Sensory Evaluation and Proximate Composition of Jackfruit Seed Oil-Based Cake

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Abstract
This study examined the Sensory Evaluation and Proximate Composition of Jackfruit Seed Oil-based Cake. Two research questions were raised and two null hypotheses was formulated and tested at 0.05 level of significance to guide the study. An experimental research design was adapted for the study. Samples were bought from Zuba main market in Gwagwalada, Abuja and transported to Akwa Ibom State. Soxhlet extraction method was used to extract oil from jackfruit seeds, in the process N-Hexane and soya bean oil was used in place of distilled water. A standard recipe for baking oil based cake was adapted from United States Department of Agriculture, only the type of oil was modified and replaced with jackfruit seed oil, which was then blended with vegetable oil at varying ratios (50:50%, 70:30%, 100%) and incorporated into cake batter using the whisking method. An additional oil based cake made with vegetable oil alone was baked to guage the assessment as control. Sensory evaluation employed a 9-point hedonic scale to assess the consumer's preference of the cakes with a 10 panelist. The cakes were coded uniquely as JSOC100 (Jackfruit seed oil based cake 100%), JSOC70 (Jackfruit seed oil based cake with 70% jackfruit seed oil), JSOC50 (Jackfruit seed oil based cake with 50% jackfruit seed oil) and VOC (Vanilla oil-based cake) as control. Data obtained from sensory evaluation was analyzed using descriptive statistics (mean and standard deviation). The Proximate analysis was conducted to determine the moisture, ash, crude protein, crude fat, carbohydrate, and fiber content, Data obtained from the proximate analysis was analyzed using Statistical Package for Social Sciences (SPSS) software. Findings from sensory evaluation revealed that there was a significant differences among samples, JSOC70 had the highest values in appearance (7.86±1.06), taste (7.86±0.90), texture (7.71±1.38), aroma (7.71±1.25), aftertaste (7.86±1.06) and overall acceptability (8.43±0.53). Findings from proximate analysis revealed significant difference in composition between JSOC70 and VOC, with JSOC70 havinger higher moisture (22.11%) and carbohydrates content (51.51%) but lower fat (16.74%) and protein content (7.00%), Energy content was also lower in JSOC70(385.35 kcal). Sensory evaluation and Proximate analysis revealed significant differences in composition between JSOC70 and the vegetable oil-based control (VOC), t-test analysis showed t-value of -3.00 and a p-value of 0.015 which is (<0.05) rejecting hypotheses 1 and 2. Based on the findings, it was concluded that jackfruit seed oil is an ideal and healthy promoting baking alternative. The researcher recommends that bakers and cake enthusiasts consider incorporating jackfruit seed oil into their recipes, leveraging its unique nutritional profile and economic benefits to create value-added baked goods.

Key Words: Jackfruit, Oil, Cake Sensory Evaluation and Proximate Composition

Introduction

Tropical fruits are horticultural products from tropical climates with an average temperature of ±27 °C. The fruit consists of various botanical families, including Anacardiaceae (mango, plum), Annonaceae (custard and sugar apple, soursop), Bromeliaceae (pineapple), Sapindaceae (rambutan, leaf, lychee, longan) and Passifloraceae (passion fruit) and Morracaea family (Jackfruit). Tropical fruit is consumed in fresh form but can be consumed as processed products, such as canned fruit or juice, as technology develops (Schlegel, 2016). Tropical fruits are more sensitive to a variety of damage than those growing in temperate climes. It causes a faster damage rate, even under optimum storage conditions (Tejpal, 2016). The damage is caused by physical, mechanical, biological, chemical, and microbiological factors (Schlegel, 2016). It results in a very short shelf-life of tropical fruit. Fruit damage factors initiate from the process of fruit maturation, the level of fruit maturity when harvesting, post-harvest handling, fruit storage and nutrition, cultivar species, and the place of growth (Tejpal, 2016).

