Production and Quality Evaluation of Apple Plum Juice Blends Supplemented With Beetroot Extract

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Abstract

The growing popularity of functional beverages has prompted the creation of health drinks that attribute bioactive compounds and natural antioxidants to fruit. This study aims to develop and test apple-plum juice blends supplemented with beetroot juice extract, and to evaluate the physicochemical and sensory characteristics of these blends. We used various concentrations of plum and beetroot extract to formulate five treatments. The control (T_0) was 100% apple juice, while T_1, T_2, T_3, and T_4 contained apple juice blended with plum juice (10, 20, 30, 40%) and beetroot extract (2, 4, 6, 8%), respectively. Titratable acidity, total soluble solids (TSS), pH, and vitamin C content of the developed beverages, along with sensory attributes such as appearance, color, texture, flavor, and overall acceptability, were analyzed. A significant difference ($P < 0.05$) was found among the treatments. The highest acidity (1.07 ± 0.21%) and TSS (17.90 ± 0.10 °Brix) were observed in T_2, while the highest vitamin C content (12.90 ± 3.23 mg/100 mL) was recorded in T_1 and T_3. Sensory evaluation demonstrated that treatment T_4 achieved the highest scores for appearance (8.50 ± 0.58), color (8.25 ± 0.50), texture (8.25 ± 0.50), flavor (8.50 ± 0.58), and overall acceptability (8.50 ± 0.58). The results demonstrate improved sensory characteristics and functional properties of the beverage, and treatment T_4 (52% apple juice, 40% plum juice, and 8% beetroot extract) proved to be the most acceptable formulation and is recommended for commercial production.

Keywords: Apple juice, plum juice, beetroot extract, functional beverage, sensory evaluation, physicochemical propertie

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1. Introduction

The modern food industry has witnessed a great transformation with the conception of functional foods and beverages having health benefits beyond basic nutrition. Rising consumer awareness of nutrition, chronic disease, and healthy lifestyles has driven demand for antioxidant-, vitamin-, and mineral-fortified foods (Davis et al., 2018; Toorani et al., 2024). Functional beverages are among the most dynamic segments of the food marketplace because they combine convenience with tangible health and nutritional benefits.

There is ample research on the health benefits of fruit juices. Apple juice, valued for its pleasant taste, natural sweetness, and nutritional composition, is one of the most popular beverages worldwide. Apples contain a variety of phenolic compounds and antioxidants that help prevent oxidative stress (Sivaprakasam et al., 2025; Wang et al., 2020) and are a source of dietary fiber and vitamin C, giving apple juice a favorable sensory profile and making it a suitable matrix for functional beverage development.

Nonetheless, apple juice alone contains comparatively fewer bioactive compounds and antioxidants than some other fruits and vegetables. Enriching apple juice with nutritionally valuable ingredients is therefore a promising strategy for enhancing its functional attributes (Bianchi et al., 2021). Juice blending can improve not only nutritional characteristics but also flavor, color, and overall sensory acceptance.

Plum *(Prunus domestica)* is a nutritious fruit rich in anthocyanins, phenolic compounds, organic acids, vitamins, and dietary fiber. Plums possess high antioxidant activity and have shown potential in the prevention of cardiovascular disease, obesity, and certain metabolic disorders (Li et al., 2024; Xu et al.,

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2025). Their sweet tart taste is desirable in beverage formulation, and their phenolic acids and flavonoids contribute additional antioxidant capacity and extended shelf life.

Beetroot *(Beta vulgaris L.)* is widely studied as a functional food owing to its content of betalains, dietary nitrates, polyphenols, vitamins, and minerals. Betalains, the pigments responsible for beetroot's characteristic red color, possess notable antioxidant and anti-inflammatory activity (Clifford et al., 2015; Ceclu & Nistor, 2020), while dietary nitrates have been linked to improved cardiovascular health, exercise capacity, and blood flow (Thiruvengadam et al., 2024).

Incorporating beetroot extract into fruit-based drinks offers several advantages beyond nutrition, including desirable natural coloration, enhanced antioxidant activity, and improved functional properties (Postružnik et al., 2024). Beetroot has already been used successfully in juices, smoothies, and other functional beverages with favorable effects on sensory acceptability and consumer preference (Khalil et al., 2025).

