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QUALITY RETENTION IN ALUM TREATED BAEL (*AEGLE MARMELOS* CORR.) PRESERVE

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ABSTRACT
Bael preserve was prepared with combination of sugar, acid, water and preservative and two cultivars of bael like Local cultivar of West Bengal and NB-5 with a large fruit of greenish yellow to yellowish green, average fruit weight (723.50 and 1212.50g), pulp per cent (75.40 and 79.62), TSS (12.2 and 14.4 °Brix), ascorbic acid (13.12 and 27.36 mg/100 g pulp) and â carotene (1868.01 and 1155.37 IU) were used in the study. The slices were dipped in alum solution (2 per cent) for two hours and blanched, were found best recipe of bael preserves. Further the product was stored at room (25-37°C) and refrigerated temperatures (8-10°C) up to 7 and 12 months as well as organoleptic score 4.82 and 4.90 was found best among all treatments of local and NB-5 cultivars respectively.

INTRODUCTION

Bael (*Aegle marmelos* Corr.) is an indigenous fruit of India belongs to family Rutaceae and it is commonly known as Bengal quince by John and Stevenson (1979), Indian quince, Golden apple, Holy fruit, Bel, Belwa, Sriphal and Maredo in India. India is the second largest producer of fruits next to China and is booming with a growth rate of 20 per cent a year. It is a very hardy sub-tropical, deciduous tree and globuse with grey or yellowish hard woody shell. Inside this, there is soft yellow or orange coloured with mucilaginous pulp and numerous seeds. It grows throughout the Indian Peninsula as well as Sri Lanka, Pakistan, Bangladesh, Burma, Thailand and most of the southeastern countries. It can grow in various soil and climatic conditions (from swampy to dry soil) and also tolerate alkaline soil. It is not injured by temperature as low as -7°C by Roy and Singh (1979). According to Jauhari and Singh (1971) Bael fruit contains 28-39 per cent total soluble solids (TSS), 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 respectively. In addition, it is rich in vitamin A (186 IU/100g pulp), volatile oils and marmlosines (bioactive compound isolated from bael fruit, has shown antihelmintic as well as antibacterial activities). Its food value is 88 calories/100g. Thus, it is richer than most of the reputed fruits like apple, guava and mango which have a calorific value of only 64, 59 and 36 respectively.

It has numerous seeds, which are densely covered with fibrous hairs and are embedded in a thick, gluey, aromatic pulp. This is one of the most useful medicinal plants of India. Its medicinal properties have been described in the ancient medical treatise in Sanskrit in *Charaka Samhita* by Aiyer (1956). 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. The fruit's medicinal value is very high when it just begins to ripen. Bael fruit is truly popular for its ability to combat constipation and its have aromatic, cooling and laxative properties. Bael is considered to be one of the richest sources of riboflavin by Mukharjee and Ahmad (1957) and provides lots of minerals and vitamins to diet by Barthakur and Arnolds (1989). 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. There is as much as 9% tannin in the pulp of wild fruits whereas the rind contains up to 20% by Singh *et al.* (2009).

According to Jauhari *et al.* (1969) and Singh and Chaurasiya (2014), it can be processed into delicious products like candy, squash, toffee, slab, pulp powder, and nectar from bael fruit. The method of making bilwa preserve have been described by Lal *et al.* (1960) and also standardized the method of extraction of bael fruit pulp and preparation of nector, squash, slab, toffee and fruit powder.

Attempt has been made to prepare value added product

namely bael preserve from the best selected local and NB-5 cultivars on the basis of bio-chemical attributes and organoleptic test, to study on their storage life at ambient and refrigerated condition.

MATERIALS AND METHODS

The experiments were carried out in the Laboratory of Post Harvest Technology, Research Complex, Kalyani (Bidhan Chandra Krishi Viswavidyalaya) West Bengal during the year 2008-2010 with a view to analyze the physico-chemical characteristics and sensory attributes of fresh fruit and its processed products. The two cultivars of bael fruit were procured from the Narendra Dev University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) cv. NB-5 and second of the Local cultivar of West Bengal from BCKV Campus, Kalyani, Nadia, West Bengal. Climatically the region comes under tropical humid with rainfall of 0.00 to 241.2 mm, temperature maximum 37.58ºC and minimum 9.26ºC alongwith RH (%) 93.25 to 57.5 (Annual average) by *AICRP on Agricultural Meteorology,* BCKV, Kalyani (2008-2010).

