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# REVEIW ARTICLE

## ORIGIN, TAXONOMY, BOTANICAL DESCRIPTION, GENETICS AND CYTOGENETICS, GENETIC DIVERSITY, BREEDING AND CULTIVATION OF MANGOSTEEN

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## ABSTRACT

Mangosteen or Purple Mangosteen belongs to the Family: Clusiaceae, Genus: *Garcinia*, Species: *Garcinia mangostana.* Burmese (mingut); Dutch (manggis, manggistan); English (mangostan, king's fruit, zangosteen); Filipino mangis, mangostan); French (mangoustanier, mangostanier, mangouste, mangostier); German (Mangostan baum); Indonesian (manggis); Lao (Sino-Tibetan) (mangkhut); Malay (sementah, manggis, semetah, mesetor); Portuguese (mangusta, mangosta, mangostao); Spanish (mangostan, palo de cruz, mangostao); Thai (mangkhut); Vietnamese (caay mwang cujt, mang cut, kandis, cay mang cut). Common Name: Mangosteen or Purple Mangosteen. Mangostino (in Spanish), Mangouste (in French), Mangostanbaum (in German). Also called 'Queen of the Fruits'. Amibiasine, Fruit des Rois, Garcinia mangostana. The fruits have a delicious taste and are highly nutritious as well as medicinal. The rind of the fruit is astringent. It is dried, powdered, and taken internally as a treatment for dysentery. Externally the rind is applied as an ointment to treat various skin problems including eczema. The rind is boiled in water (decocted) and taken as a tea for diarrhea, cystitis, gonorrhea, and "gleet" (a watery discharge from the urethra caused by gonorrhea). A decoction for the leaves and bark is used to lower fevers as well as to treat fungal candidiasis (thrush), diarrhea, dysentery and urinary problems. A tea made from the leaves combined with an unripe banana is applied externally to treat circumcision wounds. A root decoction is taken as a tea to regulate menstruation. The fruits contain various active ingredients including xanthones. Recent studies have found that mangosteen is a promising source of natural anticancer agents. Identified and purified and eight xanthones from mangosteen in order to ascertain if these phytochemical compounds inhibited the activities of mammalian DNA polymerases and human DNA topoisomerases. The results of the study demonstrated that the compound know as β-mangostin was the strongest inhibitor of both mammalian polymerases and human topoisomerases within the isolated xanthones. Additionally, β-mangostin showed the strongest suppression of human cervical cancer HeLa cell proliferation. The authors of the study concluded that β-mangostin might be a promising natural anticancer agent that could be useful as a chemotherapeutic agent. A clinical study found that a commercial juice made form mangosteen fruit lowered inflammation among the study participants, and showed promise for the treatment of obesity. Additionally, recent data suggest that supplements made from mangosteen fruit rind may have a role in the treatment of overweight and obesity. Mangosenone F (MSF) is one of many natural xanthone compounds identified and isolated from mangosteen. Some studies have reported this compound possesses a glycosidase inhibitor effect. A study evaluated the potential anti lung cancer effect of MSF both in vitro as well as in vivo. The compound was found to inhibit cancer cell cytotoxicity and elicited apoptosis (programmed cell death) by means of generating free radicals or reactive oxygen species (ROS). These results showed that MSF could be a potential candidate for a natural anticancer pharmaceutical, since it promotes ROS production. Gartanin is one of various xanthone compounds isolated from mangosteen. This compound possesses powerful antioxidant, anti-inflammatory, antifungal and anticancer effects. A study evaluated the cytotoxic effect of gartanin on hepatocellular carcinoma (HCC), known to be the third leading cause of cancer-related death worldwide. The study revealed that gartanin elicited autophagy in various cancer cells. In addition, gartanin promoted the formation of autophagosomes and autolysosomes and augmented the degradation rate of intracellular organelles, such as mitochondria, among others. Another salient feature was that gartanin promoted programmed cell death or apoptosis of the cancer cells. The researchers concluded that gartanin could be a potential anticancer agent of natural origin (Stuart, 2025).



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# INTRODUCTION

Mangosteen or Purple Mangosteen belongs to the Family: Clusiaceae, Genus: *Garcinia*, Species: *Garcinia mangostana* (Wikipedia, 2025). Burmese (mingut); Dutch (manggis,manggistan); English (mangostan, king's fruit, mangosteen); Filipino mangis, mangostan); French (mangoustanier, mangostanier, mangouste, mangostier); German (Mangostan baum); Indonesian (manggis); Lao (Sino-Tibetan) (mangkhut); Malay (sementah, manggis, semetah, mesetor); Portuguese (mangusta, mangosta, mangostao); Spanish (mangostan, palo de cruz, mangostao); Thai (mangkhut); Vietnamese (caay mwang cujt, mang cut, kandis, cay mang cut) (Orwa *et al.,* 2009). Common Name: Mangosteen or Purple Mangosteen. Mangostino (in Spanish), Mangouste (in French), Mangostanbaum (in German). Also called 'Queen of the Fruits' (COD, 2025). Amibiasine, Fruit des Rois, *Garcinia mangostana* (Webmd, 2025). Mangosteen ( *Garcinia mangostana* L.) is one of the most admired tropical fruit and known widely as the Queen of Fruits for its beautiful purple blue pericarp and delicious flavor. The edible aril is white, soft and juicy with sweet pleasant taste. Mangosteen is a climacteric fruit that undergoes rapid postharvest changes resulting in a short shelf life at ambient temperature. Physiological disorders induced by preharvest and postharvest factors have a major impact on the appearance and eating quality. In addition to fresh consumption, the aril is processed into other products. The fruit pericarp also contains many chemical compounds that have possible medicinal value (Ketsa and Paull, 2025). In the absence of fertilization, asexual ovary nucellus tissue development occurs that ensures fruit and aril growth. The asexual embryos develop from the nucellus tissue and these apomixic 'seed' are used in propagation. The 'seed' is a clone of the mother plant with little variation, but the absence of true seed associated with sexual fertilization limits, varietal development and selection. DNA and RNA marker analysis from material sourced globally has shown variation among the different mangosteen populations. Mangosteen (*Garcinia mangostana* L.). The majority of the samples had essentially the same genetic make-up (genotype) but signifi cant differences were found in same samples. This difference could be due to chance mutation or selection within the limited variation that is known to occur (Ketsa and Paull, 2025). Mangosteen fruit is now grown worldwide and is being exported and marketed in more developed countries. Often it is advertised and marketed as a novel functional food and is sometimes called a 'super fruit'. It is presumed to have a combination of • appealing characteristics, such as taste, fragrance and visual qualities, • nutrient richness, • antioxidant strength, and • potential impact for lowering risk of human diseases (Ketsa and Paull, 2025).

ny tropical plants have interesting biological activities with potential therapeutic applications (Pedraza-Chaverri *et al.,* 2008). *Garcinia mangostana* Linn. (GML) belongs to the family of Guttiferae and is named "the queen of fruits" (Pedraza-Chaverri *et al.,* 2008). It is cultivated in the tropical rainforest of some Southeast Asian nations like Indonesia, Malaysia, Sri Lanka, Philippines, and Thailand (Pedraza-Chaverri *et al.,* 2008). People in these countries have used the pericarp (peel, rind, hull or ripe) of GML as a traditional medicine for the treatment of abdominal pain, diarrhea, dysentery, infected wound, suppuration, and chronic ulcer (Pedraza-Chaverri *et al.,* 2008). Experimental studies have demonstrated that extracts of GML have antioxidant, antitumoral, antiallergic, anti-inflammatory, antibacterial, and antiviral activities (Pedraza-Chaverri *et al.,* 2008). The pericarp of GML is a source of xanthones and other bioactive substances (Pedraza-Chaverri *et al*., 2008). Mangosteen is reproduced through apomixis, from which the seed develops without fertilization. Many tropical fruit species are facultative apomicts, while the mangosteen is an obligate apomict and it is believed that all of its progenies may have same genotype as their mother plant (Mansyah *et al*., 2013). In an effort to get a better understanding about such a possibility, research to evaluate the genetic variation among mangosteen accessions as well as among progenies from one mother plant were conducted (Mansyah *et al.,* 2013). The plant material used were six mangosteen accessions from West Sumatra and 18 progenies from one mother plant. The progenies consisted of nine seedlings derived from polyembryonic seeds and nine from mono-embryonic seeds (Mansyah *et al*., 2013). Genetic observation was conducted using the Random Amplified Polymorphic DNA (RAPD) technique. Four primers were used to amplify the genomic DNA of mangosteen (Mansyah *et al.,* 2013). Based on DNA polymorphisms, it was found that genetic variations occurred among accessions and also among progenies within one mother plant (Mansyah *et al.,* 2013). The six mangosteen accessions were separated into five different genotypes that could be further divided into two groups (Mansyah *et al*., 2013). Genetic similarity of the accessions ranged from 42 to 100% (Mansyah *et al.,* 2013). Parent and offspring analysis showed that 14 of 18 progenies were found to be non-maternal, while the four others were maternal genotypes (Mansyah *et al.,* 2013). Genetic variations were found among the progenies from both poly-embryonic seeds and mono-embryonic seeds. Their genetic similarities to their mother plant ranged from 59 to 100% (Mansyah *et al.,* 2013).

Mangosteen (Garcinia mangostana) is a tropical fruit cultivated mainly in Southeast Asia (Zhuohong Xie *et al.,* 2015). Recent studies have shown mangosteen has many health benefits. In this study, we aimed to determine the effects of a mangosteen-based beverage on antioxidant and anti-inflammatory and immunity biomarkers in plasma of healthy adults (Zhuohong Xie *et al.,* 2015). A randomized, double-blind, placebo-controlled clinical trial was conducted using 60 participants, 30 men, and 30 women, ages 18–60. Participants were randomly divided into two groups, placebo and mangosteen groups, with the same number of male and female participants in each group (Zhuohong Xie *et al.,* 2015). The trial duration was 30 days. ORAC as an antioxidant biomarker was measured in both groups. It was found that after the 30-day trial, the group given the mangosteen-based drink formula showed 15% more antioxidant capacity in the bloodstream than did the placebo group (Zhuohong Xie *et al*., 2015). As for the inflammatory biomarkers, in the mangosteen group, between the preintervention and postintervention, the C-reactive protein level significantly decreased by 46%, while no significant decreases for the same biomarker was observed in the placebo group (Zhuohong Xie *et al*., 2015). Immunity biomarkers IgA, IgG, IgM, C3 and C4 were not affected in either group. In addition, the effects on hepatic function (*Aspartate Aminotransferase* and *Alanine Aminotransferase*) and kidney function (creatinine) were investigated (Zhuohong Xie *et al*., 2015). Our results indicated that after the 30-day consumption of the beverage, there were no side effects on human hepatic and kidney functions (Zhuohong Xie *et al.,* 2015). The outcome of this study showed that the mangosteen-based formula significantly increases antioxidant capacity and possesses anti-inflammatory benefits with no side effects on immune, hepatic, and renal functions for long-term consumption (Zhuohong Xie *et al.,* 2015). Mangosteen is a tropical plant cultivated in areas such as Indonesia, Malaysia, Sri Lanka, Philippines, and Thailand (Zhuohong Xie *et al.,* 2015). It has been consumed as fruit, juice and used as traditional medicine. Mangosteen has been used to treat skin infections and diarrhea. Recent scientific studies suggest that mangosteen possesses strong antioxidant, anti-cancer, anti-inflammatory, anti-allergic, anti-microbial, and anti-malarial properties (Zhuohong Xie *et al.,* 2015). Xanthone and vitamins in mangosteen are considered the major active components. Mangosteen extracts and xanthones from mangosteen were reported to scavenge 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,20-azino-bis-(3-ethylbenzthiazoline-6-sulfonic acid (ABTS), and peroxynitrite radicals (Zhuohong Xie *et al.,* 2015). Mangosteen was able to reduce LDL oxidation in vitro. Extracts of mangosteen protected against neural damage exposed to hydrogen peroxide on a neuroblastoma cell line (Zhuohong Xie *et al*., 2015). In a rat study, **α**-mangostin was able to attenuate the lipid peroxidation and damage of the antioxidant-defense system during injury-induced myocardial infarction (Zhuohong Xie *et al.,* 2015). In a clinical trial, we demonstrated a short-term increased antioxidant capacity and availability of mangosteen and vitamin B2 and B5 after a single dose oral administration of mangosteen drink (Zhuohong Xie *et al.,* 2015). Chronic inflammation has been associated with cardiovascular diseases, cancer, diabetes, chronic lower respiratory disease, stroke, Alzheimer's disease, and nephritis. The annual death owing to these diseases was over 20 million worldwide in 2012 (Zhuohong

Xie *et al*., 2015). Chronic inflammation can be triggered by cellular stress and dysfunction, such as oxidative stress, elevated blood glucose levels, and excessive calorie consumption. Extracts and isolated compounds from mangosteen have been reported to attenuate proinflammatory response (Zhuohong Xie *et al*., 2015).

Western Ghats of India is one of the mega diversity centres in the world. There are 15 species of Garcinia reported of which many are endemic in nature (Jayesh Anerao *et al.,* 2016). The genetic diversity in one of the same endemic species *Garcinia xanthochymus* was evaluated using ISSR and RAPD markers (Jayesh Anerao *et al*., 2016). Total of 15 individual plants from each location were analyzed. Six populations of *G. xanthochymus* were collected and screened using 16 ISSR and 10 RAPD markers. ISSR primers generated 80 bands of which 17 were polymorphic (21.25 % polymorphism) and RAPD primers produced 51 total bands of which 18 were polymorphic (35.29 % polymorphism) (Jayesh Anerao *et al*., 2016). The ISSR and RAPD cluster analysis grouped them into two groups. The detected polymorphism is enough at species level and therefore the RAPD and ISSR can be used as efficient markers for genetic relatedness assessment in *G. xanthochymus* (Jayesh Anerao *et al*., 2016). The UPGMA and PCoA analysis distantly grouped these populations in two groups. The genetic diversity within the population is important source for evolution of the genera (Jayesh Anerao *et al*., 2016). The genus Garcinia L. belongs to the family Clusiaceae (Guttiferae). This family consists of approximately 200 species throughout the world, among which 36 species occur in India (Jayesh Anerao *et al*., 2016). The Western Ghats region is considered as a secondary center of origin for Garcinia species, where six species are endemic to Western Ghats only. As a genus, Garcinia contains many species which include *Garcinia indica, Garcinia gummigutta, Garcinia hombroniana* and *Garcinia xanthochymus* that provide important resources in this region (Jayesh Anerao *et al.,* 2016). *G. xanthochymus* is distributed across the states of Maharashtra, Goa, Karnataka, Tamilnadu and Kerala (Jayesh Anerao *et al.,* 2016). It is cultivated extensively in Southeast Asia where the fruit is used for preserves, jams, and curries. The dried fruit sap is called gamboge and provides a dye that is used in watercolour paints (Jayesh Anerao *et al.,* 2016). Fruits are anthelmintic and cardiotonic; improves appetite. Ripe fruit is tonic, invigorating and alexipharmac; good in heart trouble and biliousness. Generally sherbat made with "Amsul" (sun-dried slices of the fruit), with a little rock-salt, pepper, cumin, ginger and sugar, is administered in bilious conditions (Jayesh Anerao *et al*., 2016). Xanthochymol present in the fruit is antibacterial against Streptococcus faecallis and Klebsiella pneumoniae; the action is better than tetracycline (Jayesh Anerao *et al*., 2016). A new prenylated xanthone, 1,3,5,6-tetrahydroxy-4,7,8-tri(3-methyl-2-butenyl) xanthone , was isolated from the wood of G. xanthochymus together with a known xanthone, garcinia xanthone . Their structures were determined by spectroscopic analysis (Jayesh Anerao *et al.,* 2016).

Fingerprints are also used as the source for genetic markers to generate linkage maps or to identify molecular markers linked to phenotypic traits and or genetic loci. Many DNA fingerprinting techniques have been developed in the past few years (Jayesh Anerao *et al*., 2016). Even though every molecular marker system is derived from distinctive principles, yet their function is to expose the genome-wide variability (Jayesh Anerao *et al*., 2016). Molecular markers offer a great advantage over the morphological and biochemical markers in species identification, phylogenetic studies and in mapping the genetic linkage (Jayesh Anerao *et al*., 2016). Combined approach of both morphological and molecular markers was also carried out to identify and characterize the species (Jayesh Anerao *et al*., 2016).

