Research Article

Development and Storage Stability of Diet Mango Juice

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Abstract | The diet of mango juice was prepared by using non-nutritive sweeteners (cyclamate, sucralose, and aspartame) instead of sugar. The samples were filled and sealed in 300 ml of transparent glass bottles. Then diet mango juice samples were stored at room temperature for physicochemical analysis (Total soluble solids, ascorbic acid, pH, percent acidity, and sugar-acid ratio) and organoleptic evaluation (appearance, taste, flavor, overall acceptability) for three months. These were prepared with sweeteners, numbered as (T_0) pure mango juice (control sample), (T_1) mango juice+2.5g sucralose, (T_2) mango juice+2.5g cyclamate, (T_3) mango juice+2.5g aspartame, (T_4) mango juice+1.25g sucralose + 1.25g cyclamate, (T_5) mango juice+1.25g sucralose +1.25g aspartame, (T_6) mango juice+1.25g cyclamate + 1.25g aspartame and (T_7) mango juice+0.75g sucralose + 0.75g cyclamate + 0.75g aspartame. TSS, pH, and ascorbic acid content decreased while acidity increased in all samples at 90 days storage interval. In TSS maximum (53.65%) and minimum (30.95%) losses were recorded, while in ascorbic acid, the maximum loss in T_5 (44.77%) and minimum in T_6 (32.59%) were recorded. Similarly, the maximum increase in pH was determined in T_6 (4.85%) and minimum in T_7 (2.53%) while in acidity, the maximum increase in T_6 (0.26%) and minimum in T_0 (0.25%) were determined. In the sugar-acid ratio, the maximum loss in T_0 (74.61%) and minimum in T_6 (73.48%) were recorded. During storage taste, flavor, color and overall acceptability were also affected. The maximum mean score in color (8.14), flavor (7.64), taste (6.70), and overall acceptability (7.37) were recorded while the minimum mean score in appearance (7.22), flavor (6.52), taste (5.91), and overall acceptability (6.39) were recorded. During the study, (T_6) mango juice+1.25g cyclamate + 1.25g aspartame was found and it was the most acceptable product by taste panel amongst the samples. Results of statistical analysis and internal comparison were found significant ($P<0.05$) at 90 days of storage.

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Introduction

Mango (*Mangiferaindica* L.) belonging to the family Anacadiacease, is the largest and vital tropical fruit. It is grown in most tropical and subtropical countries. It originated in tropical to sub-tropical monsoon areas in the foothills of the Himalayas, especially Burma and eastern parts of India. Afterward, it spread to Africa, Brazil, the Caribbean, and Central America. The production of mangoes in Pakistan is on large scale. The main varieties grown in Pakistan are Chaunsa, Sindhri, Langra, Dasehri, Anwar Ratool, Saroli, Samar Bahisht, TootaPari, Fajri, Neelum, Alphanso, Almas, Sanwal, Surkha, Sunera, and Desi. In Pakistan, the covered area for mango cultivation is 171.3 thousand hectares and

1658.6 thousand tons of mangoes were produced during the year 2013-14. Among this, the covered area and mango production in Punjab was 107.1 thousand hectares and 1252 thousand tons respectively, in Khyber Pakhtunkhwa the area and production of mango were 0.4 thousand hectares and 3.0 thousand tons respectively. Mostly mango is consumed as fresh fruit. It can't be stored for a long time because it is perishable. Mango is prepared in many ways to make pulp, ready to serve, juices, chutneys, pickles, jams, nectars, toffees mango, mango slices canned and frozen mango slices, etc. It is also used to make jellies, ice cream, milkshakes, fruit cocktails and topping products. Because of its attractive taste and flavor, mango based drink juice taste and aroma it is liked by most people. Sugar is the main ingredient used in the drink mango provides 394 Cal per 100 g (Gamman, 1981).

Besides, alternative sweeteners do not stimulate an insulin response (Benton, 2005; Kant, 2005). In 1976, British researchers discovered Sucralose. Sucralose is made from sugar in a multistep chemical process in which three hydrogen-oxygen groups are replaced with chlorine atoms. During cooking and baking, Sucralose is heat stable and is about 600 times sweeter than sugar. It can be used in a vast variety of foods and beverages. Sucralose does not promote tooth decay (USFDA, 1998c). Sucralose is considered safe for all peoples including those who have chronic health problems such as diabetes. A study of 128 people having diabetes was conducted in which sucralose is administered at a dose of 3 times the maximum estimated intake, showed no antagonistic effect on any control blood glucose measurement (Grotz *et al*., 2003).

