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Evaluation of Physico-chemical and Nutritional properties of Ragi Spread Infused with Jackfruit

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The increasing demand for health-oriented and functional foods has led to renewed interest in underutilized crops with high nutritional potential. This study explores the formulation and evaluation of a jackfruit-ragi (*Artocarpus heterophyllus* and *Eleusine coracana*) spread, aiming to create a nutrient-dense, plant-based product suitable for a wide demographic. Jackfruit, rich in dietary fibre, natural sugars, carotenoids, and antioxidants, pairs with ragi, a millet known for its high calcium, iron, and amino acid content, to produce a spread with enhanced health benefits. The physicochemical and nutritional properties of the developed spread were analyzed, revealing a titratable acidity of 0.71%, ash content of 4.5%, protein at 5.6%, fat at 12.5%, and fibre at 16.6%. These values highlight the spread's potential as a functional food, offering benefits for digestive health, energy balance, and dietary supplementation, particularly for vegetarian and vegan consumers. The high fibre and moderate protein content contribute to satiety and nutritional adequacy, while the acidity and moisture levels suggest acceptable shelf stability. This research supports the use of indigenous crops in innovative food products and demonstrates the feasibility of incorporating jackfruit and ragi into a palatable, nutrient-rich spread with applications in combating malnutrition and promoting sustainable diets.

Introduction

In recent years, there has been a growing interest in the development of functional foods that not only offer nutritional benefits but also cater to the evolving preferences of health-conscious consumers. Among various traditional and underutilized crops, *Artocarpus heterophyllus* (jackfruit) and *Eleusine coracana* (ragi or finger millet) have gained attention due to their rich nutrient profiles and potential health benefits. Jackfruit, a tropical fruit native to South and Southeast Asia, is known for its high dietary fiber, natural sugars, vitamins, and antioxidant content. Meanwhile, ragi, a resilient cereal grain widely cultivated in India and Africa, is a powerhouse of calcium, iron, and essential amino acids, particularly methionine, which is often lacking in other cereals. Combining these two ingredients into a spreadable form not only provides a novel way to consume these nutritious foods but also offers an innovative approach to promote the use of indigenous crops in value-added products. A jackfruit-ragi spread can serve as a wholesome, ready-to-eat functional food with potential applications in addressing malnutrition and supporting sustainable food systems. This research aims to develop and evaluate the physicochemical, sensory, and nutritional properties of a jackfruit-ragi spread, with the goal of creating a palatable and health-promoting product suitable for a wide demographic.

Artocarpus heterophyllus Lam, belonging to the family Moraceae (mulberry family) and popularly known as jackfruit is one of the important and commonly found trees in the home gardens of India and Bangladesh (Anonymous *et al*., 2006). Jackfruit contains many classes of compounds such as carotenoids, flavanoids, volatile acids sterols and tannins, and that their concentration changes with the variety (Arung, Shimizu, & Kondo, 2007). Carotenoids are known to impart yellowish-red color to many foods and their ratio is supposed to render the jackfruit the various yellow to orange shades of color (Jagdeesh, Reddy, Basavraj, Swamy, & Hegde, 2010). The kernel is reported to contain β-carotene, α carotene, β-zea carotene, α-zea carotene and β-carotene-5, 6α-epoxide and adicarboxylic carotenoid and crocetin (Chandrikaet *et al*., 2004). Recent studies have also shown that the key carotenoids present in jackfruit are all-trans-lutein (24–44%), all-trans-β-carotene(24–30%), all-trans-neoxanthin(4–19%), 9-cis-neoxanthin(4–9%)and9-cis-violaxanthin(4–10%). However, both qualitative and quantitative differences were seen in the fruits harvested from different varieties of trees (Faria, Rosso, & Mercadante, 2009). Wong *et al*. (1992) investigated the steam-distilled volatile constituents from jackfruit grown in Malaysia and observed that the jackfruit contained forty five volatile components of which thirty two were novel.

