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Quality characterisation of cake glazes containing tropical fruit seed powders

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Abstract: This study aims to characterise the physicochemical properties and stability of confectionery glazes made from various tropical fruit seed powders during storage. Physicochemical properties were evaluated at regular intervals throughout frozen storage to monitor quality changes. The mango seed glaze is slightly acidic, and significantly darker, with tones of green and blue. The glaze has a total soluble solid content of 73.37 °Brix, a moisture content of 19%, hardness of 46.69 g, and sagging capacity of 18.33 mm, which ensures both structural integrity and sensory appeal. Its highest viscosity among formulations suggested possible thickening and improved stability. Over 28 days, significant changes occur, with the pH stabilising to a near-neutral 6.8. The hue changes over time, migrating towards reddish tone as indicated by increasing positive *a** values, while maintaining a consistent preference for blue-toned hues with continuously negative *b** values. Moisture levels remained stable at 18.71% during storage, with minimal total soluble solid content changes, indicating sustained quality. The findings suggest that mango seed glazing is a viable option for quality preservation during storage. This study provides essential empirical insights into the potential changes in the quality characteristics of various fruit seed glazes when subjected to freezing.

Keywords: confectionery; jackfruit; mango; papaya; stability; storage

Confectionery glazes influence the visual appeal, texture, and flavour of confectionery goods. They help to provide a glossy, smooth, and aesthetically pleasing covering that enhances the overall sensory satisfaction for consumers (Subramaniam 2016). Quality characterisation of these glazes, which includes physicochemical and rheological properties, is essential to ensure consumer satisfaction and compliance with industry standards. Colour analysis is a key tool for determining the aesthetic attractiveness and consistency of the glaze coating, which is important to customers (Raihana et al. 2015). Texture has a substantial impact on the mouthfeel and overall sensory experience of confectionery items (Meza et al. 2016).

Tropical fruit seeds like jackfruit, papaya, and mango offer promising alternatives to conventional glazes (Raihana et al. 2015). Papaya (*Carica papaya*) seeds have inherent adhesive characteristics and antioxidant compounds that make it ideal for use as a glaze while also increasing shelf life and adding natural colour to glazed items (Zhou et al. 2011). Mango (*Mangifera indica*) seeds, which are rich in pectin, have excel-

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lent glazing properties, giving confectionary products a glossy appearance, enhanced texture, and a longer shelf life (Kumar et al. 2022). Jackfruit (*Artocarpus heterophyllus*) seeds, with their natural coating and starchy content, have the potential to be a sustainable alternative for synthetic glazes, with desired gloss, adhesion, and preservation properties (Brahma and Ray 2023).

Despite the growing interest in using tropical fruit seed powders as potential substitutes in confectionery glazes, there is still a major knowledge gap about the quality changes and storage stability of such glazes over time. This lack of knowledge affects the development and marketing of confectionery products containing tropical fruit seed powders, which could possibly provide consumers with healthier and more sustainable choices (Raihana et al. 2015). This study involves evaluating various quality parameters, including physicochemical properties, rheological properties, and storage stability. Such insights are critical for production of healthier and more sustainable confectionary products that meet the increased customer demand for natural and functional ingredients, while also decreasing waste by using byproducts (Subramaniam 2016).

Therefore, the primary aim of this study is to investigate the quality characteristics of confectionery glazes made from various tropical fruit seed powders during storage. Specifically, this study aims to analyse the physicochemical and rheological properties of the glazes made from different tropical fruit seed powders. Furthermore, this research seeks to evaluate the physicochemical quality of tropical fruit seed-based glazes during freeze storage.

MATERIAL AND METHODS

Raw material, chemical reagents, ingredients, and instruments

Ripe jackfruit, mango and papaya were purchased from local markets in Muar, Johor, Malaysia, for their seeds. Sugar (Gula Prai, MSM Manufacturing, Malaysia), cocoa butter (Future Food, Ghana), glucose (Rainbow Cock, Great Hope Food Industry, Malaysia), cocoa powders (Beau, Beau solution, Malaysia), and lecithin (Soy Lechitin Emulsifier, BB Soap World, Malaysia) were bought from local suppliers.

