

Review Article

QUALITATIVE FEATURES AND THERAPEUTIC VALUE OF CUSTARD
APPLE FRUIT AT REFREGIRATION STORAGE

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Abstract

Custard apple AnnonasquamosaL (Family: Annonaceae), commonly known as sugar apple or sweetsop, is a species native to tropical America, that is cultivated in different tropical countries around the world. Its ripe portion is more valuable and has significant nutritional value like it is rich in minerals and vitamins. Mostly vitamin A and C present in it. This fruit have different morphological properties as it contains high level of magnesium and iron, and due to presence of magnesium, water level is maintained in body and reduces the problem of arthritis and anemia. Custard apple also improves metabolic system and reduces the deficiency of vitamin B6. Custard apple contains antioxidant, anticancer, and antimicrobial properties. There are different acetogenins, photochemical and phenolic are present in custard apple fruits. It is used to import the caloric value of the yoghurt and increase the value of protein of the yoghurt. When custard apple added in yoghurt, micronutrients level improves. During oxidation in yoghurt, oxidative damage of lipids occurs. To check the effect of custard apple in yoghurt different treatments were applied on peel, pulp, peel and pulp yoghurt. Best results and sensory evaluation was achieved on 6% peel and pulp of yoghurt. Conclusively, it has been shown that custard apple pulp and peel in powder form, has better nutritional value and also play critical role in lowering different health disorders.

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1. Custard apple

Custard apple is edible fruit mostly known for its edible pulp and include in family Annonaceae and genus Annona. It mostly grow in India and America(Varlamova & Larionova, 2013).

Annona squamosa fruit is covered by a green skin and contains a white edible and soft pulp portion and black elongated shaped seeds. Custard apple pulp portion is soft when ripe and can be eaten fresh or made into custard apple juice. It's a rich source of carbohydrate, the most and probably important sugar which is present in custard apple is fructose and others significant vitamins that are vitamins B1, B2 and vitamin C (Herkenham et al., 1991).

2. General Description

Custard apple is a small well-branched tree or shrub that bears edible fruits species of the genus *Annona* and member of the family Annonaceae more willing to grow at lower altitudes than its relatives *Annona reticulate* and *Annonachermoula*(Committee, 1997).

The Custard Apple is an elongated tree with a spread

top and 11 to 15 inch (25-35cm) thick stem. The leaves of custard apple have visible lines having bad smell. When custard apple leaves are at maturity level show visible lines and small hairs on the top of leaves. Flowers of custard apple are in cluster form(García-Closas et al., 2004). Petals of this fruit are narrow form. Flowers of custard apple are not in open form and having three narrow petals on single leave. The flowers of custard apple contain red spot inside the base. The color of flowers are green and having white flash which is sweet and pleasant aroma (Dange & Deshpande, 2013).

3. Distribution of custard apple

The actual home of custard apple is still unknown. Custard apple flower growth depends on season because flowers lose foliage in minimum time. Growth of foliage starts respectively when one old foliage drop new foliage growth s start. The growth of tree is mostly in tropical regions like America and some other places of west indies.(Lynch et al., 2004)

Table 1. Production of custard apple

Altitude	700-2500m
Length	6-10m
Leaves	Ovate and pointed at apex
Fruit	150-500mg
Texture	Soft
Seed	Toxic (not in use)

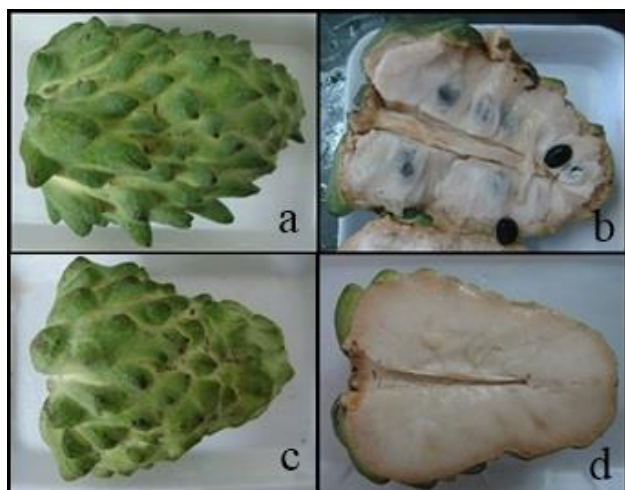


Fig 1. Custard apple fruit (a & c = peel of custard apple; b = Seed of custard apple; d = Pulp of custard apple)

