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Physicochemical changes and overall acceptability of guava-based fruit bar during ambient storage

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ABSTRACT

physicochemical changes and overall acceptability of guava-based fruit bar during 90 days of ambient storage. Eight pulp blends of guava, sapota and papaya were dried, packed in plastic boxes and stored at 20–35 °C. Observations were recorded at 0, 30, 60 and 90 days. pH declined in all treatments (T_8 : 4.01 to 3.87; T_1 : 3.44 to 3.26), while titratable acidity increased (T_1 : 1.42 to 1.50%; T_8 : 0.93 to 1.05%). TSS and reducing sugars increased, whereas non-reducing and total sugars decreased, indicating inversion of sucrose. Overall acceptability declined only slightly. Treatment T_8 (Guava:Sapota: Papaya, 40:30:30) retained the highest overall acceptability (8.95 at 0 days to 8.73 at 90 days) together with the most favourable chemical values. The 40:30:30 blend is recommended as a chemically stable and acceptable fruit bar for 90 days of ambient storage.

Keywords: Guava fruit bar, Storage, PH, TSS, Acidity, Sugars, Overall acceptability

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Introduction

Guava (*Psidium guajava* L.), sapota (*Manilkara zapota* L.) and papaya (*Carica papaya* L.) are highly perishable climacteric fruits. Post-harvest losses of 13–26% are common. Conversion of surplus pulp into a dehydrated fruit bar extends availability beyond the glut season.

During storage, moisture migration, inversion of sucrose and formation of organic acids change pH, TSS, acidity and sugar fractions (Ranganna, 1997; Sreemathi *et al.*, 2008) [1, 2]. Overall acceptability on a 9-point hedonic scale is the single sensory index used here to confirm that chemical change does not make the product unacceptable. Binary-blend bars of guava–papaya and sapota–papaya have shown a rise in TSS and reducing sugars and a fall in pH and acceptability with storage (Avhad *et al.*, 2019; Verma *et al.*, 2020) [3, 4]. Storage behaviour of a ternary guava–sapota–papaya bar under Durg conditions is less documented.

The objective of this paper is to quantify changes in pH, TSS, titratable acidity, reducing sugar, non-reducing sugar, total sugar and overall acceptability of guava-based fruit bar during 90 days of ambient storage.

Material and methods

1. Location, design and treatments

The experiment was conducted during 2025–26 at the Fruit Science Laboratory, College of Horticulture and Research Station, Sankara-Patan, Durg (20°54' N; 81°10'–81°36' E). A Completely Randomized Design with eight treatments and three replications was used. Pulp ratios of guava : sapota : papaya were T_1 100:0:0, T_2 80:20:0, T_3 80:0:20, T_4 70:20:10, T_5 70:10:20, T_6 60:20:20, T_7 50:25:25 and T_8 40:30:30.

Preparation and storage

One kilogram of blended pulp was mixed with 200 g sugar and 1 g citric acid and concentrated to 75 °Brix. The slurry was spread in 1 cm layers on glycerine-smeared trays and dried at 50 °C (about 20 h). Dried sheets were cut into 2.5 × 5 cm pieces, packed in food-grade plastic boxes and stored at 20–35 °C. No chemical preservative was added.

Observations

pH was measured with a digital pH meter and TSS (°Brix) with a hand refractometer. Titratable acidity (as citric acid) and sugars were estimated by the methods of Ranganna (1997) [1]. Overall acceptability was scored by a five-member trained panel on a 9-point hedonic scale at 0, 30, 60 and 90 days.

Statistical analysis

Data were analysed by ANOVA for CRD. Means were compared by critical difference at 5% (Panse *et al.*, 1985) [5].

Result and discussion

1. pH

pH declined during storage in seven of the eight treatments (Table 1; Fig. 1). The highest pH throughout storage was recorded in T₈ (4.01

at 0 days to 3.87 at 90 days) and the lowest in T₁ (3.44 to 3.26). Treatment T₅ showed a slight rise at 90 days (3.55 to 3.62), which remained within the CD and did not change the overall ranking. The general decline is due to accumulation of organic acids and slow breakdown of ascorbic acid. Treatments with less guava pulp (T₇ and T₈) stayed at a higher pH because sapota and papaya pulps are less acidic.

