

Development, Phytochemical Profiling and Quality Evaluation of a Fruit-Based Health Bar

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Abstract: The growing interest in healthy and nutrient-rich snack options has led to the development of innovative fruit-based products that provide numerous health advantages. This study aimed to create and assess a new health bar made from jackfruit and orange, utilizing locally accessible bioactive fruits. Three different formulations were prepared by varying the proportions of jackfruit pulp and orange juice, and these were evaluated for sensory characteristics, nutritional content, functional properties, and shelf stability. Sensory testing indicated that the formulation with 80% jackfruit and 20% orange received the best overall ratings. A proximate analysis revealed that the chosen product was rich in carbohydrates, dietary fibre, and protein, while vitamin and mineral assessments showed high levels of vitamin C, vitamin A, folate, potassium, and magnesium. The product also exhibited beneficial functional attributes and good stability during storage. The combination of jackfruit and orange enhanced the nutritional value and antioxidant capacity, making the health bar a promising functional snack. The results suggest that it could serve as a healthy, affordable, and appealing snack option for individuals of all ages, aiding in improved nutritional intake and fostering healthier eating habits.

Keywords: Jackfruit, Orange, Health Bar, all Age Group.

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I. INTRODUCTION

Jackfruit (*Artocarpus heterophyllus*), a member of the Moraceae family, is one of the largest tree-borne fruits and is widely cultivated in tropical and subtropical regions of the world. Native to the Western Ghats of India, jackfruit is also grown extensively in Southeast Asia, Africa, the Caribbean, Australia, Brazil, and several Pacific Islands (Rahman et al., 1999). The fruit occurs mainly in two distinct types, namely firm and soft. In the firm type, the perianth remains crisp and firm even at full maturity, whereas in the soft type it becomes tender, fleshy, and highly sweet upon ripening (Rahman et al., 1999). The firm variety is generally considered superior in quality because of its desirable texture and consumer preference (Alagiapillai et al., 1996). Variations in starch, total sugar, and reducing sugar contents have also been reported between these two types (Rahman et al., 1999; Nandini, 1989). Jackfruit is recognized as a highly nutritious fruit with considerable health-promoting potential. Both the edible bulbs and seeds contain higher levels of protein, calcium, iron, and thiamine compared to many commonly consumed tropical fruits (Haq et al., 2006). Furthermore, ripe jackfruit has been reported to contain

greater amounts of certain vitamins and minerals than fruits such as apples, apricots, avocados, and bananas (Tiwari & Vidyarthi, 2015). Despite its rich nutrient profile, jackfruit is relatively low in calories, providing approximately 94 kcal per 100 g of edible portion (Mukprasirt & Sajjaanantakul, 2004).

The nutritional composition of jackfruit changes during maturation. Studies have demonstrated a substantial presence of starch in both the perianth and seeds, with starch and dietary fiber levels increasing as the fruit matures (Rahman et al., 1995; Rahman et al., 1999). Jackfruit is also an excellent source of vitamin C and B-complex vitamins, particularly pyridoxine, niacin, riboflavin, and folic acid (Swami et al., 2012; Mushumbus, 2015). In addition, ripe fruits contain appreciable amounts of calcium, magnesium, vitamins, and organic acids that contribute to their nutritional and functional value (Tiwari & Vidyarthi, 2015). Fiber content in jackfruit has been reported to vary depending on maturity stage and cultivar, ranging from 0.33–0.40% in different fruit components (Ong et al., 2006), while values of 2.6% and 0.8% have been reported for immature and ripe fruits, respectively (Coronel, 1983).

Among different varieties, fiber content generally ranges from 0.50% to 0.90% (Goswami et al., 2011).

Another important nutritional attribute of jackfruit is its carotenoid content. Carotenoids are naturally occurring pigments responsible for yellow to red coloration in plants and other organisms. Beyond their role in coloration, carotenoids possess provitamin A activity and exhibit antioxidant properties that may help reduce the risk of chronic diseases, including cardiovascular disorders, cancer, inflammatory conditions, cataracts, and age-related macular degeneration (Faria et al., 2009).

