



SOURSOP: A PROMISING FRUIT FOR CANCER MITIGATION

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Abstract

Soursop (*Annona muricata* L.) which belongs to Annonaceae family is an evergreen tree species known for its anti-cancer properties, due to its annonaceous acetogenins content. It is a native of Central America. It bears the largest fruit among Annonas. It is mostly distributed in tropical and subtropical regions of the world. In regions where sweet fruits are preferred, as in South India and Guam, the soursop has not enjoyed great popularity. Soursop grows on a limited scale in Southern India, in states like Tamil Nadu, Karnataka andhra Pradesh and Kerala. It also thrives wild throughout the Southern Sub-tropical India. Fruits as well as leaves are having the acetogenin content. It is more convenient to store and transport dried leaves and stem as opposed to fruits which are highly perishable and may not ripen properly in fluctuation of storage temperature. Therefore, due to changing market demand, leaf production of soursop would be a lucrative business since the leaves contain annonaceous acetogenins.

Key words: Soursop, Cancer, Acetogenin content.

Introduction

Soursop (*Annona muricata* L.) which belongs to Annonaceae family is an evergreen tree species known for its anti-cancer properties, thanks to its annonaceous acetogenins content. It is a native of Central America. It bears the largest fruit among Annonas. It is mostly distributed in tropical and subtropical regions of the world. In regions where sweet fruits are preferred, as in South India and Guam, the soursop has not enjoyed great popularity (Morton, 1987). Soursop grows on a limited scale in Southern India, in states like Tamil Nadu, Karnataka andhra Pradesh and Kerala. It also thrives wild throughout the Southern Sub-tropical India. It does not tolerate frost and grows well in well-drained and semi-dry soil upto an elevation of 300 MSL. The soursop is truly tropical. The optimal range of latitude is between 27°N and 22.5°S (Nakasone and Paull, 1998). It grows and produces well at 21 to 30°C, being very sensitive to severe changes in temperature, especially if the limit of 12°C is reached. Young trees in exposed places are killed only by a few degrees of frost. Temporary defoliation and interruption of fruiting occurs when the temperature drops near freezing. However, good productive orchards are found at altitudes of up to 1100 m (Pinto and Silva, 1994).

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Soursop (*Annona muricata*) has three general classification: sweet, sub-acid and acid and then subdivided as round, heart-shaped, oblong or angular and finally classed according to flesh consistency which varies from soft and juicy to firm and comparatively dry. Some popular annonas are the true custard apple, or bullock's heart or Ramphal (*A. reticulata* Linn.), the sugar apple or sweetsop or Sitaphal or Custard apple (*A. squamosa* Linn.) and the cherimoya (*A. cherimola* Mill.). The tree is low-branching and bushy but slender because of its upturned limbs and reaches a maximum of 7.5-9 m in height. Young branchlets are rusty-hairy. The leaves, normally evergreen, are alternate, smooth, glossy, dark-green on the upper surface, lighter beneath, oblong, elliptic or narrow-obovate, pointed at both ends and highly aromatic when crushed. The flowers, which are borne singly, may emerge anywhere on the trunk, branches or twigs. They are short-stalked, 4 to 5 cm long, plump and triangular-conical, the three fleshy, slightly spreading, outer petals yellow-green, the three close-set inner petals pale-yellow (Morton, 1987). Soursops are more or less oval or heart-shaped, sometimes irregular, lopsided or curved due to improper carpel development or insect injury. They range in size from 10-30 cm long and up to 15 cm in width, weight ranges from 0.3 kg up to 6 kg compound

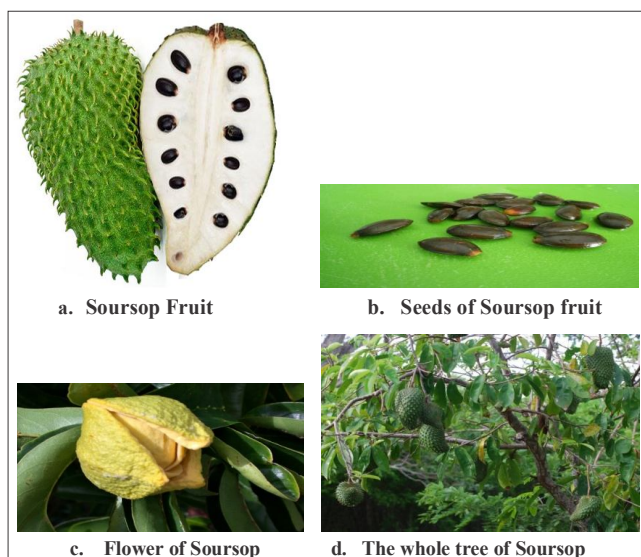


Fig. 1: a. Soursop Fruit, b. Seeds of Soursop Fruit, c. Flower of Soursop, d. The whole tree of Soursop.

