Garcinia dulcis (Roxb.) Kurz

MONOGRAPH PROJECT

AGRICULTURE CLASS

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SOFÍA BOTERO

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IMPORTANCE

Throughout the following pages, the subject that will be discussed is the species *Garcinia dulcis,* along with the conditions it is most likely to grow on, in Chapter 2; in Chapter 3, its life cycle, which is the time it is most likely to present flowering and fruiting; the way it propagates or is able to grow in different places in Chapter 4; and its uses to conclude the text in Chapter 5. Before starting the text, it is important to point out that there has not been a lot of research dedicated on this species. For this is reason, is that in a number of occasions, to discuss mostly propagation and biological factors, the information is obtained or predicted from what is the trend in the *Garcinia* genus in general.

The species will be referenced as *Garcinia dulcis* (scientic name), maphut (name in Thailand), and mundu (name in Malaysia and Indonesia). It is also known as yellow mangosteen as it belongs to the same genus. The majority of the population in the Western World does not acknowledge this fruit as its distribution abilities are not favorable to let the species grow outside its native territory, Southern Asia. Germination rates are low and seeds take about six months to germinate, given the case they do. The fruit requires a tropical environment to grow in which is why it is starting to be planted in Central America in a low amount due to its distribution limitations.

Commercially, there are no international markets that deal with the mundu, although it is frequently used in its place of origin to prepare home-made medicines and dyes. Recent research has shown the maphut has the potential to prevent unwanted and unregulated cell propagation that leads to cancer as well as to diminish adipose tissue in blood vessels that causes atherosclerosis and impedes a wholesome blood flow. Due to this solutions for human health issues *Garcinia dulcis* brings to the table and potentially for

other fields as well, is that this underinvestigated plant should be removed from this title and become highly explored material.**No se encuentran entradas de índice.**

ECOLOGY

DISTRIBUTIONAL CONTEXT

Affinities

Garcinia dulcis, popularly known as "*mundu*" belongs to one of the approximately 240 species that are in the genera, *Garcinia,* which is one of about 40 genera in the Clusiaceae family that is mainly composed of trees and shrubs (The Editors of Encyclopedia Britannica, 2008). This species is from order Gutiferales, from subclass Dilleniidae and class Magnoliopsida (FAO, 2000).

Garcinia members are mainly fruit trees that tend to grow in the tropics, especially in Asia and Africa (Gwaltney-Brant, 2016). The mangosteen, *G. mangostana,* is one of the best known members within the genus and is a purple round fruit about 7-8 cm in diameter. There are other fruits such as *G. cambogia* that are in demand due to the positive effect they have on metabolism and declining appetite and as a food condiment as well (Gwaltney-Brant, 2016). The high amounts of hydroxycitric acid found in the following

Garciniaspecies *G. cambogia, G. indica and G. atroviridis* leads them to be used as fish preservatives(Gwaltney-Brant, 2016).

Figure 1: This picture of the mangosteen, *Garcinia mangostana* was taken from *SESCAPES* website http://kauaiseascapesnursery.com/catalog/fruit-trees/mangosteen/.

Figure 2: This picture of Garcinia cambogia was taken from Quora website. https://www.quora.com/How-can-I-find-out-where-to-buy-Garcinia-Cambogia-fruit.

Fossil Record

Tertiary fossils (65 – 2.58 million years ago) of plants that belong to the Clusiaceae family have been found throughout India (Mukherjee & Durv Sen Singh, 2015). Some *Garcinia* – like leaves have been fossilized and found at Ratnagiri beds and Maharashtra by Dalvi and Kulkarni in 1982 (Mukherjee & Durv Sen Singh, 2015). *Garcinia pisduraensis* fossils have been found in Pisdura, near Nagpur, and Maharashtra, India. *G. nepalensis* fossils have also been found in Prasad over the last decade of the 1900s (Mukherjee & Durv Sen Singh, 2015). Fossils of *G. dulcis* have not been officially found (Mukherjee & Durv Sen Singh, 2015).

Origin

Mundu is a tropical tree fruit that finds its origin in Indonesia (NParks Flora & Fauna Web, n.d.). Its genus name comes from Dr. Laurent Garcin a Dutch surgeon that traveled with the Dutch India Company to Southern Asia where he collected plenty of tropical fruits as well as making botanic information of these species (JSTOR GLOBAL PLANTS, 2007),"

2007). The description *dulcis* comes from the Latin word dulcis which means sweet (NParks Flora & Fauna Web, n.d.).

