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Quality attributes of Bael (*Aeglemarmelos* Corr.) preserve and candy

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Abstract

Preserve and candy from antioxident rich tropical bael (*Aegle marmelos* Corr.) fruits, widely known for their immense medicinal properties (anti-diarrheic, anti-bacterial and anti-inflammatory) was prepared by using sugar, acid, water, blanching and preservatives. Biochemical and sensory analyses were conducted to study the proximate and sensory attributes of the preserve and candy. Bael had the composition like average fruit weight (723.5 g), pulp per cent (75.4), TSS (12.2^{O}Brix), ascorbic acid (13.12 mg/100g of pulp), and β-carotene (1868.01IU) were used in study as fresh mature condition. The slices were dipped in different concentration of lime solution for two hours and blanched (28 min at 7 kg/cm^2). The best recipes of bael preserve and candy was found 2 per cent lime concentration having 4.70 and 4.32 organoleptic value, and 1.34 & 0.70 benefit cost ratio in bael preserve and bael candy, respectively. Further product was stored at room (25-37^{O}C) and refrigerated temperatures (8-10^{O}C) for 3-8 months. Preserve prepared from bael fruit pulp is good food product, rich in anti-oxidants and having prospect for commercialization as a medicinal preserve and candy product.

Introduction

Bael (*Aegle marmelos* Corr.) belongs to family Rutaceae and it is commonly known as Bengal quince, Stone apple, Maredo, Indian quince, golden apple in English, holy fruit, bel, belwa, Sriphal in Hindi in India (John and Stevenson, 1979). Inside this, there is soft yellow or orange coloured mucilaginous pulp with numerous seeds. Bael fruit contains 28-39 per cent total soluble solids, 19-21 per cent carbohydrates, 11-17 per cent sugar, 1 per cent protein, 0.2 per cent fat and 7-21 mg/100g vitamin C. In addition, it is rich in vitamin A (186 IU/100g pulp); volatile oils and marmelosines. Its food value is 88 calories/100g. Bael is considered to be one of the richest source of riboflavin and provides lots of minerals and vitamins to diet (Barthakur and Arnolds, 1989). Bael fruits truly popular for its quality to combat constipation. Fruits have numerous seeds, which are densely covered with fibrous hairs and are embedded in a thick, gluey, aromatic pulp. All parts of this tree stem, bark, root, leaves and fruit at all stages of maturity have medicinal virtues and have been used as medicine for a long time. Rind is used for acute and amoebic dysentery, griping pain in the loins and constipation, gas, and colic, spure, scurvy. Various chemical constituents, namely, alkaloids, caumarins and steroids, have been isolated and identified from different part of bael tree (Singh *et al.*, 2009). In the Ayurvedic system of medicine, bael fruits are considered as an excellent remedy for diarrhea (Das and Das, 1995). The fruit is aromatic, cooling and laxative. It is useful in preventing or curing scurvy, strengthens the stomach, promotes its action and it's also used as an anticancer and chemo-preventive agent (Baliga *et al*., 2011). The pulp also contains a balsam-like substance, and 2 furocoumarins-psoralen and marmelosin ($C_{13}H_{12}O_3$), highest in the pulp of the large, cultivated forms. Marmelosin derived from the pulp is given as a laxative and diuretic. In large doses, it lowers the rate of respiration, depresses heart action and causes sleepiness. There is as much as 9% tannin in the pulp of wild fruits whereas the rind contains up to 20% (Singh *et al*., 2009). It can be processed into delicious products like preserve, candy, squash, toffee, slab, pulp powder, and nectar. The method of making preserve and candy have been described and also standardized the method of extraction of bael fruit pulp and preparation of nector, squash, slab, toffee and fruit powder (Rakesh *et al*., 2004, and Gehlot and Dhawan, 2005). However, efforts have been made for the development of value added

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product (Kannan and Thirumaran 2004; Sakate *et al*., 2004; Chavan *et al*., 2007; Chakraborty *et al.*, 2008; Kanghe 2008; and Mitra *et al*., 2008). This paper reports on the feasibility for the development of value added product (bael preserve and candy) from local cultivar of West Bengal in order to minimize the wastage, to promote the product as export item and to uplift the nutritional and socio-economic status of vulnerable commodities of West Bengal.