Cyclamate is very stable, but its sweetness is less intense than that of other sweeteners low in calories only 30 times that of sugar, which means that relatively large amounts (compared to other low-calorie sweeteners) need be used to sweeten food or drink (DuBois, 2000). Aspartame is broadly used in foods and beverages; mainly its taste is very closer to sucrose (DuBois, 2000). Using an alternative sweetener like aspartame can obtain a similar taste sweet sugar cleaned with power 200 times the sweetness of sucrose. Aspartame stability is a function of temperature, time, and pH (Bell and Labuza, 1991) and the other compounds' effect is not important (Homler, 1984). By adding KMS Fruit pulp can preserve for one year at room temperature.

Objectives of the study

1. To reduce the post-harvest losses of mango fruit.
2. To develop diet mango juice with non-nutritive sweeteners.
3. To study the effect of storage on the overall acceptability of mango beverage (Based on the physicochemical and sensory analysis).

Materials and Methods

This research study was conducted at the Food Processing and Quality control Laboratory of Pakistan Council of Scientific and Industrial Research (PCSIR), Peshawar, Khyber Pakhtunkhwa. Pakistan. Fully ripened, sound, and healthy mangoes were purchased from the local market of Peshawar city and were brought to the Food Process Development Section, PCSIR Labs Peshawar. The mangoes were washed with tap water to remove the dirt/dust and then sorted for diseased and bruised fruits. Mangoes were peeled manually and cut into slices. The pulp was obtained by using a mechanical pulper machine.

Preparation of drink

The drink samples were prepared by mixing pulp, water, and non-nutritive sweeteners in the suitable ratio given below, while citric acid was added for maintaining acidity, and potassium Meta bisulphate was added as a chemical preservative at the rate of 0.06% (Jahangir, 2003).

The control drink (with sucrose) was prepared by using the formula given below:

Pulp: Sugar: water
1: 1: 4

Similarly, other research samples were prepared according to the above formula, where sucrose was replaced with other synthetic low-caloric sweeteners. For 2.5 liters drink the total amount of low caloric sweetener was as under.

Proposed plan of study

T_0= Pure Mango Juice; T_1= mango juice+2.5g sucralose; T_2= mango juice+2.5g cyclamate; T_3= mango juice+2.5g aspartame; T_4= mango juice+1.25g sucralose+1.25g cyclamate; T_5= mango juice+1.25g sucralose+1.25g aspartame; T_6= mango juice+1.25g cyclamate+1.25g aspartame; T_7= mango juice+0.75g sucralose+0.75g cyclamate+0.75g aspartame.

Packing and storage of drink

The prepared drink of samples was filled in 250 ml capacity transparent glass bottles and was packed, stored at room temperature for physicochemical and organoleptic evaluation at an interval of 15 days for a total period of 90 days.

Physicochemical analysis

pH, TSS, titratable acidity, ascorbic acid, were evaluated by the standard method of AOAC (2012).

pH

pH was measured by pH meter using a standard buffer solution of ph 4 to 9, then washed electrode with distilled water and dried with cotton AOAC (2012).

Total soluble solids

TSS the acidity was determined by AOAC (2012) by using a hand refractrometer at room temperature.

Total treatable acidity (%)

Total treatable acidity was calculated by the standard method of AOAC (2012) using standard alkali solution against titrating with NaOH solution. Percent Acidity will be calculated by the following formula, N1 V1 -= N2 V2.

Ascorbic acid

Ascorbic acid was calculated by the standard method of AOAC (2012), using standard ascorbic acid, oxalic acid solution (0.4%), 2-6 dichlorophenol indophenol dye, and sodium bicarbonate.

Organoleptic evaluation

The samples were studied organoleptically for appearance, flavor, sweetness, after-taste, and overall acceptability by using 09 points hedonic scale of Larmond (1977).

Statistical analysis

Using Complete Randomized Design (CRD), a two factorial data was evaluated statistically and means were separated by LSD test at 5% level of significance as described by Steel *et al.* (1997).

Results and Discussion

Mango juice was prepared by mixing pulp, sugar, and water for the control sample, and for additional samples of diet juice instead of sugar, non-nutritive intensive sweeteners were added in the proportions as 1:1:4. The citric acid (1%) was added to maintain acidity, and potassium meta-bisulphite was added as a preservative in an amount of 0.06% on each formulation. The juice was stored in 300ml transparent glass bottles at room temperature and then properly sealed. Ascorbic acid content, pH, TSS, and titratable acidity in the range of 15 days were analyzed for a total period of 90 days. The samples were studied organoleptically for Appearance, color, aroma, flavor, and overall acceptability The TSS of natural mango juice was 12° Brix.

pH

The diet mango juice samples were analyzed physicochemically at 15 days storage interval for a total period of 90 days. During this storage process decrease in the level of this content was recorded.

