Pak. j. sci. ind. res., vol. 36, no. 4, April 1993

STUDIES ON THE QUALITY AND STORAGE STABILITY OF MIXED FRUIT SQUASHES

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(Received February 28, 1991; revised April 6, 1993)

Quality of pure (guava, citrus, mango) and mixed (guava-citrus, guava-mango, citrus-mango with mixing levels of 25,50 and 75%) fruit squashes was studied during storage at room conditions (22- 36°, 45-76% RH). High initial content and maximum retention of ascorbic acid during storage was found in citrus-mango combinations followed by guava-citrus and guava-mango combination. Cloud loss during storage was observed in citrus- guava squashes but there was no such problem in pure and mixed mango squashes. In general pure squashes were preferred over the mixed ones and the highest score was given to pure mango squash. Taste scores were positively correlated (r = 0.689) with total soluble solids/acid ratio of different drinks. All squashes were acceptable after the storage of 3-4 months and these were given more than 60% overall acceptability scores.

Key words: Guava, Citrus and mango squashes, Ascorbic acid.

Introduction

Squashes are popular drinks in Pakistan. They are nutritious and relatively cheap compared to almost all soft drinks available in the market. Results on standardization [1], quality evaluation [2], colour loss [3], fortification and preservative effect [4], packaging material and light effect [5], cultivar effect [6] and replacement of sucrose with liquid glucose [7] of squashes have been reported, but no work has been reported on squash production of two or more fruits. The present study was undertaken to evaluate the quality of squashes prepared from the combination of two different fruits (guava-mango, guava-citrus and citrus- mango).

Materials and Methods

Guava base was obtained from Food Technology Section, Agricultural Research Institute (ARI),Tarnab, Peshawar. This guava base was prepared from white guava (procured from local market) which were cut into small pieces and passed through a fruit pulper (1.3 mm sieve). Sindhri cultivar was used for guava-mango squashes whereas langra cultivar was used for citrus-mango squashes. Mango fruit was procured from local market, washed and peeled manually. Mango pulp was removed from the stones and mixed in a blender. Valencia organges were procured from the local market, washed in running tap water, juice extracted with manually operated pressured type citrus juice extractor and stored in a freezer.

This frozen citrus juice was used for the preparation of citrus squash. The following formulations (previously standardized in our laboratory) were used for the preparation of the three squashes.

Guava squash (8):

Base	=	17 parts
Water	=	33 parts
Sugar	=	50 parts
Citrus acid	=	1% w/w

Citrus squash (1):

Juice	=	50 parts
Sugar	=	50 parts
Citric acid	=	1% w/w

Mango squash (1):

Pulp	=	25 parts
Water	=	25 parts
Sugar	=	50 parts
Citric acid	=	1% w/w

All the ingredients were cold mixed throughly and passed through a muslin cloth. The mixed squashes were prepared by mixing the pure squashes in three combinations viz. guava-mango, guava-citrus and citrus-mango in the following ratios:

1. 100% A (the first component)
2. 75% A + 25% B (the second component)
3. 50% A + 50% B
4. 25% A + 75% B
5. 100% B

All the squash samples were preserved with 0.061% potassium metabisulphite (350 ppm SO_2) and then filled into steralized glass bottles, corked, waxed and stored at room conditions. Temperature and humidity over the 16 weeks of storage varied from 22-36° and 45-76% RH respectively. These were analysed for various physicochemical parameters.

Ascorbic acid, acidity and total soluble solids (TSS) were determined by standard AOAC methods [9]. Ascorbic acid was determined by titrating against standardized 2-6-dichlo-

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rophenol indophenol dye to pink end-point which persisted for 15 sec. Results were expressed as mg ascorbic acid per 100 g drink.

Total acidity was determined and calculated as volume in ml of 0.1 N NaOH required to titrate 100 g of drink to the phenolphthalein end-point and expressed as percent citric acid. Total soluble solids were determined in degrees Brix using refrectometer (K. Fuji Model No. 5601).

TSS and acid ratio was calculated. Flocculation and settling in different drinks were recorded visually.