Citrus fruits, particularly oranges (*Citrus sinensis*), are among the most economically important fruit crops worldwide and contribute significantly to the agricultural economy of many countries. Oranges are highly valued for their pleasant flavor, natural sweetness, and versatility in food applications. They are consumed fresh, processed into juice, incorporated into marmalades, or utilized as flavoring agents in bakery and confectionery products. Oranges are especially renowned for their high vitamin C content and abundance of bioactive compounds that contribute to their health-promoting properties.

Nutritionally, oranges are rich sources of vitamin C, flavonoids, carotenoids, and other phytochemicals with strong antioxidant activity. These compounds have been associated with anti-inflammatory effects and protection against various chronic diseases. Although oranges are widely consumed, large quantities of by-products such as peels, membranes, and seeds are generated during processing and are often discarded as waste. However, these by-products contain significant amounts of nutrients, including vitamin C, thiamine, niacin, pyridoxine, phosphorus, calcium, iron, magnesium, potassium, and both soluble and insoluble dietary fiber. They are also valuable sources of bioactive compounds, particularly flavonoids and phenolic acids, which have potential applications in functional food development.

Vitamin C (ascorbic acid) is an essential water-soluble vitamin that plays a critical role in maintaining human health. As a potent antioxidant, it helps protect cells from oxidative damage and may reduce the risk of chronic diseases such as cardiovascular disease and cancer (Carr & Maggini, 2017). Additionally, vitamin C is indispensable for collagen synthesis, wound healing, maintenance of connective tissues, and proper functioning of the immune system (Ashraf et al., 2012; Nader et al., 2014; Pullar et al., 2017). Adequate dietary intake of vitamin C is therefore necessary to support overall health and well-being, and its concentration in fruits can be influenced by factors such as cultivar, maturity stage, environmental conditions, and processing methods.

Considering the complementary nutritional profiles of jackfruit and orange, the incorporation of these fruits into value-added health bar presents an opportunity to develop nutrient-dense and consumer-acceptable functional food. Jackfruit contributes dietary fiber, minerals, carotenoids, and B-complex vitamins, while orange provides substantial amounts of vitamin C, flavonoids, and antioxidants. The combination of these fruits may enhance the nutritional quality, sensory appeal, and functional properties of the final product. Therefore, the present study aims to develop a fruit based health bar incorporating jackfruit and orange, with the objective of improving nutritional intake, promoting healthier eating habits among school-aged children, reducing dependence on energy-dense junk foods, and providing consumers with a wholesome and palatable snack alternative.

II. MATERIALS AND METHODS

➤ Selection and Collection of Sample:

Fresh ripe jackfruit and oranges were sourced from local marketplaces in and around Tiruppur, Tamil Nadu, India. Other components, such as cardamom and sugar, were obtained from local retail stores. The collected fruits were chosen based on their maturity, freshness, and lack of physical damage. All raw materials were transferred to the laboratory and stored hygienically until further processing.

➤ Sample Processing and Preparation:

Fresh ripe jackfruit and oranges were sourced from local marketplaces in and around Tiruppur, Tamil Nadu, India. The jackfruit was properly cleaned under running water to remove dirt and debris, then the outer peel was removed with a sharp stainless-steel knife. The edible bulbs were separated, and the seeds and fibrous core were removed manually. Oranges were washed, peeled, and juiced. Three jackfruit-orange bar formulations were created by combining jackfruit pulp and orange juice in varying proportions: V1 (90% jackfruit pulp and 10% orange juice), V2 (80% jackfruit pulp and 20% orange juice), and V3 (70% jackfruit pulp and 30% orange juice). The mixture was continually stirred until a sticky consistency was reached. The produced paste was then uniformly spread in trays to a thickness of 1.5-2.0 cm and sun dried for 2-3 days to achieve the appropriate moisture level and texture. The dried product was cut into small cube-shaped bars, packaged in food-grade materials, and stored at room temperature for additional sensory and quality evaluation.

➤ Standardization and Development of Jackfruit Orange Bar

Bar was prepared from different proportion of jackfruit and orange with addition of sugar, cardamom as per requirements. These different proportion of fruit bar will be determined or finalized by sensory evaluation method.

Table1 Ingredients and their Proportions Used in Different Variations.

