Formulation of value-added flavored Peanut spread enriched with Jackfruit seed powder

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Abstract

This study aimed to develop value-added and flavored peanut spread formulations enriched with jackfruit seed powder, an underutilized agricultural by-product, to enhance nutritional quality while promoting sustainability. Jackfruit seed powder was incorporated for its functional benefits, including dietary fiber, starch, minerals, and antioxidant properties, while peanuts contributed high-quality protein, healthy fats, and essential micronutrients. Three different flavored formulations (garlic (F2), vanilla (F3), cocoa (F4)), and a control (F1) formulation were developed using peanut, jackfruit seed powder, sunflower oil, honey, vinegar, and salt. Sensory evaluation of the formulated spreads was conducted using a five-point hedonic scale to assess appearance, texture, spreadability, aroma, flavor, mouthfeel, and overall acceptability using 35 semi-trained panelists. Based on sensory scores, the garlic flavor incorporated formulation (F2) was identified as the most acceptable treatment. Chemical analysis of the selected garlic-flavored peanut spread enriched with jackfruit seed powder (F2) formulation revealed a moisture content of 4.08%, pH of 6.3, ash content of 3.33g/100g, acidity of 7.95%, fat content of 33.83g/100g, and yeast and mold count of less than 1×10^2 CFU/g, indicating good product stability and microbiological safety. This research demonstrates the potential of jackfruit seed powder as a functional ingredient in peanut spread, adding value to an often- discarded by-product while supporting sustainable food innovation and functional food development.

Keywords: Cocoa, Garlic, Jackfruit seed powder, Peanut, Vanilla

Introduction

Spread is a semi-solid food product used to enhance the flavor or texture of food, and it can be prepared in a paste, syrup, or liquid. Peanut spread is one of the most popular due to its nutritional and taste benefits, and it is widely consumed as an affordable plant-based protein source. However, its high-fat content and allergenic nature have encouraged researchers to explore healthier and alternative formulations by incorporating novel ingredients.

Recently, the development of value-added spreads using underutilized or agricultural by-products has improved nutritional quality while reducing production cost. One such promising ingredient is jackfruit seed powder. Jackfruit (*Artocarpus heterophulls*), locally known as "kos" in Sri Lanka, is abundantly grown in tropical countries. However, jackfruit seeds are being wasted as waste despite containing nutritional value. Jackfruit seeds have starch, protein (13-15%), dietary fiber, minerals such as potassium, calcium, phosphorus, and bioactive compounds like phenolic, flavonoids, and antioxidants, and it is a suitable ingredient for the production of functional food. Converting jackfruit seed into jackfruit seed flour or powder provides a low-cost ingredient that can be used to enhance the nutritional quality of food formulations. (Suwannaporn & Linnemann, 2008).

Peanuts (*Arachis hypogaea)* are primarily grown for oil extraction. By-products of peanuts are also valuable as they contain essential nutrients such as protein (25-30%), dietary fiber (8-10%), polyphenols, vitamins such as vitamin E and niacin, antioxidants, and minerals such as magnesium, phosphorus, potassium, and iron (USDA, 2020). Peanuts are a rich source of bioactive compounds such as resveratrol, phenolic acids, flavonoids, and phytosterols, which are known to reduce the blood cholesterol absorption and promote cardiovascular health. They are a good source of co-enzyme Q10, an important antioxidant that supports cellular energy production. Additionally, peanuts contain all 20 essential amino acids, with a particularly high amount of arginine, which helps improve blood circulation and boosts immune health.

Incorporating jackfruit seed powder into peanut spread can increase dietary fiber content, improve functional properties, and reduce production costs by partially replacing peanuts. This combination also supports the utilization of underused agricultural resource, aligning with

sustainable food production and zero-waste concepts in Sri Lanka (Perera *et al*, 2020). The study aims to develop value-added and flavored peanut spread formulations enriched with jackfruit seed powder, select the best flavored product using sensory evaluation, and determine the physicochemical and nutritional properties of the selected formulation.

Materials and Methods

All analyses of this research were conducted at the laboratory of the Department of Food Technology, University College of Jaffna.

Raw materials

Raw materials were purchased from local markets and shops available in Jaffna.

Methodology

Preparation of peanut

Peanuts were roasted and then peeled. After that, it was ground into flour.

Preparation of jackfruit seed powder

Jackfruit seeds were boiled, dried, and ground to form powder.

Preparation of flavored peanut enriched with jackfruit seed flour

Peanut flour, jackfruit seed flour, sunflower oil, honey, garlic, vanilla, cocoa powder, vinegar, and salt were mixed, and then all ingredients were ground.

