

Formulation and Sensory Evaluation of Aloe Vera–Fortified Ready-to-Serve Seasonal Fruit Beverages

Aimen Tariq¹, Azka Tauqeer¹, Rabia Naz^{1*}, Mahrukh Imran¹, Nadia Akram¹

¹Department of Food Science and Human Nutrition, Kinnaird College for Women, Lahore, Pakistan

*Corresponding author: rabia.naz@kinnaird.edu.pk

Received: 18 January 2026

Revised: 23 February 2026

Accepted: 11 March 2026

Published: 19 March 2026

FIFS | Volume 1 • Issue 1 • 2026

DOI: <https://doi.org/10.66558/fifs.2026.1.2>



ABSTRACT

Aloe vera gel has attracted interest as an ingredient in value-added beverages; however, its characteristic flavour can influence consumer acceptance when incorporated at higher concentrations. This study developed ready-to-serve (RTS) beverages by blending Aloe vera gel with four seasonal fruits mango, peach, orange, and guava—and evaluated the effect of different Aloe vera levels on sensory acceptability. Four formulations containing 0, 10, 20, and 30% Aloe vera gel were prepared for each fruit beverage. Sensory characteristics, including taste, flavour, aroma, colour, viscosity, and appearance, were evaluated by trained and untrained panellists using a 9-point hedonic scale. The sensory data were summarized as mean $\pm$ standard deviation and analysed using analysis of variance. All Aloe vera-containing formulations showed acceptable sensory characteristics, although the preferred incorporation level differed among fruit types. Beverages containing 10% Aloe vera gel showed the greatest overall acceptability for mango, peach, and orange formulations, whereas 20% Aloe vera gel was preferred in the guava beverage. Across the beverages, sweetness, fresh or fruity flavour and aroma, bright colour, and desirable appearance contributed positively to sensory perception. The findings indicate that moderate incorporation of Aloe vera gel can be used in the development of acceptable RTS fruit beverages, while the optimum concentration depends on the sensory characteristics of the accompanying fruit. Further work incorporating physicochemical, nutritional, microbiological, and storage-stability assessments would be valuable before commercial application.



KEYWORDS: Aloe vera; ready-to-serve beverages; seasonal fruits; sensory evaluation; consumer acceptability; mango; peach; orange; guava

1. INTRODUCTION

Healthy eating is considered one of the most important factors for maintaining good nutritional status and overall health. A balanced diet contributes to reducing the risk of several chronic diseases, including diabetes, cardiovascular diseases, stroke, hypertension, dental caries, and certain cancers. Adequate nutrition also plays an important role in the cognitive development and healthy growth of children and young people. Dietary guidelines consistently emphasize that fruits and vegetables should form an important part of a healthy diet (Devirgiliis et al., 2024).

Fruits and vegetables provide a wide range of biologically active nutrients that contribute to the maintenance of general health and may help reduce the risk of chronic diseases. In the food and health industry, fruit- and vegetable-based beverages have gained considerable popularity. These beverages can contribute to hydration and provide nutrients such as vitamins, minerals, carbohydrates, and other bioactive compounds when consumed as part of a balanced diet. Fruit drinks are also widely consumed because of their convenience, taste, refreshment, and suitability for different social and dietary occasions. Citrus and other fruit juices can be important dietary sources of nutrients and phytochemicals (Dhuique-Mayer & Servent, 2025).

Ready-to-serve (RTS) fruit drinks are beverages prepared at a suitable concentration for direct consumption without further dilution. They may contain fruit juice, pulp, soluble solids, and other ingredients depending on the formulation. RTS beverages are valued for their convenience and can provide vitamins, minerals, and other fruit-derived constituents (Lebaka et al., 2021). Unlike concentrated beverages that require dilution before consumption, RTS drinks are consumed directly after opening. Their convenience and diversity of flavours have contributed to their popularity in the beverage market.

COPYRIGHT & LICENCE

© 2026 The Author(s). Published by Scientific Scholarly Publishing. This is an open-access article distributed under the Creative Commons Attribution 4.0 International License (CC BY 4.0)

Fruit-based beverages are consumed by different age groups and have increasingly been explored as carriers of functional ingredients. Depending on the formulation, beverages may contain vitamins, minerals, antioxidants, plant extracts, probiotics, prebiotics, dietary fibre, and other bioactive components. This versatility has supported growing interest in the development of functional and value-added fruit beverages.

Among plant-based ingredients used in functional beverages, Aloe vera has received considerable attention. Aloe vera is a succulent plant that has been used traditionally for various medicinal and food-related purposes (Njoroge et al., 2025). The inner gel is composed predominantly of water and also contains carbohydrates, minerals, proteins, lipids, and other phytochemical constituents. Because of its composition and reported biological activities, Aloe vera has increasingly been investigated as an ingredient in functional foods and beverages (Abid et al., 2025).

