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Future of jackfruit seed flour

Sherrin Royees and Dr. Pragya Pandey

Abstract
As people become more mindful of their health, the demand for concentrated proteins from plant sources has increased, either for direct ingestion or as a food additive. Any component's distinctive information is required for its efficient use in food preparation. Despite the fact that jackfruit (*Artocarpus heterophyllus*) seeds have a high nutritional value, they are underutilised by humans and animals due to a lack of knowledge about nutrient content and how to use them effectively in food formulations. The purpose of this review study was to emphasise information on physicochemical qualities, nutrient content, and the potential application of jackfruit seeds flour in food compositions. Various research findings on the use of jackfruit seeds flour in the creation of food products such as bread, cake, and noodles are shown here. Starch, protein, fibre, ash and important minerals like calcium, phosphorus, and iron are all abundant in seed flour. Water/oil absorption capacity, solubility, swelling power, bulk density, gelatinization, and foaming capacity are all functional qualities.

Keywords: Jackfruit, jackfruit seeds, jackfruit seed flour, functional properties

Introduction
Jackfruit is a tropical fruit that is produced all over the world. It's a South Indian native. It belongs to the family moraceae. It has a unique sweetness to it and may be utilised in a number of cuisines. It's also high in nutrients and has a number of health benefits. It is green or yellow in colour and belongs to the Moraceae plant family. It has a prickly outer skin. The jackfruit (*Artocarpus heterophyllus* Lam.) is the world's largest tree-borne and highly seasonal fruit, with a pulp content of 29% and a rind content of 54%. Berry and Kalra (1988) [10] estimate that seeds account for up to 12% of total fruit weight. The proper use of jackfruit wastes can boost the jackfruit's economic worthwhile also lowering waste disposal costs. The bulb, seeds, and rind make up 29 percent, 12 percent, and 59 percent of ripe jackfruit, respectively (Jagadeesh *et al*., 2007) [56]. The huge size of jackfruit is one of its distinguishing features. It is the world's largest tree fruit, with a weight of up to 35 kg. Bioactive chemicals found in fruits and vegetables provide them the power to prevent certain diseases (Galaverna and others 2008) [19]. Jackfruit is distinguished from other fruits by its high protein content. Jacalin is the main protein present in jackfruit. It's also high in antioxidants, has a reasonable number of calories, and has a lot of fibre, minerals, and vitamins like A and C. Shariful *et al*. (2015) [58] discovered that jackfruit has 5.78 percent protein and 2.49 percent crude fibre in a study. Madruga *et al*. (2014) [40] investigated the starch content of jackfruit seeds and discovered that soft and hard seeds contain 92.8 percent and 94.5 percent starch, respectively.

The jackfruit is high in phytochemicals, particularly phenolic compounds, and various value-added products, such as neutraceuticals, can be created to boost the health benefits (Umesh and others 2010) [40]. The phytonutrients lignans, isoflavones, and saponins found in jackfruit provide a wide range of health advantages. Anticancer, antihypertensive, antiulcer, and anticaking effects are all present in these phytonutrients. The jackfruit contains numerous carotenoids, including all-trans-carotene, an essential antioxidant for human health (Cadenas and Packer 1996) [70]. Carotenoids found in jackfruit may help to prevent a variety of chronic degenerative illnesses, including cancer, inflammation, cardiovascular disease, cataracts, and age-related macular degeneration (Krinsky and others 2003; Stahl and Sies 2005) [44, 65]. The main carotenoids in jackfruit were found to be all-trans lutein, all-trans-β-carotene, all-transneoxanthin, 9-cis-neoxanthin, and 9- cis-violaxanthin (De Faria and others 2009) [15]. It contains useful components in various regions of the fruit that have functional and medical properties, the jackfruit might be termed a functional food. 287 to 323 mg potassium, 30 to 73 mg calcium, and 11 to 19 g carbs are included in per 100 g of ripe flakes (Prakash *et al*., 2009) [52].

It is an energy-dense fruit that may be used to cure physical or mental exhaustion, stress, and muscular weakness, as well as athletes. Antimicrobial, anti-diabetic, anti-inflammatory, antioxidant, and anthelminthic effects have been discovered in it (Shanmugapriya *et al*., 2011) [60].

