Jackfruit (Artocarpus heterophyllus Lam) is the largest borne tree fruit in the world. It is originated from India. Climate required for growing jackfruit is tropical and subtropical. It is indigenous food crop. Humid and hot region suitable for growth of this tree. It is not tolerate cold and higher altitude also frost and drought. Jackfruit contains some vitamins like vitamin A, vitamin C, thiamine and riboflavin also some minerals like calcium, potassium, iron, sodium, zinc, niacin and many other nutrient. Jackfruit contain antioxidant which help in prevention from free radicals. It contain potassium and calcium so it regulate the blood pressure and beneficial to bones growth. It also helpful as anti-inflammatory, antibacterial, anticariogenic, antifungal and in inhibition of melanin biosynthesis, wound healing effects. The jackfruit peels utilization only 10 % for food applications that is pectin extraction. While 90% is for non-edible applications of biofilm, biosorbent, biohydrogen, and activated carbon. It contains phytonutrients like lignans, isoflavones and saponins, their health benefits are wide-ranging from anticancer to antihypertensive, antiaging, antioxidant and antiulcer. Protein, dietary fibre and carbohydrate contents of jackfruit seeds is 13.50%, 3.19% and 79.34%, respectively. The jackfruit seed has been utilized for processing like flour for bakery, extruded products, chapaties, starch extraction and confectionary. Application of jackfruit seeds in medicines, seeds are believed to be helpful in digestion.

**Key words**: Health benefits, Indigenous, Jackfruit, Phytonutrients, Seed flour


Jackfruit (Artocarpus heterophyllus Lam) is the largest borne tree fruit in the world. The *Artocarpus* consists of 50 species of large to small evergreen trees and is originated from South Asia, like *Artocarpus* include A. altulis (Breadfruit), A. integer (Chempedak), A. heterophyllus (Jackfruit), A. hypargyreus, A. lakoocha, A. kemando, A. hirsutus, A. chaplasha, A. Odoratissimus (Tang et al., 2013). The name derives from the Greek words ‘artos’ means bread and ‘karpos’ means fruit this fruit are commonly called breadfruit. The name, ‘heterophyllus’, in Latin, means leaves of different sizes and shapes. The word jackfruit comes from Portuguese Jaca, which convert into Chaka from Malayalam Language (Sreeletha et al., 2017). The family of jackfruit is Moraceae and commonly known as ‘Kathal’. Jackfruit is native from India, but it is National fruit of Bangladesh. Jackfruit is grown all over in Bangladesh, But mainly in Jaishtha and Ashar month (Saha et al., 2016). Bangladesh produces 925965 tons of jackfruit per year in area of 9977 hectares at the rate of 92.81 tons per hectares, it produces throughout the country (Goswami et al., 2011). Jackfruit tree can reach upto 80 feet in height. The jackfruit tree produces a long taproot. All taproots produces milky and sticky latex. The jackfruit flowers are borne on short shoots, both male and female flowers present on the aged branches. The
thick, rubbery rind has short, blunt spines and the one fruit can have up to 500 seeds. It is originated in the forests of the Western Ghats (India). But nowadays, it is largely grown in Bangladesh, Burma, Malaysia, Indonesia, Philippines, Thailand, Sri Lanka, Brazil and in some part of Australia (Hossain et al., 2014). India is the second biggest producer of this jackfruit and as like motherland of jackfruit. It is believed that jackfruit is originated from the rainforests of Western Ghats of India and is cultivated throughout the low lands in South and Southeast Asia (Kumari and Divakar, 2017). In India total sector under jack fruit cultivation is around 32,600 ha and jack tree is mostly grown in south Indian states viz., Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, besides in other states like Assam, Bihar, Orissa, Maharashtra and West Bengal. In only Karnataka, jack fruit is grown on an area of 10,004 ha with a production of 2,42,296 tonnes per year (Butool and Butool, 2013).

Climate and soil requirement for jackfruit is quite different from other. It was cultivated from 3,000-6,000 years ago in India. Climate required for growing jackfruit is tropical and subtropical. Humid and hot region suitable for growth of this tree. It is not tolerate cold and higher altitude also frost and drought. Jack tree mostly grown in forest and on hill slope. The jackfruit can be grown on different varieties of soil as like well drained or deep alluvial soils open texture. For Jack tree pH of soil is 5.0 to 7.5. It requires free drainage. Jackfruit also tolerates shallow, slightly saline, and infertile soils. (Tejpal and Amrit, 2016). The tree grows well in the Pacific oceans. It is area of the tropical moist (rainforest) to semi- dry forest. It also grows environments with a continuous rainfall pattern, although it grows in seasonally dry climates (Craig and Harley, 2006).