and covered with a reticulated, leathery-appearing but tender, inedible, bitter skin from which protrude few or many stubby, or more elongated and curved, soft, pliable “spines”. The tips break off easily when the fruit is fully ripe. The skin of the immature fruit is usually dark-green, becoming slightly yellowish-green before the fruit is soft to the touch. The inner surface of the skin is granular and separates easily from the mass of snow-white, fibrous, juicy segments-much like flakes of raw fish-surrounding the central, soft-pithy core. In aroma, the fruit is somewhat pineapple-like, but its musky, sub-acid to acid flavor is unique. Most of the closely-packed segments are seedless. In each fertile segment there is a single oval, smooth, hard, black seed, 1.25 to 2 cm long and a large fruit may contain a few dozen to 200 or more seeds. The fruit consists of about 67.5% edible white pulp with a pleasing fragrance and flavor. It is a good source of vitamins B and C with some calcium and phosphorus.

Food and Medicinal uses

It has numerous uses. The young green fruits with seeds that are still soft can be cooked as vegetable. When ripe, the flesh can be eaten off hand or as dessert, or processed into candies, jams and jelly. Its juice is used for flavoring or packaged into refreshing guyabano drinks. The leaves are used as herbal medicine. Because the tree is small and tolerant of partial shade, it can be intercropped with coconut or with large fruit trees like mango, durian, avocado and jackfruit. Soursop leaf contains annonaceous acetogenins which exhibited significant inhibitory effects against six human cancer cell lines: lung, breast, colon, pancreatic, kidney carcinoma (Vieira *et al.*, 2010). It has also been found to contain compounds which were responsible for inhibiting uric acid

formation in hyperuricemic induced lab wistar rat and it shows potential for developing medicine to cure gout (Sri-Wahjuni *et al.*, 2012). Soursop Leaves Crude Extract (AMCE) exhibited cytotoxicity toward breast cancer cell lines and reduced the tumor’s size and weight in lab mice. Thus it is a promising candidate for cancer treatment especially in breast cancer as an alternative to conventional drugs (Najmuddin *et al.*, 2016). Extracts of *Annona muricata* and *Annona reticulata* inhibited the growth of *Plasmodium falciparum*, a malaria causing organism (Yamthe *et al.*, 2015). The aqueous extract of *Annona muricata* (Graviola tea) has shown considerable antioxidant potentials. The bark, leaves, fruit, roots and seeds are known since long for various medicinal uses. The fruit and juice is used against worms and parasites, to cool down fevers, to increase lactation after childbirth. The seeds can be crushed and then used against internal or external parasites, head lice and worms (Taylor, 2002). The tea prepared from the leaves is used as a sedative and a soporific (inducer of sleep) in the West Indies and Peruvian Andes. This infusion is also used to relief pain or for antispasmodic purposes. For liver problems, leaf tea is used in the Brazilian Amazon (Schultes *et al.*, 1990). Traditionally it is used in medicinal herbal drugs to cure various diseases such as for diarrhoea (fruit), cough, hypertension, rheumatism, tumors, cancer, asthma, childbirth, lagtagogue (fruit), malaria, tranquilizer, skin rashes, parasites (seeds), worms (seeds), liver problems, arthritis (used externally) etc. (Morton, 1980). The leaf decoction is lethal to head lice and bedbugs. The wood is pale, aromatic, soft, light in weight and not durable. It has been used for ox yokes because it does not cause hair loss on the neck (Standley *et al.*, 1946). The roots of the tree are employed as a vermifuge and the root bark as an antidote for poisoning (Watt *et al.*, 1962). Nowadays people are more aware of the detrimental effects of Allopathic medicine. So, they are starting to look for alternative medicine, which is eco-friendly and gives no side effects. Moreover, taking delicious fruits as medicine also gives an immense pleasure to the patient thereby giving an added psychological push to the healing process. People are willing to pay any amount for a side-effects-free alternative medicine. Tea prepared from soursop leaves and stem has recently been gaining wider popularity and shade dried leaves and stem fetches very premium prices in e-commerce vendors. It is more convenient to store and transport dried leaves and stem as opposed to fruits which are highly perishable and may not ripen properly in fluctuation of storage temperature. Therefore, due to changing market demand, leaf production of soursop would be a lucrative business since the leaves contain annonaceous acetogenins.

