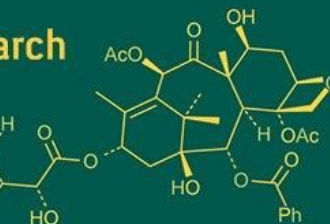


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Development and evaluation of Jackfruit-Kokum blended jam for sensory quality and economic viability

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Abstract

The present study was undertaken to develop and evaluate jackfruit-kokum blended jam for improved sensory quality and economic feasibility. Jackfruit (*Artocarpus heterophyllus* Lam.) pulp and kokum (*Garcinia indica* Choisy) juice residue were blended in different ratios (100:0, 90:10, 80:20, 70:30, and 60:40) and evaluated under a Completely Randomized Design with four replications. Sensory parameters such as colour, flavour, texture, and overall acceptability were assessed at 0, 2, and 4 months of storage using a 9-point hedonic scale. The results indicated a gradual decline in sensory scores during storage; however, all treatments remained within acceptable limits. Among the treatments, T₃ (80:20) consistently recorded superior scores for flavour, texture, and overall acceptability, attributed to the balanced combination of jackfruit sweetness and kokum acidity and colour. Treatments with higher kokum levels showed comparatively lower acceptability, while 100% jackfruit lacked desirable acidity. Economic analysis revealed that T₃ recorded the highest selling price (₹60/200 g) and benefit-cost ratio (2.37), making it the most profitable treatment. Thus, the 80:20 blend was found optimal for developing quality jam with good acceptability and economic viability, promoting value addition and sustainable utilization of local resources.

Keywords: Jackfruit, Kokum, Blended jam, Sensory evaluation, Benefit-cost ratio

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.), a member of the Moraceae family, is an important tropical fruit widely grown in the Western Ghats of India. It is valued for its sweet, aromatic pulp, which can be consumed fresh or processed into various value-added products such as chips, papad, pickles, jellies, candies, and beverages. However, due to its bulky nature and high perishability, a significant portion of the produce remains underutilized. Kokum (*Garcinia indica* Choisy), native to the Western Ghats and commonly found in the Konkan region, is well known for its medicinal and nutritional properties. It contains bioactive compounds such as hydroxy citric acid (HCA), garcinol, and organic acids, contributing to its antioxidant, anti-acidic, and cardioprotective effects. The residue obtained after juice extraction of kokum is often discarded despite its potential nutritional value. In the Konkan region, increased production of jackfruit and kokum necessitates the development of value-added products for better utilization. Jackfruit pulp, being low in acidity and rich in potassium and antioxidants, complements kokum, which is highly acidic and imparts natural colour. Blending these fruits offers a unique combination of sweetness and tanginess with enhanced nutritional and sensory qualities. Development of jackfruit-kokum blended jam can help utilize surplus produce and processing waste, reduce post-harvest losses, and promote sustainable practices. It also supports local farmers and creates opportunities for entrepreneurship and rural development. Therefore, the present study was undertaken to develop and evaluate jackfruit-kokum blended jam.

Fruits

Fruits of jackfruit and kokum were collected from the nursery no.10 and Rukhi block of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist.-Ratnagiri. Selected fruits were washed with running tap water to remove adhering dirt and then used for making value added products.

Packaging material

Food grade glass bottle of 200 g was used for storage of blended jam of jackfruit pulp - kokum residue. Packaging