Present Distribution

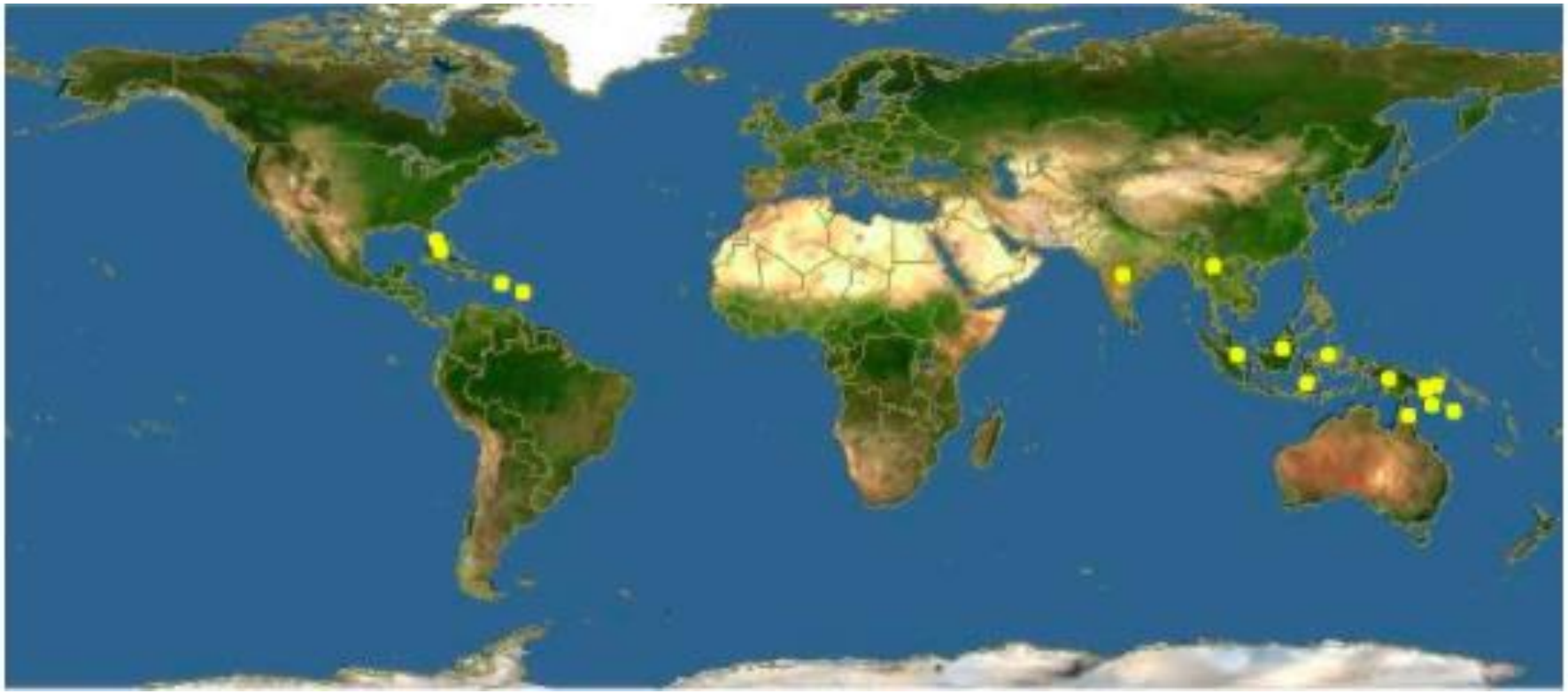


Figure 3: The distribution of Mundu. (Prickering, 2012) Yellow dots denote locations of *G.dulcis*.

ENVIRONMENTL FACTORS IN DISTRIBUTION

Elevation

Garcinia dulcis is often found in low elevations ranging from about 40m above sea level up to approximately 520 meters above sea level (Tropicos.org, 2017). It can (yet this is not the best environment) grow in other tropical places where temperatures get to reach 30°C and where the tree is constantly receiving light (NParks Flora & Fauna Web, n.d.).

Climate

This species grows best in tropical climates where the temperature is usually between 22 and 30°C (FAO, 2007). However, it can grow in places with temperatures ranging from 16°C and 38°C (FAO, 2007). It requires at least 1100 mm of rainfall annually and can tolerate up to 4000 mm although optimal condtions suggest precipitation between1500 to 3000 mm annually ((FAO, 2007). When talking about light intensity it tends to grow under clear and cloudy skies, yet it can grow under a moderate shade as well (FAO, 2007).

The species is better adapted to tropical wet and dry climactic zones, where the photoperiod (daylight) lasts 12 or less hours (FAO, 2007). *Garcinia dulcis* can also be found in subtropical or monsoonal locations (NParks Flora & Fauna Web, n.d.).

Geology and Soils

In order for the species to propagate, soil pH must not be less than 6.5 (acidic) or more basic than 8 not forgetting that a neutral pH would be optimal (FAO, 2007). It is impossible for the tree to grow in a soil depth 50 cm but it is better when planted in a place where the depth is up to 150 cm and that contains low salinity levels not superior to 4 dS/m which are electric conductivity units caused by the ionization of elements within soil(the ocean's salinity is about 50 dS/m) where water is easily drained (FAO, 2007).

GARCINIA DULCIS AS A VEGETATION COMPONENT

Chorology

The spatial distribution of *Garcinia dulcis* consists of tropical or subtropical areas that do not go above 20°N or under 20°S where altitude is relatively low (it is mostly found under 1000 meters above sea level) and rain can get to be a quantity that surpasses the 1100 in in rainfall and that does not get to be higher than 4000 mm annually (FAO, 2007). The countries that meet with these requirements are Malaysia, Indonesia, Philippines, Java, Borneo and some parts of India as Assam, Andaman & Nicobar Islands (Begum, Barthakur, & Sarma, 2013). Although this species is not native to the continent of America it has been

introduced and it is known it can successfully grow here (Begum, Barthakur, & Sarma, 2013).

Community composition

In Salawati, an Indonesian Island, *G. dulcis* is known to be part of the third forest stratification level that has trees and shrubs going from 5 to 15 m in height (Widyatmoko, 2010). Other members of the lower subcanopy level within this community include species as *Maniltoa rosea, M. plurijuga, Tabernaemontana aurantiaca, Chiseseton ceramicus, Aglaia lawii, Caryota riumphiana,* among other (WIDYATMOKO, 2010). Belonging to this same community, species in the main forest canopy, meaning they are taller than25 m, include *Instia bijuga, I. palembianca, Artocarpus altilis, Pometia pinnata, Vatica Papuana, Celtis philippensis* (Widyatmoko, 2010). The second strata, upper subcanopy (15-25 m) was found to consist of *Dillenia papuana, Naegia wallichiana, Gyrinops verstaghii, Leea indica and Myristica lancifolia* (WIDYATMOKO, 2010). No information of chromosome content has been found.

BIOLOGY

CHROMOSOME COMPLEMENT

No information of chromosome content has been found specifically for this species. However, there is research within the genus that suggests that species as *G. pedunculata* , *G. cowa*, *G.* l*ancaefolia*, *G. indica*, *G. cambogia, G.* spic*ata*, *G. pariflora* and *G. morella* have a diploid number of chromosomes where 2n = 48 (Gogoi, Das, & Barua, 2015). The exception is *G. xanthochymus* that through the process of chromosome recombination became a triploid and currently presents a higher number of chromosomes where 2n = 72 (Gogoi et al, 2015). Perhaps the most known species within the genus, *G. mangostana,* has been proven to have a wide variety of chromosome numbers ranging from 74 -110 (Midin et al., 2018). This is predicted to be due to mutations involving aneuploidy where, during the cell cycle, daughter cells get an abnormal number of chromosomes and if it turns out to be beneficial for the plant, this unusual chromosome number persists and the species can grow using the repeated genes or without using the missing genes resulting in having cells and plants with different chromosome numbers (Midin et al., 2018).

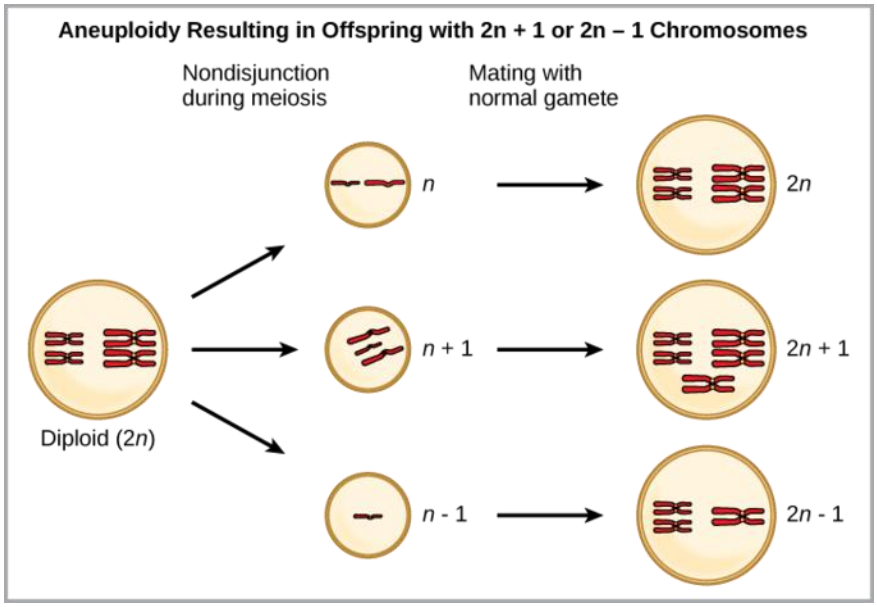


Figure 3: This shows 2n + 1 and 2n – 1 aneuploidy where cells get a singe extra or missing chromosome. Image retrieved from https://courses.lumenlearning.com/boundless-biology/chapter/formation-of-new-species/.