Table 1. Changes in pH of guava-based fruit bar during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T ₁ (100:0:0)	3.44	3.39	3.32	3.26
T ₂ (80:20:0)	3.51	3.49	3.46	3.44
T ₃ (80:0:20)	3.52	3.49	3.42	3.39
T ₄ (70:20:10)	3.65	3.62	3.61	3.59
T ₅ (70:10:20)	3.68	3.60	3.55	3.62
T ₆ (60:20:20)	3.88	3.87	3.85	3.82
T ₇ (50:25:25)	3.90	3.81	3.77	3.75
T ₈ (40:30:30)	4.01	3.95	3.92	3.87
SE _m ±	0.026	0.022	0.023	0.015
CD (5%)	0.076	0.064	0.069	0.046

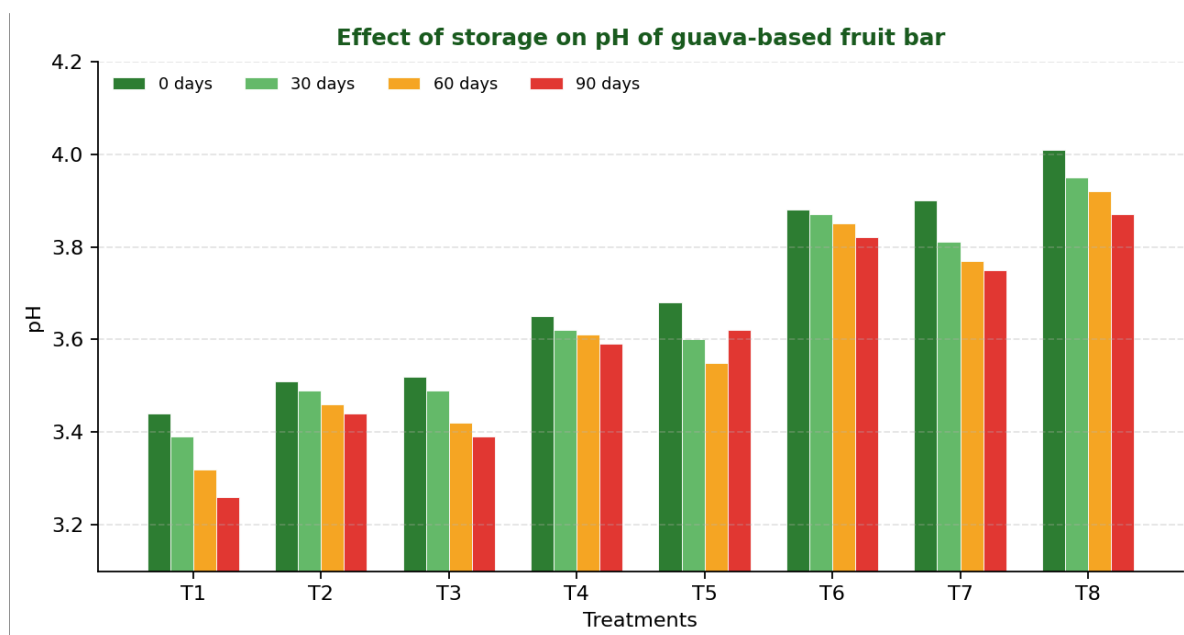


Figure 1. Effect of storage period on pH of guava-based fruit bar

3.2 Total soluble solids

TSS increased continuously during storage (Table 2; Fig. 2). Maximum TSS was recorded in T₈ (74.25 °Brix at 0 days to 75.25 °Brix at 90 days) and minimum in T₁ (72.31 to 73.30 °Brix). The rise

is due to hydrolysis of polysaccharides into simpler sugars and slight concentration from moisture loss (Pareek *et al.*, 2010) [6]. Treatment ranking did not change with time.