Jackfruit (Artocarpus heterophyllus) as asserted by Antony *et al* (2018), is cultivated in India, China, Malaya, Africa, and the East Indies. After that the spike appears, these fruits are suitable for harvesting 90 to 110 days later. When the fruit is ready for harvest, the latex will be watery (Akter, 2018). "jackfruit" finds its origins in the Portuguese term "Jaca" (Bakewell-Stone, 2023). Jackfruit (Artocarpus heterophyllus), a prominent fruit plant indigenous to Asian nations (Waghmare, 2019), represents a sizable, tree-borne tropical fruit within the Moraceae family, and both the primary and secondary branches of the jackfruit tree exhibit prolific fruit-bearing capacity. Burgeoning research has revealed that the jackfruit tree demonstrates commendable productivity, yielding an average of approximately 25.71 tons per hectare, with mature trees yielding approximately 10 to 200 fruits each, and this could be harnessed for socioeconomic livelihood welfare Ranasinghe et al. (2019). While the typical weight of a fully matured jackfruit ranges from 10 to 25kg, certain cultivars may yield giant fruits weighing up to 50kg, and an individual ripe jackfruit typically contains between 100 and 500 seeds (Waghmare, 2019).In most research, Artocarpus heterophyllus species are believed to originate from the Western Ghats of India, a region known as the foremost producer (Mandave, 2018), and cultivation outreach has now stretched to several tropical regions and countries, such as Bangladesh, Burma, Malaysia, Indonesia, Uganda, Thailand, Brazil, and Nigeria, In Nigeria, where the nut obtained from the fruits serves as good source of nutrients to the local people (Ekop & Eddy, 2015). Jackfruit is referred to as *ubong mmakara* (Ibibio and Efik) in Akwa Ibom State (Etukudo, 2018).

In regions such as Bangladesh. Jackfruit seeds, often overlooked, possess immense potential for both household consumption and industrial applications, as evidenced by various global culinary traditions and recent research findings (Waghmare, 2019). The global significance of jackfruit seeds has been recognized through diverse applications, notably, sustainable microbial fermentation and environmentally friendly green extraction methods,

yielding biochemicals, and renewable energy sources (Brahma, 2023). The multifaceted utilization of jackfruit seeds not only underscores their economic value but also contributes to the burgeoning opportunities within the sustainability discourse, especially in the energy sector. Jackfruit seeds are integral to traditional cuisines, offering unique flavors to dishes and serving as a base for stews and curries, prompting explorations into value addition and export potential (Akter, 2018).

Furthermore, these seeds find application in the production of animal feed, thereby creating new revenue streams in agricultural economies (Eburuaja, 2022); Chandran, 2022). Jackfruit seeds have gained traction in the United States as a viable meat substitute, aligning with the increasing adoption of vegetarian diets among consumers (Hamid, 2020). Consequently, consumers now have the opportunity to choose products that align with their values without compromising taste or convenience Hamid *et a*l (2020). This trend reflects a broader shift toward meeting diverse dietary needs through ethically and sustainably produced alternatives, including those derived from jackfruit seeds and the possibility of using jackfruit and its seeds for several purposes Hamid *et al* (2020).

The jackfruit seed oil is rich in Essential Fatty Acids (EFA). EFA like linoleic acid and alphalinolenic acid cannot be synthesized by the body and must be obtained from food. These fatty acids aid in the formation of healthy cell membranes, proper development and functioning of the brain and nervous system, proper thyroid and adrenal activity, production of hormones, regulation of blood circulation and promotes healthy hair and skin. The oil exhibits remarkable antioxidant properties. Several reactions occur continually inside the body giving rise to formation of free radicals. Free radicals can cause oxidative stress leading to deterioration of normal cell functions and even cell death. The antioxidant properties of jackfruit seed oil prevent the occurrence of free radicals. It is supportive in the maintenance of health and in the prevention of chronic diseases (Waghmare *et al*., 2019). The processing method which was followed for extracting oil from jackfruit seeds is ‘milling.’ This is a traditional method in which the seeds are first dried under the sun and then placed in between two rotating stone and ground. The oil obtained is then filtered to remove impurities. The benefit of this method is that at each stage of the milling process, no harmful chemical is added or no modification is done (Tejpal, 2016) The first product to be prepared is the jackfruit seed oil. About 6kg of the seed was obtained to extract 2L of oil. The oil would be extracted using the traditional method which involves grinding the dried seeds in between two stones. This oil does not undergo any processing but is just filtered to remove impurities (Tejpal, 2016). The unique characteristics of jackfruit seed oil, such as its distinct flavor and aroma (Kumar *et al*., 2017), make it essential to evaluate its impact on the sensory properties of baked products.

