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Development and Acceptability of Jackfruit (*Artocarpus heterophyllus*) Seed Cereal

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Abstract:*This study developed a cereal product using jackfruit seed (Artocarpus heterophyllus) as the main ingredient and evaluated its sensory acceptability across three formulations. It assessed the sensory attributes including appearance, aroma, taste, texture, and overall appeal, and identified any significant differences among formulations. The study also sought to analyze the physicochemical composition of the most preferred formulation. The study involved 120 respondents composed of food technology experts and consumers. Sensory evaluation was done using a hedonic scale, and data were statistically treated using frequency counts, means, standard deviations, MANOVA, ANOVA, and post hoc tests. Results showed that Formulation B consistently received the highest ratings, with all sensory attributes rated as "Like Very Much," significantly outperforming Formulations A and C, which were rated only as "Like Moderately." The most preferred formulation, B, contained 23.8 g total fat, 6.77 g crude protein, and 6.29 g total sugar per 100 g, indicating it is not only sensorially acceptable but also nutritionally beneficial.*

Keywords: Jackfruit seed cereal, sensory evaluation, formulation comparison, physicochemical analysis, consumer preference

I. INTRODUCTION

Jackfruit, a tropical fruit of Artocarpus heterophyllus, is widely cultivated for its nutrient-rich flesh and seeds. The jackfruit seed or also known as langka nuts, which is typically wasted, contains starch, protein, and dietary fiber, which makes it a good candidate for food innovation, Ranasinghe et. Al (2019). This study explores the possibility of using the jackfruit seed as the principal ingredient in creating a new cereal product. This research is based on the growing global demand for sustainable and nutritious food and addresses the twin challenges of food security and agricultural waste management Odimegwu (2019). Making a new cereal product from jackfruit seeds for a plant-based healthy cereal. Cereal is a staple enjoyed for its convenience and palatability. Still, many consumer-focused commodity ready-to-eat commercial cereals are low in fiber, high in sugar, and offer limited amounts of other nutrients needed for the balanced health benefits that many consumers desire. Overcoming these drawbacks is the aim of this research where a nut-supplemented low-fat cereal with Protein; fiber, healthy fat, and micro-repair particles have been developed. The prior research has revealed that plant-based ingredients, including jackfruit seeds, can be used to develop high-quality food products that could fulfill the customers' increasing requirements for nutritious foods Tachie et al., (2023). The idea is to serve a good healthy tasty breakfast Commodity to solve the problem of healthy Food.

Several researchers have already pointed out the nutritional composition of jackfruit seeds. They can be used as a source of gluten-free starch, antioxidants, essential amino acids, and bioactive compounds Purohit et. al (2024). The addition of jackfruit seeds to baked goods and snack foods can also enhance the nutritional contents of the product Mohammed et.al (2024). However, its full application in ready-to-eat cereal products has not been studied yet, considering its potential health benefits Lopez (2024). This study bridges the gap by using jackfruit seeds to develop a cereal that meets both consumer acceptability and nutritional requirements. Important gaps in the literature are that there is hardly any research in the area of consumer preference and sensory evaluation of jackfruit seed-based cereal, whereas nutritional potential has been established but very few studies have worked on a market-ready product which satisfies expectation of taste, texture, and convenience Lopez (2024). There seems to be a lack of research in functionality of jackfruit seed flour to be used for extrusion or flaking processes for cereal production. These gaps point

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out a need for systemic research into the process of product development and consumer acceptance. Recent progress in functional food development and sustainability practice supports this study. A paper by Brito et al. (2020) proved that the utilization of fruit byproducts is possible for innovation in food. Fruit by-products can provide some environmental and nutritional benefits. On the other hand, a study by Maniaga et al. (2024) assessed the incorporation of non-conventional ingredients, mango seed, and tamarind seed into cereal formulation. This also resulted in acceptance among consumers, and the product enhanced nutritional properties. These research findings are some of the founding grounds for the study, urging further researches with this ingredient of novel cereal.