Sensory evaluation of different squashes (in undiluted form and after dilution with water in the ratio of 1:4) was carried out for appearance, odour, taste and overall acceptability according to the scoring method of Krum [10]. A scale of 0-10 was used where 0 represented disliked extremely and 10 liked extremely. A trained panel of 10 judges (both male and female) with sufficiently discriminating palates was selected from Food Science Division, NIFA, Peshawar. Preliminary sessions were held and panelists were familiarized with the product and its quality aspects. The samples were of uniform temperature, coded with a set of three-digit random numbers and presented randomly for testing. The samples were tested independently under natural white flourescent light in an airconditioned room with off white walls.

Research design used was completely randomized design (C.R.D.) (two factor factorial). The data were analysed statistically using the analysis of variance (ANOVA) and Duncan's multiple range test was used for comparison of means [11]. Coefficient of correlation (r) and regression (b) between TSS/acid ratio and taste scores of different samples were determined, regression equation computed and regression line drawn [11].

Results and discussion

*Chemical characteristics.*The results of the chemical characteristics of pure as well as mixed fruit squashes are reported in Tables 1-3. The ascorbic acid content of fresh unmixed pure fruit squashes varied from 13.00-14.74 mg/100g in case of guava, 5.31-34.33 mg/100g in case of mango and 18.40- 23.55 mg/100g in case of citrus fruit. The variation in ascorbic acid content of mango squashes could be due to difference in the amount of this vitamin in the pulp of Sindhri and Langra cultivars [12] used in the experiment. The fruit content of guava, mango and citrus squashes were 17,25 and 50% respectively. Previous reports indicate that guava drinks (being richer source of vitamin C) contained more ascorbic acid than citrus and mango squashes even at less fruit content level [13]. The lower ascorbic acid content of guava drink than citrus and mango squashes in the present study could be due to the old guava base employed for its preparation. The mean

TABLE 1. STORAGE STABILITY OF MIXED GUAVA-MANGO SQUASH, CHEMICAL CHARACTERISTICS.

Chemical characteristics	% mix	Storage period (weeks) 0	4	8	12	16	Mean
Ascorbic	100/0	12.74	11.99	8.04	6.50	5.31	8.92^{d}
acid	75/25	12.47	9.60	6.69	4.83	4.53	7.61^{a}
mg/100g	50/50	8.99	6.67	5.10	3.47	3.34	5.51^{b}
	25/75	6.10	4.86	3.63	2.18	2.12	3.78^{c}
	0/100	4.00	2.81	2.38	1.49	1.24	2.38^{c}
	Mean	8.86^{a}	7.19^{b}	5.17^{c}	3.69^{d}	3.31^{d}	
acidity	100/0	1.25	1.27	1.15	1.20	1.16	1.21^{a}
% citric	75/25	1.22	1.15	1.10	1.10	1.10	1.13^{b}
acid	50/50	1.15	1.09	1.05	1.03	1.03	1.07^{c}
	25/75	1.09	1.03	0.99	0.99	0.94	1.01^{d}
	0/100	1.00	0.95	0.94	0.96	0.93	0.96^{e}
	Mean	1.14^{a}	1.10^{b}	1.05^{d}	1.06^{c}	1.03^{e}	
TSS	100/0	51.0	51.7	52.0	52.3	51.9^{e}	
oBX	75/25	51.5	52.7	52.6	53.1	53.0	52.6^{d}
	50/50	52.2	53.4	53.6	53.8	53.9	53.4^{c}
	25/75	52.9	54.1	54.1	54.4	54.4	54.0^{b}
	0/100	53.8	54.6	55.1	55.2	55.3	54.8^{a}
	Mean	52.3^{d}	53.3^{c}	53.5^{d}	53.8^{a}	53.8^{a}	
TSS/acid	100/0	40.8	40.7	45.2	43.6	45.1	43.1^{e}
	75/25	42.2	45.8	47.8	48.3	48.2	46.5^{d}
	50/50	45.4	49.0	51.1	52.2	52.3	50.0^{c}
	25/75	48.5	52.4	54.7	54.9	57.9	53.7^{b}
	0/100	53.8	57.5	59.3	57.5	59.4	57.5^{a}
	Mean	46.1^{c}	49.1^{b}	51.6^{a}	51.3^{a}	52.6^{a}	

Storage temperature = 22-36°; Relative humidity = 45-76%; Figures followed by different letters are significantly different at 5% level.