A weighing machine (OHAUS; Ohaus Corporation, USA) was used for accurate measurement of materials, while the pH meter (pH 700; Eutech Instruments, Singapore) determined pH values of developed confectionery glazes. The moisture analyser (MX-50; A&D, Japan) assessed moisture content, while the colourimeter (Miniscan EZ; Hunter Lab, USA) measured colour parameters. The total soluble solid was determined using a refractometer (RX-5000α-Plus; ATAGO, USA). The texture analyser (TA.XT Plus; Stable Micro System, UK) evaluated texture profiles, and a rheometer (Discovery HR-1 hybrid; TA Instruments, USA) measured flow and viscosity characteristics. Samples were stored in a freezer (PFZ-204G; Pensonic, Malaysia) under controlled conditions.

Preparation of cake glazes

The jackfruit, mango and papayas were weighed, washed under running water to remove unnecessary material, and then manually cleaned with the seeds removed. Jackfruit seeds were dried in an oven at 70 ± 2 °C for 10–12 h (Yatnatti et al. 2014), mango seeds at the same temperature for 10 h (Siol et al. 2022), and papaya seeds at 50 ± 2 °C for 48 h (Siol et al. 2022). The confectionery glazes were prepared by applying the formulation used by Stankov et al. (2020) with some modifications, and the detailed composition of the glazes is presented in Table 1. Water and crystalline sugar were heated to a boiling point, and the tropical fruit seed powder was added at 98 °C for 8 min. Glucose and cocoa butter was added to the resulting mass. The mixture was taken off the heat after adding the glucose and cocoa butter. The resulting mass was homogenised well to obtain a smooth consistency, luster, and desired viscosity.

Table 1. The formulation composition of the glazes

Ingredients	Amount	
	confectionery glazes (%)	control sample (%)
Water	22.98	22.98
Glucose	45.97	45.97
Cocoa butter	11.50	11.50
Sugar	11.50	11.50
Cocoa or carob seed powder	–	8.05
Jackfruit, mango, or papaya seed powder	8.05	–

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Analysis on physicochemical properties of confectionery glaze

Determination of pH value. Acccording to Tiroutchelvame et al. (2019), the pH values of developed confectionery glazes were determined using a pH meter and standardised with distilled water at pH 7.0.

Determination of total soluble solid. Five grams of each confectionery glaze was mixed with 10 mL of water. The total soluble solid content was determined once the confectionery glazes had completely melted. The samples were measured using a refractometer (Al-Dairi et al. 2021).

Moisture content analysis. The moisture content of each confectionery glaze was measured using a moisture analyser. One gram of the confectionery glaze was weighed and tested at 160 °C for 30 min (Wang et al. 2020).

Texture analysis. The hardness of each confectionery glaze was measured using a texture analyser. The conditions for measuring the hardness of the confectionery glazes were as follows: Pretest speed is 200 $mm \cdot s^{-1}$, test speed is 1.00 $mm \cdot s^{-1}$, and post-test speed is 5.00 $mm \cdot s^{-1}$. A 2-cm of each confectionery glaze was cut, and measured, with the result expressed as an average (Kim et al. 2017).

Colour analysis. The colour analysis procedure for each confectionery glaze was carried out in accordance with Chakraborty et al. (2021). The colour of confectionery glazes was measured using a colourimeter. A white plate was used as a calibration background. The colourimeter employed the L^*, a^*, b^* system, with L^* denoting lightness, a^* denoting red (+) and green (–) intensity, and b^* denoting yellow (+) and blue (–) intensity. These values resulted in coordinated chromaticity.

Determination of viscosity. The viscosity of each confectionery glaze was determined using the method described by Stankov et al. (2020). The viscosity of the samples was defined via a shear rate ranging from 0.17 to 72.9 s^{-1} at 30 °C. The dynamic viscosity (η) was calculated using Equation 1.

$$\eta = \frac{\tau}{D} \tag{1}$$

where: τ – shear stress (Pa); *D* – shear rate (s^{-1}).

Storage stability. Each confectionery glaze was packaged separately in a polypropylene airtight container and stored in a chest freezer maintained at –18 °C for one month for storage stability study (de Carvalho Tavares et al. 2020). During freeze storage, the glazes were examined weekly (day 0, 7, 14, 21, and 28) for appearance and any changes that occurred during storage. The frozen glaze samples were thawed prior to being evaluated for stability.

Statistical analysis. All physicochemical parameters and storage stability evaluation data were expressed as the mean of three replicates and standard deviation. The significance of differences at 95% confidence interval ($P < 0.05$) were determined using analysis of variance (ANOVA) and followed by Tukey's Honestly Significant Difference (HSD) Test using IBM SPSS Statistics (Version 23) (Wahid and Khattak 2020).

RESULTS AND DISCUSSION

Physicochemical properties of confectionery glaze. Table 2 displays the findings of the physicochemical properties analysis of confectionery glaze.