Materials and Methods

The experiments were carried out in the Laboratory of Post Harvest Technology, Research Complex, Kalyani, (Bidhan Chandra Krishi Viswavidyalaya) West Bengalwith a view to analyze the physico-chemical characteristics and sensory attributes of fresh fruit and its processed products. The local cultivar of bael collected from BCKV Campus, Kalyani, Nadia, West Bengal.

Standardization of bael preserve and candy

Fully matured and turn up of pulp colour (light yellow colour of pulp) of bael fruits were used for processed product and washed with tap water and make into half horizontally. The half cut fruits along with seeds were sliced into suitable size of pieces (2.5 X 6.0 X 0.3 cm) for preparing product with the help of a cutter machine (made by local mechanic with set two arms and kept the fruit between two arms, the fruit was tied with attached nut and bolt in two arms after that the fruit was cut by tancer blade). The pieces were treated by lime at different concentration (0.0, 1.0, 1.5, 2.0 and 2.5%) because; to develop the firmness and check the oxidation process in fruit slices and blanched (28 minutes at 7 kg/cm^2). The product was prepared with the combination of sugar syrup, citric acid and then dipped fruit pieces in 40^{O}Brix sugar syrup and kept overnight, same process repeated for three times and added citric acid (0.6%). The different formulations were used to prepare the bael preserve and candy for local cultivar. The TSS was raised from 40 to 65^{O}Brix or above and added the potassium meta-bisulphite (KMS) 100 ppm. Packed the slices with sugar syrup in glass bottle and sealed it airtight, now preserve is ready for use. For candy making before packing the fruit pieces with sugar syrup in glass bottles sieved the slices with muslin cloth and washed in hot water for a minute and spread on tray. It was dried at 55^{O}C for 3 hours and packed in polyethylene packet with the capacity of 100 g and immediately closed air tight with help of sealing machine. The product was stored at room (25-37^{O}C) and refrigerated temperature (8 -10^{O}C). Some scientist has been worked on the method of extraction of bael fruit pulp for making some other bael products.

Physico-chemical analysis

The physiochemical properties of fresh and processed product of bael fruit were analyzed by mentioned methods like TSS by Hand Refractometer, estimation of sugars by Lane and Eynon (1923), titrable acidity by AOAC (1984), ascorbic acid by 2, 6-dichlorophenol indophenols (Dye) titration method and β-carotene analyzed with the help of spectrophotometer at 452 nm by Ranganna (2000). The protein was estimated by Lowry's method (1951) and also the stored product was analyzed at monthly intervals.

Organoleptic test

Organoleptic test of freshly prepared product and stored product was evaluated by method of a 5 Point Hedonic scale (Amerine *et al*., 1965). Bael candy samples were evaluated by a panel of 10 members drawn from amongst post graduate students and others. The samples were rated for appearance, colour, taste, consistency and aroma. Overall acceptability was measured by adding of individual member scores.

Estimation of benefit: cost ratio of standardized products

The benefit: cost ratio was calculated after estimation of the cost involved including the operational as well as 10% overhead charges incurred during the preservation of bael preserve and candy.

Statistical analysis

The data obtained were subjected to Complete Randomized Design (CRD) as suggested by Raghuramula *et al.* (1983). The critical difference (CD) value at 5% level of probability was used for comparing the treatments and to find out the significant difference in between them. Each treatment was replicated for three times.

Storage

The bael preserve and candy was stored at room and refrigerated temperatures during the study period. The products of bael preserve were found safer for human consumption up to 8 months at both temperature, while bael candy up to 3 and 7 months in room and refrigerated temperatures, respectively.

