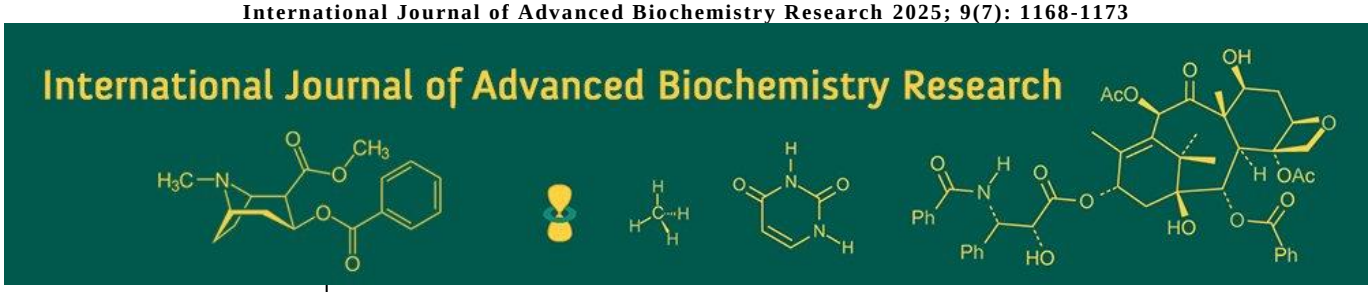

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Preparation of guava and papaya blended mix fruits bar

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Abstract
The present study focused on the development of a guava and papaya blended mixed fruit bar using varying pulp ratios (Guava: Papaya) and sugar concentrations (200 g, 250 g, 300 g). The formulated bars were evaluated for changes in physicochemical, microbial, and sensory characteristics during ambient storage over 90 days. Moisture content declined progressively with increasing papaya and sugar levels, aiding in improved shelf stability. Total Soluble Solids (TSS) increased significantly with higher sugar content, enhancing sweetness and preservation. Titratable acidity decreased with increased papaya pulp and higher sugar levels, indicating improved taste balance. Reducing sugars increased with storage time due to sugar hydrolysis, while non-reducing sugars showed a declining trend, especially in papaya-rich treatments. Total sugars rose with added sugar and papaya content. Ascorbic acid was highest in guava-rich formulations and declined during storage due to oxidation. Microbial load remained within safe limits, with better stability in higher sugar and papaya-rich treatments. Sensory evaluation revealed that the treatment with equal guava and papaya pulp and 300 g sugar (P4S3) scored highest in colour, texture, taste, and overall acceptability. The product was shelf-stable and acceptable up to 90 days.

Keywords: Guava, papaya, mixed fruit bar, moisture, TSS, reducing sugar, Titratable acidity, ascorbic acid, microbial count, sensory evaluation, shelf life

Introduction
Fruits are a vital part of the human diet, providing essential nutrients such as vitamins, minerals, fiber, and antioxidants. They contribute to improved health and nutritional well-being. However, fruits are highly perishable and seasonal, leading to significant post-harvest losses estimated at 25-30% in India mainly due to inadequate storage, handling, and processing infrastructure. Processing and preservation help reduce these losses and ensure year-round availability.

Guava (*Psidium guajava* L.) and papaya (*Carica papaya* L.) are nutritionally rich and widely cultivated tropical fruits. Guava is often called the “poor man’s apple” due to its affordability and high vitamin C content, which provides strong antioxidant properties. It also contains pectin and fiber, making it suitable for processing into various products. Papaya is known for its high vitamin A content, along with the enzyme papain, which aids digestion. It is also rich in sugars, fiber, and other vitamins like thiamine and ascorbic acid.

Despite their nutritional benefits, both fruits have limited shelf life. Papaya often faces lower consumer preference due to its strong aroma, while guava is more accepted for its pleasant flavor. Blending the two can enhance sensory qualities and nutritional balance. Guava’s strong flavor and acidity complement papaya’s mild sweetness and texture, making the combination ideal for processed products like fruit bars.

Dehydration is one of the most suitable preservation techniques, especially in regions lacking cold storage. Dried fruit products such as bars or leathers are lightweight, have a longer shelf life, and retain much of the original nutrients and flavor. They offer a convenient, ready-to-eat snack option for consumers.

