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Jackfruit seed starch characterisation in three popular varieties from Vietnam

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Abstract

Jackfruit seeds, accounting for approximately 10 - 15% of the total fruit weight, are commonly regarded as a by-product in jackfruit processing. The present work aimed to characterise the chemical composition of jackfruit seeds, and evaluate the physicochemical properties of starch extracted from three widely cultivated jackfruit varieties in Vietnam: Thai, Nghe, and Dua. The seed moisture contents ranged from 57.91 - 60.99%, while the protein, fat, and ash contents varied from 13.50 - 15.87, 0.58 - 1.58, and 0.39 - 0.58%, respectively. The amylose contents were between 30.36 and 35.37%, with total starch contents ranging from 60.47 - 76.82%, and resistant starch (RS) contents ranging from 54.08 - 63.48%; the highest RS content was observed in the Thai jackfruit variety. In terms of mineral composition, calcium, iron, zinc, sodium, and magnesium concentrations were 5.19 - 8.81, 0.81 - 1.08, 0.53 - 0.65, 3.60 - 4.51, and 6.60 - 8.69 mg/100 g, respectively. Furthermore, the present work revealed that starch from the Thai jackfruit variety exhibited the highest swelling and oil absorption capacities, while Nghe jackfruit starch demonstrated superior gel-forming ability compared to the other two varieties. These findings provided valuable insights into the potential application of jackfruit seed starch as a functional ingredient in the formulation of health-promoting food products, emphasising the importance of optimising its utilisation in value-added food processing.

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Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is a tropical fruit widely cultivated in Southeast Asia, including Vietnam, and renowned for its sweet and aromatic flavour, and edible yellow pulp. However, its seeds are often undervalued despite their considerable nutritional and economic potentials. Jackfruit seeds are a rich source of starch, making them a viable carbohydrate source for diverse applications in both the food and non-food industries (Noor *et al*., 2014).

Jackfruit seed starch is known as a rich source of resistant starch (RS), a valuable nutritional component with great potential. RS is a type of starch that resists digestion in the small intestine, reaching the colon intact, where it can be fermented by gut bacteria. This fermentation process produces short-chain fatty acids, which offer health benefits such as supporting digestive health and reducing the risk of colorectal cancer (Du *et al*., 2020; Deehan *et al*., 2020). Due to these health benefits, studying jackfruit seed starch in terms of its RS content and functional properties could reveal important applications in health-oriented food products.

Starch is a polymer of α-D-glucose, stored in the form of spherical granules in seeds, grains, and tubers. As a fundamental food component, starch plays a crucial role in determining the structural and rheological properties of food products, while also serving as an energy and/or fibre source for human consumption. The latter function has gained increasing attention, as research indicates that foods containing equal amounts of starch can elicit different glycaemic responses. Based on its digestibility, starch is classified into three categories: rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS). Starches with high SDS and RS

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contents offer the most nutritional benefits, as they contribute to a lower glycaemic index, and serve as dietary fibre (Piecyk and Domian, 2021). The RS content of jackfruit seed starch varies depending on the jackfruit variety and the processing methods used for starch extraction. Additionally, the physicochemical properties of starch, including viscosity, gelatinisation temperature, and swelling power are critical in determining its functionality in various applications. These properties are influenced by plant species, environmental factors, and processing conditions, underscoring the importance of investigating the RS content and other physical characteristics of jackfruit seed starch across different jackfruit varieties (Noor *et al*., 2014).

Therefore, the present work aimed to evaluate the physicochemical properties and resistant starch (RS) content of jackfruit seed starch from three widely cultivated jackfruit varieties in Vietnam. The present work involved analyses on starch content, amylose content, swelling power, and gel strength of the extracted starch samples. The findings of the present work would provide valuable insights for the development of novel food and non-food products utilising jackfruit seed starch, particularly in relation to its RS content and potential health benefits.