Sensory evaluation is a scientific discipline that measures human responses to various stimuli, playing a crucial role in food science and product development. It encompasses various types, including descriptive analysis, discrimination testing, preference testing, intensity scaling, and affective testing, which are conducted by trained panelists who use their

senses to evaluate products. These trained panelists use a vocabulary to describe sensory attributes, identify differences between samples, rate liking or disliking, and detect subtle variations in sensory attributes. Sensory evaluation ensures products meet quality standards, detects defects, and supports product development, with applications in food science, product development, and quality control. While facing challenges like subjectivity and variability, sensory evaluation continues to evolve, providing valuable insights into the complex relationships between products and sensory experiences Michaelsen *et al*., (2017). While sensory evaluation provides valuable information on the acceptability of jackfruit seed oil-based cakes, it is equally important to examine their nutritional content (Adelekan & Oyewole, 2015).

Proximate Composition involves the determination of the major components of a sample, including moisture, protein, fat, carbohydrates, fiber, and ash, which provides a comprehensive understanding of its nutritional value and chemical properties. This analysis is essential for various purposes such as nutritional labeling and claims, food formulation and product development, quality control and assurance, animal feed formulation and nutrition, research and development. The proximate composition of a sample is typically expressed as a percentage of the sample's dry matter or total weight, and is determined through various laboratory techniques including chemical, instrumental, and physical analysis. The results of proximate composition analysis are used to make informed decisions about the use and formulation of food and feed products, and to ensure compliance with regulatory requirements and industry standards. This analysis provides a general overview of the nutritional content and chemical makeup of a food or ingredient, helping to understand its Nutritional value, Shelf life, Functional properties and Processing characteristics. (Michaelsen, *et al*, 2017).

Purpose of the study: The purpose of this study was to prepare and evaluate oil-based cakes made with jackfruit seed oil and vegetable oil. Specifically, the study sought to determine the:

1. sensory properties of oil-based cakes made with (100%) of Jackfruit seed oil, (70%) of jackfruit seed oil and (30%) of vegetable oil, and (50%) of jackfruit seed oil and (50%) of vegetable oil.
2. proximate composition of jackfruit seed oil-based cake and vegetable oil-based cake

Research Question

The study sought to provide answers to the following research questions:

i. What is the sensory evaluation of oil-based cakes made with (100%) of Jackfruit seed oil, (70%) of jackfruit seed oil and (30%) of vegetable oil, and (50%) of jackfruit seed oil and (50%) of vegetable oil?.
ii. What is the proximate composition of jackfruit seed oil-based cake and vegetable oil-based cake?

Research Hypotheses

Ho_1: There is no significant difference in the sensory evaluation between the preferred jackfruit seed oil-based cake and the control cake.

Ho_2 : There is no significant difference in the proximate composition (moisture, protein, fat, fiber) between the most acceptable jackfruit seed oil-based cake and the control cake.

Materials and Methods

2 Jackfruits weighing 9kg each were sourced from at Zuba main market, a popular market in Gwagwalada, Abuja, transported to Akwa Ibom State. The samples are first air dried in the sun for 7 days before being cracked manually for the seed to be taken out. 186 jackfruit seeds were obtained. The dried seed is sun dried for five days and oven dried for 24 hours using a laboratory oven. The dried seed was milled using a laboratory rotary mill using a soxhlet extraction method. N-Hexane and soya bean oil (carrier oil used in place of a distilled water) was used during the conditioning process for the extraction of oil. Jackfruit seed oil was then transported to the Department of Home Economics Education laboratory in the University of Uyo, Uyo for storage prior to product formulation and subsequent analysis.

The following recipe was adapted and used by the researcher for the study.