The Artocarpus species contain a diversity of compounds especially phenolic compounds, flavonoids, stilbenoids, arylbenzofurons, carotenoids, volatile acid sterols and tannins which varies depending on the variety (Jagtap and Bapat, 2010; Baliga *et al*., 2011) Fructose, glucose and sucrose were the major sugars in jackfruit, while capric, myristic, lauric, palmitic, oleic, stearic, linoleic and arachidic acids were the major fatty acids (Chowdhury *et al*., 1991)

Jackfruit contain high amount of vitamins and minerals. The fruit is rich in carotene and carbohydrates and moderately rich in ascorbic acid (Hossain *et al*., 1979). Jackfruit also contains minerals like calcium and potassium and Vitamin B complex group like thiamin, riboflavin, and Niacin and. The seeds of jackfruit are reported to be more nutritious than its bulb. Seeds are rich in protein, carbohydrate fat, potassium and with fair amount of phosphorus and calcium (Rahim and Quaddus, 2000). Jackfruits are a good source of vitamin C. According to United State of Agriculture Department report (2016) Jackfruit has the unique nutritional values

The phytonutrients can prevent the formation of cancer cells in the body, can lower blood pressure, can fight against stomach ulcers, and can slow down the degeneration of cells that make the skin look young and vital Sajesh *et al*., 2015. Jackfruit is a tropical tree, which has numerous health benefits of jackfruit including anti-carcinogenic, anti-microbial, anti-fungal, anti-inflammatory, healing, (Sofowara, and hypoglycemic 1993). Jackfruit wound properties contains, phytonutrients including lignins, isoflavones, and saponins. These phytonutrients have anticancer, antiulcer, and anti-aging properties (Baliga *et al*., 2011). Sundarraj and Rangnathan (2017) reported that alkaloids, flavonoids, carbohydrates, proteins and triter penoids the active compounds presence in jackfruit.

Result and Discussion

Nutrient Analysis of Ragi spread infused with Jackfruit

S. No.	Parameter	Sample readings (%) (Jackfruit spread)
1.	Titratable acidity	0.71
2.	Ash content	4.5
3.	Protein	5.6
4.	Fat	12.5
5.	Fibre	16.6

This study presents the proximate composition of a formulated jackfruit spread, highlighting its potential as a nutritious plant-based food product. The jackfruit spread was evaluated for key nutritional parameters including titratable acidity, ash content, protein, fat, and fiber. The titratable acidity was found to be 0.71%, indicating a mild acidic profile suitable for preservation and palatability. The ash content measured at 4.5% reflects the presence of essential minerals and inorganic matter, contributing to the nutritional quality of the spread. Protein content was recorded at 5.6%, signifying a moderate source of plant-based protein, which may support dietary protein intake in vegetarian and vegan diets. The fat content was relatively high at 12.5%, suggesting the inclusion of lipid-rich ingredients, possibly enhancing the spread's energy density and mouthfeel. Notably, the fiber content was substantial at 16.6%, underlining the product's potential benefits for digestive health and satiety. These findings suggest that jackfruit spread not only offers a unique flavor profile but also provides a well-rounded nutritional composition, making it a promising candidate for functional food development and health-conscious consumer markets

The physicochemical and nutritional analysis of the jackfruit spread indicates a promising composition suitable for health-oriented food products.

Titratable acidity: The **titratable acidity** was measured at **0.71%**, which is within the acceptable range for fruit-based spreads. This level of acidity not only contributes to the overall flavor but also plays a role in microbial stability and shelf life. A balanced acidity is crucial for consumer acceptability, particularly in fruit-based formulations where sourness needs to complement natural sweetness. The acid present in the spread was expected to be high due to the addition of citric acid during spread making (Islam *et al.*, 2021)

Total Ash Content: The **ash content**, recorded at **4.5%**, is indicative of the total mineral content present in the spread. This relatively high ash value suggests that the spread is a good source of essential minerals, which may include calcium, potassium, magnesium, and iron, depending on the composition of the jackfruit and other ingredients used in the formulation. Haque *et al*. (2009) reported that ash contents of fresh fruits ranged from 0.053% to 0.902% in jackfruit. Most processed products such as jams, spread, *etc*., tend to have lower nutritional values when compared to fresh fruits due to exposure to the heat generated during processing (Jawaheer *et al*., 2003).