Garcinias are trees known for their delicious fruits and medicinal value (Murthy *et al*., 2018). However, germplasm exploration and analysis of genetic diversity using morphological and molecular markers depict variability in architecture of the tree, fruit shape, color, size, yield, nutrients, phytochemical levels, tolerance to drought and salinity, and other useful characteristics (Murthy *et al*., 2018). Therefore, selection is the first criterion for the improvement of *Garcinia* species. Superior genotypes have been selected with respect to size and shape of the fruit, seed number, shelf life, fruiting precocity and external coloration, in all three *Garcinia* species from natural populations and released for cultivation (Murthy *et al.,* 2018). Efforts have been made to improve these crops through mutation breeding as well. Selection of rootstock and grafting has been carried out for the improvement of drought tolerance, salinity tolerance, tree architecture and early flowering (Murthy *et al*., 2018). Garcinias are trees or shrubs belonging to the family Clusiaceae and are native to Asia, Australia, tropical and southern Africa, and Polynesia (Murthy *et al*., 2018). Around 250 species are reported from lowland tropical forests (Murthy *et al*., 2018). The fruits are small, yellow, white, green or reddish in color, with a sweet to savory in taste. Fruit juice or syrup is used as a coolant. Fruit rinds are processed as a condiment in various vegetarian and non-vegetarian preparations to impart flavor, taste and to improve keeping quality (Murthy *et al*., 2018). The seeds yield a protein and a butter or oil. Garcinias contain phytochemicals which have pharmaceutical and therapeutic value (Murthy *et al.,* 2018). Linnaeus named the genus in honor of the French naturalist Laurent Garcin for his botanical contributions in the eighteenth century and it was Garcin who provided the detailed description of *Garcinia* fruits. *Garcinia* species originate from the Malay Archipelago (Murthy *et al.,* 2018).

The potential of endophytic microbes as producers of new bioactive and antimicrobial compounds is not fully known (Achmadi *et al.,* 2019). Applications in agriculture, bioremediation, and its role as enzyme producers for industry should also be further studied considering the vast biodiversity of plants in Indonesia (Achmadi *et al.,* 2019). There are still many potential endophytic microbes that live symbiotically with unexplored plants (Achmadi *et al.,* 2019). Metabolic profiling of mangosteen is based on the ripening stages. Metabolomics is an emerging research field based on exhaustive metabolite profiling that has been proven useful to facilitate the study of postharvest fruit development and ripening (Achmadi *et al*., 2019). Specifically, tracking changes to the metabolome as the fruit ripens should provide important clues for understanding ripening mechanisms and for identifying biomarkers to improve postharvest technology of the fruits (Achmadi *et al.,* 2019). Mangosteen is one of Indonesia's horticulture products that has high economic value. Mangosteen export from Indonesia faces some problems, namely the conventional cultivation and the quality of mangosteen to meet the demand. It is suggested to expand the harvest area and fertilizer subsidies scenario to increase Indonesian mangosteen export (Achmadi *et al.,* 2019).

Mangosteen contains secondary metabolites such as prenylated compounds and polyphenols (Ayman *et al*., 2019). It has recently been noted that mangosteen contains a plentiful source of a class of polyphenols known as xanthones (Ayman *et al.,* 2019). The three-ring arrangement—which holds diverse functional groups comprising isoprene, methoxy, phenyl groups, aromatic protons, phenolic hydroxyl groups, hydroxyl protons, and dihydrofuran rings—is the main chemical structure of a xanthone (Ayman *et al.,* 2019). More than 60 types of xanthones have been isolated from its roots, while its pericarp and bark contain α-mangostin, γ-mangostin, gartanin, 8-deoxygartanin, and 9-hydroxycalabaxanthone. The important compounds in mangosteen are phenolic (Ayman *et al*., 2019). In fact, 10 phenolic acids have been found in mangosteen fruit and the major one is protocatechuic acid, which is found in mangosteen peel (Ayman *et al.,* 2019). Xanthonoids and other phytochemicals are also found in mangosteen peel (Ayman *et al.,* 2019). Significant quantities of additional bioactive compounds, such as terpenes, tannins, calcium, phosphorus, iron, thiamine, riboflavin, niacin, and ascorbic acid are also found (Ayman *et al*., 2019).

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Garcinia trees provide spice, fruit, medicine, cooking butter, colour and polishing agents for metallic surfaces such as gold and silver. The fruits of the genus contain p-hydroxycitric acid which has inhibitory effect on lipogenesis and helps in controlling obesity in human beings (Tripathi , 2021). *Garcinia* possesses. anticancer and antioxidant properties or can be used as bio preservatives. *Garcinia* has assumed great significance in the biological research arena today providing not only traditionally known products but new ones also (Tripathi , 2021). The fruits of *Garcinia* species are used for edible purpose or medicinal purpose (Tripathi , 2021). The important species of this genus in India are mangosteen (*Garcinia mangosteena*), Kokum (*Garcinia indica*), Malabar tamarind (*Garcinia gummigutta*), yellow mangosteen (*Garcinia xanthochymus*), etc. the description of these lines is given here (Tripathi , 2021). Mangosteen or purple mangosteen is a tropical evergreen tree native of South Eastern Asian countries (Tripathi , 2021). It is considered as the finest fruit of the world' or 'queen of fruits' due to exquisite flavour, softness and taste of Pulp (Tripathi , 2021). It grows mainly in Southeast Asia and tropical South American countries. In India, it was introduced long back but grown in humid tropical areas of Kerala, Tamil Nadu and Karnataka (Tripathi , 2021). The area is very limited due to orthodox climatic requirement but the demand of fruits is very high and get very high price in market (Tripathi , 2021).

It is known as the "queen of fruits" – and not without reason. The mangosteen, also known as the mangosteen or *Garcinia mangostana*, is a plant species, or more precisely an Asian tree, whose fruit is edible (Unkategorisiert, 2023). When you hear its name for the first time, you quickly associate it with the mango, which is much better known here. However, this similarity in name is pure coincidence; the lychee is a much closer relative. The melodious name comes from the Malay language, where it is also native. The benefits of the tropical fruit have long been known there and explain its high status (Unkategorisiert, 2023). Mangostin is rich in cell-protecting antioxidants, which has made it increasingly interesting for medicine and the media in recent years and has led to a sharp rise in scientific interest in it (Unkategorisiert, 2023). The tropical fruit is a true all-rounder and has long been used in traditional medicine in South East Asia to treat infections and inflammations of all kinds: For wounds, diarrhea, dysentery or urinary tract infections, but also for allergies and cardiovascular diseases (Unkategorisiert, 2023). The tomato-sized fruit contains high concentrations of antioxidants. Some of the best known are xanthones (which it contains in above-average concentrations), stilbenes, tannins, catechins and polyphenols. These have a strong anti-inflammatory, antiviral, antimicrobial and antifungal effect, which is why they are also known as broad-spectrum antioxidants – they radically combat bacteria and fungi (Unkategorisiert, 2023). The very high content of bioactive ingredients and the total of twelve vitamins it contains also provide optimum support for the human immune system (Unkategorisiert, 2023).

*Garcinia mangostana L.* (Mangosteen), a functional food, belongs to the *Garcinaceae* family and has various pharmacological effects, including anti-oxidative, anti-inflammatory, anticancer, antidiabetic, and neuroprotective effects (Bi *et al*., 2023). Mangosteen has abundant chemical constituents with powerful pharmacological effects (Bi *et al.,* 2023). *Garcinia mangostana L.* (Mangosteen), also known as *Mangji persimmon,* belongs to the family *Garcinaceae* and is usually grow in Southeast Asian countries, such as Thailand, Malaysia, and Indonesia (Bi *et al*., 2023). It is widely believed that this fruit tree that reaches a height of 6 to 25 m is native to Sunda and the Maluku islands of east Indonesia (Bi *et al.,* 2023). Mangosteen is suitable for planting in low-altitude tropical areas, and its growth is relatively slow (Bi *et al*., 2023). Its ripe fruits are spherical and measure 5–8 cm in diameter. The inedible peel constitutes more than 50% of the fresh weight and is often discarded as waste (Bi *et al.,* 2023). However, the mangosteen peel has traditionally been used for its medical properties all over the world, especially in Southeast Asia (Bi *et al.,* 2023). Mangosteen has attracted attention both in its country of origin and Western countries, where it is regarded as a functional food. Its commercial products are supplied as extract powder, capsules, and juice. For example, it is becoming a household fruit juice in America due to its high concentration of antioxidant compounds, including phenolic compounds and **α**-mangostin ( **α**-MG) (Bi *et al.,* 2023). Current research indicates that mangosteen contains abundant chemical constituents, including polysaccharides, xanthrones, procyanidin, benzophenones, bioflavonoids, and triterpenoids (Bi *et al.,* 2023). The pharmacological effects of mangosteen include anti-oxidative, anti-inflammatory, anti-tumor, anti-depressive, anti-microbial anti-parasitic, and neuroprotective effects (Bi *et al*., 2023). Mangosteen is a medical plant with a long history in Southeast Asia, including Malaysia and the Philippines (Bi *et al*., 2023). In the ayurvedic system of medicines which is widely practiced in modern India , mangosteen has high medicinal value because its hull contains **α**-MG, which has been used for the treatment of inflammation, diarrhea, cholera, and dysentery (Bi *et al*., 2023). In addition to the hull, the rind, bark, and root have also been shown to have medicinal value. The rind has been utilized as an antibacterial agent and a medicine for the management of wounds, suppurations, and chronic ulcers. Hyperkeratosis, eczema, psoriasis, and other skin disorders have been treated by an ointment extracted from the leaves and bark of mangosteen (Bi *et al.,* 2023). In addition, amibiasine is a bark extract employed for the therapy of amoebic dysentery. The rind has been used for the treatment of gleet, cystitis, gonorrhea, and diarrhea (Bi *et al.,* 2023). A root decoction has been utilized to manage menstrual disorders in women (Bi *et al.,* 2023). A decoction and infusion extracted from the peels and seeds has shown anti-pyretic, anti-scorbutic, anti-infective, and laxative effects. Specifically, it has been prescribed for gastrointestinal and urinary tract infections (Bi *et al*., 2023). The rinds and decoctions of barks and leaves are the raw materials of a tea, which has been used to treat different urinary disorders, dysentery, diarrhea, and fever in Malaya and the Philippines (Bi *et al.,* 2023).

Mangosteen (*Garcinia mangostana* var. *mangostana*) is a popular tropical fruit, yet many aspects of its biology and evolutionary history are little known (Yao *et al*., 2023). Its origin remains contentious, although recent findings suggest *G. mangostana* L. var. *malaccensis* (Hook. f.) Nazre (synonym: *G. malaccensis* Hook. *f.*) as the sole progenitor (Yao *et al*., 2023). We review hypotheses on the origin of mangosteen and clarify points that have been affected by errors of fact and interpretation (Yao *et al*., 2023). The narrow focus and lack of detail in published results make their interpretation difficult. When possible, we support our interpretations with field observations and examination of herbarium specimens (Yao *et al.,* 2023). We outline the main biological traits (*e.g.,* dioecy, facultative apomixis, and polyploidy) of mangosteen and its wild relatives to infer traits that might have evolved during domestication of mangosteen (Yao *et al.,* 2023). We find no clear indication that apomixis and polyploidy evolved during domestication. Polyploidy is known in the wild relatives, but apomixis has not yet been demonstrated (Yao *et al*., 2023). Mangosteen (*Garcinia mangostana* var. *mangostana*, Clusiaceae) is often dubbed the "Queen of Fruits". The fruit has gained great fame for the exquisite taste of its snow-white flesh and is widely considered to be the finest fruit of the world (Yao *et al*., 2023). A typical mangosteen fruit consists of usually six carpels, each with a segment of pulpy flesh, which collectively constitute the endocarp. Each segment encloses an ovule, but usually only one or two develop into seeds (asexually produced) in each fruit (Yao *et al*., 2023). Mangosteen is the only *Garcinia* L. taxon widely cultivated at commercial scale for its fruit and has been introduced throughout the humid tropics (Yao *et al.,* 2023). Southeast Asia is the major production area of mangosteen. Currently, mangosteen is also cultivated in the American and African tropics (Yao *et*

*al.,* 2023). Despite a long history of cultivation, the domestication status of mangosteen, whether wild, domesticated, or semidomesticated is still being debated (Yao *et al.,* 2023). Also, whether cultivated mangosteen has undergone substantial genetic adaptation to cultivated environments and consistent phenotypic changes under traditional cultivation management is still unknown (Yao *et al*., 2023). . Some claims regarding the origin of mangosteen appear to be baseless and theories of origin have been plagued with errors of fact and interpretation. A thorough reappraisal is thus required (Yao *et al.,* 2023). Mangosteen (*Garcinia mangostana* var. *mangostana*) is a popular tropical fruit, yet many aspects of its biology and evolutionary history are little known (Yao *et al*., 2023). Its origin remains contentious, although recent findings suggest *G. mangostana* L. var. *malaccensis* (Hook. *f*.) Nazre (synonym: *G. malaccensis* Hook. *f*.) as the sole progenitor (Yao *et al*., 2023). The narrow focus and lack of detail in published results make their interpretation difficult. When possible, we support our interpretations with field observations and examination of herbarium specimens. We outline the main biological traits (*e.g*., dioecy, facultative apomixis, and polyploidy) of mangosteen and its wild relatives to infer traits that might have evolved during domestication of mangosteen. We find no clear indication that apomixis and polyploidy evolved during domestication. Polyploidy is known in the wild relatives, but apomixis has not yet been demonstrated (Yao *et al*., 2023). Also, we propose a testable new evolutionary-ecological framework that we call "Forest-*Dusun* Interface" to infer processes in the origin of mangosteen (Yao *et al.,* 2023). *Dusun* (Malay) refers to subsistence orchards in this context. Lastly, we propose future studies to address identified knowledge gaps (Yao *et al.,* 2023). Mangosteen (*Garcinia mangostana* var. *mangostana*, Clusiaceae) is often dubbed the "Queen of Fruits" (Yao *et al.,* 2023). The fruit has gained great fame for the exquisite taste of its snow-white flesh and is widely considered to be the finest fruit of the world (Yao *et al.,* 2023). A typical mangosteen fruit consists of usually six carpels, each with a segment of pulpy flesh, which collectively constitute the endocarp. Each segment encloses an ovule, but usually only one or two develop into seeds (asexually produced) in each fruit (Yao *et al*., 2023). Mangosteen is the only *Garcinia* L. taxon widely cultivated at commercial scale for its fruit and has been introduced throughout the humid tropics. Southeast Asia is the major production area of mangosteen (Yao *et al.,* 2023). Currently, mangosteen is also cultivated in the American and African tropics. Also, whether cultivated mangosteen has undergone substantial genetic adaptation to cultivated environments and consistent phenotypic changes under traditional cultivation management is still unknown (Yao *et al*., 2023). Under cultivation, has mangosteen evolved traits different from those of its wild ancestors, and if so, is it possible to retrace their evolutionary pathway? To answer these questions, we need to study the candidate wild progenitors, and to scrutinize the traits that may plausibly be expected to have been under selection during domestication (Yao *et al.,* 2023). Some claims regarding the origin of mangosteen appear to be baseless, and theories of origin have been plagued with errors of fact and interpretation thorough reappraisal is thus required (Yao *et al.,* 2023).