400g	Flour
200g	Sugar
1 Tbsp	Baking powder
1 cup	Vegetable Oil
4	Eggs
1/2 tsp	Salt
2 tsp	Vanilla flavour
1 cup	Liquid milk

Method of Preparation of Oil-Based Cake

Oven is preheated to 180-degree celcius, pan was greased with margarine and flour. Before whisking, prepare the ingredients, including sifting dry ingredients and ensuring room temperature eggs and liquids.

1: Creaming (Oil and Sugar)
Whisk oil with sugar until light, fluffy, and doubled in volume (approximately 2-3 minutes). This incorporates air, developing cake structure.

2: Mixing Wet Ingredients
Whisk in liquid ingredients (eggs, milk, etc.), ensuring even distribution.

3: Combining Wet and Dry Ingredients
In a separate bowl, whisk sifted dry ingredients, mixing until just combined. Then gradually the dry ingredients are gradually mixed into the wet ingredients. Overmixing can lead to gluten development and tough cake.

4: Final Mixing

Whisk in additional ingredients (flavorings and liquid milk), scraping down bowl sides ensure uniform mixing. And then put into pan and baked for 25 minutes. The recipe was adopted and replaced with jackfruit seed oil which was added in varying blending percentages with vegetable oil (100%, 70%/30%, 50%/50%), 100%)vegetable oil recipe was used as a control. (USDA, 2019).

Sensory Evaluation

Sensory evaluation is a scientific method used to measure and analyze human responses to products through their sensory attributes, such as sight, smell, taste and touch (Meilgaard *et al*, 2016). This Analysis employed structured testing protocols to collect both quantitative and qualitative data, which are crucial for product development, quality control, and understanding consumer preferences. On the 11th of September, 2024, Sensory evaluation was conducted in the Home Economics Education laboratory by 11am. 10 trained panelists were invited. Each panelist was then presented with a water glass, a serviette, a teaspoon and 4 different cake samples. Three varying blended jackfruit seed oil based cake and the other cake which was the control which is with (100%) vegetable oil. The products were coded and labeled "JSOC100", "JSOC70", "JSOC50", the Control was coded "VOC". This labeling helped to maintain clarity during the evaluation process. Each panelist received four copies of a sensory evaluation form, which utilized a 9-point hedonic scale to assess their preferences. The type of sensory evaluation conducted was an Affective Testing method, this structured approach allowed the panelists to express their opinions effectively and provided valuable data for the descriptive analysis to be done. The Data was collected and analysed to determine the most preferred sample of the jackfruit blended ratio. The same day, the most preferred blended ratio was taken alongside with the control to the Food Science and Technology laboratory for further analysis.

Proximate Analysis

Proximate analysis was carried out on the cake samples which consisted of VOC (control) and JSOC70 (most preferred).

The sample was analyzed by the standard Association of Official Analytical Chemists (A.O.A.C.) methods 2010.The proximate analysis was conducted at the Food Science and Technology Laboratory, Faculty of Agriculture, University of Uyo in the following ways:

i. Moisture Content: Measures the percentage of water present in a sample, typically expressed as a percentage (%).
ii. Crude Fat Content: Determines the total fat content, including triglycerides, phospholipids, and other lipids, usually expressed as percentage (%).
iii. Crude Protein Content: Estimates the total protein content, including true protein and non-protein nitrogen, usually expressed as percentage (%).

iv. Total Ash: Measures the residual minerals and inorganic compounds left after combustion, indicating the sample's mineral content, usually expressed as percentage (%).
v. Carbohydrate Content: Calculates the total carbohydrate content, including sugars, starches, and fibers, usually expressed as percentage (%) by difference (100 - sum of other components).

Statistical Analysis

Sensory evaluation data were analyzed using descriptive statistics (mean and standard deviation) to determine samples with highest mean value.
Data from proximate analysis were gotten in triplicate and analysed using statistical package for social science (SPSS). Data were analyzed using (ANOVA) at 0.05 level of significance. The Analysis of variance (ANOVA) was used to determine the significant differences between the samples while the means were separated using Duncan Multiple Range Test at $p \geq 0.05$.