In T_0 the decrease in pH was observed and recorded from the range of 3.96 to 3.81(initial reading to 90 days of storage). Similarly, in T_1 the decrease in pH is 3.98to3.83 (initial reading to 90 days of storage). In $T_2$the decrease is 3.97to 3.88 (initial reading to 90 days of storage). In T_3 the decrease in pH was recorded from the range of 3.96 to 3.81, In $T_4$3.97 to 3.82. Similarly, in T_5 3.99 to 3.83. In T_6decrease is 3.99to3.86. In T_7 the decrease in pH was ranged from 3.99to3.77 (initial reading to 90 days of storage).

The maximum mean score in pH was noticed in T_6 (3.93) and the minimum mean score in pH was observed in T_0 (3.87), (Table 1) after 90 days storage period. The percent decrease in pH in all treated and control samples was T_0 control (3.78), T_1 (3.76), T_2 (2.26),T_3(3.78),T_4(3.77),T_5(4.01),T_6(3.25),T_7(5.51).

The results of the study for pH conclude that during the storage period the means were significantly different ($P<0.05$). Similarly, the internal comparison between treated and control samples revealed significantly different from each other. The results of the current study are in agreement with the finding of the study conducted by Jahangir (2003) who also found a significant decrease in the pH of mango drink. The minimum and a maximum increase of 3.87% and 3.93% of the current study is also in line with the past studies conducted by different researchers.

Storage study

Total soluble solids (TSS): In T_0 the decrease in TSS

was observed from the range of 4.1 ^{0}brix initial reading, 3.5 during 15 days, 3.2 during 30, 2.9 during 45, 2.7 during 60, 2.3 during 75, and 1.9 ^{0}brix during 90 days of storage. Similarly, in T_1 4.3to 2.2 ^{0}brix (initial reading to 90 days of storage). In T_2 the decrease, the range is from 4.3to 2.4 ^{0}brix. In T_3 the decrease range is 4.3 to 2.4 ^{0}brix, In T_4 4.2 to 2.0 ^{0}brix. Similarly, in T_5, the decrease in TSS was ranged from 4.2to 2.4 ^{0}brix, in the same way, in T_6 4.2 to 2.9 ^{0}brix. In T_7 the decrease range is from 4.2to 2.3 ^{0}brix. The maximum decrease in TSS was observed in T_0 (53.65%) and the minimum decrease in TSS was noted in T_6 (30.95%), (Table 2) after 90 days storage period. The percent decrease in TSS in all treated and control samples was T_0 control (53.65%), T_1 (48.83%), T_2 (44.18%), T_3 (46.51%), T_4 (52.38%), T_5 (42.85%), T_6 (30.95%), T_7 (45.23%).

The results of the study for total soluble solids (TSS) indicate that during the storage period the means were significantly different (P<0.05). Similarly, the internal comparison between treated and control samples revealed significantly different from each other. The results of the current research are matched with the finding of the study conducted by Jahangir (2003) and Durrani *et al.* (2011), who also recorded a significant decrease in TSS of diet mango juice. The minimum and maximum decrease of 30.95% and 53.65% of the current study is also in line with the past studies conducted by different researchers.

Table 1: *Effect of storage on pH of diet mango juice.*

Treatments	Storage interval (Days)							Means	S.D	% Decrease
	Initial reading	15	30	45	60	75	90			
	pH									
T_0	3.96	3.92	3.89	3.87	3.84	3.82	3.81	3.87f	0.00574	3.78
T_1	3.98	3.96	3.93	3.90	3.87	3.85	3.83	3.90cd	0.00132	3.76
T_2	3.97	3.95	3.93	3.91	3.89	3.87	3.88	3.91b	0.00221	2.26
T_3	3.96	3.92	3.90	3.87	3.85	3.83	3.81	3.87f	0.00574	3.78
T_4	3.97	3.95	3.92	3.89	3.86	3.84	3.82	3.89e	0.00221	3.77
T_5	3.99	3.97	3.94	3.90	3.87	3.85	3.83	3.90c	0.00486	4.01
T_6	3.99	3.97	3.95	3.94	3.93	3.89	3.86	3.93a	0.00486	3.25
T_7	3.99	3.97	3.95	3.92	3.87	3.82	3.77	3.89d	0.00486	5.51
Mean	3.97a	3.95b	3.92c	3.9d	3.87e	3.84f	3.82g			
S.D	0.03293	0.01781	0.00647	0.0010	0.01241	0.01997	0.02375			

Figure bearing the different letters are statistically different (P < 0.05) from each other.