S.No	INGREDIENTS	QUANTITY(gm)		
		VARIATION1	VARIATION2	VARIATION3
1	Jackfruit	90	80	70
2	Orange	10	20	30
3	Sugar	2	2	2
4	Cardamom	1	1	1

- Sensory Evaluation:**

The developed jackfruit–orange bar variations were subjected to sensory evaluation to determine the most acceptable formulation. A panel of 20 untrained members (n = 20) evaluated the samples for colour, texture, taste, flavour, appearance, and overall acceptability. The evaluation was carried out using a 9-point hedonic scale ranging from 9 (Like Extremely) to 1 (Dislike Extremely). The scores obtained for each sensory attribute were recorded, and the mean values were calculated to identify the most preferred jackfruit–orange bar variation.

- Determination of Proximate Composition:**

The FSSAI Manual of Methods' standard methods were followed in order to determine the created jackfruit–orange bar's approximate composition. To determine the moisture content, a known amount of the sample was dried in a hot air oven at 105°C until a consistent weight was achieved. The weight loss was then recorded as the moisture content. The sample was burned at 550°C in a muffle furnace until a light gray ash was produced in order to measure the total ash content. The Soxhlet extraction method, which involves extracting the dried sample with petroleum ether and quantifying the extracted fat gravimetrically, was used to determine the crude fat content. Crude fibre was determined using the fat-free sample by subjecting it to successive acid and alkali digestion, followed by drying, incineration, and calculation of fibre content from the weight difference. Carbohydrate content was calculated by difference by subtracting the sum of moisture, protein, fat, fibre, and ash from 100. The energy value of the product was expressed as kcal per 100 g and calculated using Atwater factors by multiplying protein and carbohydrate values by 4 and fat value by 9.

- Determination of Nutritional Composition:**

The nutritional composition of the developed jackfruit incorporated orange bar was determined using standard procedures prescribed in the FSSAI Manual of Methods. Mineral analysis included the estimation of magnesium and potassium content using appropriate analytical techniques after sample digestion. Vitamin A content was determined by spectrophotometric methods, while vitamin C content was estimated by standard titrimetric/spectrophotometric procedures as specified in the FSSAI guidelines. The analyses were carried out on representative samples of the developed bar, and the results were expressed per 100 g of product. The obtained values were used to evaluate the nutritional quality and nutrient contribution of the developed jackfruit–orange bar.

- Phytochemical Analysis:**

The phytochemical composition of the developed jackfruit–orange bar was analyzed to determine the presence of bioactive compounds. Total phenolic content and total flavonoid content were estimated using standard UV–Visible spectrophotometric methods. For the analysis, a known quantity of the sample was extracted using a suitable solvent and filtered. The total phenolic content was determined using the Folin–Ciocalteu reagent method, and the absorbance was measured using a UV–VIS spectrophotometer. Total flavonoid content was determined using the aluminium chloride colorimetric method, and the absorbance was recorded at the specified wavelength. The concentrations of phenolic and flavonoid compounds were calculated using standard calibration curves and expressed as milligrams per 100 g of sample. The obtained values were used to evaluate the phytochemical potential of the developed jackfruit–orange bar.

- Shelf Life Study:**

The shelf life of the created jackfruit–orange bar was assessed by storing the samples in zip-lock bags at ambient temperatures. The bars were packed after drying and cooling and stored for two weeks. During storage, the samples were checked at regular intervals for changes in color, texture, appearance, odor, and the presence of microbiological growth such as mould and yeast. Visual observations were used to assess the product's quality, and the product was considered acceptable if there were no evidence of spoiling or degradation. The shelf-life test was performed to determine the storage stability of the developed jackfruit–orange bar.

III. RESULTS AND DISCUSSION

The sensory evaluation of the Jackfruit Orange Bar was conducted using a 9-point Hedonic Scale, a widely accepted method for assessing consumer preference and product acceptability. Panelists evaluated the samples for appearance, colour, texture, flavour, taste, and overall acceptability. The scale ranged from 9 = Like Extremely, 8 = Like Very Much, 7 = Like Moderately, 6 = Like Slightly, 5 = Neither Like nor Dislike, 4 = Dislike Slightly, 3 = Dislike Moderately, 2 = Dislike Very Much, and 1 = Dislike Extremely. Higher mean scores indicated greater consumer acceptance and preference for the product.

