Review Paper on Jackfruit

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Jackfruit is an exotic fruit grown in tropical regions of the world. It is native to South India. Jackfruit (*Artocarpus heterophyllus*) is a species of tree of the mulberry family (Moraceae) is known by other names like Kathal, Panas (Hindi), Kanthal (Beng.), Palaa (Tamil), Phanas (Gujarat) and Chakka (Malayalam). Jackfruit has a spiky outer skin and is green or yellow in color. It is native to Western Ghats of India, Malaysia and also found in central and eastern Africa, south-eastern Asia, the Caribbean, Florida, Brazil, Australia, Puerto Rico and many Pacific Islands. It is a large, evergreen tree, 10-15m in height, indigenous to the evergreen forests and cultivated throughout the hotter parts of India.

Jackfruit (*Artocarpus heterophyllus* Lam) produces heavier yield than any other tree species, and bear the largest known edible fruit (up to 35 kg). The jackfruit tree has several uses. Flakes of ripe fruits are high in nutritive value; every 100 g of ripe flakes contains 287-323 mg potassium, 30.0-73.2 mg calcium and 11-19 g carbohydrates. In Bangladesh, it is commonly referred to as "poor man's food" as it is cheap and plentiful during the season. The nutritious seeds are boiled or roasted and eaten like chestnuts, added to flour for baking, or cooked in dishes.

Taxonomical classification

Kingdom: Plantae - planta, plantes, plants, vegetal
Subkingdom: Tracheobionta - vascular plants
Division: Magnoliophyta - angiosperms, flowering plants, phanerogames
Class: Magnoliopsida - dicots, dicotyledones, dicotyledons
Subclass: Hamamelidae
Order: Urticales
Family: Moraceae - mulberries
Genus: Artocarpus - breadfruit
Species: Artocaipus heterophyllus Lam.

Morphology

Size and form

Jackfruit is a medium size, evergreen tree that typically attains a height of 8-25 m (26-82 ft) and a stem diameter of 30-80 cm (12-32 in). The canopy shape is usually conical or pyramidal in young trees and becomes spreading and domed in older trees. The tree casts a very dense shade. Heavy side branching usually begins near the ground. All parts of the tree exude sticky white latex when injured.

Fruit

Jackfruit has a compound or multiple fruit (syncarp) with a green to yellow brown exterior rind that is composed of hexagonal, bluntly conical carpel apices that cover a thick, rubbery, whitish to yellowish wall. The acid to sweetish (when ripe) banana flavored flesh (aril) surrounds each seed. The heavy fruit is held together by a central fibrous core. Fruits are oblong cylindrical in shape, typically 30-40 cm (12-16 in) in length.

Seeds

Seeds are light brown, rounded, 2-3 cm (0.8-1.2 in) in length by 1-1.5 cm (0.4-0.6 in) in diameter, and enclosed in a thin, whitish membrane. Up to 500 seeds can be found in each fruit. Seeds are recalcitrant and can be stored up to a month in cool, humid conditions.

Pharmacological uses of jackfruit tree

Antioxidant effects

Ethanolic extract of the defatted jackfruit seed and the pulp shown to be effective in ABTS and FRAP assays (Soong & Barlow, 2004). Ethanolic extract of the dried mature fruits scavenged DPPH radicals in vitro (Soubir, 2007). The methanolic, ethanolic, acetone and aqueous extracts of ripe pulp shown to possess free radical scavenging effects in DPPH, FRAP, DMPD assays (Jagtap et al., 2010). Cycloheterophyllin and artonins A and artonins B also inhibited the copper-catalyzed oxidation of human low-density lipoprotein, iron-induced lipid peroxidation in rat brain homogenate, scavenged the DPPH radicals, the peroxyl radicals and hydroxyl radicals (Ko et al., 1998).