Standardization of bael preserve: 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 0.3cm) 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 alum 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 7kg/cm^2). The product was prepared with the combination of sugar syrup, citric acid and then dipped fruit pieces in 40 ^{0}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 coded as BPL_1, BPL_2, BPL_3, BPL_4, BPL_5 and BPL_6 for local cultivar and NBP_1, NBP_2, NBP_3, NBP_4, NBP_5 and NBP_6 for cultivar NB- 5. The TSS was raised to 40 to 65 ºBrix or above and added the potassium meta-bisulphite (KMS) 100 ppm. The prepared product was filled in broad mouth glass bottle with the capacity of 500 gram and closed air tight and storage at room (25-37 ºC) and refrigerated (8-10ºC) temperatures. Roy and Singh (1972) also stated the method of extraction of bael fruit pulp for making some other bael products.

Table 1: Physical and biochemical characteristics of Bael fruit

Physical characters	Local cultivar of W.B.	Cv. NB- 5
Fruit shape	Roundish	Oblong
Fruit colour	Light Greenish	Greenish yellow
Fruit weight (g)	723.5	1212.5
Rind weight (g)	154.7	231.2
Pulp colour	Yellowish	Light yellow
Pulp + seed weight (g)	568.8	981.2
Pulp recovery (g)	545.5	965.4
Pulp per cent	75.40	79.6
Rind per cent	21.4	19.1
T.S.S. (º Brix)	12.2	14.4
Total Sugar (%)	6.4	8.9
Reducing sugar (%)	2.11	2.0
Acidity (%)	0.3	0.6
Ascorbic Acid (mg/100 g or ml)	13.1	27.3
Protein (%)	3.6	8.8
â-carotene (IU)	1868.0	1155.4

Physico-chemical analysis

The physiochemical properties of fresh and processed product of bael fruit were analyzed by mentioned methods like TSS by Hand Refractometer, sugars by Lane and Eynon (1923), titrable acidity by AOAC (1984), ascorbic acid by 2, 6-dichlorophenol indophenols (Dye) titration method and â-carotene analyzed with the help of spectrophotometer at 452 nm by Ranganna (2004). 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 preserve 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.

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 was stored at room and refrigerated temperatures during the study period. The products of Local and NB-5 cultivars were found safer for human consumption up to 7 and 12 months storage at both temperatures respectively.

RESULTS AND DISCUSSION

The physical and biochemical characteristics of fresh Bael fruit have been presented in Table 1. The cultivar of local (W.B.) and NB-5 were measured roundish to oblong in shape and colour of fruit and pulp was seen light green and greenish yellow, yellow and light yellow respectively. Average fruit weight of NB-5 cultivar (1212.50g) was higher than the local cultivar (723.50g). Similarly, other physical parameter particularly pulp recovery and pulp per cent were also observed higher in NB-5 cultivar. The different bio-chemical parameters were found that the content of TSS (14.4ºBrix), total sugar (8.89%), acidity (0.67%), ascorbic acid (27.36mg/100g) and protein (8.77%) were estimated more in amount and except only reducing sugar (2.05%) and â-carotene (1155.37 IU) of NB-5 cultivar as compared to local cultivar (Table 1). The results are in agreement with the findings of Kenghe (2008), Roy and Singh (1978) and Singh *et al.,* 2014.

