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"Formulation And Quality Evaluation Of Jackfruit Seed Enriched Cereal Froot Loops"

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ABSTRACT

Jackfruit is common in tropical and subtropical regions and is often wasted. It has more nutritious benefits, yet it has not received significant research focus. Therefore, the research aims to develop, formulate, and evaluate the quality of Jackfruit seeds enriched cereal froot loops. The study was conducted at the Food Science Laboratory , Department of Nutrition and Dietetics, SRM Institute of Medicine . The newly developed Jackfruit seed enriched cereal fruit loops was prepared using jackfruit seed flour, sprouted ragi flour, sprouted wheat flour, stevia, semolina, baking powder, butter, and strawberry puree in different variations. After the organoleptic evaluation using 9 point hedonic scale ,the developed jackfruit seed enriched cereal fruit loops were evaluated for their proximate composition and shelf life, The results showed that the proximate composition of the prepared Jackfruit seed enriched cereal froot loops of 100g had provided Energy - 420.63 kcal, Protein -9.39 g, Total fat - 7.75, Carbohydrates - 78.33 g, Fiber -1.57, Ash - 1.82 g. The moisture content of the developed product (3.79 – 4.98 g) was acceptable to extend the shelf life .The protein, ash, crude fiber, and fat content of the formulated Jackfruit seed enriched cereal Froot Loops products increased with the addition of jackfruit seed flour. In contrast, the carbohydrate and energy content of the formulated products decreased with the addition of jackfruit seed . The use of nutritious jackfruit seed in food development help to prevent economical wasting and prevent protein malnutrition.

Keywords: Jackfruit flour, sprouted ragi flour, sprouted wheat flour, cereal froot loops.

INTRODUCTION

The food industry has recently been tasked with developing innovative products to promote health and enhance overall quality of life. There is an increasing demand to explore new plant sources with better nutritional profiles to encourage healthier eating habits. Currently, consumers are prioritizing nutritious and wholesome food choices. The market is flooded with a variety of enhanced products sourced from different origins such as milk, grains, and meat. Cereals like Froot Loops have gained popularity due to their easy production and affordability. Depending on their ingredients, Froot Loops can serve as a convenient way to add essential nutrients to diets. This study focuses on incorporating jackfruit seed flour into the production of value-added cereal Froot Loops, targeting school children with increased nutritional requirements. It is crucial that foods consumed by this group are rich in vital vitamins, minerals, carbohydrates, proteins, and fats. However, there is a scarcity of wholesome

options for children. Bridging this gap involves creating value-added products aligned with the emerging trends of nutraceuticals and functional foods. Froot Loops cereal, typically consumed as a dry breakfast option, undergoes various processing methods before being roasted or puffed, offering nutritional benefits, convenience, and improved affordability. Hence, this research aims to evaluate the nutritional impact of incorporating jackfruit seed into Froot Loops cereal. (1)

Jackfruit (*Artocarpus* genus), native to tropical Asia, is abundantly cultivated in Bangladesh, India, Sri Lanka, and Southeast Asia, and grows well in East Africa, Brazil, and the Caribbean (8). In Bangladesh, where it's the national fruit, jackfruit contributes 22% to total fruit production, with cultivars like *khaja*, *gala*, and *durasha* widely grown (8). Its ripe pulp is consumed fresh or processed, while its seeds—often wasted—are rich in starch, protein, minerals, and antioxidants (2). Jackfruit seeds make up over 15% of the fruit and contain 13.5% protein, 79.3% carbohydrates, plus calcium, iron, and potassium (2). They also carry bioactive compounds like flavonoids and tannins, supporting digestion, boosting immunity, and offering anticancer and heart health benefits (2). Processed into flour, jackfruit seeds can replace wheat flour in baked goods like bread, cakes, and biscuits, improving texture and nutritional value (10). Products enriched with jackfruit seed starch show better quality and are preferred by consumers (10). In India, innovations like jackfruit seed-based cookies (*Arka Jarkies*) and chocolates (*Arka Jacolates*) are growing in popularity, offering high protein, fiber, and antioxidants with lower fat (1). This value addition not only reduces food waste but also creates income opportunities, especially in rural areas (1). Given its nutritional and functional properties, industrial use of jackfruit seed flour holds great potential for food innovation and economic growth (4).Finger Millet (Ragi), cultivated in India and Africa, was rich in protein, calcium, iron, fiber, and vitamins. It had the highest calcium and iodine content among cereals, aiding diabetics by releasing glucose slowly. Germination enhanced its nutrients while reducing antinutritional factors. With 8.42% protein, 7.94% fat, and 73.32% carbohydrates, it supported bone health, weight management, and immunity. Its polyphenols provided antioxidant and antimicrobial benefits(3). Wheat, a staple grain, was valued for its affordability and nutrients, including carbohydrates, proteins, B vitamins, and fiber. Rising wheat costs encouraged alternatives like ragi and jackfruit seed flour, which improved both nutrition and cost efficiency(4). Sprouted wheat gained popularity for its enhanced bioavailability of amino acids, vitamins, and digestibility. Studies showed that sprouting increased protein, thiamine, and riboflavin levels, making wheat-based products healthier. Its versatility ensured wheat remained a key component of global diets.(7)