Jackfruit seeds are edible and may be eaten raw or cooked in a variety of dishes such as curry, bhaji, cutlet, and so on. Despite the fact that seeds are ingested and employed, they are frequently discarded/wasted or damaged due to their high moisture content. Although jackfruit seeds are underutilised and underappreciated by the general public, they have significant nutritional advantages and may be used as a functional food component. This nonleguminous plant's big seeds are difficult to digest, yet they are edible (Siddappa 1957) [61]. A single seed is encased in a white aril, which is surrounded by a thin brown spermoderm and covers the fleshy white cotyledon. The cotyledons of jackfruit are rather small. Like chestnuts, the seeds can be roasted, boiled, or preserved in syrup. To produce flour, roasted, dried seeds are pulverised and mixed with wheat flour for baking (Morton 1987) [41]. The seeds are also a wonderful source of fibre and vitamins, as well as a healthy supply of carbs and proteins. Jacalin, a significant protein extracted from jackfruit seeds, was shown to have immunological characteristics. In terms of nutrition and antioxidant qualities, jackfruit seeds have received little attention. The antioxidant activity and phenolic content of jackfruit seeds were shown to provide more than 70% of the overall antioxidant activity and content. Natural food additives and chemicals may also be found in jackfruit seeds.

Seeds, on the other hand, are nutritious and may be ground into flour for easier use and storage. Jackfruit seed flour has a moisture content of 11-14 percent, carbs of 60-70 percent, crude protein of 9-12 percent, fat of 1%, crude fibre of 2-3 percent, total mineral matter of 2-3 percent, and a calorific value of 320-360 kcal/100 g. (Airani, 2007; Gupta *et al*., 2011; Islam *et al*., 2015) [2, 23, 32]. Seed flour is also utilised in conventional and new goods to enhance value. Manganese and magnesium are found in jackfruit seed powder. Fiber, potassium, calcium, and salt are all found in jackfruit seeds. Researchers have been looking into jackfruit seeds as an alternate source of carbohydrates and protein that may be used in the industrial sector in recent years. Products containing jackfruit seed flour have a higher nutritional appeal, which leads to higher customer acceptance. The ripe fruits are consumed or transformed into snacks and canned goods. The seeds can be processed into intermediate goods like as flour, which can be kept for an extended period of time. This flour may also be used alone or in combination with other grain flours to make new food products like cake, bread, and biscuits without compromising the final product's functional and sensory qualities. Wheat flour is commonly utilised as a primary component in the confectionery and pastry industries. Wheat flour is becoming more expensive by the day. In baking and bread, jackfruit seed flour can be used as a substitute. However, jackfruit seed flour may be used with wheat flour to make healthy bread goods, reducing jackfruit seed waste after harvest.

Methodology

This paper is a report of the various use of jackfruit seed flour. The data included in this paper is collected from GOOGLE SCHOLAR. It includes the work published from the year 1998-2022. Works of different authors are collected, around 67 papers are reviewed for the completion of the review work.

Health benefits of jackfruit

Several studies have linked greater fruit consumption to a lower risk of life-threatening conditions such as coronary heart disease (CHD), diabetes mellitus, obesity, and cancer (Donaldson, 2004; Williams *et al*., 2009; Erasto and Tshikalange, 2010; Asif, 2014) [16, 72, 18, 7]. According to Kevat (2013) [33], the seeds are high in vitamin C and other antioxidants, which may assist to stimulate the immune system (immunostimulative) and improve the correct functioning of white blood cells in the body; they also contain iron, which aids in the prevention of anaemia. Morton (1987) [42] found that Jackfruit can improve glucose tolerance, meaning that it can be utilised to manage blood glucose levels.