Aloe vera-based beverages have attracted interest because of their potential functional properties and suitability for incorporation into different food formulations. Some studies have investigated the effects of Aloe vera preparations on metabolic and physiological parameters, including blood glucose regulation, although such effects depend on the type of preparation, dose, and study design (Moselhy et al., 2024). Aloe vera has also been associated with anti-inflammatory, wound-healing, anti-ulcer, and antioxidant activities in experimental and clinical research (Abid et al., 2025; Fernandes et al., 2020). However, these biological effects should not be interpreted as direct health benefits of every Aloe vera-containing beverage, as beverage formulation and processing may influence the concentration and availability of its bioactive constituents.

Consumer acceptance is an important consideration in the development of Aloe vera-based beverages. Although Aloe vera can contribute functional value, its characteristic flavour and possible bitterness may affect product acceptability when used at higher concentrations. Therefore, blending Aloe vera gel with fruit juices may provide an effective approach for improving flavour, aroma, colour, and overall sensory appeal. The sensory characteristics of the final beverage are likely to depend on both the proportion of Aloe vera used and the type of fruit incorporated.

2. Materials and Methods

2.1. Raw Materials

Fresh *Aloe vera* leaves and seasonal fruits were obtained from local sources in Lahore, Pakistan. Mango and peach were selected as summer fruits, whereas orange and guava were selected as winter fruits. The principal raw materials used for beverage preparation were *Aloe vera* gel and the respective fruits. Other ingredients, including water, sugar, honey, lemon, black salt, and cinnamon, were purchased from the local market and used during beverage formulation.

2.2. Preparation of Aloe vera Gel

Fresh, green, turgid, and visually undamaged Aloe vera leaves were selected and thoroughly washed with clean water to remove adhering dirt and surface contaminants. Approximately 1.5 inches were removed from both ends of each leaf using a clean stainless-steel knife. The leaves were then cut longitudinally into two halves, and the inner gel was carefully separated from the outer green rind. The recovered gel was thoroughly washed to minimize residual aloin and other latex-derived components before its incorporation into the beverages. This procedure was performed carefully to obtain a clean gel fraction while minimizing contamination from the outer leaf tissues.

2.3. Preparation of Fruit Juices

Fully ripened mangoes, peaches, oranges, and guavas were selected for beverage preparation. The fruits were thoroughly washed with clean tap water, and the peel, seeds, and other inedible portions were removed manually, where applicable. The edible portions were cut into small pieces and processed using an electric mixer-grinder to obtain a homogeneous juice or pulp. Orange juice was additionally passed through a strainer to remove coarse pulp and other solid particles.

2.4. Development of Ready-to-Serve Beverages

Four types of ready-to-serve (RTS) beverages were developed by blending Aloe vera gel with mango, peach, orange, or guava. These fruits were selected based on their seasonal availability and suitability for beverage formulation. Similar approaches involving Aloe vera and other plant ingredients in functional beverages have previously been reported (Kausar et al., 2020; Njoroge et al., 2025; Vijetha et al., 2021). For each fruit beverage, four formulations were prepared with different proportions of fruit and Aloe vera gel: 100:0 (T1), 90:10 (T2), 80:20 (T3), and 70:30 (T4), corresponding to 0, 10, 20, and 30% Aloe vera gel, respectively. These are the treatment ratios reported in the original experimental dataset (Table 1).

The prepared fruit portions and Aloe vera gel were blended using an electric mixer-grinder until a uniform beverage was obtained, following the general beverage-development approach described previously (Udaya Kumar et al., 2022; Haque et al., 2022). Water, sugar, honey, lemon, black salt, and cinnamon were incorporated as formulation ingredients to improve palatability and overall sensory characteristics. The same general preparation procedure was followed for the mango, peach, orange, and guava beverages.

Table 1. Formulation of Aloe vera-fortified ready-to-serve fruit beverages.

Treatment	Fruit (%)	Aloe vera gel (%)
T1	100	0
T2	90	10
T3	80	20
T4	70	30

Treatments represent the proportion of fruit and Aloe vera gel used in each ready-to-serve beverage formulation.

2.5. Sensory Evaluation

Sensory evaluation was conducted to determine the sensory characteristics and acceptability of the developed RTS beverages. Both trained and untrained panellists participated in the evaluation. The sensory attributes assessed were taste, flavour, aroma, colour, viscosity, and appearance, consistent with the original experimental design.

The beverages containing different concentrations of *Aloe vera* gel were presented to the panellists for evaluation using a nine-point hedonic scale, an established approach for assessing the degree of liking or disliking of food products (Thaksala et al., 2022; Addo-Preko et al., 2023). Panellists assessed the relevant sensory descriptors associated with each major attribute, including bitterness, sweetness, sourness and metallic taste; acidic, fresh and fruity flavour; syrup-sweet, fresh and fruity aroma; brightness, dullness and browning of colour; consistency and flowability; and foamy and colourful appearance. These descriptors correspond to those recorded in the original sensory dataset. For example, the guava beverage dataset reports separate trained and untrained panel scores for these individual attributes.