Propagation and planting

Soursop can be propagated from seed and by budding. The height of the plant is not greatly affected by budding and the majority of producers prefers using grafted seedlings rather than seeded seedlings. Propagation by seed or graft is done in plastic bags in a growth medium that varies from region to region. The constituents in the growth medium in the nursery phase are very important. Depending on the material and quantity used, there is the possibility of interfering with seed germination and of phytotoxicity burning the young leaves and causing the death of the seedlings (Pinto and Silva, 1994). Poor emergence of soursop seedlings is as a result of poor storability of the seeds. Soursop seeds lose viability easily and do not store for a very long time and are, therefore, best sown without delay (Ken and Robert, 2011). Soursop has thick black seed coat that reduces water inhibition during the first stage of germination and therefore requires some pre-sowing treatments to enhance germination and seedling emergence (Okoli *et al.*, 2016). It is preferable to select only the sunken seeds when soaked in water and sowing right after extraction. The land planting field should be deep ploughed and levelled. In normal practice a spacing of 4 to 6 meters is

recommended depending on climate and soil type (Tripathi *et al.*, 2014). In high density planting 2.4×2.4 m of spacing is adopted in Puerto Rico (Morton, 1987). Pit of $60 \times 60 \times 60$ cm size are dug and filled with a mixture of 3:1 top soil and compost. It is preferable to plant in early evening or on cloudy days. Plants should be 8-12 months old and 50-90 cm in height. Plants should be watered immediately after transplanting.

Training and pruning

Soursop trees usually attain symmetrically conical shape and are adapted to the central leader system. The fruits are borne on the lateral branches and hangs down for ease of harvesting. Little pruning is not required after training of the trees. Branch pruning is done to promote uniform air movement and light penetration. Diseased, interlocking and weak branches should be removed.

Flowering and pollination

In India, soursop flowers and fruits during the months of April to October. It

require 27-35 days for flower bud development from initiation to anthesis. Flowering can extend from 3-6 months (Tripathi *et al.*, 2014). The flowers exhibit both dichogamy and a protogynous nature. Anthesis takes place between noon and 8 pm and 4 am to 8 am with pollen release occurring between 4 am and 8 am.

Manuring

Adequate fertilization of the planting pit is a basic condition for excellent seedling growth that will result in a productive adult plant producing good quality fruit. The amount of fertilizer to apply is based on soil analysis and on the volume of pit. It is recommended to apply 40 g Nitrogen and 60 g potassium to one year old plant. Four and onwards 180 g Nitrogen, 120 g Phosphorus and 180 g Potassium should be applied to each tree. In addition adequate quality of organic manure should be applied. Fertilizer should be applied around the plant but only lightly incorporated into the soil to avoid damaging the developing root system. The required quantity of N and K fertilizer should be divided into three doses. First dose should be applied at onset of rainy season, second in the middle and third at the end of the rainy season. Water stress should be prevented to produce good crop.



Fig. 2: e. value added products from Soursop (Juice, frozen pulp, jam and jelly)

Harvest and yield

The fruit is picked when full grown and still firm but slightly yellow-green. If allowed to soften on the tree, it will fall and crush. It is easily bruised and punctured and must be handled with care. Firm fruits are held a few days at room temperature. When eating ripe, they are soft enough to yield to the slight pressure of one's thumb. Having reached this stage, the fruit can be held 2 or 3 days longer in a refrigerator. The skin will blacken and become unsightly while the flesh is still unspoiled and usable (Morton, 1987). Studies of the ripening process in Hawaii have determined that the optimum stage for eating is 5 to 6 days after harvest, at the peak of ethylene production. Thereafter, the flavor is less pronounced and a faint off odor develops. The sour sop is a shy-bearer, the usual crop being 12 to 24 fruits per tree. In Puerto Rico, production of 5 to 8 tonnes per ha is considered a good yield from well-managed orchard. A study of the first crop of 5 year-old tree in Hawaii showed an average of 42.5 kg fruits per tree. Yield was slightly lower during next year. The 3rd year, the average yield was 78 kg per tree. At this rate, the annual crop would be 16 t/ha.

