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STUDIES ON THE STORAGE STABILITY OF GUAVA FRUIT JUICE

W. H. SHAH

PCSIR Laboratories, Lahore

N. A. SUFI and S. I. ZAFAR

PCSIR Laboratories, Peshawar

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Abstract. Sugared as well as single strength guava juice samples were subjected to chemical analysis and organoleptic evaluation at 90-day intervals up to a storage period of 270 days. Results of these investigations revealed that though there had been some deteriorations in chemical constituents during storage, yet all the juice samples were organoleptically acceptable with the exception of sugared sample stored without the addition of a preservative. Single strength juice retained higher amount of ascorbic acid (35%) as compared to the sugared sample (25%). Addition of sodium citrate to sugared samples helped in preserving the natural colour and flavour of guava juice. However, in case of single strength juice, the sample without sodium citrate was preferred by the judges as compared to the single strength juice containing sodium citrate.

Guava (*Psidium guajava* L.) is grown throughout Pakistan. The fruit is of a great economic importance because of its moderately low price and a high calorific value.[6] Among the common fruits, guava is an outstanding source of ascorbic acid.[2] With proper attention and horticultural improvements, the production of guava can be increased manifold to a great advantage of the poor for securing an attractive, tasty and nourishing fruit, and nutritive guava fruit products. The guava plant is very tolerant to varying climate and soil conditions and produces at least two crops a year. These qualities make this fruit worthy of attention to all concerned. However, in Pakistan, due attention has not been given to this fruit by the gardener, the food technologist, the food industrialist, and the food economist.

Guava fruit contains as much as 1160 mg/100 gm of ascorbic acid on fresh weight basis.[2] Siddiqui and Farooqi, described guava fruit as the richest source of vitamin C among the common fruits of Pakistan. Again, among the fruits, it is the second highest in calorific value, just close to banana. However, banana is very inferior to guava in ascorbic acid, calcium and niacin content. It is superior to most of the commonly available Pakistani fruits in all major aspects of food value except that it is not as rich in vitamin A as mangoes, apricots and peaches. However, mangoes, apricots and peaches are substantially inferior to guava in all other aspects viz. calorific value, protein, fat, carbohydrates and niacin contents, and extremely poor in vitamin C contents.[11]

Though there are two crops of guava in a year, yet the fruit comes in the market during a specific and short period of time. During this period of the year there is a glut of guava in the market which sells at a very low price and quite often substantial amount of the fruit remains unsold and goes to waste. Attempts have been made by several workers to utilize the surplus by preparing low-cost nourishing products, and conventional type of products like guava cheese, guava nectar, guava squash[12] and carbonated guava beverage,[7] but unfortunately the work on storage stability and quality of stored products have not been given due attention. It was, therefore, found necessary to study the effect of storage, on the quality of the guava base which is utilized for the production of a carbonated guava beverage. In the present communication are presented investigations on the storage stability and organoleptic behaviour of the sugared juice (base) and unsweetened single strength guava juice.

Materials and Methods

Winter (Feb-March) crop of guava fruit, var. local white, was purchased from the local market, stored overnight at room temperature, and sorted for over and undermature fruit. Juice was extracted from the mature fruit according to the method developed at the PCSIR Laboratories, Peshawar.[10] The extracted juice was arbitrarily divided into two portions, named as parts I and II for subsequent work.

Part I. Cane sugar (10 lb) and citric acid (55 g) were added to guava juice (10 lb) yielding a guava base of about 40° brix. This base was further divided into three parts and made into the following formulations : (i) base (B); (ii) base + potassium metabisulphite (2.8 g/10 lb base) (BM); and (iii) base+potassium metabisulphite (2.8 g/10 lb base)+ sodium citrate (10 g/10 lb base) (BMC).

Part II. Citric acid (55 g) was added to ten lb juice and the juice was divided into two parts and made into the following formulations : (i) juice+ potassium metabisulphite (5.6 g/10 lb juice) (JM); and (ii) juice+potassium metabisulphite (5.6 g/10 lb juice)+sodium citrate (10 g/10 lb juice) (JMC).

TABLE 1. EFFECT OF PRESERVATVION TREATMENTS AND STORAGE TIME ON TOTAL SOLUBLE SOLIDS, pH AND PER CENT ACIDITY OF VARIOUS GUAVA BASE AND GUAVA JUICE SAMPLES.