Finally, three different flavored formulations garlic (F2), vanilla (F3), cocoa powder (F4) with a control formulation (F1) were prepared using peanut flour and jackfruit seed flour (Table 1).

Table 1: Recipe of the flavored spread formulations as a percentage

Ingredients	**Formulation 1 (F1)**	**Formulation 2 (F2)**	**Formulation 3 (F3)**	**Formulation 4 (F4)**
	Percentage (%)	Percentage (%)	Percentage (%)	Percentage (%)
Peanuts	51	50	50	50
Jackfruit seed powder	30	30	30	30
Sunflower oil	10	10	10	10
Honey	8	8	8	8
Salt	0.5	0.5	0.5	0.5
Vinegar	0.5	0.5	0.5	0.5
Cocoa powder	-	-	-	1
Vanilla Flavor	-	-	1	-
Garlic powder	-	1	-	-

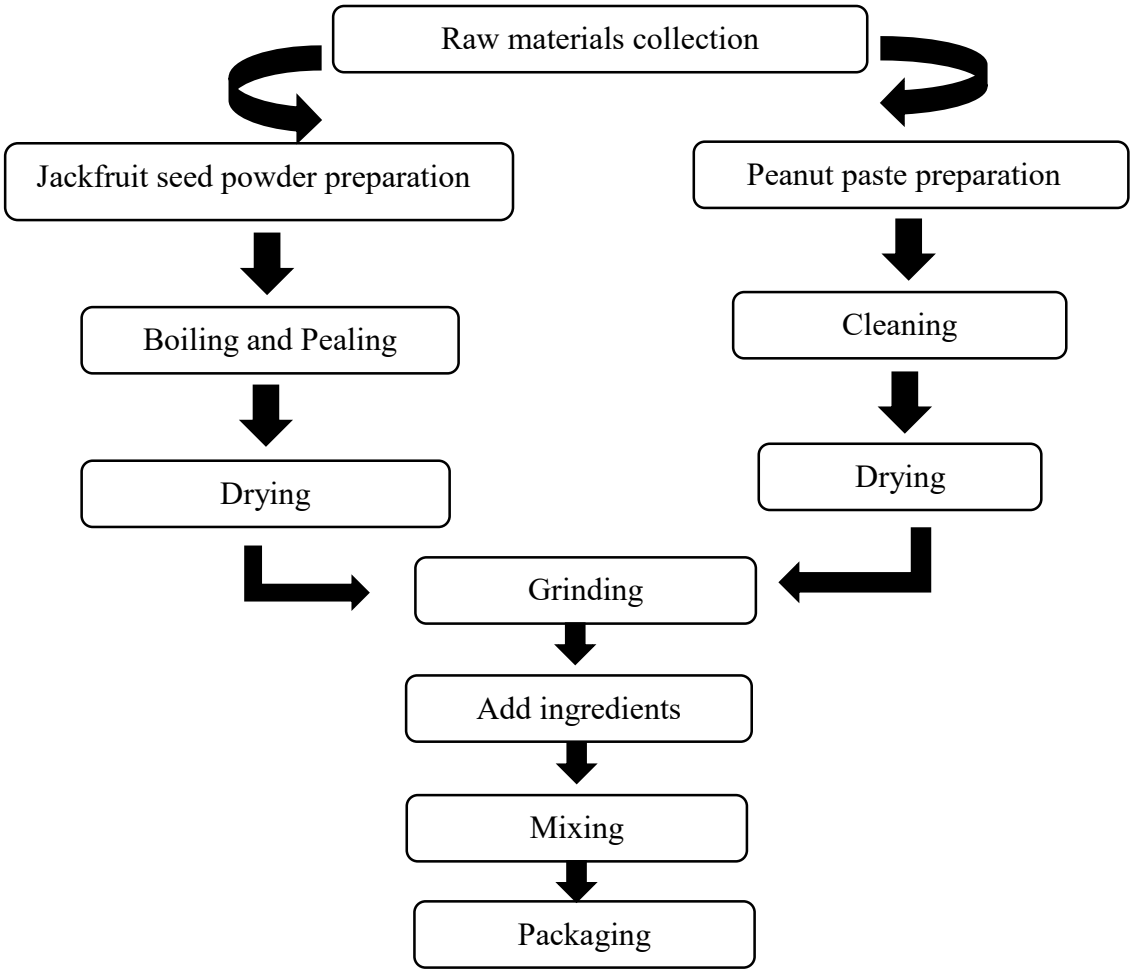

Figure 1: Processing of the peanut spread enriched with jackfruit seed powder

Selection of the most preferable treatment

A sensory evaluation was carried out to compare four different formulations of peanut spread enriched with jackfruit seed powder. A five-point hedonic scale was used, where a score of 1 indicated "extremely dislike" and a score of 5 indicated "extremely like". 35 semi-trained panelists were used for the sensory evaluation process.