Table 2: *Effect of storage on total soluble solids (TSS) ^{0}Brix of diet mango juice.*

Treatments	Storage interval (Days)							Mean	S.D	% Decrease
	Initial reading	15	30	45	60	75	90			
	TSS (^{0}Brix)									
T_0	4.1	3.5	3.2	2.9	2.7	2.3	1.9	2.04de	0.04419	53.65
T_1	4.3	3.8	3.6	3.3	3.1	2.8	2.2	3.4b	0.02651	48.83
T_2	4.3	3.7	3.4	3.2	3.0	2.7	2.4	3.34b	0.02651	44.18
T_3	4.3	3.5	3.3	3.0	2.8	2.6	2.3	3.21c	0.02651	46.51
T_4	4.2	3.2	3.0	2.9	2.6	2.3	2.0	2.98e	0.00883	52.38
T_5	4.2	3.2	3.1	3.0	2.8	2.6	2.4	3.14cd	0.00883	42.85
T_6	4.2	3.9	3.6	3.5	3.2	3.0	2.9	3.57a	0.00883	30.95
T_7	4.2	3.1	2.9	2.7	2.6	2.4	2.3	2.98e	0.00883	45.23
Mean	4.225a	3.4875b	3.2625c	3.0625d	2.85e	2.5875f	2.3g			
S.D	0.4373	0.2105	0.0971	0.0161	0.09179	0.2429	0.3941			

Figure bearing the different letters are statistically different (P < 0.05) from each other.

Acidity

The Acidity of the entire diet mango juice sample was studied. In T_0 the increase in Acidity was observed from the range of 0.17% in the initial reading, 0.21 during 15 days, 0.24 during 30, 0.26 during 45, 0.27 during 60, 0.29 during 75, and 0.31% during 90 days of storage. Also, in T_1 0.15 to 0.30% (initial reading to 90 days of storage). In the same way, in T_2 0.15 to 0.31%, In T_3 0.13 to 0.32%. In T_4 the increase in Acidity was ranged from 0.14 to 0.34%. Similarly, in T_5 0.14to 0.35% In the same way, in T_6 0.15to 0.41% and T_7 0.15 to 0.35% (initial reading to 90 days of storage).

The maximum increase in Acidity was noticed in T_6 (173.3%) and the minimum increase in Acidity was noticed in T_0 (82.35%), (Table 3) after 90 days storage period. The percent increase in acidity in all treated and control samples was T_0 control (82.35%), T_1 (100%), T_2 (106.6%), T_3 (146.1%), T_4 (142.85%), T_5 (150%), T_6 (173.3%), T_7 (133.3%).

The results of the study for acidity in diet mango juice conclude that the means were significantly different ($P<0.05$) during the storage period. Similarly, the internal comparison between treated and control samples revealed significantly different from each other. The results of the current research are similar to the finding of the study conducted by Jahangir (2003), who also found a significant increase in acidity of diet mango juice. The results of the current study for the minimum and maximum increase of 82.35% and 173.3% in means for acidity is also found in agreement with the past studies conducted by different researchers.

Ascorbic acid (Vit. C)

In T_0 the decrease in ascorbic acid was recorded from the range of 16.25 mg/100g in initial reading, 14.75 during 15 days, 13.93 during 30, 12.50 during 45, 12.01 during 60, 10.12 during 75, and 9.36 mg/100g during 90 days of storage. Similarly, in T_1 16.30 mg/100g to 10.28 mg/100g (initial reading to 90 days of storage). In the same way, in T_2 16.15 to 10.36 mg/100g, In T_3 16.10 to 10.00 mg/100g while in T_4 16.30 to 9.97 mg/100g during 90 days of storage. Similarly, in T_5 16.28 to 8.99 mg/100g, in T_6 16.29 to 10.98 mg/100g and in T_7 16.18 to 9.87 mg/100g (initial reading to 90 days of storage).

The maximum decrease in ascorbic acid was observed in T_5 (44.77%) and the minimum decrease in ascorbic acid was observed in T_6 (32.59%), (Table 4) after 90 days of storage period. The percent decrease in ascorbic acid in all treated and control samples was T_0 control (42.4%), T_1 (36.39%), T_2 (35.85%), T_3 (37.88%), T_4 (38.83%), T_5 (44.77%), T_6 (32.59%), T_7 (38.99%).