Abraham and Jayamuthunagai, (2014) [2] Jackfruit contains antioxidants that aid in the protection of free radicals. Because vitamin A is present, jackfruit has the ability to protect the integrity of the skin and mucosa. Anemia is cured by jackfruit's iron content, which is 0.60 mg per 100 g. Typical hair development is also aided by jackfruit. The completely grown jackfruit has 19.8 g of fructose and sucrose sugar per 100 g edible bulb, providing 95 calories. It also contains a large amount of dietary fibre, which aids digestion. It contains potassium and calcium, which helps to control blood pressure and promote bone formation (Tejpal and Amrit, 2016 [77]). Jackfruit has antioxidant characteristics that help to treat a variety of human ailments and improve overall health (Swami *et al*., 2012) [56]. It also has anti-inflammatory, antibacterial, Anticarcinogenic, antifungal, and anticariogenic properties, as well as inhibiting melanin production and wound healing properties (Baliga *et al*., 2011) [38].

Chemical composition and mineral content of jackfruit

Swami *et al.* (2012) [56] reported that carbohydrate of ripe fruit content varies from 16% to 25.4%. Chemical composition and mineral content of jackfruit is presented in table 1. Carbohydrate for the tender pulp is 84% (Hossain and Haq, 2006) [27]. The other chemical contents are also reported by various researchers protein 9.4% for tender pulp, fat 2.6% and fibre 0.3% (Hossain and Haq, 2006) [27]. The mineral content like calcium, phosphorous, potassium and iron is given in the table. According to (Swami *et al.* 2012) [56] the calcium content ranges from 20 to 37 (mg/g), phosphorous 38.0 to 41.0 (mg/g), potassium 191 to 407 (mg/g), iron 0.5 to 1.1 (mg/g).

Table 1: chemical composition and mineral content of jackfruit

Carbohydrate %	Protein %	Fat %	Fibre %	Calcium (mg/g)	Phosphorus (mg/g)	Potassium (mg/g)	Iron (mg/g)	Reference
84 (tender pulp)	9.4 (Tender pulp)	2.6 (Tender pulp)	0.3 (Tender pulp)	0.9 (Tender pulp)	50.1 (Tender pulp)	1.5 (Tender pulp)	97.0 (Tender pulp)	Hossain and Haq (2006) [27]
16.0 to 25.4 (Ripe fruit)	16.0 to 25.4	0.1 to 0.4	1.0 to 1.5	20.0 to 37.0	38.0 to 41.0	191 to 407	0.5 to 1.1	Swami *et al.* (2012) [56]

Jackfruit seed

Although jackfruit seeds are underutilised and underappreciated, they provide significant nutritional advantages and account for 10% to 15% of the fruit's weight (Hossain, 2014) [28]. To combat malnutrition, jackfruit seeds might be utilised as a cost-effective alternative protein source (Roy Chowdhury *et al*., 2012) [54]. The seeds are normally discarded as waste due to their perishable nature, however they have a one-month shelf life when maintained in a cold, moist environment. The roasted seeds can be powdered and used to add value to a variety of items to increase their shelf life. By combining it with wheat flour and other low-cost flours, jackfruit seed powder is used as an alternative flour in baking and confectionery items (Hossain, 2014) [28]. The seeds are consumed by boiling or roasting them in certain regions of India, or they are used to augment potato (Banerjee & Datta, 2015) [9].

Nutritional composition of jackfruit seed

The chemical composition is presented in the table 2. The jackfruit seed with spermoderm have moisture (54.06±0.85%), protein (21.99±0.51%), fat (0.70±0.01%), ash (3.14±0.22%) and fibre (7.32±0.14%) (Madrigal-Aldana *et al*., 2011) [39]. On dry basis the composition varies moisture (5.10%), protein (17.20%), fat (2.20%), ash (3.60%), fibre (3.06%), carbohydrate (74.00%) (Singh *et al*. (1991) [61] (seed with spermoderm). The proximate composition varies for seeds without spermoderm on dry basis moisture – (6.09±0.01%), protein- (13.50±0.06%), fat (1.27±0.01%), ash- (2.70±0.02%), fibre- (3.19±0.01%), carbohydrate- (79.34±0.06%), energy- (382.79±1.20 Kcal/100g) (Ocloo *et al*., 2010) [49]. The protein and fibre content given by (Goswani *et al*, 2010) [27] is very low as compared 6.73% and 1.6%. The fat and ash content is 0.80% and 4.27%.

