



## Cultivation of Underutilized Fruit Crop Malay Apple (*Syzigium malaccense*) -A Review

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### Abstract

Malay apple is a tropical fruit-bearing tree that thrives well in warm, humid climates. It can be easily recognized by its lovely, glossy leaves and the vivid red or pink coloured fruit, which resembles a small apple or pear in shape. Fruits are suitable for table purpose because of its crisp texture, sweet flavour with feeble delicate flowery scent. It is also suitable for preparing value added products such as squashes, ready to serve drinks, desserts and so on. The trees have a wide canopy that offers good shade and grows up to a height of 12 to 18 meters. The tree bears gorgeous bell-shaped flowers, usually pink or red in colour, that attracts bees and other pollinators. The fruits are abundant in antioxidants, fibre, and vitamin C which supports digestive health and strengthens the immune system. Malay apple cultivation requires well-drained soil, lots of sunshine, and consistent irrigation. It finds an important place in local cuisines and customs and is frequently grown in orchards and backyard gardens in tropical regions. Though Malay apple has got great potential, it still remains underutilized and has not found a place in international markets. So, there is a lot of scope for taking up the commercial cultivation of this fruit crop in regions and countries where warm, humid climates prevail. The ecological, nutritional, and economic significance of Malay apple is emphasized in this review, along with its role in supporting regional food habits with sustainable agriculture.

**Keywords:** Malay apple, *Syzigium malaccense*, mountain apple, underutilized fruit, cultivation

### 1. Introduction

The Malay apple (*Syzygium malaccense*), also known as the mountain apple, is a tropical underutilized fruit tree belonging to Myrtaceae family. It is a flowering tree species indigenous to the Indo-China area and is mainly found growing in Malaysia, Indonesia, Vietnam, and Thailand. It has been distributed to Australia, India, Brazil, and numerous Caribbean nations. This fruit tree is also known as Malay rose, Nakavita, Jambu merah, Jambu bol, Jambo, Otaheite cashew, and Pommerac (Fernandes and Rodrigues, 2018). Malay apple fruits have narrow diameter, medium length, wide seeds, narrow and small leaves (Nacata and Andrade, 2018). Since the fruits are seasonal and are having low shelf life, they are consumed locally rather than export (Whistler and Elevitch, 2006). Fruits are utilized for making jam and jelly, either with or without the addition of lemon juice as a flavoring ingredient (Nunes et al., 2016).

Malay apple fruits are rich reserves of bioactive compounds (Santos et al., 2016). Augusta et al. (2010) revealed these fruits' significance as they contained a fairly good amount

of Vit C and anthocyanins, especially on the fruit skin. Maia et al. (2019) reported spray drying as an effective method of preservation of this fruit in the form of powder having low humidity while conserving the bioactive compounds. Various parts of the tree including leaves, bark, and fruits are being used in traditional medicine for their potential medicinal properties such as, anti-inflammatory, antimicrobial, and antioxidant effects. It is cultivated commercially in tropical regions of Southeast Asia and the Caribbean. In Thailand, Malay apple cultivation is an important income source for small-scale farmers, contributing to rural livelihoods. The crop is also an integral part of home gardens (Pazzini et al., 2021).

Vadu et al. (2023) reported that different parts of *Syzygium malaccense* were being used in traditional medicine for curing various ailments. Numerous studies have identified potential therapeutic benefits of Malay apple due to its antioxidant-antiradical, anti-inflammatory, anti-obesity, anti-hyperlipidemic, anti-hypertensive, blood platelet aggregation inhibition, diuretic, anti-urolithic, antimicrobial, anticancer, hepatoprotective, renoprotective, antitumor, and immunomodulatory properties. The extract helps in



treatment of diabetes, metabolic syndrome, liver problems, hypertension, and inflammation. A study by Nenden (2019) suggested that the wood extract from Malayan apple has a high potential for application in halal and tayyab antidiabetic medications.

The primary bioactive substances in the edible portion are myricetin, oxalic acid, gallic acid, citronellol, cyanidin glucoside, hotrienol, phytosterols, flavonoids, carotenoids, and polyphenols, which are linked with several health benefits. Several endophytic fungi were isolated from the Malay apple namely the ones belonging to Ascomycota (*Poaceasca*, *Cladorrhinum*, *Penicillium*, *Madurella*, *Phytophthora*, *Phialemonium*, *Monascus*, *Trichoderma*, *Ramophialophora*, *Gliocladium*, *Wiesneriomyces*) and Zygomycota (*Mucor*, *Mortierella*, and *Gongronella*) phyla, many of which exhibited significant antibacterial activity (Hapida et al., 2021).

Despite its high productivity, bioactive potential, high pulp recovery and potential for cultivation in the tropical region, the crop still pertains as an underutilized fruit crop (Pazzini et al., 2021). Utilizing the unexploited horticultural wealth can help address the socioeconomic issues of unemployment, poverty, and insecure health and nutrition. The underused fruit crops can meet the nutritional needs of vulnerable groups, hence meeting the nutritional needs of needy tribal people in a world of rising economic crisis and population explosion (Nandal and Bhardwaj, 2014). Hence, the conservation and promotion of underutilized crops becomes not only important but also compulsory. Enhancing crop domestication by standardizing the cultivation practices, making planting materials accessible and raising consumer demand through proper awareness creation, and building a solid marketing network is essential to achieve this goal (Kour et al., 2018).

