



REVIEW ARTICLE

Postharvest processing of custard apple (*Annona squamosa* L.) - a review

Narotam Soni, V. D. Mudgal, P. S. Champawt

Department of Processing and Food Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Received: 18.08.2021

Accepted: 16.10.2021

ABSTRACT

As the pandemic conditions of 2020, the demand of immunity booster and highly nutritious products has led to increase in consumption of fruits and their processed products. Custard Apple (*Annona squamosa* L.) is good source of bioactive compounds along with high sensory properties. Although custard apple is antioxidant, anti-diabetic, hepato-protective, cytotoxic, genotoxic, antitumor and anti-lice agent but still it is counted as underutilized fruit, due to less processing technologies available throughout the world. In the last two decades this fruit has attracted researchers with challenges as preservation of whole fruit and pulp, de-pulping of custard apple and maintaining nutritional value for custard apple during processing. Minimally processed products from the fruit may be a convenient option for households, farmers and foodservice providers. Processed products of fruit will inhibit the quality deterioration, browning of pulp and fruit, microbial contamination and increase in shelf life as well as cost of processed products. The present chapter possesses information related to de-pulping, utilization and value added or processed products from custard apple.

Keywords: Custard apple pulp, de-pulping, processed product, value addition

Citation: Soni, N., Mudgal, V. D., and Champawt, P. S. 2021. Postharvest processing of Custard apple (*Annona squamosa* L.) - a review. *Journal of Postharvest Technology*, 9(4): 96-102.

INTRODUCTION

Custard apple (*Annona squamosa* L.) fruit belongs to annonaceae family and native to South America and West Indies. Custard apple term applies to all species of *Annona* which produce edible fruit (Khodifad and Kumar, 2019; Sharma and Panaser, 2018).

Based on species of *Annona* gene name of custard apple varies. In India varieties found are Balanagar Barbados Seedling, Sitaphal (red/lad), Mammoth, Sangareddyiz, Borhodes, Britshbaroa, Washington 97, Arka Sahan, Purandhar, Arka, Sahebganj, , Red-Speckled, White-Stemmed Crimson Yellow, and Kakarlapahad. In United States (Lessard, Kampong Mauve, Purple Sugar, Red Sugar, Barbados, British Guiana, Thai Seedless), Cuba (Seedless Cuban), Philippines (Molate, Lobo, ACESS 6333), Thailand (Nang Sir Krung, Fai Krung, Fai Kaew, Nang Kaew, Noi and Nang Thong), Taiwan (Tainung No. 1, Cu-lin, Da-mu, Ruan-zhi, Xi-lin), Egypt (BeniMazar, Abd El Razik), Australia (KJ Pinks, Maroochy Yellow, Paletorpe, Maroochy Gold, Island Gem and Nielsen) and China

(Fenglishijia) these custard apple varieties are commonly cultivated (Brandao and Santos, 2016). In India several vernacular names of custard apple are as sugar apple, sharifa, sitaphal and sweet sop in different parts of the country. Annonaceous fruits have wide adaptability to soil, climate conditions and are not much affected by pests and diseases. Its hardy nature protects the fruit from animal and damages, commonly grown in many subtropics and tropical regions of the world with a remarkable span of expansion. Custard apple needs minute agronomic care and too much production in short season, perishes due to inadequate preservation technology (Nair and Agrawal, 2017). The main season for availability of custard apple in the market is very short i.e. October to December, which leads to wastage distress and unavailability during offseason. Storage of the *A. squamosa*, fruits has constraint, because of distasteful brown coloured skin, cold storage is not promising (Kachhadiya and Jethva, 2017). Custard apple pulp canning was reported challenging as bitterness and browning developed when heated above 55° C (Kowitcharoen et al., 2018). As pulp has more shelf-life compared to the fruits therefore as an alternative of selling fruits directly if fruits are processed by pulp separation from seed and rind portion and then selling the pulp or processed products of pulp to the market will benefits the growers (Nambi et al., 2017; Bhakane et al., 2015).

