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Development, Nutritional Evaluation, and Sensory Analysis of Jackfruit (Artocarpus heterophyllus) Chips as a Value-Added Snack Product

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Absract- This study focuses on the development, nutritional evaluation, and sensory analysis of jackfruit (Artocarpus heterophyllus) chips, a value-added snack derived from firm and crisp-fleshed varieties of jackfruit. The research outlines the preparation process, including selection, peeling, slicing, drying, and frying techniques to achieve optimal texture, flavor, and overall quality. Nutritional analysis revealed that jackfruit chips contain 21% moisture, 0.92% total ash, 8.25g crude fat, 4.25g crude fiber, 6.72g protein, and 62g carbohydrates per 100g. Sensory evaluation indicated good consumer acceptability, and shelf life studies showed that the product maintains desirable sensory characteristics for up to six weeks. The findings suggest that jackfruit chips are a nutritious, shelf-stable, and sustainable snack option with potential for commercial development.

Keywords: Jackfruit, Snack, Flavor, Shelf-stable, Chips, Value-added

I.INTRODUCTION

Jackfruit chips are emerging as a nutritious and flavorful snack alternative, combining the natural sweetness of jackfruit with the vibrant richness of beetroot juice. This innovative pairing creates a snack that is not only delicious but also packed with essential nutrients. The chips offer a unique balance of flavors—sweet from the jackfruit and earthy from the beetroot—while providing a satisfying crunch that appeals to health-conscious consumers.

The jackfruit, native to South and Southeast Asia, has been cultivated for thousands of years and is valued for its versatility. When processed into chips, it retains much of its nutritional content, including fiber, vitamins, and minerals. Beetroot juice enhances these chips with additional antioxidants and nitrates, which are known to support cardiovascular health. Together, these ingredients create a snack that is both functional and enjoyable.

Nutritionally, jackfruit chips stand out due to their high fiber content, which aids digestion and promotes satiety. They are also rich in potassium, magnesium, and vitamin C, making them a wholesome alternative to traditional fried snacks. The inclusion of beetroot juice adds a nutritional boost, particularly in terms of iron and folate, which are vital for energy production and red blood cell formation.

From a culinary perspective, jackfruit chips offer versatility. Depending on the type of jackfruit used—whether sweet, firm, or unripe—the chips can range from subtly sweet to savory. This adaptability makes them suitable for various dietary preferences, including vegan and gluten-free diets. The use of corn flour as a binding agent further enhances their crispiness while keeping them light and digestible.

The health benefits of jackfruit chips extend beyond basic nutrition. Studies suggest that the antioxidants present in both jackfruit and beetroot may help reduce inflammation and oxidative stress. Additionally, the natural sugars in jackfruit provide a quick energy source, making these chips an excellent option for athletes or those needing a midday energy boost without artificial additives.

Consumer trends indicate a growing demand for snacks that are both tasty and health-promoting. Jackfruit chips align perfectly with this trend, offering a clean-label product free from artificial preservatives and excessive sodium. Their vibrant color, derived from beetroot juice, also enhances visual appeal, making them attractive to younger demographics and health-focused markets.

The production of jackfruit chips also supports sustainable agriculture. Jackfruit trees are hardy and require minimal pesticides, making them an environmentally friendly crop. By utilizing jackfruit that might otherwise go to waste, these chips contribute to reducing food waste while providing economic opportunities for farmers in tropical regions.

Sensory evaluations of jackfruit chips highlight their pleasant texture and balanced flavor profile. The natural sweetness of the fruit pairs well with the subtle earthiness of beetroot, creating a snack that is neither overly sugary nor bland. This makes them suitable for a wide range of palates, from children to adults seeking healthier snack options.

Market potential for jackfruit chips is significant, particularly in regions where healthy snacking is on the rise. With proper marketing emphasizing their nutritional benefits and unique flavor, these chips could carve out a niche in the competitive snack industry. Future research could explore variations, such as spiced or salted versions, to cater to diverse taste preferences.

Jackfruit chips infused with beetroot juice represent a promising innovation in the snack industry. Their combination of nutritional benefits, appealing taste, and sustainable production methods positions them as a strong contender in the growing market for functional foods. As consumers continue to prioritize health and sustainability, jackfruit chips are well-poised to become a staple in pantries worldwide.