Sensory scores were recorded separately for trained and untrained panellists to allow comparison of product perception between the two groups. The resulting data were used to characterize the sensory profiles of the four fruit-based beverages and to determine the most acceptable level of *Aloe vera* incorporation.

2.6. Statistical Analysis

The sensory data were compiled and expressed as mean $\pm$ standard deviation (SD). Statistical analysis was performed using SPSS version 24. Analysis of variance (ANOVA) was applied to evaluate differences among the beverage formulations containing different proportions of *Aloe vera* gel, consistent with the statistical procedure reported for the original experiment. The trained- and untrained-panel evaluations were considered separately when interpreting the sensory responses. Mean sensory scores were used to compare the formulations and identify differences in the acceptability and sensory profiles of the developed beverages.

3. Results and Discussion

3.1. Sensory Characteristics of Aloe vera–Guava Beverage

The sensory evaluation of the *Aloe vera*–guava beverage demonstrated generally favourable responses for several positive sensory attributes, although differences were observed between trained and untrained panellists. Among the taste attributes, sweetness received the highest mean score, with values of 6.54 ± 1.14 for trained panellists and 6.05 ± 1.17 for untrained panellists. In contrast, bitterness, sourness, and metallic taste received comparatively low scores (Table 2). These findings indicate that the fruit matrix was able to maintain a predominantly sweet sensory profile despite the incorporation of *Aloe vera*.

Freshness and fruitiness were particularly prominent in the flavour and aroma profiles. Trained panellists recorded scores of 6.82 ± 0.91 and 7.00 ± 0.90 for fresh and fruity flavour, respectively, while the corresponding scores from untrained panellists were 6.33 ± 1.40 and 6.11 ± 1.32 . Fresh aroma was similarly rated favourably, reaching 7.07 ± 0.90 among trained panellists. Colour was another positively perceived characteristic, with brightness receiving scores of 7.11 ± 0.69 and 7.06 ± 0.97 from trained and untrained panellists, respectively. Conversely, dullness and browning received relatively low scores, suggesting that the beverage retained desirable visual characteristics.

Viscosity also contributed positively to the sensory profile. Consistency received the highest individual score among trained panellists (7.68 ± 0.72), while flowability was rated 7.43 ± 0.88 . Untrained panellists also gave relatively high scores for consistency (6.66 ± 0.84) and flowability (6.81 ± 0.78). Overall, these results suggest that the guava-based formulation provided an appropriate matrix for incorporating *Aloe vera* while maintaining desirable sweetness, freshness, colour, and mouthfeel. Importantly, the formulation containing 20% *Aloe vera* (T3) was identified as the most acceptable guava formulation, whereas 10% *Aloe vera* was preferred for the other three fruit beverages. This indicates that the optimum level of *Aloe vera* incorporation may depend strongly on the accompanying fruit matrix rather than following a single concentration across different beverages.

This observation is consistent with recent research showing that formulation strongly influences the sensory acceptance of *Aloe vera*-containing beverages. Njoroge et al. (2025) reported that an unsweetened *Aloe vera*-based functional beverage had substantially lower taste acceptance than sweetened formulations, highlighting the importance of balancing the characteristic flavour of *Aloe vera* with other ingredients. Similarly, recent work on *Aloe vera*-enriched beverages has demonstrated that the optimum inclusion level depends on the surrounding food matrix. For example, a 2025 study of *Aloe vera*-enriched flavoured whey beverages found 15% *Aloe vera* to provide the most desirable sensory quality without adversely affecting physicochemical characteristics.

The comparatively low bitterness scores observed in the present guava beverage are particularly relevant because bitterness represents an important limitation in the development of *Aloe vera*-based beverages. Recent studies have similarly reported that combining *Aloe vera* with other plant or fruit ingredients can improve sensory characteristics by moderating undesirable flavour notes. Thus, the favourable sweetness, freshness, brightness, and viscosity scores observed for the guava beverage suggest that guava may provide a suitable sensory matrix for moderate incorporation of *Aloe vera* gel.

However, these results should be interpreted primarily as sensory findings. Physicochemical composition, antioxidant activity, microbiological stability, and storage behaviour were not measured in the present experiment; therefore, improved sensory scores should not be interpreted as evidence of enhanced nutritional functionality or shelf life.

3.2. Sensory Characteristics of *Aloe vera*–Orange Beverage

The sensory evaluation of the *Aloe vera*–orange beverage showed generally favourable responses for taste, flavour, aroma, colour, viscosity, and appearance. Among the taste attributes, sweetness was rated positively by both trained and untrained panellists, whereas bitterness, sourness, and metallic taste received comparatively lower scores. This pattern suggests that the characteristic sweetness and acidity of orange provided a suitable sensory background for the incorporation of *Aloe vera* gel.