The mangosteen (Garcinia mangostana L.) germplasm still has limitations in fruit quality, drought tolerance and susceptibility to pests or diseases (Mursyidin *et al*., 2024). This study investigated the genetic diversity and relationships of mangosteen with its wild relatives (Garcinia spp.) based on leaf morphology and the internal transcribed spacer (ITS) region, including its secondary structure (Mursyidin *et al*., 2024). Based on leaf morphology, the mangosteen and its wild relatives generally showed a low genetic diversity (Mursyidin *et al*., 2024). However, the leaf texture and pubescence had a high genetic diversity (0.71 and 0.77, respectively) (Mursyidin *et al*., 2024). Furthermore, based on the ITS markers, the genetic diversity of Garcinia at the interspecies level was much higher than that at the intraspecies one (0.043 and 0.005, respectively) (Mursyidin *et al*., 2024). The unweighted pair group method with the arithmetic average (UPGMA) revealed that mangosteen is grouped into four main clusters, with 'Manggis Banjar' and 'Palembang' in the same cluster (Mursyidin *et al*., 2024). Similarly, the ITS positioned Garcinia into several clades, with 'Manggis Banjar', 'Kandangan' and 'Palembang' grouped into a similar clade (Mursyidin *et al*., 2024). The biochemical reconstruction showed that Garcinia has unique ITS secondary structures, i.e., ring and four-helix models (Mursyidin *et al*., 2024). Even though the cultivated mangosteen and its wild relatives had low diversity based on leaf morphology, the ITS markers showed a high genetic diversity (Mursyidin *et al*., 2024). Furthermore, the reconstruction of the ITS secondary structure has supported this germplasm's phylogenetic tree (Mursyidin *et al*., 2024). Mangosteen (Garcinia mangostana L.) is a flowering plant whose fruit is edible and favored by most people worldwide. This is because apart from the taste of the fruit, some parts of the plant can also be used for other needs, especially for medicine or as a source of medicinal raw materials (Mursyidin *et al*., 2024). For example, the rind of mangosteen is rich in xanthones and can be an anticancer, antibacterial, anti-inflammatory, antioxidant and antiviral agent (Mursyidin *et al*., 2024). Mangosteen has traditionally been used by Asian society to treat various diseases, such as diabetes, jaundice, obesity and liver (Mursyidin *et al*., 2024). Concerning its potential, it is unsurprising that mangosteen has high economic value and has even become a potential export commodity (Mursyidin *et al*., 2024). Indonesia was the largest mangosteen-producing country in the world, with a production of 270,110 tons and an export transaction value of up to 75.67 million U.S. dollars (Mursyidin *et al*., 2024). The export destinations for this fruit include four neighboring countries (Malaysia, Thailand, Vietnam and Hong Kong), the Middle East (Kuwait, Oman, Qatar, United Arab Emirates and Bahrain) and Europe (Denmark and France) (Mursyidin *et al*., 2024). Moreover, because this fruit is apomictic and agamospermic (the development of fruit and seeds occurs without going through gamete fusion), the mangosteen shows a narrow genetic diversity. Therefore, the main essential activities are exploring and characterizing mangosteen germplasm and its wild relatives (Mursyidin *et al*., 2024). Analysis of genetic diversity and relationships is urgent to support plant genetic expansion (breeding) programs. These parameters can be estimated based on morphological, cytological, biochemical and even molecular (DNA sequence) approaches (Mursyidin *et al*., 2024). The mangosteen (Garcinia mangostana L.) germplasm still has limitations in fruit quality, drought tolerance and susceptibility to pests or diseases (Mursyidin at al., 2024). This study investigated the genetic diversity and relationships of mangosteen with its wild relatives (Garcinia spp.) based on leaf morphology and the internal transcribed spacer (ITS) region, including its secondary structure (Mursyidin *et al*., 2024). Based on leaf morphology, the mangosteen and its wild relatives generally showed a low genetic diversity (Mursyidin *et al*., 2024). However, the leaf texture and pubescence had a high genetic diversity (0.71 and 0.77, respectively) (Mursyidin *et al*., 2024). Furthermore, based on the ITS markers, the genetic diversity of Garcinia at the interspecies level was much higher than that at the intraspecies one (0.043 and 0.005, respectively) (Mursyidin *et al*., 2024). 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This is because apart from the taste of the fruit, some parts of the plant can also be used for other needs, especially for medicine or as a source of medicinal raw materials (Mursyidin *et al*., 2024). For example, the rind of mangosteen is rich in xanthones and can be an anticancer, antibacterial, anti-inflammatory, antioxidant and antiviral agent (Mursyidin *et al*., 2024). Mangosteen has traditionally been used by Asian society to treat various diseases, such as diabetes, jaundice, obesity and liver (Mursyidin *et al*., 2024). Concerning its potential, it is unsurprising that mangosteen has high economic value and has even become a potential export commodity (Mursyidin *et al*., 2024). Indonesia was the largest mangosteen-producing country in the world, with a production of 270,110 tons and an export transaction value of up to 75.67 million U.S. dollars. The export destinations for this fruit include four neighboring countries , the Middle East, and Europe (Mursyidin *et al*., 2024). However, when examined

more closely, the quality of Indonesian mangosteen fruit and plants still have limitations, including low fruit quality, unattractive tree characteristics, lack of drought tolerance and rootstock susceptibility to pests and diseases (Mursyidin *et al*., 2024). Moreover, because this fruit is apomictic and agamospermic (the development of fruit and seeds occurs without going through gamete fusion), the mangosteen shows a narrow genetic diversity (Mursyidin *et al*., 2024). Among the various species of Garcinia around the world, there are about 40 species of mangosteen relatives whose fruits are edible and have superior genes to support genetic expansion or mangosteen breeding. These include Garcinia atroviridis, G. hombroniana, G. indica, G. multiflora and G. pedunculata (Mursyidin *et al*., 2024). Specifically, in Indonesia, as many as 64 of 400 Garcinia spp. worldwide can be used in breeding programs (Mursyidin *et al*., 2024). Based on this number, 25 Garcinia spp. are found in Kalimantan; 22 species each are found in Sumatra and Sulawesi. The remainder occur in other islands, such as Java, Nusa Tenggara, Maluku and Papua (Mursyidin *et al*., 2024). Analysis of genetic diversity and relationships is urgent to support plant genetic expansion (breeding) programs (Mursyidin *et al*., 2024).

Mangosteen (*Garcinia mangostana*), also known as the purple mangosteen, is a tropical evergreen tree with edible fruit native to Island Southeast Asia, from the Malay Peninsula to Borneo (Wikipedia, 2025). It has been cultivated extensively in tropical Asia since ancient times. It is grown mainly in Southeast Asia, southwest India and other tropical areas such as Colombia, Puerto Rico and Florida, where the tree has been introduced (Wikipedia, 2025). The tree grows from 6 to 25 m (19.7 to 82.0 ft) tall. The fruit of the mangosteen is sweet and tangy, juicy, somewhat fibrous, with fluid-filled vesicles (like the flesh of citrus fruits), with an inedible, deep reddish-purple colored rind (exocarp) when ripe (Wikipedia, 2025). The fragrant edible flesh that surrounds each seed is the endocarp*, i.e*., the inner layer of the ovary. The seeds are of similar size and shape to almonds (Wikipedia, 2025). Genus *Garcinia* also contains several less-known fruit-bearing species, such as the button mangosteen (*G. prainiana*) and the charichuelo (*G. madruno*) (Wikipedia, 2025).

Purple mangosteen, scientifically known as *Garcinia mangostana* L., is a tropical fruit with significant relevance in food science due to its unique characteristics and potential health benefits. It is characterized by its deep reddish-purple rind and white, juicy, sweet-tangy flesh (AI, 2025d). The fruit is known for its rapid postharvest changes and short shelf life, making it a subject of study in postharvest biologybiology (AI, 2025d). Furthermore, the pericarp (rind) is rich in bioactive compounds like xanthones, anthocyanins, and polyphenols, which contribute to its antioxidant, anti-inflammatory, and other potential health-promoting properties (AI, 2025d). Mangosteen is a good source of various vitamins and minerals, including vitamin C, vitamin B2, potassium, and phosphorus (AI, 2025d). The pericarp is rich in xanthones, particularly α-mangostin, which has been extensively researched for its antioxidant, anti-inflammatory, and potential anticancer properties (AI, 2025d). Anthocyanins, responsible for the fruit's purple color, also contribute to its antioxidant capacity (AI, 2025d). Polyphenols present in the fruit, including gallic acid, have been shown to have various health benefits (AI, 2025d). Mangosteen is known for its short shelf life and rapid deterioration after harvest, making it a subject of research in postharvest biology (AI, 2025d). Studies focus on extending the fruit's shelf life through various techniques, including modified atmosphere packaging and the use of natural preservatives (AI, 2025d). Mangosteen is highly valued for its juicy, delicate texture and slightly sweet and sour flavor, the mangosteen has been cultivated in Malaysia, Sri Lanka, Borneo, Sumatra, Mainland Southeast Asia, and the Philippines since ancient times (Wikipedia, 2025). The 15th-century Chinese record Yingya Shenglan described mangosteen as *mang-chi-shih* (derived from Malay *manggis*), a native plant of Southeast Asia of white flesh with a delectable sweet and sour taste (Wikipedia, 2025). A description of mangosteen was included in the *Species Plantarum* by Linnaeus in 1753 (Wikipedia, 2025). The mangosteen was introduced into English greenhouses in 1855. Subsequently, its culture was introduced into the Western Hemisphere, where it became established in West Indies islands, especially Jamaica. It was later established on the Americas mainland in Guatemala, Honduras, Panama, and Ecuador. The mangosteen tree generally does not grow well outside the tropics (Wikipedia, 2025). In Southeast Asia, mangosteen is commonly known as the "Queen of Fruits", and is frequently paired with durian, the "King of Fruits" (Wikipedia, 2025). In Chinese food therapy, mangosteen is considered "cooling", making it a good counterbalance to the "heaty" durian. There is also a legend about Queen Victoria offering a reward of one hundred pounds sterling to anyone who could deliver a fresh mangosteen to her (Wikipedia, 2025). The journalist and gourmet R. W. Apple Jr. once said of the fruit, "No other fruit, for me, is so thrillingly, intoxicatingly luscious...I'd rather eat one than a hot fudge sundae, which for a big Ohio boy is saying a lot." stores and gourmet restaurants who serve the flesh segments as a delicacy dessert (Wikipedia, 2025). Mangosteen (*Garcinia mangostana)* is a plant that grows in Southeast Asia. The fruit is dark purple or red. The fruit pulp is slightly acidic and sweet (Webmd, 2025). Mangosteen contains chemicals that might act as antioxidants and fight infections. People use mangosteen for serious gum infections, obesity, muscle strength, diarrhea, and many other conditions, but there is no good scientific evidence to support most of these uses. Don't confuse mangosteen with garcinia. These are not the same (Webmd, 2025). A serious gum infection (periodontitis). Taking mangosteen by mouth or applying a gel containing mangosteen to the gums might help improve gum health (Webmd, 2025). There is interest in using mangosteen for a number of other purposes, but there isn't enough reliable information to say whether it might be helpful (Webmd, 2025). When taken by mouth: Mangosteen is possibly safe when taken for up to 12 weeks. It might cause constipation, bloating, nausea, vomiting, and tiredness (Webmd, 2025). When applied to the gums: Mangosteen gel is possibly safe (Webmd, 2025). When taken by mouth: Mangosteen is possibly safe when taken for up to 12 weeks. It might cause constipation, bloating, nausea, vomiting, and tiredness (Webmd, 2025). When applied to the gums: Mangosteen gel is possibly safe (Webmd, 2025). Pregnancy and breast-feeding: There isn't enough reliable information to know if mangosteen is safe to use when pregnant or breast-feeding. Stay on the safe side and avoid use (Webmd, 2025). Bleeding disorders: Mangosteen might slow blood clotting. Taking mangosteen might increase the risk of bleeding in people with bleeding disorders (Webmd, 2025). Surgery: Mangosteen might slow blood clotting. Taking mangosteen might increase the risk of bleeding during or after surgery. Stop taking mangosteen 2 weeks before surgery (Webmd, 2025). Medications that slow blood clotting (Anticoagulant / Antiplatelet drugs) interacts with Mangosteen. Mangosteen might slow blood clotting. Taking mangosteen along with medications that also slow blood clotting might increase the risk of bruising and bleeding (Webmd, 2025). Minor Interaction**:** Be watchful with this combination (Webmd, 2025).

Mangosteen (*Garcinia mangostana*), revered as the "Queen of Fruits," has a rich history of medicinal use throughout Southeast Asia dating back centuries (Caring, 2025). Traditional healers in countries such as Thailand, Malaysia, and Indonesia utilized various parts of the mangosteen fruit, particularly the rind (pericarp), for its purported health benefits (Caring, 2025). The rind was often dried and ground into powders or brewed into decoctions to address a variety of ailments, including skin infections, diarrhea, dysentery, and wounds. These remedies were highly valued for their purported anti-inflammatory, antimicrobial, and wound-healing properties (Caring, 2025). The therapeutic efficacy of mangosteen is largely attributed to its unique class of polyphenolic compounds known as xanthones (Caring, 2025). Xanthones are potent antioxidants that have drawn significant scientific interest for their ability to support immune function, reduce oxidative stress, and promote overall cellular health (Caring, 2025). In traditional medicine, mangosteen preparations were sometimes combined with other botanicals such as turmeric, ginger, or holy basil to enhance their healing potential and address a broader spectrum of health challenges. These herbal combinations were believed to create synergistic effects, amplifying the positive outcomes for digestive, respiratory, and skin health (Caring, 2025). Modern nutritional products often harness the power of mangosteen xanthones, reflecting centuries of traditional wisdom. Their positive contributions to

wellness are supported by both historical practice and emerging scientific research (Caring, 2025). As a key ingredient in herbal blends, mangosteen xanthones continue to offer a natural, holistic approach to supporting vitality and well-being, making them a highly respected component in contemporary nutritional and herbal formulations. (Caring, 2025).

*Mangosteen***, (***Garcinia mangostana*), handsome tropical tree (family Clusiaceae) native to Southeast Asia and cultivated for its tart-sweet fruit (Britannica. 2025). The mangosteen fruit is highly valued for its juicy, delicate texture and slightly astringent flavour and is commonly eaten fresh, canned, or dried (Britannica. 2025). The plant is used locally in traditional medicine and has been promoted as an alternative cancer treatment, but clinical studies in humans are lacking (Britannica. 2025). Under favourable conditions, the slow-growing mangosteen tree can reach a height of 9.5 metres (31 feet) (Britannica. 2025). It has thick, dark green, glossy leaves, 15–25 cm (6–10 inches) long, borne in opposite pairs along the stem, and large rose-pink flowers. The fruits are the size of a small orange, round or flattened on the ends (Britannica. 2025). Mangosteens have a thick, hard, deep red rind surrounding snow-white flesh, which is in segments resembling those of a mandarin orange (Britannica. 2025). Seedlings take 8 to 15 years to bear fruit. Individual trees have been reported to yield more than 1,000 fruits in a season, but the plants usually produce good crops only in alternate years (Britannica. 2025). The mangosteen has been cultivated in Java, Sumatra, Indochina, and the southern Philippines from antiquity. It is a common dooryard tree in Indonesia (Britannica. 2025). The mangosteen generally does not prosper outside the tropics and is usually found fresh only in local markets (Britannica, 2025).

## ORIGIN AND DISRTBUTION

*Garcinia mangostana* L. (mangosteen or purple mangosteen) is naturally distributed in Southeast Asia specially Indonesia and Malaysia and it has been cultivated in other tropical regions such as Australia, Cuba, Dominica, Ecuador, Gabon, Ghana, Guatemala, Honduras, India, Jamaica, Liberia, Myanmar, The Philippines, Puerto Rico, Singapore, Sri Lanka, Thailand, Trinidad and Tobago, USA, Vietnam and Zanzibar . Mangosteen is native to the Malay Archipelago and it has been suggested that it originated through hybridization between *G. malaciensis* and *G. hombroniana* (Richards 1990b).

The mangosteen (*Garcinia mangostana* L.) originated in Southeast Asia and is a member of the family Clusiaceae. In earlier works, the genus had been placed in the Guttiferae. The genus name Garcinia was given by Linnaeus in honor of French naturalist Laurent Garcin for his work as a botanist in the eighteenth century. Laurent Garcin with others had made one of the most detailed descriptions of the fruit. Although the word 'mango' occurs in the word 'mangosteen' there is no botanical relationship at the genus or family levels. The name mangosteen is thought to have been derived from Malay or Javanese (Ketsa and Paull, 2011). Mangosteen fruits are soft, juicy with round, globular, red, dark red and purplish color, sweet flavor and pleasant aroma. Mangosteen fruits are popularly referred to as the Queen of fruits. The rind or pericarp of the fruit is pigmented with abundant anthocyanins and there are 4–8 wedge shaped seeds covered with arils that are white, juicy, sweet and slightly acidic, with a pleasant flavor . Seeds are eaten roasted (Murthy *et al*., 2018). Geographical distribution of taxa of *Garcinia* sect. *Garcinia*. Bioregions appear in bold typeface. Sundaland includes Sumatra, Malay Peninsula, Java and Borneo. The numbers denote total numbers of species and varieties represented in each region; numbers in parentheses indicate the total number of taxa endemic to the region. *Garcinia mangostana* var. *mangostana* is not included in these tallies. Points in red denote localities mentioned in the text. An important outcome of the revision that is especially pertinent to the understanding of the origin of cultivated mangosteen was their recognition of three varieties of *G. mangostana*. Cultivated mangosteen is recognized as *G. mangostana* var. *mangostana*, *G. malaccensis* was synonymized as *G. mangostana* var. *malaccensis*, and a new variety, *G. mangostana* L. var. *borneensis* Nazre, was described. Notably, texture of the persistent stigma surface is identified as a diagnostic character differentiating var. *mangostana* (smooth) from var. *malaccensis* (corrugated) (Yao *et al.,* 2023).

