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Effect of Preservatives and Storage Temperatures on the Quality of Mango Slices Dipped in Sugar Solution

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Abstract

This research was carried out to develop mango slices with the addition of different chemical preservatives with enhanced physicochemical sensory and storage properties at two different temperatures (Room and refrigeration). The treatments with different Chemical preservatives were prepared and were observed for different physiochemical & sensory properties at 15 days interval for 90 days. Results showed significant increase in TSS (20.72 to 20.20 0brix); Titratable acidity (1.18% to 1.48%); and Reducing sugar (7.57% to 11.65%), while a significant decrease in pH (4.43 to 3.21); Ascorbic acid (30.41 to 20.01 mg/100 g); Sugar Acid ratio (18.17 to 14.64); Non reducing sugar (9.56% to 7.72%) color (8.51 to 7.72); Flavor (8.60 to 4.59) and Overall acceptability (8.525 to 4.40). Throughout storage interval, it was observed that Treatment MS7 (40% sugar solution+0.3% citric acid+Refrigeration temperature+0.1% KMS+Mango slices) was acceptable physicochemically and organoleptically, and we recommend it for commercial use.

Keywords: Mango slice; Chemical preservatives; Storage temperatures; Sugar solution

Introduction

Mango is a tropical fruit with a rich source of vitamin A, C, E, potassium, iron, and Carotenoids, etc. [1]. In the current world market, 76% of mango production captured by the Asian market, followed by America with 13.38%, Africa 9% and Europe less than 1% [2]. However, Pakistan is the fifth largest producer with (one million tons per annum) and has the capacity to export 80,000 tons annually [3]. Mango is a seasonal fruit which cannot be preserved longer due to its perishable nature, Therefore, researchers are trying to preserve mango in the form of different Food products I:e mango drinks [4]. Mango liquid form varies on how people manage its shelf life, which further depends on different temperature scales. Normally, it requires 4 to 8 days room temperature and 2 to 3 weeks in cold storage at 13°C [5]. Moreover, many cases have been reported regarding inappropriate storage and lack of technical knowledge made the loss of 20%-30% to business traders. Whereas, cheap methods of preservation techniques implemented to produce supreme quality to allow better utilization of mango [6]. However, various research programs have been introduced to preserve its quality measures by adding different chemical preservatives (Potassium Metabisulphite, Potassium Sorbate, and Sodium Benzoate) which results in retaining overall acceptability of nutrients stability and reduce microbial load. In the current research, mango slices were dipped in sucrose solution up to 40% with multiple preservatives like (potassium metabisulphite, potassium sorbate, and sodium benzoate) of same concentration solution in glass bottles in refrigeration, and room temperature.

Materials and Methods

This research was conducted in the laboratory of Department of Food Science and Technology, The University of Agriculture Peshawar.

Material and sample preparation

Selection of fruit and preparation of slice: Healthy and sound mango of optimal maturity and proper sizes were taken from the fruit market of Peshawar city and were transported to the laboratory of Department of Food Science And Technology, The University of Agricultural, Peshawar-Pakistan. After washing and peeling the whole fruit was sliced and placed in glass bottle jar.

The proposed plan of study: Table 1 displays the plan of the study.

Storage: The samples were packed in bottle jar and stored at ambient, and refrigeration temperature for three months, and subjected to further physicochemical and sensory analysis.

Physico-chemical analysis: The Ascorbic acid, pH, Total Soluble Solids (TSS), Titratable acidity, Sugar acid ratio, Reducing sugars, Non-reducing sugars, was determined by the standard method of AOAC [7].

Sensory evaluation: Organoleptic evaluation (color, taste, texture and overall acceptability) were evaluated by the selected panel using 9 points hedonic scale of Larmond [8].

Statistical analysis

All the analyses were performed in triplicate and the results were calculated statistically by simple CRD two way analyses as recommended by Steel and Torrie [9].