LIFE CYCLE AND PHENOLOGY

Life cycle

The maphut (the way this species is termed in Asia) is a Malaysian plant that has a perennial life cycle which technically means it lives and is able to provide fruits for more than two years, yet it is known it can do this for a prolonged period of time that is longer than 24 months (Fern, Fern, & Morris, 2018).

Phenology

The plant *Garcinia dulcis* shows no flowering during the months January through July when the flowering rate starts increasing. Flowers bloom the most in months November and December (Tropicos.org, 2017). The flowers are a shade of light yellow accompanied by a sour smell and borne in the axil (Subhadrabandhu, 2001).

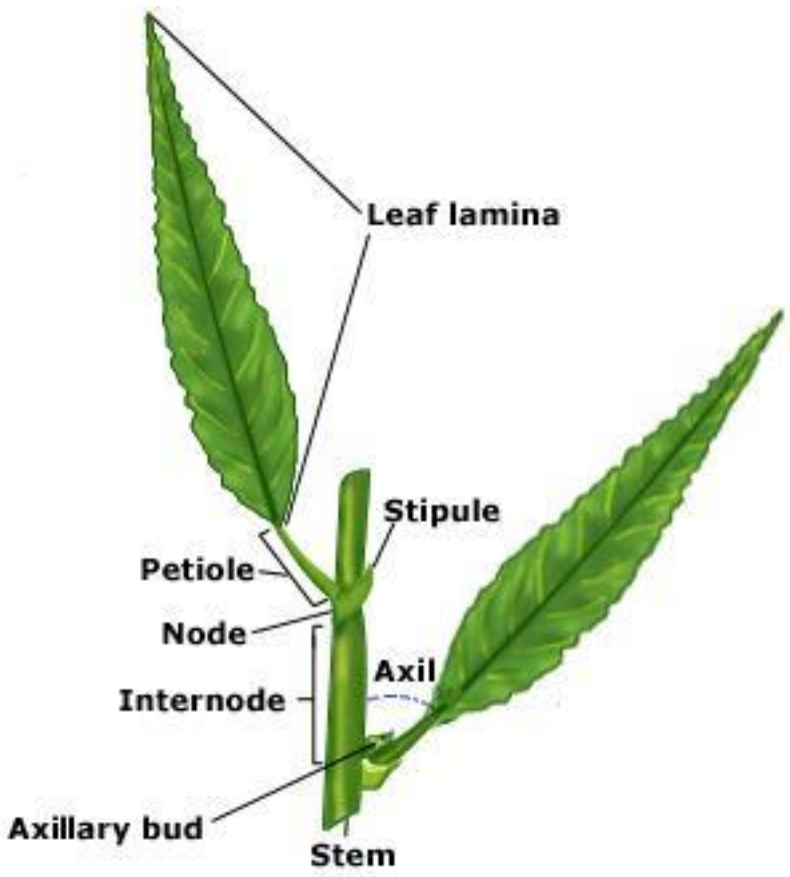
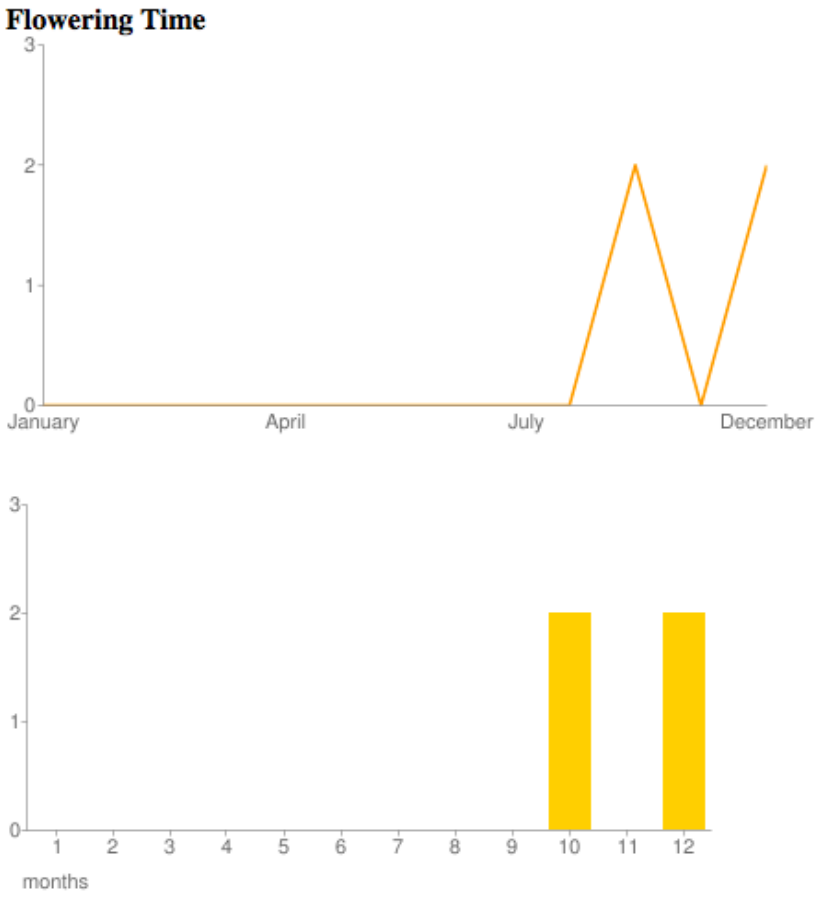