Table 2. Changes in TSS (°Brix) of guava-based fruit bar during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T ₁ (100:0:0)	72.31	72.59	72.96	73.30
T ₂ (80:20:0)	73.22	73.57	73.86	74.22
T ₃ (80:0:20)	73.51	73.83	74.17	74.51
T ₄ (70:20:10)	72.84	73.04	73.38	73.72
T ₅ (70:10:20)	72.35	72.67	73.01	73.35
T ₆ (60:20:20)	73.59	73.91	74.25	74.59
T ₇ (50:25:25)	73.84	74.19	74.50	74.84

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Treatment (G:S:P)	0 days	30 days	60 days	90 days
T_8 (40:30:30)	74.25	74.60	74.91	75.25
$SE_m \pm$	0.034	0.065	0.051	0.035
CD (5%)	0.10	0.19	0.15	0.10

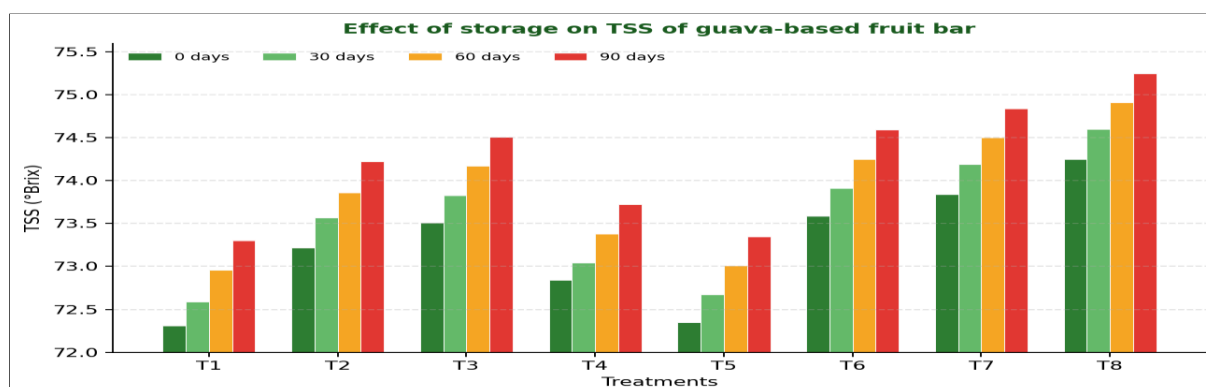


Figure 2. Effect of storage period on TSS (°Brix) of guava-based fruit bar

Titrateable acidity

Titrateable acidity increased with storage in all blends (Table 3; Fig. 3). Highest acidity was in T_1 (1.42% to 1.50%) and lowest in T_8 (0.93% to 1.05%). Higher acidity in high-guava treatments reflects

the acid content of guava pulp (0.38%). The slow rise is consistent with formation of organic acids during storage (Kuchi *et al.*, 2014) [7].