## 2. Botany

Fully grown tree reaches up to a height of 12–18 m with an erect trunk bearing cylindrical or pyramidal crown (Figure 1a). The evergreen tree bears oppositely arranged, short-petioled leaves which are elliptic to lanceolate or oblanceolate in shape. Leaves are about 10–30 cm in length, glabrous and glossy green with entire margin. The blossoms are plentiful, possessing a subtle fragrance, and emerge along the upper trunk and leafless sections of mature branches (Figure 1b). They form in clusters of 2 to 8 on short stalks and exhibit shades ranging from pink to deep red (Figure 1c). It has a long turbinate calyx, notched to form 4 lobes holding four suborbicular petals with red or pink colour. Ovary is inferior, and stamens are numerous, free and 1–2 cm in length (Whistler and Elevitch, 2006).

The fruit of Malay apple has an elongated, obovoid, or bell-shaped form, 5 to 10 cm in length and 2 to 8 cm in width at its widest point. Its skin is smooth and coloured red (Figure 1d). The fruit contains a white, juicy flesh with a sweet taste

reminiscent of green grapes. It houses a single nearly round, light-brown seed, approximately 2 cm in diameter. Each fruit typically weighs around  $39 \pm 2$  g, with the bulk of its weight attributed to the flesh ( $30 \pm 2$  g), followed by the seed ( $7 \pm 1$  g) and the skin ( $3 \pm 1$  g) (Augusta et al., 2010).



Figure 1: a) tree, b) flower buds, c) flowers and d) fruits of Malay apple (Whistler and Elevitch, 2006; Fernandes and Rodrigues, 2018)

## 3. Related Species and Known Varieties

Malay apple (*Syzygium malaccense*) is related to the other species of the genus *Syzygium* like *Syzygium aqueum* (bell apple or water apple) and *Syzygium samarangense*. The fruit of *Syzygium aqueum* are small and bell shaped. The flowers of both *Syzygium aqueum* and *Syzygium samarangense* are white rather than red. Two colour variants are believed to exist under *Syzygium malaccense*, the most common one is with red flowers and fruits and other one which is rare is with white flowers and fruits (Whistler and Elevitch, 2006).

In a morphological characterization study conducted by Jayasree et al. (2022), it was observed that *Syzygium malaccense* genotype is more vigorous in terms of tree height, canopy spread, and leaf area, whereas *Syzygium samarangense* was found to be superior in terms of yield and quality. *Syzygium jambos* was the genotype with the highest total sugar content and TSS. Out of the three under-utilized *Syzygium* species (*S. malaccense*, *S. jambos* and *S. aqueum*), *S. malaccense* has the largest fruit, the water apple has the highest pulp content because its fruit does not include seeds (Nacata and Andrade, 2018).

The assessment by Markose et al. (2024) demonstrated the differences between accessions within each of the three types viz. pink watery rose apple, white watery rose apple, and Malay apple as well as between the three types. Though there was no discernible difference between the White and Malay accessions, only in Malay apples did variation across

various size groups showed statistical significance as Malay apple recorded a greater mean fruit weight. The chemical composition and nutritional value of *Syzygium malaccense* fruit and skin are mentioned in Table 1 and Table 2 respectively.

Table 1: Chemical composition and nutritional value of *Syzygium malaccense* fruit

Component	Amount 100 g <sup>-1</sup> of the edible portion
Moisture	88±4 g
Fat	0.2±0.1 g
Fibre	0.7±0.1 g
Protein	0.6±0.1 g
Ash	0.3±0.1 g
Calcium	5.7±0.2 mg
Iron	0.5±0.3 mg
Phosphorus	14.7±3.2 mg
Vitamin A	7±4 I.U.
Vitamin C	11.7±5.2 mg
Vitamin B1 (Thiamine)	27±12 µg
Vitamin B2 (Riboflavin)	30±10 µg
Vitamin B3 (Niacin)	0.3±0.1 mg

(Fernandes and Rodrigues, 2018)

Table 2: Chemical composition and nutritional value of the skin of *Syzygium malaccense* fruit

Component	Amount 100 g <sup>-1</sup> of skin
Moisture	14.1±0.4 g
Fat	4.5±0.1 g
Fibre	9.3±0.2 g
Protein	8.6±0.2 g
Sugars	3.0±0.4 g
Ash	4.2±0.4 g
Vitamin C	292.6±0.8 mg
Anthocyanins	300.5±0.5 mg

(Augusta et al., 2010)

Pino et al. (2004) examined the aromatic components of Malay rose apple fruits (*Syzygium malaccense*) cultivated in Cuba using GC–MS and GC techniques. Analysis revealed the presence of 133 compounds in the aroma concentrate. Among these, 2-phenylethanol and its esters, including 2-phenylethyl acetate, 2-phenylethyl isopentanoate, 2-phenylethyl benzoate, and 2-phenylethyl phenylacetate, were identified as the predominant constituents.