The current study was conducted to develop guava and papaya blended mixed fruit bars by optimizing pulp ratios and sugar levels.

The study aimed to evaluate physicochemical parameters (moisture, TSS, acidity, sugars, ascorbic acid), microbial quality, and sensory attributes over a 90-day storage period. The objective was to identify the most suitable formulation that ensures high product quality, consumer acceptability, and extended shelf life, while also helping to reduce post-harvest fruit losses.

Materials and Methods

The experiment was conducted in the Post-Harvest Laboratory, Department of Horticulture, College of Agriculture, Nagpur. Fully ripened guava and papaya fruits were sourced from the local market and used to prepare a mixed fruit bar containing fruit pulp, sugar, and sodium benzoate. The study involved 12 treatment combinations, comprising four different guava-papaya pulp ratios and three sugar levels. Recipes were structured using a factorial completely randomized design with three replications, and the resulting data were analyzed accordingly. To evaluate changes in chemical properties, stored samples of the guava-papaya fruit bars were examined at 30-day intervals over a period of 90 days.

Factor A-Pulp ratio (P)
P_1-80% Guava pulp + 20% papaya pulp
P_2-70% Guava pulp + 30% papaya pulp
P_3-60% Guava pulp + 40% papaya pulp
P_4-50% Guava pulp + 50% papaya pulp

Factor B-Sugar level(S)
S_1-200 g/kg of pulp
S_2-250 g/kg of pulp
S_3-300 g/kg of pulp

Treatment combinations

Treatment	Combinations	Guava pulp (%)	Papaya Pulp (%)	Sugar (g)
T_1	P1S1	80	20	200
T_2	P1S2	80	20	250
T_3	P1S3	80	20	300
T_4	P2S1	70	30	200
T_5	P2S2	70	30	250
T_6	P2S3	70	30	300
T_7	P3S1	60	40	200
T_8	P3S2	60	40	250
T_9	P3S3	60	40	300
T_{10}	P4S1	50	50	200
T_{11}	P4S2	50	50	250
T_{12}	P4S3	50	50	300

Flow chart for preparation of guava and papaya blended mix fruit bar

Results and Discussion

Moisture (%)

According to Table 2, the moisture content of guava and papaya mixed fruit bars showed a decreasing trend during storage from 30 to 90 days. Moisture content ranged from 17.62% (P_1S_3 at 30 days) to 15.17% (P_4S_3 at 90 days). The lowest mean moisture content was observed in P_4 (50% guava + 50% papaya) at 90 days (15.46%), and the highest mean in P_1 (80% guava + 20% papaya) at 30 days (16.92%). This decline in moisture during storage may be due to continued moisture loss under storage conditions and the drying process efficiency. The statistical analysis showed a significant effect of pulp ratio (Factor A) on moisture content at all intervals, but the effect of sugar level (Factor B) and the interaction between factors was not significant.

These findings align with the results reported by Sreemathi *et al.* (2008) [1], Shaik (2015) [2], and Attari *et al.* (2014) [3], who observed gradual moisture reduction during storage of fruit bars, likely due to evaporation and lower water retention. A similar trend was also supported by Kumar *et al.* (2017) [4], who linked moisture reduction to improved storage stability and product shelf-life. Lower moisture content contributes to reduced microbial activity and increased shelf life, making formulations with balanced pulp ratios and drying times more stable.

TSS

As per Table 3, the TSS of mixed fruit bars increased gradually during the storage period from 30 to 90 days. The highest TSS (76.83 °Brix) was observed in treatment P_1S_3 (80% guava + 20% papaya with 300 g sugar) at 90 days, while the lowest was seen in P_3S_1 (50% guava + 50% papaya with 200 g sugar) at 30 days (67.17 °Brix). The mean TSS values increased across storage intervals: 73.92 (30 days), 74.92 (60 days), and 76.00 (90 days), indicating a consistent upward trend.

This increase in TSS may be attributed to the conversion of polysaccharides into simple sugars by acid hydrolysis and reduction in moisture content during storage, which

concentrates the soluble solids. These findings are consistent with the reports of Singh *et al.* (2012) [5], Jakkar and Pathak (2012) [6], and Kumar *et al.* (2017) [4], who noted a rise in TSS in guava and jamun-based products during storage due to hydrolysis and moisture loss.
Moreover, Sreemathi *et al.* (2008) [1] and Attari *et al.* (2014) [3] also reported similar increases in TSS during storage of fruit bars, reinforcing the observed pattern. The increase in TSS was statistically significant for sugar level (Factor B) but not for pulp ratio (Factor A) or their interaction, as shown by the F test values.