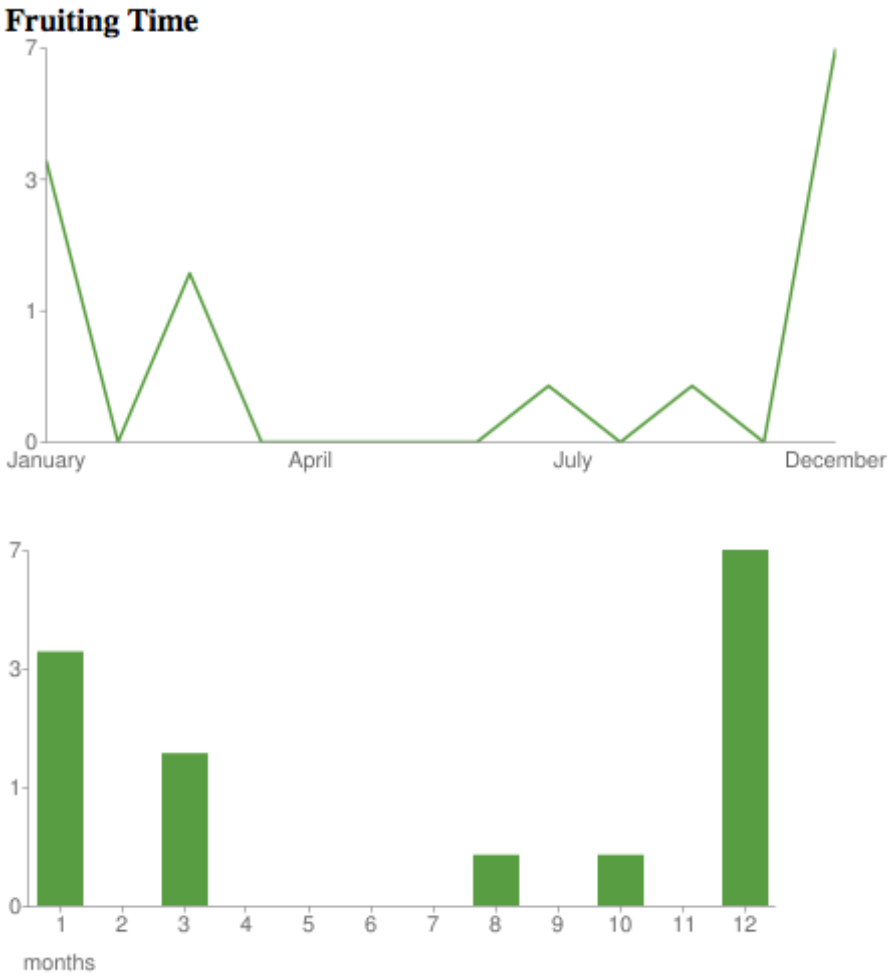
Figure 4: The axil is where *G. dulcis* develops its flowers. Image retrieved from https://www.tutorvista.com/biology/parts-of-a-plant-diagram.

Figure 5: Light yellow flowers of *G. dulcis* develops. Image retrieved from http://www.botany.hawaii.edu/faculty/carr/clusi.htm.



Graph 1: Flowering time retrieved from *tropicos.org*.

Fruits from the *Garcinia dulcis* tree are more varied than the fruiting time. The months when the "Maphuut" is more frequently harvested in January and December, the latest being when more fruits can be collected (Tropicos.org, 2017). March is a month when the amount of fruits gathered is about half the ones in December (Tropicos.org, 2017). The quantity of products garnered in August and October is low, but it is greater than the rest of the year that does not include the mentioned months above, which is close to zero (Tropicos.org, 2017).



Graph 2: Actual fruiting time retrieved from *tropicos.org.*

Figure 6: Maphuut fruit. Image retrieved from https://www.bukalapak.com/p/hobi-koleksi/berkebun/benih-tanaman/61gx2n-jual-biji-benih-buah-mundu.

REPRODUCTIVE BIOLOGY

The only known way of propagation within the *Garcinia* genus is by directly planting the seed, which takes about six months to germinate in the best of conditions (Fern, Fern, & Morris, 2018).

Sexuality

There are both female and male flowers that grow on different plants; moreover, bisexual flowers have also been reported (NParks Flora & Fauna Web, n.d.). The former are about 12 mm wide and are situated in bunches ranging from 3-6 flowers, while the male ones are narrower being 6 mm wide with pedicels of about 1.5 to 3 cm long (Subhadrabandhu, 2001). Flowers throughout the genus are all composed of four petals and four sepals (Te-chato, 2007). It is known that the maphut's flower is the biggest after the mangosteen and somkhag (Te-chato, 2007). Stamens (filaments and anthers) develop in both female and male flowers (Te-chato, 2007).

Figure 7: Male flowers that grow in bigger groups . Image retrieved from http://keys.trin.org.au/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Garcinia_dulcis.htm.

Figure 8: Female flowers that grow in smaller groups . Image retrieved from http://keys.trin.org.au/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Garcinia_dulcis.htm.

The stigma, which is the tip of the carpel, a female reproductive organ that contains the ovary, has five lobes or sections (Subhadrabandhu, 2001). In females, they are placed lower in the flower than the stigma, on the petal around the ovary (Te-chato, 2007).

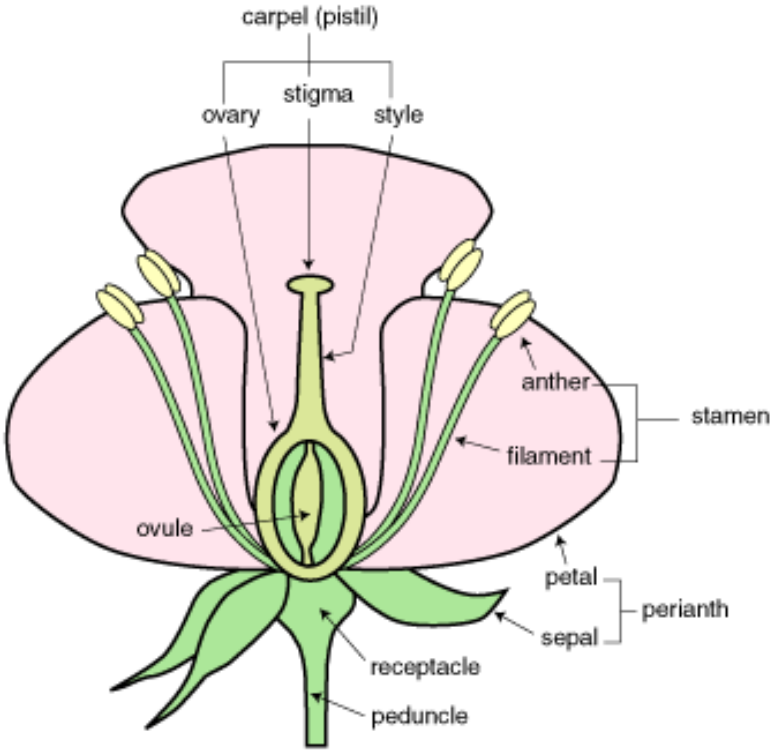


Figure 9: Diagram of the female reproductive organs as carpel and stigma mentioned above. Image retrieved from http://www2.ca.uky.edu/agcomm/ftrips/orchard/orcfluw.htm

Pollen

There is no known pollen viability in female flowers, which is the reason why these female flowers are referred to as "staminodes," and there is a very low quantity of pollen on male flowers that do not contain a rudimentary ovary and have a single bundle of sessile anther (Te-chato, 2007).