TABLE 2. STORAGE STABILITY OF MIXED GUAVA-CITRUS SQUASH, CHEMICAL CHARACTERISTICS.

Chemical characteristics	% mix	Storage period (weeks) 0	4	8	12	16	Mean
Ascorbic	100/0	13.00	11.60	8.30	6.07	4.18	8.63^{e}
acid	75/25	14.36	14.61	11.14	7.82	6.28	10.84^{d}
mg/100g	50/50	17.09	16.81	14.20	11.15	9.61	13.77^{c}
	25/75	20.82	19.10	17.49	14.20	12.61	16.84^{b}
	0/100	23.55	21.81	19.74	16.22	14.73	19.21^{a}
	Mean	17.76^{a}	16.79^{b}	14.17^{b}	11.09^{c}	9.48^{c}	
Acidity	100/0	1.29	1.24	1.18	1.20	1.14	1.21^{a}
%Citric	75/25	1.25	1.22	1.18	1.16	1.13	1.19^{b}
acid	50/50	1.26	1.19	1.16	1.14	1.14	1.18^{c}
	25/75	1.24	1.17	1.15	1.14	1.13	1.17^{d}
	0/100	1.22	1.16	1.13	1.14	1.03	1.15^{e}
	Mean	1.25^{a}	1.20^{b}	1.16^{c}	1.16^{d}	1.13^{e}	
TSS	100/0	51.0	52.4	52.7	52.6	52.9	52.3^{d}
oBX	75/25	51.5	52.5	52.4	52.8	53.0	52.4^{d}
	50/50	52.3	53.1	53.3	54.0	54.3	53.2^{c}
	25/75	52.6	52.8	53.4	54.0	54.2	53.8^{b}
	0/100	53.5	53.9	54.3	54.2	54.7	54.1^{a}
	Mean	52.2^{d}	53.1^{c}	53.3^{bc}	53.4^{b}	53.8^{a}	
TSS/acid	100/0	39.5	42.4	44.7	43.8	46.4	43.4^{b}
	75/25	41.2	43.1	44.8	45.5	46.9	44.3^{b}
	50/50	41.5	44.5	46.0	46.8	47.2	45.2^{b}
	25/75	42.7	45.9	47.0	47.4	48.2	46.2^{ab}
	0/100	43.9	46.4	48.1	47.5	50.2	47.2^{a}
	Mean	41.8^{b}	44.5^{ab}	46.1^{ab}	46.2^{a}	47.8^{ab}	

Storage temperature = 22-36°; Relative humidity = 45-76%; Figures followed by different letters are significantly different at 5% level.

Table 3. STORAGE STBILITY OF MIXED CITRUS-MANGO SQUASH, CHEMICAL CHARACTERISTICS.

Chemical characteristics	% mix	Storage period (weeks) 0	4	8	12	Mean
Ascorbic	100/0	18.40	16.70	11.75	10.45	14.33[e]
acid	75/25	22.92	20.96	14.60	12.35	17.71[d]
mg/100g	50/50	26.89	23.59	17.96	15.72	21.04[c]
	25/75	30.66	27.81	21.18	20.00	24.91[b]
	0/100	34.33	30.12	22.60	23.09	27.54[a]
	Mean	26.64[a]	23.84[b]	17.62[c]	16.32[d]	
Acidity	100/0	1.27	1.17	1.16	1.15	1.19[a]
% citric	75/25	1.20	1.14	1.11	1.08	1.13[b]
acid	50/50	1.19	1.11	1.09	1.06	1.11[c]
	25/75	1.11	1.06	1.03	1.02	1.06[d]
	0/100	1.05	1.01	1.00	0.99	1.01[e]
	Mean	1.16[a]	1.10[b]	1.08[c]	1.06[d]	
TSS	100/0	53.2	54.2	54.8	55.1	54.3[a]
oBX	75/25	52.0	53.3	53.8	54.3	53.4[c]
	50/50	52.6	53.8	54.2	54.6	53.8[b]
	25/75	53.1	54.3	54.7	54.9	54.3[a]
	0/100	52.9	54.0	54.1	54.5	53.9[b]
	Mean	52.8[d]	53.9[c]	54.3[b]	54.7[a]	
TSS/acid	100/0	41.3	46.3	47.2	47.9	45.8
	75/25	43.3	46.8	48.5	50.3	47.2
	50/50	44.2	48.5	49.7	51.5	48.5
	25/75	47.8	51.2	53.1	53.8	51.1
	0/100	50.4	53.5	54.1	55.1	53.3
	Mean	45.5[b]	49.3[ab]	50.5[ab]	51.7[a]	