Materials and methods

Samples

Jackfruit seeds

The seeds of jackfruit were obtained from three different popular jackfruit varieties in Vietnam, namely Thai, Nghe, and Dua. The fruits were harvested at the point of physiological maturity, ensuring optimal ripeness, and the seeds were carefully collected, classified, cleaned, and stored until further analyses (Figure 1).

(a) **(b)** **(c)**

Figure 1. Peeled jackfruit seeds of three jackfruit varieties: **(a)** Thai, **(b)** Nghe, and **(c)** Dua.

Chemicals

Sodium hydroxide > 97% (AR, Fisher, CAS 1310-73-2); HCl ≥ 99% by HPLC (Merck); RS assay kit (product code K-RSTAR of Megazyme); C_2H_5OH 99.99%; potassium hydroxide 85% (Merck); and refined vegetable oil (Tuong An brand, density: 0.91 g/mL) were used in the present work.

Instruments

UV-VIS spectrophotometer (Jasco V-630; wavelength range: 190 – 1,100 nm; wavelength accuracy: ± 0.2 nm; wavelength repeatability: ± 0.1 nm; wavelength scanning speed: 8,000 nm/min; spectral slit width: 1.5 nm; Japan); scanning electron microscope (SEM) JEOL JSM-5410LV (JEOL; resolution: 3.5 nm (at 30 kV, WD = 8 mm); SEI (secondary electron image) mode (magnification: ×15 (WD = 48 µm) to 200,000 (25 steps); USA); Hettich EBA20 centrifuge (maximum speed: 6,000 rpm; maximum centrifugation capacity: 8 × 15 mL; settable centrifugation time: 1....99 min; Germany); STUART CB162 hotplate stirrer (stirring speed: 100 – 1,500 rpm; heating table temperature: ambient to +450°C; heating power: 500 W; UK); and vortex mixer GEMMY-VM-300 (amplitude: 4.5 mm (circular oscillation); maximum sample processing capacity: 50 mL; speed range: 3,000 rpm; Taiwan) were used in the present work.

Sample preparation

Jackfruit seeds were peeled and washed, and starch was obtained according to Wong *et al*. (2021). The starch samples were then refrigerated until further analyses.

Number of samples analysed

Three different varieties of jackfruit seeds and 11 starch samples for each seed were analysed.

Number of repeated analyses

All measurements of instrument readings were performed three times.

Number of replicate experiments

Each experiment was repeated three times.

Design of experiment

Three types of jackfruit seeds were prepared, classified, cleaned, and then the starch was collected. Then, the basic chemical components of the three types of starch were analysed. Next, the physical and chemical properties such as swelling power, oil absorption capacity, gel-forming ability, and molecular particle size of the three types of jackfruit starch were investigated and compared.

Laboratory methods

Preparation of jackfruit seed starch

The seeds were ground and diluted with distilled water, followed by continuous stirring for 3 h before filtration. The resulting starch milk was centrifuged at 8,000 rpm for 5 min, and the top layer was removed. The sediment was then treated with 0.1 M sodium hydroxide, stirred for 18 h, and subsequently centrifuged and washed twice with 0.1 M sodium hydroxide. The sample was then rinsed, neutralised with hydrochloric acid, washed three times with distilled water, and centrifuged at 8,000 rpm for 10 min at 25°C. The obtained starch suspension was dried at 40°C for 18 h, yielding 23.21% (Wong *et al*., 2021).

Composition analysis

Starch samples were analysed for moisture, protein, lipid, ash, and metal contents. The nitrogen was determined using a Kjeldahl system (Gerhardt, Germany). The protein content was determined from the nitrogen content (N × 6.25). The lipid content was determined using Soxtherm rapid extraction system (Gerhardt, Germany). The ash content was determined by heating the samples in a muffle furnace (Pyro MA 194, Milestone Scientific, Italy) at 525°C. The metal contents were determined using inductively coupled plasma mass spectrometry (ICP-MS) (AOAC 999.10). All measurements were conducted in triplicate, and then averaged.