Table 2 Sensory Analysis of the Developed Jackfruit Orange Bar

Sensory Attributes	Control	Variation I	Variation II	Variation III
Appearance	8.23±0.73	7.20±0.91	8.60±0.40	6.97±0.81
Colour	8.07±0.69	7.13±1.07	8.37±0.61	6.73±0.94
Texture	8.17±0.79	7.30±1.02	8.47±0.57	6.93±0.99
Flavour	8.07±0.91	7.50±1.11	8.40±0.56	7.00±1.05
Taste	8.17±0.83	7.17±1.23	8.60±0.40	6.83±0.91
Overall Acceptability	8.07±0.87	7.23±0.32	8.43±0.57	6.80±0.90

The sensory evaluation results revealed significant differences among the control and three variations of the Jackfruit Orange Bar. Variation II received the highest scores for appearance (8.60), taste (8.60), texture (8.47), flavour (8.40), colour (8.37), and overall acceptability (8.43), indicating the highest consumer preference. The control sample also showed good acceptance, with scores ranging from 8.07 to 8.23. In contrast, Variation I recorded moderate scores (7.13–7.50) with an overall acceptability of 7.23, while Variation III received the lowest ratings (6.73–7.00) and overall acceptability (6.80). The results indicate that Variation II was the most preferred formulation, followed by the control, Variation I, and Variation III.

➤ Proximate Composition:

The proximate composition of the Jackfruit Orange Bar was determined using standard FSSAI methods to evaluate its nutritional quality. The results showed that 100 g of the product provided 319 kcal of energy, 70.4 g of carbohydrates, 7.5 g of protein, 0.8 g of fat, 4.0 g of dietary fibre, and 2.1 g of ash. The high carbohydrate content contributed significantly to the energy value of the product, while the presence of protein and dietary fibre enhanced its nutritional profile. The low fat content indicates that the bar can be considered a low-fat fruit-based snack. These findings demonstrate that the Jackfruit Orange Bar is a nutrient-rich product with good energy, fibre, and protein content, making it a suitable and nutritious value-added food product.

Table 3 Proximate Composition of Jackfruit Orange Bar

SNO	NUTRITIONAL PARAMETER	RESULT
1	Energy	319Kcal
2	Carbohydrates	70.4gm/100gm
3	Protein	7.5gm/100gm
4	Fat	0.8gm/100gm
5	Fibre	4.0gm/100gm
6	Ash	2.1gm/100gm

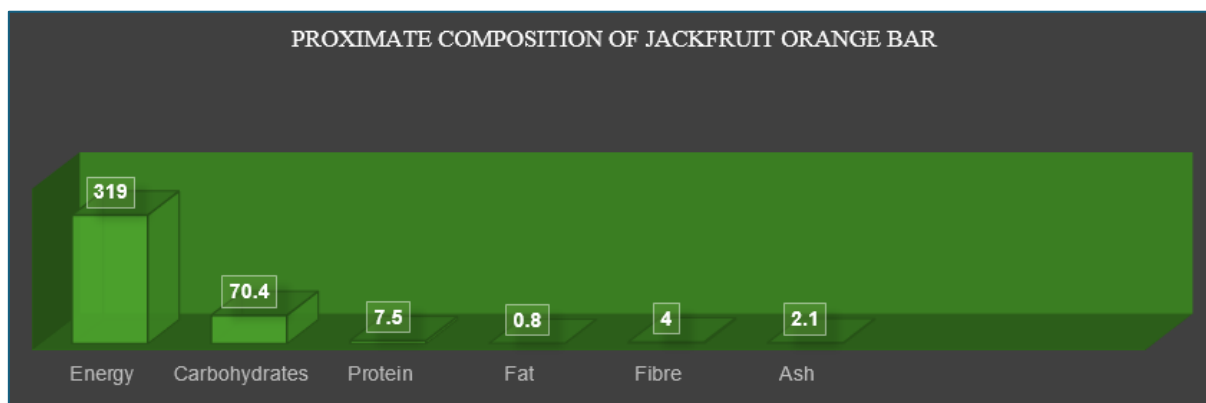


Fig 1 Proximate Composition of Jackfruit Orange Bar

➤ Nutritional Composition

The nutritional composition of the Jackfruit Orange Bar revealed the presence of essential minerals and vitamins that enhance its overall nutritional quality. Mineral analysis showed that the product contained 70 mg/100 g of magnesium and 352 mg/100 g of potassium. Magnesium is involved in numerous physiological functions, including energy metabolism, muscle contraction, nerve transmission, and bone development, while potassium plays a key role in maintaining fluid balance, supporting normal heart function, and regulating blood pressure. Vitamin analysis indicated