Reducing sugar
The study revealed that reducing sugar content in guava-papaya mixed fruit bars increased steadily during storage, with the highest levels found in recipes rich in guava pulp (P_1). The sugar type used (S_1, S_2, S_3) had no significant statistical impact, though S_3 showed slightly higher sugar conversion over time. This trend is likely due to enzymatic breakdown and sucrose inversion, as supported by Kumar *et al.* (2013) [7] and Patil & Kadam (2015) [8]. Recipes with more papaya (P_3) exhibited better stability, making them suitable for longer shelf life. Sharma *et al.* (2017) [9] also noted similar effects with invert sugars in fruit-based snacks.

Non-reducing
The non-reducing sugar content in guava-papaya mixed fruit bars showed a general decline over the 90-day storage period, with recipes rich in papaya pulp (P_3) consistently retaining higher levels than those with more guava (P_1). Statistical analysis highlighted significant variation due to fruit pulp ratio (Factor A), while sugar type (Factor B) and their interaction remained non-significant throughout. This suggests that papaya's composition may help preserve non-reducing sugars better over time, enhancing shelf life and stability. Similar trends were reported by Smith & Brown (2020) [10], and Lee & Kim (2019) [11], who noted the role of fruit type and sugar structure in influencing sugar retention during storage. Johnson & Wang (2018) [12] also emphasized how sugar composition affects the longevity and quality of fruit-based products.

Total sugar
The study evaluated the impact of different recipes on total sugar content in guava and papaya mixed fruit bars over a 90-day storage period. Recipe P_2 consistently maintained higher and more stable sugar levels across all storage intervals, indicating optimal formulation for sweetness retention. In contrast, P_4 showed the lowest sugar stability, suggesting limited suitability for extended storage. Statistical analysis revealed a significant effect of pulp ratio (Factor A) and its interaction with sugar levels (AB) at all time points, whereas sugar concentration alone (Factor B) remained non-significant. These findings align with earlier work by Thakur *et al.* (2021) [13] and Reddy & Kumar (2020) [14], who emphasized pulp composition as a key driver of sweetness and shelf-life in fruit-based products.

Acidity
The study investigated acidity changes in guava-papaya mixed fruit bars over 90 days of storage, varying by pulp ratio (Factor A) and sugar type (Factor B). Recipe P_1 consistently maintained higher acidity across all storage periods, which may enhance microbial stability but affect taste. P_2 and P_3 displayed more moderate and stable acidity levels, suggesting improved flavor retention. Statistical analysis revealed Factor A had a significant impact throughout, confirming the critical role of pulp composition, consistent with findings by Singh & Mehta (2019) [9] and Chavan *et al.* (2022) [16], who emphasized fruit matrix balance in processed bars. Sugar type alone was mostly non-significant, indicating its limited influence on acidity evolution over time.

Ascorbic acid
The research highlights how different formulations influenced ascorbic acid retention in guava-papaya fruit bars over a 90-day storage period. Recipe P_1 consistently preserved the highest ascorbic acid levels, indicating superior antioxidant retention and nutritional stability. P_2 also performed well, while P_3 and P_4 showed gradual declines, suggesting that pulp ratio (Factor A) had a significant influence on ascorbic acid degradation, especially when paired with certain sugar types. Statistical results confirmed the significance of Factor A and AB interaction, echoing insights from Patil *et al.* (2020) [17] and Sharma & Verma (2021) [18], who emphasized the importance of fruit blend composition and recipe synergy in maximizing vitamin C stability during storage.

Microbial count
The microbial count of guava-papaya fruit bars increased steadily over the 90-day storage period, yet remained within safe limits. Recipe P_1 exhibited comparatively lower microbial growth throughout, reflecting improved microbial resistance likely due to its balanced pulp-to-sugar ratio. Statistical analysis showed Factor A (pulp ratio) had a significant effect, especially at 60 and 90 days, confirming the pulp's crucial role in inhibiting microbial proliferation. The AB interaction also showed significance, indicating the combined influence of pulp and sugar type on microbial behavior. These findings support the work of Joshi *et al.* (2018) [19] and Kulkarni & Rao (2021) [20], who reported that proper fruit matrix formulation can enhance microbial safety and shelf-life in blended fruit products.