The jackfruit and papaya seed glazes have pH levels of 7.12 and 7.37, respectively. A previous study reported that jackfruit seed isolated from Cameroon's eastern forests has a low pH of 6 (Kamdem Bemmo et al. 2023). While papaya seed from the *Formosa* cultivar also has a low pH of 5.8 (Alam et al. 2024).

The total soluble solids measurements serve as an important indicator of the sugar concentration in confectionery glazes. The results imply that the incorporation of fruit seed powders influences the sugar concentration in the glazes. The carob seed glaze has the highest total soluble solids of 76.34 °Brix. This high sugar concentration may contribute to sweetness of the glaze and improve its sensory appeal. The mango seed glaze has the lowest total soluble solids of 73.37 °Brix. This is in line with prior research by Diarra (2014), which showed that mango seed powder exhibits a comparatively lower sugar content because it has a high carbohydrate content documented at value range of 58–80%.

The moisture content analysis revealed significant differences between the various glazes. The cocoa glaze had relatively higher moisture content of 21.55%, while the jackfruit seed glaze had the lowest moisture content of 15.69%. The low moisture content of jackfruit seed glaze could be attributed to the unique composition of jackfruit seeds, which may have lesser hygroscopic properties than other seeds. This characteristic is consistent with the observed lower moisture content in the glaze, indicating a possibility of longer shelf life due to reduced water activity, which is crucial in inhibiting microbial growth and maintaining product quality. Mesquita et al. (2022) discovered that papaya seed extracts had a significant water-binding and hy-

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Table 2. Result of physicochemical properties analysis of confectionery glaze

Type of glaze	Physicochemical properties						
	pH	total soluble solid (°Brix)	moisture (%)	hardness (g)	*L**	*a**	*b**
Cocoa glaze (control)	8.26 ± 0.87[b]	72.02 ± 1.08[a]	21.55 ± 1.84[b]	45.12 ± 0.97[a]	23.16 ± 0.17[a]	−2.32 ± 0.12[b]	−4.77 ± 0.92[b]
Carob seed glaze (control)	7.57 ± 1.68[b]	76.34 ± 0.32[b]	20.82 ± 0.96[b]	48.94 ± 1.78[b]	22.92 ± 0.32[a]	−2.67 ± 0.12[b]	−0.74 ± 0.25[c]
Jackfruit seed glaze	7.12 ± 0.20[a]	75.59 ± 0.43[b]	15.69 ± 1.20[a]	47.05 ± 0.73[ab]	26.01 ± 0.13[c]	1.42 ± 0.27[d]	2.69 ± 0.16[d]
Mango seed glaze	7.79 ± 0.48[b]	73.37 ± 0.23[a]	19.00 ± 1.39[ab]	46.69 ± 1.02[ab]	25.54 ± 0.29[c]	−3.83 ± 0.42[a]	−5.36 ± 0.06[a]
Papaya seed glaze	7.37 ± 1.25[a]	75.11 ± 0.19[b]	20.83 ± 2.08[b]	52.16 ± 0.74[c]	24.51 ± 0.19[b]	−1.13 ± 0.25[c]	−4.99 ± 0.11[b]

[a–d] Means in the same column marked with different letters show significant differences ($P < 0.05$); data are expressed as mean ± SD (standard deviation); *L** – lightness; *a** – red (+) and green (–) intensity; *b** – yellow (+) and blue (–) intensity

drophilic capacity due to their polysaccharide content, which may have contributed to the higher moisture content of the papaya seed glaze.

The cocoa glaze served as a baseline, with a measured hardness of 45.12 g. Among the experimental glazes, the carob seed glaze had a significantly higher hardness of 48.94 g, while the papaya seed glaze had an even higher hardness of 52.16 g compared to the cocoa glaze. The higher hardness observed in the carob-based glaze suggests a potential trend toward increased textural strength or firmness when compared to both the control and other experimental glazes. This discovery is consistent with the reports made by Basharat et al. (2023), who emphasise the binding properties of carob in food applications, which enhance structural integrity. According to Gazwi et al. (2023), papaya seed powders contained polyphenol compounds such as quercetin, apigenin and catechin, which may contain enzymatic compounds that when exposed to specific storage conditions, could potentially compromise the texture of food products.

