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DEVELOPMENT AND STORAGE QUALITY EVALUATION OF PEACH AND STRAWBERRY STEVIA SWEETENED JUICE

Original Article

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ABSTRACT

Background: Diabetes mellitus is a growing global health concern that contributes to serious complications including cardiovascular disease, obesity, and kidney dysfunction. With increasing awareness about the negative impacts of excessive sugar intake, there is a pressing demand for natural, non-nutritive sweeteners in functional food development. Stevia rebaudiana Bertoni, known for its high sweetness intensity and potential antidiabetic properties, is gaining attention as a suitable alternative to sugar in food and beverages.

Objective: This study aimed to evaluate the effect of stevia incorporation in peach and strawberry juices on their antioxidant potential, physicochemical properties, and sensory acceptability over a 30-day storage period.

Methods: Fresh peach and strawberry juices were prepared with varying concentrations of stevia (4%, 6%, and 8%) and compared against sucrose-based controls. Juices were bottled, pasteurized, and stored at 4±1°C. Evaluations of total phenolic content (TPC), DPPH radical scavenging activity, total acidity, total soluble solids (TSS), reducing sugars, and color values were conducted at 15-day intervals. Sensory analysis was carried out using a 9-point hedonic scale by a panel of 15 trained volunteers. Data were statistically analyzed using two-way ANOVA at a significance level of $p<0.05$.

Results: Stevia significantly enhanced antioxidant potential, with TPC and DPPH values decreasing from 153.09±19.20 to 136.60±19.33 mg GAE/100g and 40.03±3.50% to 27.79±3.35%, respectively, over storage. Total acidity increased from 0.33±0.10% to 0.83±0.03%, TSS ranged between 11.44±0.69 and 7.77±0.04 °Brix, and reducing sugars rose from 2.39±0.10% to 5.97±0.23%. Sensory attributes declined over time but remained within acceptable limits.

Conclusion: Stevia-sweetened fruit juices offer a promising alternative to sugar-based beverages, with better antioxidant retention and acceptable sensory quality, making them suitable for individuals with diabetes mellitus.

Keywords: Antioxidants, DPPH, Diabetes Mellitus, Juice, Physicochemical Properties, Stevia, Total Phenolic Content.

INTRODUCTION

Diabetes mellitus is a global health concern that significantly affects the quality of life of individuals, families, and communities, with increasing morbidity and mortality. It is characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Type 2 diabetes mellitus (T2DM), accounting for 90–95% of all diabetes cases, is a multifactorial metabolic disorder primarily caused by peripheral insulin resistance, insufficient insulin production, and excessive glucagon secretion. The pathophysiology of T2DM involves structural and functional changes in pancreatic β- and α-cells, with β-cell loss attributed to apoptosis and autophagy (1). Genetic predisposition and environmental influences such as poor diet, sedentary lifestyle, and obesity further compound its progression. In Pakistan, diabetes has emerged as a leading cause of morbidity, often culminating in severe complications including cardiovascular disease, nephropathy, retinopathy, and lower limb amputations. These complications not only impair patients' quality of life but also place an immense financial burden on healthcare systems and affected families (2). In 2023, approximately 26.7% of Pakistan's adult population was diagnosed with diabetes, with 32.965 million individuals affected. This figure is projected to rise to 34.4 million by 2030 and reach 37.1 million by 2045 (3). In parallel with the increasing prevalence of diabetes, there is a growing demand for nutritional interventions that can mitigate disease progression and improve metabolic health. Fruits, known for their rich antioxidant and nutrient content, have long been recognized for their role in health promotion and disease prevention. Among them, peaches (*Prunus persica*) are noted for their medicinal value, attributed to high concentrations of phenolic acids, flavonoids, anthocyanins, and essential nutrients such as vitamin C, potassium, iron, calcium, and dietary fiber. These compounds have demonstrated anti-inflammatory, antioxidant, and laxative effects, contributing to the prevention of chronic diseases and gastrointestinal health (4-6).