Pollination and Potential Pollinators

Within the genus, fruits are known to grow out of the female flower's ovary without the action of pollination or fertilization (Te-chato, 2007).

Fruit Development and Seed Set

The fruit develops 24 hours after the flower has bloomed and petals have fallen (Te-chato, 2007). This take a period of time ranging from four to six months since the petals fall (Te-chato, 2007). Only about one or two seeds that are observed at the center of the maphut develop from a fruit and have very low germination rates which is why distribution is extremely limited (Te-chato, 2007). The nucellar tissue that surrounds the female ovaries can also develop into seeds without the need of fertilization or meiosis through the asexual reproduction process of angiospermy (Te-chato, 2007).

PROPAGATION AND MANAGEMENT

NATURAL REGENERATION

Due to low germination rates, there is a very low level of natural regeneration within this species (Te-chato, 2007). It however can take place when fruits fall, and the seeds remain buried in the soil for periods that can range from three to six months, which is how long the few seeds that sprout require (Te-chato, 2007).

NURSERY PROPAGATION

Propagation from Seed

Only about one or two seeds that are observed at the center of the maphut develop from a fruit and have very low germination rates which is why distribution is extremely limited (Te-chato, 2007). The nucellar tissue that surrounds the female ovaries can also develop into seeds without the need of fertilization or meiosis through the asexual reproduction process of angiospermy (Te-chato, 2007).

Vegetative Propagation

Garcinia dulcis species has been known to propagate by "Air-Layering" technique which consists of pealing the bark and getting roots to grow within that pealed piece of the stem (NParks Flora & Fauna Web, n.d.).

Also, there has been conducted research that shows that vegetative propagation of *Garcinia kola* can be successful (Koukao et al, 2016). The experiment showed that the most effective for trees to sprout new roots out of the cut stem is by adding indole-3-butyric acid, which works as a growing hormone (Koukao et al, 2016). The best wood to use as stems, which can grow roots out of them, is semi hard wood (Koukao et al, 2016).

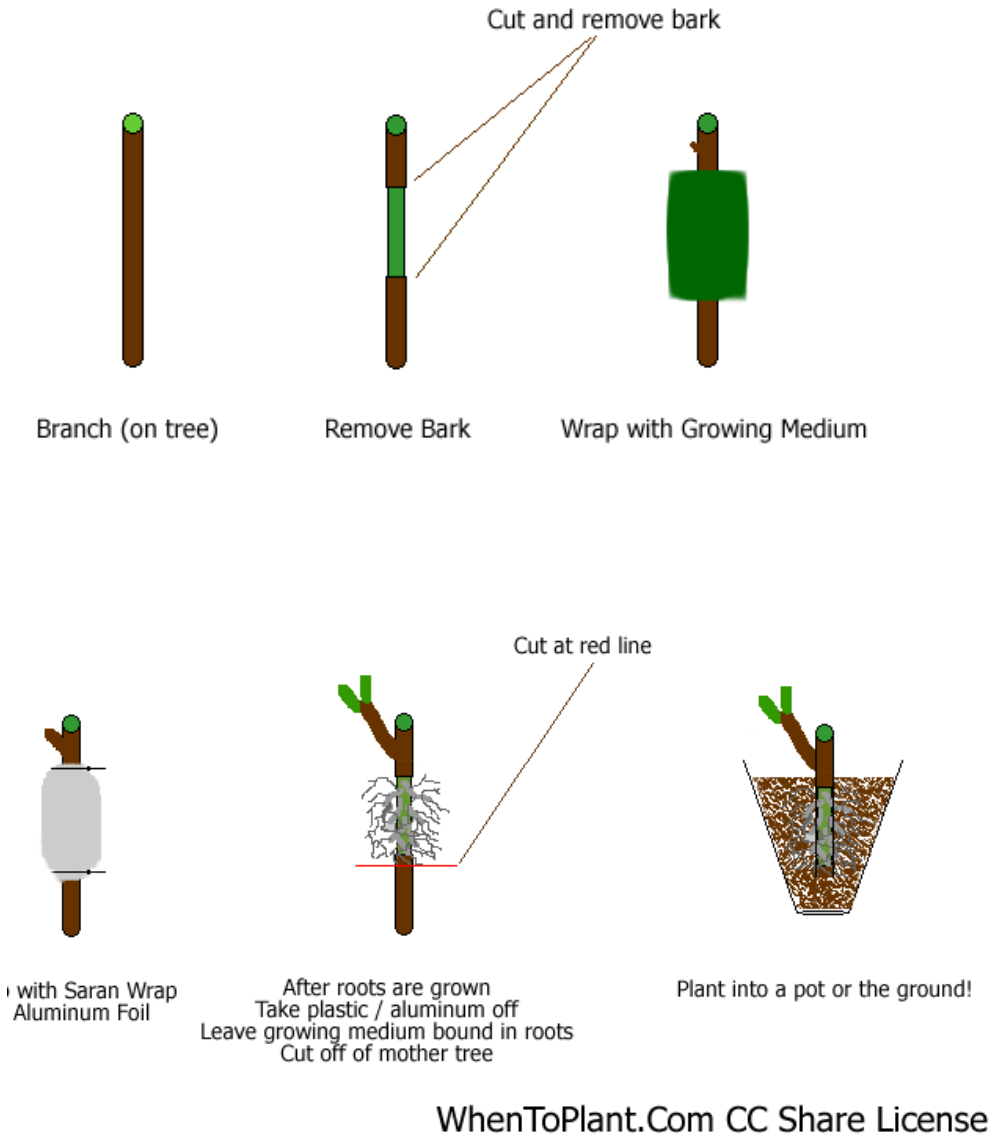


Figure 10: Air-Layering propagation steps. Image retrieved from http://gardenoftomorrow.com/air-layering-propagation-method/wtp-air-layering/.

PLANTING

This species was planted in Asia as a result of following the Taungya System, which consisted in reforestating the Southern Asian territory (Geilfu, 1994) . The government would allow local farmers to cut down forest if and only if, they would plant tree species in between their other plantations (Geilfu, 1994). To be planted by other crops that the farmers would weed and fertilize benefits the tree species, including *G. dulcis* (Geilfu, 1994). However the trees must be planted during the wet season so they had a higher probability of successfully growing (Geilfu, 1994).

MANAGEMENT

Tending

As mentioned in the Ecology chapter, *Garcinia dulcis* best grows in tropical areas where temperature goes from 22 – 30ºC although it can resist lower temperatures that can go down to 16ªC (FAO, 2007). The species must grow in easily drained and about 50 – 150 cm deep soil that does no go more acidic than 6.5 on the pH scale (FAO, 2007). It does have an optimal level of precipitation of 4000mm of rainfall annually (FAO, 2007).