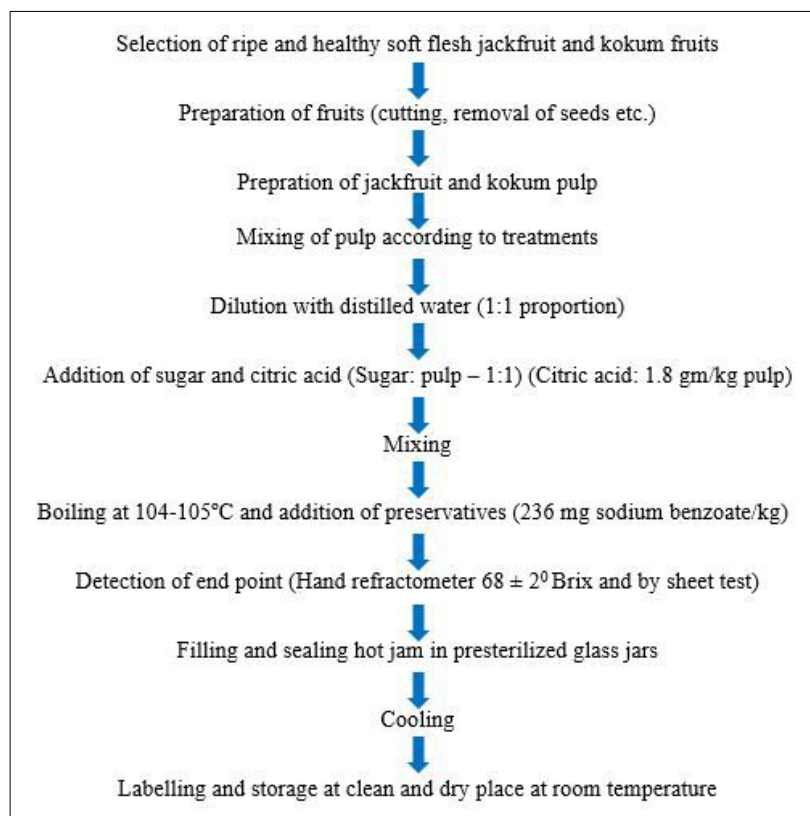
material used for this experiment was procured from R. K. Enterprise, Borivali, Mumbai, Maharashtra.

Studies on preparation of jackfruit- kokum blended jam
Experimental details

1)	Crop	:	Jackfruit and Kokum
1)	No. of treatments	:	5
2)	No. of replications	:	4
3)	Design	:	CRD
4)	No. of jars required/treatment/replication	:	6
5)	Total jars required	:	120 no.

Treatment details

Treatments	Jackfruit pulp / kokum juice residue ratio	
	Jackfruit	Kokum
T ₁	100	0
T ₂	90	10
T ₃	80	20
T ₄	70	30
T ₅	60	40

Preparation of Jackfruit - kokum blended jam**Sensory evaluation**

In sensory evaluation colour, flavour and texture of jackfruit products was observed at 0, 2, 4 months of storage after preparation. The sensory qualities were assessed by panel of 10 judges with 9-point hedonic scale score (Amerine *et al.*, 1965)^[1] as given below.

The overall quality score was obtained by averaging the score of colour, flavour and texture. The average score of 5.5 and above indicate acceptability within the score range of 1 to 9.

Sensory score rating

- 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
- 1- dislike extremely

Results & Discussion

Sensory evaluation of jackfruit kokum blended jam

1. Colour

The data regarding effect of jackfruit pulp and kokum residue blending on colour score of blended jam are presented in Table 1.

It could be seen from the pooled data that jackfruit pulp and kokum residue blending significantly affected colour score of blended jam during entire storage of four months. From the pooled data, it is seen that during storage, score for colour showed decreasing trend from '0'month (7.94) to 4 months (7.51). It is revealed from the data that the colour score of blended jam decreased during storage period of 4 months. It might be due to the darkening of the blended jam because of browning reactions during storage. Similar trend of decrease in sensory score for colour was observed by Raut (2015)^[9] in pomegranate and sapota juice blended jelly and Kekan *et al.* (2022)^[5] in pineapple-kokum blended jelly.

With respect to treatments, at '0'month storage highest colour score i.e. 8.0 was recorded in treatment T₂ (Jackfruit: Kokum residue, 90:10), T₄ (Jackfruit: Kokum residue, 70:30) and in treatment T₅ (Jackfruit: Kokum residue, 60:40) while lowest score for colour was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 7.75.

At 2 months storage highest colour score i.e. 7.80 was recorded in treatment T₂ (Jackfruit: Kokum residue 90:10) and treatment T₃ (Jackfruit: Kokum residue, 80:20) which was at par with treatment T₄ (Jackfruit: Kokum residue, 70:30) i.e. 7.75 while lowest colour score i.e. 7.55 was recorded in T₁ (Jackfruit: Kokum residue, 100:00).