Similarly, strawberries are valued for their rich nutritional profile and phytochemical composition, offering a potent mix of antioxidants, vitamin C, carotenoids, tocopherol, and vitamin K, along with moderate levels of B-complex vitamins. These bioactive constituents play a key role in reducing oxidative stress, enhancing immunity, and supporting cardiovascular function (7). In recent years, there has been a notable shift towards functional beverages that combine the nutritional benefits of fruits with natural, non-caloric sweeteners. This transition is particularly relevant for diabetic populations, where the consumption of high-sucrose beverages derived from *Saccharum officinarum* and *Beta vulgaris* has been linked to insulin resistance, obesity, and hormonal imbalances (8,9). Stevia (*Stevia rebaudiana* Bertoni) has emerged as a promising natural sweetener, renowned for its high sweetness intensity—100 to 300 times that of sucrose—owing to its steviol glycosides. Beyond its sweetness, stevia possesses therapeutic potential, including antihyperglycemic effects, pancreatic β-cell stimulation, and improved insulin sensitivity. It is also a source of essential amino acids, vitamins, minerals, dietary fiber, flavonoids, and phenolic compounds, rendering it a valuable nutraceutical in the dietary management of T2DM (10-12). The increasing popularity of stevia-enhanced beverages has prompted scientific inquiry into their sensory acceptability, physicochemical stability, and potential long-term benefits, especially in diabetic-friendly formulations. Despite its recognized benefits, limited studies have explored the influence of stevia on the physicochemical properties and sensory profiles of fruit-based beverages such as peach and strawberry juices. Most existing literature focuses on synthetic sweeteners or different fruit matrices, leaving a gap in knowledge regarding stevia's compatibility with these specific juices and its impact during storage. Additionally, the relationship between stevia incorporation and preservation of antioxidant capacity remains underexplored. This study was therefore undertaken to evaluate the phytochemical content, physicochemical attributes, and sensory acceptability of peach and strawberry juices sweetened with varying concentrations of stevia, aiming to provide a healthier and more palatable beverage option for individuals with or at risk of type 2 diabetes.

METHODS

The present experimental study was conducted to investigate the phytochemical, physicochemical, and sensory properties of peach and strawberry juices prepared with varying concentrations of *Stevia rebaudiana* as a natural non-caloric sweetener. Fresh peaches and strawberries were procured from the local fruit market in Faisalabad, Pakistan, while stevia powder was sourced from a nearby pharmacy. The fruits were sorted, washed, and manually pulped according to standardized procedures described by Wern et al. (2016). The pulp was blended with water, stevia powder, a pinch of salt, and 0.1% lemon juice. To ensure microbiological stability, 0.06% sodium benzoate was added as a preservative. The prepared juices were filled into sterilized glass bottles, sealed, and pasteurized at 85°C for 15 minutes. The samples were subsequently stored at a refrigeration temperature of 4±1°C for up to 30 days for periodic evaluation. The study was designed to compare two sets of fruit juices: peach and strawberry, each tested with three different concentrations of stevia (4%, 6%, and 8%) and one sucrose-based control (12%). The complete treatment plan included seven groups, as follows: T0a (peach with 12% sugar), T0b (strawberry with 12% sugar), T1 (peach with 4% stevia), T2 (peach with 6% stevia), T3 (peach with 8% stevia), T4 (strawberry with 4% stevia), T5 (strawberry with 6% stevia), and T6 (strawberry with 8% stevia). All treatment formulations were adjusted to maintain a consistent ratio of 1g, 1.5g, and 2g stevia per 250ml juice, respectively. Phytochemical assessments were performed to determine total phenolic contents (TPC) and antioxidant activity. The TPC was quantified using the Folin–Ciocalteu colorimetric method, following the protocol of Skegro et al. (2021), while the radical scavenging activity was assessed via the DPPH assay based on the method described by Wern et al. (2016). These analyses aimed to evaluate the antioxidant potential of the formulations during storage.

Physicochemical properties such as pH, acidity, total soluble solids (TSS), reducing sugars, and color were evaluated at intervals of 15 and 30 days. Standard methods outlined by the Association of Official Analytical Chemists (AOAC, 2016) were followed to ensure accuracy and reproducibility. Sensory evaluation was carried out by a trained panel of 15 adult volunteers (aged 20–40 years), selected based on their willingness and availability, excluding individuals with known taste or olfactory impairments, diabetes, or allergies to fruits or stevia. Informed verbal consent was obtained from all panelists prior to participation. Each panelist evaluated the samples for color, taste, flavor, and overall acceptability using a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely) (13-15). The evaluations were conducted in a controlled sensory lab environment to minimize bias. All experimental data were analyzed using two-way Analysis of Variance (ANOVA) to determine significant differences among treatments and over storage intervals. The statistical analysis was performed using Statistix software version 8.1, and results were interpreted at a 5% level of significance ($p<0.05$) (Montgomery, 2017). Ethical approval for this study was obtained from the Institutional Research and Ethics Committee of the relevant department, ensuring that all procedures adhered to ethical research standards.

Table 1: Treatment Plan

T_{0a}=Control treatment for peach, T_{0b}=Control treatment for strawberry

Treatment	Peach juice %	Strawberry juice %	Stevia %	Sugar %
T_{0a}	100	---	---	12
T_{0b}	---	100	---	12
T_1	100	---	4	---
T_2	100	---	6	---
T_3	100	---	8	---
T_4	---	100	4	---
T_5	---	100	6	---
T_6	---	100	8	---

T_1 =Peach juice+4% stevia (1g/250ml), T_2=Peach juice+6% stevia (1.5g/250ml)
T_3=Peach juice+8%stevia(2g/250ml), T_4=Strawberry juice+4% stevia (1g/250ml)
T_5=Strawberry juice+6%stevia (1.5g/250ml), T_6=Strawberryjuice+8%stevia(2g/250ml)