ORIGIN OF CUSTARD APPLE

Exact locality and originality of custard apple is a topic to debate as it is widely grown and naturalized throughout the globe. It is believed that tree was started in the West Indies. *Annona squamosa* is inhabitant to Antillean isle of Trinidad. The species spread from Mexico to South America, than later reached Asia and Africa. Swampy tropical atmospheres is most suitable for custard apple: the Antilles, southern Mexico, Polynesia, South and Central America, tropical Africa, Indonesia and Australia.(Mianasara et al., 2018). It was introduced to India in sixteenth century by Spanish and Portuguese. It is grown in high rainfall regions of India. It is very well-liked in Deccan plateau, being grown and marketed in the states of Rajasthan, Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar, Tamil Nadu, Karnataka, Orissa and Assam (Brandao and Santos, 2016).

DESCRIPTION OF CUSTARD APPLE TREE AND ITS FRUIT

A. squamosa is a semi evergreen robust little tree with an average height of 5-8 m. it starts fruit production after 2-3 years of planting sufficient rainfall and fertilization speedup harvests. Branches evident a light chestnut coloured outer bark, internal bark is light yellow. Leaves are bright green coloured 5-7 cm long and 2-6 cm wide, pointed at the tip with oval lanceolate design. While in green and purple flowers there are horizontal groups, blooming period is from spring to early summer. Average diameter of custard apple fruit ranges from 6-10 cm weighing nearly 100-230 g consisting outer thick, rough rind or peel portion that gives it pinecone appearance. This rind portion subdivided into 30-58 protuberances, each of the protuberance possesses a dark brown or black coloured seed encapsulated with edible pulp. This pulp tissues is sugary and white or bright yellow in colour. The heart shaped fruit is pendulous at 5 cm to 10 cm distance on a thickened stalk and secured with a fine blossom (Mianasara et al., 2018). Shelf life of custard apple fruits was recorded with a mean value as 3-4 days and fruit yield per plant was 120 kg per year (Nag and Dikshit, 2018).

PRODUCTION OF CUSTARD APPLE

Custard apple is grown commercially in Mexico, Malaysia, West Indies, Brazil, Thailand, Florida, Egypt and Philippines. In India, production of custard apple is 3.39 lakh MT in 40,000 ha area during 2018-19. It is developing companionably and widely in the undulating regions, squander lands and has turn out to be totally naturalized in some districts of Rajasthan, Punjab, Gujarat, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Maharashtra, Bihar, West Bengal, Assam, Tamil Nadu, Karnataka and Kerala.

USES OF CUSTARD APPLE

Custard apple is mouth-watering and highly perishable fruit through pleasant flavor, taste and good nutritive values. Unripe fruits are directly roasted on fire and eaten. When the fruit ripe, pulp becomes creamy, aromatic, pleasantly flavored with sweet taste. The fruit pulp can be use in drinks, ice-creams, confectionery, beverages and certain milk products as an ingredient and also preserved in the form of jam and jelly. As the fruit pulp is rich in vitamins, minerals and free sugars. it is known to serve as blood refresher. Custard apple leaves and seed cotyledons are found to have wide range of antifungal activity which may be helpful in developing phyto-medicinal agents for preventive conservation, especially for cultural properties, paper and allied materials etc. (Gupta et al., 2019). The seeds of *Annona squamosa* yield oil 24.5 per cent w/w basis, which is very useful for making soap and the cake can be used as manure. Custard apple seed powder and extract has insecticidal properties. Due to presence of annonaine the leaves, stem and other parts of the plants are bitter and hence are not attacked by goats or cattle. The root is drastic purgative and the leaves are used as poultice to induce suppuration. Compost produced with custard apple peel is of good quality. Custard apple can be used as a good substrate for quality vinegar production. It was found that each part of custard apple have some properties which makes it suitable for use as medical purpose. Crushed leaves of custard apple plant may be applied on hysteria, fainting spells, ulcer and wounds. Decoction with boiled leaves water is very helpful in dysentery, Prolapse of the anus, sores and swelling, in addition it is also Insecticidal and anti-plasmodic agent analgesic, anti-inflammatory, cardi tonic (Brandao and Santos, 2016) and found good for treatment of rheumatism and painful spleen. Seeds of custard apple are Grounded and macerated in water and used as Insecticide, anti-head lice, vaso-relaxant effect on rat aorta. Ripe fruits are crushed and mixed with salt and gives good remedy for tumors. Its bark is boiled and decoction with boiled water is a best treatment for tonic and halt to diarrhea. Roots of custard apple plant are good for dysentery, depression, spinal marrow diseases and other oilments.