Determination of amylose content

The amylose content of starch samples was determined using the Megazyme amylose/amylopectin assay kit (Megazyme, Bray, Ireland). A sufficient amount of starch was weighed and stirred well in heated dimethyl sulfoxide. Lipids in the starch were removed by precipitating the starch in 95% (v/v) ethanol. The precipitated starch was recovered and dispersed in a sodium acetate buffer solution. The amylose component was separated from the amylopectin based on the formation of a Concanavalin A lectin-amylopectin complex. The amylose in the upper layer was hydrolysed by enzymes into D-glucose, and measured for absorbance at a wavelength of 510 nm using a UV-VIS spectrophotometer (Jasco V-630, Japan) (Wong *et al*., 2021).

Determination of total and resistant starches

The starch content of jackfruit seeds, including total starch (TS), digestible starch (DS), and resistant starch (RS), was determined using the AOAC 2002.02 method. This procedure involved adding 0.1 g of starch sample to a sealed tube containing 0.1 M sodium acetate buffer (pH 4.5), porcine pancreatic α-amylase, and *Aspergillus niger* amyloglucosidase, followed by vortex mixing and enzymatic digestion in a water bath at 37°C for 16 h. After digestion, 4 mL of 100% ethanol was added to terminate the reaction, and the samples were centrifuged. The supernatant, containing the digestible starch fraction, was collected in a graduated cylinder. Each sample was then washed twice with 8 mL of 50% ethanol, vortexed, centrifuged, and the upper layer was combined and collected. This pooled liquid represented the digestible starch (DS) fraction, which was diluted to 100 mL for glucose quantification without further processing. The residue was air-dried and dissolved in 2 M KOH in an ice-water bath to solubilise the remaining starch. The pH was then adjusted to approximately 4.5 using an acetate buffer (pH 3.8). The dispersed starch residue, representing the RS fraction, was subsequently hydrolysed with amyloglucosidase in a water bath at 37°C for 30 min, diluted to 100 mL, and analysed using the GOPOD (glucose oxidase-peroxidase-aminoantipyrine) assay. The total starch (TS) content of the sample was calculated as the sum of the DS and RS fractions (McCleary *et al*., 2002).

Determination of swelling power

One gram of the starch sample was mixed with 10 mL of distilled water in a centrifuge tube, and heated at 80°C for 30 min with continuous shaking.

Following heating, the starch paste was centrifuged at 1,000 rpm for 15 min. The supernatant was carefully removed, and the wet residue was weighed. The swelling power of the starch was determined as the ratio of the wet residue weight (g) to the initial dry sample weight (g) (Abraham and Jayamuthunagai, 2014).

Determination of oil absorption

One gram of the starch sample was accurately weighed into a conical centrifuge tube, and approximately 10 mL of refined vegetable oil was added. The mixture was then centrifuged at 2,000 rpm for 30 min. After centrifugation, the volume of oil retained on the sediment was measured. The oil absorption capacity was expressed as the percentage of oil absorbed relative to the initial sample weight (Abraham and Jayamuthunagai, 2014).

Determination of gel strength

The minimum gel concentration for jackfruit seed starch was evaluated following the modified method of Abraham and Jayamuthunagai (2014) and Adewumi *et al*. (2020). Accordingly, starch was dispersed at 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20% (w/v) in 5 mL distilled water, and cooked under reflux at 90°C for 1 h, cooled quickly under running tap water, and further cooled for 2 h in a refrigerator at 4°C. The minimum gel concentration was the concentration at which the sample from the test tube could be inverted without falling or slipping.

Scanning electron microscopy (SEM) analysis

SEM analysis was conducted to determine the surface, shape, and size of the starch particles using JEOL JSM-5410LV (JEOL, USA) equipped with a large field detector. The acceleration voltages were 15 kV at low vacuum mode (0.7 - 0.8 Torr). The sample was mounted on a copper stub with adhesive tape, and sputter-coated with gold under vacuum. The images were captured at a magnification of 2,000× (Kittipongpatana and Kittipongpatana, 2015).