NEED OF THE STUDY

Jackfruit seeds, often neglected and quick to spoil, can stay viable for about a month when stored in cool, moist conditions. However, their potential goes beyond preservation. Once roasted and ground, the seeds turn into a versatile flour with extended shelf life and wide application in various food products. Hossain (2014) highlights jackfruit seed powder's effectiveness as a substitute for traditional flours in baking and confectionery, often blended with wheat flour for cost efficiency. Roy Chowdhury et al. (2012) further propose utilizing jackfruit seeds as a sustainable protein source to help combat malnutrition (9). In addition to their protein content, the seeds are rich in resistant starch, which aids in controlling blood sugar and promoting gut health. Incorporating jackfruit seed flour offers a promising, sustainable approach to addressing malnutrition while adding nutritional value to everyday foods (9).

METHODOLOGY

Study Design

The study used in this study is Experimental Design , conducted at SRM Institute of Medicine , Chennai Tamil Nadu.

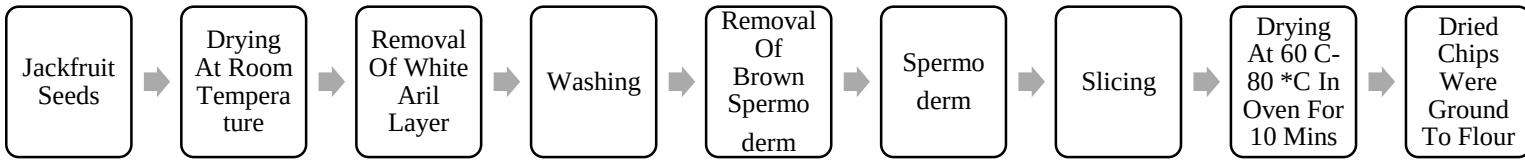
Methods For Preparation Of The Developed Product

Jackfruit seed enriched cereal froot loops was prepared using the dry ingredients like jackfruit seed flour , sprouted ragi flour , sprouted wheat flour, stevia, semolina and baking powder. And wet

ingredients like butter and strawberry puree and The cereal froot loops was prepared in three different variations .

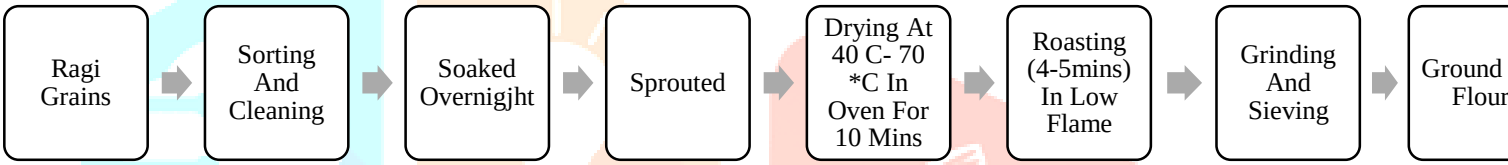
The phases of preparation of cereal froot loops was explained below:

Preparation Of Jackfruit Seed Flour



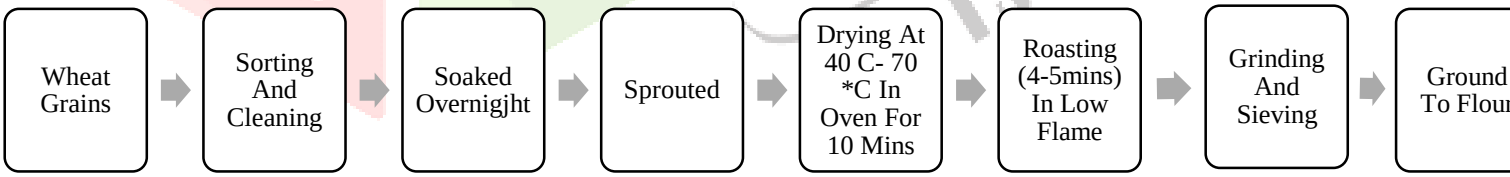
(figure 01) flowchart of preparation of jackfruit seed flour

Preparation For Ragi Flour



(figure 02) flowchart of preparation of sprouted ragi flour

Preparation For Wheat Flour

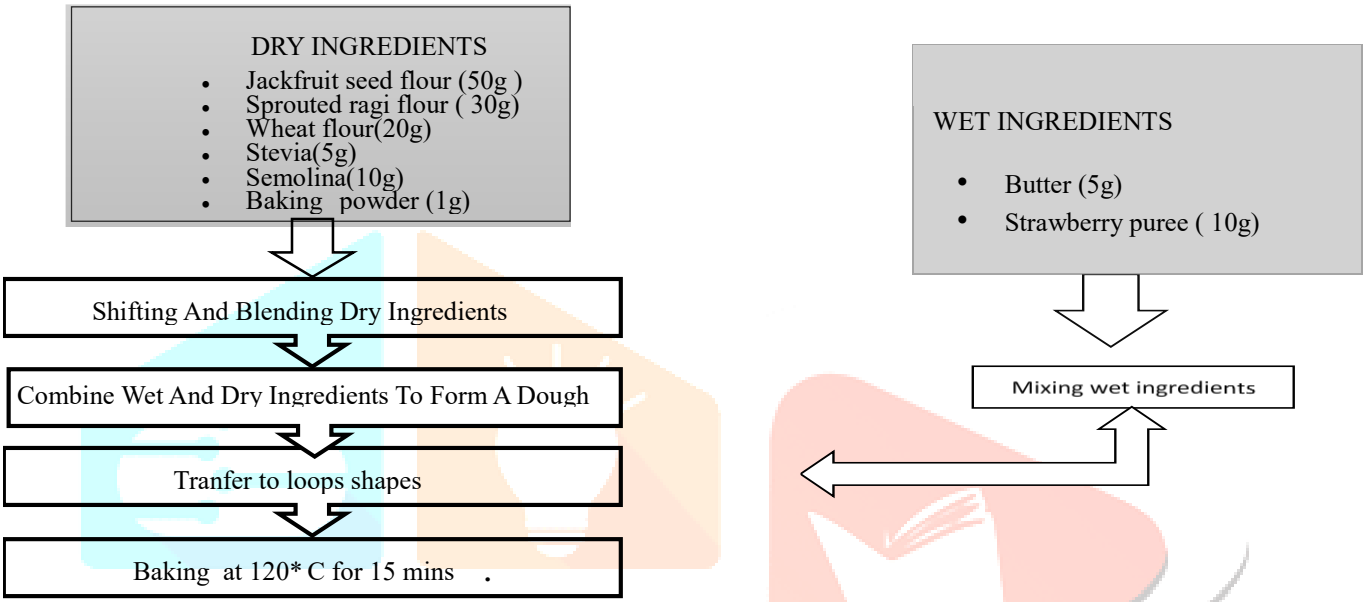


(figure 03) flowchart of preparation of sprouted wheat flour

Preparation Of Jackfruit Seed Enrich Cereal Froot Loops

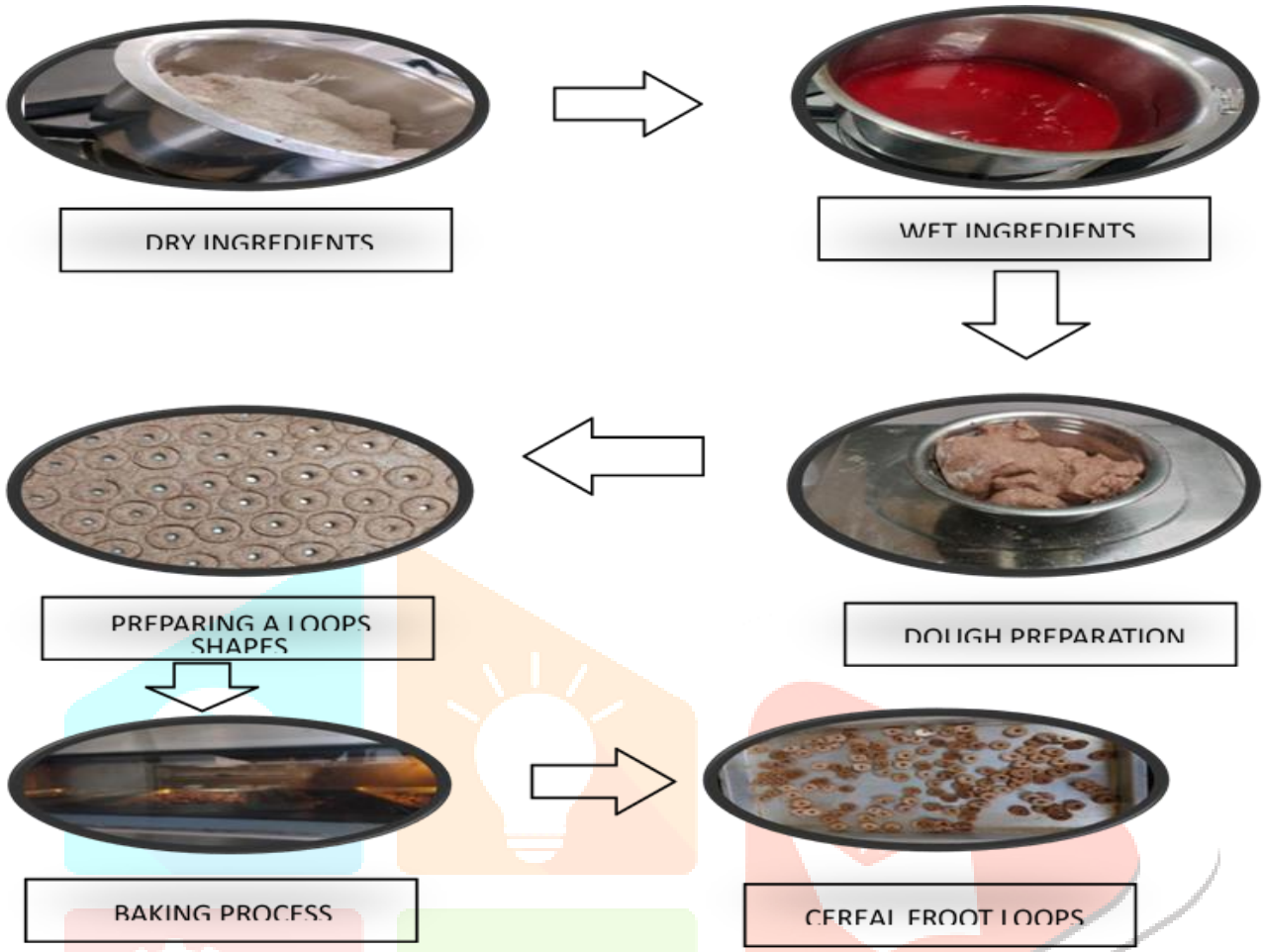
- Jackfruit seed flour enriched cereal froot loops was prepared using the ingredients like Jackfruit seed flour (50g) , Sprouted ragi flour (30g) , Wheat flour(20g) , Stevia(5g) , Semolina(10g) Baking powder (1g) , Strawberry puree (10g) .
- And using these ingredients cereal froot loops were prepared in three different variations.(tab1)
- Jackfruit seed flour was blend with sprouted ragi flour and sprouted wheat flour.

- The ingredients were thoroughly combined until a dough-like consistency was achieved.
- The dough was rolled out like a loops shape.
- All the cereal froot loops were baked on an ungreased baking sheet in a preheated oven at 120* C for 12 to 15 minutes.
- (Figure 4) depicts a flow diagram for the preparation of jackfruit seed enrich cereal froot loops.