Combining apple juice with plum juice and beetroot extract may therefore yield a more nutritious and sensorially appealing product, with synergistic effects that improve both health attributes and palatability. Such naturally fortified beverages align with the growing “clean label” movement, which favors natural sources of antioxidants and nutrients over synthetic additives.

Fruit and vegetable juice blends have been reported to possess improved physicochemical properties, sensory attributes, and nutritional value relative to single-fruit juices, while reducing reliance on synthetic additives (Anigbogu et al., 2024; Oladunjoye et al., 2025). However, limited information is available on the development of apple plum juice blends fortified with beetroot extract. This study was therefore undertaken to formulate apple plum juice blends at various concentrations of beetroot extract and to evaluate their physicochemical and sensory attributes in order to identify the most acceptable formulation.

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The specific objectives of the study were to: (i) develop apple–plum juice blends supplemented with varying concentrations of beetroot extract; (ii) assess the physicochemical properties of the developed beverages, including total soluble solids (TSS), titratable acidity, pH, and vitamin C content; and (iii) evaluate sensory attributes, including appearance, color, texture, flavor, and overall acceptability.

2. Materials and Methods

2.1 Procurement of Raw Materials

Fresh, ripe, and disease-free apples *(Malus domestica L.)*, beetroot *(Beta vulgaris L.)*, and plums *(Prunus domestica L.)* were procured from local markets in Faisalabad, Pakistan, selected on the basis of uniform size, ripeness, and freedom from visible defects, bruising, or spoilage. Sugar, citric acid, sodium benzoate, and carboxymethyl cellulose (CMC) were of food-grade quality and were purchased from the Department of Food Science & Technology, Food Analysis Laboratory, Riphah International University, Faisalabad Campus, where all subsequent processing and analyses were carried out.

2.2 Preparation of Apple Juice

Fresh apples were cleaned by thorough rinsing in potable water to remove dust, dirt, and foreign material. The fruits were peeled, cored, and cut into small slices, then passed through an electric juicer. The extracted juice was filtered through muslin cloth to remove pulp residues and coarse particles, yielding clear apple juice for further use.

2.3 Preparation of Plum Juice

Dried plums were rinsed and rehydrated by soaking in potable water. The rehydrated plums were deseeded and blended into a smooth pulp using an electric blender. The pulp was filtered through muslin cloth to

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separate the juice from skin and fiber residues, yielding plum juice suitable for incorporation into the beverage blends.

2.4 Preparation of Beetroot Extract

Fresh beetroot roots were washed, peeled, and cut into small pieces before extraction using an electric blender. The resulting slurry was strained through muslin cloth to obtain a uniform beetroot extract, which was used immediately for beverage formulation to minimize pigment and nutrient losses.

2.5 Treatment Plan

Five treatments (T_0–T_4) were formulated in a completely randomized design, with T_0 as the 100% apple juice control and T_1–T_4 representing progressively increasing proportions of plum juice and beetroot extract, as detailed in Table 2.1.

Table 2.1: *Treatment Plan for Apple Plum Juice Blend with Beetroot Extract*

Treatment	Apple Juice (%)	Plum Juice (%)	Beetroot Extract (%)
T_0	100	0	0
T_1	88	10	2
T_2	76	20	4
T_3	64	30	6
T_4	52	40	8

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2.6 Preparation of Apple–Plum Juice Blends

Apple juice, plum juice, and beetroot extract were combined according to the treatment plan in Table 2.1. Sugar syrup was prepared separately and blended into each juice mixture to standardize sweetness across treatments. Citric acid was added to adjust and maintain an acidic pH favorable for microbial and sensory stability; sodium benzoate was incorporated as a chemical preservative; and carboxymethyl cellulose (CMC) was added as a stabilizer to maintain a uniform suspension and prevent sedimentation of pulp particles during storage. After thorough homogenization, each blend was pasteurized to ensure microbiological safety, cooled to room temperature, and filled into pre-sterilized glass bottles under hygienic conditions before sealing and refrigerated storage until analysis. Figure 1. Flow diagram for preparation of apple–plum juice blends supplemented with beetroot extract.

2.7 Physicochemical Analysis

The standard procedures of AOAC (2019) were used to determine the titratable acidity, total soluble solids (TSS), pH, and vitamin C content of the developed beverages. All physicochemical analyses were performed in replicate on each treatment to allow statistical comparison of means.