Storage time (days)	Total soluble solids °Brix					pH					Total acidity (%)				
	B	BM	BMC	JM	JMC	B	BM	BMC	JM	JMC	B	BM	BMC	JM	JMC
0	40·0	40·0	40·0	8·5	8·5	3·00	3·00	3·00	3·00	3·00	1·62	1·62	1·62	1·74	1·74
30	40·0	40·6	40·5	8·7	8·6	2·98	2·98	2·98	3·01	3·01	1·63	1·64	1·62	1·78	1·79
60	39·7	40·7	40·5	8·8	8·7	2·98	2·96	2·96	3·02	3·03	1·64	1·64	1·63	1·94	1·94
90	39·5	40·7	40·6	8·8	8·7	2·95	2·94	2·95	3·00	3·01	1·65	1·66	1·64	1·98	1·99
120	39·2	40·8	40·6	8·9	8·8	2·96	2·94	2·95	3·00	3·00	1·66	1·66	1·65	2·01	2·00
150	39·1	40·8	40·6	9·1	8·9	2·95	2·93	2·93	3·00	3·00	1·66	1·67	1·65	2·00	2·00
180	38·9	40·9	40·7	9·1	8·9	2·95	2·93	2·93	2·96	3·05	1·68	1·67	1·66	2·00	2·0
210	38·8	40·0	40·8	9·2	9·0	2·94	2·92	2·92	2·95	3·00	1·68	1·68	1·66	2·02	2·04
240	38·7	41·0	40·9	9·2	9·0	2·92	2·92	2·91	2·95	2·98	1·68	1·67	1·67	2·02	2·05
270	38·5	41·0	40·9	9·2	9·0	2·90	2·91	2·90	2·94	2·96	1·68	1·68	1·67	2·04	2·05

B, base; BM, base+potassium metabisulphite; BMC, base+potassium metabisulphite+sodium citrate; JM, Juice+potassium metabisulphite; and JMC, juice+potassium matabisulphite+sodium citrate.

TABLE 2. EFFECT OF PRESERVATION TREATMENTS AND STORAGE TIME ON THE RETENTION OF SULPHUR DIOXIDE CONTENT AND ASCORBIC ACID OF VARIOUS GUAVA BASE AND GUAVA JUICE SAMPLES.

Storage time (days)	Retention of sulphur dioxide content (%)					Ascorbic acid (mg/100)				
	B	BM	BMC	JM	JMC	B	BM	BMC	JM	JMC
0	—	100	100	100	100	168·50	168·50	168·50	336·96	336·96
30	—	93	91	89	87	85·35	101·50	100·08	218·36	215·90
60	—	84	85	81	75	50·84	84·97	85·45	180·64	188·26
90	—	79	78	59	66	35·38	72·90	70·48	168·56	162·26
120	—	71	68	61	58	25·47	64·18	64·88	140·58	150·37
150	—	58	58	54	48	24·84	58·29	60·15	138·64	140·59
180	—	50	49	40	42	20·35	52·45	50·74	132·75	131·00
210	—	43	40	34	37	20·17	48·83	47·75	123·34	114·14
240	—	35	35	30	31	18·42	45·28	45·94	118·25	108·34
270	—	33	29	28	29	15·84	40·43	42·12	108·92	93·50

B, base; BM, base+potassium metabisulphite; BMC, base+potassium metabisulphite+sodium citrate; JM, juice+ptassium metabisulphite; and JMC, juice+potassium metabisulphite+sodium citrate,

All formulations from part 1 and part 2 were filled in 7 oz bottles, corked, waxed and stored at ambient temperature for further analysis. The samples were analysed for SO_2 content,[3] ascorbic acid,[8] total acidity,[1] pH (Beckman model 96), and degree brix (Abbe refractometer) at 90 days intervals up to a storage period of 270 days. Base as well as juice was subjectively analysed for flavour and colour by a panel of five judges. The judges were asked to arrange the samples provided in order of desirable guava flavour and colour. To simplify the results, the five judgements were added and named as total rank (Table 3).

Results and Discussions

Total Soluble Solids. The soluble solid contents of the samples B, BM and BMC were 40° brix at 20°C, whereas TSS of samples JM and JMC were 8.5° brix at 20°C (Table 1). When these samples were stored at ambient temperature for a period of 90 days, the TSS of the samples BM, BMC, JM and JMC resulted in a gradual increase of 0.7, 0.6, 0.3 and 0.3 units respectively. This increase in the soluble solid contents of the products may be attributed to the solubilization of the guava constituents during storage. However, the soluble solid contents of sample B decreased by 0.5 units. This may be due to the break up of sugars or other soluble solids. It was observed that opening of bottles containing sample B was always accompanied by the release of gaseous material, fermentation obviously occured, yielding a gas, probably CO_2. These observations substantiate the above conclusions that the decrease in TSS may be due to conversion of some of the soluble solids into non-soluble materials. This indicates that the addition of a preservative checks the degradation of TSS. Similar trend of increase and decrease in TSS was maintained in all the samples throughout the storage period.