Statistical analysis

The statistical analysis was performed on the experimental results with three repetitions, and processed on Microsoft Excel 2016 and Statgraphic Centurion XV.I software. The data were presented as the mean value of three repetitions ± standard deviation with a significance level of $p \leq 5\%$.

Results and discussion

Chemical composition of different jackfruit varieties

The results of the chemical composition analysis of jackfruit seed starch from three different jackfruit varieties are presented in Tables 1 and 2. Regarding moisture content, the jackfruit seeds from these varieties exhibited relatively high moisture levels, ranging from 57.9 - 67.5%. In contrast, another study reported a lower moisture content of approximately 55% in jackfruit seeds (Mahanta and Kalita, 2015). Additionally, a study conducted in Bangladesh found even lower moisture levels in jackfruit seeds from three different varieties, with values ranging from 21.10 - 42.25% (Abedin *et al*., 2012). These differences may be influenced by environmental conditions during cultivation, storage humidity, or extraction methodologies.

The results presented in Table 1 indicate that starch was the primary component of jackfruit seeds, with a high proportion of RS. The starch contents of the three jackfruit varieties—Thai, Nghe, and Dua—were 76.82, 60.47, and 71.61%, respectively. In comparison, a study by Noor *et al*. (2014) analysed starch from three different jackfruit seed cultivars using various extraction methods, including distilled water, alkali, and enzymatic treatments. The reported starch contents varied, ranging from 83.62 - 84.48%, 55.95 - 58.75%, and 50.69 - 55.51% (Noor *et al*., 2014). These findings suggested that starch content in jackfruit seeds could significantly be influenced by the extraction method used. Similarly, Abedin *et al*. (2012) investigated three jackfruit cultivars—Khaja, Gala, and Durosha—and reported starch contents of 15.61, 17.90, and 12.86%, respectively. These results indicated that the starch content of jackfruit seeds could vary widely depending on the cultivar and extraction techniques, with some reported values being relatively lower than those observed in the present work.

Overall, the findings indicated that the starch content and composition of jackfruit seeds could vary significantly depending on factors such as variety and extraction method. These results underscored the importance of further research to fully explore the potential applications of jackfruit seed starch in both food and non-food industries.

The ratio of amylose to amylopectin is an important indicator of starch quality, and can impact starch digestibility. The amylose content of starch

Table 1. Chemical compositions in seeds of three jackfruit varieties.

Variety	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Amylose (%)	Total starch (%)	RS (%)
Thai	60.99 ± 2.63^a	13.50 ± 0.80^a	0.58 ± 0.03^a	0.39 ± 0.03^a	35.37 ± 1.02^b	76.82 ± 0.86^c	63.48 ± 1.52^c
Nghe	67.48 ± 1.51^b	15.87 ± 0.80^b	1.45 ± 0.06^b	0.45 ± 0.04^a	30.36 ± 1.01^a	60.47 ± 0.91^a	54.08 ± 0.95^a
Dua	57.91 ± 1.02^a	13.73 ± 0.47^a	1.58 ± 0.03^c	0.58 ± 0.06^b	34.26 ± 0.99^b	71.61 ± 1.34^b	57.74 ± 1.55^b

Values with different lowercase superscripts within similar column are significantly different ($p < 0.05$).

Table 2. Mineral contents in seeds of three jackfruit varieties.