Nunes et al. (2016) reported that the extracts from the peel and edible portion of Malay apples shown a modest ability to block the oxidation of the  $\beta$ -carotene/linoleic acid system,

together with notable reducing power and good antioxidant activity.

#### 4. Climate

Trees of Malay apple thrives well in warm, humid climates. It requires plenty of sunlight and protection from strong winds. Even though it can grow up to an elevation of 1200 m above mean sea level, they are mostly seen below 600m from mean sea level. Mean annual temperature requirement is 24–27°C. The tree requires a mean annual rainfall of 1500 mm and it must be irrigated in areas where there is a seasonal dry period (Whistler and Elevitch, 2006). Full sunlight is the primary requirement for selecting the area for cultivating Malay apple tree, as it requires ample light for healthy growth and fruit production.

#### 5. Soil

The tree prefers well-drained, slightly acidic soil, rich in organic matter. Sandy loam or loamy soil is ideal. The ideal pH is 6.1–7.4 and so, in high pH soils, the tree exhibits nutritional deficiencies. Grows well near water sources *i.e.*, near river banks, ponds etc. The trees can tolerate medium to heavy texture soils (sandy to clayey soils).

#### 6. Propagation

Seed propagation is the common practice. Seedlings which are found beneath trees are transplanted to new plots. Vegetative propagation methods like air-layering, cuttings and grafting are also reported (Whistler and Elevitch, 2006). Ryadin et al. (2014) reported that Malay apple exhibited optimal root and shoot growth, as well as root volume, when propagated using hardwood cuttings planted in a mixture of topsoil and sand, supplemented with NAA at 1000 ppm. Yusnita et al. (2018) reported that application of a combination of 1000 ppm IBA and 1000 ppm NAA produced higher root length, better root morphology and higher shoot sprouting in Malay apple cuttings.

#### 7. Irrigation and Fertilization

Malay apple trees require regular watering, especially during dry periods and during the fruit development stage. Avoid waterlogging, as this can lead to root rot. Apply balanced fertilizer during the growing season to promote healthy growth and fruit development.

#### 8. Pruning

Prune the tree regularly to maintain its shape, to remove dead or diseased branches, and to improve air circulation within the canopy.

#### 9. Flowering, Fruiting and Harvest

In the Indo-China region, the tree flowers during May and June,



with the fruits ripening between August and September. In India, the first harvest is done from May to July, often followed by a second crop in November and December. In the Caribbean and Brazil, the tree undergoes flowering two or three times a year, corresponding to spring, summer, and autumn, with the largest yields observed during spring and autumn seasons. The fruits usually mature within a period 60 days from anthesis. Once fully ripe, the fruits tend to fall rapidly and deteriorate quickly and so harvesting has to be done manually through hand-picking (Fernandes and Rodrigues, 2018).

## 10. Harvesting

Malay apples are to be harvested when they are fully ripe, which is indicated by their vibrant colour and slightly soft texture. To harvest the fruits without damage, gently twist or cut the fruits from the tree.

## 11. Yield

Individual trees normally yield between 20 to 80 kilograms of fruit per season, depending on the age of trees.

## 12. Post-harvest Management and Storage

The fruits are highly perishable and they have a short shelf life of 3–6 days after harvest, at an ambient temperature of 28°C. Basanta and Sankat (1994) reported that the shelf life of the fruit was found to increase up to 30 days when they were stored under 5°C and also the loss of fruit colour was found to be reduced. According to a study conducted by Njilar et al. (2023), the use of aloe vera gel and 1-MCP as postharvest treatments resulted in decreased moisture loss and total soluble solids, along with the preservation of firmness of fruits and reduction in loss of fruits by decay. This treatment also led to the retention of desirable sensory qualities during storage thereby sustaining the quality of Malay apples and prolonging their shelf life from 4 to 12 days. The findings of Maia et al. (2019) showed that freeze- and spray-drying of Malay apple skin could produce a high-yield powder with low humidity and retained biocharacteristics.

## 13. Pests and Diseases

Pests and diseases are rarely reported in Malay apple. In Hawaii, attack of rose beetles on young trees were documented. These beetles are found to defoliate the trees further reducing its growth and yield. A disease incidence was reported in Brazil in November 2017 and the causative organism was found to be *Fusarium fabacearum* (Farias et al., 2021). Sonavane et al. (2017) identified *Colletotrichum acutatum* to be the causal organism for anthracnose disease of Malay apple in India. But in Brazil, *Lasiodiplodia theobromae* and *Pseudofusicoccum stromaticum* were found to be the two species which infected Malay apple causing severe dieback (Silveira et al., 2018).

## 14. Conclusion

Though the climate suitability, agronomic benefits, health

benefits and economic potential makes Malay apple a proper candidate for cultivation in the tropical and subtropical regions, limited awareness and poor marketing strategies become a major hurdle for its popularisation among farmers. Malay apple has strong potential as a niche fruit crop in India, especially in tropical regions. With better marketing strategies, improved post-harvest management, and value addition, it can become a commercially viable fruit in the country.

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