At 4 months storage highest colour score i.e. 7.70 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) while lowest colour score i.e. 7.35 was recorded in T₁ (Jackfruit: Kokum residue, 100:00).

At end of storage, colour score was found to be increased from T₁ to T₃ and then decreased from T₃ to T₅. Highest colour score recorded in T₃ may be due to better colour combination of jackfruit pulp and kokum residue in 80:20 proportion. Similar results were reported by Garje and Pawar (2024)^[2] in Jackfruit kokum blended jelly.

2. Flavour

The data regarding effect of jackfruit pulp and kokum residue blending on flavour score of blended jam are presented in Table 2.

It could be seen from the pooled data that jackfruit pulp and kokum residue blending significantly affected flavour score of blended jam during entire storage of four months. During storage, score for flavour showed decreasing trend from '0'month (8.31) to 4 months (7.66). Gradual decrease in flavour of jam with increase in storage period may be due to decrease in aromatic compounds in jam during storage. Similar results were reported by Nafri *et al.* (2021)^[7] in ripe and unripe papaya jam during storage at ambient temperature and Rahman *et al.* (2018)^[8] in guava jam.

With respect to treatment, at '0'month storage highest flavour score i.e. 8.70 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) while lowest score for flavour was recorded in treatment T₅ (Jackfruit: Kokum residue, 60:40) i.e. 7.75.

At 2 months storage, highest flavour score i.e. 8.20 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20)

while lowest score for flavour was recorded in treatment T₅ (Jackfruit: Kokum residue, 60:40) i.e. 7.45.

At 4 months storage, highest flavour score i.e. 7.95 was recorded in treatment T₂ (Jackfruit: Kokum residue, 90:10) while lowest score for flavour was recorded in treatment T₅ (Jackfruit: Kokum residue, 60:40) i.e. 7.25.

At end of storage, colour score was found to be increased from T₁ to T₂ and then decreased from T₂ to T₅. Highest colour score recorded in T₂ may be influenced by levels of jackfruit pulp and kokum rind residue levels i.e., Jackfruit: Kokum residue 90:10 proportion imparted better sugar acid blend. Similar finding was reported by Kekan *et al.* (2022)^[5] that score for flavour was decreased from T₁ (8.00) to T₃ (7.33) and then increased at T₄ (8.08) and T₅ (8.29) and again decreased till T₇ (7.46) in pineapple-kokum blended jelly.

3. Texture

The data regarding effect of jackfruit pulp and kokum residue blending on texture score of blended jam are presented in Table 3.

It could be seen from the pooled data that jackfruit pulp and kokum residue blending significantly affected texture score of blended jam during entire storage of four months. During storage, score for texture showed decreasing trend from '0'month (7.75) to 4 months (7.11). Decrease in texture score may be due to increase in moisture during storage. Similar trend was reported by Nafri *et al.* (2021)^[7] in ripe and unripe papaya jam during storage at ambient temperature and Sultana *et al.* (2021)^[10] in jackfruit jam.

With respect to treatments, at '0'month storage highest texture score i.e. 8.25 was recorded in treatment T₄ (Jackfruit: Kokum residue, 70:30) while lowest score for texture was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 6.85.

At 2 months storage, highest texture score i.e. 7.75 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) as well as in treatment T₄ (Jackfruit: Kokum residue, 70:30) while lowest score for texture was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 6.40.

At 4 months storage, highest texture score i.e. 7.65 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) while lowest score for texture was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 6.00.

Highest score for texture recorded in T₃ might be due to excellent blend between jackfruit pulp and kokum residue which imparts good consistency and viscosity. The similar findings were detected by Kushala *et al.* (2012)^[6] during storage study of jackfruit jam blended with avocado and kokum.

4.14.4. Overall acceptability

The data regarding effect of jackfruit pulp and kokum residue blending on overall acceptability score of blended jam are presented in Table 4.