(figure 04) depicts a flow diagram for the preparation of jackfruit seed enrich cereal froot

Preparation Of Jackfruit Seed Enrich Cereal Froot Loops



(figure 05) preparation of jackfruit seed enrich cereal froot loops

Different Variations Of Cereal Froot Loops

From these methodology steps .The jackfruit seed enriched cereal froot loops was developed in three different variations at different compositions.

JSF – Jackfruit seed flour , SRF – sprouted ragi flour , SWF – sprouted wheat flour .

(table 1) indicates ingredients used for preparation of jackfruit seed enrich cereal froot loops of different formulations

SI NO	VARIABLES	INGREDIENTS
1	F1	100% JSF , 0%SRF , 0% SWF
2	F2	70%JSF , 20% SRF , 10% SWF
3	F3	50 % JSF , 30% SRF , 20% SWF

- **Stevia(5g)**
- **Semolina(10g)**
- **Baking powder (1g)**
- **Strawberry puree (10g)**
- **Butter (5g)**

F1 (100:0:0) F2 (70:20:10) F3 (50:30:20)

(figure 06) variations of jackfruit seed enrich cereal froot loops

Organoleptic Evaluation Of Hedonic Rating Scale

Evaluating sensory attributes is vital for determining product quality to match consumer preferences. The 9 hedonic rating system is the primary tool for assessing food item palatability. This evaluation is conducted by a team of 20 semi trained panelists from the College of SRM. The cereal froot loops were developed in three different variations , in the ratio of (100:0:0) , (70:20:10) , (50:30:20) - (JSF : SRF: SWF). The highly accepted variation are (50 JSF:30 SRF:20 SWF).

Proximate Analysis For The Developed Product

Highly accepted jackfruit seed enrich cereal froot loops were used for the proximate analysis,

Storage Studies

Highly accepted jackfruit seed enrich cereal froot loops were packed in High Density Polyethylene (HDPE) covers. Samples were packed and kept in a clean, dry and well-ventilated room for shelf life studies for a period of four month at room temperature (for 15 days) and analyzed.

Statistical Analysis

The SPSS package was used for statistical analysis. Mean differences were determined while sensory evaluation data underwent analysis of variance (ANOVA).

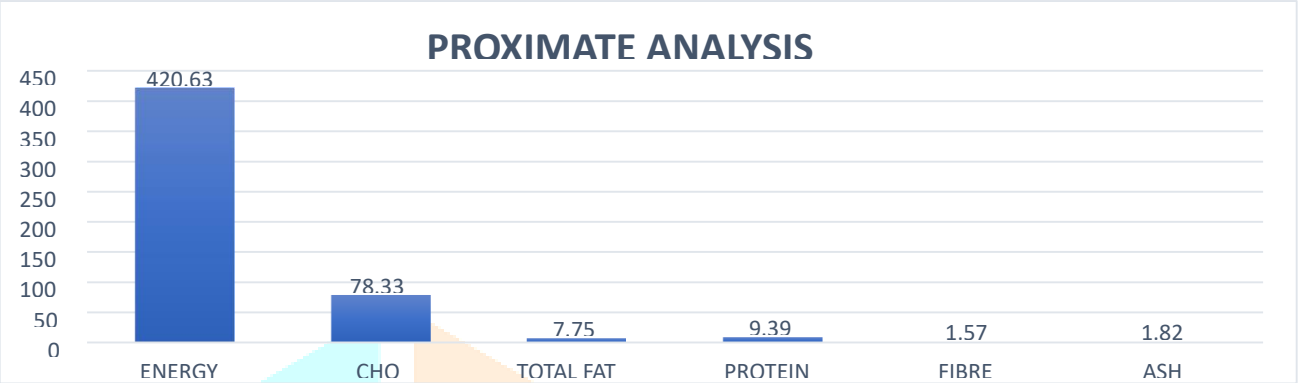
RESULTS

The results of the developed product are shown below:

- Results on Proximate analysis of cereal froot loops.
- Results on Organoleptic analysis of the cereal froot loops.

- Results on Shelf life analysis of cereal froot loops.