Table 2: nutritional Composition of Jackfruit Seed Reported by Different Researchers

Moisture	Protein	Fat	Ash	Fibber	Carbohydrate	Energy (Kcal/100g)	References
54.06±0.85 (seed with spermoderm)	21.99±0.51 (seed with spermoderm)	0.70±0.01 (seed with spermoderm)	3.14±0.22(seed with spermoderm)	7.32±0.14 (seed with spermoderm)			Madrigal-Aldana *et al*. (2011) [39]
6.09±0.01 (% DB) (seed without spermoderm)	13.50±0.06 (% DB) (seed without spermoderm)	1.27±0.01 (% DB) (seed without spermoderm)	2.70±0.02 (% DB) (seed without spermoderm)	3.19±0.01 (% DB) (seed without spermoderm)	79.34±0.06 (% DB) (seed without spermoderm)	382.79±1.20 (Kcal/100g)	Ocloo *et al*. (2010) [49]
5.10 (% DB) (seed with spermoderm)	17.20 (% DB) (seed with spermoderm)	2.20 (% DB) (seed with spermoderm)	3.60 (% DB) (seed with spermoderm)	3.06 (% DB) (seed with spermoderm)	74.00 (% DB) (seed with spermoderm)		Singh *et al*. (1991) [61]
	6.73%	0.80%	4.27%	1.6%			Goswani *et al* (2010) [27]

Mineral composition of jackfruit seed

The mineral content is showed in the table 3. The mineral analysis showed that Jackfruit seeds and pulps were rich in essential minerals. The seeds were found to both rich in potassium, sodium, calcium, magnesium, zinc and iron minerals. The phytochemical composition and antioxidant activities, were also found to be higher in the seeds than in the pulps. The potassium, calcium, sodium, zinc, copper content is given in the table the. The calcium content in jackfruit seed reported by (Ibironke Adetolu Ajayi, 2008) [31] is 29.47±0.51 which is lower than value reported by (Gupta, *et al.* 2008) [24] is 29.47±0.51.

Table 3: mineral composition of jackfruit seed

Analyse					References
Potassium	Calcium	Sodium	Zinc	Copper	
786.6±1.23	29.47±0.51	28.39±0.36	2.280±0.12		Gupta *et al* (2008) [24]
2470.00	190.00	398.50	40.85(ppm)	22.00(ppm)	Ajayi (2008) [3].
125.22 (Sun drying method)	39.78 (Sun drying method)		1.08		Nisar, *et al.* (2021) [48]

Table 4: Phytochemical composition of jackfruit seed and jackfruit pulp

Sample	Phytic acid mg/100g	Oxalate mg/100g	Alkaloid mg/100g	Tannin mg/100g	Flavonoid mg/100g	References
Jackfruit Pulp	6.14 ±0.08	3.69 ±0.13	7.88± 0.06	0.03b ±0.01	3.91a ±0.08	Amadi& Joy A.C (2018) [4]
Jackfruit Seed	8.11 ±0.06	5.53 ±0.06	8.85±0.08	0.06b ±0.01	2.03b ±0.06	Amadi (2018) [4]
J Seed			1.16±0.09 g/100 g			Gupta *et al*. (2011) [23]
Jseed 0 (sundried)			6.82%		2.08 mg/100g	Nisar *et al*. (2021) [48]

Jackfruit seed flour

Jack fruit seed Flour is a wheat flour substitute that may be used in foods such as vada, chapatti, cake, buttered biscuits, bread, pancakes and noodles. These items were processed according to industry standards. The created items' organoleptic characteristics, such as colour, texture, appearance, flavour, taste, and overall acceptability, were determined to be extremely acceptable. It is well recognised that seed processing improves food palatability, nutritional quality, and digestibility. The seeds can be processed into intermediate goods like as flour, which can be kept for an extended period of time. This flour may also be used alone or in combination with other grain flours to make novel foods like cake, bread, and biscuits while maintaining the functional and sensory characteristics of the final product. Wheat flour is commonly utilised as a primary component in the confectionery and pastry industries.