Cultivated mangosteen, like many trees in cultivation, was most probably domesticated incipiently, making the definition of cultivated, wild, or feral very challenging.The status of mangosteen, whether wild or cultivated, has long been debated. Views were contradictory in the early floristic accounts: "*native and cultivated*"; "*wild and cultivated*"; and "*cultivated… not known in the wild state*" were descriptions of the states of cultivation. *G. mangostana* occurs in the wild on the east coast of Peninsular Malaysia and in Borneo. According to F. Slik (pers. comm.), "wild" mangosteen morphologically similar to cultivated mangosteen and with similar-tasting fruits was observed in a forest about 100 km inland from Balikpapan, Kalimantan, Indonesia. However, truly wild populations of *G. mangostana* exist in Borneo. Our field observations and herbarium specimens found that *G. mangostana* var. *borneensis* is locally common in the lowland forests on the east coast of Sabah, Malaysian Borneo. Fruit trees, especially durian (*Durio zibethinus* L.) and mangosteen, are planted by the Temuan communities in the logged-over timber production forest reserves in Peninsular Malaysia. In the time before commercial logging, Temuan communities planted fruit trees in their old swiddens. Herbarium specimens of mangosteen from Borneo, particularly in the river basin of Upper Rajang, Sarawak, may well have been obtained from remnant trees in the abandoned swidden plots. Thus, specimens collected in the forests might represent feral populations. Mangosteen present in agroforests in Maninjau, West Sumatra, is sourced from home gardens (Yao *et al*., 2023). The descriptions above provide us a glimpse of occurrences of the wild relatives and the possible means of early domestication in cultivated mangosteen. In the following subsections, we present the historical record and linguistic evidence indicating the origin, and theories that have postulated the ancestors of cultivated mangosteen. Lastly, we discuss the possible domestication syndromes displayed in cultivated mangosteen (Yao *et al.,* 2023).

Concerning linguistic evidence, vernacular names of *G. mangostana* var. *mangostana* provide indications of its geographical origin. Cultivated mangosteen is locally known as *manggis*; another cultivar is called *mesta.* The names *manggis* and *mesta* (or *masta*) do not necessarily denote distinct taxonomic entities, although their association with local dialects is traceable. The definition and usage of the names have possibly changed over time. *Manggis* is generally applied to var. *mangostana*. However, var. *mangostana* is known as *set'to* / *mes'tor* in the dialects of the east coast of Malay Peninsula, related to *mestar* of the Pattani-Kelantan dialect. *Mesta* is a recently popularized name used in reference to var. *malaccensis* in cultivation. This name is very likely a spelling variant of *set'to* / *mes'tor* / *mestar* that was attributed to var. *mangostana* on the east coast of Peninsular Malaysia and in southern Peninsular Thailand. "*manggis hutan*, (*m. burong*)" as the vernacular name of *G. malaccensis*. *Hutan* means forest, and *burong* (or *burung* in modern Malay Language) means bird, denoting the relatively small leaf and fruit. Examinations of the specimens found that *manggis hutan* is not exclusively applied to var. *malaccensis*, and *mangis burong* was actually applied to a specimen of *G. penangiana* misidentified as *G. malaccensis*. Based on written historical records, inference from linguistic evidence and field observations, we speculate that mangosteen originated in the everwet zones of Southeast Asia, including Sumatra, Malay Peninsula, and Borneo, but excluding islands with a relatively pronounced dry season such as Java and Maluku (Yao *et al*., 2023).

Cultivated mangosteen, like many trees in cultivation, was most probably domesticated incipiently, making the definition of cultivated, wild, or feral very challenging. The status of mangosteen, whether wild or cultivated, has long been debated. *G. mangostana* occurs in the wild on the east coast of Peninsular Malaysia and in Borneo. "Wild" mangosteen morphologically similar to cultivated mangosteen and with similar-tasting

fruits was observed in a forest about 100 km inland from Balikpapan, Kalimantan, Indonesia. Truly wild populations of *G. mangostana* exist in Borneo. Our field observations and herbarium specimens found that *G. mangostana* ***var.*** *borneensis* is locally common in the lowland forests on the east coast of Sabah, Malaysian Borneo. The descriptions above provide us a glimpse of occurrences of the wild relatives and the possible means of early domestication in cultivated mangosteen. In the following subsections, we present the historical record and linguistic evidence indicating the origin, and theories that have postulated the ancestors of cultivated mangosteen. Lastly, we discuss the possible domestication syndromes displayed in cultivated mangosteen (Yao *et al*., 2023).

The mangosteen ( *Garcinia mangostana* L.) originated in Southeast Asia and is a member of the family Clusiaceae. In earlier works, the genus had been placed in the Guttiferae. The genus name Garcinia was given by Linnaeus in honor of French naturalist Laurent Garcin for his work as a botanist in the eighteenth century. Laurent Garcin with others had made one of the most detailed descriptions of the fruit. Although the word 'mango' occurs in the word 'mangosteen' there is no botanical relationship at the genus or family levels. The name mangosteen is thought to have been derived from Malay or Javanese (Ketsa and Paull, 2025). Cultivated mangosteen (*Garcinia mangostana* var. *mangostana*) is dioecious, but male trees are unknown. The trees produce viable seeds via apomixis, where all the embryos are essentially clones of the mother. Its extensive cultivation has made its original native range difficult to ascertain. *Garcinia mangostana* var. *mangostana* is likely to be the domesticated descendant of wild populations of *Garcinia mangostana* var. *malaccensis* (previously thought to be a separate species) and *Garcinia mangostana* var. *borneensis*, native to the Malay Peninsula and Borneo respectively. Both of these wild varieties still possess male trees, unlike the domesticated mangosteen. It may have also hybridized to a limited extent with closely related species, including *Garcinia penangiana* and *Garcinia venulosa* (Wikipedia, 2025). The Mangosteen is native to the Malay Archipelago and Indonesia. Distribution: Mangosteen was first domesticated in Thailand and Burma. Its main distribution now includes Thailand, Cambodia, Vietnam, Burma, Malaysia and Singapore. Also grown to a lesser extent in parts of Sri Lanka, India, Philippines, and parts of Africa, the Caribbean and South America (COD, 2025). It was introduced into Australia around the 1850s and planted in southern Queensland and New South Wales, but none of these survived. Subsequent test plantings were then mainly concentrated in northern Queensland, where commercial production in is centred on Bloomfield, Babinda and Innisfail. Preferred Climate and Soil Types: Mangosteen requires a tropical climate, and cannot tolerate temperatures below 5°C. It prefers deep, rich organic soil, and in fact, it prefers a little clay in the Top End soils possibly because of moisture retention during the dry (COD, 2025). Mangosteen is believed to have originated in the Sunda Islands and the Moluccas of Southeast Asia. Mangosteen is not native to India but is grown in the southern states of Kerala, Tamil Nadu, and Karnataka. Kerala is the major mangosteen producer in India, with an estimated 1000 tonnes grown annually. Tamil Nadu produces an estimated 200 tonnes, with cultivation in areas like Pollachi, Upper Palani hills, and Coonoor (AI, 2025c). Karnataka produces around 100 tonnes of mangosteen per year. Kerala's weather conditions are considered ideal for mangosteen cultivation, leading to increased production. High market rates for mangosteen are also a factor driving increased cultivation. Mangosteen is also grown in other tropical regions around the world, including parts of South America and Florida (AI, 2025c).

## TAXONOMY

The map above shows countries where the species has been planted. It does neither suggest that the species can be planted in every ecological zone within that country, nor that the species can not be planted in other countries than those depicted. Since some tree species are invasive, you need to follow biosafety procedures that apply to your planting site (Orwa *et al.,* 2009). Genus *Garcinia* is one of the important genus of fruiting plants belonging to the family Clusiaceae and includes about 200 species found in tropical Asia and Africa. Thirty five species of *Garcinia* are found in India. Out of these, 17 species are endemic. Of these, seven are endemic to the Western Ghats, six in the Andaman and Nicobar Islands and four in the northeastern region of India. Several species of this genus have traditionally been used by the natives of Asia and Africa in their day to day lives (Tripathi , 2021). The pantropical genus *Garcinia* comprises about 240 species of dioecious shrubs or trees. organized into 14 sections. The global distribution includes Central and South America, tropical Africa, Madagascar, the Mascarene islands, and throughout Southeast Asia to New Caledonia and northern Australia. Southeast Asia and Madagascar are the centers of species diversity. *Garcinia* is one of the most diverse tree genera in Asian tropical forests but is poorly represented in the Americas.The most recent global monograph for the genus. Many species have been added and the concepts of taxonomic sections remodeled over time. *Garcinia mangostana* belongs to *Garcinia* sect. *Garcinia* (Yao *et al.,* 2023).

The taxonomy of *Garcinia* is difficult, fraught with synonymies, and frequent misidentification of specimens. In this large genus, in which many species resemble one another in vegetative characters, identification to the species level is difficult when no reproductive organs are available. *Garcinia penangiana* is a species that has often been misidentified as *G. malaccensis*. The confusion thereby introduced has contributed to clouding the interpretation of the origin of mangosteen. Examinations of the specimens deposited in regional herbaria revealed that many specimens of *G. penangiana* were systematically misidentified as *G. malaccensis* by various collectors. The studies mentioned above defined the morphological characters of *G. mangostana* var. *mangostana* and the wild relatives. These findings enable us to identify the possible ancestral candidates of the cultivated mangosteen based on their morphological similarity (Yao *et al.,* 2023). The pantropical genus *Garcinia* comprises about 240 species of dioecious shrubs or trees organized into 14 sections. The global distribution includes Central and South America, tropical Africa, Madagascar, the Mascarene islands, and throughout Southeast Asia to New Caledonia and northern Australia. Southeast Asia and Madagascar are the centers of species diversity. *Garcinia* is one of the most diverse tree genera in Asian tropical forests but is poorly represented in the Americas. Many species have been added and the concepts of taxonomic sections remodeled over time. *Garcinia mangostana* belongs to *Garcinia* sect. *Garcinia*. Recently, a taxonomic revision of this section and recognized 13 species. Taxonomic concepts of this revision are followed here. Because we cite synonyms of accepted names (and the use of synonyms is duly noted) where necessary to facilitate the coherence of discussions, it is crucial for us to list the accepted names and their synonyms. In order to provide an idea of the phylogenetic position of *G. mangostana* in sect. *Garcinia*, we present a schematic phylogenetic tree. The closely related taxa repeatedly discussed in our study are illustrated with images (Yao *et al.,* 2023). The taxonomy of *Garcinia* is difficult, fraught with synonymies, and frequent misidentification of specimens. In this large genus, in which many species resemble one another in vegetative characters, identification to the species level is difficult when no reproductive organs are available. *Garcinia penangiana* is a species that has often been misidentified as *G. malaccensis*. The confusion thereby introduced has contributed to clouding the interpretation of the origin of mangosteen. Examinations of the specimens deposited in regional herbaria revealed that many specimens of *G. penangiana* were systematically misidentified as *G. malaccensis* by various collectors. Other species are also concerned by such confusion. "Dr Kostermans has for some years now been labelling as *G. celebica* L. all specimens of this species-group [*G. penangiana* and other morphologically similar species] in the herbaria he has visited". Erroneous identifications have had serious consequences for the interpretation of results used in constructing hypotheses about the origin of mangosteen. A few *Garcinia* species, namely *G. malaccensis*, *G. hombroniana* Pierre, and *G. venulosa*, have been regarded as wild species closely related to mangosteen based on morphological characters, and *G. malaccensis* was regarded as the most closely related species. Assessment of morphological affinity between these taxa was mainly based on leaf characters. Herbarium specimens with flowers are generally hard to come by. *Garcinia opaca* has never

been regarded as closely related to mangosteen based on morphological characters (Yao *et al.,* 2023). Assessment of the various hypotheses on the origin of mangosteen in light of morphological comparisons and new genetic information supports the conclusion that *G. mangostana* var. *malaccensis* is the sole progenitor of mangosteen. Below, we compare the traits of mangosteen and its wild relatives, focusing particularly on *G. mangostana* var. *malaccensis*. We examine the proximate mechanisms that might have led to changes in genetic and breeding system traits in mangosteen and the selective pressures that may have favored trait evolution (Yao *et al.*, 2023).

**Comparison of the varieties of *Garcinia mangostana***

| Taxon | Presence of pistillodes in male flowers | Fruit shap e | Fruit size | Fruit apex; persistent stigma shape, and surface texture | Cultivated or wild | Natural geographical distribution |
|---|---|---|---|---|---|---|
| *mangostana* | present*, *c*. 5 mm long. | ovoid or globose | 4–7 cm across | rounded; circle, and smooth | cultivated; known as *manggis*; feral populations might exist | Malaysia and Indonesia |
| *malaccensis* | absent, or if present *c*. 2 mm | globose, ellipsoid or ovoid | 3–4 cm across | acute to attenuate; circle, and rugose | both cultivated and wild; known as *mesta* in cultivation | Sumatra; Malay Peninsula; Borneo: Southwest Sarawak and Brunei |
| *borneensis* | absent, or if present *c*. 2 mm | globose | 3–4 cm across | rounded; circle or oval, and smooth to slightly rugose | Wild | Borneo: East coasts of Sabah and Kalimantan |

(Yao *et al.,* 2023).

Mangosteen (*Garcinia mangostana*) is a tropical fruit native to Southeast Asia, traditionally valued for its delicious taste and purported health benefits. One of its key bioactive components is a group of polyphenolic compounds known as xanthones. Historically, mangosteen fruit and its rind have been used in folk medicine throughout Asia for centuries to address a variety of ailments, including skin infections, inflammation, and digestive issues. Scientific interest in *Mangosteen xanthones* has grown in recent decades. Laboratory and animal studies have shown that xanthones, particularly alpha-mangostin, possess notable antioxidant, anti-inflammatory, and antimicrobial properties.

For example, some in vitro studies suggest that xanthones can scavenge free radicals and modulate inflammatory pathways, supporting their role in promoting cellular health and immune function. Preliminary clinical research in humans has begun to explore the benefits of mangosteen-derived supplements. Some small-scale studies indicate potential positive effects on markers of inflammation, immune response, and even skin health. For instance, a few pilot trials have reported improvements in antioxidant status among participants consuming mangosteen juice or extracts. However, large-scale, well-controlled human studies are still limited, and the precise health benefits of mangosteen xanthones in nutritional products remain to be conclusively established. While further research is warranted to fully validate the health-promoting claims of *Mangosteen xanthones*, their historical use and promising laboratory findings suggest they may be a valuable addition to nutritional formulations. As a natural source of potent phytonutrients, *Mangosteen xanthones* continue to attract interest for their potential contributions to wellness and healthy living. (Caring, 2025).

**BOATNICAL DECSIPTION**

The mangosteen is a small, evergreen tree, very slow-growing, erect with a pyramidal crown; attains 6-25 m in height, has dark-brown or nearly black, flaking bark, the inner bark containing yellow, gummy, bitter latex. Leaves opposite, short-stalked, ovate-oblong or elliptic, leathery and thick, dark-green, slightly glossy above, yellowish-green and dull beneath; 9-25 cm long, 4.5-10 cm wide, with conspicuous, pale midrib. New leaves rosy. Flowers 4-5 cm wide, fleshy, may be male or hermaphrodite on the same tree. The former are in clusters of 3-9 at the branch tips; there are 4 sepals and 4 ovate, thick, fleshy petals, green with red spots on the outside, yellowish-red inside. Stamens many, fertile and sterile. The hermaphrodite are borne singly or in pairs at the tips of young branchlets; their petals may be yellowish-green edged with red or mostly red, and are quickly shed (Orwa *et al*., 2009). Fruit a subglobose berry, capped by the prominent calyx at the stem end, with 4-8 triangular, flat remnants of the stigma in a rosette at the apex, dark-purple to red-purple and smooth externally, 3.4-7.5 cm in diameter. The rind is 6-10 mm thick, red in cross-section, purplish-white on the inside; contains bitter yellow latex and a purple staining juice. There are 4- 8 triangular segments of snow-white, juicy, soft flesh (actually the arils of the seeds) (Orwa *et al*., 2009). The fruit may be seedless or have 1-5 fully developed seeds. Seed ovoid-oblong, somewhat flattened, 2.5 cm long and 1.6 cm wide that cling to the flesh. Flesh slightly acid, mild to distinctly acid in flavor, acclaimed to be exquisitely luscious and delicious. The generic name is after L. Garcin (1683-1751), a naturalist and a correspondent of Linnaeus (Orwa *et al*., 2009). Smooth round fruit, 3.4 to 7.5 cm in diameter, is capped by a prominent calyx at the stem end that has 4 to 8 triangular, flat remnants of the stigma in a rosette at the apex. When the fruit is mature and ripe, it is dark-purple to reddish-purple. The rind (pericarp) is 6 to 10 mm thick and spongy and in cross-section is red outside and purplish-white on the inside. The pericarp has a bitter yellow latex, and a purple, staining juice. Inside the pericarp are 4 to 8 triangular segments of snow-white, juicy, soft edible flesh (aril) that clings to the seeds. The fruit may be seedless or have 1 to 5 fully developed seeds. The seeds are ovoid-oblong, somewhat flattened, 2.5 cm long and 1.6 cm wide (Ketsa and Paull, 2011).