*L** values indicate the lightness or darkness of the glazes. The jackfruit seed glaze has the highest *L** value of 26.01, indicating a significantly lighter colour than the other evaluated glazes. The carob seed glaze has the lowest *L** value of 22.92, which is comparable to the darkness level of cocoa glaze and indicates a darker shade compared to the other samples. The darkness is due to the presence of pigments or compounds in carob seeds that have increased light-absorbing capabilities, thereby contributing to its darker appearance. Basharat et al. (2023) found that the direct impact of seed composition variations on colour parameters in food products, confirming the lower *L** value observed in the carob seed glaze.

The *a** values show significant differences along the red-green axis among the tested glazes. The mango seed glaze has an *a** value of –3.83, suggesting a shift towards the green spectrum. This tendency toward greenness is due to specific compounds or pigments found in mango seeds, which result in greenish tones. The jackfruit seed glaze has the highest *a** value of 1.42, indicating a pronounced tendency towards redness. The specific compounds or pigments present in jackfruit seeds are responsible for contributing to their reddish appearance.

The *b** values of the studied glazes display significant differences along the yellowness-blueness axis. The jackfruit seed glaze has the highest *b** value of 2.69, indicating a significant shift towards the yellow spectrum. This significant yellow hue has the potential to improve the visual appeal of products coated with this glaze, therefore appealing to consumer preferences. Conversely, the mango seed glaze has the lowest *b** value of –5.36, indicating an increased tendency towards the blue spectrum. The differences in yellowness and blueness among the glazes can be attributed to the various pigments or compounds inherent in different fruit seed powders.

Figure 1 illustrates the relationship between viscosity and shear rate, with flow curves explaining the rheological behaviour of the glazes added with cocoa, carob seed powder and tropical fruit seeds powder. The cocoa glaze exhibits non-Newtonian behaviour, with viscosity

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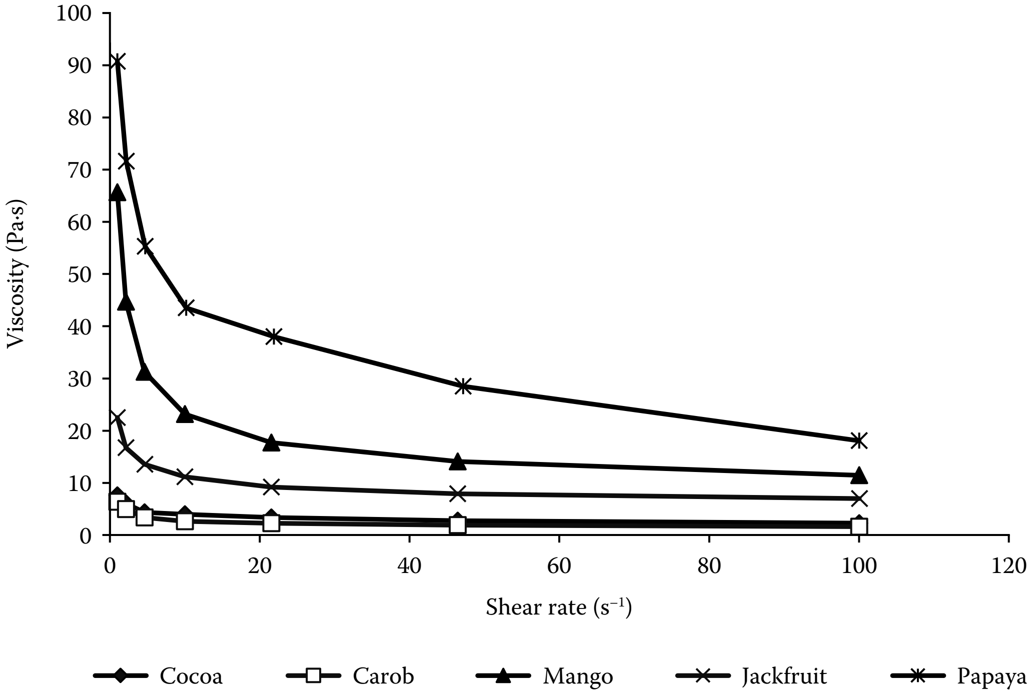

Figure 1. The flow curve of four samples and a control of tropical fruit seeds confectionery glaze depending on the shear rate at 30 °C

decreasing as the shear rate increases (Meza et al. 2016). The carob seed glaze shows a similar trend but consistently lower viscosity values across all shear rates. Both mango seed and jackfruit seed glazes have decreasing viscosity trends, but with significantly higher viscosity values, especially at lower shear rates. The papaya seed glaze behaves differently from other glazes, with a sharp decrease in viscosity as shear rate increases. This finding indicates the diverse rheological responses influenced by different seed powders (Meza et al. 2016). This decreasing viscosity trend emphasises the unique flow behaviour of the papaya seed glaze and indicates potential challenges in maintaining structural stability during storage compared to other formulations.