The flavour and aroma characteristics were particularly well perceived. Fruity and fresh notes received relatively high scores, indicating that the characteristic citrus profile remained evident following the incorporation of *Aloe vera*. Fruity aroma received mean scores of 7.68 ± 0.72 and 7.19 ± 0.72 from trained and untrained panellists, respectively. The favourable perception of fruit-associated aroma is important because the intrinsic flavour of *Aloe vera* can become a limitation when incorporated into beverages at higher concentrations.

Colour and appearance were also among the strongest sensory characteristics of the orange beverage. Brightness received scores of 7.93 ± 0.60 and 7.23 ± 1.05 from trained and untrained panellists, respectively, while colourful appearance was rated 7.54 ± 0.92 and 7.52 ± 0.89 , respectively. In contrast, undesirable visual attributes such as dullness and browning were rated comparatively low. These findings indicate that the orange formulation maintained an appealing visual profile, which is an important component of consumer perception of fruit-based beverages. The viscosity-related attributes also indicated acceptable consistency and flowability. Overall, the combination of favourable colour, fruity aroma, flavour, and appearance suggests that orange provided an appropriate sensory matrix for *Aloe vera* incorporation. Among the tested formulations, T2 containing 10% *Aloe vera* gel was identified as the most acceptable orange beverage, indicating that moderate incorporation was preferable to higher inclusion levels in this fruit matrix.

The present findings are supported by previous research specifically involving orange and *Aloe vera*. Moselhy et al. (2024) reported that orange contributed positively to the taste and flavour of mixed juices containing *Aloe vera*, and their optimized formulation contained 75% orange juice, 20% carrot juice, and 5% *Aloe vera* gel. Earlier work on orange–*Aloe vera* RTS beverages similarly found that relatively low *Aloe vera* incorporation produced better sensory acceptance, whereas further increases reduced sensory scores. This supports the present observation that 10% rather than 20 or 30% *Aloe vera* was preferred in the orange formulation.

Recent studies using other beverage matrices show a similar formulation-dependent response. Njoroge et al. (2025) demonstrated that the sensory acceptability of *Aloe vera*-based beverages depended substantially on formulation and that sweetened formulations were better accepted than the unsweetened beverage. Likewise, a 2024 study developing ready-to-drink *Aloe vera* beverages with ginger and lemon found differences in sensory and quality characteristics among formulations, further demonstrating that the surrounding ingredients play an important role in determining the acceptability of *Aloe vera*-containing beverages.

Taken together, the results indicate that orange can effectively complement the sensory characteristics of *Aloe vera*, particularly with respect to aroma, brightness, and appearance. However, the preference for the 10% *Aloe vera* formulation (T2) also suggests that increasing *Aloe vera* concentration does not necessarily improve sensory quality. Rather, an appropriate balance between the fruit and *Aloe vera* components appears necessary to maintain desirable sensory characteristics.

Table 2. Sensory characteristics of Aloe vera-guava and Aloe vera-orange ready-to-serve beverages evaluated by trained and untrained panelists.

Sensory attribute	Descriptor	Guava		Orange	
		Trained	Untrained	Trained	Untrained
Taste	Bitter	1.71 ± 0.90	2.31 ± 1.19	1.93 ± 0.77	2.02 ± 1.16
	Sweet	6.54 ± 1.14	6.05 ± 1.17	5.82 ± 1.28	6.78 ± 1.30
	Sour	1.54 ± 0.64	1.60 ± 0.66	5.29 ± 1.61	3.85 ± 1.80
	Metallic	1.61 ± 0.74	1.65 ± 0.77	1.46 ± 0.58	1.86 ± 0.84
Flavor	Acidic	1.89 ± 0.69	1.69 ± 0.72	2.43 ± 0.88	3.35 ± 1.94
	Fresh	6.82 ± 0.91	6.33 ± 1.40	6.96 ± 0.96	6.84 ± 0.89
	Fruity	7.00 ± 0.90	6.11 ± 1.32	7.54 ± 0.69	6.85 ± 1.21
Aroma	Syrup-sweet	6.54 ± 1.10	5.98 ± 1.08	6.86 ± 1.04	6.77 ± 0.99
	Fresh	7.07 ± 0.90	6.32 ± 1.19	7.07 ± 0.86	7.26 ± 0.79
	Fruity	7.04 ± 0.84	6.02 ± 1.29	7.68 ± 0.72	7.19 ± 0.72
Color	Bright	7.11 ± 0.69	7.06 ± 0.97	7.93 ± 0.60	7.23 ± 1.05
	Dull	1.57 ± 0.69	1.94 ± 0.91	1.46 ± 0.58	1.37 ± 0.53
	Browning	1.50 ± 0.64	2.28 ± 1.39	1.32 ± 0.48	1.54 ± 0.73
Viscosity	Consistency	7.68 ± 0.72	6.66 ± 0.83	4.96 ± 2.12	4.70 ± 1.75
	Flowable	7.43 ± 0.88	6.81 ± 0.78	4.25 ± 1.18	5.48 ± 2.06
Appearance	Foamy	6.82 ± 1.09	6.10 ± 1.01	5.50 ± 1.23	2.39 ± 0.99
	Colorful	7.00 ± 0.77	6.51 ± 1.27	7.54 ± 0.69	7.52 ± 0.75

Values are mean ± SD. Sensory evaluation was conducted using a 9-point hedonic scale. Trained and untrained panelists were evaluated separately.