It could be seen from the pooled data that jackfruit pulp and kokum residue blending significantly affected overall acceptability of blended jam during entire storage of four months. During storage, score for overall acceptability showed decreasing trend from '0'month (7.85) to 4 months (7.28). The gradual decrease in overall acceptability throughout the storage is due to reduction in colour, flavour and texture score of jackfruit and kokum residue blended jam during storage. Similar results were obtained by Imtiaz and Iftikhar (2010)^[3] during comparative study on apricot

and apple blended jam. Nafri *et al.* (2021) [7] reported that score for overall acceptability of ripe and unripe papaya jam decreased during storage when stored at ambient temperature.

With respect to treatment, at '0'month storage highest overall acceptability score i.e. 8.25 was recorded in treatment T₄ (Jackfruit: Kokum residue, 70:30) while lowest score for overall acceptability was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 6.65.

At 2-month storage, highest overall acceptability score i.e. 7.92 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) while lowest score for overall acceptability was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 7.33.

At 4 months storage, highest overall acceptability score i.e. 7.70 was recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) while lowest score for overall acceptability was recorded in treatment T₁ (Jackfruit: Kokum residue, 100:00) i.e. 7.03.

This might be due to combination effect of better colour, flavour, texture score of this treatment T₃ (Jackfruit: Kokum residue, 80:20). Kaushik *et al.* (2002) [4] reported similar observation in Bael jam.

4.15. Cost of processing of jackfruit kokum blended jam.

The data related to economics of 1 Kg jackfruit kokum blended jam is shown in Table 5.

The total cost of production for the preparation of jackfruit kokum blended jam (200 g) was highest ₹ 28.08 under treatment T₁ (Jackfruit: Kokum residue, 100:00) and lowest ₹ 23.73 in T₅ (Jackfruit: Kokum residue, 60:40).

According to overall acceptability score, selling price of 5 treatments were decided. For overall acceptability score 7.0 to 7.2 sell price of blended jam was taken as ₹180 kg⁻¹. For overall acceptability score 7.2 - 7.4 sell price were taken as ₹ 220 kg⁻¹ and overall acceptability score 7.4 - 7.6 sell price were taken as ₹ 260 kg⁻¹ and for overall acceptability score 7.6 - 7.8 sell price were taken as ₹ 300 kg⁻¹

As per sensory evaluation is concerned, treatment T₃ (Jackfruit: Kokum residue, 80:20) was best acceptable. Selling price of jam was found to be highest in T₃ (₹ 60/200 g) and its benefit cost ratio was 2.37 which was highest among all treatments under study. Depending on overall acceptability score, minimum selling price (₹36/200 g) was of T₁ (Jackfruit: Kokum residue, 100:00).

Highest benefit cost ratio recorded in treatment T₃ (Jackfruit: Kokum residue, 80:20) might be due to excellent sugar acid blend and also due to highest sensory score than all other treatments which results in fetching the highest price among all the treatments.

The similar findings were detected by Kushala *et al.* (2012) [6] who revealed that benefit cost ratio of jackfruit jam blended with avocado and kokum was 3.53:1.

Table 1: Effect of jackfruit pulp and kokum residue blending on colour of jackfruit- kokum blended jam during storage

Treatments	2022			2023			Pooled data		
	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months
T ₁	7.50	7.30	7.00	8.00	7.80	7.70	7.75	7.55	7.35
T ₂	7.80	7.50	7.20	8.20	8.10	8.00	8.00	7.80	7.60
T ₃	7.70	7.60	7.50	8.20	8.00	7.90	7.95	7.80	7.70
T ₄	7.70	7.50	7.40	8.30	8.00	7.70	8.00	7.75	7.55
T ₅	8.00	7.50	7.20	8.00	7.70	7.50	8.00	7.60	7.35
Mean	7.74	7.48	7.26	8.14	7.92	7.76	7.94	7.70	7.51

Table 2: Effect of jackfruit pulp and kokum residue blending on flavour of blended jam during storage

Treatments	2022			2023			Pooled data		
	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months
T ₁	8.50	8.00	7.50	8.20	8.10	8.00	8.35	8.05	7.75
T ₂	8.00	8.00	7.90	8.50	8.20	8.00	8.25	8.10	7.95
T ₃	8.70	8.00	7.70	8.70	8.40	7.80	8.70	8.20	7.75
T ₄	8.80	8.20	7.50	8.20	8.00	7.70	8.50	8.10	7.60
T ₅	7.50	7.20	7.00	8.00	7.70	7.50	7.75	7.45	7.25
Mean	8.30	7.88	7.52	8.32	8.08	7.80	8.31	7.98	7.66