Physicochemical analysis of tropical fruit seed confectionery glaze during storage. Table 3 shows the physicochemical properties of tropical fruit seed confectionery glaze over a 28-day storage period. The pH values of confectionery glazes made from various tropical fruit seed powders demonstrate a stability trend over the storage period. Initial pH levels varied significantly amongst different fruit seed glazes, with the highest initial pH recorded. The minimal variation and lack of a consistent increasing or decreasing trend indicate that the glazes have a stable pH profile.

There were significant differences in total soluble solids (TSS) values between the glazes, suggesting variations in the amount of soluble solids present. Mango and jackfruit seed glazes tended to slightly increase TSS with time, suggesting that concentration or composition may change while being stored. The stability or minimal change in the TSS content observed during the storage period may be related to moisture loss or other physicochemical processes in the glazes, as indicated by the consistency or slight increase in TSS values observed across these glazes. When compared to other formulations, the TSS values of the carob seed glaze were consistently higher during the 28-day storage period. The gradual increase in TSS values suggests that there may be a concentration effect or limited moisture loss, which highlights the stability or controlled changes in this glaze during storage.

Moisture content significantly impacts the texture, shelf life, and overall quality of food products. There was a consistent increasing trend in moisture content across these glazes, indicating an uptake of moisture from the environment or internal composition changes affecting water retention. Despite starting with the high moisture content, the cocoa glaze tended to increase further during storage.

It was discovered that papaya seed glaze had the highest hardness, while cocoa glaze had the lowest. Initially, papaya seed glaze had the highest texture value, maintaining consistency until day 21, when a significant de-

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Table 3. Physicochemical analysis values of tropical fruit seed confectionery glaze during storage