RESULTS

The analysis revealed that both treatment type and storage duration significantly influenced the total phenolic content (TPC) and antioxidant activity of peach and strawberry juices. The mean TPC declined from 153.09±19.20 to 136.60±19.33 mg GAE/100g over 30 days of storage. Notably, stevia-treated juices exhibited higher TPC values compared to control groups. Among treatments, strawberry juices sweetened with 4–8% stevia maintained the highest phenolic content initially, peaking at 295.40±39 mg GAE/100g. However, these values declined progressively during storage, with the steepest reductions observed in higher-concentration stevia treatments. Similarly, DPPH radical scavenging activity decreased significantly over the 30-day period from an initial mean of 40.03±3.50% to 27.79±3.35%. The greatest antioxidant activity was recorded in T6 (70.20±6.80%), followed by T5 (69.80±6.88%) and T4 (63.60±7.21%), while the control peach juice (T0a) exhibited the lowest activity throughout storage. The pattern of antioxidant decline was more prominent in strawberry-based formulations compared to peach juices, suggesting that juice type and stevia concentration modulate the antioxidant stability over time. Total acidity increased gradually during storage, rising from a mean of 0.52±0.04% to 0.59±0.05%, with strawberry-based treatments, particularly T6, T5, and T4, reaching values as high as 0.87±0.03%. Peach juices maintained lower acidity values, with the lowest recorded in T2 (0.21±0.03% at baseline). A significant effect of stevia concentration was also evident, as higher concentrations were associated with elevated acidity levels.

Total soluble solids (TSS) also increased slightly with storage, from 9.01±0.26°Brix to 9.39±0.27°Brix. Among treatments, the peach juice control (T0a) consistently had the highest TSS, reaching up to 11.90±0.33°Brix. In contrast, strawberry juice treatments with stevia, especially T5 and T6, exhibited significantly lower TSS values, stabilizing around 7.55±0.13°Brix and 7.77±0.04°Brix, respectively. The reducing sugar content of the juices increased progressively from 3.88±0.12% to 4.16±0.13% during the storage period. Strawberry juices with higher stevia concentrations (T5 and T6) maintained the highest sugar content, ranging from 5.80±0.22% to 6.12±0.24%, whereas peach juice treatments, particularly T3, had the lowest values (as low as 1.91±0.03%). Color parameters including L*, a*, and b* values were significantly affected by both treatment and storage. The L* value, indicating lightness, decreased over time for all treatments, with T0a retaining the highest values throughout (mean 77.81±0.13). Stevia-treated strawberry juices had markedly lower L* values, particularly T6 (mean 47.86±0.72). The a* values, representing redness, declined across storage for all samples. T0b recorded the highest a* value at baseline (38.75±0.32), while T3 and T6 recorded the lowest over time. Similarly, b* values declined in all treatments, with the greatest stability seen in T0a and the steepest drop in T6. Sensory evaluation indicated that all treatments experienced a gradual decline in sensory attributes such as color, taste, flavor, and overall acceptability. At day 0, the highest flavor scores were observed in T0b (8.56±0.03), followed by T0a (8.15±0.03). Over time, scores for flavor and taste declined across treatments, particularly in those with higher stevia content such as T3 and T6. The highest overall acceptability was observed in T0a (8.18±0.03), while the lowest was in T6 (7.56±0.03). Notably, treatments with moderate stevia concentrations (T1 and T2) retained acceptability comparable to control groups, suggesting better consumer preference at these levels.

Table 2: Effects of Storage and Treatment on TPC and DPPH content of Peach and Strawberry Juice

		Storage period			
Parameters	Treatments	0 day	15 days	30 days	Means
TPC (mg GAE/100g)	T_{0a}	18.45±0.11^{b}	18.39±0.12^{b}	18.32±0.14^{b}	18.37±0.12^{b}
	T_{0b}	273.40±40^{a}	260.10±39^{a}	245.50±40^{a}	259.66±39.6^{a}
	T_1	21.35±0.19^{b}	21.33±0.15^{b}	21.26±0.18^{b}	21.31±0.17^{b}
	T_2	22.32±0.17^{b}	22.30±0.15^{b}	22.24±0.18^{b}	22.28±0.16^{b}
	T_3	23.41±0.18^{b}	23.36±0.20^{b}	23.29±0.19^{b}	23.35±0.19^{b}
	T_4	289.10±38^{a}	270.90±35^{a}	272.01±37^{a}	277.34±36.60^{a}
	T_5	291.40±36^{a}	269.80±39^{a}	240.30±41^{a}	267.16±38.60^{a}
	T_6	295.40±39^{a}	271.20±33^{a}	249.84±36^{a}	268.81±36.00^{a}
	Means	153.09±19.20^{a}	144.67±18.32^{ab}	136.60±19.34^{b}	
DPPH (%)	T_{0a}	12.81±0.21^{g}	12.57±0.22^{g}	12.38±0.24^{g}	12.57±0.22^{c}
	T_{0b}	55.61±6.32^{abcd}	43.40±6.45^{def}	36.32±6.22^{f}	45.11±6.33^{b}
	T_1	14.85±0.26^{g}	14.69±0.15^{g}	13.89±0.22^{g}	14.47±0.21^{c}
	T_2	15.83±0.18^{g}	15.74±0.19^{g}	15.53±0.22^{g}	15.70±0.19^{c}
	T_3	17.55±0.16^{g}	17.41±0.19^{g}	17.30±0.17^{g}	17.42±0.17^{c}
	T_4	63.60±7.21^{ab}	51.41±7.34^{bcde}	39.78±5.99^{ef}	51.59±6.84^{ab}
	T_5	69.80±6.88^{a}	54.60±6.46^{bcde}	42.75±6.98^{def}	55.71±6.77^{a}
	T_6	70.20±6.80^{a}	58.71±6.70^{abc}	44.36±6.80^{cdef}	57.76±6.76^{a}
	Means	40.03±3.50^{a}	33.56±3.46^{b}	27.79±3.35^{c}	