The edible aril is white, juicy, sweet and slightly-acid, with a pleasant flavour. It is similar in shape and size to a tangerine. The circle of wedge-shaped arils contains 4 to 8 segments, the larger of which contain the apomictic seeds that are unpalatable unless roasted. Fruit are harvested at various stages of ripeness, referred to as Stage 1 to Stage 6. During ripening, Hue angle and pericarp firmness decline significantly, while soluble solids contents (SSC) increases and titratable acidity (TA) decreases resulting in an increase of SSC: TA ratio, and better tasting fruit. Fruit harvested at Stage 1 and allowed to ripen to Stage 6 show no significant differences in sensory quality and fruit appearance to fruit harvested at Stage 6. In the absence of fertilization, asexual ovary nucellus tissue development occurs that ensures fruit and aril growth. The asexual embryos develop from the nucellus tissue and these apomixic 'seed' are used in propagation. The 'seed' is a clone of the mother plant with little variation, but the absence of true seed associated with sexual fertilization limits varietal development and selection. DNA and RNA marker analysis from material sourced globally has shown variation among the different mangosteen populations. The majority of the samples had essentially the same genetic make-up (genotype) but significant differences were found in same samples.

This difference could be due to chance mutation or selection within the limited variation that is known to occur (Ketsa and Paull, 2011). The mangosteen is a very slow-growing, erect tree with a pyramidal crown. The tree can attain 6 to 25 m and has dark-brown or nearly black, flaking bark, the inner bark containing much yellow, gummy, bitter latex. This evergreen has opposite, short-stalked leaves that are ovate-oblong or elliptic, leathery and thick, dark-green, slightly glossy above and yellowish-green and dull beneath. New leaves have a rosy hue. The mature leaves are 9 to 25 cm long and 4.5 to 10 cm wide with conspicuous, pale midribs. Female flowers are 4 to 5 cm wid. The flowers are borne

singly or in pairs at the tips of young branchlets; their fleshy petals may be yellowish-green, edged with red or mostly red, and the petals are quickly shed. No male flowers or trees have been described, though it is said to be dioecious. Mangosteen is only known as a female cultivated plant. Based on morphological characters, mangosteen may be a sterile allopolyploid hybrid (2n = 88 – 90) between two *Garcinia* spp. the smooth round fruit, 3.4 to 7.5 cm in diameter, is capped by a prominent calyx at the stem end eds. The fruit may be seedless or have 1 to 5 fully developed seeds. The seeds are ovoid-oblong, somewhat flattened, 2.5 cm long and 1.6 cm wide. The edible aril is white, juicy, sweet and slightly-acid, with a pleasant flavor . It is similar in shape and size to a tangerine. The circle of wedge-shaped arils contains 4 to 8 segments, the larger of which contain the apomictic seeds that are unpalatable unless roasted. Fruit are harvested at various stages of ripeness, referred to as Stage 1 to Stage 6. During ripening, Hue angle and pericarp firmness decline significantly, while soluble solids contents (SSC) increases and titratable acidity (TA) decreases resulting in an increase of SSC: TA ratio, and better tasting fruit. Fruit harvested at Stage 1 and allowed to ripen to Stage 6 show no significant differences in sensory quality and fruit appearance to fruit harvested at Stage 6 (Ketsa and Paull, 2011). Mangosteen is a small, evergreen tree grows up to 25 m, erect with a pyramidal crown, bark dark-brown with latex.

Leaves opposite, short-stalked, ovate-oblong, leathery and thick, dark-green, yellowish-green beneath, 9–25 cm long and 5–10 cm wide, with a conspicuous midrib. Flowers, male or hermaphrodite on the same tree, fleshy. Four sepals green in color, petals 4 green with red spots. Stamens many, fertile or sterile. Fruit a berry, sub-globose in shape, persistent calyx at the stem end and flat remnants of the stigma in a rosette at the apex. dark-purple to red in color, smooth externally, 4–8 cm in diameter. Rind 6–10 mm thick, red in cross section, purplish white inside with snow white, juicy, soft fleshy arils. Fruits have 0–5 seeds which are ovoid-oblong, somewhat flattened, 2.5 cm long and 1.5 cm wide (Murthy *et al*., 2018). The mangosteen tree is slow growing, upright in habitat, with a pyramid shaped crown. The tree grows to between 6-25 m in height with nearly black, flaky outer bark and a gummy, extremely bitter latex contained inside the bark.

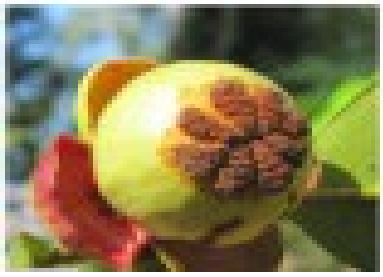
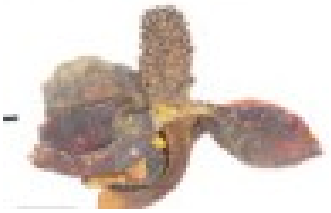
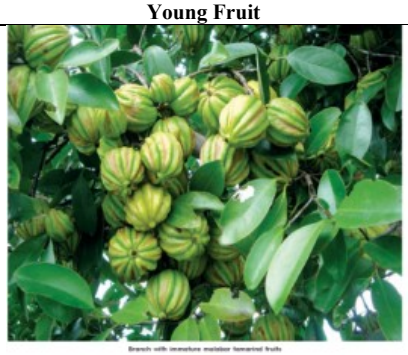
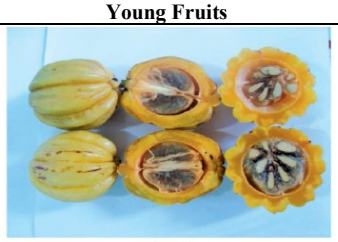
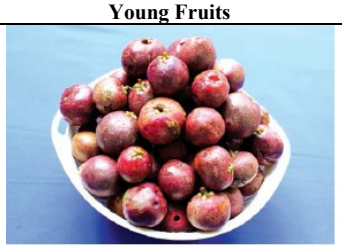
This evergreen tree has short stalked, dark green leaves that are oblong and glossy atop and yellow-green and dull on the underside. New leaves are rosy red and oblong. Blooms are 3.8-4 cm wide, and may be male or hermaphrodite on the same tree. Male flowers are borne in clusters of three to nine at the branch tips; fleshy, green with red spots on the outsides and yellowish red on the interior. They have many stamens, but the anthers bear no pollen. Hermaphrodite blooms are found at the tip of branchlets and are yellowish green bordered with red and are short lived. The resulting fruit is round, dark purple to reddish purple, smooth and about 3-8 cm in diameter. The fruit has a notable rosette at the apex composed of four to eight triangle shaped, flat remnants of the stigma. The flesh is snow white, juicy and soft, and may or may not contain seeds. The mangosteen fruit is acclaimed for its luscious, delectable, slightly acidic flavor. In fact, the fruit of the mangosteen is often referred to as the "queen of tropical fruit." (Gardening, 2021).

The mangosteen plant can reach a height of 6–25 m, with dense foliage covering the crown. The growth of mangosteen is relatively slow, as it takes 7–9 years for the first harvest after planting. The fruit matures from May to October every year, and the yield is highest from August to October. After ripening, the fruit is spherical, dark purple, and 5–8 cm in diameter. It has white flesh and a hard rind. Due to its unique taste and medicinal value, mangosteen is known as the "Queen of Fruits." The edible aril is juicy and soft, with a sweet and slightly sour taste and a pleasant fragrance. Moreover, mangosteen seeds are present in one or both septa of each fruit. Mangosteen is classified as a fragile plant due to its sensitivity to drought and low temperatures (Bi *et al.,* 2023).

The subsurface chemistry of the mangosteen exocarp comprises an array of polyphenols, including xanthones and tannins that assure astringency which discourages infestation by insects, fungi, plant viruses, bacteria, and animal predation while the fruit is immature. Colour changes and softening of the exocarp are natural processes of ripening that indicate the fruit can be eaten and the seeds have finished developing. Once the developing mangosteen fruit has stopped expanding, chlorophyll synthesis slows as the next colour phase begins. Initially streaked with red, the exocarp pigmentation transitions from green to red to dark purple, indicating a final ripening stage. This entire process takes place over a period of ten days as the edible quality of the fruit peaks. Over the days following removal from the tree, the exocarp hardens to an extent depending upon post-harvest handling and ambient storage conditions, especially relative humidity levels. If the ambient humidity is high, exocarp hardening may take a week or longer when the flesh quality is peaking and excellent for consumption. However, after several additional days of storage, especially if unrefrigerated, the flesh inside the fruit might spoil without any obvious external indications. Using the hardness of the rind as an indicator of freshness for the first two weeks following harvest is therefore unreliable because the rind does not accurately reveal the interior condition of the flesh. If the exocarp is soft and yielding as it is when ripe and fresh from the tree, the fruit is usually good (Wikipedia, 2025).

The edible endocarp of the mangosteen has the same shape and size as a tangerine 4–6 cm in diameter, but is white. The number of fruit segments corresponds exactly with the number of stigma lobes on the exterior apex; accordingly, a higher number of fleshy segments also corresponds with the fewest seeds. The circle of wedge-shaped segments contains 4–8, rarely 9 segments, the larger ones harbouring the apomictic seeds that are unpalatable unless roasted. As a non-climacteric fruit, picked mangosteen does not ripen further, so it must be consumed shortly after harvest. Often described as a subtle delicacy, the flesh bears an exceptionally mild aroma, quantitatively having about 1/400th of the chemical constituents of fragrant fruits, explaining its relative mildness. The main volatile components having caramel, grass and butter notes as part of the mangosteen fragrance are hexyl acetate, hexenol and α-copaene. Ethyl octanoate, ethyl hexanoate and 3-methyl-2-butene-1-thiol were detected as aroma components in mangosteen wine (Wikipedia, 2025). Hailed as the "Queen of Fruits", the mangosteen's popularity is said to be rivalled only by the durian. The tree is part of the Guttiferae family and has the distinction of being remarkably difficult to raise. Seedlings are fragile and perish easily. The few that do reach maturity can take up to 15 years to bear fruit and even longer to propagate. The mangosteen tree has a straight, central trunk and grows to a medium height of 20 ft to 40 ft.

The bark is slightly scaly and has a sooty brown or black colouration. Its low branches and lush foliage provide good shade in private gardens. Leaves are simple, thick and have a slight sheen. Mature leaves may be an attractive shade of olive to dark green, but have pale, drab undersides. The wide and fleshy flowers may be male or hermaphrodite on the same tree. The round fruit is initially a crisp green, and ripens to a deep, purplish zurgundy. A firm outer rind and a crown of sepals encase four to eight luscious, white segments. It is possible to predict the number of segments, as they always correspond with the number of lobes found at the apex of the fruit. The fruit may be seedless or have one to five fully developed seeds, ovoid-oblong and somewhat flattened, that cling to the flesh. To avoid picking fruits with too many seeds, a general rule is to choose fruits with the largest number of lobes, and hence, the largest number of segments. The segments are arranged centrally and can be easily loosened with the fingers. The fruit is popular for its delicate flavour, subtle sweetness and melting texture. However, one must be careful of the fruit's indelible crimson stains (Dass, 2025) (Fig. 1 & 2).

| | | |
|---|---|---|
|  |  |  |
| **Tree** | **Fruits** | **Seeds** |
|  |  |  |
| **Plant** | **Shoot** | **Plant** |
|  Young tree of mangosteen |  |  |
| **Young Tree** | **Flower and Fruits** | **Young fruit** |
|  |  |  |
| **Young Fruit** | **Young Fruit** | **Male Flower** |
|  Branch with immature malabar tamarind fruits |  |  Immature fruits of mangosteen |
| | | **Immature Fruit** |
| | **Young Fruits** | **Young Fruits** |
|  |  Mature fruits |  Ripe fruits of Kokum |
| **Fruits** | | |

Continue …..

Cut Fruit

**Fruis**

Cut Fruit

**Fruits**

**Dry Fruits**

**Fig. 1. Botanical Description**

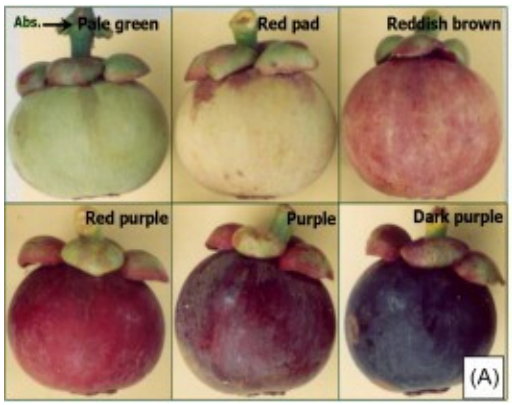



**Fig. 2. Different Color Fruits**

## GENETICS AND CYTOGENETICS

In this study, we conclude that *G. mangostana* has 2*n* = 74–110 chromosomes, which is in agreement with findings obtained by several previous researchers: 2*n*=76; 2*n*=96; 2*n*=110–120; 2*n*=88–90; and 2*n*=90. No male fl owers or trees have been described, though it is said to be dioecious. Mangosteen is only known as a female cultivated plant. Based on morphological characters, mangosteen may be a sterile allopolyploid hybrid (2n = 88 − 90) between two *Garcinia* spp. (Ketsa and Paull, 2025).

## GENETIC DIVERSITY

The genetic improvement of a plant to produce high-yielding varieties depends on genetic variability. It is widely known that the mangosteen plant (*Garcinia mangostana L.*) does not have genetic variability because it has an apomictic reproductive mechanism. Analysis of genetic diversity can be carried out by analysis of similarities and clusters between accessions of plants or with their close relatives of the Garcinia genus. This research was carried out to analyze the genetic diversity of 50 mangosteen accessions at mangosteen production centers in four provinces in Java, Indonesia (Banten, West Java, Central Java, and East Java provinces) using RAPD-based primers. RAPD-based amplification revealed a total of 30 amplicons, 28 as polymorphic and two as monomorphic, with an average percentage of polymorphism of 72.22%. The results of PCR-RAPD visualization produce bands measuring 300 bp - 1500 bp. The dendrogram shows the grouping of all types of **G.** *mangostana* L. in general. The primer used can amplify the samples properly. Genetic variation occurs with coefficient values ranging from 25% to 100%. This study also explains the pattern of the spread of *G. mangostana* L. in Java for the first time. These results can be used as a reference for conserving *G. mangostana* L. and future breeding (Susilo, 2023). Mangosteen (*Garcinia mangostana* var. *mangostana*) is a popular tropical fruit, yet many aspects of its biology and evolutionary history are little known. Its origin remains contentious, although recent findings suggest *G. mangostana* L. var. *malaccensis* (Hook. *f.*) Nazre (synonym: *G. malaccensis* Hook. *f.*) as the sole progenitor. We review hypotheses on the origin of mangosteen and clarify points that have been affected by errors of fact and interpretation. The narrow focus and lack of detail in published results make their interpretation difficult. When possible, we support our interpretations with field observations and examination of herbarium specimens. We outline the main biological traits (e.g., dioecy, facultative apomixis, and polyploidy) of mangosteen and its wild relatives to infer traits that might have evolved during domestication of mangosteen. We find no clear indication that apomixis and polyploidy evolved during domestication. Polyploidy is known in the wild relatives, but apomixis has not yet been demonstrated. Also, we propose a testable new evolutionary-ecological framework that we call “Forest-*Dusun* Interface” to infer processes in the origin of mangosteen. *Dusun* (Malay) refers to subsistence orchards in this context. Lastly, we propose future studies to address identified knowledge gaps (Yao *et al*., 2023).

The mangosteen (*Garcinia mangostana* L.) germplasm still has limitations in fruit quality, drought tolerance and susceptibility to pests or diseases. This study investigated the genetic diversity and relationships of mangosteen with its wild relatives (*Garcinia* spp.) based on leaf morphology and the internal transcribed spacer (ITS) region, including its secondary structure. Based on leaf morphology, the mangosteen and its wild relatives generally showed a low genetic diversity. However, the leaf texture and pubescence had a high genetic diversity (0.71 and 0.77, respectively). Furthermore, based on the ITS markers, the genetic diversity of *Garcinia* at the interspecies level was much higher than that at the intraspecies one (0.043 and 0.005, respectively). The unweighted pair group method with the arithmetic average (UPGMA) revealed that mangosteen is grouped into four main clusters, with 'Manggis Banjar' and 'Palembang' in the same cluster. Similarly, the ITS positioned *Garcinia* into several clades, with 'Manggis Banjar', 'Kandangan' and 'Palembang' grouped into a similar clade. The biochemical reconstruction showed that *Garcinia* has unique ITS secondary structures, i.e., ring and four-helix models. Even though the cultivated mangosteen and its wild relatives had low diversity based on leaf morphology, the ITS markers showed a high genetic diversity. Furthermore, the reconstruction of the ITS secondary structure has supported this germplasm's phylogenetic tree (Pesqui, 2024).

