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Development and storage stability of papaya (*Carica papaya* L) toffee and leather

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ABSTRACT

Various treatments were optimized for the preparation of toffee and bar/leather from papaya fruit. Out of various treatments papaya toffee prepared in combination with apricot (50:50) and papaya bar/leather prepared using 30ºB TSS, 0.5 per cent acidity and 0.02 per cent KMS were rated the best on the basis of sensory evaluation. The papaya toffee contained 85.97ºB TSS, 1.19 per cent acidity, 18.20 mg/100 g ascorbic acid, 17.70 mg/100 g calcium and 147 µg/100 g carotenoids whereas the developed papaya leather contained 54.2ºB TSS, 0.79 per cent acidity, 181.4 mg/100 g ascorbic acid, 21.6 mg/100 g calcium and 1689.6 µg/100 g carotenoids at six months storage period. The storage stability of the developed products was also assessed by packing in polyethylene pouches and storing at ambient temperature (13-27°C) for a period of six months. During storage an increase in moisture content, reducing sugars and decrease in total sugar, ascorbic acid, carotenoid content and calcium content was noticed. The sensorial quality of the developed products was not affected during storage and these were rated 'liked very much' even after six months of storage at ambient temperature.

Keywords: Papaya; toffee; bar/leather; carotenoids; intermediate moisture

INTRODUCTION

Papaya (*Carica papaya* L) is cultivated in all the tropical and sub-tropical countries of the world. Due to its fast growth it yields more but being perishable in nature possesses problem in marketing even to primary market. The commercial importance of fruit is due to its high nutritive and medicinal value being a rich source of antioxidant nutrients like carotenes, vitamin C, vitamin B. Its mineral composition comprises of K and Mg along with calcium, iron, manganese, phosphorus, zinc etc (Hardisson et al 2004). Papaya is wholesome fruit used mostly as desert; ripened fruit is eaten as salad and when unripe it is cooked as vegetable. It is laxative, stimulates digestion and the production of bile which may lead to healthy liver and pancreas (Aravind et al 2013). Being a rich source of fiber papaya

consumption helps in lowering high cholesterol level. Papaya fruit has also been included in commercial preparation such as meat tenderizer, chew-gums and as stabilizer and to clarify the beer. Though some work on utilization of papaya in preparation of value added products viz beverages jam, jelly, osmo dried etc has been reported in the literature but negligible work on development of toffee and leather has far been reported. Therefore in the present study efforts were made to develop nutritious and palatable papaya based toffee and leather and to analyze their storage stability at ambient temperature.

MATERIAL and METHODS

The study was conducted in the Department of Food Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan. Fully matured, firm, ripe and healthy fruits of papaya were collected from the local market for the preparation of two value added products viz papaya toffee and papaya bar/leather.

Preparation of papaya toffee: Different combinations of papaya pulp with apricot and plum pulp were tried as detailed below:

T_0= Papaya 100 %, T_1= Papaya: plum (50:50), T_2= Papaya:apricot (50:50)

The toffee were prepared as per the procedure given by Revanwar and Sakhale (2003) with certain modifications as detailed in Fig 1.