3.3. Sensory Characteristics of Aloe vera–Mango Beverage

The sensory evaluation of the *Aloe vera*–mango beverage indicated generally favourable responses for sweetness, fresh and fruity characteristics, colour, viscosity, and appearance. Among the taste attributes, sweetness received mean scores of 6.71 ± 0.98 and 6.56 ± 1.27 from trained and untrained panellists, respectively. In comparison, undesirable taste characteristics such as bitterness and metallic taste received relatively lower scores. This suggests that the naturally distinctive sensory profile of mango was compatible with moderate incorporation of *Aloe vera* gel (Table 3).

The flavour and aroma attributes also contributed positively to the sensory profile of the beverage. Fresh and fruity characteristics were favourably perceived by both groups of panellists, indicating that the characteristic mango profile remained noticeable in the blended beverage. This is particularly relevant for *Aloe vera*-based products because increasing *Aloe vera* concentration can introduce less desirable flavour characteristics and consequently reduce consumer acceptance. Colour was one of the strongest sensory attributes of the mango beverage. Brightness received scores of 7.54 ± 0.64 and 7.34 ± 0.99 from trained and untrained panellists, respectively. Colourful appearance was similarly rated favourably, with scores of 7.04 ± 0.95 and 7.38 ± 0.84 , respectively. The favourable colour and appearance scores indicate that incorporation of *Aloe vera* at the tested levels did not prevent the beverage from maintaining desirable visual characteristics.

Among the four formulations, T2 containing 10% *Aloe vera* gel and 90% mango was identified as the most acceptable mango formulation. This indicates that relatively moderate *Aloe vera* incorporation provided a better sensory balance than the formulations containing 20 or 30% *Aloe vera*. The result is particularly interesting because the same 10% incorporation level was preferred for peach and orange, whereas the guava beverage showed greater acceptability at 20% *Aloe vera*.

The present findings agree well with recent research specifically examining *Aloe vera* and mango combinations. Jamil et al. (2025) developed an instant beverage mix containing different proportions of *Aloe vera* gel powder and mango powder and found that formulations containing balanced proportions of the two ingredients showed better sensory acceptance. Importantly, increasing *Aloe vera* progressively reduced flavour scores, with the 100% *Aloe vera* formulation receiving the lowest sensory ratings. The authors identified formulations containing approximately 10–15% *Aloe vera* as favourable options based on the combined sensory characteristics.

The agreement between that recent study and the present findings is notable despite differences in product type. Jamil et al. (2025) investigated a powdered instant beverage, whereas the present study used fresh *Aloe vera* gel in an RTS fruit beverage. Nevertheless, both studies indicate that moderate incorporation can provide a more favourable balance between mango and *Aloe vera* than higher concentrations. Earlier research on *Aloe vera*–mango RTS beverages has similarly reported that the sensory quality of the product depends strongly on the proportion of *Aloe vera* incorporated.

Overall, the findings demonstrate that mango is a suitable fruit matrix for the development of an *Aloe vera*-containing RTS beverage, particularly at the 10% incorporation level. The favourable sweetness, brightness, appearance, and other fruit-associated sensory characteristics observed in the present study support this formulation from a sensory perspective. However, these findings relate specifically to sensory quality; nutritional composition, antioxidant activity, physicochemical characteristics, microbial stability, and shelf life were not determined and therefore should not be inferred from the sensory results.

Table 3. Sensory characteristics of Aloe vera-mango and Aloe vera-peach ready-to-serve beverages evaluated by trained and untrained panelists.