Anti-inflammatory effect

Cycloheterohyllin, artonins B, and artocarpanone inhibited the superoxide anion formation in fMLP-stimulated rat neutrophils (Wei et al., 2005). Dihydroisocycloartomunin inhibited release of beta glucuronidase and histamine from rat peritoneal mast cells stimulated with P-methoxy-N methylphenethylamine (Wei et al., 2005). Artocarpanone inhibited the release of lysozyme from rat neutrophils stimulated with formyl-Met-Leu-Phe. Artocarpanone inhibited LPS-stimulated production of NO and expression of iNOS in RAW 264.7 cells (Wei et al., 2005). Artocarpesin, norartocarpetin and oxyresveratrol isolated from the fruits caused a dose dependent decrease in the production of LPS-induced production of nitric oxide in vitro (Fang et al., 2008). Artocarpesin was effective in inhibiting the production of prostaglandin E2 (PGE2), reactive oxygen species and to decrease the levels of cyclooxygenase 2 (COX-2) and inducible nitric oxide synthase (iNOS) protein expression in the LPS-stimulated RAW 264.7 cells (Fang et al., 2008). Protease fraction and artocarpain also possess anti-inflammatory effects in carrageenan induced rat paw oedema and Cotton pellet-induced granuloma model (Chanda et al., 2009).

Antibacterial effects

The methanolic extracts of stem, root, barks, heart wood, leaves, fruits and seeds as well as their various fractions evaluated for antibacterial effects. The butanol fractions of the root bark and fruits were most effective (Khan et al., 2003). The aqueous extract as well the aqueous and ethyl acetate fraction of jackfruit leaves studied for the antibacterial effects by the agar diffusion and broth dilution methods. The activity varied from organism (Loizzo et al., 2010). The ethanolic and methanolic extracts of the jackfruit seed powder were observed to be effective on multidrug resistant Methicillin resistant *Staphylococcus aureus* (Karthy et al., 2009).

Anticariogenic effects

Methanolic extract of the leaves and the phytochemicals artocarpin and artocarpesin, possess inhibitory effects on the primary cariogenic bacteria in vitro (Sato et al., 1996).

Antifungal activity

The extract of the jackfruit leaf shown to be ineffective (Khan et al., 2003). However, the chitin-binding lectin present in the seeds (denoted as jackin) is reported to inhibit growth of *Fusarium moniliforme* and *Saccharomyces cerevisiae* (Trindade et al., 2006)

Wound healing

The ethanol extract of dried leaves and its various fractions (petroleum ether, butanol, butanone and methanol) possess wound healing effects in rats. The methanol fraction was observed to possess the best effect (Patil, Jadhav, and Joshi, 2005)

Jackfruit cultivation in India

Jackfruit (Artocarpus heterophyllus Lam.) is native to India and grows wild in the rain forests of Western Ghats of India (Reddy, Patil, Shashikumar, and Govindaraju, 2004). Jackfruit grows in many parts of Asia but is abundant in India and Bangladesh. Its distribution is continuous on the western coast of India with high rainfall up to Konkan and sporadic in the areas with low rainfall. In Western Ghats, it is found up to 1500 m and has tremendous diversity (Muralidharan, Ganapathy, Velayudhan, and Amalraj, 1997).

In India, the fruit is popular in the eastern and southern parts. Flakes of ripe fruits are rich in nutritive value, containing 18.9 g carbohydrates, 0.8 g minerals, and 30 IU vitamin A and 0.25 mg thiamine for every hundred grammes (Samaddar, 1985).

Jackfruit application in food industry

Jackfruit seed as a substrate supplement for production of edible pigments

Jackfruit seed as a substrate supplemented with carbon sources like mannitol, lactose, starch and fructose and nitrogen sources like yeast extract, peptone, ammonium sulphate and ammonium nitrate to produce pigments by *Monascus purpureus* in solid-state fermentation (SSF).

The interest in red pigments produced by *Monascus spp.* for use in the food industry has been mounting given the flexibility in production and easy down streaming process. *Monascus* is reported to produce non-toxic pigments, which can be used as food colorant. Besides to adding color, it enhances the flavor of the food and acts a food preservative. The use of jackfruit seeds for substrate is cost-effective as well as environment friendly.

Jackfruit seed starch and its application as a thickener and stabilizer in chilli sauce

Rengsutthi *et al.,* (2010) stated that jackfruit seed starch (JFSS) is suitable as a thickener and stabilizer in chilli sauce because chilli sauce with JFSS had the lowest serum separation and highest viscosity during storage compared with control chilli sauce and sauce containing cornstarch (CS). In addition, sensory evaluation demonstrated that chilli sauce containing JFSS received the highest score in terms of color, mouth feel, homogeneity and overall quality.

