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Influence of fruit pulp blending ratios on sensory quality and acceptability of pineapple-apple-mango mixed fruit jam during refrigerated storage

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Abstract
Fruit-pulp blending can improve the sensory appeal of processed horticultural products, although consumer-relevant quality may deteriorate during storage. This investigation assessed the influence of pineapple, apple and mango pulp proportions on the sensory properties of mixed fruit jam. Ten pulp combinations were studied in a completely randomized design with three replications. Six judges assessed colour, appearance, taste, flavour and overall acceptability using a nine-point hedonic scale at 0, 15, 30, 45 and 60 days of refrigerated storage. The equal-proportion formulation T_1 (33.3:33.3:33.3) recorded the highest mean scores for colour (8.34), appearance (8.03), taste (8.23), flavour (8.27) and overall acceptability (8.20). T_7 (30:40:30) and T_{10} (30:30:40) were the next strongest formulations for overall acceptability, with mean scores of 8.14 and 8.06, respectively. All treatments showed declining sensory scores during storage; however, T_1 retained an overall acceptability score of 7.91 at 60 days compared with 8.45 initially. The results support balanced pineapple–apple–mango blending as a promising formulation strategy for maintaining favourable sensory properties of refrigerated mixed fruit jam over the evaluated 60-day period. Microbiological safety and shelf life beyond the study conditions cannot be inferred from sensory scores alone.

Keywords: Apple, Blended Jam, Hedonic Evaluation, Mango Organoleptic Quality, Pineapple, Refrigerated Storage

1. Introduction

Jam is a widely consumed fruit product prepared by cooking fruit pulp with sugar, acid, and pectin to achieve desirable consistency, flavour, and shelf life. It supports fruit preservation, reduces post-harvest losses, and ensures year-round availability. Jam typically contains 67–68% total soluble solids (TSS), while conventional standards generally require approximately 65% or higher, depending on the applicable standard (Baker *et al*., 2005) [1]. Its quality depends on raw materials, ingredient proportions, and processing conditions (Nindo *et al*., 2005) [2]. Mixed-fruit jams may enhance nutritional value and sensory acceptability by combining the attributes of different fruits (Basary *et al.*, 2022) [3].

Pineapple (*Ananas comosus*), a member of the Bromeliaceae family, contains vitamins, minerals, carotenoids, organic acids, and bromelain (Guang, 2016; Linares, 2005). Its high moisture content increases perishability, while its sugars and citric acid contribute to its characteristic flavour (Hossain *et al.*, 2015) [4]. Processing pineapple into jam extends shelf life and minimizes wastage (Chalchisa *et al*., 2022) [5]. Apple (*Malus sylvestris*) belongs to the Rosaceae family and contains flavonoids and polyphenols, particularly in the skin, while its sugar and acid composition favours processing (Nafisah *et al*., 2020; Kanchan *et al*., 2020). Mango (*Mangifera indica* L.) is valued for its sweetness, colour, aroma, and nutritional properties; however, post-harvest losses of 20–30% highlight the importance of processing (Ahmad *et al*., 2018; Shahnawaz *et al*., 2012) [6].

The development of mixed-fruit jam from pineapple, apple, and mango offers a practical approach to utilizing perishable fruits and reducing post-harvest losses. Evaluating its physicochemical characteristics, sensory quality, and storage stability is essential to determine product quality and consumer acceptability.

2. Materials and Methods

2.1 Experimental design and treatments

The study was conducted during 2025–2026 at the Post-Harvest Processing Laboratory, College of Horticulture and Research Station, Sankara-Patan, Durg, Chhattisgarh, India. Fresh pineapple, apple, and mango fruits were procured from local markets and processed into jam. The experiment was laid out in a

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Completely Randomized Design (CRD), comprising 10 treatments with 3 replications each. Jam preparation was standardized to achieve a total soluble solids (TSS) content of 68 °Brix and an acidity level of 0.3%. The prepared jam samples were stored under refrigerated conditions for a period of 60 days. The fruit proportions used in the different treatments are expressed in the order of pineapple: apple: mango.