Wheat flour is becoming more expensive by the day. In baking and bread, jackfruit seed flour can be used as a substitute. However, jackfruit seed flour may be used with wheat flour to make healthy bread goods, reducing jackfruit seed waste after harvest. Carbohydrates, protein, and minerals abound in jackfruit seed flour. Anticarcinogenic, antispasmodic, antiulcer, and antihypertensive activities are all present. It can be used as a gluten-free alternative to Maida in baked goods such as cakes, biscuits, energy drinks, and other bakery items.

Functional properties of jackfruit seed flour

Functional properties of jackfruit seed flour is given in the table 5.

Functional qualities such as water and oil absorption capacities, swelling power, bulk density of the seeds were analysed.

Water absorption capacity

Water absorption capacity refers to the ability of flour to bind with water when water is scarce. The water absorption capacity reported by (Odoemelam, 2005) [50] is 2.3g/ml lower than the value reported by (Eke- Ejiofor *et al.*, 2014) [17] 4.0g/ml - 6.0g/ml. The values of (Tulyathan *et al*., 2002) [67] and (Rajarajeshwari and Jamuma, 1999) [63] is somewhat similar 2.05g/ml and 2.1g/ml. (Niba *et al*., 2001) [58] described water absorption capacity as an important processing parameter that has implications for viscosity. Water absorption capacity is also crucial in product bulking and uniformity, as well as baking applications. The discrepancies might be ascribed to both the procedure and the varietal variances. The outcome demonstrates that the flour has a strong ability to bind water. This finding implies that jackfruit seed flour might be employed in the banking sector.

Oil absorption capacity

Oil absorption is an essential attribute in the formulation of food products since it affects flavour and mouth feel. For each approach utilised, there were significant differences ($P > 0.05$) in the samples. Oil absorption is a crucial feature in food compositions since it enhances flavour and mouth feel (Kinsella, 1976) [35]. Chowdhary, *et al*, 2012 [82] reported the value as 0.97g/ml which is lower than the value 2.8g/ml reported by (Odoemelam, 2005) [50]. For roasted jackfruit seed flour the value ranges from 1.5 g/ml -3.0 g/ml (Eke-Ejiofor *et al*. 2014) [17]. The discrepancies might be ascribed to both the procedure and the varietal variances. The results demonstrate that jackfruit seed flour has a good flavour retention rate, suggesting that it might be effective in food systems such as ground meat compositions.

Bulk density

The particle size of the samples determines bulk density. Odoemelan (2005) [50] also found that uncooked flour from Jackfruit seeds had a bulk density of 0.61g/ml. Bulk density is a measurement of a flour sample's heaviness. Eke-Ejiofor *et al*, (2014) [17] reported the value of roasted jackfruit seed flour 0.256 g/ml- 0.327 g/ml. It's crucial for defining packaging needs, material handling, and application in the food industry's wet processing. The Jackfruit seed flour investigated might be utilised as a thickening since flours with high bulk densities are commonly employed as thickeners in food items.

Swelling power

Swelling power of the seed flour samples ranging from 6.58% to 9.46% (Eke-Ejiofor, *et al.*, 2014) [17] is lower than that reported by Ocloo *et al*, (2010) [49], who gave a value of 4.77%. Shariful Islam, *et al*. (2015) [58] reported a value 1.46% which very lower than the value of Ocloo, *et al*, (2010) [49] and (Eke-Ejiofor, *et al*. 2014) [17]. Swelling power is a metric for swollen starch granules, and food eating quality is linked to water swollen starch granule retention.

Table 5: Functional properties of jackfruit seed flour

Water absorption capacity	Oil absorption capacity	Bulk density	Swelling power	References
2.3 g/ml	2.8 g/ml	0.61g/ml		Odoemelam (2005) [50]
2.05 g/ml	0.92 g/ml			Tulyathan *et al*., (2002) [67]
2.1 g/ml	1.8 g/ml			Rajarajeshwari and Jamuma, (1999) [63]
4.0 g/ml -6.0 g/ml (roasted)	1.5 g/ml -3.0 g/ml (roasted)	0.256 g/ml- 0.327 g/ml (roasted)	6.58% to 9.46%	Eke-Ejiofor *et al*, (2014) [17]
2.03 g/ml	0.97g/ml			Chowdhary *et al* (2012) [82]
72.00±0.20 ml/100gm			1.46%	Islam *et al*. (2015) [32]
25.00±1.67%		0.80 ± 0.02g/cm3	4.77%	Ocloo *et al*,(2010) [49]