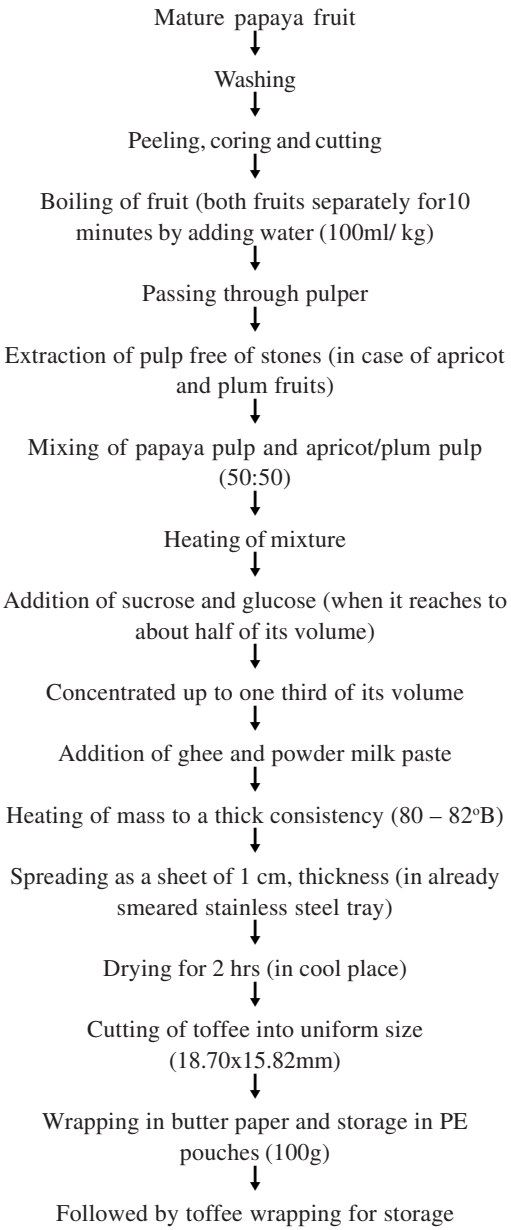

Fig 1. Flow diagram for the preparation of papaya toffee

Preparation of papaya bar/leather

Table 1. Standardization of treatments for the preparation of papaya bar/leather

Treatment	Papaya bar/leather
T_0 (control)	TSS and acidity were maintained at 25°B and 0.5% respectively.Whole mixture was heated and poured as layer in greased tray and dried at a temperature of 50-55°C in a mechanical dehydrator. The fruit bars were wrapped and packed.
T_1	TSS and acidity were maintained at 25°B and 0.5% respectively. Whole mixture was heated and KMS was added @ 0.02%. Heated mixture was poured as layer in greased tray and dried at a temperature of 50-55°C in a mechanical dehydrator. The fruit bars were wrapped and packed.
T_2	TSS was maintained 30ºB and rest of the procedure was as mentioned for T_1.
T_3	TSS was maintained 35°B and rest of the procedure was as mentioned for T_1.

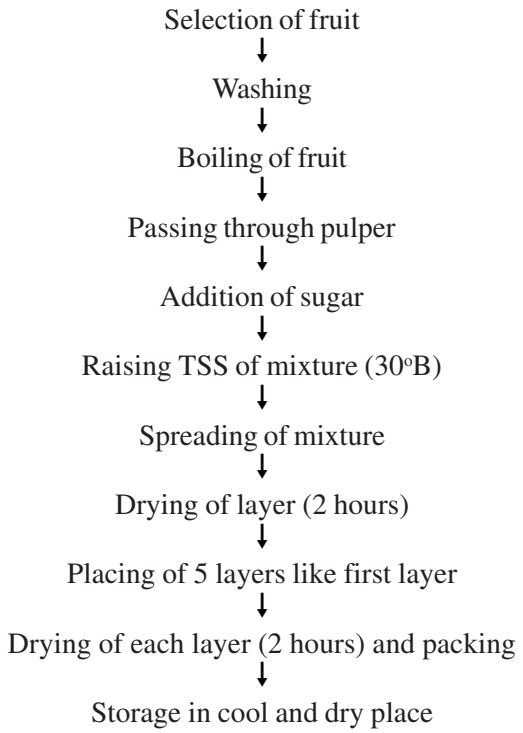

Fig 2. Flow diagram for the preparation of papaya fruit leather/bar

Physico-chemical and sensory analysis

Fresh papaya fruits as well as papaya products were analyzed for various physico-chemical parameters as per standard procedures. Fruit length and width were recorded with vernier caliper while weight of the fruits was recorded by weighing the individual fruit in top pan balance. Papaya products of best treatment were analyzed for chemical as well as for sensory attributes viz moisture, ash, TSS, acidity, fiber and pectin, sugars (reducing and total sugars), ascorbic acid, carotenoid and calcium content. The total soluble solids in the fruits were measured with the help of hand refractrometer. Moisture, ash, titratable acidity, ascorbic acid, carotenoid and calcium content were determined by methods given by Ranganna (1999). Fiber content was determined by the method given by Gould (1978). Sensory quality parameters were determined by adopting a 9-point hedonic scale (1= dislike extremely, 9= like extremely) (Ranganna 1999).

Statistical analysis

The data pertaining to chemical characteristics obtained in this study were subjected to statistical analysis using CRD while those of sensory quality using RBD.

RESULTS and DISCUSSION

The general quality characters of papaya fruit used in this study presented in Table 2 indicate that the length and diameter of fruits ranged from 23-25 and 13.7-14.0 cm respectively. The average fruit weight ranged from 1.8-2.2 kg. The papaya fruit contained 89.5 per cent moisture, 9.2ºB per cent TSS, 0.062 per cent acidity, 3144 µg/100g carotenoid, 250 mg/100 g ascorbic acid, 1.2 per cent fiber and 29.8 mg/100 g calcium (Table 2). As expected it is evident from the data that fruits used in the study were rich in vitamin A and vitamin C. Similar results were also reported by Othman (2009) with certain variations which could be due to differences in season and varieties.

