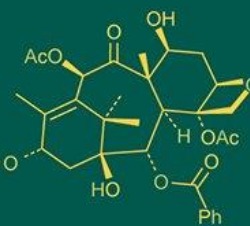
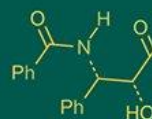


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Effect of variety and chemical preservatives on quality and storability of guava pulp during frozen storage

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Abstract

An experiment was conducted to evaluate the effect of guava variety and chemical preservatives on the quality and storability of guava pulp during frozen storage. Pulp from two guava varieties, L-49 (V1) and Arka Kiran (V2), was treated with potassium metabisulfite (P1, 0.1%), sodium benzoate (P2, 0.1%) or no preservative (P3, control), giving six treatment combinations. The treatments were replicated three times in a factorial completely randomized design. Pulp was packed in polyethylene pouches and stored at -20°C for 90 days. Total soluble solids (TSS), titratable acidity, pH, ascorbic acid, reducing sugars, non-reducing sugars and total sugars were evaluated at 0, 30, 60 and 90 days of storage. At 90 days, Arka Kiran treated with potassium metabisulfite (V2P1) recorded the highest TSS (13.20 °Brix), reducing sugar (7.05%) and total sugar (9.31%) among the treatment combinations. L-49 treated with potassium metabisulfite (V1P1) retained the highest ascorbic acid content (189.32 mg 100 g⁻¹). Titratable acidity increased and pH decreased during storage, while ascorbic acid generally declined. The results indicate that the response to preservation depended on both variety and preservative, with Arka Kiran + potassium metabisulfite showing the most favorable overall physicochemical profile at 90 days, whereas L-49 + potassium metabisulfite was superior for ascorbic-acid retention.

Keywords: Arka Kiran, L-49, guava pulp, potassium metabisulfite, sodium benzoate, frozen storage, storability

1. Introduction

Guava (*Psidium guajava* L.) is an important tropical fruit valued for its nutritional composition and commercial potential. The fruit is highly perishable and ripens rapidly after harvest, resulting in a short storage life and substantial post-harvest losses. The manuscript cites a post-harvest loss estimate of 15.05% from NABCONS (2022) and notes that preservation of surplus guava as pulp can extend availability beyond the fresh-fruit marketing period.

Processing guava into pulp provides an opportunity to reduce losses, improve utilization of seasonal production and supply raw material for value-added products. Chemical preservatives such as potassium metabisulfite and sodium benzoate can be used in fruit pulp preservation, particularly when combined with controlled storage conditions.

However, preservation performance may vary with cultivar because varieties differ in their physicochemical and nutritional composition. The present study therefore evaluated two contrasting guava varieties, L-49 and Arka Kiran, in combination with potassium metabisulfite, sodium benzoate and an untreated control during frozen storage at -20°C . The objective was to characterize changes in physicochemical and nutritional quality over 90 days and identify the treatment combination providing the most favorable quality profile.

2. Materials and Methods

2.1 Experimental material and pulp preparation

The investigation was conducted during 2024-2025 in the laboratory of the Post-harvest Technology Unit, Horticulture Section, Shri Shivaji College of Horticulture, Amravati, affiliated with Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Fruits of cv. L-49 were procured from the Horticultural Farm, Horticulture Section, Shri Shivaji College of Horticulture, Amravati, while fruits of cv. Arka Kiran were collected from a progressive farmer in Shegaon Tahsil, Buldhana District, Maharashtra. Healthy, sound fruits free from visible disease and pest damage were selected.

Mature and ripe fruits were washed, cut into pieces and pulped at low speed using a pulper. The pulp was passed through a stainless-steel sieve to separate seeds and obtain a smooth pulp.

2.2 Preservative treatments and storage

Potassium metabisulfite and sodium benzoate were incorporated at 1 g kg⁻¹ pulp (0.1% w/w) and thoroughly homogenized. The control received no chemical preservative. Approximately 350 g of pulp was filled into food-grade polyethylene pouches described in the original manuscript as 300 gauge/300 micron and sealed. The pouches were stored at -20 °C and evaluated at 0, 30, 60 and 90 days.

2.3 Quality analysis

Total soluble solids were measured using a digital refractometer (0-32 °Brix, Erma) and corrected to 20 °C using a temperature-correction chart. pH was measured directly using a pH meter. Titratable acidity, ascorbic acid, reducing sugars, non-reducing sugars and total sugars were determined according to Ranganna (1986)^[15]. Organoleptic quality was assessed using a nine-point hedonic scale following Amerine *et al.* (1965)^[12]. Microbiological quality was assessed using total plate count (TPC) following Luna-Guzman and Barrett (2000)^[12].