Total Protein Content: The **protein content** of the spread was found to be **5.6%**, which is relatively higher than that of most traditional fruit-based spreads, such as jams or jellies, which typically contain minimal protein. This moderate protein level may be attributed to the natural composition of jackfruit and any added protein-rich components, enhancing the product's value as a supplemental protein source, especially for vegetarian or vegan consumers. The composition was found to vary with variety, environment and different maturity stages (Ahmed *et al.*, 2011). The protein content of malted ragi was higher when compared with the un-treated ragi samples which might be due to micro-organisms utilized the carbohydrate to synthesis amino acid in the food needed for their growth and development with simultaneous production of simple sugar by amylolytic enzymes (Sudha Tiwari *et al.*, 2018). Soaking and Germination if used in combination can increase the protein digestibility as suggested by Liang *et al*. (2009) the same research suggested that protease enzymes break down the peptide bonds into proteins and produces amino acids. Zakari, 2008 also stated that during germination of finger millet will increase protein content with the use of protease activities

Crude Fat Content: The **fat content**, measured at **12.5%**, is considerably high for a fruit spread. This suggests the inclusion of lipid-rich ingredients such as coconut milk, nut butters, or plant-based oils, which are often used to improve mouthfeel, texture, and caloric density. While the fat content increases energy value, it also plays a role in the spread's palatability and structural integrity. The soaking process decreases the fat content of ragi grain because of absorption of water after the enzyme is activated and then into the endosperm and digest food reserve substance. Lipase enzyme helps in breaking down of fats into glycerol and fatty acids, because these compounds are water soluble, they can diffuse into the cells tissue (Nidhi Chaudhary *et al.*, 2019). The fat content of spread was increased due to high fat content of butter incorporated in spread. This result is close agreement with Curley (2008) in oat porridge (Goswami *et al.*, 2017).

Crude Fibre Content: The **fiber content** was notably high, reaching **16.6%**, which is a significant nutritional attribute. High dietary fiber is associated with a range of health benefits, including improved digestive health, regulation of blood sugar levels, and promotion of satiety. This level of fiber makes the jackfruit spread especially appealing as a functional food product targeting consumers interested in weight management and gut health. The percent crude fibre of the fresh ripe jackfruit was 2.13 %. This value is slightly low compared to the value 3.06 % reported by Singh *et al*. (1991). The difference may be due to varietal distinctions and the geographical location while crude fibre in jackfruit jam was 0.48%. The fiber content of jackfruit helps protect the colon mucous membrane by binding to and eliminating cancer-causing chemicals from the colon. The fiber content was increased with increasing the ratio of supplementation of ragi in composite flour (Goswami *et al.*, 2017) to prepare spread. The minor increment in fibre could be due to increased bran matter and the building of dry matter during the growth and development (germination) of the plant (Tiwari *et al.*, 2018). Fiber content varies depending on the type and degree of ripeness of dates which could account for the differences observed. This means that the consumption of 100g of ragi spread can provide more than 25% of the recommended daily amount of fiber.
Moisture Content: The moisture content levels of pineapple spread (32%), jackfruit spread (33%) and sapota spread (35%) were high and varied. All of the spread possessed similar levels of moisture content (30–35%). Pineapple spread had the lowest moisture content followed by jackfruit spread and sapota spread. The moisture contents for the spreads were comparable with that for roselle jam which has been reported to be between 33% and 34% (Ashaye *et al.*, 2009). Generally, the moisture content of foods can be used as an indicator of its shelf life (Fellows, 2000). Low moisture content indicates that the jams have a long shelf life (Naeem *et al.*, 2017).

Conclusion

The development and analysis of a jackfruit-ragi spread demonstrate its potential as a functional, nutrient-rich food product that leverages the nutritional strengths of two underutilized indigenous crops. The formulation exhibited favorable physicochemical and nutritional characteristics, including high dietary fibre, moderate protein levels, essential minerals, and beneficial fat content. These attributes make the spread suitable for health-conscious consumers and particularly valuable in vegetarian and vegan diets where plant-based protein and fibre are in demand. The acidity and moisture content observed also suggest good sensory acceptability and microbial stability, which are critical for shelf life and commercial viability. By combining jackfruit's antioxidant and vitamin-rich profile with ragi's mineral and amino acid density, the spread offers a holistic approach to addressing nutritional gaps and enhancing dietary quality. Furthermore, this study underscores the potential of value-added food innovations to promote sustainable food systems and encourage the wider use of traditional crops. Future research can explore sensory evaluations, consumer preferences, and shelf life studies to optimize the product for market introduction.

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