T_{0a}=Control treatment for peach, T_{0b}=Control treatment for strawberry
T_1 =Peach juice+4% stevia (1g/250ml), T_2=Peach juice+6% stevia (1.5g/250ml)
T_3=Peach juice+8%stevia(2g/250ml), T_4=Strawberry juice+4% stevia (1g/250ml)
T_5=Strawberry juice+6%stevia (1.5g/250ml), T_6=Strawberryjuice+8%stevia(2g/250ml)

Table 3: Effects of Storage and Treatment on Total Acidity, TSS and Reducing Sugars of Peach and Strawberry Juice

		Storage period			
Parameters	Treatments	0 day	15 days	30 days	Means
Total Acidity (%)	T_{0a}	0.31±0.11^{b}	0.33±0.08^{b}	0.35±0.12^{b}	0.33±0.10^{bc}
	T_{0b}	0.75±0.02^{a}	0.77±0.04^{a}	0.84±0.05^{a}	0.79±0.03^{a}
	T_1	0.22±0.02^{b}	0.25±0.05^{b}	0.30±0.03^{b}	0.26±0.03^{bc}
	T_2	0.21±0.03^{b}	0.24±0.06^{b}	0.29±0.08^{b}	0.25±0.05^{c}
	T_3	0.29±0.03^{b}	0.33±0.02^{b}	0.38±0.04^{b}	0.33±0.03^{b}
	T_4	0.76±0.03^{a}	0.79±0.04^{a}	0.84±0.01^{a}	0.80±0.03^{a}
	T_5	0.79±0.01^{a}	0.80±0.03^{a}	0.86±0.04^{a}	0.82±0.03^{a}
	T_6	0.81±0.03^{a}	0.82±0.02^{a}	0.87±0.03^{a}	0.83±0.03^{a}
	Means	0.52±0.04^{b}	0.54±0.04^{ab}	0.59±0.05^{a}	
TSS (Brix°)	T_{0a}	11.01±0.91^{abcd}	11.42±0.83^{ab}	11.90±0.33^{a}	11.44±0.69^{a}
	T_{0b}	7.45±0.05^{e}	7.48±0.04^{e}	7.51±0.02^{e}	7.49±0.03^{d}
	T_1	10.70±0.04 ^{abcd}	11.20±0.03^{abc}	11.53±0.42^{ab}	11.14±0.16^{ab}
	T_2	10.10±0.43^{cd}	10.61±0.33^{bcd}	10.93±0.23 ^{abcd}	10.54±0.33^{b}
	T_3	9.80±0.18^{d}	9.93±0.99^{cd}	9.99±0.75^{cd}	9.90±0.64^{c}
	T_4	7.81±0.31^{e}	7.84±0.34^{e}	7.88±0.28^{e}	7.84±0.31^{d}
	T_5	7.50±0.11^{e}	7.55±0.14^{e}	7.59±0.13^{e}	7.55±0.13^{d}
	T_6	7.73±0.05^{e}	7.78±0.07^{e}	7.82±0.01^{e}	7.77±0.04^{d}
	Means	9.01±0.26^{b}	9.22±0.24^{ab}	9.39±0.27^{a}	
Reducing Sugar (%)	T_{0a}	2.05±0.11^{c}	2.08±0.08^{c}	3.05±0.12^{b}	2.39±0.10^{b}
	T_{0b}	5.75±0.12^{a}	5.87±0.14^{a}	5.96±0.15^{a}	5.86±0.13^{a}
	T_1	1.99±0.02^{c}	2.02±0.02^{c}	2.07±0.03^{c}	2.03±0.02^{c}
	T_2	1.93±0.03^{c}	1.97±0.02^{c}	2.04±0.03^{c}	1.98±0.03^{c}
	T_3	1.91±0.03^{c}	1.93±0.02^{c}	1.99±0.02^{c}	1.94±0.02^{c}
	T_4	5.79±0.18^{a}	5.87±0.19^{a}	5.95±0.21^{a}	5.87±0.19^{a}
	T_5	5.80±0.22^{a}	5.98±0.23^{a}	6.09±0.25^{a}	5.96±0.23^{a}
	T_6	5.81±0.23^{a}	5.97±0.22^{a}	6.12±0.24^{a}	5.97±0.23^{a}
	Means	3.88±0.12^{b}	3.96±0.12^{b}	4.16±0.13^{a}	