The results of the study for ascorbic acid conclude that the means were significantly different ($P<0.05$) during the storage period. Similarly, the internal comparison between treated and control samples revealed significantly different from each other. The results of the current study are similar to the finding of the study conducted by Jahangir (2003), Durrani *et al.* (2011), who also found a significant decrease in ascorbic acid of diet mango juice. The results of the current study for the minimum and maximum increase of 32.59% and 44.77% in means for ascorbic acid is also found in agreement with the past studies conducted by different researchers.

Table 3: *Effect of storage on acidity of diet mango juice.*

Treatments	Storage interval (Days)							Means	S.D	% increase
	Initial reading	15	30	45	60	75	90			
	Treatable acidity (%)									
T_0	0.17	0.21	0.24	0.26	0.27	0.29	0.31	0.25c	0.007955	82.35
T_1	0.15	0.17	0.20	0.23	0.26	0.29	0.30	0.22f	0.000884	100
T_2	0.15	0.19	0.21	0.22	0.25	0.28	0.31	0.23ef	0.000884	106.6
T_3	0.13	0.16	0.19	0.21	0.25	0.27	0.32	0.21g	0.006187	146.1
T_4	0.14	0.17	0.19	0.23	0.26	0.31	0.34	0.23e	0.002652	142.85
T_5	0.14	0.15	0.20	0.26	0.29	0.32	0.35	0.24d	0.002652	150
T_6	0.15	0.19	0.23	0.27	0.28	0.35	0.41	0.26a	0.000884	173.3
T_7	0.15	0.17	0.21	0.29	0.31	0.33	0.35	0.25b	0.000884	133.3
Mean	0.14g	0.17f	0.20e	0.24d	0.27c	0.30b	0.33a			
S.D	0.0302	0.0151	0.0037	0.0037	0.0075	0.0151	0.0226			

Figure bearing the different letters are statistically different ($P < 0.05$) from each other.

Acid ratio

The mean score for the sugar-acid ratio of the samples recorded initially from T_0 to T_7 was 24.11, 28.66, 28.66, 33, 30, 30, 33.07, and 28 which was gradually decreased to 6.12, 7.33, 7.74, 7.18, 5.88, 8.77 and 6.38 respectively during 90 days of storage interval. The mean value for the sugar-acid ratio of samples was (T_0) 12.76, (T_1) 16.04, (T_2) 15.46, (T_3) 16.36, (T_4) 14.36, (T_5) 14.71, (T_6) 17.31, (T_7) 13.05 as shown in Table 5.

The maximum decrease in sugar-acid ratio was noticed in T_4 (80.4%) and the minimum decrease in taste was observed in T_2 (72.99%), after 90 days storage period (Table 5). During storage, results showed a significant (P<0.05) difference for the sugar-acid ratio of different juice samples and internal comparison between all samples also showed statistically significant results (P<0.05). These results are in agreement with the finding of Jahangir, (2003), that blends of sweeteners were more similar to sucrose than any individual sweetener.

Organoleptic evaluation

The diet mango juice samples were organoleptically evaluated for flavor, color, after-taste, and overall acceptability after 15, 30, 45, 60, 75, and 90 days of storage. A 9-point hedonic scale was used ranging from 1-9, where 1 was for "extremely dislike", 2 for "Dislike very much", 3 for "Dislike moderately", 4 for "Dislike slightly", 5 for "Neither like nor Dislike", 6 for "Like slightly", 7 for "Like moderately", 8 for "Like very much" and 9 for "Extremely like".

Table 4: *Effect of storage on ascorbic acid (mg/100ml) of diet mango juice.*

Treatments	Storage interval (Days)							Means	S.D	% Decrease
	Initial reading	15	30	45	60	75	90			
	Ascorbic acid (mg/100ml)									
T_0	16.25	14.75	13.93	12.50	12.01	10.12	9.36	12.70e	0.0066	42.4
T_1	16.30	14.50	13.76	12.00	11.91	11.75	10.28	12.92c	0.0243	36.93
T_2	16.15	14.37	14.18	13.50	12.96	12.29	10.36	13.40b	0.0287	35.85
T_3	16.10	13.93	13.22	12.56	12.10	11.54	10.00	12.77de	0.0464	37.88
T_4	16.30	14.36	13.96	13.18	11.44	10.98	9.97	12.88cd	0.0243	38.83
T_5	16.28	14.10	13.58	11.55	10.23	9.57	8.99	12.04f	0.0172	44.77
T_6	16.29	15.18	14.97	13.86	13.90	11.22	10.98	13.77a	0.0207	32.59
T_7	16.18	14.34	13.92	12.77	11.88	10.24	9.87	12.74e	0.0181	38.99
Mean	16.23 a	14.44b	13.94c	12.74d	12.05e	10.96f	9.97g			
S.D	1.3406	0.7737	0.4638	0.0766	0.2618	0.9762	1.2634			

Figure bearing the different letters are statistically different (P < 0.05) from each other.

