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Jackfruit seed flour: Processing technologies and applications

■ **Prajakta Mandave, Hanuman Bobade and Sachin Patil**

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See end of the Paper for authors' affiliation

Correspondence to :

Prajakta Mandave
Department of Agricultural Engineering, Maharashtra Institute of Technology, Aurangabad (M.S.) India

■ **Abstract :** Jackfruit (*Artocarpus heterophyllus* Lam) is the largest produced 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 riboûavin 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-inûammatory, 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 bioûlm, biosorbent, biohydrogen, and activated carbon. It contains phytonutrients like lignans, isoûavones and saponins, their health beneûts 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

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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. altilis (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 hectors, 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 upto 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 :

Jackfruitis indigenous food crop, it contains some vitamins like vitamin A, vitamin C, thiamine, riboûavin 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, ûavanoids, 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, isoûavones, and saponins that shows some health beneûts 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 benefial 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-inûammatory 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

bulb is canned with sugar syrup in Thailand and Vietnam. In Malaysia, jackfruit juice used in drink like lassi and mostly used in rice dishes, salads, mixed with shrimps. In Indonesia ripe jackfruit used as dessert in toppings of icecreams. In Philippines unripe fruit is mostly cooked in coconut milk and eaten together with rice. Now-a-days jackfruit seeds are grounded in flour and used mainly in bakery products. In Srilanka jackfruit is used in a wine and pickles making (Tejpal and Amrit, 2016). From ripe and unripe pulp chips and papads prepared in jackfruit growing area (Butool and Butool, 2013). The jackfruit peels utilization only 10 % for food applications that is pectin extraction for jam, jellies and for other confectionary product. While 90% is for non-edible applications of bioûlm, biosorbent, biohydrogen, and activated carbon (Cheok *et al*., 2016).

In India, use of this fruit is in more quantity in west Bengal, fruits are eaten after maturity as like table fruit, besides juice extracted and used as drink. In Karnataka, pulp of this is used for burfi and natural chewy candy making also jackfruit bulb is used to make fried chips (Tejpal and Amrit, 2016). The unripe jackfruit is used in curry dishes for making spicy food by replacing meat (Islam *et al*., 2015). Leaves and non-pulpy parts are used for feedings to animals (Baliga *et al*., 2011). The poor people used this fruit with rice, for one time in a day. Hence, Jackfruit is called "poor man's food in jackfruit growing area (Saha *et al*., 2016). In Karnataka, many products develop from jackfruit that are candy, finger chips, fruit bars, fruit leather, halvah, papad, ready to-serve beverages, toffee and milk-based srikhand, icecream, and kulû. Immature bulbs can be processed into bulb powder and then used for the preparation of traditional snacks as like pakoda, biscuits, and mufûns (Swami *et al*., 2012). Jackfruit content 29% pulp, 12% seeds and peel and fibrous part is 54%.

Jackfruit seeds :

Fully mature sweet bulb contain seeds which is 10 to 15 % of fruit weight. Colour of this is light brown, oval, oblong ellipsoid or rounded in shapes length of this is 2-3 cm and diameter is 1-1.5 cm. Upto 500 to 550 seeds can be found in each jackfruit (Abraham and Jayamuthunagai, 2014). Jackfruit seeds have some pasting, antioxidant properties (Tulyathan *et al*., 2002). Jackfruit seeds mostly not used as vegetable. It is eaten whole by boiling or roasting. This are easily digestible. Also it contains same composition as like grains. The two lectins found in jackfruit seeds which have been proved to evaluation of immune status of HIV infected patients. It possesses 13, 14 immunological properties (Gupta *et al*., 2011).

Chemical compositionof jackfruit seeds :

Jackfruit seeds contain starch is 22% and dietary ûber 3.19%. It contains lignans, isoûavones, saponins, all phytonutrients and their health beneûts are wide-ranging from anticancer to antihypertensive, antiaging, antioxidant, antiulcer. Protein, and carbohydrate contents of jackfruit seeds as 13.50%, and 79.34%, respectively (Ocloo *et al*., 2010). The protein content is very different, because the seeds were collected from different region because different region sample have slightly different nutrition content (Swami *et al*., 2012). Various triterpenes and flavonoids can be isolate from this fruits it also contain alkaloids, phenols, tannins, saponins, steroids (Hari *et al*., 2014). The antinutritional factors present in jackfruit such as tannin and trypsin inhibitors, result is digestive ailment when eaten raw (Swami *et al*., 2012). When seed converted into seed flour then the ash and fat contents were 2.70 % and 1.27 %, respectively. The Jackfruit seed contains very high amount of calcium that is 3087 mg/kg, iron 130.74 mg/kg, potassium content 14781 mg/kg, sodium contain 60.66 mg/kg, copper 10.45 mg/kg and manganese 1.12 mg/kg. The pH and titratable acidity values is 5.78 and lactic acid is 1.12 % (Ocloo *et al*., 2010).

Health benefits of jackfruit seeds :

Diarrhea and dysentery are treated by using jackfruit seeds. Seeds are helpful in digestion. The excess amount of free radicals disrupted the biomolecules and their prevention is vital for cytoprotective effects. All past studies proved that polyphenols, carotenoids, anthocyanin's and ûavonoids present in this fruits and this works as excellent scavengers of the free radicals and the human body protects from cellular damage (Baliga *et al*., 2011). Jackfruit seeds have lignans, isoûavones, saponins, and all phytonutrients and their health beneûts are wide-ranging from anticancer to antihypertensive, antiaging, antioxidant, antiulcer. The seeds content starch which is considered as useful in relieving biliousness, besides the roasted seeds are considered as an aphrodisiac. The jackfruit seeds worked

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 ûour (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 160^0 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 4^0 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 40^0 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 160^0C for an hour then due to

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 posses 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 posses 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 Bobade and Sachin Patil, Department of Agricultural Engineering, Maharashtra Institute of Technology, Aurangabad (M.S.) India

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