VALUE ADDED PRODUCTS FROM CUSTARD APPLE

Under the cold storage conditions of custard apple fruits unattractive red colour develops which leads to product quality loss. Pulp of custard apple is very susceptible to spoilage either if left open in environment discoloration and fungal infections within an hour. Custard apple pulp can be store up to a year without deterioration in quality under deep freeze storage. Starting from ready to serve beverage, fresh/frozen fruit pulp, jam, jelly, fruit mix, cereal flakes, spray-dried powder and nectar with storage existence of six months were obtained from custard apple pulp. Custard

apple bagasse pulp powder blended with flour and cookies were made from this formulation. Custard apple milk shake of the composition of 90:10 for milk and custard apple pulp, Ice cream using 15 per cent custard apple pulp with equal proportion of pulp and sugar, low fat custard apple ice cream with 10 per cent fat, 15 per cent pulp, sugar in corporate with various combinations of ascorbic acid and reported that most acceptable combination was 0.3 per cent ascorbic acid. Custard apple wine was also prepared using different combinations of pulp and water from 1:1 to 1:4 with or without 0.1 per cent concentration of DAHP (di-ammonium hydrogen phosphate) and 125 ppm KMS (potassium meta sulphate). Optimized parameter for custard apple wine are 1:4 dilution, 8.14 v/v alcohol content, 1.91 per cent reducing sugar, 5.53per cent total sugars, 0.56per cent titratable acidity, 231.66 µg/ml phenols and 3.72 pH during fermentation process. Custard apple milk shake was prepared and the process optimization was performed to standardize milk and pulp proportion, microbial, physico-chemical and sensory properties. It was found that the TSS of prepared milk shake was increased from 17.4 to 24.20° Brix with increase in pulp concentration from 0 to 40 per cent and 35:65 proportion of custard apple pulp and cow milk was found optimum.

DE-PULPING OF CUSTARD APPLE

Bakane et al. (2015) evaluated the performance of custard apple de-pulping machine as shown in plate 2.1, various variables of roller speed, feeding rate and cylindrical sieves was used and reported that cylinder having inlet and outlet diameter of 213 and 177 mm respectively gives machine efficiency and minimum pulp loss as 82.50 per cent of 2.09 per cent at 257 rpm roller speed and 0.6 kg/min feeding rate.



Plate 1: Custard apple de-pulping machine developed by Bakane et al. (2015)

The maximum machine capacity was found 36.08 kg/h. Authors also suggested that as the roller speed and feeding rate increases the machine capacity and efficiency were also increases.

Nambi et al. (2017) developed an automatic pulper for custard apple fruit (plate 2.2) with a capacity of 100-120

kg/h. The machine has fruit cutting, scooping and pulping mechanisms. Performance evaluation of developed machine with different speeds of pulping shaft, inclination of pulping chamber, two types of beater and three type of pulping sieve revealed that at 600 rpm of shaft speed with inclined slotted sieve highest coarse pulp recovery has been observed with inclined slotted sieve along with 29° inclination of pulping chamber.



Plate 2: Custard apple de-pulping machine developed by Nambi et al. (2017)



Plate 3: Custard apple de-pulping machine developed by Mudgal (2020)

The Maharana Pratap University of Agriculture and Technology, Udaipur, India (Mudgal, 2020) studied the existing mechanism for de-pulping of custard apple fruit and reported to develop a de-pulping machine (Plate 2.3) with high capacity (724.61 kg/h) and segment recovery (59.55 per cent).