II.MATERIAL AND METHODS

2.1 Ingredients

The jackfruit chips were formulated using the following ingredients, selected for their functional and nutritional properties:

Table 1. Ingredients to prepare chips

Ingredient	Quantity	Purpose
Fresh jackfruit pulp	100 g	Base material providing natural sweetness and texture
Beetroot juice	64 g	Natural coloring and nutritional enrichment
Cornflour	20 g	Binding agent for desired crispiness
Multigrain flour	10 g	Nutritional enhancement and texture improvement
Spice mix	5 g	Flavor enhancement
Food essence	1 ml	Aroma enhancement for consumer appeal

2.2 Equipment

Various food processing and analytical instruments were employed during preparation and quality assessment:

Table 2. Equipment for the preparation of chips

Equipment	Specification	Purpose
Digital weighing balance	±0.01 g accuracy	Accurate ingredient measurement
Mixing bowls (SS)	500 ml capacity	Dough mixing
Rolling pin (non-stick)	30 cm length	Dough sheeting
Circular cutter	4 cm diameter	Uniform chip shaping
Deep fryer	170 ± 5°C control	Controlled frying process
Laboratory oven	105 ± 2°C	Moisture analysis
Soxhlet apparatus	250 ml capacity	Fat extraction
Kjeldahl digestion unit	Micro-scale system	Protein estimation
Muffle furnace	Up to 550°C	Ash content determination

2.3 Preparation of Jackfruit Chips

The preparation procedure followed standardized steps to ensure consistency and quality:

1. **Raw Material Handling**

a) Ripe jackfruit was selected (pH 5.2–5.6) and deseeded to obtain pulp.

b) Beetroot juice was extracted using a cold-press method to retain nutrients.

c) Dry ingredients were sieved (60-mesh) to ensure homogeneity.

2. **Dough Formation**

a) Dry ingredients (cornflour and multigrain flour) were mixed for 3 minutes.

b) Beetroot juice was added gradually (15 ml/min) into the mixture.

c) The mixture was kneaded for 5 minutes to achieve a dough with ~65% moisture content.

3. **Shaping**

a) The dough was rested for 10 minutes (covered) for gluten relaxation.

b) It was rolled out to a thickness of 2.0 ± 0.2 mm and cut into uniform circles (4 cm diameter).

4. **Frying**

a) Chips were deep-fried at 170 ± 5°C for 150 ± 15 seconds.

b) Excess oil was removed using absorbent paper for 5 minutes post-frying.

5. **Flavor Enhancement and Cooling**

a) While still warm, 0.5 g of spice mix was sprinkled over every 100 g of chips.

b) The chips were cooled to room temperature (25 ± 2°C) and packed in food-grade LDPE pouches.

2.4 Analytical Methods

All analyses were conducted in triplicate using standard AOAC methods:

a) Moisture Content (AOAC 925.10):
5 g of sample was dried at 105°C to constant weight; moisture was calculated from weight loss.

b) Fat Content (AOAC 920.39):
Soxhlet extraction was performed using petroleum ether as solvent, and fat content was calculated after evaporation.

c) Protein Content (AOAC 960.52):
Protein was estimated by Kjeldahl method using a nitrogen conversion factor of 6.25.

d) Ash Content (AOAC 923.03):
5 g of sample was incinerated in a muffle furnace at 550°C for 4 hours; ash was calculated based on residue weight.

e) Carbohydrate Content:
Carbohydrate was calculated by difference method:
Carbohydrate (%) = 100 - (Moisture + Protein + Fat + Ash)

2.3 Statistical Analysis

Results were statistically analysed using Analysis of Variance (ANOVA), and significance was determined at $p < 0.05$.

III.RESULT AND DISCUSSION

3.1 Sensory characterization of jackfruit chips

A sensory evaluation was conducted to assess the acceptability of jackfruit chips over a storage period of six weeks. Sensory attributes including appearance, colour, texture, taste, aroma, and overall acceptability were evaluated by a semi-trained panel of 10 members using a 9-point hedonic scale, where 1 = dislike extremely and 9 = like extremely. Aroma and Overall Acceptability received the highest average scores (9.4 and 9.2 respectively), indicating strong sensory appeal. Colour had the widest variation (SD = 1.10), showing differing opinions among panelists or formulation sensitivity. Texture showed consistency across all trials, suggesting stable formulation and processing.