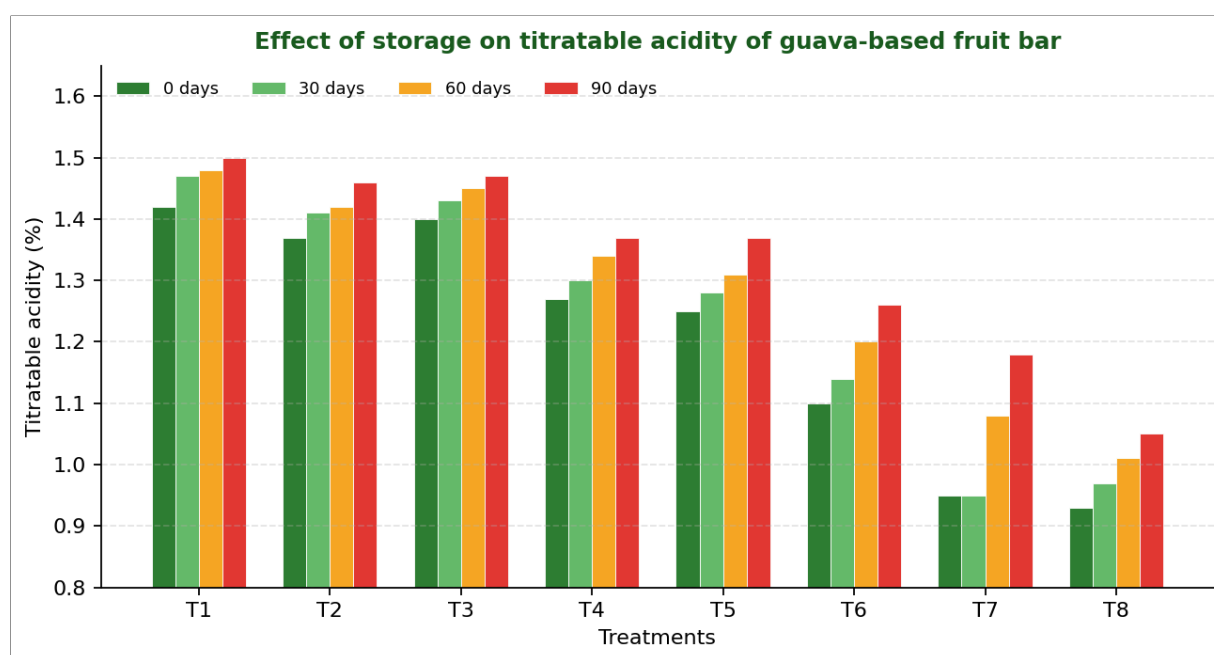


Figure 3. Effect of storage period on titrateable acidity (%) of guava-based fruit bar

Reducing, non-reducing and total sugars

Reducing sugars increased in every treatment (Table 4; Fig. 4). T_8 rose from 8.39% to 8.90% and T_1 from 7.42% to 8.10%. Non-reducing sugars declined (Table 5; Fig. 5): T_8 from 58.99% to 57.64% and

T_3 from 57.25% to 55.88%. Total sugars also declined modestly (Table 6; Fig. 6), with T_8 retaining the highest content (67.38% to 66.54%).

Table 3. Changes in titrateable acidity (%) during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T_1 (100:0:0)	1.42	1.47	1.48	1.50
T_2 (80:20:0)	1.37	1.41	1.42	1.46
T_3 (80:0:20)	1.40	1.43	1.45	1.47
T_4 (70:20:10)	1.27	1.30	1.34	1.37
T_5 (70:10:20)	1.25	1.28	1.31	1.37

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Treatment (G:S:P)	0 days	30 days	60 days	90 days
T_6 (60:20:20)	1.10	1.14	1.20	1.26
T_7 (50:25:25)	0.95	0.95	1.08	1.18
T_8 (40:30:30)	0.93	0.97	1.01	1.05
$SE_m \pm$	0.015	0.013	0.011	0.012
CD (5%)	0.045	0.039	0.034	0.037

These three trends are linked. Under the acidic pH of the bar, sucrose is inverted to glucose and fructose, so reducing sugars rise while non-reducing and total sugars fall (Gowri *et al.*, 2007; Khan *et al.*, 2012)

[8, 9]. Inversion proceeded at a similar rate in all blends; T_8 remained the most sugar-rich bar at every interval.

Table 4. Changes in reducing sugars (%) during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T_1 (100:0:0)	7.42	7.69	7.92	8.10
T_2 (80:20:0)	7.64	7.81	8.05	8.23
T_3 (80:0:20)	7.51	7.85	8.03	8.33
T_4 (70:20:10)	7.93	8.08	8.27	8.46
T_5 (70:10:20)	8.21	8.32	8.47	8.66
T_6 (60:20:20)	8.22	8.41	8.54	8.72
T_7 (50:25:25)	8.27	8.53	8.65	8.84
T_8 (40:30:30)	8.39	8.56	8.71	8.90
$SE_m \pm$	0.09	0.07	0.06	0.06
CD (5%)	0.27	0.22	0.20	0.20