T_{0a}=Control treatment for peach, T_{0b}=Control treatment for strawberry
T_1 =Peach juice+4% stevia (1g/250ml), T_2=Peach juice+6% stevia (1.5g/250ml)
T_3=Peach juice+8%stevia(2g/250ml), T_4=Strawberry juice+4% stevia (1g/250ml)
T_5=Strawberry juice+6%stevia (1.5g/250ml),T_6=Strawberryjuice+8%stevia(2g/250ml)

Table 4: Effects of Storage and Treatment on Color Parameters L*, a* and b* of Peach and Strawberry Juice

		Storage period			
Color	Treatments	0 day	15 days	30 days	Means
L*	T_{0a}	78.11±0.11^{a}	77.95±0.17^{a}	77.33±0.11^{ab}	77.81±0.13^{a}
	T_{0b}	49.75±1.02^{e}	49.57±1.14^{ef}	49.41±1.25^{efg}	49.59±1.13^{e}
	T_1	77.04±0.09^{ab}	76.95±0.14^{ab}	76.89±0.12^{abc}	76.97±0.11^{b}
	T_2	76.21±0.17^{bcd}	76.17±0.15^{bcd}	76.12±0.18^{bcd}	76.18±0.16^{c}
	T_3	75.29±0.14^{cd}	75.23±0.19^{d}	75.15±0.14^{d}	75.23±0.15^{d}
	T_4	49.01±0.43^{efgh}	48.94±0.44^{efgh}	48.87±0.39^{efgh}	48.95±0.42^{ef}
	T_5	48.79±0.31^{efgh}	48.71±0.33^{efgh}	48.67±0.34^{efgh}	48.73±0.32^{f}
	T_6	47.98±0.73^{fgh}	47.82±0.72^{gh}	47.74±0.71^{h}	47.86±0.72^{g}
	Means	62.77±0.37^{a}	62.67±0.41^{a}	62.52±0.40^{a}	
a*	T_{0a}	7.97±0.18^{g}	7.59±0.15^{g}	7.33±0.12^{gh}	7.62±0.15^{e}

		Storage period			
	T_{0b}	38.75 ± 0.32^{a}	38.68 ± 0.32^{ab}	38.56 ± 0.35^{ab}	38.28 ± 0.33^{a}
	T_1	6.58 ± 0.12^{hi}	6.45 ± 0.15^{i}	6.32 ± 0.13^{i}	6.46 ± 0.13^{f}
	T_2	5.21 ± 0.13^{j}	5.09 ± 0.16^{j}	4.96 ± 0.18^{jk}	5.08 ± 0.15^{g}
	T_3	4.29 ± 0.11^{kl}	4.09 ± 0.12^{l}	3.95 ± 0.14^{l}	4.12 ± 0.12^{h}
	T_4	38.49 ± 0.33^{abc}	38.23 ± 0.34^{abcd}	38.09 ± 0.31^{abcde}	38.26 ± 0.32^{b}
	T_5	37.89 ± 0.31^{bcdef}	37.76 ± 0.33^{cdef}	37.63 ± 0.34^{def}	37.76 ± 0.32^{c}
	T_6	37.51 ± 0.36^{def}	37.39 ± 0.29^{ef}	37.21 ± 0.28^{f}	37.36 ± 0.31^{d}
	Means	22.09 ± 0.23^{a}	21.91 ± 0.62^{b}	21.76 ± 0.23^{b}	
b*	T_{0a}	29.73 ± 0.11^{f}	29.29 ± 0.18^{f}	28.93 ± 0.12^{f}	29.31 ± 0.13^{d}
	T_{0b}	36.65 ± 0.52^{a}	36.47 ± 0.54^{ab}	36.29 ± 0.55^{abc}	36.48 ± 0.54^{a}
	T_1	28.69 ± 0.12^{f}	28.61 ± 0.15^{f}	28.56 ± 0.13^{f}	28.63 ± 0.13^{e}
	T_2	27.21 ± 0.13^{g}	27.14 ± 0.16^{g}	27.06 ± 0.18^{g}	27.61 ± 0.16^{f}
	T_3	26.19 ± 0.13^{g}	26.13 ± 0.12^{g}	26.07 ± 0.14^{g}	26.12 ± 0.13^{g}
	T_4	35.96 ± 0.53^{abcd}	35.79 ± 0.54^{abcde}	35.61 ± 0.51^{abcde}	35.78 ± 0.53^{b}
	T_5	35.39 ± 0.53^{bcde}	35.21 ± 0.53^{cde}	35.09 ± 0.54^{cde}	35.24 ± 0.53^{bc}
	T_6	34.97 ± 0.53^{de}	34.82 ± 0.52^{de}	34.74 ± 0.53^{e}	34.85 ± 0.53^{c}
	Means	31.85 ± 0.33^{a}	31.68 ± 0.34^{ab}	31.54 ± 0.36^{b}	