This study aimed to create a jackfruit seed cereal and evaluate its acceptability in terms of sensory attributes, such as taste, texture, appearance, and aroma. Furthermore, this research aimed to analyze the product's nutritional composition in order to be in compliance with dietary guidelines for breakfast cereals. In doing so, this research aims to support the body of knowledge in terms of functional foods and sustainable food systems while promoting a solution towards reducing food waste as well as ensuring healthy eating practices. It also concerns local agriculture and sustainability. With the use of the underrated yet packed with nutrients, the study could have paved the way for better handling of the langka nuts, thus helping reduce post-harvest waste from jackfruits. In addition, by advocating for locally available nuts in the recipes for preparing these foods, this research may unveil fresh revenue-making prospects for farmers in areas where jackfruit is grown. In the long run, the results of this study can contribute to the design of other innovative, healthy, locally sourced food appealing to consumers and sustainable food production.

In general, this research seeks to combine nutritional findings with consumers' demands by exploring ways to improve consumers' convenient diets using nutrient-dense locally available products. Such an approach can promote not only consumer education and health but also the local economy and sustainability of food production.

II. LITERATURE REVIEW

Nutritional Profile of Jack Fruit Seeds

Jackfruit seeds are a valuable but underutilized resource because of their high nutritional content, which includes carbohydrates, proteins, dietary fiber, and essential minerals. Hu (2024) research showed that jackfruit seeds have high resistant starch levels, which is good for gut health . Brito et al. (2020) also pointed out that they are a potential gluten-free ingredient with bioactive compounds, thus ideal for functional food development. As established jackfruit seeds are brightly acknowledged in terms of nutritional benefits and it is good source of carbohydrates, protein, dietary fiber and some minerals. According to Nabubuya et al. (2022), functional properties of roasted jackfruit seeds are better than raw seeds: water absorption, and antioxidant activity should be added to the cereal product. In the same way, Patel et al. (2024) observed that judicious incorporation of jackfruit seed flour can enhance the protein and mineral qualities of food products for combating malnutrition.

Phytochemical Analysis of Jackfruit Seed

Orie et al. (2023) compared phytochemical composition of fresh fruit and seed of A. heterophyllus (jackfruit) and found that both parts contains unique and important bioactive compounds. In the case of the fruit, it had higher levels of flavonoids including resveratrol, naringenin, flavones, and catechin, whereas the seed showed higher levels of proanthocyanin, naringin, anthocyanin, and epicatechin. Unique phytochemicals were also detected in fruit and seed; ribalinidine and ephedrine, for example, were not found in seed, whereas seed contained cyanogenic glycosides, lunamarin and flavan□3□ol exclusively. The fruit and seeds also shared similar compounds including tannins, oxalates, phytates, saponins, triterpenoids and cardiac glycosides. The results indicate that both the fruit and seed of A. heterophyllus are endowed with health and therapeutic potential. Research indicates that both the fruit and seed of *A. heterophyllus* have notable health benefits and potential uses in medicine. The fruit's high levels of flavonoids help explain its antioxidant and healing properties, while the seed contains unique compounds that could lead to new drugs. (Orie et al., 2023)

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Utilization of Jackfruit Seed Flour as a Functional Ingredient in Food Systems

The local jackfruit seed flour is incorporated in various foods such as breads and other pastries, snacks and breakfast foods. Guangzhou further evaluated its applicability in maize based breakfast cereals where the final products harvested had better average protein and fibre values. Similarly, Maniaga et al. (2024) also pointed out that food items such as bakery and cereal products, made from jackfruit seed flour in place of regular flours have better nutritional profile and can cover consumer's requirements of healthier food products. Jackfruit seed flour has been added to cereals to improve their nutritional properties. Mohammed et. al (2024) used both jackfruit seed flour and defatted soy flour for twin screw extrusion of breakfast cereal. His research confirmed that up to 20% of JSF incorporation caused an excellent improvement in protein and fiber; however, acceptability scores were not unfavorably affected. Brito et al. (2020) has even backed these findings and stated that incorporation of jackfruit seed flour in cereals provided enhanced functional and health beneficent attributes.

Consumer acceptability and sensory evaluation

One of the primary success factors for new food products is, therefore, consumer preferences. According to M, Ibrahim et al., 2023, consumers gave high overall acceptability ratings for Jackfruit seed based bread spreads on aspects such as taste and aroma. According to Nordin et al. (2024), cereal blends with maize containing up to 15 % jackfruit seed flour did not significantly affect the acceptability of the product, but did enhance the nutritional value. These findings emphasise the view that for formulation all the sensory aspects need to be maintained to some extent. Furthermore, Maniaga et al. (2024) observed a balance that the incorporation level of jackfruit seed flour should be between 10 to 15% to hold desirable sensory characteristics in the cereals and other products but any higher level of replacement lowers the overall acceptability of the products.