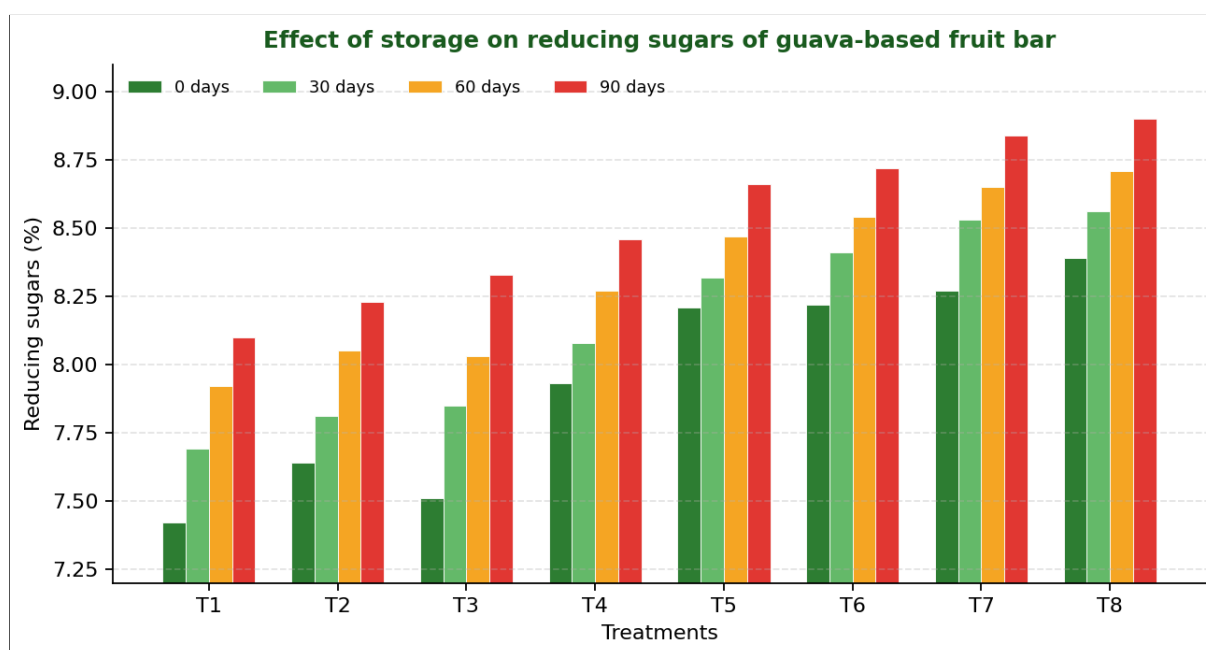


Figure 4. Effect of storage period on reducing sugars (%) of guava-based fruit bar

Table 5. Changes in non-reducing sugars (%) during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T_1 (100:0:0)	58.14	57.75	57.28	56.75
T_2 (80:20:0)	58.65	58.27	57.80	57.25
T_3 (80:0:20)	57.25	56.90	56.40	55.88
T_4 (70:20:10)	57.41	57.07	56.56	56.05
T_5 (70:10:20)	57.72	57.35	56.86	56.35
T_6 (60:20:20)	58.65	58.28	57.78	57.24
T_7 (50:25:25)	58.43	58.05	57.58	57.07
T_8 (40:30:30)	58.99	58.62	58.14	57.64
$SE_m \pm$	0.18	0.16	0.18	0.20

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Treatment (G:S:P)	0 days	30 days	60 days	90 days
CD (5%)	0.56	0.48	0.54	0.57