Results and Discussion

The physico-chemical composition of fresh bael fruit is presented in table – 1. The local cultivar of bael were observed its shape, colour of fruit and pulp colour was roundish, light green and yellow colour, respectively. Average fruit weight of local cultivar (723.50 g), TSS (12.2^{O}Brix), TS (6.4%), RS (2.11%), acidity (0.3%), ascorbic acid (13.10 mg/100 g of pulp), protein (3.60%) and β-carotene (1868 IU) were observed in fresh mature fruits and the results are in agreement with the findings (Kanghe, 2008).

Total soluble solids

Total soluble solids content of lime treated bael preserve and bael candy were found an increasing trend during storage at both temperatures (Table- 2 and 3). The TSS content of Preserve varied from 61.17 to 62.5^{O}Brix while in bael candy it varied from 38.47 to 38.73^{O}Brix. The bael preserve was found safe up to 8 months on both temperature, and bael candy was found up to 3 and 7 months at room and refrigerated temperature, respectively. The increase in TSS might be due to depletion of moisture in the form of water vapour from the packaging material through the sealing points. A similar result was found in the pear candy (Rani and Bhatia, 1985) and in the bael products (Kenghe, 2008).

Total sugar

From the Table 2 & 3, the total sugar content of lime treated preserved and candy was noticed a slightly increasing in order during storage at both temperatures. The total sugar content of lime treated bael preserve was found 31.47 to 46.75 per cent, while in bael candy it was 35.32 to 37.81 per cent. The total sugar increased due to breakdown of complex sugars was reported by Sogi and Singh (2001) in Kinnow candy.

Reducing sugar

The conversion of reducing sugar (12.79 to 22.25 per cent) was more at refrigerated temperature than room condition (25.26 per cent) up to 8 months storage in local cultivar bael preserve, while in bael candy it varied from 7.61 to 12.54 per cent was more at refrigerated temperature as compared to room temperature 10.58 per cent up to 3 and 7 month of storage respectively (Table- 2 and 3). The conversion was due to the breakdown of sugars and more inversion of sucrose (Rani and Bhatia, 1985) and a similar result was found in bael products (Chand and Gehlot, 2006).

Table. 1 Physical and biochemical characteristics of Bael fruit

Physical characters	Local cultivar of W.B.
Fruit shape	Roundish
Fruit colour	Light Greenish
Fruit weight (g)	723.50
Rind weight (g)	154.70
Pulp colour	Yellowish
Pulp + seed weight (g)	568.80
Pulp recovery (g)	545.50
Pulp per cent	75.40
Rind per cent	21.40
T.S.S. (° Brix)	12.20
Total Sugar (%)	6.40
Reducing sugar (%)	2.11
Acidity (%)	0.30
Ascorbic Acid (mg/100 g or ml)	13.10
Protein (%)	3.60
β carotene (IU)	1868.0

Acidity

The acidity content of bael candy for both products were observed a continuous increase, the rate of increase being more at room temperature (0.15 to 0.40 per cent) than refrigeration condition (0.15 to 0.36%) in bael preserve up to 8 months of storage, whereas bael candy were found same (0.15%) up to 3 months of storage at both temperature but in later stage bael candy at room temperature was not safe for human consumption, and refrigerated condition was better (0.17%) in condition up to 7 months of storage (Table 2 & 3). The increase in acidity may be caused by adding of KMS due to conversion of sulphurous acid in products. Similar findings were found in bael products (Kenghe, 2008), carrot candy (Madan and Dhawan, 2005), and sugar candy foam products (Sucharzewska, 2003).

Ascorbic acid

The value of ascorbic acid (9.45 to 1.49 mg/100g) was noticed that the decrease in more at room temperature than refrigerated condition (2.14 mg/100g) in bael preserve up to 8 months of storage. While in bael candy decrease was more at room temperature (5.81 to 1.892.63 mg/100g) than refrigerated condition (2.91 mg/100g) up to 3 months storage (Table- 2 and 3), but the bael candy was stored up to 7 months of storage (1.46 mg/100g) due to good organoleptic value. The reduction was due to oxidation of ascorbic acid into dehydro ascorbic acid by oxidase enzyme like ascorbic acid oxidase. The