Agro-industrial potential of jackfruit byproducts as a source of food additives

The entire body of Jackruits is rich in bioactive compounds, such as phenolic constituents, carotenoids, vitamins, and dietary fiber. However, the fruit processing industry deals with the large percentage of byproducts, such as peels, seeds, and unused flesh, generated in the different steps of the processing chains.

Soong and Barlow (2004), evaluated the antioxidant capacity and phenolic contents of seed and pulp of jackfruit, using ABTS (2,2-azinobis-3-ethylbenzothiazoline-6-sulfonic acid), FRAP (ferric-reducing antioxidant power) and FCR (Folin–Ciocalteu reagent) methods. This study showed that the seeds of this fruit had a higher antioxidant capacity and phenolic content than the pulp. The ABTS, FRAP and FCR values for the seeds of jackfruit were 7.4 µmol of ascorbic acid/g; 2.8 µmol of gallic acid equivalents/g and 27.2 mg of gallic acid equivalents/g, respectively. The ABTS, FRAP and FCR values for the pulp of jackfruit were: 3.0 µmol of ascorbic acid/ g; 6.8 µmol of gallic acid equivalents/g and 0.90 mg of gallic acid equivalents/g, respectively.

Value added products from jackfruit bulbs

The bulbs of jackfruit possess a desirable texture and a rich appetizing taste. The Pulp of ripe jackfruit can be eaten fresh, made into various local delicacies including chutney, jam, jelly or can be preserved as candies and fruit leather among others (Crane, 2005 and ICUC, 2003). The potentiality of some of the processed product from jackfruit bulb is reviewed below.

Jackfruit Jam and Jelly

The increasing demand for dietary compounds with antioxidant action has focused interest on fruits as natural sources of these compounds, but also fruit products, such as jams, can be good source of biologically active compounds with considerable antioxidant potential (Wicklund et al., 2005; Kim and Padilla-Zaokur,

2004; Amakura et al., 2000).

Appreciable amounts of pectins are found in all parts of jackfruit. The pectin content (as % calcium pectate) is 3.2 - 5.8 in bulbs, 1.02-2.66 in aborted flowers (fleshy ribbon like structure), 3.06-4.6 in seeds, 2.86-3.64 in rind and 1.95-2.23 in cores (Haq, 2006) Low ester pectins can form into gels in the presence of a small quantities of divalent ions (Vilasachandran et al., 1982).

Jackfruit leather

Fruit leathers are pectic gels obtained by dehydrating fruit purees to produce restructured, attractive flexible sheets which retain shape and are eaten as snack or dessert. These products add variety to a healthy diet and possess dietary fibre, vitamins and minerals while providing a good energy intake (Natalia *et al.*, 2012). Various earlier studies described the technique for processing of fruit leather.

Jackfruit toffee

The confectionery products are highly popular among the children throughout the world due to their taste and flavor. Toffee is one of the sugar-based products which is largely consumed by the children. The conventional toffees are generally made from sugar, skim milk powder and other synthetic colors and flavors. Jackfruit pulp incorporated toffee was prepared successfully by GRAMA, a Non-Government Organization of Bharananganam (India) (APPARI, 2012).

Other jackfruit products

CFTRI (1977) standardized nectar from jackfruit pulp. Jackfruit nectar was standardized successfully from the two popular varieties of jackfruit available in Kerala individually and by blending with other fruit pulp.

TFnet (International Tropical Fruit Network) reported about the processing methods for some jackfruit value added products like canned jackfruit slices, jackfruit cordials, frozen jackfruit and vacuum fried jackfruits.

Datta and Biswas (1972) described the process for making vinegar from fruit juice. They mentioned that jackfruit vinegar recovered from the ripe fruits yielded 7 % alcohol and 6 per cent acetic acid upon fermentation. Moreover, Khader (1999) standardized a method for preparation of vinegar from jackfruit. The vinegar processed in this standardized process found to have a shelf life of one year.

Sharma *et al.* (2012) optimized the fermentation process for making jackfruit wine. Various studies had successfully attempted to standardize the process ofmaking jackfruit finger chips. Kotoky *et al.* (2014) studied the quality attributes of chips prepared from jackfruits of

different maturity stages and reported that unripe mature jackfruit (140 days from fruit setting) was found to be superior for processing of jackfruit finger chips. The chips prepared from this maturity stage was best in terms of colour, taste, appearance and crispness.

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