Results and Discussions

The pH of mango slices was decreased during storage (Table 1). The mean pH value was decreased from 4.43 to 3.21 during storage. The Highest mean value for treatment was MS_7 (4.06) followed by MS_5 (4.01) while the Lowest value was MS_0 (3.52) followed by MS_1 (3.68). The highest decrease was found in MS_0 (38.68%) followed by MS_1 (33.25%). Statistical analysis showed that storage interval and treatments

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had a significant (P<0.05) effect on the pH value of all mango slices samples. These results are in agreement with findings of Hussian et al. [4], Akubor [10] and Malundo et al. [11] who observed decreased in pH of mango pulp during storage. An increased was observed in Total soluble solids of mango slices throughout the storage (Table 2). The mean TSS values were increased from 20.72 to 25.20 during storage. For treatments maximum mean value was recorded in MS_0 (23.55) followed by MS_1 (23.28), while minimum increased was observed in MS_7 (22.32) followed by MS_6 (22.66). The highest percentage increase was recorded in MS_0 (22.44%) followed by MS_1 (20.36%) while the lowest percentage increase was in MS_7 (13.33%) followed by MS_5 (16.21%). The increase in TSS value may be due to an increase in temperature and inversion of sucrose into glucose and fructose. Statistically, storage interval and treatments had significantly (p<0.05) effect on TSS value of all mango

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	4.42	3.73	3.22	2.71	38.68	**3.52d**
MS_1	4.42	3.93	3.44	2.95	33.25	**3.68cd**
MS_2	4.43	3.99	3.57	3.11	29.79	**3.77c**
MS_3	4.47	4	3.53	3.07	31.39	**3.76c**
MS_4	4.42	4	3.61	3.22	27.15	**3.81bc**
MS_5	4.42	4.15	3.88	3.61	18.33	**4.01ab**
MS_6	4.43	4.01	3.63	3.25	26.64	**3.83bc**
MS_7	4.41	4.15	3.93	3.78	14.28	**4.06a**
Means	**4.43a**	**3.99b**	**3.60c**	**3.21d**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 1: Effect of treatment applied and storage interval on pH of mango slices during 90 days of storage.

Treatments	Storage Interval (30 days)				% Increase	Means
	Initial	30	60	90		
MS_0	20.7	22.35	24.47	26.69	22.44	**23.55a**
MS_1	20.72	22.09	24.3	26.02	20.36	**23.28ab**
MS_2	20.71	22.53	23.98	25.25	17.98	**23.11abc**
MS_3	20.72	22.21	23.79	25.35	18.26	**23.01abc**
MS_4	20.7	22.59	23.75	24.89	16.83	**22.98abc**
MS_5	20.72	22.38	23.6	24.73	16.21	**22.85bcd**
MS_6	20.73	21.79	23.37	24.75	16.24	**22.66cd**
MS_7	20.73	21.78	22.85	23.92	13.33	**22.32d**
Means	**20.72d**	**22.21c**	**23.76b**	**25.20a**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 2: Effect of treatment applied and storage interval on TSS of mango slices during 90 days of storage.

Treatments	Storage Interval (30 days)				% Increase	Means
	Initial	30	60	90		
MS_0	1.2	1.5	1.8	1.94	3.05	**1.61a**
MS_1	1.19	1.39	1.48	1.75	2.56	**1.45b**
MS_2	1.17	1.25	1.36	1.42	1.4	**1.30c**
MS_3	1.18	1.26	1.36	1.46	1.53	**1.31bc**
MS_4	1.18	1.24	1.32	1.37	1.1	**1.27c**
MS_5	1.19	1.22	1.27	1.35	0.94	**1.25c**
MS_6	1.17	1.23	1.31	1.34	1.01	**1.26c**
MS_7	1.18	1.21	1.24	1.26	0.5	**1.22c**
Means	**1.18c**	**1.28b**	**1.39a**	**1.48a**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 3: Effect of treatment applied and storage interval on titrable acidity of mango slices during 90 days of storage.