## BREEDING

**Propagation:** Mangosteen is usually propagated by seedlings. Vegetative propagation is difficult and seedlings are more robust and reach fruiting earlier than vegetatively propagated plants. Mangosteen produces a recalcitrant seed which is not a true seed strictly defined, but rather described as a nucellar asexual embryo. As seed formation involves no sexual fertilization, the seedling is genetically identical to the mother plant. If allowed to dry, a seed dies quickly, but if soaked, seed germination takes between 14 and 21 days when the plant can be kept in a nursery for about 2 years growing in a small pot. When the trees are approximately 25–30 cm (10–12 in), they are transplanted to the field at a spacing of 20–40 m (66–131 ft). After planting, the field is mulched in order to control weeds. Transplanting takes place in the rainy season because young trees are likely to be damaged by drought. Because young trees need shade, intercropping with banana, plantain, rambutan, durian or coconut leaves is effective. Coconut palms are mainly used in areas with a long dry season, as palms also provide shade for mature mangosteen trees. Another advantage of intercropping in mangosteen cultivation is the suppression of weeds (Wikipedia, 2025).

**Germplasm Collection, Conservation and Utilization:** Extensive research work has been carried out by various research groups in collection, conservation and utilization of Garcinia germplasm, from its center of diversity. The International Plant Genetic Resources Institute (IPGRI) was also involved in large-scale collection and conservation of Mangosteen from Southeast Asian countries including Myanmar, Laos, Thailand, Cambodia, Vietnam, Malaysia, Brunei, Singapore, The Philippines, Indonesia and Papua New Guinea (Murthy *et al.,* 2018).

Various approaches have been proposed to conserve Garcinia genetic resources; among them the in situ based conservation strategies are very prominent because Garcinia seeds are recalcitrant. It was reported that mangosteen, seeds are high in moisture content, possess no dormancy, exhibit low seed viability and short lived. Mangosteen, are described as agamospermic without a differentiated embryo, endosperm or embryonic axis. Therefore, seed storage is hampered. Freshly harvested seeds of these species can be stored at ambient temperatures for up to 30 days and seed longevity could be extended up to 60 days by storage at 15 °C. However, chilling treatment at 5 °C, leads to considerable loss of viability of up to 60% . Nevertheless, ex situ conservation methods are also followed for conservation of Garcinia germplasm and the gene banks are established at the National Bureau of Plant Genetic Resources (NBPGR), New Delhi, India (Murthy *et al.,* 2018).

Mangosteen is a polyploid (2n _ ≈90) hybrid between *G. homroniana* (2n _ 48) and *G. malacensis* (2n _ ≈42) and exhibits much variability in its native lands of Indonesia and Malaysia. They also attributed such variation to environmental factors. They also reported variability in fruit characteristics namely fruit weight, length, diameter, length/diameter ratio, rind thickness, peduncle length, total soluble solids and presence of fruit latex in populations collected from the four named sites. They achieved a good positive correlation with fruit diameter, fruit weight, fruit length, rind thickness and number of seed/fruit. Also suggested that the fruits from Kaligesing were superior for larger size and seed number/fruit, and the fruits from Watulimo for sweetness and lower yellow latex content. Such studies suggest the usefulness of population evaluation for morphological variability and selection of plants/clones for superior characteristics. Selections were made by a different group of scientists in different South-eastern countries. Reported a cultivar from The Philippines called *Julu*, which possessed larger fruits than normal, the seeds were larger and the pulp was more acidic. The commercially-availableMalaysian cultivar Mesta is a seedless variety with a smaller fruit size than the typical mangosteen (Murthy *et al.,* 2018).

### Germplasm Management

Seeds are recalcitrant and should be stored in their fruit at room temperature, or in moist peat moss, even these will lose viability in 5 days after removal from the fruit, though they are viable for 3-5 weeks in the fruit. Viability can be maintained for 1-2 months in moist storage at 20 deg C, storage temperature of 10 deg C is damaging. Seeds packed in lightly dampened peat moss, sphagnum moss or coconut fiber in airtight containers have remained viable for 3 months. Only 22% germination has been realized in seeds packed in ground charcoal for 15 days. Soaking in water for 24 hours expedites and enhances the rate of germination. Generally, sprouting occurs in 20 to 22 days and is complete in 43 days (Orwa *et al*., 2009).

### Breeding

Most *Garcinia* species are apomictic and fruit and seed development in these species is through agamospermy *i.e.,* production of seed without the fusion of gametes. The mode of embryo and seed development has been studied only in *G. mangostana* and it was reported that embryo development in mangosteen is from integuments rather from the egg. Therefore, *Garcinia* species are considered as exclusively apomictic and plants produced by seed or vegetative propagation are homogeneous and genetically identical. Consequently, variability observed in mangosteen, in the field/wild is likely due to difference of environmental conditions. Nevertheless, several studies have revealed that a population from apomictic reproduction does not always carrying the same genetic properties, even in obligate apomixes; variability in progenies and populations has been reported in obligate apomictic species *Taraxacum.* Hence, improvement of *Garcinia* species is mostly exploitation of existing genetic variability and improvement of these species is only through selection rather than

**Conventional breeding. The major breeding objectives for improvement of *Garcinia* species are as follows:**

**Fruit quality**: Great variability exists among natural population of mangosteen, with respect to fruit size, shape, content of fruit pulp, number of arils and seeds, and shelf life. Accordingly, selection of plants with respect to the above characteristics along with color, flavor, texture and nutritional value of fresh fruits is themain priority in the improvement *Garcinia* species.

**Tree characteristics**: Mangosteen trees raised from seeds have a long juvenile period (7–12 years for fruiting) and depict constraints of less fruit-bearing capacity. Therefore, selection of early maturing, early and late blooming (in a year), and high yielding/fruit bearing plants/population is highly desirable.

**Drought tolerance**: *Garcinia* species are sensitive to drought during the early growth period (up to 5 years) and shade should be provided during that period. Hence, selection of drought tolerant plants/populations is very much essential.

**Rootstock improvement**: Information of rootstocks, stock-scion relationships is fragmentary in *Garcinia* species; thus, selection of root stock and scion with respect to wide geographic adaptability, resistance to biotic and abiotic stresses, and high productivity with good quality fruits is another area to be explored (Murthy *et al*., 2018).

Information on breeding biology of wild *Garcinia* spp. is scarce, but some are known to form seeds parthenogenetically. Seeds are formed by an adventive embryo originating from a somatic cell in the epithelium of the inner integument layer of the ovary in *G. kydia* Roxb. and *G. treubii* Pierre. “Embryonic buds” formed on the inner integument were also observed in *G. parvifolia* and *G. scortechinii* King but do not develop into adventive embryos. In *G. parvifolia*, the unfertilized egg cell develops into an embryo. Mesta, the cultivated *G. mangostana* var. *malaccensis*, is likely capable of producing fruits apomictically, as our field observations and interviews with growers found no male individuals in cultivation. The capability of both cultivated and wild *G. mangostana* var. *malaccensis* and var. *borneensis* to reproduce apomictically could be ascertained with empirical studies, for example, bagging experiments on wild trees with staminodes removed, coupled with studies of embryonic development. These studies would confirm whether plants of these taxa are capable of apomictic reproduction (Yao *et al*., 2023).

In the breeding of perennial mangosteen, the selection of rootstock and grafting are significant issues to overcome constraints to production, harvesting, or seasonality.[5] Most of the genetic resources for breeding are in germplasm collections, whereas some wild species are cultivated in Malaysia and the Philippines. Conservation methods are chosen because storage of seeds under dried and low-temperature conditions has not been successful (Wikipedia, 2025). Because of the long duration until the trees yield fruits and the long resulting breeding cycles, mangosteen breeding has not proven attractive for transplanting or research. Breeding objectives that may enhance mangosteen production include (Wikipedia, 2025). Drought tolerance, especially sensitivity to drought in the first 5 years after germination. Tree architecture to produce a tree with a crown that is regular and pyramid-shaped. Fruit quality including i) overcoming bitter taste components caused by changes in pulp, pericarp or aril and ii) pericarp cracking resulting from excessive water uptake. Rootstock for improved adaptation to drought and robust development in early years of growth (Wikipedia, 2025

**Apomixis:** Agamospermy may be frequent in *Garcinia*, and somatic embryogenesis has been demonstrated in cultivated mangosteen. Asexual seeds are formed by an adventive embryo originating from a somatic cell in the epithelium of the inner integument layer of the ovary. Mangosteen does not produce viable pollen. However, Horn's observations were based on shriveled flowers from two trees in an experimental station and may not constitute robust evidence. On another 50 flowers, staminodes were removed prior to bagging. She found that flowers in both treatments set fruit, showing that fruit set did not require the presence of pollen. Fruit set in flowers from which staminodes had been removed (20%) was lower than in intact flowers (53%), owing probably to damage inevitably caused by manipulation during removal of staminodes. Unfortunately, there is no empirical genetic evidence for apomictic reproduction, *e.g*., highly similar or even identical multi-locus microsatellite genotypes between a mother tree and its progeny (Yao *et al*., 2023). Successfully pollinated *G. mangostana* var. *mangostana* flowers with *G. mangostana* var. *malaccensis* pollens in garden experiments and obtained viable seeds. The resulting seeds developed into triploid seedlings, suggesting that they were sexually produced, in contrast to the tetraploid seedlings that result from apomictic reproduction of mangosteen. The results of these experiments suggest that mangosteen is facultatively apomictic, capable of sexual reproduction when a suitable source of viable pollen is available. From these findings, we know that at least some *G. mangostana* var. *malaccensis* produce viable pollen. If this is a general trait of this wild species, it might be inferred that male sterility evolved in cultivated mangosteen. However, given the paucity of studies of the reproductive biology of *G. mangostana* var. *malaccensis* and other wild species, we cannot exclude the possibility that pollen viability is a variable trait in the wild ancestor and that male sterility may thus have preceded the evolution of cultivated mangosteen. Systematic comparative studies of pollen viability in wild relatives are crucial to validate our inference (Yao *et al.,* 2023). These findings suggest parallels with the evolution of parthenocarpy in banana (*Musa* L. spp.). Domesticated bananas produce no functional stamens, and produce seedless fruits parthenocarpically. However, some “primitive” cultivars are facultatively parthenocarpic: they can produce normal seeds through sexual reproduction if they receive viable pollen from wild relatives. Later in evolution under domestication, “advanced” banana cultivars became obligately parthenocarpic. Replication of the cross-pollination experiments and genotyping of parents and progeny would resolve key questions about the biology and breeding of mangosteen, such as its ability to produce sexual seeds if supplied with an appropriate pollen source (Yao *et al*., 2023).
Agamospermy may be frequent in *Garcinia*, and somatic embryogenesis has been demonstrated in cultivated mangosteen. Asexual seeds are formed by an adventive embryo originating from a somatic cell in the epithelium of the inner integument layer of the ovary mangosteen does not produce viable pollen. Conducted a bagging experiment to test whether pollen is required for seed production in mangosteen. On 50 bagged flowers, staminodes were left intact. On another 50 flowers, staminodes were removed prior to bagging. She found that flowers in both treatments set fruit, showing that fruit set did not require the presence of pollen. Fruit set in flowers from which staminodes had been removed (20%) was lower than in intact flowers (53%), owing probably to damage inevitably caused by manipulation during removal of staminodes. Unfortunately, there is no empirical genetic evidence for apomictic reproduction, *e.g*., highly similar or even identical multi-locus microsatellite genotypes between a mother tree and its progeny (Yao *et al.,* 2023).

**Polyploidy:** The postulated earliest event of evolution of polyploidy in *Garcinia* traces back to 86.3 MYA and the dating of the whole-genome duplication event was inferred from analyses of the 1000 Plants (1KP). The chromosomes of *Garcinia* are small and difficult to count. A number of *Garcinia* species variably display diploidy, dysploidy and polyploidy. Chromosome number of *G. mangostana* var. *malaccensis* was first published only recently; diploidy and natural triploidy were observed. Polyploidy thus exists within species of sect. *Garcinia* and is not exclusive to mangosteen. The variation in chromosome number is notably greater in mangosteen than in related taxa, but this might be due to inadequate study of the wild taxa. Polyploidy is well-documented in mangosteen. Mangosteen accessions displayed more than two alleles per locus in microsatellite markers in population-genetic studies. Reported highly variable chromosome numbers, 74–110, in an analysis of 20 metaphase spreads, demonstrating dysploidy/aneuploidy in mangosteen (Yao *et al*., 2023).

**Variation:** Progeny produced by apomixis are in theory genetically identical to the maternal plant. Apomixis in mangosteen led to the supposition that only limited genetic variation would be found within mangosteen populations, provided that all domesticates derived from a

single original clone. However, genetic variation was detected by various markers in mangosteens grown in Australia and Indonesia. It is essential to identify the sources of the observed variation. Genetic variation in mangosteen might arise from three sources: (i) multiple selections of wild progenitors originating from independent events of sexual reproduction; (ii) heritable somatic mutation; and (iii) facultative apomixis that allows gene flow from wild populations. Variation in cultivated mangosteens arose from several initial events of adoption of sexually produced progenitors with considerable genetic differences among them. These could be ancient adoptions. Extensive population-genetic studies that include a considerable number of accessions of mangosteen and of its putative wild relatives might allow a test of this hypothesis. Are somaclonal mutations the major source of variation in mangosteen. Apomixis and other forms of asexual propagation are expected to lead to increased heterozygosity, because as somatic mutations are incorporated and transmitted, it is very unlikely that the same mutation will occur at the same locus on both chromosomes. Variation at neutral loci may be notable in mangosteen, because this type of variation increases during somaclonal evolution. Microsatellite markers often evolve by stepwise mutations, so that if allele size diversity is small in relation to allele number diversity, this indicates recent differentiation, consistent with diversification via somaclonal mutation. Cross-pollination between mangosteen and wild *G. mangostana* var. *malaccensis* is possible. In this context, gene flow would be unidirectional from wild var. *malaccensis* to cultivated mangosteen, with variation contributed only by pollen donors. Sexuality generally exists in perennial apomictic plants, and events of sexual reproduction in a generally apomictic line, although infrequent, can have a disproportionately large effect on genetic variability. Based on both empirical findings and theoretical arguments, the expectation that genetic variation is absent in mangosteen owing to its apomictic reproduction should be abandoned. However, the pattern of genetic variation in apomictic species is different from that in sexually propagated species (Yao *et al.,* 2023).

**Male and Female**: Prior to the taxonomic revision of Peninsular Malaysian Guttiferae, *G. malaccensis* was deemed rare, being known only from Maingay's collections from Malacca. Maingay's collections were first identified as *G. cornea* L. until J.D. Hooker in Anderson (1874) recognized them as constituting a new species and established *G. malaccense.* King (1890) mentioned that "*In its leaves*, *in the colour of its flowers*, *and in its 8-lobed stigma*, *this resembles G. mangostana*." Although the observations were only based on Maingay's collections with young flowers and flower buds—a solitary specimen of *G.malaccensis* consisting of a few duplicates—these early writings may have influenced subsequent authors' notions about the origin of mangosteen, especially the affinity between *G. hombroniana* on the one hand, and *G. mangostana* and *G. malaccensis* on the other. They also compared the morphology of male flowers of *G. mangostana* with that of *G. malaccensis* and *G. hombroniana*. They drew attention to the morphological similarity of *G. venulosa* to *G. mangostana* var. *malaccensis* and to G. *mangostana* var. *borneensis*, in leaf and fruit traits, respectively.

In our ongoing morphometric study of mangosteen and its wild relatives, we observed morphological intermediates between sympatric populations of *G. mangostana* var. *malaccensis* and *G. penangiana*. The studies mentioned above defined the morphological characters of *G. mangostana* var. *mangostana* and the wild relatives. These findings enable us to identify the possible ancestral candidates of the cultivated mangosteen based on their morphological similarity (Yao *et al*., 2023). Dioecy accounts for 5%–6% of angiosperms and is prevalent in *Garcinia* species. Whether male trees exist in mangosteen has been a subject of debate since the 1830s. On the occurrence of male trees within mangosteen plantations in Cochin–China (now southern Vietnam), where mangosteen was introduced as a fruit crop. Pierre examined about 1500 trees yet could not find a male plant. "*all Garcinia trees are dioecious but the female plants of mangosteen also bear male organs so that all the male plants in a garden can be removed without inconvenience.* Chevalier did not state whether the male organs on female plants were present in (i) separate male and female flowers on the same plant (that is monoecy), or (ii) in hermaphrodite flowers. Descriptions of the practice of culling male trees are therefore dubious. To the best of our knowledge, no report of a practice of culling of male trees has appeared in other literature, nor is this practice known from any commercial orchard (Yao *et al.,* 2023).

