Effect of Recipe on Qualitative Changes in Sapota Squash during Storage

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Abstract Sapota squash was prepared with different levels of juice (25%, 30% and 35%), TSS (45° and 50°B) and acidity (1.0 %). Qualitative changes exhibited the increasing trend in TSS, reducing sugar, total sugar and pH with decline in acidity of squash during the storage period of six months. The squash recipes with 50°B TSS maintained initially recorded higher levels of TSS, reducing sugar and total sugar than those with 45°B TSS. Except texture, the acceptability of all sensory parameters like colour, flavour, texture and taste of squash was declined significantly during storage period of six months. Sapota squash with 30% juice and 50°B TSS (T4) recorded the highest sensory score for flavour and taste. Increasing the juice level beyond 30 per cent declined the flavour acceptability of the squash. As per the sensory evaluation for overall acceptability, the squash prepared with 30% juice, 50°B TSS and 1.0% acidity was most acceptable, but remained at par with the squash recipe of 25% juice + 50°B TSS + 1.0% acidity. The cost of production of sapota squash increased as the juice and TSS level in the squash increased with corresponding decline in net profit as well as B: C ratio.

Keywords Recipe; Sapota; Squash; Sensory score

Background

Sapota (Manilkara achras (Mill) Fosberg) is a delicious tropical fruit, native of tropical America and grown commercially in coastal states of India. India is supposed to be the largest producer of Sapota, followed by Mexico, Guatemala and Venezuela (Pawar, 2010). Sapota fruit is highly appreciated due to its pleasant flavour, sweet taste and deep orange red colour of the pulp. Edible portion of sapota contains 73.7 g moisture, 21.49 g carbohydrates, 0.7 g protein, 1.1 g fat, 28 mg calcium, 27 g phosphorous, 2 mg iron and 6 mg ascorbic acid per 100 g (Bose and Mitra, 1990).

Sapota fruits can be used for the preparation of various processed products such as sweet chutney (Sawant, 1989), jam, jelly, butter and cheese (Relekar et al., 2011), osmodehydrated slices (Relekar et al., 2003) and wine (Gautam and Chundawat, 1998).

The demand for fruit beverages has been steadily increasing in tropical country like India for quenching the thirst during hot summer. Sapota fruits can be used for the preparation of nutritious squash. The quality of squash mainly depends upon the concentration of juice and brix-acid ratio, however, no work has so far been reported in this regards in sapota.

Keeping this in view, the present study was undertaken to use the sapota juice for the preparation of sapota squash with an objective to determine optimum recipe as well as quality and storage stability of squash under ambient conditions.

Results and Discussion

The changes in chemical constituents of sapota squash during storage are presented in Table 1. The various recipes had significant effect on the TSS of the sapota squash; however, the variation in TSS was mainly due to the TSS level maintained initially in the squash. The TSS content of the squash was not influenced by increasing the juice level from 25% to 35%. An increasing trend in TSS level of the squash was noticed throughout the storage period of six months. This increase in TSS could be attributed to the hydrolsis of complex saccharides present in squash by acids. A gradual increase (45° to 47.5°B) in TSS of jamun squash was noticed by Kannan and Thirumaran (2001) and mentioned that the rise in TSS during storage might be due to partial hydrolysis of complex carbohydrates during storage. The present findings are also in line with the observations recorded by Ramajayam and Jagannath (2003) in Kokum-Simarouba squash.
Table 1 Changes in chemical composition of sapota squash during storage