Table 2. Changes in quality attributes of Lime treated bael preserve (Local cultivar of W. B.) during storage

Bio-chemical parameters	Temp	Storage life Month (M-8)									CD (0.05)		
		0	1	2	3	4	5	6	7	8	M	T	MT
TSS (°Brix)	T_1	61.17	61.33	61.5	61.67	61.83	62	62.17	62.33	62.5	NS	NS	NS
	T_2	61.17	61.17	61.17	61.17	61.33	61.33	61.33	61.5	61.67			
TS (%)	T_1	31.47	34	35.53	36.84	38.33	40.01	41.93	44.15	46.75	**	NS	NS
	T_2	31.47	32.18	33.7	35.02	36.5	38.18	40.11	42.33	44.93			
RS (%)	T_1	12.79	14.28	15.48	16.35	17.2	18.62	21.53	22.49	25.26	**	**	NS
	T_2	12.79	13.27	14.47	15.34	16.19	17.62	20.52	21.48	22.25			
Acidity (%)	T_1	0.15	0.2	0.23	0.25	0.3	0.36	0.39	0.4	0.44	**	**	NS
	T_2	0.15	0.17	0.21	0.23	0.27	0.29	0.34	0.36	0.37			
Ascorbic acid (mg/100g)	T_1	9.45	7.88	6.83	6.3	5.39	4.65	3.44	2.78	1.49	**	**	NS
	T_2	9.45	8.19	7.81	7.28	6.53	4.96	4.08	3.81	2.14			
Protein (%)	T_1	2.52	1.74	1.68	1.57	1.48	1.33	1.17	0.96	0.85	**	**	*
	T_2	2.52	1.8	1.74	1.67	1.54	1.39	1.35	1.25	1.17			
β-carotene (IU)	T_1	1470.87	1338.88	1157.15	1049.74	978.99	897.74	791.14	662.9	446.01	**	**	73.63
	T_2	1470.87	1387.66	1239.27	1131.85	1061.11	979.85	873.25	745.01	528.12			
Organoleptic test (n- 10)	T_1	4.7	4.58	4.46	4.18	4.02	3.54	3.1	2.76	2.48	**	NS	NS
	T_2	4.7	4.66	4.54	4.22	4.1	3.6	3.22	2.92	2.74			

T_1- Room Temperature (25 to 37°C), T2- Refrigerated Temperature (8 to 10°C), n- 10 (10 panelist), NS- Non Significant, **- Highly significant, * significant, M- Month (0 to 8 month), r (Replication) – 3, T- Temperature
Samples acceptability scores of 2.5 and above were considered acceptable.

similar finding was given in jamun beverages (Das, 2009) and pear candy (Rani and Bhatia, 1985).

Protein

The protein content was decreased with the increase in storage life at both temperatures, the rate of decrease in protein of bael preserve was measured slightly low (2.52 to 1.17 per cent) at refrigerated than room condition (0.85 per cent) up to 8 months of storage (Table-2). Whereas, bael candy of protein decreases was 2.27 to 1.77 per cent at room temperature after 3 months, and slightly more decrease (0.91 per cent) at refrigerated temperature after7 month of storage. The decrease in protein content during storage of bael candy might be due the denaturation of protein caused by heat in presence of moisture. Similar trend of declining in protein content of stored aonla syrup (Reddy and Chkkasubbanna, 2009) was noticed in palm spread and toffee (Chaurasiya *et al*., 2014).

β-Carotene

Results revealed that the β-Carotene values (1470.87 to 446.01 IU) was found low in decreasing order during storage at room temperature but more in refrigerated condition (528.12 IU) up to 8 months storage of bael preserve (Table- 2), while in bael candy was 791.72 IU to 348.65 IU after 3 months storage at room temperature while 146.46 IU was found at refrigerated condition up to 7 months of storage (Table-3). However, the rate of decrease showed more at room temperature and the retention of β- Carotene was noticed more at refrigerated temperature in both cultivars. Because, it is light sensitive and more stable in neutral pH and decrease in β-Carotene was found during storage at both temperatures (Chaurasiya *et al.*, 2014) in palm spread and palm toffee.