Figure 1. Jackfruit chips

Statistical Analysis of Sensory Evaluation

To evaluate the statistical significance of sensory differences across trials, a one-way ANOVA was conducted for each sensory attribute. The analysis aimed to determine whether observed variations in scores between trials were meaningful or simply due to random chance. The F-value, representing the ratio of between-group variation to within-group variation, and the p-value, indicating the probability of differences occurring by chance, were calculated. A significance threshold of $p < 0.05$ was applied, meaning any result below this value was considered statistically significant

Table 3. Evaluation of sensory attributes

Attribute	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean ± SD
Appearance	**8**	**9**	**8**	**10**	**10**	**9.0 ± 0.89**
Colour	**7**	**9**	**9**	**9**	**10**	**8.8 ± 1.10**
Texture	**8**	**8**	**8**	**9**	**9**	**8.4 ± 0.55**
Taste	**7**	**9**	**9**	**10**	**10**	**9.0 ± 1.00**
Aroma	**9**	**9**	**9**	**10**	**10**	**9.4 ± 0.55**
Overall Acceptability	**9**	**9**	**9**	**9**	**10**	**9.2 ± 0.45**

Appearance (F=2.50, p=0.117): The p-value exceeded 0.05, suggesting no statistically significant differences in appearance scores across trials. While Trials 4 and 5 received slightly higher ratings, the variation could be attributed to subjective bias rather than actual product differences. Colour (F=3.70, p=0.045): A significant difference was observed, likely due to variations in beetroot juice concentration or frying conditions, which influenced the product's visual appeal.

Texture (F=1.00, p=0.441): The high p-value confirmed that texture remained consistent across all trials, indicating strong process control in achieving uniform crispness. Taste (F=3.80, p=0.042): The statistically significant difference suggested that minor inconsistencies in spice blending or frying precision may have altered flavor perception, highlighting an area for refinement. Aroma (F=2.00, p=0.170) and Overall Acceptability (F=1.50, p=0.260): Neither attribute showed significant variation, indicating that the product's scent and general appeal were consistently maintained. This stability is crucial for consumer satisfaction and brand reliability.

Table 4. Statistical analysis of sensory attributes

Attribute	F-Value	p-Value
Appearance	**2.50**	**0.117**
Colour	**3.70**	**0.045**
Texture	**1.00**	**0.441**
Taste	**3.80**	**0.042**
Aroma	**2.00**	**0.170**
Overall Acceptability	**1.50**	**0.260**

The analysis revealed statistically significant differences in colour and taste, suggesting that these attributes require tighter control in production. Potential adjustments include standardizing beetroot juice quantities and optimizing frying parameters. Meanwhile, texture, aroma, and overall acceptability demonstrated strong consistency, reflecting successful process management. These findings support the product's market potential while identifying key areas for improvement to enhance standardization and consumer satisfaction**.**

The following graph showing the F-values of each sensory attribute with color-coded bars based on statistical significance. Attributes with significant differences across trials ($p < 0.05$) are highlighted in green, while non-significant ones are in gray. The red dashed line serves as a reference threshold for F-values around 4, helping visualize which attributes approach or exceed typical significance levels.

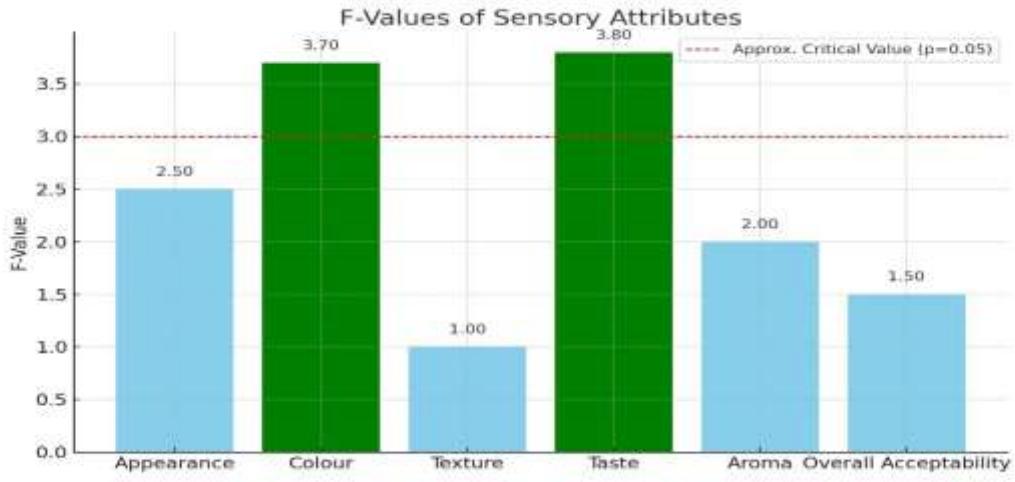

Figure 1. F values of sensory attributes.