Determination of Physicochemical and Nutritional Properties

To ensure accuracy and reliability, all physicochemical tests were conducted in triplicate. The analysis focused on key quality parameters, including moisture content, pH, fat content, ash content, and minerals (Na, K, Ca, Mg, and salt) using standard AOAC procedures.

Statistical Analysis

SPSS version 25 was used to analyze the sensory evaluation and physicochemical analysis.

For the sensory test, non-parametric statistical tests were applied to determine significant differences among the formulations at a 5% level of significance.

For the physicochemical test, one-way ANOVA was used to assess whether there were significant differences among the various formulations. When significant differences were found, Tukey's HSD post hoc test was used to pinpoint which formulations differed, with statistical significance ($p < 0.05$).

Results and Discussion

Sensory analysis

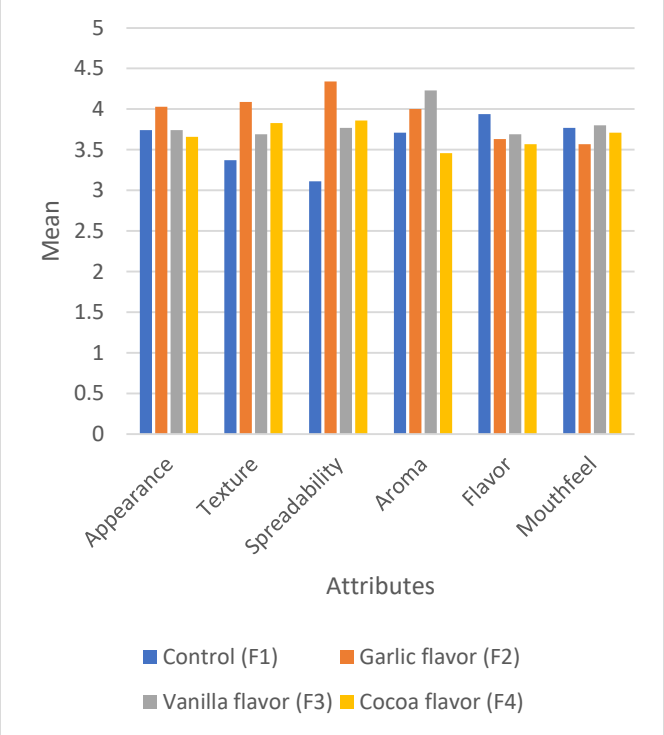

Figure 2: Results of sensory evaluation of flavored peanut spreads enriched with jackfruit seed flour

The bar chart (Figure 2) represents the sensory evaluation results of flavored peanut spreads enriched with jackfruit seed flour for five attributes: appearance, texture,

spreadability, aroma, flavor, and mouth feel. Four formulations (control (F1), garlic flavor (F2), vanilla flavor (F3), and cocoa flavor (F4)) were compared using different colors: blue for F1, orange for F2, gray for F3, and yellow for F4. The scale ranges from 0 to 5, with higher scores indicating better performance.

Based on the sensory evaluation results, the four formulations (F1, F2, F3, and F4) show their own strengths across different sensory attributes. Based on the appearance, texture, and spreadability of the formulations, the F2 formulation (garlic flavor) was scored higher than the other three formulations, which contributes to steady overall acceptance. A higher score was observed in the F3 formulation (vanilla flavor) for the aroma and mouthfeel attributes. F1 formulation (control) was given a higher score for flavor than the other three formulations. Overall, F2 formulation (garlic flavor) emerges as the most well-rounded sample, performing competitively across all attributes.

Nutritional Parameters

Table 2: Determination of Nutritional parameters

Nutritional parameters	**Results**
Sodium	28.72mg/100g
Potassium	305.39mg/100g
Calcium	33.20mg/100g
Magnesium	129.49mg/100g
Salt	0.16g/100g
Fat	33.83g/100g

Table 2 describes the nutritional properties of the garlic-flavored peanut spread enriched with jackfruit seed powder. It can be described as a wholesome and functional food made by thoughtfully combining peanuts, jackfruit seed powder, and garlic. As expected for a peanut-based product, it contains a relatively high fat content (33.83 g/100 g), most of which comes from healthy unsaturated fats that support heart health, provide energy, promote fullness, and help the body absorb fat-soluble vitamins. The inclusion of jackfruit seed powder adds complex carbohydrates and dietary fiber, helping to create a more balanced formulation.