Results On Proximate Analysis Of Cereal Froot Loops : (Per 100g)



(figure 07) result on proximate analysis

In this study, various characteristics of composite flours were assessed using established protocols . It encompasses determining moisture, ash, lipid, protein, and carbohydrate levels in product developed cereal froot loops . The proximate composition analysis of the blends was conducted accordingly.

ENERGY CONTENT : The calorie content of the highly accepted variation of cereal froot loops product made with (50%)jackfruit seed flour is 420kcal/100g. and the calorie content was analysised using ALPL/FD/SOP/067 test method .

PROTEIN CONTENT: The protein content of cereal froot loops made with (50%)jackfruit seed flour is 9.39 g/100g. And the protein content was analysised by IS:7219:1973 test method. This is attributed to the higher protein content of jackfruit seed flour. The inclusion of jackfruit seed flour in cereal froot loops formulations enhances the essential amino acid content in the final product, potentially addressing the global issue of protein malnutrition.

TOTAL FAT: The total fat content of the highly accepted variation cereal froot loops product made with (50%) jackfruit seed flour is 7.75/100g. and the total fat content was analysed using AOAC21st Edn 2016 chapter 32 922.06 test method . This could be attributed to the increase in fat with increased levels of JSF due to oil absorbed to replace the pores.

CARBOHYDRATE CONTENT: The carbohydrate content of the higly accepted variation of cereal froot loops product made with (50%) jackfruit seed flour is 78.33/100g. and the carbohydrate content was analysised using ALPL/FD/SOP/065 test method .Furthermore, JSP flour contains relatively low carbohydrate when compared to wheat flour (Akter et al., 2020), which may result in a gradual decrease in total carbohydrate in JSF based food products.

FIBRE CONTENT: The fibre content of the finalized cereal froot loops product made with (50%) jackfruit seed flour is 1.57/100g. and the fibre content was analysised using IS:12711-1989 test method .

ASH CONTENT: The ash content of the highly accepted variation of cereal froot loops product made with (50%) jackfruit seed flour is 1.82/100g. and the carbohydrate content was analysised using AOAC21st Edn2016:900.02 test method , The outcome aligns with Akter et al.'s (2020) discoveries, indicating that the ash content in cereal froot loops enriched with jackfruit seed flour (JSF) rises proportionally with the quantity of JSF replacing wheat flour in the recipe. This correlation may stem from the higher ash content inherent in jackfruit seed flour compared to refined wheat flour.

Results On Organoleptic Analysis Of Cereal Froot Loops:

The semi trained panel of judges evaluated how jackfruit seed flour impacted the sensory attributes of cereal froot loops samples, including color, taste, flavor, texture, and overall acceptability.The sensory evaluation results of cereal froot loops samples with varying jackfruit seed flour amounts are depicted .

(table 02) anova on sensory score of cereal froot loops

SI NO	JSF: SRF: SWF	TASTE	TEXTURE	APPEARANCE	AROMA	OVERALL
1	100:30:20	3.95 ± 1.28	4.4±1.74	4.5±1.62	4.1±1.72	4.4±1.62
2	70:30:20	6.7±1.00	7.2±1.16	6.7±1.1	6.9±0.94	6.85±0.85
3	50:30:20	8.65±0.47	8.5±0.66	8.7±0.45	8.6±0.489	8.75±0.43
	MEAN	6.43	6.71	6.63	6.53	6.66
	CV	0.29	0.25	0.25	0.28	0.26
	LOWEST RANGE	3.9	4.4	4.5	6.9	4.4
	HIGHEST RANGE	8.6	8.5	8.7	8.6	8.7

(table 03) anova on sensory parameters of cereal froot

	DF	SS	MSS	F- Statistic	P-Value
TASTE	2	223.0333	111.5167	110.1639	P<0.05
TEXTURE	2	179.2333	89.6167	52.6885	P<0.05
APPEARANCE	2	180.7	90.35	63.6189	P<0.05
AROMA	2	206.5333	103.2667	71.4345	P<0.05
OVERALL	2	190.2333	95.1167	76.2538	P<0.05

Increasing the jackfruit seed flour proportion led to lower mean scores for all attributes and overall consumer acceptability. Cereal froot loops with higher jackfruit seed flour amounts exhibited the lowest mean scores for aroma, taste, and overall acceptance.