2.4 Experimental design and statistical analysis

The experiment consisted of two guava varieties × three preservative treatments, with three replications, in a factorial completely randomized design. For each storage interval, treatment effects were evaluated using analysis of variance according to the statistical procedure adopted for the experiment. Standard error of the mean [SE(m)+] and critical difference (CD) at the 5% probability level are reported in the tables. The final statistical statement should be adjusted if storage period was included as an additional factor in the original analysis.

Important statistical clarification required before submission: the present tables report factorial effects separately at each storage interval, but the manuscript does not explicitly state whether storage period was included as a factor in the statistical model or whether the same experimental unit was followed over time. The final manuscript should state the exact statistical model used.

3. Results and Discussion

3.1 Total soluble solids

Total soluble solids (TSS) increased progressively during storage in all treatment combinations. At 90 days, V2P1 (Arka Kiran + potassium metabisulfite 0.1%) recorded the highest TSS (13.20 °Brix), followed by V2P2 (12.85 °Brix), V1P1 (12.80 °Brix), V2P3 (12.76 °Brix), V1P2 (12.71 °Brix) and V1P3 (12.60 °Brix). The variety × preservative interaction was significant at all four storage intervals. The increase in TSS is consistent with the conversion or solubilization of complex carbohydrate constituents during storage. Similar increases in TSS have been reported in preserved guava pulp during storage. The present data therefore indicate that Arka Kiran, particularly when combined with potassium metabisulfite, maintained the highest soluble-solids concentration through 90 days.

3.2 Titratable acidity

Titrate acidity increased with advancement of storage. At 90 days, V2P3 recorded the highest acidity (0.74%), followed by V2P2 (0.69%), V1P3 (0.67%), V2P1 (0.63%), V1P2 (0.60%) and V1P1 (0.59%). The variety × preservative interaction was non-significant at 0, 30 and 60 days but became significant at 90 days. Thus, the treatment combinations did not differ in the same manner throughout storage. The increase in acidity may reflect biochemical changes in organic constituents during storage. Because individual organic acids were not measured, the mechanism should not be attributed solely to ascorbic-acid degradation.

3.3 pH

Guava-pulp pH decreased during storage. At 90 days, V2P3 had the highest pH (3.77), followed by V2P2 (3.68), V2P1 (3.61), V1P3 (3.53), V1P2 (3.50) and V1P1 (3.49). The variety × preservative interaction was non-significant at 0 and 30 days but significant at 60 and 90 days. The progressive decline in pH indicates increasing acidity during storage and is consistent with the increase in titratable acidity. The treatment differences should be interpreted as changes in chemical stability rather than assuming that a higher pH necessarily represents superior product quality.

3.4 Ascorbic acid

Ascorbic acid content decreased during storage in all treatment combinations. At 90 days, V1P1 retained the highest concentration (189.32 mg 100 g⁻¹), followed by V1P2 (179.40 mg 100 g⁻¹), V1P3 (163.20 mg 100 g⁻¹), V2P1 (153.98 mg 100 g⁻¹), V2P2 (148.22 mg 100 g⁻¹) and V2P3 (139.48 mg 100 g⁻¹). The variety × preservative interaction was non-significant at day 0 but significant at 30, 60 and 90 days. The data therefore show that treatment differences in ascorbic-acid retention became more pronounced as storage progressed. L-49 consistently retained more ascorbic acid than Arka Kiran, and potassium metabisulfite produced the highest retention within each variety. The decline is consistent with oxidative degradation of ascorbic acid during storage.

3.5 Reducing sugars

Reducing sugar content increased with storage in all treatment combinations. At 90 days, V2P1 recorded the highest reducing sugar content (7.05%), followed by V1P1 (6.89%), V2P2 (6.84%), V1P2 (6.82%), V2P3 (6.70%) and V1P3 (6.69%). The variety × preservative interaction was significant at all storage intervals. The increase may be associated with hydrolysis of complex carbohydrate fractions and formation of soluble sugars during storage. The manuscript originally stated that V2P1 increased from 3.17 to 7.05%; Table 2 gives the initial value as 3.56%, so the numerical statement should read 3.56 to 7.05%.

The original manuscript states that V2P1 increased from 3.17 to 7.05%. Table 2 reports the initial V2P1 value as 3.56%; therefore, the text should be corrected to 3.56 to 7.05%.