T_{0a}=Control treatment for peach, T_{0b}=Control treatment for strawberry
T_1 =Peach juice+4% stevia (1g/250ml), T_2=Peach juice+6% stevia (1.5g/250ml)
T_3=Peach juice+8%stevia(2g/250ml), T_4=Strawberry juice+4% stevia (1g/250ml)
T_5=Strawberry juice+6%stevia (1.5g/250ml), T_6=Strawberryjuice+8%stevia(2g/250ml)

Table 5: Effects of Storage and Treatment on Sensory Properties of Peach and Strawberry Juice

		Storage period			
Parameters	Treatments	0 day	15 days	30 days	Means
Color	T_{0a}	8.25 ± 0.03^{a}	8.16 ± 0.04^{ab}	8.03 ± 0.02^{cd}	8.14 ± 0.03^{a}
	T_{0b}	8.12 ± 0.03^{bc}	8.03 ± 0.02^{cd}	7.94 ± 0.02^{def}	8.02 ± 0.02^{b}
	T_1	8.00 ± 0.03^{de}	7.93 ± 0.02^{ef}	7.87 ± 0.02^{fg}	7.94 ± 0.02^{c}
	T_2	7.83 ± 0.03^{g}	7.79 ± 0.03^{gh}	7.71 ± 0.04^{hij}	7.79 ± 0.03^{d}
	T_3	7.73 ± 0.03^{hi}	7.69 ± 0.04^{ijk}	7.61 ± 0.02^{klmn}	7.67 ± 0.03^{e}
	T_4	7.72 ± 0.02^{hij}	7.68 ± 0.02^{ijkl}	7.60 ± 0.03^{klmno}	7.68 ± 0.02^{e}
	T_5	7.63 ± 0.05^{jklm}	7.59 ± 0.03^{lmno}	7.53 ± 0.02^{no}	7.57 ± 0.03^{f}
	T_6	7.67 ± 0.03^{ijklm}	7.58 ± 0.02^{mno}	7.51 ± 0.04^{o}	7.58 ± 0.03^{f}
	Means	7.87 ± 0.03^{a}	7.81 ± 0.03^{b}	7.73 ± 0.03^{c}	
Taste	T_{0a}	7.01 ± 0.03^{bc}	6.93 ± 0.04^{cde}	6.87 ± 0.02^{ef}	6.95 ± 0.03^{b}
	T_{0b}	7.12 ± 0.03^{a}	7.07 ± 0.02^{ab}	7.01 ± 0.02^{bc}	7.06 ± 0.02^{a}
	T_1	6.98 ± 0.03^{bcd}	6.89 ± 0.02^{de}	6.75 ± 0.02^{gh}	6.88 ± 0.02^{c}
	T_2	6.73 ± 0.03^{gh}	6.67 ± 0.03^{hi}	6.59 ± 0.04^{ij}	6.67 ± 0.09^{d}
	T_3	6.58 ± 0.03^{ijk}	6.51 ± 0.04^{jkl}	6.47 ± 0.02^{lm}	6.53 ± 0.03^{e}
	T_4	7.02 ± 0.02^{bc}	6.94 ± 0.02^{cde}	6.86 ± 0.03^{ef}	6.95 ± 0.02^{b}
	T_5	6.78 ± 0.05^{fg}	6.69 ± 0.03^{gh}	6.58 ± 0.02^{ijk}	6.69 ± 0.03^{d}
	T_6	6.55 ± 0.03^{jkl}	6.49 ± 0.02^{klm}	6.41 ± 0.04^{m}	6.47 ± 0.03^{e}
	Means	6.85 ± 0.02^{a}	6.77 ± 0.03^{b}	6.69 ± 0.03^{c}	
Flavor	T_{0a}	8.15 ± 0.03^{fg}	8.07 ± 0.04^{gh}	7.99 ± 0.02^{hi}	8.06 ± 0.03^{c}
	T_{0b}	8.56 ± 0.03^{a}	8.48 ± 0.02^{ab}	8.41 ± 0.02^{bc}	8.47 ± 0.02^{a}
	T_1	7.94 ± 0.03^{ij}	7.88 ± 0.02^{jk}	7.81 ± 0.02^{kl}	7.89 ± 0.02^{d}