Fruiting

Fruiting takes place during the dry season which, as shown above is mistluy during the months of January and December in their native location, Southern Asia (NParks Flora

& Fauna Web, n.d.). Since the species is known to be Angiosperms, they contain the seed surrounded by a yellow, sour and edible pulp that is in turn surrounded by a harder layer (NParks Flora & Fauna Web, n.d.) This fruit surrounding the seed is the ovary of the flower (NParks Flora & Fauna Web, n.d.). When the fruits are still unripe, they are used to get a greenish dye and when ripe the pulp is eaten alone or used to make jam (Fern et al, 2018).

Pest and Disease Control

There is no specific research done on *Garcinia dulcis* pest issues. However, there are parasites that are known to benefit from other species that share the *Garcinia* genus. The grass hopper, *Busoniomimus manjunathi* has been observed infesting seedlings and young sapplings of *Garcinia cambogia* and *Garcinia gummi-gutta* causing the death of affected tissue (Mathew, 2011). Symptoms start when upper leaves begin dropping a viscous substances which causes them to dry and then brings upon mold appearance in lower leaves that decreases photosynthetic activity (Sivakumar, Chandrika, & Babu, 2013). Plants have been observed to die a month after the pest is noticed (Sivakumar et al, 2013). An ant species, *Anoplolepis gracilipes* is associated with the plants presenting this pest (Sivakumar, Chandrika, & Babu, 2013). They feed on the honey-like substance that the *B. manjunathi* produce and therefore serve as an indication that the *Garcinia cambogia* and *Garcinia gummi-gutta* are displaying the pest (Sivakumar et al, 2013).

Figure 11: *Busoniomimus manjunathi* adult on *G. cambogia* attended by ants *Anoplolepis gracilipes*. Image retrieved from. Image retrieved from http://www.academicjournals.org/article/article1380828382_Sivakumar%2520et%2520al.pdf

Garcinia gummi-gutta has also been documented to have 10% of its nursery seedling be attacked by two-winged leaf miners of unrecorded species that cause leaves to fade (Mathew, 2011). Aphids, insects of the family Aphidoidea sucking sap and termites feeding on roots have also been noted (Mathew, 2011). Aphids are only harmful when they grow in big cultures, so it is not worth applying strong pesticides when aphid population is not large enough to takeover a significant number of trees (Flint, 2016). The best solution is to get rid of completely infested plants and generate an environment where natural predators, pollinator insects such as bees, can diminish aphid population (Flint, 2016). This would be accomplished by adding flowering plants to attract the predators (Flint, 2016).

If using a pesticide to get rid of grass hoppers, aphids and termites, the preeminent choice would be natural oils as vegetable and orange oil mixed with soap that abstain from containing nitrogen (should also be avoided in fertilizers) and other oils as petroleum since the former can end up attracting more insects and the latest can get to be toxic for the plant (Flint, 2016). This technique also helps with termite control (Flint, 2016).

MARKETS AND USES

MARKETS

There are no known international markets that take the mundu into account (FAO, 2000). However, this fruit is sold at local South Asian markets where people eat it and give it other uses that will be mentioned further in the chapter (FAO, 2000). Despite its lack of protagonism in any international market, investigators believe it is a fruit with potential that should have a higher level of research dedicated upon (Álvaro Caicedo, pers. comm. 2018).

USES

The uses locals give to *Garcinia dulcis* in its original place of origin, the area of Thailand and Malaysia include medicinal, obtaining dye and simply eating it (Fern et al, 2018).

Edible Uses

The maphut fruit has a sour and juicy pulp that surrounds its seeds, which along with the yellow pulp, people enjoy eating fresh. The jam it produces is also well received (Fern et al, 2018).

Composition of Maphuut fruits (data expressed per 100 g. fresh weight) (Poomipamorn and Kumkong, 1997)

Carbohydrates (g)	12.2
Protein (g)	0.4
Fat (g)	0.5
Fibres (g)	1.0
Calcium (mg)	5.0
Phosphorous (mg)	13.0
Iron (mg)	0.4
Vitamin A (carotene) (IU)	42.0
Vitamin B (thiamine) (mg)	0.06
Vitamin B_2 (riboflavin) (mg)	0.04
Vitamin B_5 (niacin) (mg)	0.3
Vitamin C (mg)	5.0

Table 1: The information above goes over the nutritional elements of the species showing its abundance in vitamins and other elements living things require to function. Table retrieved from http://www.fao.org/3/a-ab777e.pdf.

Medicinal Uses

What locals most often utilize the crushed fruit is is as a relief expectorant, or a substance that helps the lungs and bronchi exile the mucus accumulated as well for coughs and scurvy (Subhadrabandhu, 2001). The crushed root can serve as a detoxifying agent that reduces poisoning and fever too (Subhadrabandhu, 2001). The substance obtained from the bark of the tree is applied to wounds to clean them and crushed seeds are convenient to diminish the swelling as well (Subhadrabandhu, 2001).

There has also been an estonishing study in which *G. dulcis* extract is found as a possible agent to induce cell aptosis, which is cell-programmed death in the HepG2 cell line which leads to the formation of liver cancer (Fadzelly et al, 2015). It was right before these cells could start replicating their DNA, in the cell cycle G1 that they presented aptosis. This was concluded by staining the media with Anexin V- FITIC, an antibody, and propidium iodide where the cells showing a blue color (sick cells) reduced 41.2% in a time interval of 72 hours after being exposed to the maphut's extract (Fadzelly et al, 2015). This happens due to the activation of Caspase-3, a protein that starts aptosis, which in turn eliminates the HepG2 cells (Fadzelly et al, 2015). The chemicals that seem to produce these effects are hydroxymethylfurfural and 3-methyl-2,5-furandione, together with xanthones (an organic molecule characteristic to the *Garcinia* genus and rare in food in food in general) and flavonoids (another organic compound beneficial to health) and give the Southern Asian fruit a chemotherapeutic potential.