Type of glaze	Storage (days)	Physicochemical properties						
		pH	total soluble solid (°Brix)	moisture (%)	hardness (g)	L^*	a^*	b^*
Cocoa glaze (control)	0	8.26 ± 0.87^{b}	72.02 ± 1.08^{a}	21.55 ± 1.84^{b}	45.12 ± 0.97^{a}	23.16 ± 0.17^{b}	−2.32 ± 0.12^{b}	−4.77 ± 0.92^{b}
	7	6.81 ± 0.03^{a}	72.51 ± 0.77^{a}	21.91 ± 1.84^{b}	44.30 ± 1.12^{a}	20.17 ± 0.04^{a}	−3.71 ± 2.12^{a}	−5.51 ± 0.66^{a}
	14	6.86 ± 0.04^{a}	73.36 ± 0.08^{a}	22.25 ± 1.12^{c}	43.88 ± 1.24^{a}	19.98 ± 0.61^{a}	−3.66 ± 0.05^{a}	−5.58 ± 0.13^{a}
	21	6.90 ± 0.07^{a}	73.43 ± 0.19^{a}	22.51 ± 0.47^{c}	43.88 ± 1.24^{a}	19.53 ± 0.57^{a}	−4.21 ± 0.56^{a}	−5.96 ± 0.19^{a}
	28	6.85 ± 0.11^{a}	73.50 ± 0.15^{a}	22.86 ± 0.12^{d}	44.55 ± 1.07^{a}	19.57 ± 0.53^{a}	−4.55 ± 0.42^{a}	−5.77 ± 0.09^{a}
Carob seed glaze (control)	0	7.57 ± 1.68^{b}	76.34 ± 0.32^{d}	20.82 ± 0.96^{b}	48.94 ± 1.78^{b}	22.92 ± 0.32^{a}	−2.67 ± 0.12^{b}	−0.74 ± 0.25^{c}
	7	6.56 ± 0.09^{a}	76.20 ± 0.75^{d}	20.91 ± 0.97^{b}	47.62 ± 1.64^{b}	20.53 ± 0.53^{a}	−2.78 ± 0.95^{b}	−0.77 ± 0.37^{c}
	14	6.62 ± 0.10^{a}	76.74 ± 0.15^{d}	21.52 ± 0.13^{b}	46.53 ± 1.59^{b}	20.23 ± 0.30^{a}	−2.73 ± 0.32^{b}	−0.85 ± 0.01^{c}
	21	6.66 ± 0.16^{a}	76.81 ± 0.08^{d}	21.72 ± 0.23^{c}	46.53 ± 1.59^{b}	19.60 ± 0.17^{a}	−2.92 ± 0.32^{b}	−1.26 ± 0.37^{c}
	28	6.78 ± 0.95^{a}	76.84 ± 0.13^{d}	21.73 ± 0.14^{c}	43.20 ± 0.49^{a}	19.39 ± 0.21^{a}	−4.38 ± 0.10^{a}	−0.97 ± 0.05^{c}
Jackfruit seed glaze	0	7.12 ± 0.20^{a}	75.59 ± 0.43^{c}	15.69 ± 1.20^{a}	47.05 ± 0.73^{b}	26.01 ± 0.13^{d}	1.42 ± 0.27^{c}	2.69 ± 0.16^{d}
	7	6.81 ± 0.06^{a}	75.62 ± 0.46^{c}	16.75 ± 0.32^{a}	46.01 ± 0.86^{b}	27.53 ± 0.37^{d}	1.21 ± 0.04^{c}	−3.78 ± 0.03^{b}
	14	6.84 ± 0.55^{a}	76.63 ± 0.23^{d}	19.19 ± 1.05^{a}	44.93 ± 0.39^{ab}	26.40 ± 0.13^{d}	1.24 ± 0.03^{c}	−3.86 ± 0.01^{b}
	21	6.79 ± 0.03^{a}	76.76 ± 0.20^{d}	17.73 ± 0.33^{a}	44.92 ± 0.38^{ab}	25.83 ± 0.71^{c}	1.51 ± 0.58^{c}	−3.64 ± 0.57^{b}
	28	6.83 ± 0.05^{a}	76.79 ± 0.21^{d}	17.77 ± 0.27^{a}	42.69 ± 1.02^{a}	25.61 ± 0.43^{c}	1.34 ± 0.28^{c}	−3.37 ± 0.03^{b}
Mango seed glaze	0	7.79 ± 0.48^{b}	73.37 ± 0.23^{a}	19.00 ± 1.39^{a}	46.69 ± 1.02^{b}	25.54 ± 0.29^{c}	−3.83 ± 0.42^{a}	−5.36 ± 0.06^{a}
	7	6.64 ± 0.30^{a}	74.69 ± 0.30^{b}	19.14 ± 1.08^{ab}	47.29 ± 0.61^{b}	24.36 ± 0.14^{b}	−0.26 ± 0.05^{c}	−5.62 ± 0.05^{a}
	14	6.74 ± 0.13^{a}	74.90 ± 0.61^{b}	19.79 ± 0.46^{b}	48.39 ± 0.28^{b}	23.72 ± 0.32^{b}	−0.29 ± 0.06^{c}	−5.48 ± 0.33^{a}
	21	6.81 ± 0.09^{a}	74.85 ± 0.11^{b}	19.69 ± 0.21^{b}	48.39 ± 0.28^{b}	24.08 ± 0.71^{b}	−0.54 ± 0.53^{c}	−5.93 ± 0.16^{a}
	28	6.84 ± 0.11^{a}	74.91 ± 0.07^{b}	20.06 ± 0.43^{b}	48.95 ± 0.53^{b}	23.58 ± 0.71^{b}	−0.04 ± 0.55^{c}	−5.02 ± 0.86^{a}
Papaya seed glaze	0	7.37 ± 1.25^{a}	75.11 ± 0.19^{c}	20.83 ± 2.08^{b}	52.16 ± 0.74^{c}	24.51 ± 0.19^{b}	−1.13 ± 0.25^{c}	−4.99 ± 0.11^{b}
	7	6.76 ± 0.19^{a}	75.77 ± 0.12^{c}	21.50 ± 1.33^{b}	51.31 ± 1.06^{c}	22.48 ± 0.26^{b}	−1.48 ± 0.26^{c}	−5.52 ± 0.03^{a}
	14	6.79 ± 0.15^{a}	75.63 ± 0.37^{c}	21.94 ± 1.07^{c}	50.56 ± 0.47^{c}	21.82 ± 0.43^{b}	−1.36 ± 0.09^{c}	−5.78 ± 0.10^{a}
	21	6.92 ± 0.05^{a}	75.64 ± 0.35^{c}	22.29 ± 0.33^{c}	50.65 ± 0.47^{c}	22.21 ± 0.47^{b}	−1.16 ± 0.53^{c}	−5.67 ± 0.47^{a}
	28	6.94 ± 0.03^{a}	75.81 ± 0.15^{c}	22.41 ± 0.58^{c}	42.41 ± 1.78^{a}	21.73 ± 0.17^{b}	−1.65 ± 0.03^{c}	−5.72 ± 0.35^{a}

[a–d] Means in the same column marked with different letters show significant differences ($P < 0.05$); data are expressed as mean ± SD (standard deviation); L^* – lightness; a^* – red (+) and green (–) intensity; b^* – yellow (+) and blue (–) intensity

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crease was observed. Carob, jackfruit and papaya seed glazes showed texture changes over time, implying significant alterations in consistency or structural properties during storage. These textural variations are caused by inherent compositional differences, moisture changes, or interactions among ingredients, all of which affect the structural integrity of the glazes over time.