the presence of Vitamin A (35 µg/100 g), Vitamin C (28 mg/100 g), and Folate (64 µg/100 g). Vitamin A is essential for maintaining healthy vision, skin integrity, and immune function. Vitamin C acts as a powerful antioxidant that helps protect cells from oxidative damage and supports immune health, whereas folate is important for cell division, tissue growth, and DNA synthesis. The presence of these essential micronutrients demonstrates that the Jackfruit Orange Bar is a nutritionally valuable product and may contribute to meeting daily micronutrient requirements while serving as a healthy value-added snack.

Table 4 Nutritional Composition of Jackfruit Orange Bar

Parameters	Amount per servings (100g)
Magnesium	70mg
Potassium	352mg
Vitamin A	35 µg
Vitamin C	28 mg
Folate	64 µg

➤ Phytochemical Analysis

The phytochemical analysis of the Jackfruit Orange Bar revealed the presence of important bioactive compounds that contribute to its functional and health-promoting properties. The product contained 12.5 mg/100 g of flavonoids, as determined by UV–VIS spectrophotometric analysis. Flavonoids are naturally occurring phytochemicals known for their antioxidant, anti-inflammatory, and protective effects against oxidative stress. In addition, the antioxidant analysis showed a β -carotene content of 1.8

mg/100 g, indicating the presence of carotenoid compounds that contribute to the product's nutritional and antioxidant value. β -carotene acts as a precursor of Vitamin A and plays an important role in supporting vision, immune function, and cellular health. The presence of these phytochemicals demonstrates that the Jackfruit Orange Bar possesses beneficial antioxidant properties and may serve as a functional food with potential health benefits beyond basic nutrition.

Table 5 Phytochemical Analysis of Jackfruit Orange

Parameters	Amount per servings (100g)
Flavonoids	12.5 mg
β Carotenoids	1.8mg

➤ Shelf Life Analysis

The shelf-life of the developed Jackfruit Orange Bar was evaluated using zip-lock cover packaging, which provides protection against external contamination and helps maintain product quality during storage. The packaged bars were stored under normal conditions and monitored for signs of microbial spoilage. The product remained acceptable with no visible mould or yeast growth during the initial storage period. However, after 15 days of storage, the appearance of fungal growth was observed, indicating the onset of microbial spoilage and the end of the product's acceptable shelf life under the given packaging conditions. These findings suggest that zip-lock cover packaging can effectively preserve the quality of the Jackfruit Orange Bar for up to 15 days, after which microbial deterioration may occur.

period. Cost analysis further showed that the health bar could be produced economically, making it a feasible and affordable snack option. The developed jackfruit–orange health bar has significant potential as a functional and nutritious food product. It can encourage healthier eating habits among children, reduce dependence on nutrient-poor junk foods, and contribute to better growth, immunity, and overall health. The study successfully achieved all its objectives and demonstrated the scope for utilizing locally available fruits in innovative food product development.

IV. CONCLUSION

The developed jackfruit–orange health bar was formulated as a nutritious and appealing snack product to provide a healthier alternative to junk foods commonly consumed by children. Jackfruit and orange were selected for their nutritional benefits and processed using appropriate methods to prepare a value-added food product. Various formulations of the health bar were developed, standardized, and subjected to sensory evaluation to determine consumer acceptability in terms of appearance, texture, taste, flavor, and overall quality. The findings revealed that the developed jackfruit–orange health bar was highly acceptable and possessed desirable sensory characteristics. Proximate analysis indicated that the product contained valuable nutrients, including dietary fiber, vitamins, and natural antioxidants, which contribute to improved health and well-being. Shelf-life evaluation demonstrated that the product remained stable and acceptable for a reasonable storage

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