		Storage period			
	T_2	7.79±0.03^{kl}	7.72±0.03^{lm}	7.67±0.04^{m}	7.74±0.03^{f}
	T_3	7.43±0.03^{n}	7.32±0.04^{o}	7.21±0.02^{p}	7.33±0.03^{g}
	T_4	8.44±0.02^{b}	8.32±0.02^{cd}	8.25±0.03^{de}	8.35±0.02^{b}
	T_5	8.20±0.05^{ef}	8.11±0.03^{fg}	7.98±0.02^{hi}	8.11±0.03^{c}
	T_6	7.93±0.03^{ij}	7.80±0.02^{kl}	7.66±0.04^{m}	7.81±0.03^{e}
	Means	8.06±0.03^{a}	7.96±0.03^{b}	7.87±0.03^{c}	
Overall Acceptability	T_{0a}	8.26±0.03^{a}	8.16±0.04^{b}	8.08±0.02^{bcd}	8.18±0.03^{a}
	T_{0b}	8.11±0.03^{bc}	8.04±0.02^{cde}	7.95±0.02^{efg}	8.02±0.02^{b}
	T_1	8.01±0.03^{def}	7.92±0.02^{fg}	7.86±0.02^{gh}	7.94±0.02^{c}
	T_2	7.82±0.03^{h}	7.77±0.03^{hi}	7.69±0.04^{ijk}	7.77±0.03^{d}
	T_3	7.72±0.03^{ij}	7.67±0.04^{jkl}	7.59±0.02^{lmn}	7.67±0.03^{e}
	T_4	7.71±0.02^{ijk}	7.66±0.02^{jklm}	7.58±0.03^{lmn}	7.66±0.02^{e}
	T_5	7.62±0.05^{klm}	7.57±0.03^{mn}	7.51±0.02^{n}	7.58±0.03^{f}
	T_6	7.65±0.03^{jklm}	7.57±0.02^{mn}	7.50±0.04^{n}	7.56±0.03^{f}
	Means	6.85±0.03^{a}	6.77±0.03^{b}	6.69±0.03^{c}	

T_{0a}=Control treatment for peach, T_{0b}=Control treatment for strawberry
T_1 =Peach juice+4% stevia (1g/250ml), T_2=Peach juice+6% stevia (1.5g/250ml)
T_3=Peach juice+8%stevia(2g/250ml), T_4=Strawberry juice+4% stevia (1g/250ml)
T_5=Strawberry juice+6%stevia (1.5g/250ml), T_6=Strawberryjuice+8%stevia(2g/250ml)