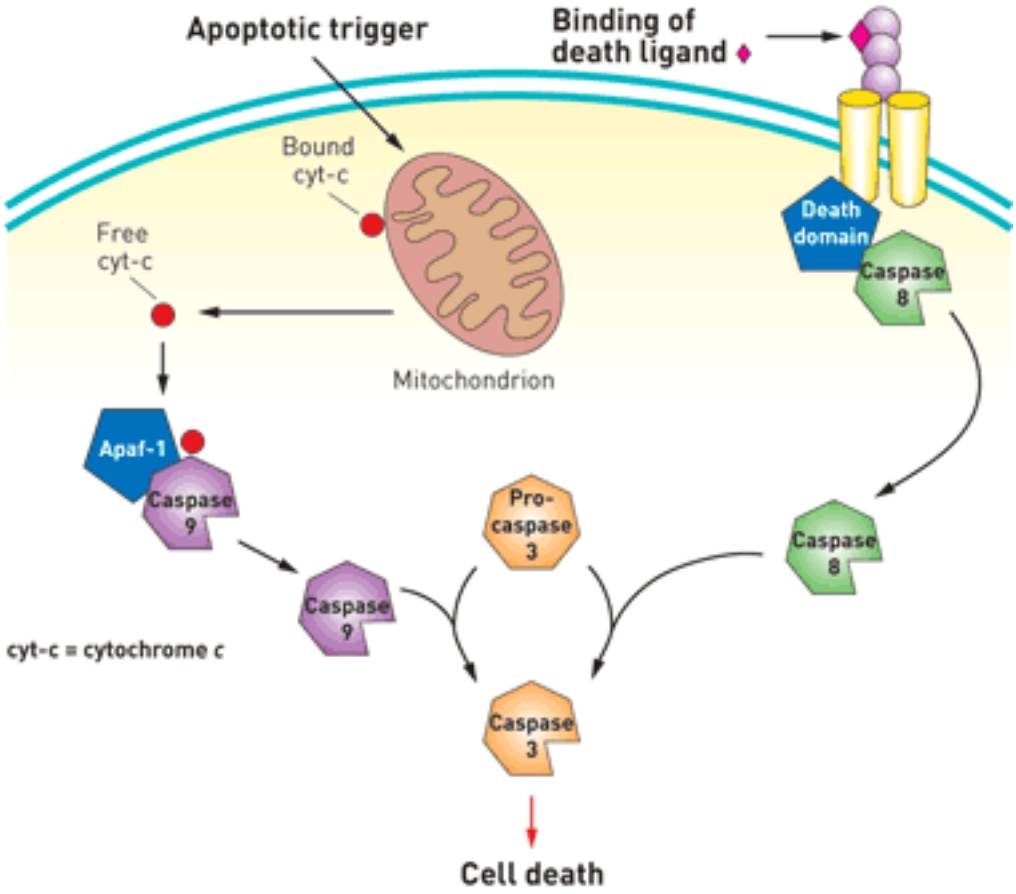


Figure 12: Above is the cell pathway that activates catapase 3 and consequently triggers cell aptosis. The death ligand would then be the described chemicals hydroxymethylfurfural and 3-methyl-2,5-furandione that cause this signal transduction pathway to occur. Image retrieved from http://blogs.shu.edu/cancer/2016/03/09/vanquish-oncology-procaspase-3-activation-factor-to-selectively-induce-apoptosis/.

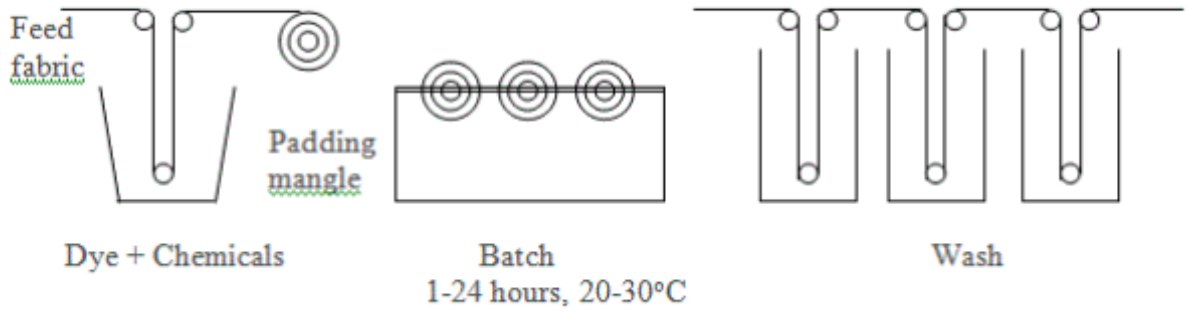
Morelloflavone ($C_{30}H_{20}O_{11}$), another organic compound within mundu extract is also useful to treat vascular diseases (Tuansulongeta al, 2010). Studies show that this substance aside from stopping the migration of vascular smooth muscle cell that invade arteries and cause atherosclerosis, which is fat accumulating and obstructing arteries which diminishes

blood flow, and reducing this fat accumulation by 26%, also act as competitive inhibitors of the HMG-CoA enzyme that is responsible of the cholesterol biosynthetic pathway (Tuansulongeta al, 2010). This means the moreloflavone binds to the enzyme without letting the actual ligand molecule that activates the cholesterol formation process bind to it and stopping the production of cholesterol by this enzyme which reduce its accumulation and stops the patient from having the dangerous excess of it that leads to vascular diseases (Tuansulongeta al, 2010).

Use in Textiles

Yellow dye can be obtained through the unripe mundu fruits while a green color can be acquired through the bark of the tree (FAO, 2000). There is two ways in which these can ecologically be used to add color to cotton and other fabric material for the textile industries. These techniques include the "pad-batch" and "pad-dry" methods. For both to be effective, the panting factors must contain an alkali component (as calcium in *Garcinia dulcis*) (Mongkholrattanasit et al., 2016). This is because alkali are often good reactors that in contact with the fabric would chemically react resulting in the change of color the dyeing consists on (Mongkholrattanasit et al., 2016).

a. Pad (alkali)-batch (cold) process.



b. Pad batch (hot) process:

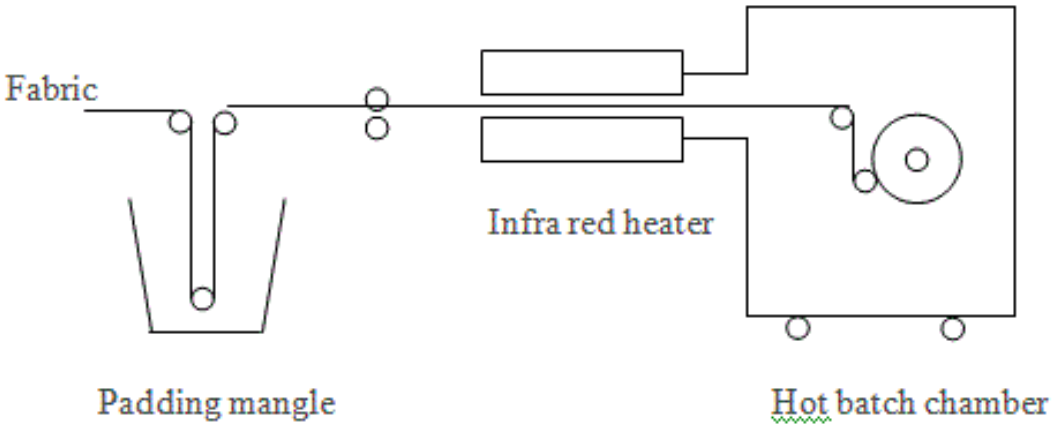


Figure 12: The images below show the steps of the two processes. The first one does not require heat as the second one does. Dyeing agents, including the alkali are located on the paddling mantle or before entering the paddling mantle. Image retrieved from http://textilelearner.blogspot.com.co/2012/01/different-methods-of-reactive-dye.html-