Sensory attribute	Descriptor	Mango		Peach	
		Trained	Untrained	Trained	Untrained
Taste	Bitter	1.82 ± 0.98	1.95 ± 1.03	2.20 ± 1.48	2.45 ± 1.11
	Sweet	6.71 ± 0.98	6.56 ± 1.27	6.14 ± 1.18	5.56 ± 0.79
	Sour	1.29 ± 0.54	1.40 ± 0.60	1.25 ± 0.44	1.90 ± 0.72
	Metallic	1.75 ± 0.70	1.95 ± 0.98	1.79 ± 0.79	2.31 ± 0.86
Flavor	Acidic	1.36 ± 0.49	1.58 ± 0.68	1.21 ± 0.42	1.70 ± 0.68
	Fresh	6.96 ± 0.84	6.77 ± 1.29	6.21 ± 0.92	6.29 ± 0.99
	Fruity	6.79 ± 0.88	6.80 ± 0.82	6.29 ± 0.98	6.05 ± 1.35
Aroma	Syrup-sweet	6.54 ± 0.92	6.84 ± 1.11	5.82 ± 0.86	5.85 ± 1.25
	Fresh	6.79 ± 0.88	6.59 ± 1.07	6.68 ± 0.55	6.20 ± 1.11
	Fruity	6.75 ± 0.89	6.56 ± 1.00	6.46 ± 0.51	6.38 ± 0.93
Color	Bright	7.54 ± 0.64	7.34 ± 0.99	6.68 ± 0.72	7.16 ± 0.63
	Dull	1.64 ± 0.73	1.60 ± 0.73	1.79 ± 0.69	2.04 ± 0.56
	Browning	1.39 ± 0.63	1.51 ± 0.66	1.36 ± 0.49	1.41 ± 0.49
Viscosity	Consistency	3.68 ± 1.25	3.50 ± 1.72	3.50 ± 1.00	3.41 ± 1.18
	Flowable	7.04 ± 0.51	6.22 ± 1.02	6.43 ± 0.92	6.99 ± 0.97
Appearance	Foamy	6.54 ± 0.84	6.07 ± 0.96	5.89 ± 1.07	6.31 ± 1.27
	Colorful	7.04 ± 0.64	7.38 ± 0.84	7.04 ± 0.64	7.22 ± 0.59

Values are mean ± SD. Sensory evaluation was conducted using a 9-point hedonic scale. Trained and untrained panelists were evaluated separately.

3.4. Sensory Characteristics of Aloe vera–Peach Beverage

The sensory evaluation of the *Aloe vera*–peach beverage showed acceptable responses across the evaluated taste, flavour, aroma, colour, viscosity, and appearance attributes. Among the taste characteristics, sweetness received mean scores of 6.14 ± 1.18 and 5.56 ± 0.79 from trained and untrained panellists, respectively. In comparison, undesirable attributes such as bitterness and metallic taste were rated relatively lower. These findings suggest that peach provided an acceptable sensory base for the incorporation of *Aloe vera*, although sweetness was perceived somewhat less strongly than in the mango beverage.

The flavour and aroma profiles further contributed to the overall sensory characteristics of the beverage. Fresh and fruity attributes were favourably perceived, while undesirable sensory characteristics remained comparatively less prominent. The balance between the characteristic peach flavour and the sensory properties introduced by *Aloe vera* is particularly important because excessive incorporation of *Aloe vera* may adversely affect palatability.

Visual characteristics were among the more positively perceived attributes. Bright colour received scores of 6.68 ± 0.72 and 7.16 ± 0.63 from trained and untrained panellists, respectively. Similarly, colourful appearance was rated 7.04 ± 0.64 by trained panellists and 7.22 ± 0.59 by untrained panellists. These relatively high scores indicate that the peach beverage

maintained an attractive visual profile following the incorporation of *Aloe vera*. The differences between trained and untrained panellists also demonstrate the value of including both groups when characterizing the sensory profile of newly developed beverages.

Among the tested formulations, T2, containing 90% peach and 10% *Aloe vera* gel, showed the greatest overall acceptability. Higher *Aloe vera* incorporation levels of 20 and 30% were comparatively less preferred. This result follows the same general pattern observed for the mango and orange beverages, for which T2 was also the preferred formulation, whereas the guava beverage showed the highest acceptability at 20% *Aloe vera* (T3).

The preference for a moderate *Aloe vera* concentration is consistent with recent beverage-development studies demonstrating that sensory acceptability is highly dependent on the level of *Aloe vera* and the ingredients with which it is combined. Njoroge et al. (2025), for example, demonstrated significant formulation-dependent differences in the sensory characteristics of *Aloe vera*-based beverages containing moringa and baobab, with flavour modification through sweetening substantially improving taste acceptance. Likewise, recent research on *Aloe vera*-enriched flavoured whey beverages found that an intermediate incorporation level provided the most favourable sensory characteristics rather than the highest *Aloe vera* concentration.

The preference for T2 in the present peach beverage may therefore reflect a more favourable balance between the characteristic sensory properties of peach and those contributed by *Aloe vera*. However, this interpretation should remain cautious because the present experiment did not quantify individual flavour compounds, sugars, organic acids, or volatile constituents. Consequently, the sensory differences observed among formulations cannot be attributed to specific chemical components without additional analytical evidence.

Overall, the results demonstrate that *Aloe vera* gel can be incorporated into peach-based RTS beverages while maintaining acceptable sensory characteristics, with 10% *Aloe vera* (T2) providing the most favourable sensory response among the tested formulations. Taken together with the results for mango, orange, and guava, the findings further demonstrate that the preferred *Aloe vera* concentration is fruit-matrix dependent, supporting the need to optimize the incorporation level separately for different fruit beverages.