| Treatments | Storage period (months) | CD @ 5% |
|------------|-------------------------|---------|
|            | 0          | 3      | 6      | Mean | Tr. | 0.47 |
| TSS (°B)  |             |        |        |      |     |      |
| T1        | 45.34      | 45.45  | 46.14  | 45.64 | Tr. | 0.47 |
| T2        | 50.29      | 50.83  | 50.54  | 50.55 | Period | 0.33 |
| T3        | 45.30      | 45.58  | 46.48  | 45.78 | T X P | NS |
| T4        | 50.30      | 50.10  | 51.10  | 50.50 |        |      |
| T5        | 45.48      | 45.90  | 46.20  | 45.86 |        |      |
| T6        | 50.18      | 50.35  | 51.11  | 50.55 |        |      |
| Mean      | 47.81      | 48.03  | 48.59  |        |      |      |
| Titratable acidity (%) |             |        |        |      |     |      |
| T1        | 0.981      | 0.948  | 0.928  | 0.952 | Tr. | NS |
| T2        | 0.985      | 0.943  | 0.943  | 0.957 | Period | 0.016 |
| T3        | 0.985      | 0.915  | 0.925  | 0.942 | T X P | NS |
| T4        | 0.973      | 0.949  | 0.921  | 0.948 |        |      |
| T5        | 0.983      | 0.939  | 0.935  | 0.952 |        |      |
| T6        | 0.996      | 0.943  | 0.934  | 0.958 |        |      |
| Mean      | 0.984      | 0.939  | 0.931  |        |      |      |
| pH        |             |        |        |      |     |      |
| T1        | 2.74       | 2.79   | 2.84   | 2.79  | Tr. | NS |
| T2        | 2.74       | 2.79   | 2.84   | 2.79  | Period | 0.033 |
| T3        | 2.76       | 2.83   | 2.86   | 2.82  | T X P | NS |
| T4        | 2.71       | 2.85   | 2.88   | 2.81  |        |      |
| T5        | 2.74       | 2.85   | 2.88   | 2.82  |        |      |
| T6        | 2.73       | 2.85   | 2.85   | 2.81  |        |      |
| Mean      | 2.74       | 2.83   | 2.86   |        |      |      |
| Reducing sugars (%) |             |        |        |      |     |      |
| T1        | 35.17      | 37.68  | 38.78  | 37.21 | Tr. | 0.60 |
| T2        | 37.05      | 39.18  | 41.47  | 39.23 | Period | 0.43 |
| T3        | 35.50      | 37.84  | 39.55  | 37.63 | T X P | NS |
| T4        | 38.09      | 40.24  | 41.14  | 39.82 |        |      |
| T5        | 36.28      | 38.93  | 39.33  | 38.18 |        |      |
| T6        | 38.38      | 41.26  | 41.99  | 40.54 |        |      |
| Mean      | 36.74      | 39.19  | 40.38  |        |      |      |
| Total sugars (%) |             |        |        |      |     |      |
| T1        | 41.58      | 42.43  | 43.63  | 42.55 | Tr. | 0.47 |
| T2        | 46.16      | 46.87  | 48.50  | 47.18 | Period | 0.33 |
| T3        | 42.10      | 42.72  | 44.08  | 42.97 | T X P | NS |
| T4        | 46.29      | 47.77  | 48.51  | 47.52 |        |      |
| T5        | 42.17      | 42.82  | 44.05  | 43.01 |        |      |
| T6        | 46.51      | 47.78  | 48.62  | 47.64 |        |      |
| Mean      | 44.14      | 45.06  | 46.23  |        |      |      |

Note: T1: 25% juice+45°B TSS; T2: 25° B juice+50°B TSS; T3: 30% juice+45°B TSS; T4: 30% juice+50°B TSS; T5: 35% juice+45°B TSS; T6: 35% juice+50°B TSS

The recipe treatments of squash had no effect on the titratable acidity and pH level of the sapota squash as same acidity level was maintained in all recipes initially. A significant decrease in acidity level with increase in pH level was noticed during storage period of six months. This might be due to utilization of acids for converting polysaccharides and non-reducing sugars into hexose sugars in the presence of metal ions (Srinivas et al., 2007). Bhatia et al (1956) reported that the degree of reduction in acidity depends on the concentration of sugar and is a general phenomenon during storage of beverages in the presence of sugars. According to Palaniswamy and Muthukrishnan (1974), the declining trend in acidity might be due to chemical reactions between the chemical constituents of juice induced by temperature influencing enzymatic action. The fall in acidity and increase in pH level was reported by Jain et al (1986) in Phalsa, Kaphal and Litchi squashes.