Table 3: Effect of jackfruit pulp and kokum residue blending on texture of blended jam during storage

Treatments	2022			2023			Pooled data		
	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months
T ₁	7.20	6.80	6.00	6.50	6.00	6.00	6.85	6.40	6.00
T ₂	7.50	7.00	6.50	8.20	8.20	8.00	7.85	7.60	7.25
T ₃	7.60	7.50	7.50	8.40	8.00	7.80	8.00	7.75	7.65
T ₄	8.00	7.50	7.00	8.50	8.00	7.80	8.25	7.75	7.40
T ₅	7.00	7.00	6.80	8.60	8.20	7.70	7.80	7.60	7.25
Mean	7.46	7.16	6.76	8.04	7.68	7.46	7.75	7.42	7.11

Table 4: Effect of jackfruit pulp and kokum residue blending on overall acceptability of blended jam during storage

Treatments	2022			2023			Pooled data		
	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months	0 Month	2 Months	4 Months
T ₁	7.73	7.37	6.83	7.57	7.30	7.23	7.65	7.33	7.03
T ₂	7.77	7.50	7.20	8.30	8.17	8.00	8.03	7.83	7.60
T ₃	8.00	7.70	7.57	8.43	8.13	7.83	8.22	7.92	7.70
T ₄	8.17	7.73	7.30	8.33	8.00	7.73	8.25	7.87	7.52
T ₅	7.50	7.23	7.00	8.20	7.87	7.57	7.85	7.55	7.28

Mean	7.83	7.51	7.18	8.17	7.89	7.67	8.00	7.70	7.43
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Table 5: Effect of jackfruit pulp and kokum residue blending on cost of processing of blended jam (1 Kg).

Sr. No.	Particulars	T ₁ (J: 100% + K: 00%)		T ₂ (J: 90% + K: 10%)		T ₃ (J: 80% + K: 20%)	
		Quantity	Cost Rs.	Quantity	Cost Rs.	Quantity	Cost Rs.
1	Soft flesh Jackfruit	2.86 Kg	17.16	2.57 Kg	15.42	2.29 kg	13.74
2	Kokum residue @ 2 Rs/kg	00	00	80 g	0.16	160 g	0.32
3	RO water @ 10 Rs/litre	00	00	41.66 g	0.083	83.32 g	0.161
4	Sugar @ 39 Rs/kg	0.909 Kg	35.46	0.833 Kg	32.50	0.806 Kg	31.45
5	Citric acid @ 92 Rs/kg 1.8 g/kg of jam	1.01 g	0.150	1.5 g	0.138	1.45 g	0.134
6	Sodium benzoate @ 240 Rs/Kg	0.235 g	0.056	0.235 g	0.056	0.235 g	0.056
7	Glass jars @ 8 Rs/glass jar	5	40	5	40	5	40
8	Aluminium foil @ Rs.100 per 200 g i.e. 0.57 g/glass jar	2.85 g	1.425	2.85 g	1.425	2.85 g	1.425
9	Fuel gas @ 950 Rs. of 14.2 Kg Rs. 0.00178 per hour	42.25 min	0.00125	38.62 min	0.00114	33.82 Min	0.00100
10	Electricity charges @ 9.64 Rs/unit 0.321 Rs/ min	0.381 min	0.122	0.387 min	0.124	0.396 min	0.127
11	Labour charges @ 300 Rs. per skilled labour 0.625 Rs/min	47.25 min	29.531	43.63 min	27.268	38.84 min	24.275
A	a) Variable cost	123.77		117.18		111.69	
	b) Supervision charges @ 10% on variable cost	12.38		11.72		11.17	
	c) Interest on variable cost @ 10% for 4 months	4.13		3.91		3.72	
	d) Total variable cost (a+b+c)	140.28		132.81		126.58	
B	Fixed cost						
	a) Depreciation charges @ 10% on fixed cost on Rs 8000 for gas stove and 3000 mixer for different hour or minutes as per treatment	0.06047		0.05550		0.04892	
	b) Interest on fixed cost @ 10% on fixed cost on Rs 8000 for gas stove and 3000 mixer for different hour or minutes as per treatment	0.06716		0.06163		0.05432	
	c) Total fixed cost (a + b) in (₹)	0.12763		0.11713		0.10324	
C	Total cost (total variable cost + total fixed cost) in (₹)	140.41		132.93		126.68	
D	Cost of processing for 1 kg jackfruit jam	140.41		132.93		126.68	
E	Cost of processing for 200 g jackfruit kokum jam	28.08		26.59		25.34	
F	Selling price of jam/kg	180		260		300	
G	BC ratio	1.28		1.96		2.37	