Chemical composition of Jackfruit:
Jackfruit is indigenous food crop, it contains some vitamins like vitamin A, vitamin C, thiamine, riboflavin also some minerals like calcium, potassium, iron, sodium, zinc, and niacin also many other nutrients. Jackfruit has a very low calories content that is 100 g of jackfruit contains only 94 calories. Besides jackfruit is a rich source of potassium with 303 mg found in 100 g of jackfruit. According to study food rich in potassium helps to lower blood pressure (Swami et al., 2012). On the past study jackfruit contains many compounds like carotenoids, õavanoids, volatile acids, sterols and tannins, and their different concentration depend on varieties and climates. Carotenoids imparts yellowish-red colour to many fruits and their yellow to orange shades present in jackfruit after fully ripening (Baliga et al., 2011). Jack fruit is a highly nutritious seasonal food, which is known as poor man’s food in south East Asia. Edible bulb of jack fruit after fully ripening is rich in carbohydrate, protein, fibre, calcium, phosphorus, besides Fructose, glucose and sucrose are the major sugars present in jack fruit. Some major fatty acids found in jackfruit are palmitic, oleic, stearic, linoleic, lauric, arachidic (Hari et al., 2014). Jackfruit contains phytonutrients like lignans, õavanones, and saponins that shows some health benefits that are wide ranging from antiulcer, antibacterial, antioxidant, anti-inflammatory and antihypertensive (Swami et al., 2012). The unripe and ripe edible parts of jackfruits have good amount of phenolic acids and this have importance in human health (Singh et al., 2015).

Health benefits of jackfruit:
Jackfruit contain antioxidant which help in prevention from free radicals (Abraham and Jayamuthunagai, 2014). Jackfruit have integrity of maintaining skin and mucosa because in which vitamin A is present. Jackfruit cures anemia by iron which is present per 100 g contain 0.60 mg. jackfruit also beneficial in typical hair growth. The fully mature jackfruit contain fructose and sucrose sugar in quantity of 19.8 g per 100 g edible bulb which provides 95 calories, also this have high contain of dietary fibre which help in digestion. It contain potassium and calcium so it regulate the blood pressure and benefial to bones growth (Tejpal and Amrit, 2016). Jackfruit have antioxidant properties that plays role to cure the some human disorder and improving health problem (Swami et al., 2012). It also helpful in anti-inflammamatory effect, antibacterial effects, anticariogenic activity, antifungal activity, inhibition of melanin biosynthesis, wound healing effects (Baliga et al., 2011).

Present utilization of jackfruit:
Jackfruit is commonly used as food all over world. In Bangladesh immature fruit used for curry preparation. In Florida ice creams, jam, jelly is prepared by using ripe jackfruit pulp and also preparation of sweet curry and fruit salads. The immature jack fruit is a popular vegetable and soups, pickles also making from it. Ripe...
Jackfruit is a large tropical fruit that is native to India. It is known for its unique texture and distinctive flavor. Jackfruit seeds are an important part of the fruit and are used in various ways.

**Chemical composition of jackfruit seeds:**

Jackfruit seeds contain starch is 22% and dietary fiber 18.7%. The seeds contain high amounts of protein, fiber, and fat, also containing vitamins and minerals such as calcium, iron, and potassium. The seeds are high in antioxidants and have antihypertensive properties.

**Health benefits of jackfruit seeds:**

Jackfruit seeds are known for their health benefits, which include:

- **Antioxidant properties:** Jackfruit seeds are high in antioxidants, which help protect the body from damage caused by free radicals.
- **Antihypertensive properties:** The seeds contain compounds that help lower blood pressure.
- **Anti-inflammatory properties:** The seeds contain substances that reduce inflammation in the body.
- **Protected from cellular damage:** The phytochemicals in the seeds work as excellent scavengers of free radicals, protecting the body from cellular damage.

**Processing technologies & applications:**

Jackfruit seeds can be processed into flour, which can be used in various applications such as confectionary products, bread, and snacks. The flour can also be used as an alternative to wheat flour in baking.
As a cooling as well as a nutritious tonic (Swami et al., 2012). For good hair growth jackfruit seeds are very beneficial besides healthy blood circulations and also healthy digestion. High amount of starch, low in calcium and iron and very good source of vitamin B2 (Arpit and John, 2015). A class of glycoprotein that is lectin present in jackfruit seeds which shows some antibacterial, antifungal and anticarcinogenic properties (Chowdhury et al., 2012). Dietary fibre present in jackfruit in high amount, which makes it an excellent bulk laxative. Fibre have ability to protect the colon mucous membrane by reducing exposure time and also binding to cancer-causing chemicals in the colon (Mondal et al., 2013). This seeds are also helpful in bone health because rich in magnesium which is an essential mineral necessary in absorption of calcium and works along with calcium for strengthening the bones and prevents disease like Osteoporosis (Maurya, 2016).

Processing technology of jackfruit seeds:

After ripening of the fruit, processing is done on seeds in jackfruit growing area. The fruit is opened with knife, seeds are separated from the bulb that embedded in fruit. Every fruit contains about 100–500 seed, there is no relation between fruit size and the quantity of seeds that fruit contains. There are about 50–90 seeds/kg of fruit. The thin, slimy coating of bulb around the seed which should be removed and thoroughly rinsed in water to remove any remaining pulp juice or sugary residue. Seeds when shade dried for an hour for handling its slimy layer get removed but should not dried more time in open place because may be loss of nutrients (Craig and Harley, 2006). The jackfruit seed has been utilized for processing more than the peel. Nowadays the extensive processing of jackfruit seeds is done and it is becoming new trend to utilize the jackfruit seeds for various purposes. About 75% of the Jackfruit seeds are converted into flour (Cheok et al., 2016). For processing of seeds into flour, the seeds are first sorted and then cleaned. Cleaning is followed by roasting, roasting is done at appropriate temperature, when roasting is done at 160°C then good retention of nutrients like protein, minerals due to reduction of moisture content. The roasted seeds are then dried in tray drier or in cabinet drier and milling in flour mill. Flour is also prepared as it is after drying (Eke-Ejiofor et al., 2014). Flour of jackfruit seeds is used in bakery, extruded products, confectionary, chapatti making and as a baby food.