Results

Research Question 1: What is the sensory evaluation of oil-based cakes made with 100% of Jackfruit seed oil, (70%) of jackfruit seed oil and (30%) of vegetable oil, and (50%) of jackfruit seed oil and (50%) of vegetable oil?

Table 1: Sensory Evaluation of Oil-based cakes made with (100%, 70/30%, 50/50%) of Jackfruit seed oil and 100% of Vegetable oil.

Sample	Appearance	Taste	Texture	Aroma	Aftertaste	Overall acceptability
JSOC50	6.57±0.97	6.86±1.02	6.71±0.95	6.50±1.10	6.43±0.97	7.34±0.72
JSOC70	7.86±1.06	7.86±0.90	7.71±1.25	7.71±1.25	7.86±1.06	8.43±0.53
JSOC100	5.57±0.81	5.43±0.68	5.58±0.50	5.55±0.89	5.43±1.13	7.40±0.53
VOC	7.29±0.75	5.43±0.78	6.00±0.57	5.57±0.90	5.43±1.13	7.43±0.53

Keys: "JSOC50" - Jackfruit seed oil-based cake with 50% jackfruit seed oil,
"JSOC70" - jackfruit seed oil-based cake with 70% jackfruit seed oil,
"JSOC100" - jackfruit seed oil-based cake with 100% jackfruit seed oil
" VOC" - Vanilla oil-based cake

Table 1. shows that JSOC50 scored 6.57±0.97 for appearance, 6.86±1.02 for taste, 6.71±0.95 for texture, 6.50±1.10 for aroma, 6.43±0.97 for aftertaste, and 7.34±0.72 for overall acceptability. JSOC70 received higher scores, with 7.86±1.06 for appearance, 7.86±0.90 for taste, 7.71±1.38 for texture, 7.71±1.25 for aroma, 7.86±1.06 for aftertaste, and 8.43±0.53 for overall acceptability. JSOC100 had lower scores, scoring 5.71±0.92 for appearance, 4.97±0.89 for taste, 5.99±0.95 for texture, 5.60±0.90 for aroma, 6.10±0.81 for aftertaste, and 7.10±0.71 for overall acceptability. VOC scored 7.29±0.75 for appearance, 5.43±0.78 for taste, 6.00±0.57 for texture, 5.57±0.90 for aroma, 5.43±1.13 for aftertaste, and 7.43±0.53 for overall

acceptability. Overall, JSOC70 scored the highest, achieving exceptional ratings across all attributes, with scores ranging from 7.71 to 8.43, and an overall acceptability score of 8.43±0.53.

Research Question 2: What is the proximate composition of jackfruit seed oil-based cake and vegetable oil-based cake?

Table 2: Proximate analysis of Jackfruit seed oil-based cake and vegetable oil-based cake

Sample	Moisture	Ash	Fat	Protein	Fibre	CHO	Energy
JSOC	22.11±0.15	1.18±0.07	16.74±0.14	7.00±0.43	1.40±0.05	51.51±0.60	385.35±0.57
VOC	20.90±0.05	1.70±0.05	19.10±0.13	9.19±0.43	1.71±0.07	47.39±0.17	398.23±0.10

Values were means ± standard deviation (STD)
Keys : "JSOC70" - jackfruit seed oil cake with 70 % of jackfruit seed oil,
"VOC"- Vanilla oil-based cake(control).

Table 2: shows JSOC contained 22.11±0.15% moisture, 1.18±0.07% ash, 16.74±0.14% fat, (7.00±0.43%) protein, (1.40±0.05%) fiber, (51.51±0.60%) carbohydrates, and had an energy value of 385.35±0.57 kcal. The VOC sample had (20.90±0.05%) moisture, (1.70±0.05%) ash, (19.10±0.13%) fat, (9.19±0.43%) protein, (1.71±0.07%) fiber, (47.39±0.17%) carbohydrates, and an energy value of 398.23±0.10 kcal. Proximate composition of sample indicated that moisture, ash, and carbohydrate contents recorded were higher than in VOC. On the other hand, fat, protein, fibre,and total energy of sample JSOC was lower than what was recorded in the VOC sample.