Papaya toffee

Papaya toffee in combination with apricot fruit (50:50) T2 was found best on the basis of its sensory attributes (data not shown). The selected product was evaluated for various physico-chemical parameters on initial day and during storage at different intervals (Tablen 3). The toffee contained 8.0 per cent moisture, 86.7°B TSS, 1.28 per cent acidity, 27.7 per cent reducing sugar, 62.5 per cent total sugars, 176 µg/100 g carotenoid and 21.6 mg/100 g vitamin C content when evaluated on the preparation day. It has also been observed that in papaya apricot toffee there was decrease in TSS (85.7%), increase in reducing sugar (29.9%) while decrease in acidity (1.19%) in total sugars (59.8%), carotenoid (142 µg/100 g) and vitamin C contents (17.6 mg/100 g) during 3 months of storage. The decline in carotenoid content could be due to the thermo-labile and photosensitive nature, isomerization and epoxide forming nature of carotene (Mir

Plate1. Papaya leather/bar

Plate 2. Papaya-apricot toffee

Table 2. Physico-chemical characteristics of fresh papaya fruit

Parameter	Mean
Moisture (%)	89.5
Ash (%)	4.1
TSS (^{o}B)	9.2
Acidity (%)	0.062
Ascorbic acid (mg/100 g)	250
Fiber (%)	1.2
Reducing sugar(%)	2.8
Total sugar(%)	5.5
Calcium(mg/100 g)	29.8
Carotenoids (µg/100 g)	3144

Table 3. Effect on Physico-chemical characteristics of papaya toffee during storage at ambient temperature

Parameter	Storage period/interval (months)				
	0	3	6	Mean	$CD_{0.05}$
Moisture (%)	8.0	9.3	9.9	9.07	0.13
Ash (%)	2.26	2.20	2.21	2.22	0.029
TSS (^{o}B)	86.7	85.7	85.5	85.97	0.158
Acidity (%)	1.28	1.19	1.10	1.19	0.122
Ascorbic acid (mg/100 g)	21.6	17.6	15.4	18.20	0.18
Fiber (%)	0.35	0.31	0.28	0.31	0.012
Reducing sugar (%)	27.7	29.9	32.4	30.0	0.755
Total sugar (%)	62.5	59.8	57.3	59.87	0.745
Calcium (mg/100 g)	19.5	17.2	16.4	17.70	0.725
Carotenoids (µg/100 g)	176	142	123	147	1.42

and Nath 1993). Increased TSS content during storage might be due to conversion of left over polysaccharides into soluble sugar. Total sugar, reducing sugars and non-reducing sugars probably decreased due to the inversion of sugars to monosaccharide by acid hydrolysis (Muralikrishna et al 1969). There was increase in reducing sugar (32.4%) while decrease in acidity (1.10%), total sugars (57.3%), carotenoids (123 µg/ 100 g) and vitamin C contents (15.4 mg/ 100 g) during 6 months of storage. Slight decrease in carotenoid, vitamin C and calcium contents was found during 3 and 6 months storage. Vitamin C losses may be attributed to heat and light sensitivity of the ascorbic acid (Devidek et al 1990). The values for its ash and fiber content remained same as that of at 0 day.

The data in Table 4 of sensory quality attribute measured on 9-point hedonic scale for papaya toffee with best treatment T_2 papaya and apricot fruit pulp (50:50) show that color, flavor, taste, texture and overall acceptability rating was higher (8.95, 9.00, 7.5, 7.72,8.0 respectively) in this treatment at 0 day and negligible changes in its color, flavour, taste, texture and overall acceptability during storage. Henceforth papaya fruits can be blended with acidic fruits to produce a best quality toffee because this fruit is not acidic (0.037 to 0.064%). This blend for toffee was at par with toffee prepared with papaya and plum (50:50). Table 4 shows that color, flavor, taste, texture and overall acceptability rating was 7.8, 7.3 6.7, 6.5, 7.0 respectively during 3 months of storage and after 6 months storage color, flavour, taste, texture and overall acceptability rating was 7.4, 6.0, 6.2, 6.1, and 6.3 respectively. Toffee prepared singly from papaya was very good at 0 day but during storage its

Table 4. Effect on sensory quality attributes of papaya toffee during storage at ambient temperature

