



Preparation of Custard Apple (*Annona squamosa* L.) Kulfi: A Value Addition Approach for Increasing the Income of Tribal Farmers of Bastar

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Custard apple (*Annona squamosa* L.) is an important underutilized tropical fruit crop that grows abundantly in the Bastar region of Chhattisgarh. The fruit is highly nutritious, containing carbohydrates, dietary fibre, vitamins, minerals and antioxidants. However, its short shelf life and highly perishable nature result in significant post-harvest losses, reducing the income of tribal farmers. Value addition through processing is an effective strategy to minimize these losses and improve farmers' economic returns. Among various processed products, custard apple kulfi has emerged as a promising dairy-based frozen dessert because of its pleasant flavour, creamy texture, nutritional quality and consumer acceptability. Preparation of custard apple kulfi extends the utilization period of the fruit, enhances its market value and creates opportunities for entrepreneurship among tribal farmers, women Self-Help Groups (SHGs) and rural youth. This review summarizes the production status, nutritional composition, post-harvest constraints, value-addition potential, processing technology of custard apple kulfi and its role in enhancing the livelihood of tribal farmers in Bastar. The review also highlights the need for strengthening processing infrastructure, skill development and market linkages for sustainable income generation.

Keywords: Custard apple, *Annona squamosa*, Kulfi, Value addition, Tribal farmers, Bastar, Post-harvest management and Rural entrepreneurship.

Introduction

Custard apple (*Annona squamosa* L.) belongs to the family Annonaceae and is one of the most important tropical fruit crops cultivated in India. It is widely distributed in Asia, Africa and the Americas and has adapted well to the semi-arid and dryland ecosystems of the Indian subcontinent (Nakasone, 1972, Nakasone, H.Y. and Paul, R.E. 1998) In India, the crop is commercially cultivated in Andhra Pradesh, Gujarat, Maharashtra, Karnataka, Tamil Nadu, Chhattisgarh, Madhya Pradesh, Odisha and Rajasthan. Chhattisgarh, particularly the Bastar region, possesses rich natural biodiversity of custard apple, where the fruit is collected from forests and cultivated on marginal lands by tribal farmers.

The Bastar region has immense potential for establishing village-level processing units based on locally available custard apple. Promotion of custard apple kulfi can strengthen rural entrepreneurship, support women Self-Help Groups (SHGs), reduce post-harvest losses, and increase the income of tribal farmers. Therefore, this review aims to summarize the available literature on custard apple production, nutritional importance, value addition, processing technology of custard apple kulfi and its role in improving the livelihood of tribal communities in Bastar.

Origin, Distribution and Production

Custard apple (*Annona squamosa* L.), commonly known as sugar apple or sitaphal, belongs to the family Annonaceae, which comprises approximately 109 genera and more than 2,400 species, of which only a few have commercial importance (Chatrou *et al.*, 2012). The genus *Annona* includes economically important species such as *A. squamosa*, *A. cherimola*, *A. muricata*, *A. reticulata* and *A. atemoya* (Popenoe, 1974).

The exact centre of origin of *Annona squamosa* remains a subject of scientific discussion; however, it is widely accepted that the species originated in the tropical regions of the Americas and was subsequently introduced into Asia, Africa and other tropical countries through early trade routes (Popenoe, 1974; Morton, F.J. and Miami, F.L. 1987). At present, custard apple is cultivated extensively in India, Brazil, Mexico, Thailand, Philippines, Egypt, Australia and several African countries because of its adaptability to tropical and subtropical climates (Morton, F.J. and Miami, F.L. 1987).

In India, custard apple is grown commercially in Andhra Pradesh, Maharashtra, Gujarat, Chhattisgarh, Madhya Pradesh, Karnataka, Tamil Nadu, Rajasthan, Odisha and Telangana. The crop performs well under dryland conditions and requires comparatively low agricultural inputs, making it suitable for cultivation by small and marginal farmers. According to the Third Advance Estimate (Anonymous, 2025), custard apple occupies approximately 48.26 thousand hectares in India with an annual production of about 411.22 thousand metric tonnes.