Total soluble solids

Table 2: Changes in quality attributes of Alum 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	61.2	61.3	61.7	62.0	62.3	62.7	63.0	63.2	63.7	NS	NS	NS
	T_2	61.2	61.2	61.2	61.3	61.3	61.3	61.5	61.7	61.8			
TS (%)	T_1	20.0	21.1	22.3	25.1	26.8	28.7	30.9	33.5	36.6	2.27**	1.07*	NS
	T_2	20.0	20.7	22.3	23.6	25.1	26.8	28.7	30.9	33.5			
RS (%)	T_1	4.3	6.1	6.4	6.8	7.4	9.1	10.8	13.3	14.3	0.24**	0.11**	0.34**
	T_2	4.3	4.5	4.7	4.9	5.3	5.8	6.1	6.4	8.0			
Acidity (%)	T_1	0.21	0.21	0.25	0.27	0.32	0.36	0.40	0.41	0.43	0.04	0.02	0.05
	T_2	0.21	0.21	0.23	0.25	0.26	0.28	0.31	0.33	0.34			
Ascorbic acid (mg/100g)	T_1	13.9	9.5	8.3	7.8	6.8	5.2	4.9	3.1	2.2	0.45**	0.21**	NS
	T_2	13.9	10.2	9.3	8.2	7.4	6.6	5.0	4.2	3.9			
Protein (%)	T_1	2.2	1.5	1.4	1.4	1.3	1.1	1.0	1.0	1.0	0.02**	0.01**	NS
	T_2	2.2	1.4	1.4	1.3	1.2	1.0	1.0	0.9	0.9			
Carotene(IU)	T_1	1482.0	1363.2	1333.5	1185.1	1096.0	977.2	888.1	680.3	620.9	60.94**	28.73**	NS
	T_2	1482.0	1358.4	1308.5	1126.8	986.0	881.9	754.0	660.7	552.5			
Organoleptic test (n- 10)	T_1	4.8	4.6	4.3	4.1	3.9	3.5	3.1	2.9	2.5	0.31**	NS	NS
	T_2	4.8	4.7	4.5	4.2	4.0	3.5	3.1	3.0	2.7			

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, TSS- Total Soluble Solids, TS- Total Sugar, RS- Reducing Sugar, CD- Critical Difference ; Samples acceptability scores of 2.5 and above were considered acceptable.

Table 3: Nutritional value of Alum treated bael preserve (cv. NB 5) during storage

Bio-chemical parameters	Storage life Month (M-12) Temp	0	1	2	3	4	5	6	7	8	9	10	11	12	CD(0.05) M	T	MT
TSS(° Brix)	T_1	64.0	64.0	64.3	64.5	64.7	64.8	65.0	65.2	65.3	65.5	65.7	65.8	66.0	NS	NS	NS
	T_2	64.0	64.0	64.0	64.3	64.3	64.5	64.7	64.8	65.0	65.2	65.3	65.5	65.7			
TS (%)	T_1	36.6	37.9	39.3	40.7	41.7	42.1	43.5	44.4	46.2	47.3	49.5	52.6	53.4	5.07**	NS	NS
	T_2	36.6	36.6	37.6	38.8	40.3	40.3	42.1	44.8	44.8	45.8	46.3	48.2	50.5			
RS (%)	T_1	9.8	11.1	12.8	13.7	14.4	15.1	15.6	16.0	17.1	18.5	19.8	20.8	23.0	1.51**	0.59**	NS
	T_2	9.8	10.6	11.4	12.1	12.9	13.3	13.8	14.8	15.4	16.9	18.3	19.2	20.2			
Acidity (%)	T_1	0.20	0.21	0.23	0.25	0.28	0.29	0.31	0.34	0.35	0.36	0.38	0.41	0.42	0.04**	NS	NS
	T_2	0.20	0.20	0.22	0.26	0.27	0.29	0.30	0.32	0.33	0.34	0.36	0.38	0.39			
Ascorbic acid	T_1	18.6	14.3	13.0	10.0	9.6	8.7	7.8	7.4	6.7	5.1	4.3	3.1	2.7	1.22**	0.48**	NS
(mg/100g)	T_2	18.6	15.6	13.3	11.3	10.9	9.1	8.7	8.1	7.3	6.3	6.1	5.3	4.4			
Protein (%)	T_1	6.6	5.0	4.6	3.7	3.5	3.3	3.0	2.5	2.2	2.0	1.7	1.4	1.3	1.04**	NS	NS
	T_2	6.6	5.8	4.6	4.4	4.3	3.7	3.2	3.0	2.7	2.0	1.9	1.8	1.8			
Carotene(IU)	T_1	996.4	895.0	859.4	841.6	725.6	698.8	562.3	510.3	469.2	396.2	360.5	303.5	253.6	29.19**	11.45**	41.30*
	T_2	996.4	889.5	853.8	836.0	704.4	633.3	531.3	463.7	390.6	355.0	310.1	248.1	232.45			
Organoleptic test	T_1	4.9	4.9	4.8	4.7	4.7	4.7	4.6	4.6	4.5	4.2	3.8	3.6	3.5	0.12**	0.05*	0.17
(n- 10)	T_2	4.9	4.9	4.8	4.8	4.8	4.7	4.7	4.6	4.5	4.3	3.9	3.8	3.6			