Nutritional composition of jackfruit seed flour

The chemical composition of jackfruit seeds flour is presented in the table 6. The chemical composition of jackfruit seeds flour is also affected by processing treatment. When compared to raw jackfruit seed flour, the protein content of heated jackfruit seed flour increased the maximum (61%). The increase in protein content after heat treatment of jackfruit seeds might be due to protein denaturation, which is then followed by protein aggregation, either soluble or insoluble protein complexes. The method of extracting protein from plants consists of an extraction stage and protein precipitation, which can be accomplished using thermo coagulation (temperature action), auto coagulation (fermentation), flocculation, ultrafiltration, and organic solvent extraction (Coldebella *et al*., 2013) [14]. When compared to raw jackfruit seed flour, however, germination treatment had little effect on protein content.

The moisture content of germinated jackfruit seed flour reported by Eke- Ejiofor *et al*, (2014) [17] is 3.20% to 6.6%. The value of moisture reported by (Odoemelam, 2005) [50] is 15% that is higher as compared to the value reported by (Ocloo *et al*., 2010) [49] 6.09%. The ash value is reported by Tulyathan *et al*. (2002) [67], Nansereko *et al*. (2021) [56] as 3.92%, 2.35%. The protein content of germinated seed flour is reported by (Eke-Ejiofor *et al*, 2014) [17].

Table 6: Nutritional composition of jackfruit seed flour

Moisture	Ash	Protein	Carbohydrate	Fat	Reference
3.20% to 6.6% (germinated)	2.45% to2.76% (germinated)	12.25 to 16.80% (germinated)	70.76% to 79.04% (germinated)	0.13% to 0.77% (germinated)	Eke- Ejiofor *et al*, (2014) [17]
6.09%		13.50%		1.27%	Ocloo *et al*., (2010) [49]
8.57%		6.34%			Amornrat (2004) [53]
6.34%		8.57%			Karmontip (2004)
	3.92%		81.64%		Tulyathan *et al*., (2002) [67]

4.43%	2.00%	21.30%	63.85%	2.73%	Rajarajeshwari and Jamuma (1999) [63]
			75.71%		Siti and Noor, (2003) [26]
10.7%	2.56%	14.02%			
7.63%	2.35%	10.26%	78.65%	1.11%	Nansereko (*et al*. (2021) [56]
15.88±1.26%		5.78±0.04%	71.46±0.15%	1.77±0.02%	Odoemelam (2005) [50]

Mineral composition of jackfruit seed flour

Minerals are inorganic compounds found in all tissues and fluids of the body. Despite the fact that they don't produce any energy, they play a crucial part in the body's numerous functions (Soetan *et al*., 2010) [62]. Calcium, phosphorous, and magnesium are required for glucose metabolism, bone and tooth development, enzyme function, and the maintenance of the body's acid-alkaline balance (Scarlbet, 1991 and Brody, 1994) [57, 12]. Iron is a necessary ingredient for the production of blood (Kittiphoom, 2012) [36]. Iron metabolism is aided by copper. Manganese serves as a cofactor in a number of enzymes, whereas zinc is required by over 100 enzymes involved in energy metabolism (Huskisson *et al*., 2007) [30].

Table 7: Mineral composition of jackfruit seed flour

Minerals (mg/100g)							Reference
Phosphorous mg	**Magnesium**	**Copper**	**Manganese**	**Zinc**	**Iron**	**Calcium**	
139.00 mg/100 g	150.70 mg/100 g	3.16 mg/100 g		1.50 mg/100 g		308.7 mg/100 g	Abedin *et al*. (2012) [1]
	338.0 mg/100 g	1.04 mg/100 g					Ocloo *et al*. (2010) [49]
		1.45 mg/100 g			13.07 mg/100g		Banerjee and Datta (2015) [9]
	295.10mg/100g	2.50mg/100g	4.20 mg/100 g		1.30mg/100g	166.10mg/100g	Okafor *et al*., (2015) [51]
105.93 ± 0.03	162.51 ± 0.02	4.25 ± 0.03	2.02 ± 0.03	2.03 ± 0.02	12.55 ± 0.03	234.24 ± 0.02	Borgis *et al* (2020) [14]
43.7		1.04	0.12		0.59	77.3mg/100g	Nansereko (*et al*. (2021) [56]