Sustainability and utilization of wastes

The consumption of fruit byproducts like jackfruit seeds is consistent with concerns for practice sustainability food production. The authors Brito et al. (2020) equally state that turning agricultural waste into functional ingredient is useful in the conservation of the environment and management of resources. Jackfruit seed is considered waste but can actually be processed and eaten to feed the increasing population while enhancing food security. The inclusion of the jackfruit seeds in the production of foods serves the environmental best practice of attempting to reduce waste. Nabubuya et al. (2022) further noted that the practices help overcome the problem of excess food discards and, at the same time, promote new economic niches—the food product differentiation.

Functional and Health Benefits

They include vitamins, minerals, fats, proteins, fibers, aminoacids and other bioactive compounds found in jackfruit seeds. A cross-sectional study by Maniaga et al., (2024) work showed that food items that are made with jackfruit seed flour increase dietary fibre and antioxidant; therefore, can lower chances of chronic diseases. According to Palamthodi et al., (2021), Jackfruit seed flour has various functional applications in food products and has functional benefits associated with them particularly being beneficial for digestion.

Technological Challenges in Cereal Development

Potential of jackfruit seed flour in cereals must be optimized by considering preparation methods and physicochemical characteristics. Patel et al. (2024) have recently reviewed the extrusion technology for the formulation of cereals using non conventional flours, with significant focus on the optimization of process parameters to obtain ideal textural and sensory profile. Moreover, preparation of jackfruit seeds in flour form needs some specific treatments including the reduction of antinutritional factors as highlighted by Mohammed et al., (2024).

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Aroma

Taste is one of the important factors, which influence the acceptability of food products and aroma also matter a lot. According to Palamthodi et al. (2021), the addition of jackfruit seed flour to bakery products improved the aroma because the nutty, slightly sweet-flavoured flour was well received by sensory panelists. Similarly, Nordin et al. (2024) affirmed that the jackfruit blends based cereal had a specific uncovered flavor that changed its acceptability with notable weights, most panelists based on the squeamish towards fresh and natural appeal. It was also found in some literature that low processing of jackfruit seeds assists in retaining scent and flavor of food product which would be one way of making the product quite attractive to consumer.

Appearance

Size, shape, color, and texture of the food are normally the first things that help set the consumers' interest in the food. Nabubuya et al. (2024) reported that, cereal products produced from incorporation of jackfruit seed flour did not affect the natural appealing colour of the products and the flour had slightly darker colour. Interestingly, Mohammed et. al (2024) noted that incorporation of jackfruit seed flour into cereal formulations gave it a natural golden browncolorpreerred by the public. Thus, according to Patel et al. (2024), the particle size distribution should remain homogenous during processing in order to achieve a beautiful final appearance of the finished product.

Taste

Flavor is one of the most important concerns that a customer has to consider when choosing a food product. Maniaga et al., (2024) stated that the jackfruit seed flour has a low level of flavor and taste rather close to nutty to make the cereals tasty if added with sweetener or spies. M, Ibrahim et al. (2023) revealed high taste preference indices for jackfruit seed-based bread spreads due to the added natural sugars from jackfruit seeds. In addition, Nordin et al. (2024) discovered that cereal blends containing not more than 20% jackfruit seed flour attracted high acceptability with regards to palatability.

Texture

One of the more important qualitative characteristics of the food that defines the experience of the consumption is texture. Brito et al. (2020) noted that addition of jackfruit seed flour improved the surface texture of extruded cereal products making them more consumer attractive. Mohammed (2024) said that the expansion of jackfruit seeds in cereal matrices maintained a satisfactory texture even at higher flour replacement levels. Palamthodi et al. (2021) stated that water absorption characteristic facilitated softness but firmness of products made from jackfruit seed flour especially for breakfast cereals.

III. METHODOLOGY

This study utilized both experimental and descriptive research designs. It consisted of three phases: evaluation of newly developed products, sensory analyses or evaluation of developed products and data analysis. The sensory characteristics for taste, texture, aroma, appearance and overall acceptability would be recorded on a 5-point hedonic scale among a sample of 50 experts and consumers. The objective of the study is to produce an acceptable and healthy cereal product that complies with safe food and ethical principles and obtain knowledge on future sale of the product. The food product development was conducted in food technology laboratory that bears all the instruments and paraphernalia used in preparation of cereals through milling machines, ovens, mixers and weighing scales among others. These facilities were used to process the seeds into flour and to form the cereal as well as initial testing to the quality of the cereal. Data were gathered from 20 food experts and 100 consumers using a 9-point Hedonic Scale. Mean and Standard Deviation were used to determine the acceptability of the Jackfruit Seed Cereal in terms of appearance, aroma, flavor/taste, and texture. Multivariate Analysis of Variance (MANOVA) for Repeated Measures and Bonferroni's Test were used to compare the three formulations of Jackfruit Seed Cereal in terms of the four sensory attributes: appearance, aroma, taste, and texture.

