macroptera*, *C. latipes* and *C. indica* (Malik *et al.*, 2006). Among these, *Citrus macroptera* Montr. (Satkara) belonging to the Rutaceae family is an endangered wild species of Northeast India with a restricted distribution in the states of Meghalaya, Manipur, Mizoram and Assam. It is locally known by different names, Chambil in Garo, Heiribob in Manipuri, Hatkora in Mizo, Sohkwit in Khasi and Satkara in Assamese. This wild fruit remains underutilized and faces increasing threats due to habitat destruction and changing landuse patterns.

Characteristics

Citrus macroptera species is a perennial, evergreen fruit tree. It typically grows to a height of 5–7 m, characterized by profuse branching and a dense canopy. It is well adapted to subtropical and warm humid climates with high annual rainfall. The leaves are deep green in colour, alternately arranged, and compound, comprising 3–5 narrowly elliptic leaflets with distinct winged petioles. One of the most distinctive features of the plant is the presence of numerous long, sharp thorns. The species thrives across a wide range of soil types and climatic conditions but performs best in well drained, fertile soils. The fruits are medium-sized, highly juicy, and possess a characteristic strong sour taste. The fruits are depressed in shape,



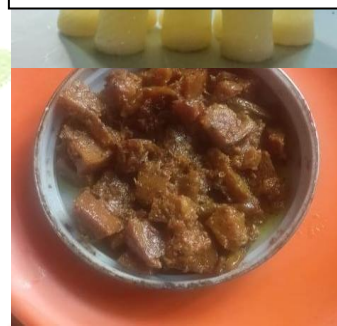
with 10-12 segments each containing 1-2 seeds. At maturity, the fruits are light yellow in colour, while the thick rind contains numerous aromatic oil glands that impart a unique fragrance and are widely used as a spice in traditional culinary preparations. Propagation is mainly carried out through seeds, although vegetative methods are also practiced. Fruits are harvested either at the green stage or after full maturity. To preserve its characteristic aroma and essential oil content, harvested fruits are protected from direct sunlight, as it can reduce their aromatic quality. The fruit is resistant to citrus greening disease and is also tolerant to psorosis and exocortis viruses.

Nutritional and Medicinal Properties

In states of NE India, the fruit is widely used as a spice in various preparations of curries and dishes, consumed as juice to aid digestion and processed into pickles after harvest. The traditional culinary uses of *C. macroptera* across different states of Northeast India are presented in Table 1. The fruit is a rich source of vitamin C, dietary fiber, essential minerals, antioxidants, and bioactive compounds such as flavonoids, phenolics, and essential oils which contribute to numerous health promoting properties. The fruit and different parts of the plant is popular among the locals for treating various ailments like fever, jaundice, alimentary disorders, stomach discomfort, loss of appetite etc. Researchers have also observed that extracts of *C. macroptera* possess antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and hepatoprotective activities. The fruits reportedly have numerous pharmaceutically important bioactive compounds which are cytotoxic, antimicrobial, antihypertensive, antipyretic, anti-diabetic and appetite stimulant potentials (Nongalleima *et al.*, 2019 and Paul *et al.*, 2015). In Manipur, *C. macroptera* fruit juice is used for stomach ailments, while the fruit peel serves as a spice and is employed in cases of dyspepsia (Singh *et al.*, 2014).



Juice (Mizoram)



Pickle (Garo Hills), Meghalaya



Dried peels (Manipur)



Table 1. Traditional culinary uses of *C. macroptera*

State	Part of fruit used	Uses	References
Mizoram and Assam	Peel	Cooked with lentil and fish in the form of decoction	De, 2016
Meghalaya (Khasi Tribes)	Peel	Pork, beef, fish and chicken is cooked with fresh or dried fruit peel	Upadhaya <i>et al.</i> , 2016
	Pulp	Sundried and pickled	
	Juice	Used as a flavoring agent to cook pork. It is believed to neutralize fat	
Meghalaya (Garo Tribes)	Peel	Fresh or dried peel is used to cook pork, beef, fish, and chicken. Delicacy of Garo with this fruit is called as “Wak Chambil Phura” it is a pork preparation with peel	Upadhaya <i>et al.</i> , 2016
	Fruit	Sundried and pickled	
Manipur	Peel	Dried and used as spice element	Nongalleima <i>et al.</i> , 2017

Decline of the species

Causes

Although the region has a rich genetic diversity of *C. macroptera*, very recently the plant population is decreasing in an alarming rate. Although many farmers are aware of its health benefits, they have shifted to cultivating other fruit crops that give more assured income and receive better government support. The plant usually starts declining with gradual decrease in vigour and yield. Declined trees not usually die but remain impoverished and unproductive. The symptoms comprised of chlorotic leaves, sparse foliage, dieback of twigs and in general, a sickly appearance of the tree (Shivankar, 2000). The high rainfall and humidity prevailing in the region create a favourable environment for most of the pests and diseases, multiply and attack citrus for a longer period. Excessive soil moisture and poor drainage is also an important factor for decline. Waterlogged conditions inhibit root development, promote root rot and predispose the trees to fungal diseases like phytophthora root rot and collar rot which results in die-back of the shoots (Chaudhary *et al.*, 2016). Nutrient imbalances in both the soil and trees are indirect factors contributing to the decline. Limited knowledge of value addition and processing opportunities has also contributed to decline in cultivation of this fruit. The species is becoming endangered due to



gradual decrease of farmer's interest in commercial cultivation and mostly of clearance of forest cover caused by shifting cultivation.

Management Strategies

Sustainable management of citrus decline under changing climatic conditions requires an integrated approach. Regular monitoring, early detection, and integrated pest management practices using biological, cultural, and chemical control measures are essential for minimizing pest and disease incidence. The use of certified disease free planting material, timely pruning, efficient soil and water management, and balanced nutrient application help maintain tree health and productivity. Improving soil organic matter through application of farmyard manure, vermicompost, compost and green manures further enhances soil resilience to climate stresses. Strengthening extension services through regular training and awareness programmes for citrus growers is very essential for improving good orchard management practices. Government support through subsidies, quality planting material, along with farmer's participation can further enhance the sustainability of this fruit tree. Climate adaptation practices such as mulching, rainwater harvesting etc. are also important for improving the orchards against climate variability.

Conclusion

Citrus macroptera is a unique and valuable wild citrus species of Northeast India. This citrus species is widely used as a spice in various preparations of curries and dishes, consumed as juice to aid digestion and is processed into pickles after harvest. Fresh peel of the fruit is especially used to cook with pork, beef, fish and chicken in Meghalaya. The dried peels are used as spice element in various culinary dishes of Manipur. Further juice of the fruit is consumed as a refreshing drink which aids in digestion in Mizoram. Despite of its rich biodiversity and wide range of traditional uses, the species is gradually declining due to low fertility, changing land use patterns, low commercial cultivation, pest and disease infestation, and limited awareness about its value added products. Conserving this endangered fruit requires a combination of scientific management, sustainable cultivation practices, and active participation of farming communities. Strengthening extension services, developing value added products, creating better market linkages, and providing policy support will encourage farmers to cultivate this underutilized species. Conserving *C. macroptera* is not only important for safeguarding the rich citrus genetic diversity of Northeast



India but also for preserving the traditional knowledge, food culture, and livelihood opportunities associated with this indigenous fruit.

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