4. Ecology and Climate Required for Development

The *Annonasquamosa* is probably the most droughts tolerant among other species of *Annonaceae* family as it grows and produces poorly where rains are frequent. (Argo forestry Database 4.0) Temperature is a limiting factor, with frost killing young trees, but older trees show some tolerance. Seedlings have high photosynthesis activity at 30°C and show vigorous shoot growth (Yang et al., 1998). Poor pollination is a frequent problem under high temperatures (>30°C) and low humidity (<60% relative humidity (RH)), even with hand pollination. Lower temperature (25°C) and higher humidity (70% or higher RH) greatly improves pollination. Optimal soil pH for custard apple is 6.0-6.5. It grows in almost all types of soil and has wide range of soils (Reddy et al., 2010).

5. Botanical description of *Annonasquamosa*

Custard apple branches and small branches are in properly arranged on small tree and the bark of custard apple is thin. Custard apple crown is flattened. Leaves of custard apple are long 11-14 cm and 2-4 cm in wide

range. Leaves are sharp at the tip and at the base wedge shape at the low side of base the leaves pattern arranged respectively (Dange & Deshpande, 2013). Production of custard apple is highly effected by the change s in environmental conditions. When rain falling is low or temperature is not high production of custard apple is affected. The effect of change is not observed on all trees (Sun, Shen, & Luo, 2011). Flowers of custard apple are arranged in cluster form and numbers of flowers are 2-4 on tree. The length of flower is observed 2.7cm and green at the base portion. Nitidulid beetles are the important pollinators with wind and self-pollinating being low (Wyllie, Cook, Brophy, & Richter, 1987). Fruits with white pulp are edible, round or heart shaped with many round protuberances, ranging in length from 1.3 to 1.6 cm, with a pale swelling at the helium or albumen filled with numerous transverse, brown lines of clefts (Chang & Wu, 2001).

5.1 Leaves

Leaves are oblong 12-14 cm long and 2-4 cm wide, alternately arranged on short petioles, young leaves are slightly hairy, solitary and clustered crystals occur in epidermal cells (Soosaar, Burch-Smith, & Dinesh-Kumar, 2005).

5.2 Flowers

Flowering season of custard apple is start in spring to early summer, and in highly moisture areas, flowering season throughout the year. Inflorescences are super auxiliary. The flowers are penicillate, actinomorphic, proteaginous. (pistils are mature before pollen is liberated from anthers), Spiro cyclic and bisexual (Olesen & Muldoon, 2012). Flower is 2-4 cm long and contains three degenerated sepals and six petals. The six petals are arranged into two whorls with three each and the petals of the inner whorl are degenerated into small scales or completely disappear. The multiple pistils grow on the conical receptacle, in the center of the flower with a number of stamens at the periphery (George & Nissen, 1992)

5.3 Fruits

Trees start to bear fruit when 3-4-year-old. In India fruits are produced in July-august. The taste of custard apple is sugar like sweet. Custard apple flash is soft. The rind is thick with knobby segments but will turn soft and crack open, releasing a sweet aroma

when it rips. Normal ripening occurred at a temperature between 15-30°C. (Broughton et al., 1981)

5.4 Roots

Branched tap root (Verma & Stellacci, 2010)

5.5 Seeds

Seeds are black or dark brown in color. There are 30-40 seeds in an average fruit. The *Annonasquamosa* is a diploid species with $2n=14$ (Cole et al., 2005).