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IV. RESULTS AND DISCUSSION

Table 1 presents the acceptability ratings of the appearance of three jackfruit seed cereal formulations.

TABLE 1
ACCEPTABILITY OF APPEARANCE OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	*D*	M	SD	*D*	M	SD	*D*
1. The color of the product looks appealing.	7.18	0.95	***LM***	8.23	0.62	***LVM***	7.15	0.96	***LM***
2. The color is vibrant and fresh.	7.18	0.98	***LM***	7.70	1.62	***LVM***	7.18	0.97	***LM***
3. The product's color is consistent and uniform.	7.03	0.89	***LM***	7.93	2.62	***LVM***	7.01	0.89	***LM***
4. The color of the product is suitable for its type.	7.12	0.89	***LM***	7.55	3.62	***LVM***	7.14	0.88	***LM***
5. The product's color matches my expectations for this type of product.	6.94	0.87	***LM***	7.98	4.62	***LVM***	6.93	0.87	***LM***
Average	7.09	0.52	***LM***	7.88	5.62	***LVM***	7.08	0.52	***LM***

Formulation A received an average rating of 7.09, corresponding to "Like Moderately" (LM). The highest-rated statement for this formulation was a tie between "The color of the product looks appealing" and "The color is vibrant and fresh," both scoring a mean of 7.18. The lowest-rated statement was "The product's color matches my expectations for this type of product," with a slightly lower mean of 6.94. The low standard deviations (ranging from 0.87 to 0.98) indicate consistency in responses among the raters. Overall, the appearance of Formulation A was positively received, though there is slight room for improvement in aligning the product's color more closely with consumer expectations. Formulation B had the highest overall average among the three, with a mean rating of 7.88, which corresponds to "Like Very Much" (LVM). The highest-rated statement was "The color of the product looks appealing," which received a mean score of 8.23, indicating a strong visual appeal. The lowest-rated statement, although still favorably evaluated, was "The color of the product is suitable for its type," with a mean of 7.55. However, the notably high standard deviations—especially for this statement (3.62) and others—suggest considerable variability in participant opinions. Despite this variability, Formulation B emerged as the most visually appealing cereal overall. Formulation C received an average score of 7.08, also interpreted as "Like Moderately" (LM), nearly identical to Formulation A. The highest-rated statement for this formulation was "The color of the product is suitable for its type," with a mean of 7.14. The lowest-rated statement was "The product's color matches my expectations for this type of product," with a mean of 6.93, mirroring Formulation A's lowest point. Like Formulation A, the standard deviations were low, indicating consistent evaluations across the panel.

Table 2 details the acceptability ratings for the aroma of three jackfruit seed cereal formulations.

TABLE 2
ACCEPTABILITY OF AROMA OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Statement	Formulation A			Formulation B			Formulation C		
	M	SD	*D*	M	SD	*D*	M	SD	*D*
1. The product has an appealing odor.	7.21	0.94	***LM***	8.33	0.64	***LVM***	7.19	0.93	***LM***
2. The product's odor is pleasant and not overpowering.	7.18	0.93	***LM***	7.94	0.81	***LVM***	7.00	0.86	***LM***
3. The product has a natural odor.	7.20	0.93	***LM***	8.18	0.88	***LVM***	7.20	0.91	***LM***

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4. The odor of the product is pleasant enough to encourage consumption.	7.08	0.89	***LM***	7.17	0.87	***LM***	7.00	0.79	***LM***
5. The product's odor is consistent with its intended flavor.	7.14	0.94	***LM***	7.48	0.97	***LM***	7.24	0.93	***LM***
Average	7.16	0.49	***LM***	7.82	0.38	***LVM***	7.13	0.53	***LM***