Table 5: *Effect of storage on sugar acid ratio of diet mango juice.*

Treatments	Storage interval (Days)							Means	S.D	% Decrease
	Initial reading	15	30	45	60	75	90			
	Sugar acid ratio									
To	24.11	16.66	13.33	11.15	10	7.93	6.12	12.76e	1.8835	74.61
T_1	28.66	22.35	18	14.34	11.92	9.65	7.33	16.04b	0.2748	74.42
T_2	28.66	19.47	16.19	14.54	12	9.64	7.74	15.46c	0.2748	72.99
T_3	33	21.87	17.36	14.28	11.2	9.62	7.18	16.36b	1.2595	78.24
T_4	30	18.82	15.78	12.6	10	7.41	5.88	14.36d	0.1988	80.4
T_5	30	21.33	15.5	11.53	9.65	8.12	6.85	14.71d	0.1988	77.16
T_6	33.07	23.32	18.01	15.45	12.22	10.34	8.77	17.31a	1.2842	73.48
T_7	28	18.23	13.8	9.31	8.38	7.27	6.38	13.05e	0.5082	77.21
Mean	29.44a	20.26b	16.00c	12.90d	10.67e	8.75f	7.03g			
S.D	4.2909	1.4751	0.2165	0.6074	1.0421	1.8244	2.5086			

Figures bearing the different letters are statistically different (P < 0.05) from each other.

Color

The mean score for the color of the samples recorded by a panel of judges initially from T_0 to T_7 was 8.2, 8.0, 8.6, 8.5, 8.2, 8.3, 8.8, 8.9 which was gradually decreased to 6.2, 7.1, 6.7, 7.3, 7.0, 7.1, 7.7 and 7.3 respectively during 90 days of storage interval. The mean value for the color of the samples were (T_0) 7.22, (T_1) 7.55, (T_2) 7.77, (T_3) 7.97, (T_4) 7.62, (T_5) 7.72, (T_6) 8.14, (T_7) 8.01 as shown in Table 6. The maximum decrease in color was noticed in T_0 (24.39%) and the minimum decrease in color was observed in T_1 (11.26%), after 90 days storage period (Table 6). Results showed a significant ($P<0.05$) difference for the color of different juice samples during storage and internal comparison between all samples also showed statistically significant results ($P<0.05$).

Sugar

The results of the current study are in agreement with the results of the study conducted by Jahangir, (2003), who also found a significant decrease in the color of diet mango squash. The results of the current study for the minimum and maximum increase of 11.26% and 24.39% in means for color is also found in agreement with the past studies conducted by different researchers.

Flavor

The mean score for the flavor of the samples recorded by a panel of judges initially from T_0 to T_7 was 8.7, 8.2, 8.5, 8.1, 8.0, 8.1, 8.3, and 8.5 which was gradually decreased to 4.2, 6.6, 6.4, 6.6, 6.5, 6.8, 6.9 and 6.2 respectively during 90 days of storage interval. The mean value for the appearance of samples was (T_0) 6.52, (T_1) 7.42, (T_2) 7.51, (T_3) 7.37, (T_4) 7.2, (T_5) 7.35, (T_6) 7.64, (T_7) 7.44 as shown in Table 7. The maximum decrease in flavor was noticed in T_0 (51.72%) and the minimum decrease in flavor was observed in T_5 (16.04%), after 90 days storage period (Table 7).

Table 6: *Effect of storage on color of diet mango juice.*

Treatments	Storage interval (Days)									
	Initial reading	15	30	45	60	75	90	Means	S.D	% Decrease
	Color (score rate)									
T_0	8.2	8.0	7.5	7.2	6.9	6.6	6.2	7.22f	0.0839	24.39
T_1	8.0	7.9	7.7	7.5	7.4	7.3	7.1	7.55e	0.1546	11.26
T_2	8.6	8.4	8.1	7.8	7.6	7.2	6.7	7.77c	0.0574	22.09
T_3	8.5	8.4	8.2	8.0	7.8	7.6	7.3	7.97b	0.0220	14.11
T_4	8.2	8.0	7.8	7.7	7.4	7.3	7.0	7.62de	0.0839	14.63
T_5	8.3	8.1	7.9	7.8	7.6	7.3	7.1	7.72cd	0.0486	14.45
T_6	8.8	8.5	8.3	8.1	7.9	7.7	7.7	8.14a	0.1281	12.5
T_7	8.9	8.6	8.2	8.0	7.7	7.4	7.3	8.01b	0.1635	17.97
Mean	8.43a	8.23b	7.96c	7.76d	7.53e	7.3f	7.05g			
S.D	0.3671	0.2915	0.1025	0.0107	0.1241	0.2375	0.3887			

Figure bearing the different letters are statistically different ($P < 0.05$) from each other.