samples during storage. These results are in agreement with findings of Singh et al. [12], Hussain et al. [4], Akhtar et al. [13], and Majid et al. [14] who reported an increase in TSS in mango pulp preserved in chemicals. The titratable acidity for Mango slices was decreased during the storage period (Table 3). The mean values for Titratable acidity increased from 1.18% to 1.48% during storage. The treatment MS_0 have highest %age mean value (1.61%) followed by MS_1 (1.45%), while the lowest %age mean value was observed in MS_7 (1.22) followed by MS_5 (1.25). Maximum increase was recorded in MS_0 (3.05%) followed by MS_1 (2.56%), while the minimum increase was recorded in MS_7 (0.50) followed by MS_5 (0.94). The reason behind the increase in acidity is the degradation of non-reducing sugar and pectins forms acids compounds which increases the acidity [15]. Alaka et al. [16] and Imtiaz et al. [17] studied an increase in acidity during mango pulp storage. Same increase was studied by Kumar et al. [18]. Titratable acidity was significantly (p<0.05) affected by storage intervals and treatments. The ascorbic acid of Samples was decreased during 3 months of storage (Tables 4 and 5). The highest mean value for treatments was recorded in MS_7 (25.98 mg/100 g) followed by MS_5 (25.78 mg/100 g), while the lowest mean value was recorded in MS_0 (23.59 mg/100 g) followed by MS_1 (24.74 mg/100 g). For the storage period, the maximum decrease in percentage was examined in MS_0 (45.10%) followed by MS_1 (39.03%), while a minimum decrease in percentage was examined in MS_7 (29.10%) followed by MS_5 (30.56%). The reason behind fall of ascorbic acid content was fluctuation in temperature or increase in temperature and light during the storage period. Loss of ascorbic acid was also observed by Kumar et al. [18] and Sabina et al. [19]. The Sugar acid ratio for Samples was reduced throughout storage interval. Reduction in mean value during storage was from 18.17 to 14.64. The greatest mean value was calculated in MS_5 (17.18) followed by MS_6 (16.91), while the minimum mean value was calculated in MS_0 (14.96) followed by MS_1 (15.96). Highest decreased in percentage was in MS_0 (31.03%) followed by MS_1 (20.90%), while the lowest decrease in percentage was in MS_7 (14.66%) followed by MS_5 (14.99%). The sugar-acid ratio of mango slices was significantly (p<0.05) affected by treatments and storage. Muhammad et al. [20] and Durrani et al. [21] experienced a reduction in sugar acid ratio during storage. An increase was observed in Reducing Sugar during storage (Table 6). Mean of storage varies from 7.57 to 11.65. The maximum increase in treatment mean value was MS_0 (11.29) followed by MS_1 (10.79), while the minimum increase in treatment means was in MS_7 (8.84) followed by MS_5 (8.97). The highest percentage increase was observed in MS_0 (49.63%) followed by MS_1 (46.25%), while the lowest percentage increase was in MS_7 (25.46%) followed by MS_5 (25.87%). Ayub et al. [22], found a Raise in reducing

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	30.42	25.92	21.32	16.7	45.1	**23.59c**
MS_1	30.41	26.56	23	18.54	39.03	**24.74bc**
MS_2	30.4	27.15	23.9	20.67	32	**25.53ab**
MS_3	30.43	27.13	22.79	19.56	35.72	**24.97ab**
MS_4	30.42	27.28	24.12	20.95	31.13	**25.69ab**
MS_5	30.43	27.33	24.23	21.13	30.56	**25.78a**
MS_6	30.4	27.28	24.16	21.03	30.82	**25.71a**
MS_7	30.41	27.46	24.51	21.56	29.1	**25.98a**
Means	**30.41a**	**27.01b**	**23.56c**	**20.01d**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 4: Effect of treatment applied and storage interval on ascorbic acid content of mango slices during 90 days of storage.

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	17.95	15.56	13.97	12.38	31.03	**14.96d**
MS_1	17.89	16.41	15.39	14.15	20.9	**15.96c**
MS_2	17.62	16.56	15.49	14.36	18.5	**16.00c**
MS_3	18.02	17.34	15.98	14.43	19.92	**16.44bc**
MS_4	18.67	17.42	16.22	15.22	18.47	**16.88ab**
MS_5	18.47	17.83	16.72	15.7	14.99	**17.18a**
MS_6	18.58	17.34	16.32	15.41	17.06	**16.91ab**
MS_7	18.21	17.16	16.3	15.54	14.66	**16.80ab**
Means	**18.17a**	**16.95b**	**15.79c**	**14.64d**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 5: Effect of treatment applied and storage interval on sugar acid ratio of mango slices during 90 days of storage.