Storage temperature = 22-36°; Relative humidity = 45-76%; Figures followed by different letters are significantly different at 5% level.

ascorbic acid values (mg/100g) for citrus-mango, guava-citrus and guava-mango drinks ranged from 14.33-27.54, 8.63-19.21 and 2.38-8.92, respectively. The difference in kind and content of fruit was responsible for the variation in ascorbic acid content of different drinks.

The retention of ascorbic acid during storage is mainly dependent on its initial content in a drink [4]. Pure or mixed fruit squash formulations containing higher initial ascorbic acid, retained significantly ($P<0.05$) more ascorbic acid (percent) during storage. Maximum ascorbic acid (56.8-69.3) was retained by citrus-mango combinations followed by guava citrus (46.7-67.9) and guava-mango (31.0-41.7%) after 3 months storage at room temperature. The decrease of ascorbic acid in squashes during storage could be due to oxidation by molecular oxygen. This reaction is directly or indirectly catalysed by native enzymes present in the fruit [14].

The difference in TSS, acidity and TSS/acid ratio among various pure and mixed fruit squashes (Tables 1-3) was due to different kind of fruits and fruit content used for their preparation. The acidity of different squashes decreased significantly ($p<0.05$) whereas TSS and TSS/acid ratio increased significantly ($P< 0.05$) throughout the storage period. Insoluble macromolecules might have been degraded under acidic conditions to soluble low molecular weight compounds during the storage of squashes, resulting in an increase in TSS [3].

TABLE 4. STORAGE STABILITY OF MIXED FRUIT SQUASHES, ORGANOLEPTIC CHARACTERISTICS.

Quality characteristics (0-10)	Percentage mix1 100/0	75/25	50/50	25/75	0/100	Storage period (week)2 0	4	8	12	16	Mean
Guava/mango											
appearance	6.33[c]	6.68b[c]	6.99[ab]	7.12[ab]	7.47[a]	6.91	6.90	7.08	6.94	6.76	6.92
Odour	6.99	6.65	6.54	6.55	6.78	7.06[a]	6.73[ab]	6.64[ab]	6.74[ab]	6.34[b]	6.70
taste	6.89[ab]	6.78[b]	6.60[b]	6.90[ab]	7.35[a]	6.91[ab]	7.10[a]	7.15[a]	6.86[ab]	6.48[b]	6.90
overall	6.74	6.70	6.71	6.88	7.20	6.97	6.92	6.97	6.85	6.53	6.85
acceptability Guava/citrus											
appearance	6.55[b]	6.26[b]	6.37[b]	6.67[b]	7.15[a]	6.74	6.83	6.65	6.56	6.23	6.60
odour	6.93[a]	6.41[b]	6.24[b]	6.48[b]	6.56[b]	6.48	6.65	6.38	6.59	6.51	6.52
taste	6.75	6.64	6.49	6.33	6.59	6.80[a]	6.84[a]	6.45[bc]	6.51[b]	6.20[c]	6.56
overall	6.74[a]	6.44[b]	6.37[b]	6.50[b]	6.76[a]	6.67[ab]	6.77[a]	6.50[bc]	6.55[abc]	6.31[c]	6.56
accetability Citrus/mango											
appearance	6.00[d]	6.60[c]	7.04[b]	7.18[b]	7.53[a]	6.83	7.03	6.94	6.71		6.88
adour	6.58	6.64	6.68	6.64	6.68	6.59	6.63	6.82	6.53		6.64
taste	6.38[c]	6.50[c]	6.71[bc]	6.92[ab]	7.24[a]	6.66[ab]	6.85[ab]	6.93[a]	6.56[b]		6.75
overall	6.32[d]	6.59[c]	6.81[bc]	6.89[ab]	7.11[a]	6.65[bc]	6.84[ba]	6.90[a]	6.59[c]		6.75

0 = disliked extremely 10 = liked extremely; 1. Mean value of five storage periods; 2. Mean values of five percentage mixes Figurs followed by different letters are significantly different at 1% level.