The spread contains low levels of salt (0.16 g/100 g) and sodium (28.72 mg/100 g), making it a good choice for individuals mindful of blood pressure and heart health, while garlic naturally enhances flavor

without the need for excess salt. Its high potassium content (305.39 mg/100 g) supports normal muscle and nerve function, maintains fluid balance, and helps offset the effects of sodium on blood pressure. Calcium (33.20 mg/100 g) contributes to strong bones and teeth, while magnesium (129.49 mg/100 g) plays an important role in energy production, muscle relaxation, nervous system function, and blood sugar regulation. Overall, this formulation brings together healthy fats and plant protein from peanuts, fiber and minerals from jackfruit seed powder, and the natural antioxidant and heart-protective benefits of garlic, making Formulation 2 a nutritious, heart-friendly, and appealing value-added spread.

Chemical parameters

Moisture analysis

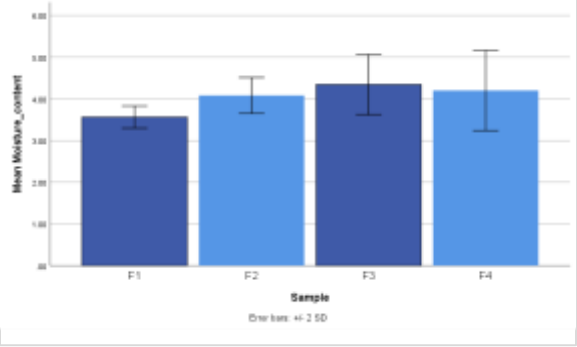

Figure 3: Moisture content of spread formulations

The pairwise comparison results show analysis for moisture content; a significant difference was found only between Formula 1 (F1) and Formula 3 (F3), with a p-value of 0.036. In summary, only F1 and F3 differed meaningfully in moisture content, while the other formulation (F2 and F3) had relatively comparable moisture levels.

Determination of fat content

Table 3: Determination of Fat Content

Formula	Average Fat Content
F1	34.00±2.28
F2	33.83±1.79
F3	32.33±1.10
F4	33.61±0.25

The fat content of four formulations was slightly differ with each other. Minor numerical differences in fat content were observed among formulations F1 to F4; the Tukey HSD analysis confirms that these differences are not statistically significant. Consequently, fat content does not appear to have a meaningful influence on the spreadability of the samples. Any observed variation in spreadability or related sensory properties is therefore more likely attributable to natural sample variability or experimental error rather than differences in formulation composition (Lawless & Heymann, 2010).

Determination of ash content

Table 4: Determination of ash content

Formulations	Average Ash
F1	3.120/100g
F2	3.336g/100g

The ash content of the two formulations was measured to understand their total mineral content. Formulation F1 had an ash content of 3.120%, while F2 was slightly higher at 3.336%. This means that F2 contains a little more mineral than F1 due to the addition of garlic.

Analysis of pH

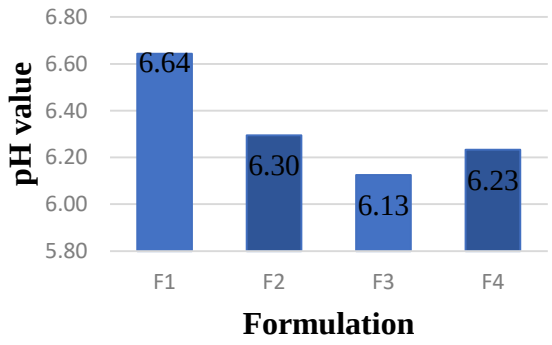

Figure 4: pH of spread formulations

The pH results (Figure 4) show clear differences among the four formulations (F1–F4). F1 recorded the highest pH value at 6.64, making it slightly more neutral or basic compared to the others. F2 and F4 showed moderately lower pH levels of 6.30 and 6.23, indicating a mildly more acidic character. The lowest pH was found in F3 at 6.13, making it the most acidic formulation in the group.

Conclusion

This study successfully developed and evaluated flavored peanut spread enriched with jackfruit seed powder, using complementary ingredients such as roasted peanuts, jackfruit seed powder, sunflower oil, honey, salt, and vinegar. The four spread formulations were optimized through a systematic sensory evaluation using 35 semi trained panelist, who identified that garlic-flavored peanut spread enriched with jackfruit seed powder (F2) was selected as the most acceptable formulation. Chemical analysis of the selected formulation (F2) revealed a moisture content of 4.08%, pH of 6.3, ash content of 3.33g/100g, acidity of 7.95%, fat content of 33.83g/100g, and yeast and mold count of less than 1×10^2 CFU/g, indicating good product stability and microbiological safety.

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