Organoleptic quality

The organoleptic quality of lime treated bael preserve and candy was evaluated at both temperatures and found that the product (bael preserve) acceptance score was 4.70 to 2.48 and 2.74 at room temperature and under refrigerated condition up to 8 months of storage (Table-2). While, in candy scores were 4.56 to 2.98 at room temperature after 3 months of storage and 2.36 at refrigerated condition after 7 months of storage (Table-3). Organoleptic scores were judged on the basis of 5 point Hedonic Scale. In this study was considered slightly acceptable on the basis of organoleptic rating of 2.5 and above by the panelist. A similar finding was observed in pear candy by Rani and Bhatia, 1985 and Prasad and Singh, 2001 in bael products. Overall acceptability was found by adding scores for individual member. Significance of difference between samples was determined by analysis of variance of organoleptic data and product (Raghuramula *et al*., 1983).

Economic analysis of processed products

For the preparation of 1 Kg bael preserve and candy was Rs. 42.70 and Rs. 100, gross income Rs. 100 and Rs. 170 that means net income was Rs. 57.30 and Rs. 70 Respectively. Thus the economic analysis revealed that the income per rupee investment of bael preserve and candy approximately Rs. 1.34 and Rs. 0.70 respectively. Thus it could be assumed that bael

Table 3. Changes in quality attributes of Lime treated bael candy (Local cultivar of W. B.) during storage

Bio-chemical parameters	Temp	Storage life Month (M-8)								CD (0.05)	CD (1%)
		0	1	2	3	4	5	6	7		
TSS (°Brix)	T_1	38.47	38.53	38.6	38.67					NS	0.54
	T_2	38.47	38.47	38.47	38.53	38.53	38.6	38.67	38.73	NS	0.51
TS (%)	T_1	35.32	35.79	37.02	37.35					NS	4.03
	T_2	35.32	35.32	35.4	35.8	36.09	36.33	37.51	37.81	NS	5.78
RS (%)	T_1	7.61	8.48	9.21	10.58					**	1.39
	T_2	7.61	7.88	8.22	8.78	9.2	10.67	11.69	12.54	**	1.08
Acidity (%)	T_1	0.14	0.14	0.15	0.15					NS	0.04
	T_2	0.14	0.14	0.14	0.15	0.16	0.16	0.17	0.17	NS	0.04
Ascorbic acid (mg/100g)	T_1	5.81	3.56	2.78	2.63					**	2.65
	T_2	5.81	4.93	3.8	2.91	2.74	2.34	1.67	1.46	**	2.13
Protein (%)	T_1	2.27	2.22	1.87	1.77					**	0.27
	T_2	2.27	2.24	1.89	1.76	1.64	1.32	1.19	0.91	**	0.61
β-carotene (IU)	T_1	791.72	525.06	494.79	348.65					**	151.09
	T_2	791.72	672.27	532.3	415.96	283.62	232.47	196.29	146.46	**	135.11
Organoleptic test (n- 10)	T_1	4.56	4.44	3.86	2.98					**	0.7
	T_2	4.56	4.5	3.98	3.3	3.24	3.02	2.72	2.36	**	0.72

T_1- Room Temperature (25 to 37°C), T_2- Refrigerated Temperature (8 to 10°C), n- 10 (10 panelist), NS- Non Significant, **- Highly significant, *significant, M- Month (0 to 8 month), r (Replication) – 3, T- Temperature
Samples acceptability scores of 2.5 and above were considered acceptable.

preserve was more profitable than bael candy.

Conclusion

From the results were obtained that the bael prepared from local cultivar was safer up to 8 months at room and refrigerated condition, and bael candy was also safer up to 3 and 7 months of storage at room and refrigerated temperature respectively. These products (preserve and candy) will be useful in order to minimize the wastage, by promoting the product as export item and uplifting the nutritional and socio-economic status of vulnerable commodities of West Bengal.

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