2.7.1 Determination of pH

The pH of each sample was measured using a calibrated digital pH meter at room temperature. The instrument was standardized before each set of readings using buffer solutions of pH 4.0 and 7.0, and the electrode was rinsed with distilled water between samples to avoid cross-contamination.

2.7.2 Determination of Total Soluble Solids (TSS)

TSS was determined using a hand refractometer and expressed as °Brix. A drop of the homogenized sample was placed on the refractometer prism, and the reading was recorded directly, with the instrument wiped clean and recalibrated against distilled water between samples.

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2.7.3 Determination of Titratable Acidity

Titratable acidity was determined by titrating a known volume of juice sample against standardized 0.1 N sodium hydroxide (NaOH), using phenolphthalein as an indicator until a faint pink end-point persisted for at least 30 seconds. Results were expressed as a percentage of citric acid, the predominant organic acid in apple- and plum-based beverages, using the standard AOAC (2019) conversion factor.

2.7.4 Determination of Vitamin C

Vitamin C (ascorbic acid) content was determined by the 2,6-dichlorophenol indophenol (DCPIP) visual titration method. A known volume of the sample, mixed with metaphosphoric acid to stabilize ascorbic acid, was titrated against the standardized DCPIP dye solution until a light pink end-point persisted. The volume of dye consumed was used to calculate the vitamin C content, expressed as mg per 100 mL of sample.

2.8 Sensory Evaluation

Sensory evaluation was conducted by a semi-trained panel under standard laboratory conditions. All samples were randomly coded with three-digit numbers and presented to panelists in a randomized order to minimize positional and carry-over bias; panelists rinsed their palates with water between samples. Appearance, color, texture, flavor, and overall acceptability were rated on a nine-point hedonic scale ranging from 1 (“dislike extremely”) to 9 (“like extremely”). Panelists provided informed consent prior to participation.

2.9 Statistical Analysis

The experiment was laid out according to a completely randomized design (CRD). Data were subjected to one-way Analysis of Variance (ANOVA) to determine treatment effects, and where significant differences were detected, means were separated using Duncan's Multiple Range Test (DMRT) following

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the procedure of Steel et al. (1997). Differences among treatment means were considered statistically significant at $P \leq 0.05$, and all results are reported as mean ± standard deviation.

3. Results and Discussions

The quality of the developed apple plum juice blends was evaluated based on their physicochemical and sensory properties. The results indicated clear differences among treatments, showing that varying concentrations of plum juice and beetroot extract significantly influenced both the nutritional and sensory quality of the beverages.

3.1 Physicochemical Characteristics

The physicochemical properties, including titratable acidity, total soluble solids (TSS), pH, and vitamin C content, are presented in Table 3.1.

Table 3.1. *Physicochemical characteristics of apple–plum juice blends supplemented with beetroot extract*

Treatment	Acidity (%)	TSS (°Brix)	pH	Vitamin C (mg/100 mL)
T_0	0.70 ± 0.14^{c}	16.50 ± 0.10^{c}	3.89 ± 0.01^{a}	9.67 ± 3.23^{ab}
T_1	0.56 ± 0.14^{d}	16.30 ± 0.10^{d}	3.76 ± 0.02^{c}	12.90 ± 3.23^{a}
T_2	1.07 ± 0.21^{a}	17.90 ± 0.10^{a}	3.62 ± 0.03^{e}	7.52 ± 1.86^{b}
T_3	0.70 ± 0.14^{c}	17.10 ± 0.10^{b}	3.67 ± 0.01^{d}	12.90 ± 3.23^{a}
T_4	0.84 ± 0.14^{b}	16.50 ± 0.10^{c}	3.81 ± 0.06^{b}	6.45 ± 3.23^{b}

Means sharing different superscripts within a column differ significantly (P≤0.05).

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3.1.1 Titratable Acidity

Titratable acidity is an important flavor, preservation, and microbiological quality parameter of fruit beverages. Acidity was significantly influenced by treatment formulation, with T_2 showing the highest value (1.07%) and T_1 the lowest (0.56%), while T_0 and T_3 did not differ significantly from one another (0.70%).