Export quality standard of jackfruit seed flour

ISO 22000:2005 and FSSAI are the quality exporting standards for jackfruit seed flour. To be exported, jackfruit seed flour must meet certain criteria. The basic material is derived from non-genetically modified organisms. After choosing jackfruit seed, it should be cleaned, peeled, sliced, and dehydrated to eliminate as much moisture as possible before being ground, sorted, and packaged. The flour should be finely ground and have a colour ranging from off white to brown. Microbiological criteria such as total bacterial count, yeast, and mould must fall within the table range. Salmonella and Ecoli must not be present in the flour. Nitrogen gas is flushed into the package, which is packed in linear low-density polyethylene bags with gas barrier qualities. The ambient temperature is used to describe the storage conditions. The flour should be finely ground and have a colour ranging from off white to brown. Microbiological criteria such as total bacterial count, yeast, and mould must fall within the table range. Salmonella and Ecoli must not be present in the flour. Nitrogen gas is flushed into the package, which is packed in linear low-density polyethylene bags with gas barrier qualities. The ambient temperature is used to describe the storage conditions. The table is presented in the table 8.

Table 8: Export quality standard of jackfruit seed flour

Title	**Organic jackfruit seeds powder**
Botanical Name	*Artocarpus heterophyllus*
Description	Made of sound, jackfruit seeds powder that have been selected, washed, peeled, cut, dehydrated, grind, processed, sorted and packed.
Organic Certification	USDA
Quality standards	ISO 22000:2005 and FSSAI
Subject to Supplier Agreement/Additional Certification	

S. No.	**Parameters**	**Standards**
1.	**Physical Parameters**	
1.1	Appearance	Fine powder
1.2	Color	Off white-brown color
1.3	Taste	Characteristic
1.4	Sieve analysis: ± 5% -0.3 mm	98%
1.	Extraneous matter (%) max	Nil
2	**Chemical Parameters**	
2.1	Moisture (%) Max	10
3	**Micro-Biological Parameters**	
3.1	Total bacterial count (CFU/g) max	10
3.2	Total yeast and mound count (CFU/g) max	10
3.3	E. coli (CFU/g) max	Absent
3.4	Salmonella (in 25 g)	Absent
4	**Ingredients/ Non GMO Status**	
4.1	Ingredients	100% jackfruit seeds
4.2	Non GMO Status	The source of raw material is Non-GMO
5	Allergen	Free
6	Storage	At ambient temperature. Below 25 °C, dry place.

7	Packing	In Food grade NLLDPE bags in carton with gas barrier properties (Ex: O2, N2 & Moisture). Bags are flushed with N2 gas
8	Country of Origin	Srilanka
Pesticides		
Free from pesticides and chemical residues		

Future of jackfruit seed flour

Munishamanna *et al*. (2007) [44] investigated if jack fruit seeds might be used as a food additive. According to Hema (2015) [32], jack fruit seeds flour might be a substitute for wheat flour in foods such as vada, chapatti, bread, cake, buttered biscuits, pancakes, and noodles. These items were processed according to industry standards. The created items' organoleptic characteristics, such as colour, texture, appearance, flavour, taste, and overall acceptability, were determined to be extremely acceptable. Praveenasri *et al*. (2006) [53] investigated the use of jack fruit seeds flour in extruded goods such as snacks, noodles, and vermicelli. Moreover, the incorporation of seed flour to deep fat fried products has found to reduce the fat absorption to a remarkable extent (Rajarajeshwari and Jamuna, 1999) [63].