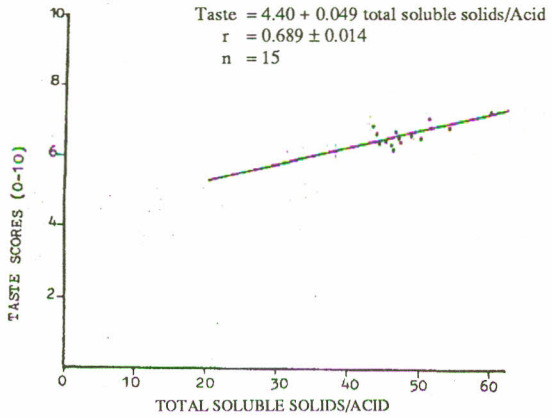

Fig. 1. Linear regression between total soluble solids/acid ratios and taste scores of mixed fruit squashes stored at room conditions (22-36°, 45-76% RG).

Flocculation and settling. In case of pure mango squash and those containing 25% or more of it, the problem of flocculation or settling was not observed throughout the storage period of 4 months. Settling was observed in pure guava squash whereas pure citrus squash showed flocculation. Citrus-guava mixed squashes showed both flocculation and settling simultaneously. Cloud loss has been reported extensively in citrus drinks [3] whereas mango squash has been found to be free from this defect [2].

Organoleptic characteristics. In general, squash samples containing higher amount of mango obtained significantly ($P<0.01$) higher scores for appearance, taste and overall acceptability than those containing higher amount of guava or citrus (Table 4). In pure mango squash these sensory attributes ranged from 7.47-7.53, 7.24-7.35 and 7.11-7.20 respectively.

The sensation of sweet taste in the mouth is influenced by sugar/acid ratio of a drink. As brix/acid ratio increases, consumer perception of sweetness increases and decreases for tartness [15]. Regression analysis, therefore, was carried out to establish relationship between TSS/acid ratio and taste scores of pure and mixed squashes stored at room conditions. The regression equation for regression of taste scores on TSS/acid ratio of squashes was

$$Y = 4.40 + 0.049 \text{ x (Fig. 1)}$$

Where Y = taste scores and X = TSS/acid ratio. The correlation coefficient for this relationship was positive and highly significant ($r=0.689 + 0.01$). The increase in taste scores of squashes, therefore, correlated to increase in TSS/acid ratio. The coefficient of detrmination (r^2) of taste versus TSS/acid ratio was 0.48. This indicated that 48% variation in taste scores could be explained by change in TSS/acid ratio. Mean total soluble solids/acid ratio in pure guava, citrus and mango squashes varied from 43.1-43.4, 45.8-47.2 and 53.3-57.5 respectively. Higher scoring for taste of pure mango squash and its blends, therefore, was partly due to its high TSS/acid ratio. The bright colour of carotenoids in mango pulp could have contributed to attractive appearance of its squash.

Pure guava and citrus squashes were considered better than the mixed guava-citrus squashes. The diluted citrus and guava squashes showed cloud loss at the time of organoleptic evaluation which could have resulted in less attractiveness. The guava squash had strong and typical odour which was liked very much by the judges. The maximum mean odour scores (6.93-6.99) were given to pure guava squash. In guava-mango squashes the odour and taste scores decreased significantly ($P<0.01$) whereas changes for appearance and overall acceptability scores were non- significant during storage (Table 4). The taste scores of guava- citrus and citrus-mango squashes decreased significantly ($P<0.01$) during storage which resulted in significant ($P<0.01$) decrease in their overall acceptability.

Conclusion

Pure squashes proved better than mixed fruit squashes and pure mango squash was liked very much. In spite of the fact that both physicochemical and organoleptic quality declined during a storage period of 3-4 months, pure and mixed squashes were acceptable and were given more then 60% scores for all the sensory quality attributes.

Acknowledgement. We are grateful to Dr. A. G. Arain, Principal Scientific Officer, Dr. K. A. Siddiqui, Director and Dr. A. R. Azmi, Ex-Director, Atomic Energy Agricultural Research Centre, Tandojam for critically reviewing the manuscript.

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