The lightness (L^*) values of confectionery glazes made from tropical fruit seed powders exhibit significant trends and differences among the formulations. The L^* values of jackfruit and mango seed glazes consistently decrease over time, indicating a tendency towards darker hues. The minor variations in L^* values observed in these glazes during storage could be influenced by various factors, such as oxidation, moisture content, or interactions between components, all of which can affect the colour stability of food products. Jackfruit seed glaze initially had the highest L^* among the glazes. However, the L^* decreases with the storage duration. Despite this reduction, jackfruit seed glaze maintained relatively higher L^* values than other formulations at each time point.

The a^* values, which represent the red-green colour axis, vary significantly in tropical fruit seed glazes over storage. The red-green colour aspect influences the perceived hue and visual appeal of food products (Muniz et al. 2023). The variations in a^* values among these glazes are due to compositional changes, oxidative reactions, or interactions between the constituents during storage. The increasing trend in a^* values indicate specific biochemical reactions or interactions occur within the jackfruit seed glaze, influencing its red hue during storage (Muniz et al. 2023). Despite initial differences, the mango seed glaze shifted towards higher redness values, which could be due to compositional changes or alterations in pigment compounds during storage (Kumar et al. 2023).

The b^* values, which indicate the yellow-blue colour axis, vary significantly among the tropical fruit seed glazes during storage. Jackfruit seed glaze has the highest initial b^* value of the samples, but it gradually decreases to more negative values over storage. Although initially more blue-toned, this glaze shifts towards yellowish hues over time, displaying a noticeable change along the yellow-blue colour axis. This tendency may indicate specific biochemical reactions or interactions in the jackfruit seed glaze, influencing its colour profile during storage (Muniz et al. 2023). The mango seed glaze had the most negative initial b^* value. This glaze maintains negative b^* values throughout storage, suggesting a stable tendency towards blue-toned colours. Despite initial differences, the mango seed glaze showed a slight decrease in negative values, which could indicate minor changes in the yellow-blue colour axis during storage (Kumar et al. 2023).

CONCLUSION

This study discovered significant differences in key parameters among glazes made from various tropical fruit seeds. The mango seed glaze showed promise, with a slightly darker appearance and favourable rheological properties. It remained stable in pH, total soluble solids, moisture content, and texture during freeze storage. The outcomes of this study provide valuable insights regarding the resilience and potential changes in the quality attributes of these glazes when stored under freezing conditions.

REFERENCES

Al-Dairi M., Pathare P.B., Al-Yahyai R. (2021): Chemical and nutritional quality changes of tomato during postharvest transportation and storage. Journal of the Saudi Society of Agricultural Sciences, 20: 401–408.

Alam M., Hasan M.M., Debnat M.K., Alam A., Zahid M.A., Alim M.A., Rahman M.N., Molla M.M., Khan M.R., Biswas M. (2024): Characterization and evaluation of flour's physico-chemical, functional, and nutritional quality attributes from edible and non-edible parts of papaya. Journal of Agriculture and Food Research, 15: 100961.

Basharat Z., Afzaal M., Saeed F., Islam F., Hussain M., Ikram A., Pervaiz M.U., Awuchi C.G. (2023): Nutritional and functional profile of carob bean (*Ceratonia siliqua*): A comprehensive review. International Journal of Food Properties, 26: 389–413.

Brahma R., Ray S. (2023): Finding out various potentials and possibilities of jackfruit seed and its usage in the industry: A review. Food Production, Processing and Nutrition, 5: 55.

Chakraborty R., Samanta R., Das S. (2021): Preservation of Aloe vera and soybean flour fortified Granny Smith apple through optimised quartz-halogen radiated vacuum drying: Kinetics and quality evaluation. Journal of the Science of Food and Agriculture, 101: 3564–3574.

de Carvalho Tavares I.M., Sumere B.R., Gómez-Alonso S., Gomes E., Hermosín-Gutiérrez I., Da-Silva R., Lago-Vanzela E.S. (2020): Storage stability of the phenolic compounds, color and antioxidant activity of jambolan juice powder obtained by foam mat drying. Food Research International, 128: 108750.