Formulation A received an overall average rating of 7.16, corresponding to "Like Moderately" (LM). The statement with the highest mean was "The product has an appealing odor," scoring 7.21, followed closely by "The product has a natural odor" at 7.20. The lowest mean was for the statement "The odor of the product is pleasant enough to encourage consumption," which received 7.08. The relatively low standard deviations (ranging from 0.89 to 0.94) suggest that participants gave consistent ratings, indicating a stable, moderately favorable impression of the aroma. Formulation B achieved the highest aroma rating among the three, with an average score of 7.82, falling into the "Like Very Much" (LVM) category. The most highly rated statement was "The product has an appealing odor," with a mean of 8.33, indicating a strong positive reaction to the initial smell of the cereal. The lowest-rated item was "The product's odor is consistent with its intended flavor," which still received a solid 7.48. All statements for Formulation B were rated between 7.17 and 8.33, with low standard deviations (from 0.64 to 0.97), indicating both a high level of acceptability and consistency in perception among the raters. Formulation C had an average aroma rating of 7.13, interpreted as "Like Moderately" (LM)—comparable to Formulation A but slightly lower. The highest-rated statement was "The product's odor is consistent with its intended flavor," with a mean of 7.24, while the lowest-rated statements were tied between "The product's odor is pleasant and not overpowering" and "The odor of the product is pleasant enough to encourage consumption," both scoring 7.00. Standard deviations were similar to the other formulations, suggesting consistent responses.

Table 3 presents the acceptability ratings for the taste of three jackfruit seed cereal formulations.

Formulation A received an overall average mean of 7.08, indicating it was "Liked Moderately" (LM). The highest-rated statement for this formulation was "The product has a balanced taste," with a mean score of 7.20, closely followed by statements on sweetness/saltiness and aftertaste. The lowest-rated item was "The taste of the product is unique and refreshing," which scored 6.89, although still within the moderate liking range. Standard deviations across all statements were low (ranging from 0.81 to 0.93), suggesting consistent and stable responses from the panel. Overall, Formulation A was positively received in terms of taste, though its uniqueness could be enhanced to improve appeal further.

TABLE 3
THE ACCEPTABILITY OF TASTE OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Statement	**Formulation A**			**Formulation B**			**Formulation C**		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The taste of the product is enjoyable.	6.99	0.82	***LM***	8.17	0.75	***LVM***	7.64	0.73	***LVM***
2. The product has a balanced taste.	7.20	0.93	***LM***	7.79	0.78	***LVM***	7.29	0.83	***LM***
3. The taste of the product is unique and refreshing.	6.89	0.85	***LM***	7.85	0.81	***LVM***	7.04	0.86	***LM***
4. The product has the right level of sweetness or saltiness.	7.18	0.90	***LM***	7.47	0.70	***LM***	6.97	0.83	***LM***
5. The aftertaste of the product is pleasant.	7.16	0.81	***LM***	7.98	0.65	***LVM***	7.05	0.92	***LM***
Average	7.08	0.50	***LM***	7.85	0.36	***LVM***	7.20	0.51	***LM***

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Formulation B achieved the highest overall mean rating for taste at 7.85, corresponding to "Like Very Much" (LVM). The highest-rated statement was "The taste of the product is enjoyable," which scored 8.17, indicating strong consumer satisfaction. The lowest mean was still high at 7.47, associated with the statement "The product has the right level of sweetness or saltiness." These consistently high ratings, paired with very low standard deviations (from 0.65 to 0.81), reveal that participants not only favored the taste of Formulation B but also agreed strongly in their evaluations. This formulation clearly excelled in flavor, balancing enjoyment, uniqueness, and pleasant aftertaste effectively. Formulation C garnered an average mean of 7.20, placing it in the "Like Moderately" (LM) category. The highest-rated statement was "The taste of the product is enjoyable," with a mean score of 7.64, nearly approaching the "Like Very Much" range. The lowest-rated was "The product has the right level of sweetness or saltiness," which received 6.97, suggesting that improvements could be made in flavor balance. The ratings for Formulation C were generally favorable but not as strong or consistent as those for Formulation B.

Table 4 outlines the acceptability ratings for the texture of three jackfruit seed cereal formulations.