Treatment	Pineapple : apple: mango pulp ratio
T_1	33.3:33.3:33.3
T_2	80:10:10
T_3	60:20:20
T_4	40:30:30
T_5	10:80:10
T_6	20:60:20
T_7	30:40:30
T_8	10:10:80
T_9	20:20:60
T_{10}	30:30:40

2.2 Sensory evaluation and statistical treatment

Sensory evaluation of the prepared jam samples was conducted by a six-member panel to assess colour, appearance, taste, flavour, and overall acceptability using a nine-point hedonic scale, ranging from 1 (dislike extremely) to 9 (like extremely). Evaluations were performed at 0, 15, 30, 45 and 60 days of refrigerated storage. Sensory scores of 5 or above were considered indicative of acceptability, and the scores obtained were averaged for further analysis. Treatment means, along with their corresponding standard errors of the mean (SEm) and critical differences (CD) at the 5% level of significance, are presented in the supplementary tables. The experimental data were subjected to analysis of variance (ANOVA) following a Completely Randomized Design (CRD). However, the raw data for individual panellists and the detailed statistical model accounting for treatment and storage duration were unavailable for independent reanalysis. In addition, details regarding panellist recruitment, sample blinding and the order of sample presentation require verification from the original experimental records.

3. Results and Discussion

3.1 Colour

Among the five assessment dates, T_1 recorded the highest mean colour score of 8.34, while T_2 exhibited the lowest mean score of 5.77. The mean colour score of the highest-rated formulation declined from 8.63 on day 0 to 8.02 on day 60, representing a reduction of 0.61 hedonic points. A similar decreasing trend in colour scores was observed across the other pulp combinations.

The better performance of the balanced blend indicates that colour acceptability was likely influenced by the combined visual characteristics of the three fruit pulps rather than by the predominance of any single fruit. Storage-associated colour deterioration may be attributed, in part, to oxidation and non-enzymatic browning reactions; however, pigment-related changes were not directly assessed in the sensory analysis. A similar decline in colour during the storage of carrot and apple blended fruit jam was reported by Ullah *et al.* (2018) [7] and Patel *et al.* (2015) [8].

3.2 Appearance

Across the five evaluation dates, T_1 recorded the highest mean appearance score (8.03), while T_2 exhibited the lowest (5.71). The formulation with the highest ranking showed a reduction in its mean appearance score from 8.27 on day 0 to 7.75 on day 60, indicating a decline of 0.52 hedonic points. A similar decreasing trend in appearance scores was observed for the other pulp combinations during storage.

Appearance characteristics are determined by factors such as perceived colour uniformity, visual texture, and overall product presentation. The relatively higher appearance scores recorded for T_1, T_7, and T_{10} indicate that these formulations may have exhibited a more favourable visual balance. Storage-related changes may be associated with biochemical processes, including moisture loss, sugar inversion, pectin and ascorbic acid degradation, and Maillard reactions, as also reported by Ullah *et al.* (2018) [7] and Bukya *et al.* (2018) [9].

3.3 Taste

Across the five evaluation dates, T_1 exhibited the highest mean taste score (8.23), whereas T_2 recorded the lowest (5.57). The formulation with the highest rating showed a decrease in its mean taste score from 8.50 on day 0 to 7.92 on day 60, representing a decline of 0.58 hedonic points. A similar decreasing trend in taste scores was observed across the other pulp combinations during storage.

The balanced formulation received more favourable taste ratings than the combinations dominated by pineapple, apple, or mango pulp. This outcome may be attributed to a more harmonious balance between sweetness and acidity; however, sweetness, sourness, and astringency were not evaluated separately by the sensory panel. A gradual decline in taste scores during storage has also been reported by Patel *et al.* (2015) [8] and Basary *et al.* (2022) [3].

3.4 Flavour

Across the five evaluation dates, T_1 recorded the highest mean flavour score (8.27), while T_2 exhibited the lowest (5.96). The formulation with the highest rating showed a decline in its mean flavour score from 8.58 on day 0 to 7.95 on day 60, corresponding to a reduction of 0.63 hedonic points. A similar downward trend in flavour scores was observed across the other pulp combinations during storage.

Flavour acceptability may be attributed to the combined effects of retronasal aroma and basic taste perceptions. The reduction in flavour scores during storage could be associated with the loss or alteration of volatile aroma compounds; however, this proposed explanation was not confirmed through volatile-compound analysis. Comparable declining trends in flavour scores during jam storage have been reported by Ullah *et al.* (2018) [7] in carrot–apple jam, Ehsan *et al.* (2003) [10] in mixed fruit jam, and Khan *et al.* (2012) [11] in strawberry jam.