TASTE: The taste of cereal Froot Loops consistently decreased with increasing jackfruit seed flour (JSF) levels. Higher JSF proportions resulted in a slightly bitter taste. The highest mean value (8.6) was recorded when JSF incorporation was reduced to 50%. The taste of the three variations was analyzed using the ANOVA statistical method, showing $P<0.05$, indicating no significant difference between or within the variations (Tab 3).

TEXTURE: The texture of cereal Froot Loops became softer with increasing JSF content. The highest mean value (8.5) was recorded when JSF incorporation was reduced to 50%. The texture analysis using ANOVA showed $P<0.05$, indicating no significant difference between or within the variations (Tab 3).

APPEARANCE: The appearance of the developed product was more acceptable with lower JSF incorporation, with a mean value of 8.75. As JSF levels increased, the cereal color darkened from light brown (7.96) to dark chocolate (6.64), consistent with Khang et al. (2020). ANOVA results ($P<0.05$) showed no significant difference between or within variations (Tab 3).

AROMA: The highest aroma mean value (8.6) was recorded when JSF incorporation was at 50%. ANOVA analysis showed $P<0.05$, indicating no significant difference between or within the variations (Tab 3).

OVERALL ACCEPTABILITY: Overall acceptability scores declined with higher JSF levels but remained acceptable up to 30% sprouted ragi flour and 20% sprouted wheat flour substitution. The highest acceptability (8.75) was recorded with 50% JSF incorporation. ANOVA results ($P<0.05$) indicated no significant difference between or within variations (Tab 3). However, the 50% JSF formulation received the highest sensory scores for color, flavor, taste, and texture, showing strong consumer preference. Additionally, protein content increased with JSF addition. Sensory evaluation suggests that replacing 50% of sprouted ragi and wheat flour with JSF in cereal Froot Loops formulations meets consumer preferences.

Results On Shelf Life Analysis Of Cereal Froot Loops

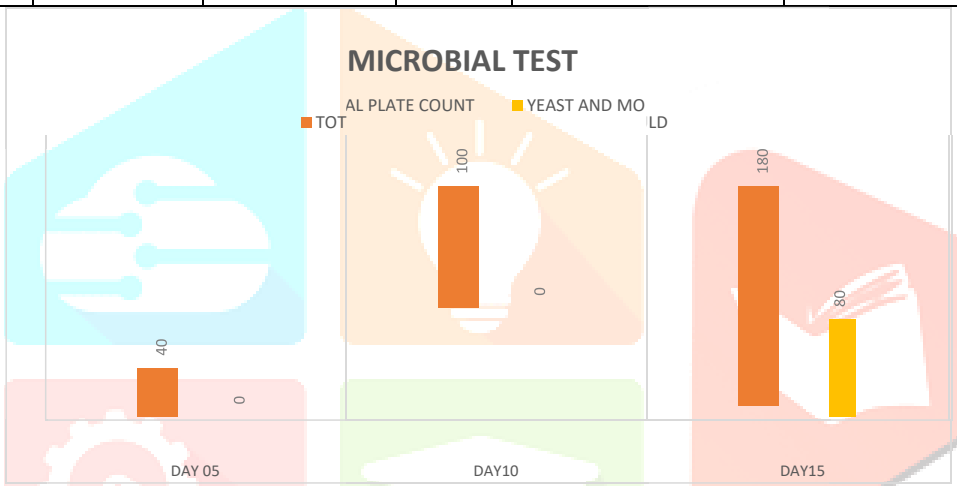
Cereal froot loops with jackfruit seeds were stored in HDPE covers in a controlled room for four months for further analysis.

(table 04) results on chemical test

Si No	Testing Day	Date Of Analysis	End Date	Storage Temperature	Storage Humidity	Chemical Test	
						Moisture (G/100g)	Acidity Of Extract Fat (G/100g)
1	DAY05	14/05/ 2024	18/05/2024	50*C	75%	3.79	0.11
2	DAY10	20/05/ 2024	24/05/2024	50*C	75%	4.03	0.15
3	DAY15	24/05/2024	28/05/2024	50*C	75%	4.98	0.19

(table 05) results on microbiological test

Si No	Testing Day	Date Of Analysis	End Date	Storage Temperature	Storage Humidity	Chemical Test	
						Total Plate Count (Cfu/G)	Yeast And Mould (Cfu/G)
1	DAY05	14/05/2024	18/05/2024	50*C	75%	40	<10
2	DAY10	20/05/2024	24/05/2024	50*C	75%	100	<10
3	DAY15	24/05/2024	28/05/2024	50*C	75%	180	80



(figure 08) results on shelf life analysis of the developed cereal froot loop .