3.6 Non-reducing sugars

Non-reducing sugar content showed treatment-dependent changes rather than a uniform storage trend. For the V × P combinations, V1P1 declined from 2.87% at day 0 to 2.08% at day 90, whereas V2P3 declined from 2.65% to 2.13%; other combinations showed different patterns. The V × P

interaction was non-significant at days 0, 60 and 90 but significant at day 30. Because the interaction was not significant at most storage intervals, interpretation should emphasize the overall storage pattern and the main effects rather than attributing persistent treatment differences to the interaction.

3.7 Total sugars

Total sugar content increased during storage. At 90 days, V2P1 recorded the highest total sugar content (9.31%), followed by V2P2 (9.13%), V1P1 (9.02%), V1P2 (8.82%), V2P3 (8.80%) and V1P3 (8.73%). The variety × preservative interaction was significant at all storage intervals. The increase in total sugars may be associated with hydrolysis and solubilization of carbohydrate

constituents during storage. The consistently higher total sugar values in Arka Kiran indicate a varietal contribution to the final sugar profile.

3.8 Overall treatment response

Considering the physicochemical and sugar attributes together, V2P1 (Arka Kiran + potassium metabisulfite 0.1%) showed the most favorable profile at 90 days, particularly for TSS, reducing sugars and total sugars. In contrast, V1P1 (L-49 + potassium metabisulfite 0.1%) retained the highest ascorbic acid content. These results indicate that the most favorable treatment depends on the quality attribute considered rather than a single treatment being uniformly superior for all variables.

Table 1: Effect of guava variety and preservative treatments on TSS, titratable acidity and pH of guava pulp during storage at -20 °C.

Treatment	TSS 0	TSS 30	TSS 60	TSS 90	TA 0	TA 30	TA 60	TA 90	pH 0	pH 30	pH 60	pH 90
Variety V1	11.82	12.02	12.44	12.70	0.38	0.47	0.54	0.62	3.82	3.69	3.57	3.50
Variety V2	12.11	12.57	12.87	12.93	0.35	0.45	0.59	0.69	4.10	3.88	3.77	3.69
Variety: F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
Variety: SE(m)+	0.02	0.03	0.01	0.02	0.007	0.006	0.007	0.006	0.01	0.01	0.01	0.01
Variety: CD 5%	0.07	0.10	0.04	0.08	0.023	0.018	0.022	0.018	0.04	0.03	0.04	0.03
Preservative P1	12.05	12.47	12.83	13.01	0.33	0.42	0.53	0.61	3.94	3.75	3.61	3.55
Preservative P2	11.91	12.27	12.63	12.78	0.38	0.47	0.57	0.64	3.98	3.79	3.67	3.59
Preservative P3	11.94	12.15	12.50	12.68	0.39	0.49	0.59	0.70	3.97	3.82	3.71	3.65
Preservative: F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.
Preservative: SE(m)+	0.03	0.04	0.01	0.03	0.009	0.007	0.009	0.007	0.01	0.01	0.01	0.01
Preservative: CD 5%	0.09	0.12	0.06	0.10	0.028	0.022	0.027	0.022	-	0.04	0.05	0.04
V1P1	11.82	12.07	12.56	12.80	0.35	0.44	0.51	0.59	3.81	3.67	3.55	3.49
V1P2	11.80	12.01	12.45	12.71	0.40	0.47	0.54	0.60	3.83	3.70	3.57	3.50
V1P3	11.86	12.00	12.31	12.60	0.40	0.50	0.57	0.67	3.84	3.71	3.59	3.53
V2P1	12.29	12.63	12.96	13.20	0.32	0.40	0.56	0.63	4.07	3.83	3.68	3.61
V2P2	12.02	12.36	12.83	12.85	0.36	0.47	0.60	0.69	4.13	3.87	3.78	3.68
V2P3	12.03	12.20	12.56	12.76	0.39	0.48	0.62	0.74	4.11	3.94	3.84	3.77
V×P: F-test	Sig.	Sig.	Sig.	Sig.	NS	NS	NS	Sig.	NS	NS	Sig.	Sig.
V×P: SE(m)+	0.04	0.05	0.02	0.04	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01
V×P: CD 5%	0.13	0.17	0.08	0.14	-	-	-	0.03	-	-	0.07	0.05

Note: TSS = total soluble solids; TA = titratable acidity. Storage periods are 0, 30, 60 and 90 days. Values and significance statements are reproduced from the supplied Table 1.

Table 2: Effect of guava variety and preservative treatments on ascorbic acid and sugar fractions of guava pulp during storage at -20 °C.