The reducing and total sugar content of sapota squash varied significantly due to recipe treatments and storage period. Higher level of reducing sugar was noticed in recipes with 50°B TSS maintained initially than those with 45°B TSS. A significant
increase in reducing sugar content in the squash was observed when the juice content increased up to 35%. Thus, the maximum conversion into reducing sugars was noted in the treatment (T6) having higher level of juice as well as TSS in the product. This treatment contributes to the sufficiently high level of polysaccharides from juice and maximum level of sugar (50°B TSS) which are broken down into simple sugars under the influence of high acid level in the squash. Enzymes (invertase) could also contribute to this inversion to a little extent. The total sugar content was higher in squash recipes with 50°B TSS maintained initially than those with 45°B TSS. Analogous observations were recorded by Reddy and Chikkasubbanna (2008) in lime blended aonla squash and reported higher values of reducing and total sugars with increase in the brix of the squash. In the present investigation, total sugar content increased significantly throughout the storage period of six months. This could be due to the hydrolysis of polysaccharides during storage. The present results are in line with the observations made by Jain et al (1988) who reported increasing trend in reducing sugar (45% to 50.2%) and total sugar (50.55% to 52.88%) in litchi squash cv Calcuttia, whereas Sudha et al (2007) noticed increasing trend in total sugar content (40.84% to 41.76%) of sapota squash prepared from sapota fruits of CO2 cultivar after 30 days of storage.

The sensory parameters except colour and texture were significantly influenced by recipes whereas variation in all sensory parameters except texture was also noted due to storage period (Table 2). The squash recipes had no effect on the colour acceptability scores; however, it declined significantly throughout the storage period. A slight discolouration of sapota squash was noticed which might be due to oxidation and amino acid sugar interaction (Saikia and Saikia, 2002). A decrease in colour score of plum squash was reported to be due to copolymerization, interaction between phenolic compounds and proteins as well as formation of cation complexes with pectin (Barwal et al., 2002).

The sensory score for flavour was highest in the sapota squash with 30% juice+50°B TSS (T4). However, increasing the juice level up to 35% declined the flavour acceptability as it imparted more intense flavour which was not liked by the panelists. In storage, decreasing trend in flavour score could be due to loss of volatile aromatic substances responsible for flavour (Thakur and Barwal, 1998). Gajanana et al (2007) reported slightly higher flavour score (2.73) for aonla squash with 25% pulp+40°B TSS than the squash with 25% pulp+50°B TSS (2.61).

Non-significant effects of recipes and storage period were noticed on the textural qualities of sapota squash, but taste score was significantly influenced by the juice and TSS level. The squash with 30% juice and 50°B TSS was rated superior to all other recipes with respect to taste, which might be due to better compatibility of juice and TSS levels arriving at suitable sugar-acid ratio in the product. Taste acceptability score declined significantly due to loss of flavour components during storage. Sethi (1993) reported lower taste score of 5.5 for litchi squash by the end of six months of storage.

As regards overall acceptability of the product, the squash prepared with 30% juice+50°B TSS was rated the best, but remained at par with the squash recipe of 25% juice + 50°B TSS. It indicated that the juice and TSS level of 25% and 50°B TSS was the optimum for the preparation of sapota squash. This might be due to better colour, flavour, texture and acceptable sugar-acid blend of the squash prepared with this recipe. The overall acceptability of the squash influenced significantly by the storage period and declined significantly during storage period of six months due to decline in colour, flavour and taste acceptability of the product. Waskar and Khirdiya (1987) observed decline in overall acceptability of phalsa squash from 8.10 to 4.40 after 180 days of storage. Similar declining trend in overall acceptability was noticed by Dwivedi et al (2004) in sea buckthorn squash and Jadhav et al (2004) in Karonda squash.