**Quality Characteristics:** Fruit have pinkish-red skin when mature, turning to a dark purple skin and white flesh. The skin should be thick and soft, but firm, when ripe. Fruit have a soft, sweet, slightly acid flesh with a pleasant flavor. Misshapen and damaged fruit should be removed. Burst latex vessels leave a yellow dried latex on the skin that should be scraped off, followed by washing the fruit with a soft brush. Fruit are graded to remove damaged fruit and for size. Some Thai growers and exporters coat cleaned fruit with lacquer, giving fruit skin damaged by thrips prior to harvest a more attractive appearance (Paull and Ketsa, 2025).

**Horticultural Maturity Indices:** Skin color is the major criterion used to judge maturity. Immature fruit that have a light, greenish-yellow skin with scattered pinkish spots do not ripen to full flavor if harvested. The minimum harvest stage for high quality fruit is when the skin has distinct irregular, pink-red spots over the whole surface. Fruit are at the edible, ripe stage when the skin has darkened to reddish-purple, no latex remains in the skin, and the flesh segments separate easily from the skin (Tongdee and Suwanagal 1989). Careful handling is essential in order to avoid mechanical Injury (Paull and Ketsa, 2025).

What is the wild ancestor of *G. mangostana* var. *mangostana**?***

In this section, we examine the taxa that have been proposed as the wild progenitors of mangosteen and critically examine the theories of its origin. Various hypotheses regarding the origin of mangosteen have been proposed. These hypotheses were but did not provide in-depth interpretation. We especially discuss these hypotheses in light of findings from molecular biology accumulated over the past few decades (Yao *et al.,* 2023).

**Mangosteen is a hybrid of two wild relatives:** The hypothesis that *G. mangostana* arose from an allotetraploid hybrid between *G. hombroniana* and *G. malaccensis* has been cited in numerous horticultural monographs. Based on cytogenetic findings and morphological comparisons, posited that *G. mangostana* ($2n = 90$?) arose from hybridization between *G. hombroniana* ($2n = 48$) and *G. malaccensis* ($2n = 42$–$43$?). Richards (1990b) conducted chromosome counts of *G. hombroniana*, whereas the count for *G. malaccensis* was cited from an unpublished. Several subsequent molecular-genetic studies have examined this hypothesis (Yao *et al*., 2023).

**Mangosteen derived solely from** *G. malaccensis.* Phylogenetic relationships between mangosteen and 16 wild species using ITS sequences. Both unordered parsimony and neighbor-joining analyses pointed to **G. malaccensis** as the closest relative of mangosteen. Again, extensive variation of chromosome numbers in mangosteen precludes drawing convincing conclusions about the hybrid origin of mangosteen based on chromosome counts. Direct cytogenetic observation of male meiosis of a triploid produced from the crossing, if available, should be made. Also, the pattern of chromosome pairing could help ascertain whether there are two or four genomes of **G. malaccensis** in **G. mangostana** (Yao *et al*., 2023).

**Uses**

Mangosteen fruits are eaten fresh; the fleshy white arils are delicious, sweet, and slightly acidic and have a mild flavor. Fleshy segments are sometimes canned. Syrup and jam are also prepared . The rind is astringent and it is made into jelly by treatment with6%sodium chloride. The seeds are eaten roasted or boiled. The aril portion of the fruit possesses 18.4 g carbohydrate, 0.5 g protein, 0.2 g fat, 1.7 g fiber, thus a modest source of essential nutrients. Mangosteen juice products sometimes possess polyphenols extracted from the pericarp to add polyphenol value. The arils also contain volatiles namely hexyl acetate, hexanol and α-copaene which are responsible for the mangosteen fragrance. Mangosteen seeds are rich in oil and seed flour is a good source of minerals specially potassium (7071 mg/kg), magnesium (865 mg/kg) and calcium (454 mg/kg). Seed oil is golden-orange in color, with a specific gravity of 0.98 and remains liquid at room temperature (25 °C). The chemical properties of mangosteen seed oil suggests that it could be used as an edible oil. angosteen fruit is used as a medicine to treat skin infections, wounds, and dysentery. The fruit pericarp has been used for treatment of inflammation and diarrhea , and cholera and dysentery in Ayurvedic system of medicine. Secondary metabolites such as prenylated and oxygenated xanthones are the major components of the pericarp and whole fruit (Murthy *et al*., 2018). Without fumigation or irradiation (to kill the Asian fruit fly), fresh mangosteens were illegal to import into the United States until 2007. Following export from its natural growing regions in Southeast Asia (particularly Thailand), the fresh fruit is available seasonally in some local markets in North America such as those of Chinatowns. Mangosteens are available fresh, canned and frozen in Western countries.

The fruit may be served as a dessert or made into jams. In Vietnam, the ripe fruit is also used as a salad ingredient. Upon arrival in the US in 2007, fresh mangosteens sold at up to $130/kg ($60/lb) in specialty produce stores in New York City, but wider availability and somewhat lower prices have become common in the United States and Canada. Despite efforts described above to grow mangosteen in the Western Hemisphere, nearly the entire supply is imported from Thailand (Wikipedia, 2025). Before ripening, the mangosteen shell is fibrous and firm but becomes soft and easy to pry open when the fruit ripens. To open a mangosteen, the shell can be scored with a knife, pried gently along the score with the thumbs until it cracks, and then pulled apart to reveal the fruit. Alternatively, the mangosteen can be opened without a knife by squeezing the shell from the bottom until it breaks, allowing the shell to be removed and the fruit eaten while intact with the stem. In Southeast Asian countries, the mangosteen is usually served with the bottom part of the shell intact. Occasionally, during peeling of ripe fruits, the purple exocarp juice may stain skin or fabric (Wikipedia, 2025).

**Nutritional values of mangosteen fruit** (per 100 g edible portion).

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Content per 100 g & edible portion

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Water 80.9 g
Energy 76.0 cal
Protein 0.5 g
Fat 0.2 g
Carbohydrate 18.4 g
Dietary fi ber 1.7 g
Ash 0.2 g
Calcium 9.0 mg
Phosphorus 14.0 mg
Iron 0.5 mg
Copper 0.11 mg
Zinc 0.1 mg
B1 (Tiamine) 0.09 mg
B2 (Ribofl avin) 0.06 mg
Niacin 0.1 mg
Vitamin C 2.0 mg
(Ketsa and Paull, 2025).

**Highly nutritious:** Parinda Yatha / EyeEm/Getty Images

Mangosteen is relatively low in calories yet provides many essential nutrients (1Trusted Source).

A 1-cup (196-gram) serving of canned, drained mangosteen packed in syrup offers (1Trusted Source):

- **Calories:** 143
- **Carbs:** 35 grams
- **Fiber:** 3.5 grams
- **Fat:** 1 gram
- **Protein:** 1 gram
- **Vitamin C:** 6% of the daily value (DV)
- **Vitamin B9 (folate):** 15% of the DV
- **Vitamin B1 (thiamine):** 9% of the DV
- **Vitamin B2 (riboflavin):** 8% of the DV
- **Manganese:** 9% of the DV
- **Copper:** 15% of the DV
- **Magnesium:** 6% of the DV (Hill, 2024).

The vitamins and minerals in mangosteen are important for maintaining many bodily functions, including DNA production, muscle contraction, wound healing, immunity, and nerve signaling (2Trusted Source, 3Trusted Source, 4Trusted Source, 5Trusted Source). Moreover, a single cup (196 grams) of this fruit provides almost 12.5% of the DV for fiber − a nutrient often lacking in people's diets (6Trusted Source) (Hill, 2024). Rich in powerful antioxidants: Perhaps one of mangosteen's most significant attributes is its unique antioxidant profile. Antioxidants are compounds that can neutralize the damaging effects of potentially harmful molecules called free radicals, which are linked to various chronic diseases (7Trusted Source). Mangosteen contains several nutrients with antioxidant capacity, such as vitamin C and manganese. Plus, it provides xanthones − a unique type of plant compound known to have strong antioxidant properties (8Trusted Source, 9Trusted Source). Several studies have shown that the antioxidant activity of xanthones may promote anti-inflammatory, anticancer, anti-aging and antidiabetic effects (10Trusted Source). Thus, xanthones in mangosteen may be responsible for many of its potential health benefits. Still, more human research is needed before definitive conclusions can be drawn (Hill, 2024).

May have anti-inflammatory properties: The xanthones found in mangosteen may play a role in reducing inflammation. Test-tube and animal studies suggest that xanthones have an anti-inflammatory effect and may reduce your risk of inflammatory diseases, such as cancer, heart disease, and diabetes (10Trusted Source). Mangosteen is also rich in fiber, which offers various benefits. For instance, some animal research indicates that a higher-fiber diet may help reduce your body's inflammatory response (11Trusted Source). Though this data is encouraging, more research is needed to better understand how mangosteen affects inflammation and disease progression in humans (Hill, 2024). May have anticancer effects: Population studies show that diets rich in vegetables and fruits like mangosteen are associated with reduced incidences of cancer (12Trusted Source). Specific plant compounds in mangosteen − including xanthones − have antioxidant and anti-inflammatory effects, which may help fight the development and spread of cancerous cells (10Trusted Source, 12Trusted Source). Multiple testtube studies reveal that xanthones can inhibit cancer cell growth, including in breast, stomach, and lung tissue (12Trusted Source). Similarly, a small number of studies observed that this compound may slow the progression of colon and breast cancer in mice (12Trusted Source). Though these results are promising, insufficient research has been done in humans (Hill, 2024).

**5. May promote weight loss:**

**5. May promote weight loss:** In the health and wellness industry, one of mangosteen's biggest claims to fame is its potential to aid weight loss. One study found that mice on a high-fat diet who received supplemental doses of mangosteen gained significantly less weight than mice in the control group (13Trusted Source). Similarly, in a small, 8-week study, people who supplemented their diets with 3, 6 or 9 ounces (90, 180, or 270 ml) of mangosteen juice twice daily tended to have a lower body mass index (BMI) than the control group (14Trusted Source). Additional research on mangosteen and obesity is limited, but experts theorize that the fruit's anti-inflammatory effects play a role in promoting fat metabolism and preventing weight gain (15Trusted Source).

Ultimately, more studies are needed to better understand how mangosteen may fit into an effective weight loss plan (Hill, 2024).
**6. Supports blood sugar control:** Both test-tube and animal studies show that xanthone compounds in mangosteen may help you maintain healthy blood sugar levels (16Trusted Source). A recent 26-week study in women with obesity found that those receiving 400 mg of supplemental mangosteen extract daily had significant reductions in insulin resistance — a risk factor for diabetes — compared to the control group (17Trusted Source). It should be noted that mangosteen extract has a more concentrated dose of antioxidants, and it would be necessary to eat a large quantity of the fruit to see similar results (17Trusted Source). The fruit is also a good source of fiber, a nutrient that can help stabilize blood sugar and improve diabetes control (17Trusted Source). The combination of the xanthone and fiber contents in mangosteen may help balance blood sugar. However, more research is needed (Hill, 2024).

**7. Promotes a healthy immune system:** Fiber and vitamin C — both of which can be found in mangosteen — are important for a healthy immune system (1Trusted Source). Fiber supports your healthy gut bacteria — an essential component of immunity. On the other hand, vitamin C is needed for the function of various immune cells and has antioxidant properties (18Trusted Source, 19Trusted Source). Additionally, some research suggests that certain plant compounds in mangosteen may have antibacterial properties — which could benefit your immune health by combating potentially harmful bacteria (20Trusted Source). In a 30-day study in 59 people, those taking a mangosteen-containing supplement experienced reduced markers of inflammation and significantly greater increases in healthy immune cell numbers compared to those taking a placebo (21Trusted Source). Your immune system requires many different nutrients to function optimally. Mangosteen may be a healthy choice to include alongside other nutrient-dense foods as part of a balanced diet (Hill, 2024).

**8. Helps maintain healthy skin:** Skin damage from sun exposure is a common occurrence worldwide and a major contributor to skin cancer and signs of aging (22Trusted Source). One study in mice treated with supplemental mangosteen extract observed a protective effect against ultraviolet-B (UVB) radiation in the skin (23Trusted Source). What's more, a small, 3-month human study found that people treated with 100 mg of mangosteen extract daily experienced significantly more elasticity in their skin and less accumulation of a particular compound known to contribute to skin aging (24Trusted Source). Researchers assert that mangosteen's antioxidant and anti-inflammatory capacity is the main reason for these skin-protective effects, but more studies in this area are needed (Hill, 2024).

**9**. **Heart health.** Animal studies show that mangosteen extract effectively reduced heart disease risk factors like LDL (bad) cholesterol and triglycerides while increasing HDL (good) cholesterol (25Trusted Source, 26Trusted Source, 27Trusted Source) (Hill, 2024).

**10.Brain health.** Studies indicate that mangosteen extract may help prevent mental decline, decrease brain inflammation, and improve symptoms of depression in mice, though human studies in this area are lacking (28Trusted Source, 29Trusted Source) (Hill, 2024).

**11. Digestive health.** Mangosteen is packed with fiber. Just 1 cup (196 grams) provides about 14% of the RDI. Fiber is essential for digestive health, and high-fiber diets help promote bowel regularity (1Trusted Source, 6Trusted Source). Though these results are promising, human studies in these areas are lacking. It's still too early to make definitive claims regarding mangosteen's role in supporting brain, heart, and digestive health in humans (Hill, 2024).

**Traditional Medicine**

Various parts of the plant have a history of use in traditional medicine, mostly in Southeast Asia; it may have been used to treat skin infections, wounds, dysentery, urinary tract infections, and gastrointestinal complaints, although there is no high-quality clinical evidence for any of these

effects. Dried fruits are shipped to Singapore to be processed for medical uses which may include dysentery, skin disorders, and various other minor diseases in several countries across Asia. There is no reliable evidence that mangosteen juice, puree, bark or extracts is effective as a treatment for human diseases (Wikipedia, 2025). The extract of mangosteen peels is traditionally used in Indonesia as natural dye for coloring of brown, dark brown, purple or red hues applied to tenun ikat and batik textiles. The lobed end of the mangosteen is a common pattern in Malay fabrics like songket called *tampuk manggis*, it symbolises one's sweet character regardless of their appearance (Wikipedia, 2025).

## CLTIVATION

**Tree Management:** A spacing of 10.7-12 m is recommended. Planting is preferably done at the beginning of the rainy season. Pits 1.2 x l.2 x l.3 m are prepared at least 30 days in advance, enriched with organic matter and topsoil and left to weather. The young tree is put in place very carefully to avoid root injury and given a heavy watering. Partial shading with palm fronds or other means should be maintained for 3-5 years. Indian growers give each tree regular feeding with well-rotted manure, (45-90 kg) and peanut meal (4.5-6.8 kg) total, per year. Some of the most fruitful mangosteen trees grow on the banks of streams, lakes, ponds or canals where the roots are almost constantly wet. However, dry weather just before blooming time and during flowering induces a good fruit-set. Where a moist planting site is not available, irrigation ditches should be dug to make it possible to maintain an adequate water supply and the trees are irrigated almost daily during the dry season. In Malaysia and Sri Lanka, it is a common practice to spread mulch of coconut husks or fronds to retain moisture. It has been suggested that small inner branches be pruned from old, unproductive trees to stimulate bearing. Cropping is irregular and the yield varies from tree to tree and from season to season ranging from 6 years in Central America to 12-20 years in Thailand. The first crop may be 200-300 fruits. Average yield of a full-grown tree is about 500 fruits. The yield steadily increases up to the 30th year of bearing when crops of 1 000-2 000 fruits may be obtained. In Madras, individual trees between the ages of 20-45 years have borne 2 000-3 000 fruits. Productivity gradually declines thereafter, though the tree will still be fruiting at 100 years of age (Orwa *et al*., 2009). Planting is done at 6×6 m distance. The seedling tree starts flowering 8 to 10 years of planting whereas grafted plants start flowering after 7-8 years. The tree flowers in March-April and flowers are pink coloured. Leaf eater, leaf miner, fruit borer and leaf blight, Diplodia fruit rot, brown root disease are major pests and diseases of mangosteen. The fruits mature in after 120-128 days of fruit set, mostly in the month of July-August in south India and tree starts full fruiting after 15 years and a grown up tree gives 40-60 kg/tree fruits. The immature fruits are yellow green and turn dark-purple to red-purple. The fruits have smooth surface and 3.4 to 7.5 cm diameter. The fruit rind is 6 to 10 mm thick, red, purplish-white on the inside. The pulp is snow-white, juicy, soft flesh, very sweet (Tripathi , 2021).

The Mangosteen is very slow-growing, erect, medium size tree with ovate-oblong, leathery, thick, dark-green leaves. It grows in frost-free regions with equatorial climate up to an altitude of 400–900 m and receiving 180-250 cm rainfall. Deep, well-drained soil with high content of organic matter is suitable for cultivation. There is no recommended variety in India. Jolo, large leaves and fruits of variable size, small leaves and small fruits are important varieties grown in South Eastern Asian counties. It may be propagated by seed and grafting. Traditionally eed propagation is use to multiply plants as seed is parthinocarpic (Tripathi , 2021).