Table 7: *Effect of storage on flavor of diet mango juice.*

Treatments	Storage Interval (Days)							Means	S.D	% Decrease
	Initial reading	15	30	45	60	75	90			
	Flavor (score rate)									
T_0	8.7	7.8	7.1	6.4	6.2	5.3	4.2	6.52e	0.1414	51.72
T_1	8.2	8.0	7.7	7.4	7.3	6.8	6.6	7.42bc	0.0353	19.51
T_2	8.5	8.2	7.9	7.6	7.1	6.9	6.4	7.51b	0.0707	24.70
T_3	8.1	8.0	7.7	7.3	7.1	6.8	6.6	7.37c	0.0707	18.51
T_4	8.0	7.8	7.5	7.1	6.8	6.7	6.5	7.2d	0.1060	18.75
T_5	8.1	7.9	7.6	7.2	7.0	6.9	6.8	7.35c	0.0707	16.04
T_6	8.3	8.1	7.9	7.7	7.4	7.2	6.9	7.64a	0	16.86
T_7	8.5	8.3	8.0	7.4	7.1	6.6	6.2	7.44bc	0.0707	27.05
Mean	8.3 a	8.01b	7.67c	7.26d	7e	6.65f	6.27g			
S.D	0.8207	0.4805	0.2159	0.0485	0.1241	0.4643	0.8801			

The figure bearing the different letters are statistically different ($P < 0.05$) from each other.

Results showed a significant (P<0.05) difference for the flavor of different juice samples during storage and internal comparison between all samples also showed statistically significant results (P<0.05). The results of flavor (Table 7) showed an excellent consumer acceptance for T_6 (7.64) containing cyclamate and aspartame compared to other combinations. The results of the current study are similar to the finding of the study conducted by Jahangir, (2003), Durrani *et al*. (2011), who also found a significant decrease in the flavor of diet mango squash. The results of the current study for the minimum and maximum increase of 16.04% and 51.72% in means for flavor is also found in agreement with the past studies conducted by different researchers.

Taste

The mean score for the taste of the samples recorded by a panel of judges initially from T_0 to T_7 was 7.5, 7.2, 7.8, 7.5, 7.1, 7, 7.9, and 7.2 which was gradually decreased to 3.5, 5.1, 5.3, 5.6, 5.1, 5.1, 5.8 and 5.2 respectively during 90 days of storage interval. The mean value for the appearance of samples was (T_0) 5.91, (T_1) 6.01, (T_2) 6.51, (T_3) 6.47, (T_4) 6.19, (T_5) 5.99, (T_6) 6.70, (T_7) 6.26 as shown in table 8. The maximum decrease in taste was noticed in T_0 (53.33%) and the minimum decrease in taste was observed in T_4 (19.71%), (Table 8) after 90 days storage period.

Results showed a significant (P<0.05) difference for the taste of different juice samples during storage and internal comparison between all samples also showed statistically significant results (P<0.05). The results of taste showed excellent consumer acceptance for T_6 (6.70) containing cyclamate and aspartame compared to other combinations. There was deterioration in the taste of all samples over time (Table 8). The results of the current study are similar to the finding of the study conducted by Jahangir, (2003), who also found a significant decrease in the taste of diet mango squash. The results of the current study for the minimum and maximum increase of 19.71% and 53.33% in means for taste are also found in agreement with the past studies conducted by different researchers.

Overall acceptability

The mean score for overall acceptability of the samples recorded by a panel of judges initially from T_0 to T_7 was 8.5, 8.7, 8.8, 8.6, 8.7, 8.6, 8.3, and 8.8 which was gradually decreased to 4.2, 5.8, 5.7, 5.9, 6, 5.9, 6.2 and 5.1 respectively during 90 days of storage interval. The mean value for overall acceptability of samples was (T_0) 6.39, (T_1) 7.23, (T_2) 7.20, (T_3) 7.07, (T_4) 7.30, (T_5) 7.30, (T_6) 6.37, (T_7) 6.69 as shown in Table 9. The maximum decrease in overall acceptability was noticed in T_0 (50.58%) and the minimum decrease in overall acceptability was observed in T_6 (25.30%), (Table 9) after 90 days storage period.