In general, the cost of production of sapota squash increased as the juice and TSS level in the squash increased with corresponding decline in net profit as well as B: C ratio (Table 3).
Table 2 Changes in sensory qualities of sapota squash during storage

| Treatments | Storage period (months) | Mean | CD @ 5% |
|------------|-------------------------|------|---------|
|            | 0  | 3  | 6  |     |
| Colour     |    |    |    |     |
| T1         | 7.65 | 7.10 | 6.60 | 7.12 | Tr. | NS |
| T2         | 7.80 | 7.25 | 6.60 | 7.22 | Period | 0.26 |
| T3         | 7.60 | 7.10 | 6.60 | 7.10 | T X P | NS |
| T4         | 7.85 | 7.45 | 6.50 | 7.27 |
| T5         | 7.35 | 7.00 | 6.35 | 6.90 |
| T6         | 7.55 | 7.10 | 6.15 | 6.93 |
| Mean       | 7.63 | 7.17 | 6.47 |
| Flavour    |    |    |    |     |
| T1         | 7.30 | 6.95 | 6.75 | 7.00 | Tr. | 0.31 |
| T2         | 7.70 | 7.45 | 7.25 | 7.47 | Period | 0.22 |
| T3         | 7.45 | 7.20 | 6.80 | 7.15 | T X P | NS |
| T4         | 8.55 | 7.95 | 7.35 | 7.95 |
| T5         | 7.45 | 7.25 | 7.05 | 7.25 |
| T6         | 7.70 | 7.30 | 7.00 | 7.33 |
| Mean       | 7.69 | 7.35 | 7.03 |
| Texture    |    |    |    |     |
| T1         | 7.40 | 7.50 | 7.00 | 7.30 | Tr. | NS |
| T2         | 7.55 | 7.35 | 7.45 | 7.45 | Period | NS |
| T3         | 7.40 | 7.25 | 6.90 | 7.18 | T X P | NS |
| T4         | 7.45 | 7.25 | 7.15 | 7.28 |
| T5         | 7.15 | 6.90 | 7.00 | 7.02 |
| T6         | 7.70 | 7.05 | 7.10 | 7.08 |
| Mean       | 7.34 | 7.22 | 7.10 |
| Taste      |    |    |    |     |
| T1         | 7.05 | 6.95 | 6.65 | 6.88 | Tr. | 0.35 |
| T2         | 7.70 | 7.45 | 7.15 | 7.43 | Period | 0.25 |
| T3         | 7.40 | 7.20 | 6.70 | 7.10 | T X P | NS |
| T4         | 8.40 | 7.80 | 7.60 | 7.93 |
| T5         | 7.45 | 7.05 | 6.90 | 7.13 |
| T6         | 7.75 | 7.60 | 7.10 | 7.48 |
| Mean       | 7.63 | 7.34 | 7.02 |
| Overall acceptability |    |    |    |     |
| T1         | 7.35 | 7.13 | 6.75 | 7.08 | Tr. | 0.23 |
| T2         | 7.69 | 7.38 | 7.11 | 7.39 | Period | 0.17 |
| T3         | 7.46 | 7.19 | 6.75 | 7.13 | T X P | NS |
| T4         | 8.07 | 7.62 | 7.15 | 7.61 |
| T5         | 7.35 | 7.05 | 6.83 | 7.08 |
| T6         | 7.53 | 7.27 | 6.84 | 7.21 |
| Mean       | 7.57 | 7.27 | 6.91 |

Note: T1: 25% juice+45°B TSS; T2: 25° B juice+50°B TSS; T3: 30% juice+45°B TSS; T4: 30% juice+50°B TSS; T5: 35% juice+45°B TSS; T6: 35% juice+50°B TSS

Since the squash recipe with 25% juice+50°B TSS+1.0% acidity results in a better product with respect to overall sensory qualities and with lower cost of production than recipe T4, the commercial feasibility of the sapota squash with this recipe may be explored.