3.5 Overall acceptability

Across the five evaluation dates, T_1 recorded the highest mean overall acceptability score (8.20), whereas T_5 exhibited the lowest (6.44). The formulation with the highest rating showed a decrease in its mean overall acceptability score from 8.45 on day 0 to 7.91 on day 60, representing a decline of 0.54 hedonic points. A similar decreasing trend in overall acceptability was observed across the other pulp combinations during storage.

Overall acceptability exhibited a trend consistent with the ratings of the individual sensory attributes. T_1, T_7, and T_{10} maintained the three highest storage-averaged scores, with respective day-60 values of 7.91, 7.82, and 7.80. The reported critical difference at day 60 was 0.23; therefore, these formulations cannot be considered significantly different from one another at this assessment point based on the statistical results presented in the thesis. Nevertheless, T_1 retained the highest numerical ranking throughout the study. These findings are in agreement with the observations reported by Ehsan *et al.* (2003) [10] for mixed fruit jam, Khan *et al.* (2012) [11] for strawberry jam, and Ullah *et al.* (2018) [7].

3.6 Integrated sensory interpretation

The sensory evaluation across the five attributes demonstrated a consistent advantage for the equal-proportion fruit blend. T_1 achieved the highest storage-averaged scores for all five sensory attributes, whereas T_7 and T_{10} also exhibited comparable overall acceptability. These findings suggest that the complementary flavour profiles and visual characteristics of different fruits may enhance the sensory quality of blended jam compared with formulations dominated by a single

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fruit. Although hedonic scores declined during storage, the leading formulations remained within the "like moderately" to "like very much" range after 60 days. However, these results represent sensory panel-based liking scores and should not be considered indicative of population-level consumer preferences without further validation through a larger-scale consumer acceptance study.

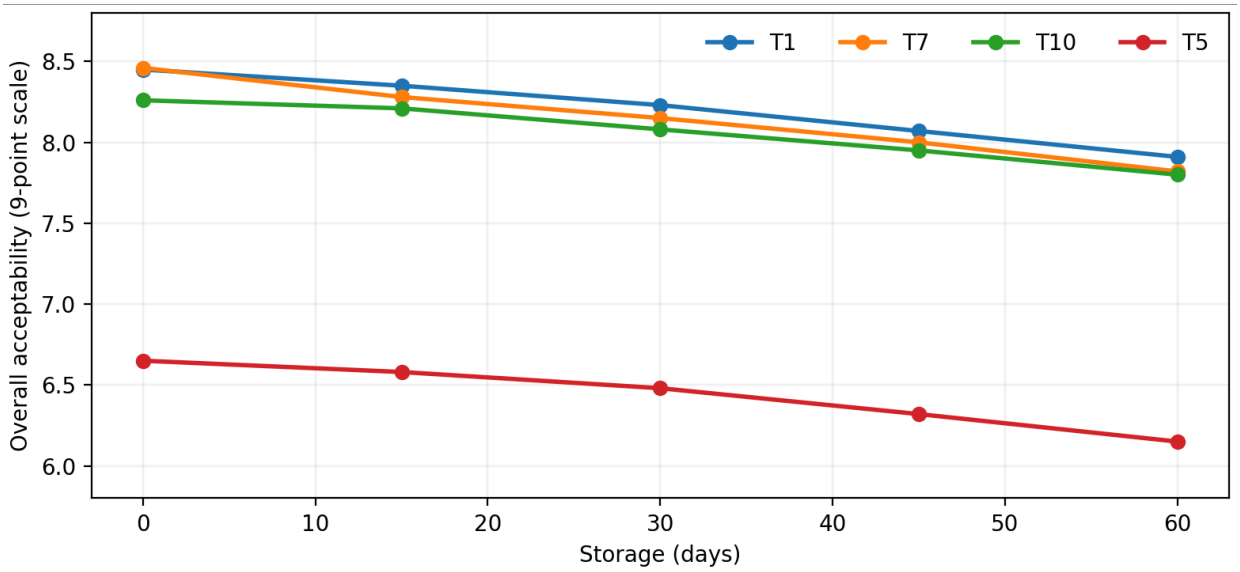


Figure 1. Overall acceptability during storage for selected formulations.