TABLE 4

ACCEPTABILITY OF TEXTURE OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Statement	Formulation A			Formulation B			Formulation C		
	M	**SD**	***D***	**M**	**SD**	***D***	**M**	**SD**	***D***
1. The texture of the product is smooth and pleasant.	7.09	0.92	***LM***	8.06	0.77	***LVM***	7.13	0.88	***LM***
2. The product has the right amount of crunch or softness.	7.23	0.93	***LM***	7.75	0.77	***LVM***	6.88	0.69	***LM***
3. The texture is consistent throughout the product.	7.01	0.88	***LM***	7.98	0.79	***LVM***	7.25	0.92	***LM***
4. The texture makes the product enjoyable to eat.	7.18	0.85	***LM***	7.53	0.71	***LVM***	7.10	0.93	***LM***
5. The texture is suitable for the type of product.	6.96	0.91	***LM***	8.02	0.70	***LVM***	7.01	0.92	***LM***
Average	7.09	0.52	***LM***	7.87	0.31	***LVM***	7.07	0.51	***LM***

Formulation A obtained an overall mean of 7.09, corresponding to "Like Moderately" (LM). The highest-rated statement was "The product has the right amount of crunch or softness," with a mean of 7.23, suggesting that texture balance was well appreciated. The lowest mean was for "The texture is suitable for the type of product," scoring 6.96, which may indicate a slight misalignment between the expected and actual texture. The standard deviations for all statements were relatively low (ranging from 0.85 to 0.93), showing consistent feedback from respondents. In general, Formulation A was moderately liked for its texture, though refining its suitability for the product type could enhance overall sensory experience.

Formulation B achieved the highest texture rating with an average mean of 7.87, interpreted as "Like Very Much" (LVM). The highest-rated statement was "The texture of the product is smooth and pleasant," scoring 8.06, while the lowest-rated item—though still highly rated—was "The texture makes the product enjoyable to eat" at 7.53. All texture aspects of Formulation B received favorable evaluations with very low standard deviations (between 0.70 and 0.79), indicating a high level of agreement among raters. These results highlight that Formulation B offered an appealing and well-balanced texture, contributing positively to the overall eating experience. Formulation C had an average mean of 7.07, which also falls under "Like Moderately" (LM). The most positively rated statement was "The texture is consistent throughout the product," with a mean of 7.25, showing appreciation for uniformity in texture. The lowest-rated statement was "The product has the right amount of crunch or softness," which received 6.88, suggesting some participants found the texture either too soft or too crunchy. Nonetheless, the ratings remained generally positive, and standard deviations were moderate, indicating some variation in preferences but still within acceptable limits.

Tables 5 and 6 present the results of statistical analyses conducted to determine whether there are significant differences in the sensory attributes—appearance, aroma, taste, and texture among the three jackfruit seed cereal formulations.

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TABLE 5
SIGNIFICANT DIFFERENCE ON THE ACCEPTABILITY OF THE SENSORY ATTRIBUTES OF THE THREE FORMULATIONS OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Attribute	F	p	Decision on Ho	Interpretation
Appearance	113.90	<0.01	Rejected	Significant
Aroma	81.77	<0.01	Rejected	Significant
Taste	117.61	<0.01	Rejected	Significant
Texture	122.38	<0.01	Rejected	Significant

Wilks' Lambda Λ= 0.227, F=64.519, p<0.01

Table 5 summarizes the MANOVA (Multivariate Analysis of Variance) results, which were analyzed using Wilks' Lambda. The Wilks' Lambda value of Λ = 0.227, with an associated F-value of 64.519 and p < 0.01, indicates a statistically significant multivariate effect across the formulations. This means that, when considered together, the sensory attributes significantly differed depending on the formulation. The follow-up univariate tests for each individual attribute which are appearance, aroma, taste, and texture, all yielded very high F-values, ranging from 81.77 to 122.38, with p-values less than 0.01, leading to the rejection of the null hypothesis in all cases. Thus, each sensory attribute was significantly affected by the formulation used.

TABLE 6
PAIRWISE COMPARISONS ON SENSORY ATTRIBUTES OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Attribute	Formulation (Mean)		p	Decision on Ho	Interpretation
Appearance	A (M=7.09)	B (M=7.88)	<0.01	Rejected	Significant
	A (M=7.09)	C (M=7.08)	1.000	Not Rejected	Not Significant
	B (M=7.88)	C (M=7.08)	<0.01	Rejected	Significant
Aroma	A (M=7.16)	B (M=7.82)	<0.01	Rejected	Significant
	A (M=7.16)	C (M=7.13)	1.000	Not Rejected	Not Significant
	B (M=7.82)	C (M=7.13)	<0.01	Rejected	Significant
Taste	A (M=7.08)	B (M=7.85)	<0.01	Rejected	Significant
	A (M=7.08)	C (M=7.2)	.064	Not Rejected	Not Significant
	B (M=7.85)	C (M=7.2)	<0.01	Rejected	Significant
Texture	A (M=7.09)	B (M=7.87)	<0.01	Rejected	Significant
	A (M=7.09)	C (M=7.07)	1.000	Not Rejected	Not Significant
	B (M=7.87)	C (M=7.07)	<0.01	Rejected	Significant