Sr. No.	Particulars	T ₄ (J: 70% + K: 30%)		T ₅ (J: 60% + K: 40%)	
		Quantity	Cost Rs.	Quantity	Cost Rs.
1	Soft flesh Jackfruit @ 6 rs/ Kg	2.00	12.00	1.71	10.26
3	Kokum residue @ 2 Rs/kg	240 g	0.48	320 g	0.64
2	RO water @ 10 rs/litre	0.391	3.906	0.379	3.788
4	Sugar @ 39 Rs/kg	0.781	30.469	0.758	29.542
5	Citric acid @ 92 Rs/kg 1.8 g/kg of jam	1.406	0.129	1.363	0.125
6	Sodium benzoate @ 240 Rs/Kg	0.235	0.056	0.235	0.056
7	Glass jars @ 8 Rs/glass jar	5	40	5	40
8	Aluminium foil @ Rs.100 per 200 g i.e. 0.57 g/glass jar	2.85	1.425	2.85	1.425
9	Fuel gas @ 950 Rs.of 14.2 Kg Rs. 0.00178 per hour	29.75	0.00088	24.30	0.000721
10	Electricity charges @ 9.64 rs/unit 0.321 rs/ min	0.404	0.130	0.423	0.136
11	Labour charges @ 300 Rs. per skilled labour 0.625 Rs/min	33.75	21.094	29.81	18.631
A	a) Variable cost	109.69		104.60	
	b) Supervision charges @ 10% on variable cost	10.97		10.46	
	c) Interest on variable cost @ 10% for 4 months	3.66		3.49	
	d) Total variable cost (a+b+c)	124.32		118.55	
B	Fixed cost				
	a) Depreciation charges @ 10% on fixed cost on Rs. 8000 for gas stove and 3000 mixer for different hour or minutes as per treatment	0.04335		0.03588	
	b) Interest on fixed cost @ 10% on fixed cost on Rs. 8000 for gas stove and 3000 mixer for different hour or minutes as per treatment	0.04813		0.03983	
	c) Total fixed cost (a + b) in (₹)	0.09148		0.07571	
C	Total cost (total variable cost + total fixed cost) in (₹)	124.41		118.63	
D	Cost of processing for 1 kg jackfruit kokum jam	124.41		118.63	
E	Cost of processing for 200 g jackfruit kokum jam	24.88		23.73	
F	Selling price of jam/kg	260		220	
G	BC ratio	2.09		1.85	



Plate 1: Jackfruit kokum blended jam

Conclusion

The study revealed that blending jackfruit pulp with kokum residue significantly influenced the sensory quality and economic viability of the jam. Among the treatments, the 80:20 ratio (T_3) of jackfruit to kokum rind residue performed best, recording higher scores for colour, flavour, texture, and overall acceptability throughout the four months of storage. Although sensory scores declined gradually over time, all treatments remained within acceptable limits. The superior performance of T_3 may be due to the optimal balance between the sweetness of jackfruit and the acidity and colour of kokum, resulting in a desirable flavour and consistency. Treatments with higher kokum levels showed comparatively lower acceptability, while 100% jackfruit lacked acidity and colour. Economically, T_3 was most profitable, with the highest selling price (₹60/200 g) and benefit-cost ratio (2.37). Thus, the 80:20 blend is ideal for quality product development and commercial viability.

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