Bread

Ayodele and Oginni (2003) [8] investigated the use of jackfruit seeds flour in the making of bread and other confectionery goods The seeds of the jackfruit were ground into flour and used to make bread, cake, buttered biscuits, and pancakes. According to Hasidah and Noor (2003) [26], jackfruit seeds flour can be utilised as an alternate component in bakery and bread making. The water absorption capacity rose as the quantity of replacement increased, resulting in a shorter bread dough peak time and longer dough stability duration. With a 5% substitution of jackfruit seeds flour, the bread's specific baking volume was lowered by 51%. The bread made with jackfruit seeds flour has the hue of 'brown bread' made with wheat flour. Butool and Butool (2013) [13] studied for replacement of wheat flour with various proportions (10%, 20%) of jackfruit seeds flour. The dry ingredients along with salt and baking powder were mixed properly and sieved through 1 mm sieve. It was discovered that adding jack fruit seeds flour to bread increased the crude fibre content. The created items' organoleptic characteristics, such as colour, texture, appearance, flavour, taste, and overall acceptability, were determined to be extremely acceptable.

Chapatti

Sultana *et al*. (2014) [65] conducted research on the manufacture of jackfruit seeds flour-fortified chapatti. They claimed that jackfruit seeds flour may replace up to 25% of wheat flour with sensory acceptability. Preservatives including alcohol, vinegar, benzoates, and sorbets can increase the shelf life of such chapattis to 3 to 4 days at room temperature and up to 30 days when refrigerated (Sultana, *et al*. 2014) [65]. Many researchers have previously used jackfruit seed starch or flour as an alternative to wheat flour to produce gluten-free pastry products due to its low viscosity and lack of gluten protein.

Cake

In the banking sector, cake is a very important product. This product is well-liked by customers all over the world. Cake contains a lot of calories, therefore eating too much of it can lead to obesity. As a result, consumers are looking for low-calorie, high-fibber cakes that include de all of the important elements. Various studies are underway to develop bakery goods that are supplemented with high-fibber components. A few studies targeted at fortifying jackfruit seeds flour in cake production have also been identified in the literature in this regard. Arpit and John (2015) [6] used 5 to 15% jackfruit seeds flour in cake preparation and were able to produce a cake that had a positive panel response in sensory evaluation. The addition of jackfruit seeds flour to the cake samples increased the protein content while lowering the fat content.

Cookie

A cookie is a baked sweet treat that is typically small, flat, and round or square in shape. For the manufacture of cookies, Airani (2007) [2] used 10% to 50% jackfruit seeds flour combined with wheat flour (Maida and whole wheat flour). The product was acceptable with a decent sensory profile at 20% and 30% integration, whereas 50% incorporation resulted in a hard texture.

Noodles

Extruded products, such as noodles, are also made from jackfruit seed flour. Nandkule, *et al*. (2015) [45] boosted the protein and dietary fibre content of noodle by extruding up to 20% seeds flour. Amin (2009) [5] found that using jackfruit seeds flour in noodles increased the protein content and improved the overall nutritional value. When compared to control noodles, the samples made with jackfruit seeds flour had more fat and moisture content. The ash and crude fibre content of the 30 percent jackfruit seeds flour substituted sample was higher than the control sample.

Conclusion

Despite their great nutritional value, jackfruit (*Artocarpus heterophyllus*) seeds are underutilised by people and animals due to a lack of understanding of nutrient content and how to use them effectively in food compositions. The demand for concentrated proteins from plant sources has increased as people become more health conscious, whether for direct consumption or as a food ingredient. The distinctive information of any component is necessary for its efficient usage in food preparation. The goal of this review was to highlight data on physicochemical properties, nutrient content, and the potential use of jackfruit seeds flour in food compositions. The addition of jackfruit seeds flour resulted in nutritionally superior products, which were especially rich in minerals and fibre. According to the literature, the functional qualities of seeds flour are advantageous for the production of processed foods. These seeds can be processed and used for a variety of reasons based on their nutritional information, functional characteristics, and overall attractiveness. Various research findings on the usage of jackfruit seeds flour in the production of food products such bread, cake, and noodles are displayed here. Seed flour is high in starch, protein, fibre, ash, and essential minerals like calcium, phosphorus and iron. Majority of the reviewed studies indicated that processing of jackfruit seeds flour into value added products certainly serves towards sustaining farm income of jackfruit growers through enhancing their return.

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