BIBLIOGRAPHY

Begum, A., Barthakur, S. K., & Sarma, J. (2013). *Garcinia dulcis* (Roxburgh) Kurz [Clusiaceae]: a new distributional record Assam India. *East Himalayan Socety for Spermatophyte Taxonomy*. Retrieved from http://www.ehsst.org/journals/Pleione72/025%20Garcinia%20dulcis%20new%20to%20Assam.pdf

Caicedo, A. 2018. Personal communication. Corpoica SI Palmira

FAO. (2007). *Garcinia dulcis*. Ecocrop. Retrieved from http://ecocrop.fao.org/ecocrop/srv/en/dataSheet?id=2302

FAO. (2000). *Garcinia Dulcis*. ecoport. Retrieved from http://ecoport.org/perl/ecoport15.pl?searchType=entityDisplay&entityId=2302

Fern, K., Fern, A., & Morris, R. (2018). Garcinia dulcis. Useful Tropical Plants. Retrieved from http://tropical.theferns.info/viewtropical.php?id=Garcinia%20dulcis

Flint, M. L. (2016, June 21). Aphids. University of California Statewide IPM Program.

Garcin, Laurent (1683-1752). (2007). JSTOR. Retrieved from http://plants.jstor.org/stable/10.5555/al.ap.person.bm000062286

Geilfu, F. (1994). *The Tree at Service of the Farmer*. Turrialba, Costa Rica.

Gogoi, B., Das, R. P., & Barua, U. (2015, December 11). Chromosome Number of Four Garcinia Species of Assam. *Internationsl Journal of Africulture Innovations and Research*.

Gwaltney-Brant, S. M. (2016). Chapter 7 - Nutraceuticals in Hepatic Diseases A2 - Gupta, Ramesh C. In *Nutraceuticals* (pp. 87–99). Boston: Academic Press. https://doi.org/10.1016/B978-0-12-802147-7.00007-3

JSTOR GLOBAL PLANTS. (2007). Laurent Garcin. JSTOR. Retrieved from http://plants.jstor.org/stable/10.5555/al.ap.person.bm000062286

Kouakou K. L., Dao J. P., Kouassi K. I., Beugré M. M., Koné M., Baudoin J.-P., Zoro Bi I. A. (2016). Propagation of *Garcinia kola* (Heckel) by stem and root cuttings. Silva Fennica vol. 50 no. 4 article id 1588. https://doi.org/10.14214/sf.1588

Mathew, G. (2011). Nursery pest problems on some native tree species in Kerala province, India. Working Papers of the Finnish Forest Research Instittute.

Midin, M. R., Nordin, M. S., Madon, M., Saleh, M. N., Goh, H.-H., & Mohd Noor, N. (2018). Determination of the chromosome number and genome size of Garcinia mangostana L. via cytogenetics, flow cytometry and k-mer analyses. *Caryologia*, *71*(1), 35–44. https://doi.org/10.1080/00087114.2017.1403762

Mohd Fadzelly Abu Bakar, Nor Ezani Ahmad, Monica Suleiman, Asmah Rahmat, and Azizul Isha, "Garcinia dulcis Fruit Extract Induced Cytotoxicity and Apoptosis in HepG2 Liver Cancer Cell Line," BioMed Research International, vol. 2015, Article ID 916902, 10 pages, 2015. doi:10.1155/2015/916902

Mongkholrattanasit, R., Saiwan, C., Rungruangkitkrai, N., Punrattanasin, N., Sriharuksa, K., Klaichoi, C., & Nakpathom, M. (2016). Eco-Dyeing of Silk Fabric with Garcinia Dulcis (Roxb.) Kurz Bark as a Source of Natural Dye by using The Padding Technique. *Journal of Natural Fibers*, *13*(1), 65–76. https://doi.org/10.1080/15440478.2014.984056

Mukherjee, D., & Durv Sen Singh. (2015). OCCURRENCE OF *GARCINIA* - LIKE FOSSIL FRUIT FROM THE DINOSAURIAN SEDIMENTS (UPPER CRETACEOUS), PISDURA, MAHARASHTRA, INDIA. *International*

Journal of Geology, Earth & Environmental Sciences. Retrieved from http://www.cibtech.org/J-GEOLOGY-EARTH-ENVIRONMENT/PUBLICATIONS/2015/Vol_5_No_1/03-JGEE-003--DEBI-DUTTA-GARCINIA.pdf

NParks Flora & Fauna Web. (n.d.). *Garcinia dulcis* (Roxb.) Kurz. Singapore Government. Retrieved from https://florafaunaweb.nparks.gov.sg/special-pages/plant-detail.aspx?id=2925

Prickering, J. (2012). Discover Life: Point Map of *Garcinia dulcis.* In *Encyclopedia of Life* (Discover Life). Retrieved from http://eol.org/data_objects/21243905

Sivakumar, T., Chandrika, M., & Babu, M. (2013). Incidence and management of the leaf hopper, Busonimimus manjunathi, on Malabar Tamarinf, Garcinia cambogia. *African Journal of Agricultural Research*.

Subhadrabandhu, S. (2001). Under-Utilized Tropical Fruits of Thailand. Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific.

Te-chato, S. (2007). Floral and fruit morphology of some species in Garcinia spp.

The Editors of Encyclopedia Britannica. (2008, July 2). *Garcinia*. In *Encyclopedia Britannica* (Encyclopedia Britannica Inc.). Retrieved from https://www.britannica.com/plant/Garcinia

Tropicos.org. (2017). *Garcinia dulcis* (Roxb.) Kurz. Missouri Botanical Garden. Retrieved from http://www.tropicos.org/NamePage.aspx?nameid=7801586&tab=specimens

Tuansulong, K., Hutadilok-Towatana, N., Mahabusarakam, W., Pinkaew, D., & Fujise, K. (2010, August 23). Morelloflavone from Garcinia dulcis as a Novel Biflavonoid Inhibitor of HMG-CoA Reductase. In *Wiley Online Library* (Vol. 25, pp. 424–428).

WIDYATMOKO, D. (2010). Population Status and Ecological Preferences of the Palm Sommieria leucophylla Beccari in Salawati Island. *HAYATI Journal of Biosciences*, *17*(3), 137–144. https://doi.org/10.4308/hjb.17.3.137