Addition of sodium citrate both to juice and base resulted in a lesser increase in the TSS (0.5 and 0.9 units respectively) as compared to the samples having no citrate (0.7–1.0 units respectively) at the conclusion of the experiment (Table 1). These observations indicate the stabilizing effects of sodium citrate on the TSS of various samples.

pH and Titratable Acidity. At the start of the experiment the pH value of the samples was 3.00. The pH values of the samples B, BM, BMC, JM and JMC decreased by 0.10, 0.09, 0.10, 0.06 and 0.04 respectively during the storage period of 270 days. Samples B, BM and BMC showed a gradual decrease in pH during storage. However, samples JM and JMC showed an initial minor increase (0.01–0.03) up to a storage time of 90 days, thereafter pH started decreasing. The reasons for this obviously unusual phenomenon could not be ascertained. The decrease in pH may be attributed to the hydrolysis of pectin and formation of free acids.

Titratable acidity of B, BM and BMC increased gradually during 270 days of storage by 0.05–0.06%. The increase in samples JM and JMC were slightly higher viz. 0.09–0.10%. This rise in the per cent acidity could probably be due to the degradation of the pectic substances and the formation of free uronic acids.[4] This degradation process could be slowed down by the addition of sugars into the juice resulting in a lower increase of acidity in the sugared samples (Table 1).

Retention of Sulphur Dioxide Content. Both the juice as well as the base samples were preserved with potassium metabisulphite at the rate of 600 and 300 p.p.m. in juice and base respectively. All the samples were analysed for sulphur dioxide content at various storage intervals. Sulphur dioxide content of all the samples decreased gradually with the increase in storage time. Although juice samples contained double the amount of sulphur dioxide content (600 p.p.m.) as compared to base samples (300 p.p.m.), yet per cent retention of these content, as observed during various analysis intervals, was almost equal (Table 2).

Organoleptic evaluation of the samples clearly indicates the favourable effects of sulphur dioxide during storage on the preservation of colour and flavour of the guava base. It may further be noted that guava base, though sealed, but stored without preservative ranked lowest both in flavour and colour during storage for 90, 180 and 270 days, compared to its top rank in flavour and second in colour only to BM when organoleptically evaluated at the time of the start of the experiment (Table 3).

Ascorbic Acid. Loss of vitamin C in the bottled samples has been determined at intervals over a period of 270 days. The results (Fig. 1) show that 80% of vitamin C was lost in the first 90-days storage in the sample B having no preservative. Whereas, in a similar sample containing metabisulphite as preservative the loss of vitamin C in the first 90 days was only 50%. In general all the samples suffered a maximum loss of ascorbic acid during first 90-days storage (Table 3). Thereafter, the degradation process of the vitamin was considerably slowed down. The total loss of vitamin C in various samples during 270-day storage ranged from 65 to 90%. The maximum retention of vitamin C was in the sample JM (35%), which is a single strength guava juice preserved with sulphur dioxide. In case of single strength juice containing sodium citrate, the retention was 32%. After 270-day storage the sample B, BM, and BMC showed 9.4, 24 and 25% retention of ascorbic acid respectively.

It may be explained from the above observations that single strength guava juice can retain comparatively higher percentage of vitamin C during storage as compared to the sugared base (B, BM and BMC). Therefore, it follows that the behaviour of vitamin C in guava juice (maximum retention 35%) is quite different than that in citrus juices where maximum retention of ascorbic acid (75%) has been recorded in case of bottled citrus juices.[5] However, low retentions might possibly be due to insufficient protection from atmospheric oxygen during handling of processing.

Fruit juices containing anthocyanin pigments have been reported to lose ascorbic acid at an accelerated rate.[13] Guava has also been reported to contain significant amount of such pigments,[9] therefore, accelerated losses of ascorbic aicd during

TABLE 3. SUBJECTIVE RANKING OF GUAVA BASE AND GUAVA JUICE FOR DESIRABLE GUAVA FLAVOUR AND COLOUR AT VARIOUS STORAGE INTERVALS.