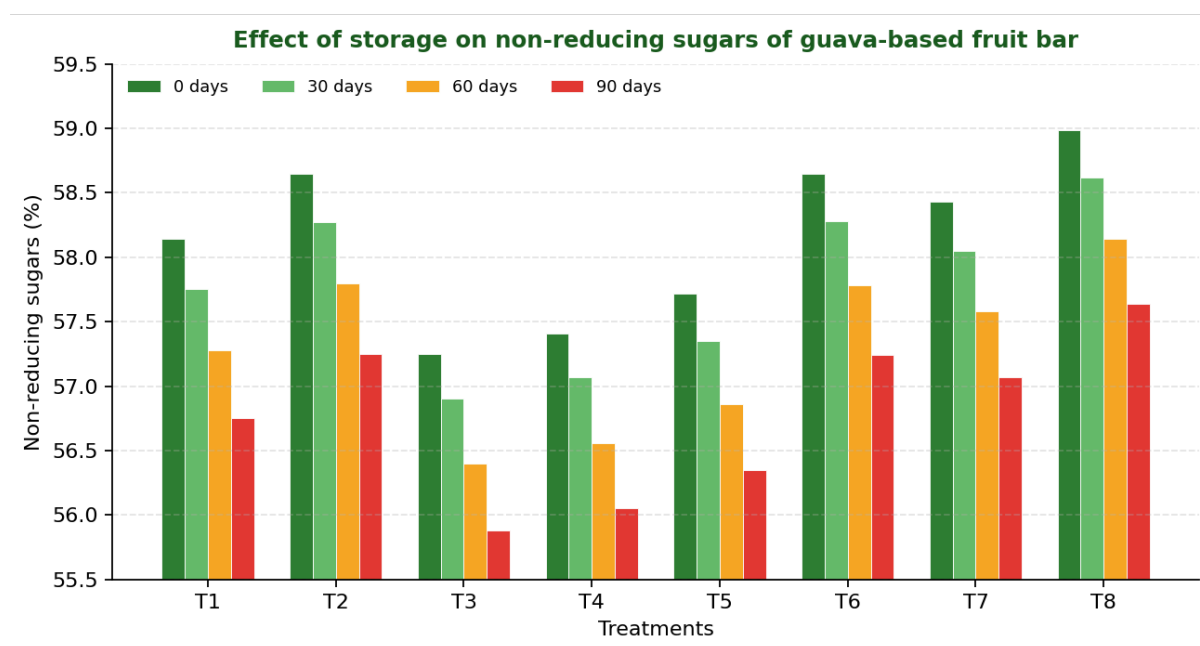


Figure 5. Effect of storage period on non-reducing sugars (%) of guava-based fruit bar

Table 6. Changes in total sugars (%) during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T ₁ (100:0:0)	65.56	65.44	65.20	64.85
T ₂ (80:20:0)	66.29	66.08	65.85	65.48
T ₃ (80:0:20)	64.76	64.75	64.43	64.21
T ₄ (70:20:10)	65.34	65.15	64.83	64.51
T ₅ (70:10:20)	65.93	65.67	65.33	65.01
T ₆ (60:20:20)	66.87	66.69	66.32	65.96
T ₇ (50:25:25)	66.70	66.61	66.23	65.91
T ₈ (40:30:30)	67.38	67.15	66.85	66.54
SE _m ±	0.11	0.12	0.14	0.10
CD (5%)	0.35	0.37	0.40	0.32