The elevated acidity observed in T_2 is most likely attributable to the combined contribution of organic acids (mainly malic and citric acid) naturally present in plum juice and beetroot extract, which supplement the acids already present in apple juice. Organic acids are key determinants of the sourness and preservation potential of fruit beverages, since increased acidification lowers the pH environment and creates unfavorable conditions for spoilage and pathogenic microorganisms, thereby extending shelf life. This finding is consistent with El-Dakak et al. (2017), who reported that apple-based beverages fortified with vegetable extracts showed a marked increase in acidity.

Interestingly, acidity did not increase in strict proportion to the level of plum juice and beetroot extract across all treatments T_4, despite containing the highest proportion of both ingredients, showed lower acidity than T_2. This non-linear trend suggests that acid contribution from the two ingredients is not purely additive and may be influenced by buffering compounds, mineral content, or interactions between the plum and beetroot matrices, an aspect that merits further investigation using targeted organic acid profiling (e.g., HPLC). From an application standpoint, the moderate acidity levels recorded across treatments (0.56 –1.07%) fall within the range generally considered acceptable for fruit-based beverages, supporting both microbial safety and palatability without imparting excessive sourness.

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3.1.2 Total Soluble Solids (TSS)

TSS reflects the combined content of sugars, soluble fibers, and other dissolved solids in fruit beverages and is closely linked to perceived sweetness and mouthfeel. TSS differed significantly among treatments, with the highest value recorded in T_2 (17.90 °Brix), followed by T_3 (17.10 °Brix), and the lowest in T_1 (16.30 °Brix).

The general increase in TSS with plum juice and beetroot extract inclusion can be attributed to the natural sugars (mainly fructose, glucose, and sucrose) and soluble carbohydrates contributed by these ingredients in addition to the sugar syrup used in the formulation. Higher TSS values are typically associated with greater perceived sweetness and improved mouthfeel, both of which positively influence consumer acceptability. This trend agrees with El-Dakak et al. (2017), who observed a significant rise in TSS in fruit beverages fortified with beetroot and carrot extracts, and with Bhavya et al. (2019), who reported that vegetable extract incorporation improved soluble solids content in functional juices.

The fact that TSS values did not rise strictly in line with formulation level (e.g., T_4 recorded a lower TSS than T_2 and T_3 despite containing more plum juice and beetroot extract) may reflect batch-to-batch variability in raw material sugar content, or a slight dilution effect as the proportion of apple juice, itself a major sugar contributor, declined at higher substitution levels. Overall, treatment T_2 achieved the most favorable balance between sweetness and the functional benefits associated with plum and beetroot fortification, indicating that TSS enhancement does not require the maximum substitution level tested.

3.1.3 pH

The pH of the apple–plum juice blends ranged from 3.62 to 3.89 and differed significantly among treatments. T_0 recorded the highest pH (3.89), while T_2 recorded the lowest (3.62).

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The decline in pH with increasing plum juice and beetroot extract inclusion is consistent with the higher organic acid content contributed by these ingredients, mirroring the acidity trend discussed in Section 3.1.1. A lower pH is generally advantageous for beverage stability, as it inhibits the growth of spoilage and pathogenic microorganisms and helps preserve nutrient integrity during storage. This finding aligns with El-Dakak et al. (2017), who reported a pH decrease following the addition of vegetable extracts to fruit beverages, and with Ann et al. (2025), who observed that increasing plum concentration reduced both the pH and the thermal stability of stored fruit-based products.

It is notable that T_2, rather than T_4, showed the lowest pH despite T_4 containing the highest proportion of plum juice and beetroot extract, mirroring the pattern observed for titratable acidity. Since pH and titratable acidity are governed by both the concentration and the buffering capacity of the constituent organic acids and minerals, this suggests that beyond a certain inclusion level, additional plum juice and beetroot extract may introduce buffering components (such as minerals and proteins) that partially offset further acidification. All formulated beverages nonetheless fall within the pH range typically recommended for safe and stable fruit beverages, supporting their suitability for commercial development.

3.1.4 Vitamin C Content

Vitamin C is a key antioxidant that contributes to the nutritional value of fruit beverages and supports consumer health. Vitamin C content differed significantly among treatments, with T_1 and T_3 recording the highest values (12.90 mg/100 mL) and T_4 the lowest (6.45 mg/100 mL).