Variable tested	Storage time (days) 0				90				180				270			
	Sample	Total* rank	Mean rank	Rank order	Sample	Total* rank	Mean rank	Rank order	Sample	Total* rank	Mean rank	Rank order	Sample	Total* rank	Mean rank	Rank order
Flavour	B	5	1·0	1	BMC	7	1·4	1	BM	7	1·4	1	BMC	7	1·4	1
	BMC	12	2·4	2	BM	10	2·0	2	BMC	8	1·6	2	BM	8	1·6	2
	BM	13	2·6	3	B	13	2·6	3	B	15	3·0	3	B	15	3·0	3
	JM	7	1·4	1	JMC	7	1·4	1	JMC	7	1·4	1	JM	7	1·4	1
	JMC	8	1·6	2	JM	8	1·6	2	JM	8	1·6	2	JMC	8	1·6	2
Colour	BM	9	1·8	1	BM	7	1·4	1	BMC	7	1·4	1	BMC	7	1·4	1
	B	10	2·0	2	BMC	8	1·6	2	BM	8	1·6	2	BM	8	1·6	2
	BMC	11	2·2	3	B	15	3·0	3	B	15	3·0	3	B	15	3·0	3
	JM	7	1·4	1	JM	7	1·4	1	JMC	7	1·4	1	JM	7	1·4	1
	JMC	8	1·6	2	JMC	8	1·6	2	JM	8	1·6	2	JMC	8	1·6	2

*An average of five judgements. B, base; BM, base+potassium metabisulphite; BMC, base+potassium metabisulphite+sodium citrate; JM, juice+potassium metabisulphite; and JMC, juice+potassium metabisulphite+sodium citrate.

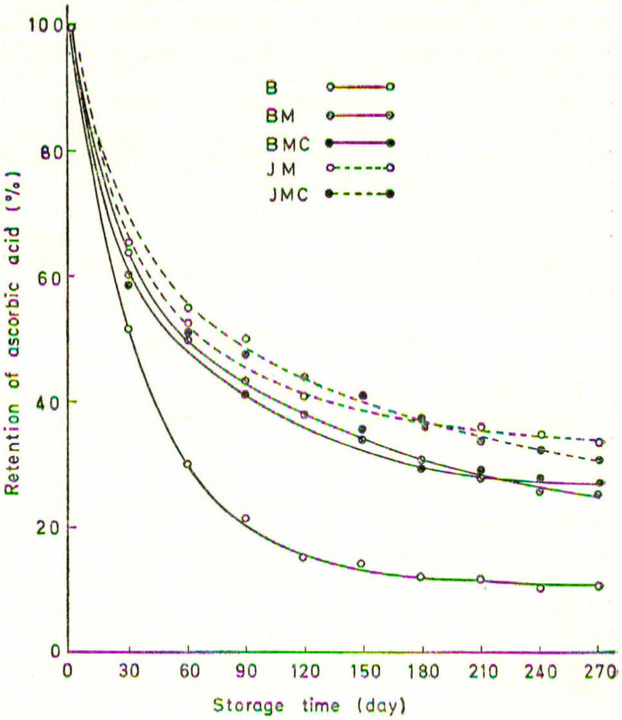

Fig. 1. Effect of storage time on per cent retention of ascorbic acid in guava base and guava juice.

storage of bottled guava products may be attributed to the presence of anthocyanin pigments.

Organoleptic Evaluation. Among the group I although the flavour of the sample B (without preservative) was best at the start, yet its flavour deteriorated during storage (Table 3). Therefore, BMC and BM samples ranked higher at the termination of the experiment as compared to the sample B. Likewise, the colour also exhibited the same pattern.

Amongst the group II JM ranked slightly better both in flavour and colour, as compared to JMC. This behaviour was observed almost throughout the storage period, which indicates that addition of sodium citrate is not really helpful in this case.

It may, however, be pointed out that in group I the sample BMC ranked slightly better than sample BM towards the end of the experiment. This indicates that in the case of samples to which sugar had been added the addition of sodium citrate was useful to preserve the original flavour of guava juice.

Conclusion

It may be concluded from the results of these investigations that bottled guava juice, both sugared as well as single strength samples, can be stored at least for 270 days without losing its acceptability. However, for safe storage of samples addition of a chemical preservative is essential both in sugared as well as in the single strength juice. Single strength guava juice has ability to retain higher percentage of ascorbic acid as compared to the sugared samples,

while addition of sodium citrate is more helpful in preserving colour and flavour in the case of sugared samples as compared to the single strength guava juice.

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