Treatment	AA 0	AA 30	AA 60	AA 90	RS 0	RS 30	RS 60	RS 90	NRS 0	NRS 30	NRS 60	NRS 90	TS 0	TS 30	TS 60	TS 90
Variety V1	233.96	217.36	198.83	177.30	2.92	3.22	4.79	6.80	3.07	2.80	3.06	2.17	5.87	6.26	7.58	8.79
Variety V2	197.13	178.38	158.04	147.22	3.38	3.66	4.94	6.87	3.28	3.04	2.58	2.02	6.19	6.47	7.88	9.11
Variety: F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
Variety: SE(m)+	1.90	1.39	1.12	1.21	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.03	0.02	0.02	0.01	0.02
Variety: CD 5%	5.86	4.28	3.44	3.65	0.06	0.04	0.04	0.05	0.06	0.08	0.04	0.10	0.06	0.06	0.04	0.07
Preservative P1	219.85	205.45	171.72	171.65	3.28	3.51	4.98	6.97	2.71	2.99	2.79	2.14	6.10	6.50	7.83	9.16
Preservative P2	220.15	200.21	179.41	163.81	3.07	3.43	4.88	6.83	2.94	3.01	2.79	2.07	6.04	6.44	7.74	8.97
Preservative P3	206.64	188.36	184.17	151.34	3.10	3.38	4.73	6.70	2.76	2.77	2.88	2.08	5.95	6.15	7.62	8.72
Preservative: F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.
Preservative: SE(m)+	2.33	1.70	1.37	1.45	0.02	0.01	0.01	0.02	0.02	0.03	0.01	0.04	0.02	0.02	0.01	0.03
Preservative: CD 5%	7.18	5.24	4.22	4.46	0.07	0.05	0.05	0.06	0.07	0.10	0.05	0.12	0.08	0.07	0.05	0.09
V1P1	241.26	228.12	206.90	189.32	3.01	3.25	4.95	6.89	2.87	3.18	2.55	2.08	5.88	6.43	7.64	9.02
V1P2	239.37	220.38	200.81	179.40	2.84	3.23	4.80	6.82	3.09	3.15	2.55	1.97	5.93	6.38	7.59	8.82
V1P3	221.27	204.39	188.78	163.20	2.93	3.19	4.61	6.69	2.87	2.78	2.65	2.03	5.80	5.98	7.50	8.73
V2P1	198.45	182.78	161.45	153.98	3.56	3.78	5.02	7.05	2.56	2.79	3.04	2.20	6.32	6.58	8.02	9.31
V2P2	200.93	180.03	158.02	148.22	3.31	3.64	4.96	6.84	2.80	2.87	3.03	2.18	6.16	6.51	7.89	9.13
V2P3	192.02	172.33	154.66	139.48	3.29	3.57	4.85	6.70	2.65	2.75	3.12	2.13	6.10	6.33	7.74	8.80
V×P: F-test	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	NS	NS	Sig.	Sig.	Sig.	Sig.
V×P: SE(m)+	3.30	2.40	1.94	2.05	0.03	0.02	0.02	0.03	0.04	0.05	0.02	0.05	0.03	0.03	0.02	0.04
V×P: CD 5%	-	7.41	5.96	6.31	0.10	0.07	0.07	0.09	-	0.15	-	-	0.11	0.11	0.07	0.13

Note: AA = ascorbic acid (mg 100 g⁻¹); RS = reducing sugar (%); NRS = non-reducing sugar (%); TS = total sugar (%). Storage periods are 0, 30, 60 and 90 days. Values and significance statements are reproduced from the supplied Table 2.

Treatment key

V1 = L-49 (Lucknow-49); V2 = Arka Kiran; P1 = potassium metabisulfite 0.1%; P2 = sodium benzoate 0.1%; P3 = control without chemical preservative.

4. Conclusion

Frozen storage at -20°C maintained the measured physicochemical and nutritional attributes of guava pulp for 90 days, although storage was accompanied by increases in TSS, titratable acidity, reducing sugars and total sugars and decreases in pH and ascorbic acid. At 90 days, Arka Kiran + potassium metabisulfite 0.1% (V2P1) produced the highest TSS, reducing sugar and total sugar contents, whereas L-49 + potassium metabisulfite 0.1% (V1P1) retained the highest ascorbic acid content. Thus, potassium metabisulfite was the most promising preservative among the treatments evaluated, but the preferred variety depends on the quality attribute prioritized. A final claim regarding overall shelf life should be made only after the sensory and microbiological datasets are incorporated and the statistical model is confirmed.

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