Fig 2:



Table 2. Nutritional Value of Custard Apple

Moisture	71.5%
COH	19.9%
Protein	1.7%
Fat	0.4%
Minerals	0.7%
Vitamin C	38%
Total Soluble Solids	25.40%
pH	5.6
Tannins	0.4%
Fat	0.3-0.5g
Sodium	4-5g
Calcium	17mg
B-Carotene	10mg
Ascorbic Acid	50mg

6. Chemistry of Custard Apple

There are different compounds which are present in custard apple fruit. Every compound has a specific behavior. These compounds are alkaloids, phenolic compounds and glycoside. Different compounds like

hexanoic acid and octanoic acid are also present in custard apple fruit (Wyllie et al., 1987). The acerogenins are related to custard apple family and in *In vivo* and *In vitro* studies showed that it has effective anti-cancer and anti-hypertensive properties.

7. Phyto chemistry of *Annonasquamosa*

The medicinal properties against diseases of medicinal plants are mostly due to the occurrence of many secondary metabolites. The extraction of different parts of custard apple in different solvents revealed that different compounds carbohydrate, flavonoids, phenols, alkaloids, sterols and tannins (Topalian et al., 2012). Flavonoids have antimicrobial activity and showed from aqueous extract of custard apple. (Kotkar et al., 2002). Podophyllotoxin (a non-alkaloid toxin lignin compound) also isolated from the branches (Mazzali et al., 2002). GC analysis of fatty acid methyl esters (FAMES) of seed oil revealed the presence of saturated fatty acids like Stearic acid, Palmitic acid and different unsaturated fatty acids like Octadecenoic acid (Oleic acid) (Alassane, 2004).

7.1 Antioxidants Activity of custard apple

An antioxidant is substance which is present in low concentration and substrate is present in higher concentration and antioxidant play an important role for delay in oxidation process of substrate. There are different antioxidants but mostly in fruits and vegetables the antioxidants which are presents in higher amount are polyphenols and phytonutrients. *Annonasquamosa* L. (Family: Annonaceae), also called as custard apple or sugar apple. custard apple is also present mostly in different tropical regions mostly native in tropical region of central America which is consider highly sweet and having white flash and can be used as ingredient in preparing the ice creams and milk. consumer demand of custard apple is highly ripe and sweet (Lima, Pimenta, & Boaventura, 2010).

Custard apple fruit contain different polyphenolic compounds which have different kind of biological and some compounds have different free radical scavenging properties. There is no critical step in levels of phenolic compounds and their structural property in plants are of considerable interest but most critical step in biological active where compounds represent a diverse spectrum of compounds is a sample. To extract the bioactive compounds solvent extraction method is used and solvent extraction method is also depending upon the purpose and the

methods of extraction and also analysis of extracted material solvent extraction has been widely used to extract bioactive components from plants and depends upon, nature and component, physical and chemical properties of matrix, safety and the availability of equipment's. Ethanol, methanol and acetone are mostly used in extraction of different phenolic compounds. These all compounds are mostly organic and alcoholic solvents (Musa, Abdullah, Jusoh, & Subramaniam, 2011).

7.2 Anti diabetic activity

Custard apple fruits possess anti-diabetic effect and that study was done on rats inducing by using streptozotocin. The study was done for 30 days and showed that blood glucose level, uric acid and urea was reduced. When proper insulin was done the level of glucose was reduced due to activities of insulin in rats.

7.3 Antitumor activity

Custard apple seeds have shown antitumor activities and parameter was checked for antitumor activities was different. According to effect of results estimations of *in vitro*, DNA fragment analysis were checked. That study was carried on rat histolytic tumor cells.

The results of that study showed when regulation of antitumor gene decrease resulted significant death of tumor cell. In addition, DNA fragmentation showed that the extracts induced apoptosis in tumor cells through the oxidative stress. Custard apple extracts of seeds possessed significant antitumor activity against tumor (Pardhasaradhi, Reddy, Ali, Kumari, & Khar, 2004).

7.4 Anticancer Activity

Tumor cells have three properties.