Research Hypothesis 1: There is no significant difference in the sensory evaluation between the preferred jackfruit seed oil-based cake and the control cake.

Table3: Summary of the independent t-test significant difference in the sensory evaluation between the preferred jackfruit seed oil-based cake and the control cake

Categories	N	SD	df	t-cal	Sig-value	Decision
JSOC70	5	0.83	8	-3.00	0.015	Significant
VOC	5	0.63	8			

Significant at p<0.05

The results of the t-test analysis comparing the sensory evaluation of the preferred Jackfruit Seed Oil-Based Cake (JSOC70) and the control cake (VOC) are presented. The mean difference between the two groups was evaluated, revealing a standard deviation of 0.83 for JSOC70 and 0.63 for the control. The t-test yielded a t-cal value of -3.00 with 8 degrees of freedom, resulting in a significant p-value of 0.015. Since the p-value (0.015) is less than the set alpha level of 0.05, the null hypothesis is rejected, indicating a significant difference in the sensory evaluation between JSOC70 and the control at 0.05 level of significance.

Null Hypothesis 2: There is no significant difference in the proximate composition (moisture, protein, fat, fiber) between the most acceptable jackfruit seed oil-based cake and the control cake.

Table 3: Independent t-test Analysis showing significant difference of the most preferred substitute and control

Categories	N	SD	df	t-cal	Sig-value	Decision
JSOC70	5	61.5	8			
				-3.00	0.015	Significant
VOC	5	63.3	8			

Significant at p<0.05

The results of the t-test analysis comparing the proximate composition of Jackfruit Seed Oil-Based Cake (JSOC70) and VOC (control) .are presented. The mean difference between the two groups was evaluated, revealing a standard deviation of 61.51 for JSOC70 and 63.30 for the control. The t-test yielded a t-cal value of -3.00 with 8 degrees of freedom, resulting in a significant p-value of 0.015. Since the p-value (0.015) is less than the set alpha level of 0.05, the null hypothesis is rejected, indicating a significant difference between JSOC70 and the control at 0.05 level of significance.

Discussion of Findings

The sensory evaluation of jackfruit seed oil-based cakes showed significant differences among the samples. JSOC70 scored highest in appearance (7.86±1.06), taste (7.86±0.90), texture (7.71±1.38), aroma (7.71±1.25), and aftertaste (7.86±1.06). JSOC70 was also the most preferred in overall acceptability (8.43±0.53). In contrast, JSOC100 scored lower in all attributes, including appearance (5.57±0.81), taste (5.33±0.68), aroma (5.55±0.89), aftertaste (5.43±1.13), and overall acceptability (5.40±0.53).

The proximate analysis also revealed distinct differences between JSOC70 and the control (VOC). JSOC70 had higher moisture content (22.11%), which may affect its texture and shelf life, potentially making it more perishable. It also had higher carbohydrate content,

but lower fat, protein, and energy content. In contrast, VOC had a more balanced nutritional profile. These differences suggest that JSOC70 has a unique nutritional profile that may influence consumer preferences and nutritional choices.

Conclusion

The research focused on substituting jackfruit seed oil into oil-based cake recipe. The researchers concluded that jackfruit seed oil can be substituted into oil based recipe but in blending ratio with conventional vegetable oil and the most favourable ratio is (70%) of jackfruit seed oil and 30% of vegetable oil as it is more appealing to the eyes, has more appreciative taste and better overall acceptability and also has lower fat content which aligns with consumers who prefers low fat cakes and also has enough carbohydrate which encourage longer satiety.

Recommendations

Based on the results of this study, the following recommendations are provided;

1. Food manufacturers and bakers should incorporate jackfruit seed oil into existing product lines to leverage its nutritional profile and sensory properties, and optimize recipes with (70%) jackfruit seed oil for enhanced sensory appeal.
2. Nutrition professionals can recommend jackfruit seed oil-based products to clients seeking healthier alternatives, and collaborate with food manufacturers to develop targeted products.
3. Home economics educators should integrate jackfruit seed oil-based recipes and sustainable food preparation methods into their teaching, and foster industry collaborations to enhance students' understanding of sustainable food systems.

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