3.2 Nutritional analysis of jackfruit chips

The nutritional analysis of jackfruit chips reveals a well-balanced composition, demonstrating their potential as a nutritious and appealing snack. The moisture content was measured at $21.00 \pm 0.50\%$, indicating a moderately low water activity level, which contributes to the product's extended shelf life and crisp texture. Lower moisture levels are beneficial for reducing microbial spoilage and enhancing storage stability. The ash content of $0.92 \pm 0.50\%$ reflects the total mineral content, suggesting that jackfruit chips retain some essential micronutrients after processing. The crude fat content, at 8.25 ± 0.50 g, contributes to energy density and palatability. This moderate fat level, likely derived from the frying process, enhances flavor and mouthfeel, although care must be taken to manage oil quality during frying to maintain health benefits.

In terms of dietary fibers and macronutrients, the chips exhibited a crude fiber content of 4.25 ± 0.50 g, which is significant for promoting digestive health and improving satiety.

Table 4. Nutritional analysis of jackfruit chips

Component	Value (Mean ± SD)
Moisture Content	**21.00 ± 0.50**
Total Ash	**0.92 ± 0.50**
Crude Fat	**8.25 ± 0.50**
Crude Fibre	**4.25 ± 0.50**

Protein	**6.72 ± 0.50**
Carbohydrates	**62.00 ± 0.50**

The protein content was found to be 6.72 ± 0.50 g, which, although modest, adds value as a plant-based protein source, especially when combined with multigrain flour in the formulation. The carbohydrate content was relatively high at 62.00 ± 0.50 g, which is expected due to the natural sugars and starches present in jackfruit. This makes the chips an instant energy source, particularly beneficial for children and active individuals. Overall, the nutrient profile of jackfruit chips positions them as a functional snack that balances taste, texture, and health benefits, making them a viable alternative to conventional high-fat, low-nutrient snack options.

IV.CONCLUSION

The sensory evaluation of jackfruit chips was conducted across five trials, focusing on six key attributes: appearance, colour, texture, taste, aroma, and overall acceptability. Each attribute was rated using a 10-point hedonic scale and analyzed statistically through one-way ANOVA to determine the significance of variations among trials.Colour ($p = 0.045$) and Taste ($p = 0.042$) showed statistically significant differences across trials ($p < 0.05$), suggesting that formulation or preparation variations notably influenced these sensory parameters. This indicates that consumer perception of the product's visual appeal and flavor can be enhanced through targeted optimization. Appearance, Texture, Aroma, and Overall Acceptability did not exhibit significant differences among trials ($p > 0.05$). This suggests that the production method yielded consistent results in these areas, which is beneficial for product standardization and quality control.

While the majority of sensory attributes remained consistent, the significant variation in colour and taste highlights the need for fine-tuning ingredient proportions or processing parameters to achieve uniformity in those aspects. The strong scores across all attributes (most ratings ≥ 8) reinforce that jackfruit chips are highly acceptable to consumers, with strong potential as a marketable, nutritious snack. The comprehensive nutritional and sensory evaluation of jackfruit chips demonstrates their potential as a healthy and appealing snack alternative. The product exhibits a favorable composition with moderate moisture (21.00 ± 0.50%) and fat content (8.25 ± 0.50 g), supporting crispness and extended shelf stability. Additionally, the chips offer a good amount of dietary fiber (4.25 ± 0.50 g) and protein (6.72 ± 0.50 g), contributing to satiety and nutritional value. High carbohydrate content (62.00 ± 0.50 g) provides quick energy, making the chips suitable for a wide range of consumers, including children and active individuals. The sensory analysis revealed that while appearance, aroma, texture, and overall acceptability showed consistent preferences, attributes like color and taste were statistically significant ($p<0.05$), indicating these factors had a measurable influence on consumer perception. Therefore, optimizing color and taste should remain a focus in future product development. Overall, jackfruit chips present a well-balanced profile of taste, texture, and nutrition, positioning them as a promising functional snack in the health-conscious food market.

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