Variety	Calcium (mg/100 g)	Iron (mg/100 g)	Zinc (mg/100 g)	Sodium (mg/100 g)	Magnesium (mg/100 g)
Thai	5.19 ± 0.2^{a}	0.81 ± 0.03^{a}	0.65 ± 0.02^{b}	4.51 ± 0.24^{b}	7.81 ± 0.14^{b}
Nghe	6.90 ± 0.08^{b}	1.08 ± 0.09^{b}	0.53 ± 0.03^{a}	3.77 ± 0.18^{a}	6.60 ± 0.22^{a}
Dua	8.81 ± 0.12^{c}	0.97 ± 0.05^{b}	0.55 ± 0.01^{a}	3.60 ± 0.14^{a}	8.69 ± 0.15^{c}

Values with different lowercase superscripts within similar column are significantly different ($p < 0.05$).

plays an important role in determining the functional properties of RS. Amylose is a linear polysaccharide with a less branched structure than amylopectin. When the amylose content is high, starch molecules tend to be more tightly packed, reducing the ability of digestive enzymes to break down in the small intestine, thereby increasing the resistance to digestion, and forming resistant starch. In the present work, three jackfruit cultivars were evaluated, and the Thai jackfruit variety was found to have the highest amylose content at 35.37%, while the Nghe cultivar had the lowest at 30.36%. These values were higher than previously reported values of 32.05 and 24.90%, as reported by Tulyathan *et al*. (2002) and Chen *et al*. (2016), respectively. The higher amylose content in the Thai variety correlated with increased RS, contributing to potential health benefits and industrial functionality. The Thai jackfruit variety also had the highest RS content at 63.48%, which may be attributed to its high amylose content compared to the other two varieties. Another study reported that the RS content of jackfruit seed starch can be as high as 74.26% (Chen *et al*., 2016), while another study found a lower value of about 30% for jackfruit seeds in Thailand (Kittipongpatana and Kittipongpatana 2015), indicating that RS content may vary based on the variety and region of cultivation.

Table 1 highlights the significant contribution of protein to the nutritional value of jackfruit seeds, with the content ranging from 13.50 - 15.87% among the three different jackfruit varieties studied. This agreed with the protein content of 13.50% reported in the jackfruit variety studied by Ocloo *et al.* (2010). In comparison, the protein content in the seed powder of Gala, Durosha, and Khaja jackfruit varieties were 11.34, 9.75, and 9.19%, respectively (Noor *et al*., 2014), which was similar to the value of 11.17% reported by Singh *et al*. (1991). However, the protein content of jackfruit seed powder was much lower in the study by Menaka *et al*. (2011) where it was reported to be only 6.34 - 8.57%. These variations in protein content could be attributed to differences in the growth and development of the jackfruit tree, as well as environmental conditions and growing methods.

The lipid content of the three jackfruit varieties was relatively low, ranging from 0.58 - 1.58%. Similarly, the ash content was also minimal, varying between 0.39 - 0.58%. However, previous studies have reported significantly higher ash content in jackfruit seeds grown in certain regions, suggesting that geographical and environmental factors may influence mineral composition (Ocloo *et al*., 2010; Abedin *et al*., 2012).

Table 2 presents the results of the metal content analysis for the Thai, Nghe, and Dua jackfruit seed varieties. Among these, the Dua variety exhibited the highest calcium content at 8.81 mg/100 g, followed by the Nghe variety at 6.90 mg/100 g, and the Thai variety at 5.19 mg/100 g. In contrast, a previous study reported significantly lower calcium levels in the Khaja, Gala, and Durosha jackfruit seed varieties, with values ranging from 0.02 - 0.38 mg/100 g. These differences suggested that calcium content in jackfruit seeds may vary considerably depending on the variety and growing conditions (Abedin *et al*., 2012).

According to Ocloo *et al*. (2010), jackfruit seed powder contains a substantial amount of calcium (3087 mg/kg), iron (130.74 mg/kg), sodium (60.66 mg/kg), and manganese (1.12 mg/kg). While the calcium content of the Thai jackfruit seed starch in the present work was relatively high compared to the other two varieties analysed, it was significantly lower than the levels reported by Ocloo *et al*. (2010). Similarly, although the sodium content in the three studied jackfruit seed varieties was relatively high, it was still lower than the sodium content found in jackfruit seed powder in Ocloo *et al*. (2010)'s study. These differences may be attributed to variations in sample preparation, processing methods, or environmental factors affecting mineral composition.