Chhattisgarh is one of the important custard apple-producing states due to its vast forest area and favorable agro-climatic conditions. According to the Directorate of Horticulture and Farm Forestry, Government of Chhattisgarh (Anonymous, 2024–25), custard apple is cultivated on approximately 9.63 thousand hectares with an annual production of 53.72 thousand metric tonnes. Bastar district contributes significantly to the state's production, with approximately 0.109 thousand hectares under cultivation and an annual production of about 0.273 thousand metric tonnes. In addition to cultivated orchards, naturally occurring custard apple populations are widely distributed throughout the forests of Bastar, providing seasonal employment and supplementary income to tribal communities.

The abundant availability of wild and cultivated custard apple in Bastar offers tremendous opportunities for value addition through processing into products such as pulp, beverages, ice cream and kulfi. Development of village-level processing enterprises can reduce post-harvest losses, improve market utilization and enhance the income of tribal farmers.

Nutritional Importance

Custard apple (*Annona squamosa* L.) pulp is highly nutritious and contains approximately 70–75 % moisture, 23.5–25.2 g carbohydrates, 1.6–2.1 g protein, 0.3–0.6 g fat, 2.0–3.1 g dietary fiber and 0.7–1.0 g ash per 100 g edible portion. It is also a good source of essential minerals, containing about 17–24 mg calcium, 21–47 mg phosphorus, 0.4–1.5 mg iron, 247–382 mg potassium and 18–23 mg magnesium per 100 g pulp. The fruit contains 15–44 mg vitamin C, 0.07–0.10 mg thiamine (vitamin B₁), 0.05–0.14 mg riboflavin (vitamin B₂) and 0.5–1.0 mg niacin (vitamin B₃) per 100 g edible portion. The edible pulp also contains 12.4–18.2 % total sugars and provides approximately 94–105 kcal of energy per 100 g. In addition, custard apple is rich in natural phenolic compounds and antioxidants, which contribute to its nutritional and functional properties. Owing to its balanced nutritional composition, the fruit is highly suitable for the preparation of dairy-based value-added products such as kulfi, ice cream, yoghurt and flavoured milk beverages (Morton, F.J. and Miami, F.L. 1987; Pareek, 2016).

Post-Harvest Losses

Custard apple (*Annona squamosa* L.) is a highly perishable climacteric fruit with a shelf life of about 3–5 days under ambient conditions. Post-harvest losses, estimated at 20–40 % are mainly caused by rapid ripening, mechanical injury, moisture loss and microbial spoilage.

Proper harvesting, packaging, storage and value addition can reduce these losses and improve farmers' income. (Kader, A. A. 2002 and Pareek, S. 2016).

Value Addition

Value addition through processing is an effective strategy to minimize post-harvest losses and enhance the economic value of custard apple (*Annona squamosa* L.). Owing to its highly perishable nature, the fruit is processed into a variety of products such as frozen pulp, nectar, juice, jam, squash, ice cream, kulfi, yoghurt, and bakery products. Under appropriate processing and storage conditions, frozen custard apple pulp can be preserved for 6–12 months at -18°C , while jam and squash remain stable for approximately 9–12 months and 6–9 months, respectively, at ambient temperature. Custard apple nectar and juice generally have a shelf life of 2–6 months and 1–3 months, respectively, depending on processing and packaging. Frozen products such as ice cream and kulfi can be stored for about 2–4 months and 2–3 months, respectively, at -18°C , whereas custard apple yoghurt remains acceptable for 14–21 days under refrigeration (4°C). Bakery products prepared with custard apple pulp are generally suitable for consumption for 3–7 days at ambient conditions. These value-added products improve shelf life, reduce post-harvest losses increase consumer acceptability and provide higher returns to farmers and food-processing industries (Pareek, 2016, Marshall *et al.*, 2013, Tamime A.Y. 2009 and FSSAI, 2021). Processing also enhances marketability, creates employment opportunities, and increases income for tribal and smallholder farmers by utilizing surplus fruits that would otherwise be wasted (Pareek, 2016, Kader, 2002 and FAO, 2022).