The jackfruit seeds are also processed for extraction of starch which is used as binding agent. Starch extraction is done by soaking and subjecting the seeds to enzymatic treatment. pH is maintained at 6.0 then this mixture is filtered by 212 mesh sieve. Remaining filter cake is washed by using distilled water. The filtrate is mixed and precipitated overnight at 4°C. The supernatant is discarded and then by using distilled water crude starch is cleaned. This step is done three times and the starch cake was dried at 40°C for 24 h in oven dryer, then grinding is done. The ground starch is packed in a plastic bag and kept at room temperature for further use (Noor et al., 2014). After fully ripening jackfruit quality like colour, texture, aroma, sweetness, taste improved so, it produces high quality juice which is nutritious so, processing of this is done for juice extraction (Sim et al., 2003). Jackfruit seed is used for preparation of raw jackfruit meal by grinding with coffee meal. Jackfruit is also used for preparation of boiled jackfruit seed meal, by boiling seeds in coffee meal this processing is done in Mexico (Jose et al., 2017). Today processing done for making seed flour by using different treatment like boiling, roasting, dried seeds flour (Eke-Ejiofor et al., 2014).

Applications:

The jackfruit seed have higher nutrition content so nowadays it is used in bakery products like bread by using 10 and 20% jackfruit seed flour with wheat flour for reducing gluten content and for digestion aid (Butool and Butool, 2013). Cake making also done by incorporation of jackfruit seed flour 5 to 15% and result is increase protein and reduction in fat content (Arpit et al., 2015). Extruded product also prepared by using jackfruit seed flour like noodles, upto 20% seed flour is incorporate in it and its protein and dietary fibres increased (Nandkule et al., 2015). Jackfruit seed flour, upto 25 per cent level, can also be utilized in chapatti preparation. Addition of preservatives in such chapatti extends its shelf life upto 3 to 4 days for ambient and upto 30 days at refrigeration temperature (Sultana et al., 2014). Also seeds are used in starch extraction starch was isolated from the flour because its amylose content is high, also it shows good paste stability during heating (Tulyathan et al., 2002).

Nowadays jackfruit seed is used as a nut by roasting. When roasting is done at 160°C for an hour then due to
Jackfruit seed flour: Processing technologies & applications

reduction in moisture content protein, carbohydrates and minerals are increased and beside reduction in fat content also fat absorption capacity get reduced, hence these days roasted nuts are famous in jackfruit growing area (Eke-Ejiofor et al., 2014). This gluten-free seed flour can be used as a substitute to wheat flour for the persons suffering from specific food allergies. Jackfruit seeds are used for preparation of thousands of value-added products. The jackfruit seed flour can also be used in South Indian recipe as a milled flour in dosa, dhokla, idli preparation with rice flour. The seeds of jackfruit can be used as table nuts after salting. The seeds can also be utilized as brine seeds alone. The breakfast cereals could be prepared by using jackfruit seed flour of different composition in which jackfruit seed flour, soy flour, sugar, milk powder, cocoa powder and salt is used. Chakraborty et al. (2013) developed such products in which all ingredients, except the soy flour were mixed together in same amount and moisture was adjusted at 5-6%. This mixture was allowed to pass through a 100 mesh screen. Soy flour was added after moisture adjustment and sieving. After mixing storing (for conditioning) them in food grade poly bags for 30 minutes. After conditioning, the ingredients were added in the twin-screw extruder and Extruded products were collected, cooled and stored, by using this process breakfast cereals are prepared.

Conclusion:

India is the second biggest producer of jackfruit and also called motherland of jackfruit, after Bangladesh. Jackfruit is very nutritious fruit and reported to possess many health benefits. The fruit is considered as one of the low calorie fruits. The jackfruit seeds were considered as waste part after utilization of jackfruit. However, it has been found that the jackfruit seeds also contain many phytonutrients. The seed portion of jackfruit constitute about 10-12 per cent. These seeds can be processed and utilized for various purposes. The seeds can be simply milled into flour after drying. The flour of jackfruit seeds prepared by roasting result increased nutritive value due to reduction in moisture content. The seed flour found to possess applications in bakery (bread, cookies, and cake), extruded (snacks, noodles, breakfast cereals) products, as a baby foods. These seeds could also be utilized for starch extraction also.

Authors’ affiliations:
Hanuman Bohade and Sachin Patil, Department of Agricultural Engineering, Maharashtra Institute of Technology, Aurangabad (M.S.) India

REFERENCES