3.5. Overall Comparison of the Developed RTS Beverages

Across the four fruit beverages, the comparative profiles of selected positive sensory descriptors showed generally favorable scores for sweetness, fresh and fruity flavour and aroma, brightness, flowability, and colourful appearance (Figure 1).

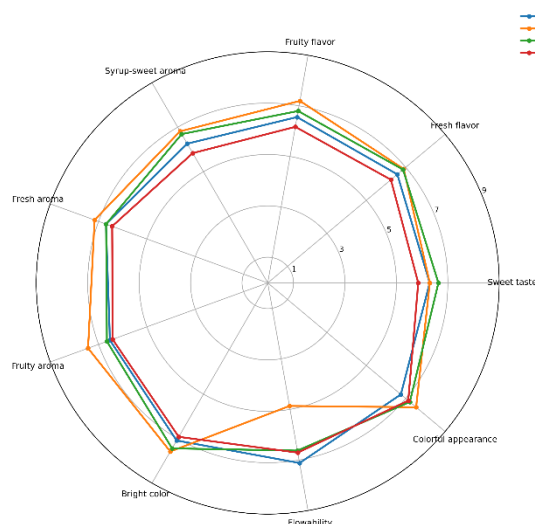


Figure 1. Comparative sensory profiles of *Aloe vera*–fruit ready-to-serve beverages based on selected positive sensory descriptors.

Values represent the average of trained and untrained panel mean scores for selected positive sensory descriptors.

Across the sensory profiles, desirable characteristics such as sweetness, fresh and fruity flavour and aroma, brightness, consistency, flowability, and colourful appearance generally contributed positively to product perception. At the same time, the results indicate that increasing *Aloe vera* concentration beyond the preferred level did not necessarily improve sensory acceptability. The fruit matrix therefore appears to play an important role in determining how much *Aloe vera* can be incorporated while retaining desirable sensory properties.

These findings provide a useful basis for the formulation of *Aloe vera*–fruit RTS beverages. Nevertheless, the present study was restricted to sensory evaluation. Future studies should therefore characterize the optimized formulations for pH, total

soluble solids, titratable acidity, colour, viscosity, nutritional and phytochemical composition, antioxidant properties, microbial quality, and storage stability. Such analyses would be necessary before making conclusions regarding nutritional functionality, shelf life, or commercial applicability.

Conclusion

This study demonstrated the feasibility of incorporating *Aloe vera* gel into ready-to-serve beverages prepared from four seasonal fruits mango, peach, orange, and guava. Sensory evaluation by trained and untrained panellists showed that all developed beverages were acceptable; however, the preferred level of *Aloe vera* varied according to the fruit matrix. The formulation containing 10% *Aloe vera* gel (T2) showed the greatest overall acceptability for mango, peach, and orange beverages, whereas 20% *Aloe vera* gel (T3) was preferred for the guava beverage. Overall, desirable sensory characteristics, particularly sweetness, fresh and fruity flavour and aroma, bright colour, appropriate consistency, and attractive appearance, contributed to the acceptability of the developed beverages. The findings indicate that moderate incorporation of *Aloe vera* gel can be successfully used in fruit-based RTS beverages, although the optimum incorporation level depends on the accompanying fruit. Further studies should evaluate the optimized formulations for physicochemical properties, nutritional and phytochemical composition, antioxidant activity, microbial quality, and storage stability to determine their potential for commercial application.

Author Contributions: Aimen Tariq: Conceptualization, investigation, data analysis, and writing – original draft; Azka Tauqeer: Investigation, data collection, and writing; Rabia Naz: Conceptualization, supervision, validation, and writing – review and editing; Mahrukh Imran: Data curation, analysis, and review; Nadia Akram: Methodology, validation, and review. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