The iron content in all three studied jackfruit varieties ranged from 0.81 - 1.08 mg/100 g, which was significantly lower than the value reported by Ocloo *et al.* (2010) for jackfruit seed powder (13.074

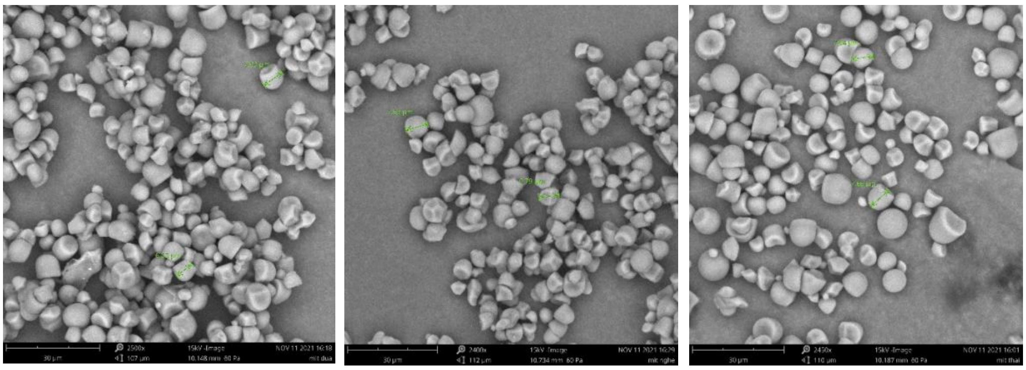
mg/100 g), approximately ten times higher. Similarly, the zinc and magnesium contents in the three studied jackfruit varieties were considerably lower than those reported by Abedin *et al*. (2012). In their study, the jackfruit seed powder of the Khaja, Gala, and Durosha varieties contained remarkably high zinc levels of 1,500, 2,333, and 3,100 mg/100 g, respectively, as well as magnesium contents of 150.7, 168.7, and 210.0 mg/100 g, respectively. These significant discrepancies suggested that mineral content in jackfruit seeds may be highly influenced by variety, environmental factors, and processing methods (Abedin *et al*., 2012).

Morphological characteristics of three types of jackfruit seed starch are shown in Figure 2. The starch granules exhibited a circular and bell-shaped morphology, with particle sizes ranging from 6.03 - 7.66 μm. These findings agreed with the observations reported by Kittipongpatana and Kittipongpatana (2011), though some small, deformed, and fractured granules were observed, likely due to the extraction or grinding process prior to starch characterisation. SEM analysis further revealed that, despite the distinct external shapes of the seeds among the three jackfruit varieties, the starch granule morphology remained largely consistent across all samples, showing no significant structural differences.

Physical and chemical properties of jackfruit seed starch

Swelling power

The swelling power of jackfruit seed starch varied among the three studied varieties, as illustrated in Figure 3. This functional property is a crucial characteristic influencing the potential applications of jackfruit seed starch. The swelling index values for Thai, Nghe, and Dua jackfruit seed starches were 13.48, 11.19, and 8.19%, respectively, with Thai jackfruit seed starch exhibiting the highest swelling power. Ocloo *et al*. (2010) reported that the swelling index of jackfruit seed starch from three different varieties ranged from 8.79 - 12.93%, depending on the starch extraction method. This variability can be attributed to differences in fat and amylose contents, as higher fat contents reduce water absorption and swelling power (Ocloo *et al*., 2010).



(a) (b) (c)

Figure 2. SEM images of seed starch from three jackfruit varieties: **(a)** Thai, **(b)** Nghe, and **(c)** Dua.