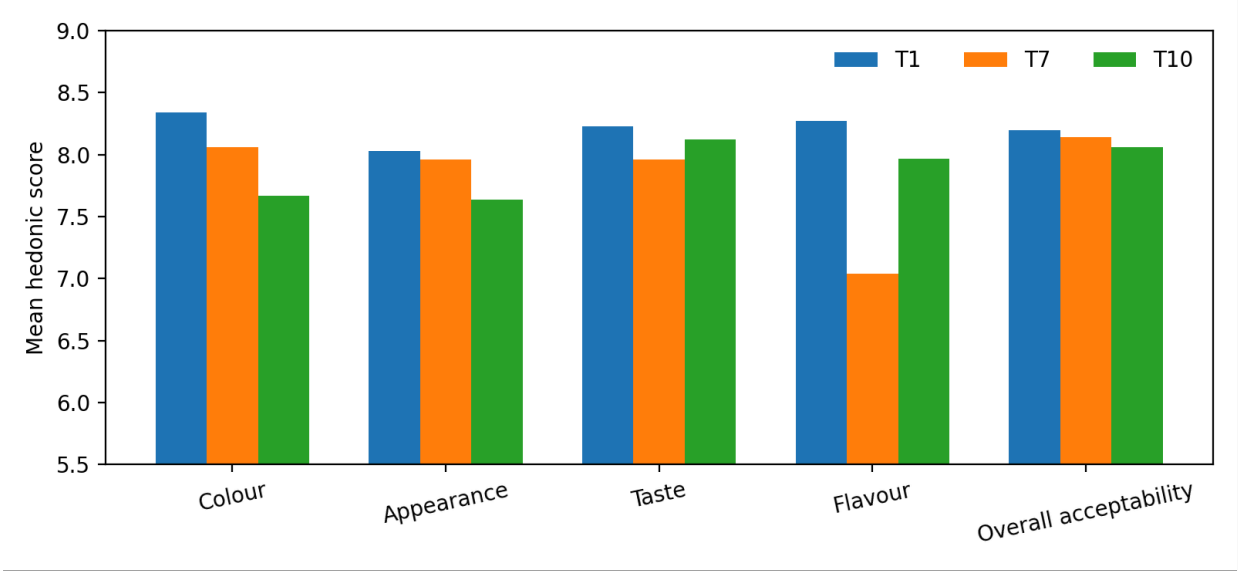


Figure 2. Mean sensory scores across five storage intervals for T_1, T_7 and T_{10}.

4. Conclusion

The relative proportions of pineapple, apple, and mango pulp affected the sensory characteristics of mixed fruit jam during refrigerated storage. Among the formulations evaluated, the balanced blend T_1 (33.3:33.3:33.3) recorded the highest numerical mean scores for colour, appearance, taste, flavour, and overall acceptability, with an average overall acceptability score of 8.20 over the storage period of 0–60 days. Despite a gradual decline in sensory ratings during storage, T_1 maintained an overall acceptability score of 7.91 on day 60. Formulations T_7 and T_{10} also demonstrated favourable sensory performance and were statistically comparable to T_1 in overall acceptability at the final evaluation, based on the reported critical difference. Therefore, the equal-proportion blend may be considered a promising formulation for further consumer acceptance studies, scale-up evaluation, and independent microbiological validation of its shelf life.

Supplementary tables: complete sensory scores

Table 1. Organoleptic evaluation (Colour) of mixed fruit Jam during storage (0 to 60 days).

Treatment	0 d	15 d	30 d	45 d	60 d	Mean
T_1	8.63	8.50	8.35	8.18	8.02	8.34
T_2	6.07	5.92	5.78	5.62	5.45	5.77
T_3	6.08	5.96	5.82	5.65	5.48	5.80
T_4	6.97	6.82	6.68	6.52	6.35	6.67

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Treatment	0 d	15 d	30 d	45 d	60 d	Mean
T_5	6.08	5.94	5.82	5.68	5.52	5.81
T_6	7.05	6.92	6.78	6.62	6.45	6.76
T_7	8.35	8.20	8.08	7.92	7.75	8.06
T_8	6.36	6.22	6.08	5.92	5.78	6.07
T_9	6.66	6.52	6.38	6.22	6.08	6.37
T_{10}	7.97	7.82	7.68	7.52	7.35	7.67
$SE_m \pm$	0.19	0.17	0.14	0.13	0.10	
C.D.(5%)	0.55	0.51	0.42	0.39	0.30	

Table 2. Organoleptic evaluation (Appearance) of mixed fruit Jam during storage (0 to 60 days).