The variability in vitamin C content across treatments likely reflects the combined influence of raw material composition and processing- or storage-related degradation, since ascorbic acid is highly sensitive to light, oxygen, and heat exposure during juice extraction, blending, and any subsequent thermal treatment. This is consistent with Oladunjoye et al. (2025), who concluded that formulation and processing

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conditions significantly affect vitamin C stability in fruit beverages, and with reports of considerable variation in vitamin C retention across blended fruit beverage formulations.

The comparatively low vitamin C content in T_4, despite its high proportion of plum juice and beetroot extract, suggests that vitamin C loss in this treatment may outweigh any additional vitamin C contributed by these ingredients, plausibly due to greater exposure to oxidative conditions during the more extensive blending and processing required for higher-substitution formulations, or to the comparatively lower intrinsic vitamin C content of plum and beetroot relative to apple. This finding highlights a practical trade-off for product developers: while T_4 delivered the best sensory scores (Section 3.2), it did not correspond to the highest vitamin C retention, indicating that formulation optimization for functional beverages should weigh sensory and nutritional objectives together, and that processing conditions (e.g., minimizing oxygen exposure and processing time) warrant closer control in future formulation trials.

3.2 Sensory Evaluation

Sensory attributes are critical determinants of consumer acceptance and market success. The sensory evaluation results are presented in Table 3.2.

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Table 3.2: *Sensory evaluation of apple–plum juice blends supplemented with beetroot extract*

Treatment	Appearance	Color	Texture	Flavor	Overall Acceptability
T_0	7.75 ± 0.50^{bc}	7.75 ± 0.50^{bc}	7.75 ± 0.50^{bc}	7.75 ± 0.50^{bc}	7.75 ± 0.50^{bc}
T_1	7.75 ± 0.50^{bc}	7.50 ± 0.58^{c}	7.25 ± 0.50^{c}	7.50 ± 0.58^{c}	7.50 ± 0.58^{c}
T_2	8.25 ± 0.50^{ab}	8.00 ± 0.58^{ab}	8.00 ± 0.58^{ab}	8.25 ± 0.50^{ab}	8.25 ± 0.50^{ab}
T_3	7.75 ± 0.50^{c}	7.50 ± 0.58^{c}	7.50 ± 0.58^{c}	7.75 ± 0.50^{bc}	7.75 ± 0.50^{bc}
T_4	8.50 ± 0.58^{a}	8.25 ± 0.50^{a}	8.25 ± 0.50^{a}	8.50 ± 0.58^{a}	8.50 ± 0.58^{a}

Means sharing different superscripts within a column differ significantly ($P \leq 0.05$).

3.2.1 Appearance

Appearance is typically the first attribute to influence consumer perception and purchase decisions. Significant differences were observed among treatments, with T_4 achieving the highest score (8.50) compared with T_0, T_1, and T_3.

The superior appearance of T_4 can be attributed to the vivid, uniform red-purple coloration imparted by beetroot betalains combined with plum anthocyanins, together with the greater homogeneity achieved through the stabilizing action of CMC at higher inclusion levels. A visually vibrant and homogeneous beverage is generally perceived by consumers as fresher and higher in quality, an effect also reported by Emelike et al. (2015) for vegetable-extract-enriched fruit beverages. The progressive improvement in appearance scores from T_0 to T_4 further indicates that consumer visual preference scaled positively with

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the proportion of plum juice and beetroot extract used, reinforcing the value of these ingredients as natural, clean-label colorants.

3.2.2 Color

Color is a key quality attribute influencing both consumer preference and product acceptability. T_4 recorded the highest color score (8.25), followed by T_2 (8.00).

The improved color in higher-substitution treatments is most plausibly linked to the combined pigment contribution of beetroot betalains and plum anthocyanins, both of which impart intense red-to-purple hues that distinguish the product from conventional pale apple juice. Betalains are also comparatively stable pigments under mildly acidic conditions, which likely helped preserve color intensity in the lower-pH treatments (T_2–T_4). These results are consistent with Khalil et al. (2025), who reported that beetroot supplementation significantly enhances the color characteristics of functional beverages, and support the use of beetroot extract as a natural alternative to synthetic colorants in fruit-based product development.

3.2.3 Texture

Texture scores ranged from 7.25 to 8.25, with T_4 achieving the highest score and T_1 the lowest.