Parameter	Storage interval (months)				
	0	3	6	Mean	$CD_{0.05}$
Color	8.95	7.8	7.4	8.05	1.015
flavor	9.0	7.3	6.0	7.43	1.054
Taste	7.5	6.7	6.2	6.80	0.403
Texture	7.72	6.5	6.1	6.77	0.356
Overall	8.0	7.0	6.3	7.10	0.839

Table 5. Effects on physico-chemical characteristics of papaya leather/bar during different storage intervals

Parameters	Storage period (months)			
	0	3	6	$CD_{0.05}$
Moisture (%)	9.3	9.9	10.0	0.166
Pectin (%)	0.88	0.70	0.61	0.054
Ash (%)	1.59	1.52	1.48	0.055
TSS(°B)	55.9	54.7	54.2	0.753
Acidity (%)	0.83	0.81	0.79	0.013
Ascorbic acid (mg/100g)	200	189.2	181.4	0.869
Fiber (%)	0.73	0.71	0.69	0.006
Reducing sugar (%)	16.6	18.1	22.4	0.340
Total sugar (%)	36.0	33.9	30.2	0.864
Calcium (mg/100g)	24.2	22.5	21.6	0.485
Carotenoid (µg/100g)	1946.20	1729.4	1689.6	1.080

taste and texture have totally been changed but change in color was negligible.

The values for quantitative parameters of papaya leather/bar (Table 5) indicate that papaya bar contained 55.9°B TSS, 0.83 per cent acidity, 16.6 per cent reducing sugar, 36.0 per cent total sugar, carotenoid 1946.20 µg/100 g, 200 mg/100 g vitamin C, 0.73 per cent fiber and 24.2 mg/100 g calcium content at 0 day. There was slight decrease in TSS (54.7° B), acidity (0.81%), total sugar (33.9%) ascorbic acid (189.2 mg/100 g), carotenoid content (1729.4 µg/100 g) while increase in reducing sugar (18.1%) and moisture content (9.9%) during 3 months storage period. Rozina (2012) worked on preparation of fruit leather from apple, mango and guava and concluded that all leathers remained unchanged during storage period. After 6 months storage interval slight decrease was observed in TSS (44.2°B), total sugar (30.2%), acidity (0.79%), ascorbic acid

(181.4 mg/100 g), carotenoid content (1689.6 µg/100 g) and calcium (21.6 mg/100 g). However moisture content and reducing sugar of papaya leather/bar showed slight increase.

The data in Table 6 of sensory quality measured on 9-point-hedonic scale for papaya bar with best treatment T_2 indicate that colour, flavour, texture, taste and overall acceptability were higher in this treatment 8.0, 7.7, 7.5, 7.9, 8.0 respectively at 0 day with slight changes in these parameters during storage. Chan and Cavalleto (1978) suggested the use of sulphur dioxide in the preparation of papaya leather and low temperature storage for good quality papaya leather. Henceforth papaya fruits can be blended with acidic fruit and organic acids can be used to produce best quality bar as this fruit is low in acidity (0.037-0.064%). It is clear from the data that colour, flavour, taste, texture and overall acceptability rating was 7.7, 7.4.7.5,7.4,7.5 during 3 months of storage. After 6 months of storage colour, flavour, taste, texture and overall acceptability rating was 7.5, 7.0, 7.0, 6.7, 7.0 respectively. Different workers have reported that the colour and leather taste of product were improved by the addition of sugar to the mango pulp while preparing mango leather. Heikal et al (1972) reported that flavour and texture of finished product can be improved by the addition of citric acid and pectin.

CONCLUSION

Conclusively it emerges that papaya fruit alone was not found good for the preparation of toffee because of its low acid content. However it can be used for the preparation of nutritionally enriched products singly or in combination with other fruits. The blending of papaya pulp with acidic fruits in case of papaya toffee and use of organic acid in case of papaya leather/bar gave better results. Among the different treatments tried papaya toffee prepared in combination with apricot pulp (50:50) and papaya bar/leather with TSS and acidity maintained to 25°B and 0.5 per cent was found best on the basis of sensory

Table 6. Effect on sensory quality attributes of papaya leather/bar during different storage intervals

Parameter	Storage period			
	0	3	6	$CD_{0.05}$
Color	8.0	7.7	7.5	0.233
Flavor	7.5	7.4	7.0	0.403
Taste	7.9	7.5	7.0	0.355
Texture	7.9	7.4	6.7	0.403
Overall acceptability	8.0	7.5	7.0	0.586

evaluation. The products were rich source of calcium, carotenoids, vitamin C and were shelf-stable for a period of six months at ambient temperature.

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