CONCLUSION

Custard apple is a rich source of bio chemical compounds and is found worldwide with its vernacular names and cultivar varieties. It is found that production of this fruit is very high but due to several drawbacks *i.e.* bulk availability in specific season, short shelf life, difficulty in peeling and separation of pulp and seeds put this fruit into the category of underutilized fruit. Separated pulp of custard apple provides an effective platform for industries related in fruit processing in increasing the consumption of custard apple. However, during processing and postharvest handling operations quality loss occurs. This chapter presents information about processing, value addition, storage and packaging of custard apple fruit and pulp. It is found that good processing practices and contamination free environment should be ensured during postharvest handling and storage to increase the shelf life of custard apple pulp. From several studies it can be inferred that, preservation of pulp with suitable preservative chemical *i.e.* ascorbic acid and KMS is used at temperature below -18 prolong the shelf life of pulp up to 90 days. However, the quality of stored pulp was varied among storage conditions. Therefore, advance investigations are necessary to optimize parameter without or minimum deterioration in quality. Chemical preservative agents and packaging material are needed to replace with natural eco-friendly alternatives for better health and environment. Furthermore, investigations are necessary to find varieties of custard apple and new biodegradable packaging for production of value added products of custard apple pulp like toffee, ice-cream, beverages and many more which are still to be found. Custard apple can be used as a good substrate for quality vinegar production. Custard apple bagasse pulp powder formulations can be a good alternative in waste utilization and to minimize losses of this perishable fruit.

REFERENCES

- Bakane, P. H. Khakare, M. M. Gajabe, M. H. Borkar, P. A. and Khobragade, H. M. 2015. Comparative storage study of custard apple pulp separated by machine and manual. *International Journal of Agriculture Sciences*, 7(8): 647-651.
- Brandão, A. P. and Santos, D. Y. 2016. Nutritional Value of the Pulp of Different Sugar Apple Cultivars (*Annona squamosa* L.). In *Nutritional Composition of Fruit Cultivars*, Elsevier Inc.: 195-212. <http://dx.doi.org/10.1016/B978-0-12-408117-8.00009-X>
- Gupta, S.P. Singh, M. Nigam, N. Ahmed, I. Kumar, P. and Sharma, D.N. 2019. A comparative study of antifungal activity of ethenolic leaf and seed extracts of *Annona Squamosa* L. *International Journal of Advanced Research*, 7: 111-115. <http://dx.doi.org/10.21474/IJAR01/8467>.
- Kachhadiya, S. and Jethva, K. R. 2017. Physico-Chemical Properties of Custard Apple. *International Journal of Biochemistry Research and Review*, 20(1): 1-13.

- Khodifad, B. C. and Kumar, N. 2019. Foaming properties of custard apple pulp and mathematical modelling of foam mat drying, *Journal of Food Science and Technology*, <https://doi.org/10.1007/s13197-019-04082-0>
- Kowitcharoen, L. Wongs-Aree, C. Setha, S. Komkhuntod, R. Kondo, S. and Srilaonga, V. 2018. Pre-harvest drought stress treatment improves antioxidant activity and sugar accumulation of sugar apple at harvest and during storage. *Agriculture and Natural Resources* 52: 146-154.
- Mainasara, M.M. Bakar, M.F. Mohamed, M. Linatoc, A.C. and Sabran, F. 2018. Sugar Apple - *Annona squamosa* Linn. In: *Exotic Fruits Reference Guide*. 397-402. DOI: <http://dx.doi.org/10.1016/B978-0-12-803138-4.00054-X>
- Mudgal, V. D. 2020. Development of modern processing plant for under-utilized fruits, In: *Annual progress report submitted to Indian Council of Agricultural Research (ICAR), New Delhi, India*.
- Nag, J. L. Tiwari, A. and Dikshit, S. N. 2018. Physico-chemical analysis of quality attributes in custard apple (*Annona squamosa* L.) genotypes. *International Journal of Chemical Studies*, 6(5): 810-814.
- Nair, R. and Agrawal, V. 2017. A Review on the Nutritional Quality and Medicinal Value of Custard Apple – An Under Utilised Crop of Madhya Pradesh, India. *International Journal of Current Microbiology and Applied Sciences* 6(9): 1126-1132. <https://doi.org/10.20546/ijcmas.2017.609.135>
- Nambi, V. E. Gupta, R. K. Viswakarma, R. K. and Kausik, R. A. 2017. Development of pneumatic assisted electronically controlled automatic custard apple pulper. *Agricultural Mechanization in Asia, Africa and Latin America*, 48(4): 38-44.
- Sharma, H. K. and Panesar, P. S. 2018. Processing and value addition of Custard Apple. In: *Technologies in Food Processing*. Apple Academic Press Inc., Waretown, USA.



© The Author(s)

This is an  Open Access article licensed under a Creative Commons license Attribution 4.0 International (CC-BY).