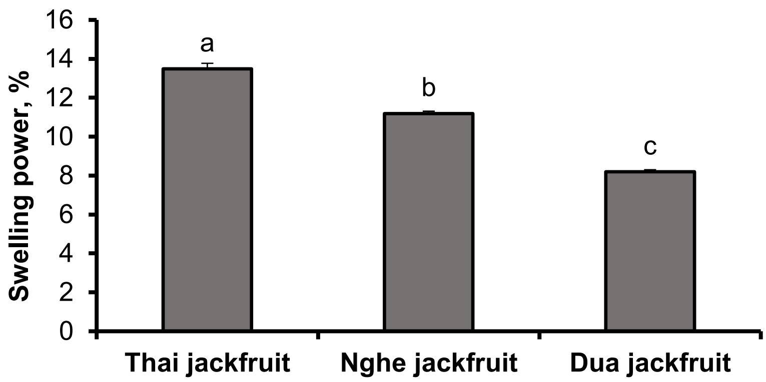


Figure 3. Swelling power of seed starch from three jackfruit varieties.

Oil absorption capacity

Oil absorption capacity is a crucial functional property that enhances the mouthfeel of food products while helping to retain their flavour (Iwe *et al*., 2016). The ability of proteins in food to bind oil and water is influenced by intrinsic factors such as protein structure, amino acid composition, and surface polarity or hydrophobicity. These properties play a key role in determining the functionality and application of starch and protein-rich ingredients in food formulations (Chandra and Samsher, 2013).

Figure 4 shows that Thai jackfruit seed starch exhibits the highest oil absorption capacity at 26.73%, while Nghe jackfruit has the lowest at 19.42%. The oil absorption capacity of Dua jackfruit seed starch is nearly equivalent to that of Thai jackfruit at 25.66%. In comparison, previous studies have reported significantly higher oil absorption capacities for jackfruit seed flour. Tulyathan *et al*. (2002) found that jackfruit seed flour can absorb up to 92.6% oil, while Singh *et al*. (1991) reported a similarly high value of 90.2%. Additionally, Akter and Haque (2018) observed an even greater oil absorption capacity of 126.9% for jackfruit seed flour. These substantial differences may be attributed to variations in composition, processing methods, and the presence of proteins and lipids, which can enhance oil-binding properties.

Gelation ability

Gelation is a critical functional property in food products, contributing to their structural integrity, elasticity, and characteristic sponginess, which define various food textures.

The gel-forming abilities of starch from three jackfruit varieties—Thai, Nghe, and Dua—were 5.33 ± 0.67, 6.67 ± 0.67, and 8.67 ± 0.67%, respectively (Figure 5). Among these, Dua jackfruit starch exhibited the highest gel-forming ability. During the gelatinisation process, starch granules absorb water and swell upon heating, leading to the formation of a gel network. The differences in gelation ability among the three varieties may be attributed to variations in amylose and amylopectin content, as well as differences in starch granule structure and interactions with water.

A study by Adewumi *et al*. (2020) on the gel-forming ability of natural and modified starches from coco, white, and bitter yam found that none of the starches formed a gel at 2 or 4% concentration. However, all types successfully formed a strong gel at concentrations of 8% or higher (Adewumi *et al*., 2020). Additionally, a comparative study on the rheological properties of jackfruit seed, potato, and rice—analysed using a texture analyser (TA.XT Plus, Stable Micro Systems, United Kingdom) with a flat cylindrical probe (P/75 mm)—demonstrated that jackfruit seed starch exhibited significantly higher hardness, springiness, and elasticity compared to rice and potato starches. However, it had a lower breaking force, indicating a strong gel-forming ability. This unique characteristic makes jackfruit seed starch particularly suitable for food applications requiring elastic and firm gel textures, such as in confectionery, dairy products, and plant-based texturising agents (Wong *et al*., 2021).