- Abid, A., Javed, M., Zafar, S., Hamdani, S. A. Z., Shah, S. H. B. U., Abid, J., & Ahmad, A. M. R. (2025). The green healer: An updated review on the phytochemical profile and therapeutic potential of *Aloe vera*. *Frontiers in Nutrition*, 12, 1689700. <https://doi.org/10.3389/fnut.2025.1689700>
- Addo-Preko, E., Amissah, J. G. N., & Adjei, M. Y. B. (2023). The relevance of the number of categories in the hedonic scale to the Ghanaian consumer in acceptance testing. *Frontiers in Food Science and Technology*, 3, 1071216. <https://doi.org/10.3389/frfst.2023.1071216>
- Alam, S., Ahiduzzaman, M., Islam, M. N., Haque, M. A., & Akanda, M. A. M. (2022). Formulation and senso-chemical evaluation of *Aloe vera* (*Aloe barbadensis* Miller) based value added beverages. *Annals of Bangladesh Agriculture*, 25(1), 43–54. <https://doi.org/10.3329/aba.v25i1.58154>
- Devirgiliis, C., Guberti, E., Mistura, L., & Raffo, A. (2024). Effect of fruit and vegetable consumption on human health: An update of the literature. *Foods*, 13(19), 3149. <https://doi.org/10.3390/foods13193149>
- Dhuique-Mayer, C., & Servent, A. (2025). An overview of the nutritional quality and health benefits linked to the world diversity of citrus fruits/juices. *Journal of Food Science*, 90, e17576. <https://doi.org/10.1111/1750-3841.17576>
- Fernandes, F. A., Caroch, M., Heleno, S. A., Rodrigues, P., Dias, M. I., Pinela, J., Prieto, M. A., Simal-Gandara, J., Barros, L., & Ferreira, I. C. F. R. (2020). Effect of natural preservatives on the nutritional profile, chemical composition, bioactivity and stability of a nutraceutical preparation of *Aloe arborescens*. *Antioxidants*, 9(4), 281. <https://doi.org/10.3390/antiox9040281>
- Haque, M. O., Moni, M. A., Rani, S., et al. (2022). Standardization of recipe of value-added functional *Aloe vera* drink enriched with Moringa leaf. *Malaysian Journal of Halal Research*. <https://doi.org/10.2478/mjhr-2022-0007>
- Jamil, F., Firdous, N., Farooq, U., Ainee, A., Bakhtawar, F., Hussain, A., Khan, A. A., Ali, W., Aziz, T., Binsaleh, A. Y., Al-Hoshani, N., & Al-Asmari, F. (2025). Utilization of *Aloe vera* gel and mango powder in the preparation of instant beverage mix: Physicochemical, phytochemical, and antioxidant analyses. *Italian Journal of Food Science*, 37(4), 422–435. <https://doi.org/10.15586/iifs.v37i4.3041>
- Kausar, T., Shamim, F., Gors, F. I., & Ainee, A. (2020). Preparation and quality evaluation of ready to serve beverage (RTS) from orange juice and *Aloe vera* gel during storage. *Pure and Applied Biology*, 9(1), 219–228. <https://doi.org/10.19045/bspab.2020.90026>

- Kumar, S. S., Swathi, S., Swarnalatha, G., & Kartikeyan, S. (2025). Development and evaluation of *Aloe vera* enriched flavored whey beverage. *International Journal of Bio-resource and Stress Management*, 16(6), 01–09. <https://doi.org/10.23910/1.2025.6129>
- Lebaka, V. R., Wee, Y.-J., Ye, W., & Korivi, M. (2021). Nutritional composition and bioactive compounds in three different parts of mango fruit. *International Journal of Environmental Research and Public Health*, 18(2), 741. <https://doi.org/10.3390/ijerph18020741>
- Moselhy, S. N., Al-Nashwi, A. A., Raya-Álvarez, E., Abu Zaid, F. O., Shalaby, H. S. T., El-Khadragy, M. F., Shahein, M. R., Hafiz, A. A., Aljehani, A. A., Agil, A., & Elmahallawy, E. K. (2024). Physicochemical, microbiological, and sensory properties of healthy juices containing *Aloe vera* gel and probiotics and their antidiabetic effects on albino rats. *Frontiers in Nutrition*, 11, 1328548. <https://doi.org/10.3389/fnut.2024.1328548>
- Njoroge, P. N., Kunyanga, C. N., Onyango, C. M., Muthike, C. W., & Mwangi, A. W. (2025). Development and quality evaluation of a functional beverage from *Aloe vera* (*Aloe barbadensis* Miller), *Moringa oleifera* and baobab pulp. *Applied Food Research*. <https://doi.org/10.1016/j.afres.2025.101366>
- Tahosin, A., Halim, M. A., Khatun, H., Ove, T. A., et al. (2024). Production and evaluation of quality characteristics of ready-to-drink *Aloe vera* juice incorporation with ginger and lemon. *Food and Humanity*, 3, 100324. <https://doi.org/10.1016/j.foohum.2024.100324>
- Thaksala, H. K. S., Hettiarachchi, H. A. C. O., & Gunathilake, K. D. P. P. (2022). Evaluation of functional properties in ready-to-drink beverage formulated with *Kalanchoe pinnata* (Akkapana) and *Aloe vera*. *Journal of Food Bioactives*, 20, 168–177. <https://doi.org/10.22059/jfabe.2022.348521.1128>
- Udaya Kumar, K. P., Chaturvedi, K., Swamy, G. S. K., Sane, A., Singh, P., & Suresh, G. J. (2022). Development and evaluation of ready to serve (RTS) beverage from bael (*Aegle marmelos* Correa.). *Journal of Horticultural Sciences*, 17(1), 166–173. <https://doi.org/10.24154/jhs.v17i1.1297>
- Vijetha, P., Katari, N. K., Subbaiah, T., & Naik, K. M. (2021). Preparation of nutraceutical health drink using *Aloe vera* as a base ingredient. *Journal of The Institution of Engineers (India): Series E*, 102, 473–480. <https://doi.org/10.1007/s40033-021-00273-2>