Treatment	0 d	15 d	30 d	45 d	60 d	Mean
T_1	8.27	8.18	8.05	7.90	7.75	8.03
T_2	6.03	5.88	5.72	5.55	5.38	5.71
T_3	6.26	6.14	6.02	5.88	5.72	6.00
T_4	6.81	6.71	6.55	6.40	6.22	6.54
T_5	6.14	6.02	5.92	5.78	5.62	5.90
T_6	7.12	7.01	6.88	6.70	6.52	6.85
T_7	8.28	8.12	7.98	7.82	7.62	7.96
T_8	6.45	6.30	6.18	6.02	5.88	6.17
T_9	6.59	6.42	6.32	6.18	6.02	6.31
T_{10}	7.95	7.82	7.65	7.48	7.32	7.64
$SE_m \pm$	0.21	0.19	0.16	0.14	0.13	
C.D.(5%)	0.61	0.57	0.49	0.43	0.38	

Table 3. Organoleptic evaluation (Taste) of mixed fruit Jam during storage (0 to 60 days).

Treatment	0 d	15 d	30 d	45 d	60 d	Mean
T_1	8.50	8.38	8.25	8.08	7.92	8.23
T_2	5.87	5.72	5.58	5.42	5.25	5.57
T_3	6.20	6.10	5.98	5.82	5.65	5.95
T_4	6.47	6.35	6.22	6.08	5.92	6.21
T_5	5.97	5.82	5.70	5.55	5.38	5.68
T_6	6.36	6.28	6.15	6.02	5.88	6.14
T_7	8.25	8.12	7.98	7.82	7.62	7.96
T_8	6.08	5.95	5.82	5.68	5.52	5.81
T_9	6.13	6.02	5.92	5.80	5.68	5.91
T_{10}	8.39	8.27	8.12	7.98	7.82	8.12
$SE_m \pm$	0.22	0.20	0.17	0.15	0.16	
C.D.(5%)	0.64	0.59	0.49	0.45	0.49	

Table 4. Organoleptic evaluation (Flavour) of mixed fruit Jam during storage (0 to 60 days).

Treatment	0 d	15 d	30 d	45 d	60 d	Mean
T_1	8.58	8.43	8.28	8.12	7.95	8.27
T_2	6.25	6.12	5.98	5.82	5.65	5.96
T_3	6.84	6.70	6.58	6.40	6.20	6.54
T_4	7.25	7.10	6.95	6.80	6.62	6.94
T_5	6.37	6.25	6.12	5.98	5.82	6.11
T_6	6.40	6.30	6.18	6.02	5.88	6.16
T_7	7.27	7.18	7.05	6.92	6.78	7.04
T_8	6.92	6.75	6.58	6.42	6.25	6.58
T_9	7.13	7.02	6.88	6.72	6.55	6.86
T_{10}	8.27	8.15	8.00	7.82	7.62	7.97
$SE_m \pm$	0.14	0.13	0.11	0.07	0.06	
C.D.(5%)	0.43	0.40	0.31	0.22	0.17	

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Table 5. Organoleptic evaluation (Overall acceptability) of mixed fruit Jam during storage (0 to 60 days).

Treatment	0 d	15 d	30 d	45 d	60 d	Mean
T_1	8.45	8.35	8.23	8.07	7.91	8.20
T_2	6.86	6.71	6.58	6.42	6.25	6.56
T_3	6.78	6.66	6.55	6.38	6.22	6.52
T_4	7.29	7.22	7.10	6.95	6.80	7.07
T_5	6.65	6.58	6.48	6.32	6.15	6.44
T_6	7.10	7.02	6.94	6.82	6.68	6.91
T_7	8.46	8.28	8.15	8.00	7.82	8.14
T_8	6.87	6.72	6.62	6.52	6.40	6.63
T_9	7.19	7.12	7.02	6.88	6.72	6.99
T_{10}	8.26	8.21	8.08	7.95	7.80	8.06
$SE_m \pm$	0.10	0.10	0.11	0.09	0.08	
C.D.(5%)	0.30	0.30	0.29	0.28	0.23	

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