Custard Apple Kulfi

Kulfi is a traditional Indian frozen dairy dessert prepared by concentrating milk and incorporating sugar and flavouring ingredients (Aneja *et al.*, 2002). Incorporation of custard apple pulp improves the flavour, nutritional quality, colour and overall acceptability of kulfi. Custard apple kulfi is a nutritious frozen dairy dessert prepared by blending concentrated milk with custard apple (*Annona squamosa* L.) pulp, sugar and a stabilizer. Fresh, ripe custard apples are washed, peeled and deseeded to obtain the pulp. Full-cream milk is heated and concentrated to about 60–70 % of its original volume, after which sugar (10–15 %) is added and dissolved completely. The mixture is cooled to approximately $35\text{--}40^{\circ}\text{C}$ and custard apple pulp (15–25 %) is incorporated with continuous stirring. A stabilizer such as carboxymethyl cellulose (CMC) (0.2–0.5 %) may be added to improve texture and reduce ice crystal formation. The mix is homogenized, poured into kulfi moulds and frozen at -18°C until a firm product is obtained.

Custard apple kulfi is valued for its pleasant flavour and high nutritional quality. Depending on the formulation, 100 g of custard apple kulfi contains approximately 180-230 kcal of energy, 4-6 g protein, 8-12 g fat, 20-28 g carbohydrates, 0.5-2.0 g dietary fibre, 80-180 mg calcium, 90-160 mg potassium, 0.2-0.5 mg iron and 5-15 mg vitamin C. The addition of custard apple pulp also contributes natural antioxidants, minerals and dietary fibre, thereby improving the nutritional profile compared with plain kulfi. When stored hygienically in airtight moulds or food-grade containers at -18°C , custard apple kulfi generally remains acceptable for 2-3 months without significant deterioration in sensory quality. However, once thawed, it should not be refrozen and should be consumed immediately to maintain its quality and ensure food safety. (Pareek, S. 2016, Marshall, *et al.* 2013, FSSAI, 2021 and Tamime, A. Y. 2009).

Yadav *et al.* (2010), Pawar *et al.* (2011), Wagh (2011) and Makwana *et al.* (2018) reported that approximately 15 % custard apple pulp produced superior sensory quality and consumer acceptance in frozen dairy products.

Scope for Tribal Farmers of Bastar

Value addition through custard apple kulfi can substantially enhance farmers' income by reducing post-harvest losses and increasing the market value of the fruit. Village-level

processing units can generate employment for rural youth and women Self-Help Groups while strengthening Farmer Producer Organizations (FPOs). Government support through training, processing infrastructure, branding, and market linkage can further improve the commercialization of custard apple-based products in Bastar. Value addition through the preparation of products custard apple kulfi, offers significant opportunities for tribal farmers. Processing not only minimizes post-harvest losses but also increases product shelf life, improves market value and enables year-round marketing. Frozen products such as custard apple pulp and kulfi can be stored under appropriate conditions, allowing farmers and entrepreneurs to sell them beyond the harvesting season and obtain better prices.

The establishment of small-scale processing units, self-help groups (SHGs), farmer producer organizations (FPOs) and rural food-processing enterprises can generate employment, especially for tribal women and rural youth. Skill development, access to cold storage, improved packaging and support through government schemes such as PM Formalization of Micro Food Processing Enterprises (PMFME), National Horticulture Mission (NHM) and Tribal Cooperative Marketing Development Federation of India (TRIFED) can further strengthen value addition and market linkages. Development of branded custard apple products, including kulfi, also has the potential to promote agro-tourism and regional identity in Bastar. Thus value addition of custard apple represents a sustainable approach to reducing post-harvest losses, increasing farmers' income, creating rural employment and supporting the socio-economic development of tribal communities in Bastar.

Conclusion

Custard apple is a nutritionally rich but underutilized fruit with significant potential for value addition. Preparation of custard apple kulfi represents a simple, economical and consumer-acceptable technology that can effectively reduce post-harvest losses while increasing the economic value of the fruit. Promotion of this technology among tribal farmers in Bastar can generate additional income, create employment opportunities, encourage rural entrepreneurship, and support sustainable livelihood development. Future research should focus on product standardization, shelf-life extension, nutritional evaluation and commercialization strategies to maximize the benefits of custard apple value addition.

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