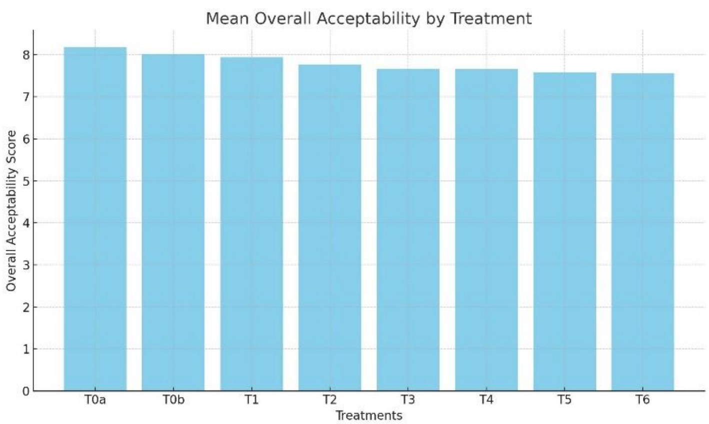

Figure 1 Mean Overall Acceptability by Treatment

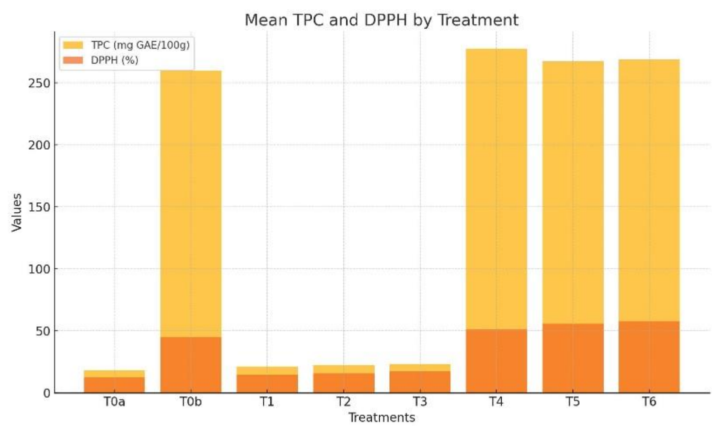

Figure 2 Mean TPC and DPPH by Treatment

DISCUSSION

The present study demonstrated a significant decrease in total phenolic content (TPC) during storage, which is attributed to natural degradation processes initiated by light exposure, oxygen availability, and enzymatic activity. Oxidation and polymerization reactions further contributed to the degradation of phenolic compounds, a trend supported by earlier research that reported similar declines in phenolic content over extended storage periods. Interestingly, stevia-treated juices exhibited initially higher TPC levels compared to control groups, suggesting that steviol glycosides may exert a stabilizing effect on phenolics during processing (16,17). These findings aligned with previous observations where stevia-enhanced fruit juices retained more phenolic compounds than their sucrose-based counterparts, though the decline during storage remained inevitable. Antioxidant activity, measured via DPPH radical scavenging capacity, also showed a marked reduction over the 30-day storage period. Although stevia treatments initially demonstrated higher antioxidant potential, this benefit diminished with time (18). The decline in DPPH activity is explained by the natural interaction of antioxidants with free radicals and the gradual breakdown of reactive antioxidant compounds, particularly in strawberry juices. The loss of activity was consistent with reports in other fruit-based beverages, highlighting the susceptibility of antioxidant constituents to storage-induced degradation (19,20). The stability of steviol glycosides over time, however, may provide a promising avenue for retaining some level of antioxidant protection even in the later stages of product shelf life.

Physicochemical properties, including total soluble solids (TSS), pH, and total acidity, responded predictably to the conditions of storage and stevia inclusion. TSS exhibited a slight rise over time, likely due to water evaporation and solute concentration. The increase in total acidity during storage was associated with the accumulation of organic acids such as citric acid and mild fermentation-related reactions. This trend has been observed in preserved juices and is consistent with previously documented chemical alterations in fruit juices subjected to natural or induced preservation techniques (21,22). Stevia at higher concentrations did not significantly alter reducing sugar levels, and instead, these sugars increased during storage, possibly due to sucrose hydrolysis into glucose and fructose. This observation supports the hypothesis that natural acids and low temperatures facilitate the breakdown of disaccharides into simpler sugars, enhancing sweetness without external sugar addition. The reduction in L*, a*, and b* color scores indicated progressive loss in color quality, likely due to pigment degradation, oxidation, and enzymatic browning. The presence of stevia did not prevent this phenomenon and, in some cases, appeared to accelerate discoloration when compared to control treatments (23). The deterioration of anthocyanins and carotenoids in fruit juices has long been recognized as a limiting factor in visual appeal, especially during extended storage. The lighter color in stevia-based formulations may reflect less Maillard browning due to the absence of sucrose but also highlights the need for pigment stabilization techniques in functional beverages (24). Sensory evaluation revealed that although stevia-based juices remained acceptable to panelists, sensory attributes such as flavor and taste declined steadily over time. Treatments with moderate stevia concentrations were more favorably received compared to those with higher levels, indicating that stevia's intensely sweet profile may become overpowering or interact unfavorably with fruit acids over time (25). These findings reinforce the importance of optimizing stevia concentration in juice formulations to strike a balance between sweetness and palatability.

One of the strengths of this study lies in its comprehensive evaluation of both peach and strawberry juices under standardized conditions, allowing for comparative insights across different fruit matrices. The inclusion of phytochemical, physicochemical, and sensory parameters offers a multidimensional understanding of product stability and consumer acceptability. Furthermore, the integration of natural non-caloric sweeteners into functional beverage development aligns well with current trends in health-conscious product innovation. However, several limitations must be acknowledged. The storage duration was restricted to 30 days, which, although sufficient for initial observations, does not reflect longer-term shelf-life considerations relevant to commercial distribution. The study did not assess microbial stability or potential fermentation effects, which are critical for ensuring product safety and integrity over extended storage. Additionally, pH values were not explicitly reported, despite being fundamental to interpreting the interplay between acidity and enzymatic activity. Future research should extend the storage duration beyond 30 days and include microbial analysis, shelf-life modeling, and advanced analytical techniques to assess anthocyanin stability, vitamin degradation, and aroma profile retention. It would also be beneficial to explore synergistic preservation strategies combining stevia with natural preservatives, antioxidants, or modified atmospheric packaging to enhance quality retention. Inclusion of a broader sensory panel with diverse demographic representation could further validate consumer acceptability across populations. In conclusion, this study provides valuable insights into the role of stevia as a functional sweetener in peach and strawberry juices, emphasizing its positive influence on phenolic retention and initial antioxidant activity. Nonetheless, the observed degradation trends during storage underline the need for formulation and processing innovations to ensure long-term quality, stability, and consumer satisfaction in naturally sweetened fruit-based beverages.

CONCLUSION

This study concluded that stevia serves as a viable and health-conscious alternative to conventional sugar in fruit-based beverages, particularly peach and strawberry juices. Its incorporation not only enhanced the antioxidant stability and preserved key physicochemical properties but also helped maintain better sensory quality during storage compared to sucrose-sweetened controls. The findings support the potential of stevia-sweetened juices as a functional and appealing option for individuals seeking to reduce sugar intake, particularly those at risk of metabolic disorders. Overall, this research contributes to the growing interest in natural sweeteners and offers a practical pathway toward healthier beverage formulations.

AUTHOR CONTRIBUTION

Author	Contribution
Saira Mukhtar*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nosheen Naz	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Fatima Mukhtar	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Faisal Mukhtar	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Virsha Shehzad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Nawal Waheed	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Ambreen Naz	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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