Diarra S.S. (2014): Potential of mango (*Mangifera indica* L.) seed kernel as a feed ingredient for poultry: A review. World's Poultry Science Journal, 70: 279–288.

Gazwi H.S., Soltan O.I., Abdel-Hameed S.M. (2023): Cakes fortified with papaya seeds effectively protects against CCl4-induced immunotoxicity. Environmental Science and Pollution Research, 30: 111511–111524.

Kamdem Bemmo U.L., Bindzi J.M., Tayou Kamseu P.R., Houketchang Ndomou S.C., Tene Tambo S., Ngoufack Zambou F. (2023): Physicochemical properties, nutritional value, and antioxidant potential of jackfruit (*Artocarpus heterophyllus*) pulp and seeds from Cameroon eastern forests. Food Science & Nutrition, 11: 4722–4734.

Kumar A., Hasan M., Mangaraj S., Pravitha M., Verma D.K., Srivastav P.P. (2022): Trends in edible packaging films and its prospective future in food: A review. Applied Food Research, 2: 100118.

Kumar S., Seluriyal P., Sharma S., Kumar V., Bisht B., Joshi S., Dobhal A., Saikumar A. (2023): Functional and nutritional prospectives of low-fat cookies fortified with jamun pulp, jamun seed, mango kernel powder. Applied Food Research, 3: 100340.

Mesquita M.d.S., Santos P.D.d.F., Holkem A.T., Thomazini M., Rodrigues C.E.d.C., Fernandes A.M., Favaro-Trindade C.S. (2022): Papaya seeds (*Carica papaya* L. var. *Formosa*) in different ripening stages: Unexplored agro-industrial residues as potential sources of proteins, fibers and oil as well as high antioxidant capacity. Food Science and Technology, 43: e105422.

Meza B.E., Peralta J.M., Zorrilla S.E. (2016): Rheological characterization of full-fat and low-fat glaze materials for foods. Journal of Food Engineering, 171: 57–66.

Muniz V.R.G.d.F., Ribeiro I. S., Beckmam K.R.L., de Godoy R.C.B. (2023): The impact of color on food choice. Brazilian Journal of Food Technology, 26: e2022088.

Raihana A.R.N., Marikkar J.M.N., Amin I., Shuhaimi M. (2015): A review on food values of selected tropical fruits seeds. International Journal of Food Properties, 18: 2380–2392.

Siol M., Sadowska A., Król K., Najman K. (2022): Bioactive and physicochemical properties of exotic fruit seed powders: Mango (*Mangefiera indica* L.) and rambutan (*Nephelium lappaceum* L.) obtained by various drying methods. Applied Sciences, 12: 4995.

Stankov S., Dzhivoderova-Zarcheva M., Dimitrova E., Damyanova-Bakardzhieva M., Fidan H. (2020): Rheological and sensory properties of glazes prepared with carob and cocoa powders. Journal of Food Processing and Preservation, 44: 14580.

Subramaniam P. (2016): The stability and shelf life of confectionery products. In: Subramaniam P. (ed.): The Stability and Shelf Life of Food. Cambridge, United Kingdom, Woodhead Publishing (Elsevier): 545–573.

Tiroutchelvame D., Maran J.P., Pragalyaashree M.M. (2019): Response surface analysis and optimization of osmotic dehydration of *Musa acuminata* slices. The Journal of Microbiology, Biotechnology and Food Sciences, 8: 1016.

Wahid N.R., Khattak M.M.A.K. (2020): An assesment of acceptibitlty of sensory attributes of chips cooked by pan frying method from mushroom, herbs and spices. International Journal of Allied Health Sciences, 4: 1535–1546.

Wang H., Yang Q., Ferdinand U., Gong X., Qu Y., Gao W., Ivanistau A., Feng B., Liu M. (2020): Isolation and characterization of starch from light yellow, orange, and purple sweet potatoes. International Journal of Biological Macromolecules, 160: 660–668.

Yatnatti S., Vijayalakshmi D., Chandru R. (2014): Processing and nutritive value of mango seed kernel flour. Current Research in Nutrition and Food Science Journal, 2: 170–175.

Zhou K., Wang H., Mei W., Li X., Luo Y., Dai H. (2011): Antioxidant activity of papaya seed extracts. Molecules, 16: 6179–6192.

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