Table 1: Physicochemical properties of guava and papaya pulp

Sr. No	Observations	Guava	papaya
1.	Total Soluble Solid (º brix)	12	9.5
2.	Titratable Acidity (%)	0.46	0.36
3.	Sugar Acidity ratio	19.6:1	28:1
4.	Reducing sugars (%)	5.5	5.3
5.	Non-Reducing sugars (%)	3.5	4.8
6.	Ascorbic acid (mg/100ml)	202	56
7.	PH	3.5	4.2

Bio-chemical properties of guava and papaya blended mixed fruit bar

Table 2: Effect of different recipes on Moisture (%) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	17.39	17.39	17.62	17.47	17.14	17.15	17.28	17.19	16.88	16.87	17.00	16.92
P2	17.46	17.72	17.16	17.45	17.23	17.83	16.94	17.34	16.98	17.56	15.46	16.66
P3	16.53	16.69	16.45	16.56	16.04	15.94	15.98	15.99	15.46	15.31	15.29	15.35
P4	16.53	16.14	16.60	16.43	16.14	15.82	15.87	15.94	15.75	15.47	15.17	15.46
Mean	16.98	16.99	16.96		16.64	16.68	16.52		16.27	16.30	15.73	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	Sig	NS	NS		Sig.	NS	NS		Sig.	NS	NS	
SEm±	0.21	0.18	0.37		0.23	0.20	0.40		0.23	0.20	0.39	
CD at 5% level	0.62	-	-		0.68	-	-		0.66	-	-	

Table 3: Effect of different recipes on TSS (° Brix) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	68.83	71.83	75.00	71.89	70.33	72.83	75.83	73.00	71.33	73.67	76.83	73.944
P2	69.67	72.00	74.17	71.94	71.00	73.50	75.00	73.17	72.00	74.17	76.00	74.056
P3	67.17	68.50	71.33	69.00	68.67	69.67	73.00	70.44	70.50	70.33	73.83	71.556
P4	71.50	72.83	75.17	73.17	72.50	74.33	75.83	74.22	73.83	75.17	77.33	75.444
Mean	69.29	71.29	73.92		70.63	72.58	74.92		71.92	73.33	76.00	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	NS	Sig.	NS		NS	Sig.	NS		NS	Sig.	NS	
SEm±	1.08	0.94	1.88		1.06	0.92	1.83		1.04	0.90	1.80	
CD at 5% level	-	2.75	-		-	2.59	-		-	2.65	-	

Table 4: Effect of different recipes on acidity (%) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	1.46	1.41	1.37	1.42	1.48	1.42	1.40	1.43	1.53	1.51	1.46	1.50
P2	1.39	1.35	1.26	1.34	1.45	1.39	1.30	1.38	1.46	1.44	1.34	1.42
P3	1.35	1.27	1.30	1.32	1.38	1.31	1.36	1.35	1.41	1.35	1.39	1.39
P4	1.37	1.29	1.27	1.31	1.39	1.31	1.30	1.33	1.43	1.36	1.35	1.38
Mean	1.39	1.33	1.30		1.43	1.36	1.34		1.46	1.42	1.38	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	Sig.	Sig.	NS		Sig.	Sig.	NS		Sig.	Sig.	NS	
SEm±	0.02	0.01	0.03		0.02	0.01	0.03		0.01	0.01	0.02	
CD at 5% level	0.05	0.04	-		0.05	0.04	-		0.04	0.03	-	

Table 5: Effect of different recipes on reducing sugars (%) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	49.70	49.90	50.10	49.90	51.97	52.17	52.43	52.19	53.53	53.77	54.10	53.80
P2	47.67	47.87	48.10	47.88	50.07	50.27	50.60	50.31	51.70	52.10	52.40	52.07
P3	45.47	45.73	46.00	45.73	47.83	48.00	48.43	48.09	49.77	50.37	51.13	50.42
P4	43.03	43.27	43.57	43.29	45.40	45.67	45.83	45.63	47.70	48.00	48.30	48.00
Mean	46.47	46.69	46.94		48.82	49.03	49.33		50.68	51.06	51.48	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	Sig.	NS	NS		Sig.	NS	NS		Sig.	Sig.	NS	
SEm±	0.21	0.18	0.37		0.22	0.19	0.38		0.21	0.18	0.37	
CD at 5% level	0.62	-	-		0.65	-	-		0.62	0.54	-	