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	7.58	10.01	12.53	15.05	49.63	**11.29a**
MS_1	7.53	9.76	11.89	14.01	46.25	**10.79a**
MS_2	7.57	8.75	9.96	11.03	31.36	**9.32b**
MS_3	7.61	8.71	9.83	11.19	31.99	**9.33b**
MS_4	7.57	8.72	9.85	10.83	30.1	**9.24b**
MS_5	7.59	8.55	9.52	10.24	25.87	**8.97b**
MS_6	7.57	8.66	9.75	10.75	29.58	**9.18b**
MS_7	7.55	8.41	9.27	10.13	25.46	**8.84b**
Means	**7.57d**	**8.94c**	**10.32b**	**11.65a**		

Table 6: Effect of treatment applied and storage interval on reducing sugar of mango slices during 90 days of storage.

sugar is due to the inversion of sucrose to reducing sugar because of acids. Conversion of pectin into fructose and glucose because of the rise in temperature during storage was observed by Kumar et al. [8]. Storage and treatment results were significant (p<0.05). A decrease was observed in Non-Reducing Sugar during storage (Table 7). Reduction results in mean values during storage were from 9.56 to 7.72. Between the treatment highest mean value was in MS_7 (9.19) followed by MS_5 (9.12), and the lowest value was in MS_0 (7.35) followed by MS_1 (8.94). Highest decrease in percentage was observed in MS_0 (46.61%) followed by MS_1 (41.23%), while the lowest percentage of decrease was in MS_7 (7.74%) followed by MS_5 (9.40). During storage sucrose in fruit continuously converted into fructose and glucose which results in a reduction in Non-Reducing Sugar. The results are in agreement with Akhtar et al. [16] and Hussain et al. [17]. Results demonstrated that storage and treatment have significant (p<0.05) effect on mango slices.

The mean value for color throughout storage was decreased from 8.51 to 4.72 (Table 8). Highest drop in mean throughout treatment was in MS_7 (7.65) followed by MS_5 (7.29), while the lowest drop in mean through treatment was in MS_0 (4.69) followed by MS_1 (15.48). Percentage wise highest reduction was observed in MS_0 (87.41%) and MS_1 (71.39%) and the lowest reduction were observed in MS_7 (21.05%) and MS_5 (28.26%). Millard reaction results in reducing color during storage Kumar et al. [8] and Hussain et al. [23]. Ayub et al. [13] also observed a reduction in color of guava during storage. The color was significantly (p<0.05) affected by storage and treatments. The mean value for flavor throughout storage was decreased from 8.60 to 4.59 (Table 9). Highest value in treatments was in MS7 (7.42) followed by MS5 (7.28), while the lowest value was observed in MS_0 (5.25) followed by MS_1 (5.64). Highest percentage in fall of flavor values was seen in MS_0 (78.8%) followed by MS_1 (68.98%). Breakdown of sugar content

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	9.59	8.1	6.61	5.12	46.61	**7.35b**
MS_1	9.53	8.23	6.93	5.6	41.23	**7.57b**
MS_2	9.63	9.2	8.77	8.43	12.46	**9.00a**
MS_3	9.6	9.15	8.7	8.25	14.06	**8.92a**
MS_4	9.55	9.16	8.76	8.41	11.93	**8.97a**
MS_5	9.57	9.27	8.97	8.67	9.4	**9.12a**
MS_6	9.52	9.18	8.84	8.5	10.71	**9.01a**
MS_7	9.56	9.28	9.1	8.82	7.74	**9.19a**
Means	**9.56a**	**8.94ab**	**8.33bc**	**7.72c**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 7: Effect of treatment applied and storage interval on non reducing sugar of mango slices during 90 days of storage.