Post harvest Handling

High temperature can cause premature fruit ripening and fermentation of the fruit. Fruit is harvested when fully mature and firm. The skin colour changes as the fruit approaches maturity. The immature sour sop is dark green and shiny and becoming slightly yellowish green at maturity. Sour sop respiration begins to increase within a day after harvest and reaches its peak at the sixth to eighth day. Total soluble solids increase from around 10-16% during the first 3 days of ripening. The major titrable acids are malic and citric acids. After day 5 to 6 titrable acidity, produce a bland flavor and even a slightly odour. The optimum edible stage is at days 6-7, which coincide with ethylene production. Fruit is hand harvested and put into boxes or baskets. Harvested fruit should be handled with care to prevent bruising of the skin. Firm fruit are held after harvest for 4-7 days at room temperature before softening begins, optimum quantity processing occurring 5 and 6 days later. The skin of ripening soursop gradually turns dark brown to black, but the flesh is unspoiled. Storage below 15°C causes chilling injuries and failure to develop full flavor. At lower temperatures skin discoloration rapidly occurs. It can be used as fresher for processing after removal of outer skin and seeds.

Conclusion

Today Cancer is one of the most challenging and life threatening health problems in the entire world. The use of phytochemicals may be a true therapeutic strategy for

eradicating cancer cells. Hence cultivation and utilization of soursop can be popularized among the people.

References

- Ken, L. and E.P. Robert (2011). Soursop. *Fruits and nuts.*, **22**: 1-6.
- Morton, J. (1987). Soursop. In: Fruits of warm climates. Julia F. Morton, Miami, FL: 75-80.
- Morton, J.F. (1980). Caribbean and Latin American folk medicine and its influence in the United States. *Q.J. Crude Drug Res.*, **18(2)**: 57-75.
- Najmuddin, S.U.F.S., M.F. Romli, M. Hamid, N.B. Alitheen and N.M.A.N.A. Rahman (2016). Anti-cancer effect of *Annona Muricata* Linn. Leaves Crude Extract (AMCE) on breast cancer cell line. *BMC Complementary and Alternative Medicine.*, **16(1)**: 311.
- Nakasone, H.Y. and R.E. Paull (1998). Tropical Fruits. CAB International, London: 45-75.
- Okoli, N.A., J.C. Obiefuna, R.A. Alagba and L.C. Emma-Okafor. (2016). Improvement of germination and seedling vigour of soursop (*Annona muricata* L.) using hydro-priming and dehydration treatments. *Futo J. Series.*, **2(1)**: 57-61.
- Pinto, A.C., Q. de and E.M. Silva (1994). Graviola for export, aspects Production technicians. Embrapa-SPI, Brasilia.
- Schultes, R.E. and Raffauf (1990). The Healing Forest: Medicinal and Toxic plants of the Northwest Amazonia. Dioscorides Press, Portland, OR.
- Sri-Wahjuni, Putra-Manuaba, I.B. Rahayu-Artini, N.P. and S. Wahyu-Dwijani (2012). Uric acid inhibition activity of *Annona muricata* L. leave extract in hyperuricemia induced wistar rat. *Adv. Pure Appl. Chem.* **2(1)**: 86-90.
- Standley, P.C. and J.A. Steyermark (1946). Flora of Guatemala. Fieldiana. Chicago Nat. Hist. Mus., Chicago: **24(4)**: 276-7.
- Taylor, L. (2002). Technical Data Report for Graviola: *Annona muricata*. Sage Press, Inc.
- Tripathi, P.C., V. Sankar and Senthil R. Kumar (2014). Sour Sop -An emerging fruit of future. Central Hort. Exp. Sta., Chettalli, Kodagu, Karnataka. Tech. Bul., 5/2014. 14.
- Vieira, G.H.F., J.A. Mourão, A.M. Ângelo, R.A. Costa and R.H.S.F. Vieira (2010). Antibacterial effect (*in vitro*) of *Moringa oleifera* and *Annona muricata* against gram positive and gram negative bacteria. *Rev. Inst. Med. Trop. Sao Paul.* **52(3)**:129-132.
- Watt, J.M. and M.G. Breyer-Brandwijk (1962). Medicinal and Poisonous Plants of Southern and Eastern Africa. 2nd ed. E. & S. Livingstone Ltd., Edinburgh and London.
- Yamthe, L.R.T., P.V.T. Fokou, C.D.J. Mbouna, R. Keumoe, B.L. Ndjakou, P.T. Djouonzo, A.N. Mfopa, J. Legac, N. Tsabang, J. Gut, P.J. Rosenthal and F.F. Boyom (2015). Extracts from *Annona Muricata* L. and *Annona Reticulata* L. (Annonaceae) potently and selectively inhibit *Plasmodium falciparum*. *Medicines.* **(2)**: 55-66.