- They have transport glucose mechanizing process to faster into them.
- They develop neoangiogenesis
- They also have a multi-drug resistance protein save from killing action of anticancer drugs (Pardhasaradhi *et al.*, 2004)

Acetogenins are responsible for anticancer properties of custard apple fruits and these acetogenins are specific to custard apple fruit family. Different types of cancer cell breast, colon were tested through acetogenins (Kelloff, Hawk, & Sigman, 2008). Major source of energy for the cell are ATP. ATP are inhibited by acetogenins and also disturb the system of

electron transport in mitochondria (Chih, Chiu, Tang, Chang, & Wu, 2001).

7.5 Anti-infective

Custard apple fruits have shown the antibacterial activities. The antibacterial activities have been shown due to different compounds which include acetogenins, essential oil along with benzyl isoquinone Compound. Methanol extract of custard apple fruit against *Staphylococcus aureus* were used for antibacterial activity (Le, Ostergard, Bhatia, & Huggins, 2005).

7.6 Medicinal properties

Custard apple fruit have various medicinal properties like study shown that its extract increased the hemoglobin level in animal feeding. These responses have been observed in humans. Custard apple fruits peel and pulp portion have been used for diseases like cold, dysentery and diarrhea. Its powder can be used as killer of fleas and head lice. Custard apple fruit is easily digestible even at old age. (Pandey & Barve, 2011) studied that this fruit have medicinal properties against muscle weakness due to presence of potassium and also helpful to regulate the water balance in body due to presence of magnesium in it, which is also helpful in removing the acid from the body joints. The portion other than fleshy part have been used for anti-tumor activities (Gupta *et al.*, 2005).

8. Preservation Methods of Custard Apple

Custard apple fruits have been shown highly ethylene production and highly ethylene production due to its fast ripening. Custard apple fruit climate is highly climacteric behavior.

It can become soft within 3-4 days after harvest and some will crack open. If the fruit is not consumed within a few days after harvest, it begins to decay the pericarp turns to brown or black color and loses its commercial value. The critical temperature of chilling injury for the fruit is around 15°C and when stored at this temperature the shelf life for the fruit is around 10 days. Frozen preservation is an effective method for extending shelf life of sugar apple from approximately 10 days to 12 months (Chua & Yang, 1988). One of the problems with freezing sugar apple arises since the fruit is frozen without blanching and then becomes brown easily as a result of enzymatic browning (Vogt *et al.*, 1992).

8.1 Drying

Drying experiment of *Annonasquamosa* pulp and peel was carried out by using three different methods. Drying through air was done using room temperature (~20°C) with maintained good air circulation in the room. Air dry process completed after two weeks to achieve its consistent weight. Oven drying is done by using two different temperatures, 40 and 60°C until consistent weight was achieved. Freeze drying process was conducted in -80°C by using lyophilization machine (LabConco Free Zone, 12 Plus) for two days before going through freeze dry process for four days until consistent weight was achieved

8.2 Health benefits of custard apple

- Custard apple provides protection from disease like heart attack, and cancer due to presence of different vitamins and minerals.
- Custard apple provides water balance in body and also controls the fluctuating blood pressure in body.
- Due to presence of vitamin A custard apple provides healthy skin.
- Due to presence of vitamins custard apple fruit pulp and peel enhance the eye sight and increase vision.
- Due to presence of magnesium custard apple help in maintain the water balance in a body to Due to presence of highly amount of magnesium reduce the risk of arthritis and remove the various acids.

Custard apple fruit is use to reduce the risk of vomiting and vitamin B6 deficiency.

9. Conclusion

As literature showed that Custard apple haverobust nutritional profile and various medicinal properties. This fruit have anti-oxidants, ant diabetic, anticancer and anti-tumor properties .So it can be used to cure the different diseases. Custard apple fruit can be used in different dairy products for better nutrition profile. As this fruit is a rich source of carbohydrate, the most important sugar which is present is fructose and others significant vitamins which are present in custard apple are vitamins B1, B2 and vitamin C. This fruit is sweet and have high aroma of fruit. It also has many beneficial, nutritional and antioxidants properties. So it can be concluded that functional foods are more nutritious than the basic food and also functional dairy foods provide more beneficial effects on the health of consumer.

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