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	8.5	5.9	3.3	1.07	87.41	**4.69b**
MS_1	8.53	6.5	4.47	2.44	71.39	**5.48b**
MS_2	8.51	7.41	6.31	5.21	38.77	**6.86a**
MS_3	8.52	7.37	6.22	5.07	40.49	**6.79a**
MS_4	8.5	7.47	6.44	5.41	36.35	**6.95a**
MS_5	8.49	7.69	6.89	6.09	28.26	**7.29a**
MS_6	8.48	7.58	6.68	5.78	31.83	**7.13a**
MS_7	8.55	7.95	7.35	6.75	21.05	**7.65a**
Means	**8.51a**	**7.23b**	**5.95c**	**4.72d**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 8: Effect of treatment applied and storage interval on color of mango slices during 90 days of storage.

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	8.63	6.38	4.13	1.88	78.21	**5.25c**
MS_1	8.61	6.63	4.65	2.67	68.98	**5.64bc**
MS_2	8.6	7.31	6.02	4.73	45	**6.66a**
MS_3	8.59	7.24	5.89	4.54	47.14	**6.56ab**
MS_4	8.58	7.37	6.16	4.95	42.3	**6.76a**
MS_5	8.6	7.71	6.82	5.99	30.34	**7.28a**
MS_6	8.64	7.69	6.74	5.79	32.98	**7.21a**
MS_7	8.62	7.82	7.02	6.22	27.84	**7.42a**
Means	**8.60a**	**7.26b**	**5.92c**	**4.59d**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 9: Effect of treatment applied and storage interval on flavor of mango slices during 90 days of storage.

increases of acidity and loss of Vitamin Care the reason for an increase in flavor degradation. The result is an agreement with Ayub et al [13] also observed a reduction in flavor in guava during storage. The mean value for overall acceptability throughout storage was decreased from 8.60 to 4.59 (Table 10). Mean value during storage was from 8.52 to 4.40. Maximum mean value through treatment was in MS_7 (7.45) followed by MS_5 (7.04), while the minimum mean value was in MS_0 (4.98) followed by MS_1 (5.25). Highest decrease in percentage was in MS_0 (81.85%) followed by MS_1 (75.00%), while the lowest decrease was in MS_7 (27.74%) followed by MS_5 (34.81%). Progressive degradation occurred in overall acceptability was due to the losses of ascorbic acid furfural increase, accumulation of furfural level in slices is the main reason for the reduction in overall acceptability. Results are in agreement with

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
MS_0	8.43	6.13	3.83	1.53	81.85	**4.98b**
MS_1	8.4	6.3	4.2	2.1	75	**5.25b**
MS_2	8.56	7.3	6.04	4.78	44.15	**6.67a**
MS_3	8.52	7.22	5.92	4.62	45.77	**6.57a**
MS_4	8.51	7.31	6.11	4.91	42.3	**6.71a**
MS_5	8.53	7.54	6.55	5.56	34.81	**7.045a**
MS_6	8.6	7.55	6.5	5.45	36.62	**7.025a**
MS_7	8.65	7.85	7.05	6.25	27.74	**7.45a**
Means	**8.525a**	**7.15b**	**5.77c**	**4.40d**		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 10: Effect of treatment applied and storage interval on overall acceptability of mango slices during 90 days of storage.

Sabrina et al. who studied the loss of overall acceptability of mango which was osmotically dehydrated in sugar syrups. Majid et al. [20] and Akhtar et al. [16] who studied the pulp preserved in chemical preservatives retains overall acceptability due to maximum nutrients stability and maximum sensory values during storage at ambient temperature.

Conclusion

The mango slices stored at refrigeration condition had maximum quality as compared to room temperature during three months of storage. The potassium metabisulphite was found more effective on keeping maximum quality followed by sodium benzoate and potassium sorbate. Treatment MS7 (Mango slice+40% sucrose solution+0.3% citric acid+0.1% potassium metabisulphite+refrigeration) had shown the best result as compare to other treatments under sensory evaluations and physiochemical analysis during storage.

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