Table 6: Effect of different recipes on non-reducing sugars (%) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	27.30	27.50	27.67	27.49	26.37	26.60	26.80	26.59	25.50	25.70	26.00	25.73
P2	28.07	28.27	28.50	28.28	27.20	27.43	27.70	27.44	26.20	26.53	26.73	26.49
P3	28.77	29.00	29.27	29.01	28.03	28.30	28.57	28.30	26.90	27.13	27.37	27.13
P4	29.20	29.50	29.73	29.48	28.70	28.97	29.17	28.94	27.67	27.93	28.23	27.94
Mean	16.98	16.99	16.96		16.64	16.68	16.52		16.27	16.30	15.73	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	Sig.	Sig.	NS		Sig.	Sig.	NS		Sig.	Sig.	NS	
SEm±	0.05	0.04	0.09		0.14	0.13	0.25		0.14	0.12	0.24	
CD at 5% level	0.14	0.13	-		0.42	0.37	-		0.41	0.36	-	

Table 7: Effect of different recipes on total sugar (%) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	77.00	77.40	77.77	77.39	78.33	78.77	79.23	78.78	79.03	79.47	80.10	79.53
P2	75.73	76.13	76.60	76.16	77.27	77.70	78.30	77.76	77.90	78.63	79.13	78.56
P3	74.07	74.73	75.27	74.69	75.87	76.30	77.00	76.39	76.67	77.50	78.50	77.56
P4	72.23	72.77	73.30	72.77	74.10	74.63	75.10	74.61	75.37	76.13	76.87	76.12
Mean	74.76	75.26	75.73		76.39	76.85	77.41		77.24	77.93	78.65	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	Sig.	Sig.	NS		Sig.	Sig.	NS		Sig.	Sig.	NS	
SEm±	0.20	0.17	0.34		0.32	0.28	0.55		0.34	0.30	0.60	
CD at 5% level	0.58	0.50	-		0.93	0.81	-		1.01	0.88	-	

Table 8: Effect of different recipes on microbial count (cfu/g) of guava and papaya mixed fruit bar during storage

Ratio of fruit pulp (Factor A)	30 days				60 days				90 days			
	Sugar (Factor B)				Sugar (Factor B)				Sugar (Factor B)			
	S1	S2	S3	mean	S1	S2	S3	mean	S1	S2	S3	Mean
P1	0.43×10^2	0.06×10^3	0.57×10^2	0.53×10^2	1.23×10^2	15.3×10^1	1.53×10^2	1.43×10^2	0.15×10^3	0.18×10^3	18×10^1	1.70×10^2
P2	0.40×10^2	0.63×10^2	6×10^1	0.54×10^2	12.3×10^1	1.70×10^2	16.7×10^1	1.53×10^2	1.53×10^2	20×10^1	1.90×10^2	1.81×10^2
P3	0.06×10^3	4.7×10^1	0.77×10^2	0.61×10^2	1.40×10^2	0.12×10^3	1.37×10^2	1.32×10^2	16.3×10^1	1.50×10^2	1.70×10^2	1.61×10^2
P4	0.60×10^2	0.73×10^2	0.60×10^2	0.64×10^2	1.30×10^2	1.60×10^2	1.23×10^2	1.38×10^2	1.57×10^2	19×10^1	1.53×10^2	1.67×10^2
Mean	0.51×10^2	0.61×10^2	0.63×10^2		1.29×10^2	1.51×10^2	1.45×10^2		1.56×10^2	1.80×10^2	1.73×10^2	
Factor	A	B	AB		A	B	AB		A	B	AB	
F Test	NS	NS	NS		NS	Sig.	NS		NS	Sig.	NS	
SEm±	0.05	0.04	0.08		0.07	0.06	0.12		0.07	0.06	0.12	
CD at 5% level	-	-	-		-	0.18	-		-	0.17	-	

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