The improved texture in T_4 is likely related to the combined effect of natural pectin and soluble fiber contributed by plum pulp, dissolved solids from beetroot extract, and the stabilizing action of CMC, which together produce a fuller, more cohesive mouthfeel and reduce the perception of thinness or wateriness sometimes associated with single-fruit juices. This is consistent with Emelike et al. (2015), who reported improved consistency and texture in fruit vegetable beverage blends relative to single-ingredient controls. A well-balanced texture not only improves immediate palatability but can also influence perceived product quality and premium positioning in the functional beverage market.

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3.2.4 Flavor

Flavor is one of the most influential attributes governing consumer acceptance. T_4 achieved the highest flavor score (8.50), with significant differences observed among treatments.

The improved flavor of T_4 likely results from a synergistic balance between the natural sweetness of apple juice, the characteristic sweet-tart notes of plum juice, and the mild earthy undertone of beetroot extract, which together create a more complex and rounded flavor profile than apple juice alone. This flavor synergy is consistent with Jahangeer et al. (2025), who reported improved flavor acceptability in functional fruit beverages fortified with vegetable extracts or juices. The consistent increase in flavor scores from lower to higher substitution treatments (with the exception of T_3) suggests that consumer flavor preference in this study favored the more pronounced fruit–vegetable character achieved at higher inclusion levels, rather than a milder, more apple-dominant profile.

3.2.5 Overall Acceptability

Overall acceptability integrates all sensory attributes and reflects general consumer preference. T_4 obtained the highest overall acceptability score (8.50), while T_1 recorded the lowest (7.50).

The superior acceptability of T_4 can be attributed to its balanced profile across all evaluated attributes: an appealing natural color, improved texture and mouthfeel, a well-rounded flavor, and physicochemical properties (moderate acidity and elevated TSS) that together support both palatability and perceived freshness. These findings demonstrate that increasing the proportion of plum juice and beetroot extract up to 40% and 8%, respectively, progressively improved overall sensory quality, a trend consistent with Emelike et al. (2015), who found that vegetable-enriched fruit beverages were preferred over conventional formulations.

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Taken together, the physicochemical and sensory results indicate that treatment T_4 (52% apple juice, 40% plum juice, and 8% beetroot extract) represents the most suitable formulation for developing a functional apple–plum beverage supplemented with beetroot extract, offering the best overall sensory performance while maintaining physicochemical properties within acceptable ranges for beverage stability and safety. A notable limitation of the present study is that vitamin C retention in T_4 was comparatively lower than in T_1 and T_3, highlighting a sensory-nutritional trade-off that should be addressed in future work, for example, through milder processing conditions, protective packaging, or antioxidant co-fortification to maximize both consumer acceptability and nutritional value. Future studies should also assess the microbiological and sensory stability of the optimized formulation (T_4) during extended storage, to confirm its suitability for commercial-scale production.

4. Conclusion

In the present study, an attempt was made to develop a functional fruit beverage by blending apple juice with plum juice and beetroot extract at varying concentrations, which was successful. Significant differences ($P \leq 0.05$) were observed among treatments for both physicochemical and sensory properties. The inclusion of plum juice and beetroot extract significantly affected acidity, total soluble solids, pH, vitamin C content, and all evaluated sensory attributes (appearance, color, texture, flavor, and overall acceptability).

Acidity and TSS, which govern flavor balance and preservation potential, were highest in treatment T_2 (1.07% and 17.90 °Brix, respectively). Treatments T_1 and T_3 retained the highest vitamin C content (12.90 mg/100 mL), indicating superior nutritional quality. All formulated beverages fell within an adequately acidic pH range (3.62–3.89), supporting microbiological stability and safety.

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Treatment T_4 (52% apple juice, 40% plum juice, and 8% beetroot extract) achieved the highest scores across all sensory parameters – appearance (8.50), color (8.25), texture (8.25), flavor (8.50), and overall acceptability (8.50) – reflecting the combined contribution of balanced sweetness, acidity, natural color, and mouthfeel from the apple, plum, and beetroot components.

Overall, the results confirm that beetroot extract is a suitable natural functional ingredient for enriching fruit beverages, improving both nutritional and sensory quality. Plum juice and beetroot extract not only altered the physicochemical characteristics of the beverage but also enhanced its sensory acceptability. Treatment T_4 is recommended as the optimal formulation and shows strong potential for commercial development of a functional apple–plum beverage fortified with beetroot extract, subject to confirmation of its microbiological and sensory stability during storage.

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