The answer to “how to grow mangosteen fruit trees” is that you probably can't. As previously mentioned, many efforts to propagate the tree have been attempted all around the globe with little luck. This tropic loving tree is a bit finicky. It does not tolerate temps below 40 degrees F. (4 C.) or above 100 degrees F. (37 C.). Even nursery seedlings are killed off at 45 degrees F. (7 C.). Mangosteens are picky about elevation, humidity and require annual rainfall of at least 50 inches (1 m.) with no drought. Trees thrive in deep, rich organic soil but will survive in sandy loam or clay containing course material. While standing water will kill off seedlings, adult mangosteens can survive, and even thrive, in regions where their roots are covered with water most of the year. However, they must be sheltered from strong winds and salt spray. Basically, there must be the perfect storm of components when growing mangosteen fruit trees.

Propagation is done through seed, although experiments with grafting have been attempted. Seeds are really not true seeds but hypocotyls tubercles, as there has been no sexual fertilization. Seeds need to be used five days from removal from fruit for propagating and will sprout within 20-22 days. The resulting seedling is difficult, if not impossible, to transplant due to a long, delicate taproot, so should be started in an area where it will stay for at least a couple of years before attempting a transplant. The tree may fruit in seven to nine years but more commonly at 10-20 years of age. Mangosteens should be spaced 35-40 feet (11-12 m.) apart and planted in 4 x 4 x 4 ½ (1-2 m.) pits that are enriched with organic matter 30 days prior to planting. The tree needs a well irrigated site; however, dry weather just before bloom time will induce a better fruit set. Trees should be planted in partial shade and fed regularly. Because of the bitter latex exuded from the bark, mangosteens suffer rarely from pests and are not often plagued by diseases (Gardening, 2021).

**Harvest and Yield:** Maturation of mangosteen fruits takes 5–6 months, with harvest occurring when the pericarps are purple (Wikipedia, 2025). Mangosteen trees may reach fruit-bearing in as little as 6 years but may require 12 or more years, depending on climate and cultivation methods. The yield of the mangosteen is variable, depending on the climate and age of the tree. If the young tree is bearing for the first time, 200–300 fruits may be produced, whereas at maturity, 500 fruits per season are average. At age 30 to 45 years in full maturity, each tree may yield as many as 3,000 fruits, with trees as old as 100 years still producing (Wikipedia, 2025).

**Regional Production:** Major mangosteen production occurs in Southeast Asia, mainly in Thailand as the country with the most acreage planted, estimated at 4,000 ha in 1965 and 11,000 ha in 2000, giving a total yield of 46,000 tons. Mangosteen is seasonally available in Thailand from May through September. Indonesia, Malaysia and the Philippines are other major Asian producers. Mangosteen production in Colombia and Puerto Rico has been successful (Wikipedia, 2025).

**Products**

**Food:** The best table fruits are those with the highest number of stigma lobes at the apex, for these have the highest number of fleshy segments and the fewest seeds. The numbers always correspond. Mangosteens are usually eaten fresh as dessert. The fleshy segments are sometimes canned, but they are said to lose their delicate flavor in canning, especially if pasteurized for as much as 10 minutes. Tests have shown that it is best to use a 40% syrup and sterilize for only 5 minutes. The more acid fruits are best for preserving. To make jam, in Malaysia, seedless segments are boiled with an equal amount of sugar and a few cloves for 15-20 minutes and then put into glass jars. In the Philippines, a preserve is made by boiling the segments in brown sugar, and the seeds may be included to enrich the flavour. The seeds are sometimes eaten alone after boiling or roasting. The rind is rich in pectin. After treatment with 6% sodium chloride to eliminate astringency, the rind is made into a purplish jelly. Timber: In Thailand, all non-bearing trees are felled, so the wood is available but usually only in small dimensions. It is dark-brown, heavy, almost sinks in water, and is moderately durable. It has been used in construction and cabinetwork, to make handles for spears and rice pounders. Tannin or dyestuff: The fruit rind contains 7-14% catechin tannin and rosin, and is used for tanning leather in China. It also yields a black dye.

**Poison:** The fruit hulls show anti-fungal and anti-protozal activity. Medicine: The sliced and dried rind is powdered and administered to overcome dysentery. Made into an ointment, it is applied on eczema and other skin disorders. The rind decoction is taken to relieve diarrhoea and cystitis, gonorrhoea and gleet and is applied externally as an astringent lotion. A portion of the rind is steeped in water overnight and the infusion given as a remedy for chronic diarrhoea in adults and children. Filipinos employ a decoction of the leaves and bark as a febrifuge and to treat thrush, diarrhoea, dysentery and urinary disorders. In Malaysia, an infusion of the leaves, combined with unripe banana and a little benzoin is applied to the circumcision wound. A root decoction is taken to regulate menstruation. A bark extract called "amibiasine", has been marketed for the treatment of amoebic dysentery. Other products: Mangosteen twigs are used as chewsticks in Ghana. The rind of partially ripe fruits yields a polyhydroxy-xanthone derivative termed mangostin, also ß-mangostin. That of fully ripe fruits contains the xanthones, gartanin, 8-disoxygartanin, and normangostin. A derivative of mangostin, mangostin-e, 6-di-O-glucoside, is a central nervous system depressant and causes a rise in blood pressure (Orwa *et al.,* 2009).

**Physiological Disorders:** Fruit damage during harvesting and marketing can affect >20% of fruit. The “gamboges” disorder occurs where latex seeps into the flesh (aril), turning it yellow and giving it a bitter taste. “Gamboges” also moves onto the outer surface of the fruit. This is a preharvest disorder of unknown cause that makes it difficult to separate the aril from the surrounding tissue, even in ripe fruit; it causes hardening of the pericarp. This should not be confused with impact injury that leads to hardening of the pericarp at the point of impact and aril collapse, dehydration, pink color development, or browning. A drop of 10 cm can cause slight pericarp damage, indicated as hardening at the point of impact within 24 h. Higher drops causing significantly greater damage often lead to downgrading of the fruit. Ketsa and Atantee 1998). Another disorder of mangosteen fruit is translucent aril (nue-kaew), believed to be induced by heavy rain during fruit growth and development, even if just before harvest . The specific gravity of fruit with translucent aril is >1.0, while that of normal aril is <1.0. This allows separation of fruit by floating them in water (Podee 1998). Fruit with translucent aril have lower SSC and TA than normal fruit (Paull and Ketsa, 2025).

**Pests and Diseases:** A leaf-eating caterpillar in India may perhaps be the same as that which attacks new shoots in the Philippines and which has been identified as *Orgyra* sp. of the tussock moth family, Lymantridae. A small ant, *Myrnelachista ramulorum*, in Puerto Rico, colonizes the tree, tunnels into the trunk and branches, and damages the new growth. Mites sometimes deface the fruits with small bites and scratches. Fully ripe fruits are attacked by monkeys, bats and rats in Asia. In Puerto Rico, thread blight caused by the fungus, *Pellicularia koleroga*, is often seen on branchlets, foliage and fruits of trees in shaded, humid areas. The fruits may become coated with webbing and ruined. In Malaysia, the fungus, Zignoella garcineae, gives rise to "canker"–tuberous growths on the branches, causing a fatal dying-back of foliage, branches and eventually the entire tree. Breakdown in storage is caused by the fungi Diplodia gossypina, Pestalotia sp., Phomopsis sp., Gloeosporium sp., and Rhizopus nigricans. A major physiological problem called "gamboge" is evidenced by the oozing of latex onto the outer surface of the fruits and on the branches during periods of heavy and continuous rains. It does not affect eating quality (Orwa *et al.,* 2009).

The pathogens that attack mangosteen are common in other tropical trees. The diseases can be divided into foliar, fruit, stem and soil-borne diseases (Wikipedia, 2025). Pestalotiopsis leaf blight (*Pestalotiopsis flagisettula* (only identified in Thailand)) is one of the diseases that infect especially young leaves. Furthermore, the pathogen causes the fruits to rot before and after the harvest. Additional stem canker and dieback are caused by the pathogen. Some of the symptoms of stem canker are branch splitting, gummosis and bark blistering. The main areas where the disease was observed are Thailand, Malaysia, and North Queensland(Wikipedia, 2025). Another common disease is the thread blight or white thread blight disease (*Marasmiellus scandens*) whereas the name comes from the mycelia which resembles thread. Leaves, twigs, and branches may also be damaged by the disease. The spores spread with the help of wind, raindrops, and insects, and thrive in shady, humid, and wet conditions (Wikipedia, 2025). An important post-harvest disease affecting mangosteen, especially in Thailand is called Diplodia fruit rot (*Diplodia theobromae*) which, as a secondary pathogen, enters the host plant through wounds. *Phellinus noxius* living on the roots and trunk bases causes brown root disease, a name derived from the appearance of the mycelium-binding soil particles. The distribution of the fungus happens through contact with infected wood or thick rhizomorphs on tree stumps (Wikipedia, 2025). There are a few pests that feed on mangosteen leaves and fruits including leaf eater (*Stictoptera* sp.), leaf miner (*Phyllocnictis citrella*) and fruit borer (*Curculio* sp.). Especially in nurseries, the larval stage of the leaf eater can cause visible damage on young leaves, but can be managed by biological control agents.[20] The larval stage of fruit borer (*Curculio* sp.) feeds on different parts of fruit before ripening (Wikipedia, 2025).

**Control Measures for Diseases and Pests**

**Different management options can be applied to control mangosteen diseases.**

- Measures to inhibit sun scalding to minimize leaf blight and stem canker.
- Reduction of wounds caused by insects and storm damage to minimize disease incidence.
- Change of the microclimate by tree spacing and pruning.
- Chemicals applied to root collars and tree stumps to control root diseases (Wikipedia, 2025).

**Grades, Sizes, and Packaging:** There are no U.S. or international standards. Fruit are graded by size and color. Mangosteens are normally sold in single-layer, fiberboard cartons holding 2.25 kg (5 lb) with padding, or sometimes in trays with fruit individually wrapped to prevent injury (20 to 24 fruit per tray). In Southeast Asia, fruit are sold in baskets or strung in bundles of 10 to 25 fruit (Paull and Ketsa, 2025).

**Precooling Conditions:** Room-cooling is normally used (Paull and Ketsa, 2025).

**Optimum Storage Conditions:** Recommendations vary from 4 to 6 °C (39 to 42 °F) with 85 to 90% RH for 7 weeks (Pantastico 1975) to 13 °C (56 °F) with 85 to 90% RH for 14 to 25 days. Storage at 4 °C (39 °F) or 8 °C (46 °F) can lead to significant hardening of the skin (Augustin and Azudin 1986), though the flesh may still be acceptable after 44 days. Current practice is to store fruit at 12 to 14 °C (54 to 57 °F), giving storage life of about 20 days without chilling injury. Application of surface coatings reduces weight loss and prevents calyx wilting (Paull and Ketsa, 2025).

**Controlled Atmosphere (CA) Considerations:** An atmosphere of 5% O 2 and 5% CO 2 has been used for 1 mo and resulted in best overall retention of peel appearance and internal quality. Holding fruit in polyethylene film bags reduces weight loss and disease.; however, it is not clear if the effects are due to the prevention of water loss or to the modified atmosphere in the bags (Paull and Ketsa, 2025).

**Retail Outlet Display Considerations:** Fruit are commonly displayed in overwrapped trays or in closed styrene, clam-shell containers with no perforations at 10 to 14 °C (50 to 57 °F). They should not be misted (Paull and Ketsa, 2025).

**Chilling Sensitivity:** Storage at <10 °C (50 °F) leads to rapid hardening and darkening of pericarp when fruit are returned to ambient temperature (Uthairatanakij and Ketsa 1996, Choehom 1997). Ethylene Production and Sensitivity. Mangosteen is a climacteric fruit. Ethylene production is about 29 nL kg -1 h-1. The respiratory peak occurs sooner when fruit are treated with ethylene. Ethylene treatment triggers autocatalytic ethylene production (Paull and Ketsa, 2025).

**Respiration Rates:** Respiration rate is 21 mg (12 μL) CO 2 kg -1 h-1 at 25 °C. Heat production is 4,620 BTU ton -1 day -1 (1,281 kcal tonne -1 day -1 ) (Paull and Ketsa, 2025).

**Postharvest Pathology:** Botryodiplodia theobromae, Diplodia spp., Pestalotia flagisettula, Phomopsis spp., and Rhizopus spp. have been reported; they harden the skin and decay the aril (Paull and Ketsa, 2025).

**Quarantine Issues:** Mangosteen is a fruit fly host. Irradiation at 300 grays has potential for disinfestation. Alternatively, harvested fruit are carefully cut open and the aril inspected; fruit are then frozen whole and shipped (Paull and Ketsa, 2025).

**How to Choose Mangosteen:** The tropical fruit mangosteen is grown abundantly in Thailand. It's the size of a tennis ball, with a firm shell that is deep purple. This unique fruit has a sweet flavor and very soft texture and is rich in antioxidants and micronutrients. It can be found in Asian food stores and markets. Good mangosteens have healthy-looking green caps and a nice glossy sheen on their outer skins. The fruit should be firm and have no cracks. Make sure the fruit is bug-free, and do not buy fruit that has hardened beads of yellow resin on the outer rinds as those often contain sections that have suffered from resin seepage (Schmidt, 2023).

**Cut Into Your Mangosteen:** To open your mangosteen, hold it firmly on its side and make a cut with a serrated knife. The older the mangosteen, the harder the skin will be (a sawing action may be needed). Cut shallowly all around the circumference, about 1/4 to 1/3 inch deep, just enough to create an opening for your fingers to get in. You do not want to cut all the way through to the middle. If you do not have a knife, you can hold the mangosteen between your two palms and squeeze your hands to crush the purple shells. Once the shells are cracked, you should be able to peel them off. Just keep in mind this way is messier and may result in the internal sections getting crushed, releasing some of the juice (Schmidt, 2023).

**Pry Open the Mangosteen:** Once you have cut around the entire fruit, try prying it open with your fingers or gently pulling apart each half with your hands, similar to opening an avocado. If you cannot do this, or cannot see the white of the fruit, you have not cut deeply enough ( Schmidt, 2023).

**Expose the Mangosteen:** Pull away the skin to reveal the white mangosteen fruit. If a little of the purple shell of the mangosteen sticks to the fruit, leave it be; this deep purple skin is full of antioxidants and valuable micronutrients. Good mangosteens have sections that are opaque white, firm, and not translucent or yellowish (Schmidt, 2023).

**Separate the Mangosteen Fruit:** Mangosteen fruit looks similar to an orange in that it has internal sections. Simply use your fingers to pull the sections apart from one another. The seeds are soft and edible and do not need to be removed. In some cases, you might not even notice the seeds are there. Some people choose not to eat the seeds because they may be hard and bitter (Schmidt, 2023).

**Where is it Found?:**This slow growing tree is native to Asia and can be found in India, Indonesia, the Philippines, and Malaysia, among other countries. It is also grown in some parts of tropical America, including Costa Rica (Stuart, 2025).

**Parts of the Plant Used:** The leaves, bark, fruit, seeds, and root (Stuart, 2025).

**How is it Used:** The roots, leaves, bark, and fruit rind (peel or pericarp) are used both internally as well as externally to treat a great array of diseases. Various supplements including capsules, pills, and Mangosteen fruit juice are available in various health food stores (Stuart, 2025).

**Safety/Precautions:** Mangosteen's safety during pregnancy and lactation has not been established. Certain companies that market mangosteen supplements, especially mangosteen fruit juice, have made various claims pertaining to its purported beneficial health benefits. Lobb (2012) opines that some of the research data mentioned in the commercial ads may not possess the desired quality in order to back such claims, and therefore be misleading to the consumer (Stuart, 2025).

**How to Eat Mangosteen:** Mangosteen is easy to prepare and eat — though it may be difficult to find depending on where you live. The fruit's season is relatively short, which often limits its availability. Your best bet is to look for it at specialty Asian markets, but be aware that fresh mangosteen can be quite expensive. Frozen or canned forms may be cheaper and easier to find — but be mindful that canned versions often contain added sugar. The fruit can also be found in juice form or as a powdered supplement. If you happen to score a fresh supply, choose fruits with a smooth, dark purple outer rind. The rind is inedible but can be easily removed with a serrated knife. While the rind itself isn't edible, extracts from mangosteen peel may also yield health benefits, according to some studies (30Trusted Source, 31Trusted Source). The inner flesh is white and very juicy when ripe. This part of the fruit can be eaten raw or added to smoothies or tropical fruit salads for a delicious boost of flavour (Hill, 2024).

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