Materials and Methods
Sapota cv Kalipatti fruits were procured from the orchard of Regional Horticultural Research Centre, ASPEE College of Horticulture and Forestry, N.A.U., Navsari, Gujarat. After ripening, the fruits were peeled and sliced with stainless steel knife. The seeds as well as the central white core were removed and fruit pieces were chopped to obtain homogenous pulp. Later on, juice was extracted by squeezing the pulp through twofold muslin cloth. Sapota squash was prepared as per the following treatments: T1 25% juice+45°B TSS+1.0% acidity, T2 25% juice+50°B TSS+1.0% acidity, T3 30% juice+45°B TSS+1.0% acidity, T4 30% juice+50°B TSS+1.0% acidity, T5 35% juice+45°B TSS+1.0% acidity and T6 35% juice+50°B TSS+1.0% acidity. The squash was heated gently up to 80°C temperature and preserved with potassium meta bisulphite (700 mg/kg) in pre-sterilized glass bottles of 200 mL.
capacity and stored under ambient temperature conditions for 6 months. Total soluble solids, acidity, pH and sugars were estimated using the methods described by Ranganna (1991). The sensory evaluation of the product was done initially and at three months interval up to six months on hedonic scale by a panel of five judges as described by Amerine et al (1965). The data collected on changes in chemical composition of products and sensory qualities during storage were statistically analyzed by the standard procedure (Gomez and Gomez, 1984).

Table 3 Cost of production of sapota squash (100 kg)

| Sr. No. | Particulars                     | T1   | T2   | T3   | T4   | T5   | T6   |
|---------|--------------------------------|------|------|------|------|------|------|
| 1       | Cost of sapota fruits @$6/-kg   | 416.64 | 416.64 | 500.52 | 500.52 | 582.84 | 582.84 |
| 2       | Labour charges @$ Rs100/- per Labour | 1 100 | 1 100 | 1 200 | 1 200 | 1 300 | 1 300 |
| 3       | Glass bottles @$Rs2/-          | 840  | 820  | 840  | 820  | 840  | 820  |
| 4       | Sugar @@$Rs18/-kg              | 711  | 801  | 691.92 | 778.32 | 667.08 | 767.88 |
| 5       | Citric acid @ Rs200/- per kg   | 200  | 200  | 200  | 200  | 200  | 200  |
| 6       | KMS @ Rs300/- per kg           | 21   | 21   | 21   | 21   | 21   | 21   |
| 7       | Crown caps @Rs1.00/piece       | 420  | 410  | 420  | 410  | 420  | 410  |
| 8       | Fuel charges @$ Rs2/- per kg   | 200  | 200  | 200  | 200  | 200  | 200  |
| 9       | Cost of production             | 3 908.64 | 3 968.64 | 4 073.44 | 4 129.84 | 4 230.92 | 4 301.72 |
| 10      | Working capital (item 1 to 7)  | 3 908.64 | 3 968.64 | 4 073.44 | 4 129.84 | 4 230.92 | 4 301.72 |
| 11      | Supervision charges @10% of the working capital | 390.86 | 396.86 | 407.34 | 412.98 | 426.09 | 430.17 |
| 12      | Depreciation charges of the fixed capital item (2% on Rs10000/-) | 200  | 200  | 200  | 200  | 200  | 200  |
| 13      | Interest on the fixed capital (@13% on Rs 10000/-) | 1 300 | 1 300 | 1 300 | 1 300 | 1 300 | 1 300 |
| A.      | Total cost of production       | 5 799.5 | 5 865.5 | 5 980.78 | 6 042.82 | 6 187.01 | 6 231.89 |
|         | Gross production (kg)          | 100  | 100  | 100  | 100  | 100  | 100  |
|         | Gross production (No. of bottles) | 420  | 410  | 420  | 410  | 420  | 410  |
| B.      | Gross returns (@ Rs20/- per 200 mL bottle) | 8 400  | 8 200  | 8 400  | 8 200  | 8 400  | 8 200  |
| C.      | Net profit (B-A) (Rs)          | 2 600.5 | 2 334.5 | 2 419.22 | 2 157.18 | 2 212.99 | 1 968.11 |
|         | Per cent net profit            | 44.84 | 39.80 | 40.45 | 35.70 | 35.77 | 31.58 |
|         | Benefit : Cost ratio           | 1.45  | 1.40  | 1.40  | 1.36  | 1.36  | 1.32  |
|         | Sale price per 200 mL (if profit margin is 20%) | 16.57  | 17.17  | 17.09  | 17.69  | 17.68  | 18.24  |

Note: T1: 25% juice+45°B TSS; T2: 25°B juice+50°B TSS; T3: 30% juice+45°B TSS; T4: 30% juice+50°B TSS; T5: 35% juice+45°B TSS; T6: 35% juice+50°B TSS

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