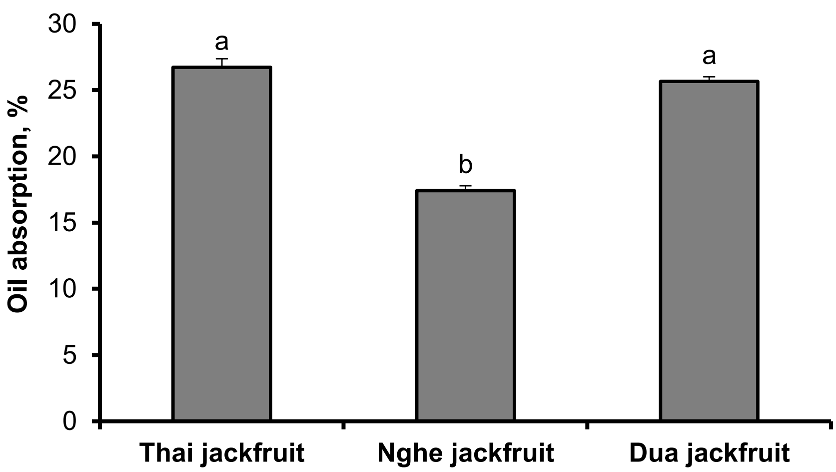


Figure 4. Oil absorption capacity of seed starch from three jackfruit varieties.

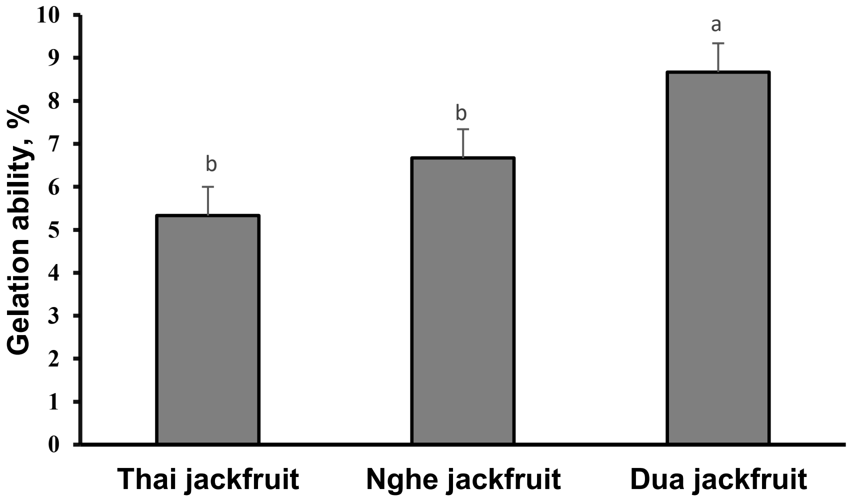


Figure 5. Gelation ability of seed starch from three jackfruit varieties.

Conclusion

The present work demonstrated that jackfruit seeds represent a significant, yet underutilised, source of valuable components, particularly resistant starch (RS), protein, and essential minerals, while containing minimal fat. Notably, starch extracted from these seeds exhibited promising functional properties, including high oil absorption, swelling capacity, and gel-forming ability, suggesting their potential as a versatile ingredient in various food applications. Specifically, the Thai jackfruit variety stood out due to its exceptionally high RS content; this starch can be used as a prebiotic ingredient in dietary supplements or as a functional thickener in low-glycaemic food formulations. The observed variations in chemical compositions and physicochemical properties across the three jackfruit varieties highlighted the importance of considering varietal differences in future applications. These findings not only validated the nutritional richness of jackfruit seeds but also paved the way for their incorporation into value-added products, contributing to both food security and waste reduction. Future research should focus on optimising extraction and processing methods to maximise the yield and functionality of jackfruit seed starch, as well as exploring its impact on human health through *in vivo* studies. Investigating the specific mechanisms underlying the high RS content in the Thai variety, and developing targeted applications in functional food formulations are also recommended.

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