Table 6 details the pairwise comparisons between the three formulations for each sensory attribute using Bonferroni's test to control for Type I error. Across all four attributes, Formulation B was significantly different and superior in appeal when compared with Formulation A and Formulation C, as indicated by p-values less than 0.01 in each comparison involving Formulation B. This confirms the consistent dominance of Formulation B across all sensory domains. For appearance, Formulation B received the highest mean score of 7.88, significantly outperforming both Formulation A (M = 7.09) and Formulation C (M = 7.08). The pairwise comparisons show significant differences between B and A (p < 0.01) and between B and C (p < 0.01), while A and C showed no significant difference (p = 1.000). This indicates that raters found the visual quality of Formulation B most appealing.

In terms of aroma, Formulation B also led with a mean of 7.82, again significantly higher than both Formulation A (M = 7.16) and Formulation C (M = 7.13). The differences were statistically significant between B and A (p < 0.01) and between B and C (p < 0.01), but not between A and C (p = 1.000). These results suggest that the smell of Formulation B was more pleasant and appealing to the raters. For taste, Formulation B achieved the highest mean rating of 7.85, significantly outperforming Formulation A (M = 7.08) and Formulation C (M = 7.20). The taste difference was significant between B and A (p < 0.01) and between B and C (p < 0.01). The difference between A and C was not

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significant ($p = 0.064$), showing again that Formulation B stood out in terms of flavor, while A and C were rated similarly. Regarding texture, Formulation B had the top mean score of 7.87, which was significantly higher than Formulation A ($M = 7.09$) and Formulation C ($M = 7.07$). The differences between B and A ($p < 0.01$) and between B and C ($p < 0.01$) were significant, whereas A and C did not differ significantly ($p = 1.000$). This highlights that Formulation B provided the most pleasant and acceptable texture experience.

Table 7 presents the physicochemical composition of Jackfruit Seed Cereal Formulation B, providing insights into its nutritional profile based on laboratory analysis. The data include values for total fat, crude protein, and total sugar, expressed in grams per 100 grams of the product.

TABLE 7
PHYSICOCHEMICAL COMPONENTS OF FORMULATION "B" OF JACKFRUIT (*Artocarpus heterophyllus*) SEED CEREAL

Analysis	Unit	Results
Total Fat	g/100g	23.8
Crude Protein (N × 6.25)	g/100g	6.77
ᵠTotal Sugar	g/100g	6.29

The total fat content of the cereal is 23.8 grams per 100 grams, which is relatively high for a cereal-based product. This suggests that the formulation is energy-dense and may offer satiety benefits, making it potentially suitable for individuals seeking a calorie-rich food option, such as athletes or those with high energy needs. The high fat content may also contribute positively to the product's palatability by enhancing its mouthfeel and flavor, which aligns with the sensory evaluation results where Formulation B was consistently rated highly for taste and texture. In terms of crude protein, Formulation B contains 6.77 grams per 100 grams, indicating a moderate protein level. This amount reflects a meaningful contribution to daily protein intake, especially considering the plant-based source of the product. The presence of protein is important not only for nutritional value but also for contributing to the cereal's structural properties and texture, which may have played a role in the favorable sensory evaluations related to texture consistency and enjoyment. The total sugar content is 6.29 grams per 100 grams, suggesting that the product has a mildly sweet taste. This level of sugar is moderate and likely contributes to the cereal's appealing flavor without making it excessively sweet. It strikes a balance between taste enhancement and health considerations, as excessive sugar content is often viewed negatively by health-conscious consumers. The moderate sugar level also aligns well with the sensory ratings where taste was described as enjoyable and balanced.

V. CONCLUSION

Formulation B has the highest potential for market success compared to the moderately liked Formulations A and C. However, Formulation A emerged as most preferred by the participants. The favorable balance of fat, protein, and sugar in Formulation B supports its high sensory ratings, making it not only palatable but also nutritionally appealing to consumers.

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