DISCUSSION

The findings of the present study are consistent with the results reported by Nkiru E. Odimegwu et al. (2019), where cereal flakes developed using jackfruit seed flour exhibited significantly improved nutritional profiles. Their study showed that the incorporation of jackfruit seed flour led to higher levels of protein, ash, crude fiber, and fat, while simultaneously reducing the carbohydrate content. Similarly, in our research, the enrichment of cereal Froot Loops with jackfruit seed flour resulted in enhanced nutritional value, particularly in terms of fiber and protein content. Both studies observed that products formulated with lower percentages of jackfruit seed flour achieved higher mean sensory scores, indicating better taste, texture, and overall acceptability among consumers. This suggests that while jackfruit seed flour can fortify cereals nutritionally, its proportion must be optimized to maintain product appeal. Additionally, the utilization of jackfruit seeds in food product development offers a sustainable solution to address the problem of wastage and postharvest losses associated with jackfruit, which is often discarded despite its nutritional potential. Therefore, incorporating jackfruit seed flour not only improves the health profile of cereal products but also supports environmental sustainability and promotes value addition to an underutilized agricultural resource. This dual benefit of enhancing nutrition and reducing waste underscores the importance of exploring jackfruit seed flour in future food innovations.

CONCLUSION AND SUMMARY

Jackfruit is a relatively unknown and underutilized fruit crop with potential for human consumption. Most of its nutritional qualities are found in jackfruit (Artocarpus heterophyllus). Jackfruit seeds are a good source of protein and can be ground into flour. Due to its superior functional properties compared to refined wheat flour, jackfruit seed flour can be partially substituted for wheat flour in the bakery industry.

The nutritional quality and value addition of jackfruit seed were examined to document its proximate, and Physical properties, as well as its use in convenience foods. The experiments were conducted in Department of nutrition and dietetics ,SRM institute for medical science and the standardization was done in SRM , ekkattuthangal. This study aimed to develop and analysis the nutrition profile of the jackfruit seed enriched cereal froot loops.

SUMMARY

Jackfruit seed flour enrich cereal froot loops

- The jackfruit seed enrich cereal froot loops was developed with the composition of sprouted ragi flour and sprouted wheat flour. The value added product was developed in three different variation of (100:30:20) (70:30:20) (50:30:20)(JSF:SRF:SWF).
- The highly accepted variation (50:30:20) of jackfruit seed enrich cereal froot loops as be taken for the proximate analysis and it content 1.82g ash, 9.34g protein, 7.75g fat, 1.57g fibre, 78.33g carbohydrates, and 420.63 kcal energy.
- The 50 percent incorporated JSF and a composition of 30percent SRF and 20 percent SWF of cereal froot loops received the highest overall acceptable score of 8.5, indicating that they were liked very much . The overall acceptability of cereal froot loops made with JSF was rated as very good.
- Highly accepted jackfruit seed enriched cereal froot loops were packed in High Density Polyethylene (HDPE) covers. Samples were packed and kept in a clean, dry and well-ventilated room for shelf life studies for a period of four month at room temperature

Recommendation for Further Research

- Explore and promote underutilized fruits from various regions for the development of value-added products.
- Efficiently process raw jackfruit bulbs into shelf-stable value-added products such as jackfruit toffee, leather, and jam.
- Use bread and cookies (snacks) made from jackfruit pulp flour to help alleviate malnutrition in nutritionally disadvantaged populations.
- Incorporate composite flours, including jackfruit seed flour, in product formulations. Conduct intervention studies to assess the health benefits of jackfruit seed flour.
- Strongly encourage the development of baked products with higher enrichment/substitution, using more than 10% dried mature jackfruit seed flour.
- Raise public awareness about the food potential of jackfruit through media symposiums, seminars, and conferences.

- Investigate the development of new weaning foods containing jackfruit seed flour.
- Provide training in entrepreneurship centers to encourage the commercialization and small-scale production of bakery products made from jackfruit seed flour

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