Results showed a significant (P<0.05) difference for the overall acceptability of different juice samples during storage and internal comparison between all samples also showed statistically significant results (P<0.05). These results are in agreement with the finding of Jahangir, (2003), that blends of sweeteners were more similar to sucrose than any individual sweetener.

Table 8: *Effect of storage on taste of diet mango juice.*

Treatments	Storage Interval (Days)									
	Initial reading	15	30	45	60	75	90	Means	S.D	% Decrease
	Taste (score rate)									
T_0	7.5	7.4	6.6	6.1	5.5	4.8	3.5	5.91f	0.0353	53.33
T_1	7.2	6.8	6.4	5.9	5.4	5.3	5.1	6.01e	0.0707	29.16
T_2	7.8	7.2	6.9	6.6	6.1	5.7	5.3	6.51b	0.1414	32.05
T_3	7.5	7.1	6.9	6.3	6.1	5.8	5.6	6.47b	0.0353	25.33
T_4	7.1	6.8	6.5	6.1	5.9	5.8	5.1	6.19d	0.1060	19.71
T_5	7	6.6	6.2	5.9	5.6	5.5	5.1	5.99e	0.1414	27.14
T_6	7.9	7.3	7	6.7	6.3	5.9	5.8	6.70a	0.1767	26.58
T_7	7.2	7.1	6.7	6.3	5.8	5.5	5.2	6.26c	0.1767	27.77
Mean	7.40a	7.04b	6.65c	6.24d	5.84e	5.54f	5.09g			
S.D	0.599344	0.5615	0.2591	0.0701	0.1565	0.4211	0.9125			

The figure bearing the different letters are statistically different (P < 0.05) from each other.

Table 9: *Effect of storage on overall acceptability of diet mango juice.*

Treatments	Storage interval (Days)							Means	S.D	% Decrease
	Initial reading	15	30	45	60	75	90			
	Over all acceptability (score rate)									
T_0	8.5	7.9	7.2	6.5	5.4	5	4.2	6.39e	0.0441	50.58
T_1	8.7	8.2	7.7	7.2	6.8	6.2	5.8	7.23b	0.0265	33.33
T_2	8.8	8.1	7.8	7.2	6.7	6.1	5.7	7.20b	0.0618	35.22
T_3	8.6	8.1	7.5	7	6.4	6	5.9	7.07c	0.0088	31.39
T_4	8.7	8	7.7	7.3	6.9	6.5	6	7.30ab	0.0265	31.03
T_5	8.6	8.1	7.8	7.3	6.8	6.6	5.9	7.30ab	0.0088	31.39
T_6	8.3	8.2	7.9	7.4	7	6.6	6.2	7.37a	0.1149	25.30
T_7	8.8	8.2	7.5	6	5.7	5.5	5.1	6.69d	0.0618	42.04
Mean	8.63a	8.10b	7.64c	6.99d	6.46e	6.06f	5.60g			
S.D	0.7991	0.5723	0.3077	0.0431	0.3725	0.5237	0.8261			

The figure bearing the different letters are statistically different ($P < 0.05$) from each other.

Conclusions and Recommendations

From the current research, we conclude that diet mango juice having a combination of 1.25g cyclamate and 1.25g aspartame showed the best results followed by the sample having a single sweetener about sensory characteristics.

During the three-month storage interval, a decrease was recorded in all samples of ascorbic acid, TSS, PH, and Acidity. Statistical analysis showed that taste, color, the flavor was highly affected by treatment and storage period.

Expanding the core of study on this project will further help in the future in certain areas and the following concluding recommendation will be helpful in further studies regarding the title.

- The same research work should be administrated on other fruits.
- This research study was also conducted at refrigeration temperature.
- Using colored glass bottles for the storage of samples of this research will further elaborate its physicochemical stability as well as helpful in sensory evaluation studies.

Novelty Statement

This study is novel as the research is based on using non-nutritive sweeteners (cyclamate, sucralose and aspartame) instead of sugar for diet mango juice.

Author's Contribution

Zaka ur Rehman: Did research, data analysis and wrote draft of the manuscript.
Kashif Akbar: Helped in analysis.
Altaf ur Rehman: Provided technical support.
Hassan Waqas: Worked in experiments.
Alif Khan: Helped in manuscript format.
Asad Ali: Provided technical and guidelines.

Conflict of interest
The authors have declared no conflict of interest.

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