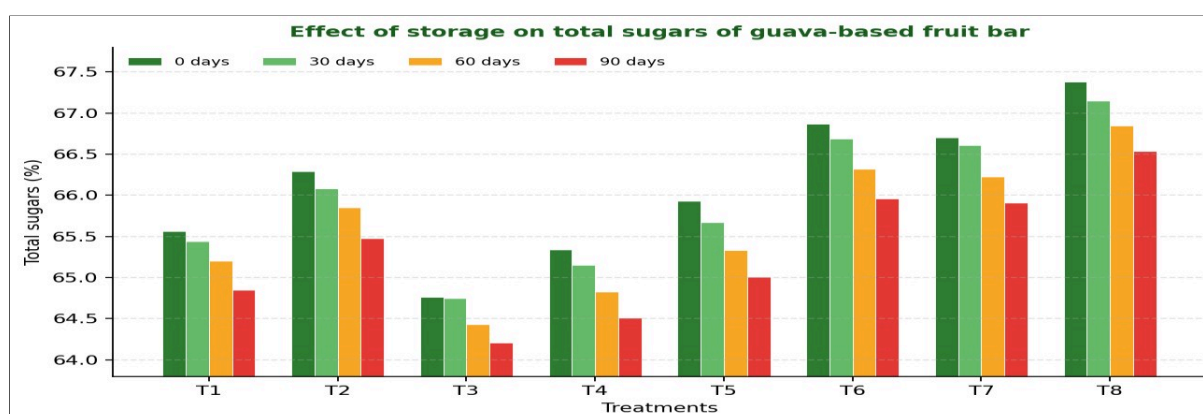


Figure 6. Effect of storage period on total sugars (%) of guava-based fruit bar

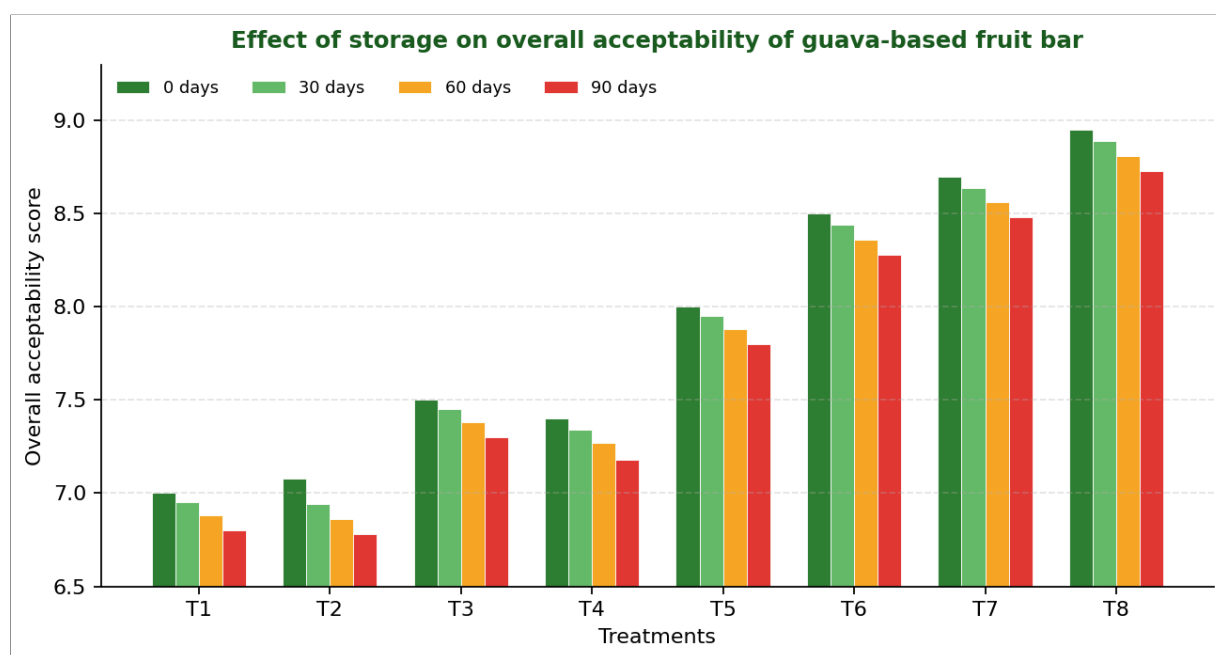
Overall acceptability

Overall acceptability declined slightly with storage but remained in the acceptable range on the 9-point scale (Table 7; Fig. 7). T₈ recorded the highest score at every interval (8.95, 8.89, 8.81 and 8.73). T₇ ranked second (8.70 to 8.48). T₁ declined from 7.00 to 6.80.

The small, parallel decline across treatments is typical of fruit bars stored at ambient temperature and is linked to slow loss of volatiles and slight darkening (Vennilla, 2004; Avhad *et al.*, 2019) [10, 3]. Because the loss was small, the blend that started best (T₈) also finished best. A 90-day ambient shelf life is therefore supported by both chemistry and overall acceptability.

Table 7. Changes in overall acceptability (9-point hedonic scale) during ambient storage

Treatment (G:S:P)	0 days	30 days	60 days	90 days
T ₁ (100:0:0)	7.00	6.95	6.88	6.80
T ₂ (80:20:0)	7.08	6.94	6.86	6.78
T ₃ (80:0:20)	7.50	7.45	7.38	7.30
T ₄ (70:20:10)	7.40	7.34	7.27	7.18
T ₅ (70:10:20)	8.00	7.95	7.88	7.80
T ₆ (60:20:20)	8.50	8.44	8.36	8.28
T ₇ (50:25:25)	8.70	8.64	8.56	8.48
T ₈ (40:30:30)	8.95	8.89	8.81	8.73
SE _m ±	0.08	0.07	0.08	0.08
CD (5%)	0.24	0.21	0.24	0.24

**Figure 7.** Effect of storage period on overall acceptability of guava-based fruit bar

Conclusion

During 90 days of ambient storage, guava-based fruit bar showed a consistent pattern: pH decreased, titratable acidity increased, TSS and reducing sugars increased, and non-reducing sugar, total sugar and overall acceptability decreased. None of these changes made the product unacceptable. T₈ (Guava : Sapota : Papaya = 40 : 30 : 30) recorded the most favourable physicochemical values at every interval and the smallest loss of overall acceptability (8.95 to 8.73). This blend can be stored for 90 days at room temperature without a chemical preservative.

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