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 12 month), r (Replication) - 3, T- Temperature TSS- Total Soluble Solids, TS- Total Sugar, RS- Reducing Sugar, CD- Critical Difference; Samples acceptability scores of 2.5 and above were considered acceptable.

TSS content of alum treated of both preserve was found an increasing trend during storage at both temperatures (Table 2 and 3). The TSS content of preserve varied from 61.17 °Brix to 63.67 °Brix and 61.83 °Brix at room and refrigerated temperatures up to 7 months storage for local cultivar (Table 2), whereas the product of NB-5 was found more TSS (64.00 °Brix to 66.00 °Brix and 65.67 °Brix) content up to 12 months at room and refrigerated temperatures (Table 3) respectively. The TSS of NB-5 was slightly more increased than local cultivar. The increase in TSS might be due to depletion of moisture in the form of water vapour from the packaging material (broad mouth glass bottle with plastic capping) through the ceiling points. The loss of moisture increases the concentration of solids in the product. In this case also the moisture loss was more at room temperature as compared to under refrigeration condition. Similar results were reported by Verma and Gehlot (2007) in bael RTS and Kenghe (2008) in the bael products, Bhupinder and Gursharan (2006) in banana products also and Satkar *et al.* (2013) in bitter gourd RTS.

Total sugars

The total sugar content of alum treated bael preserve was found 20.03 to 36.57 and 33.49 per cent in local cultivar at both temperatures up to 7 months storage (Table 2). Whereas, in NB-5 the value varied from 36.57 to 53.43 and 50.53 per cent up to 12 months storage (Table 3) at both temperatures (room and refrigerated). Under refrigerated condition, the per cent of sugar was increased comparatively at a lower rate than room temperature and it is due to hydrolysis of polysaccharides to increase the sugar per cent for long time storage was reported by Chand and Gehlot (2006) and Singh *et al.* (2014).

Reducing sugar

The conversion of reducing sugar (4.30 to 14.30 per cent) was more at room temperature than refrigerated condition (7.95 per cent) up to 7 months storage in local cultivar while in NB-5 it varied from 9.76 to 23.03 per cent was more at room temperature as compared to refrigerated condition 20.17 per cent (Table 2 and 3). The conversion of value was due to the breakdown of sugars and more inversion of sucrose by Rani and Bhatia (1985). A similar result was recorded in bael products by Chand and Gehlot (2006).

Acidity

The acidity content of bael preserve for both cultivars were observed a continuous increase, the rate of increase being more at room temperature (0.21 to 0.43 per cent) than refrigeration condition (0.34 per cent) in local cultivar up to 7 months while in NB-5 also more at room temperature (0.20 to 0.42 per cent) than under refrigerated condition (0.39 per cent) up to 12 months storage (Table 2 and 3). It could be increase the acidity by adding of KMS due to conversion of sulphurous acid in products and break down of ascorbic acid. Similar findings were found in bael products by Kenghe (2008) and Madan and Dhawan (2005) in carrot candy.

Ascorbic acid

The value of ascorbic acid (13.89 to 2.21 mg/100g) was noticed that the decrease in more at room temperature than refrigerated condition (3.88 mg/100g) in local cultivar up to 7 months storage (Table 2). While in NB-5 decrease was more at room temperature (18.59 to 2.69 mg/100g) than refrigerated condition (4.39 mg/100g) up to 12 months storage (Table 3). The reduction was due to oxidation of ascorbic acid into dehydro ascorbic acid by oxidase enzyme like ascorbic acid oxidase. The similar finding was given in Jamun. The similar finding was given in Jamun beverage by Das (2009).

Protein

The protein content was decreased with the increase in storage life at both temperatures, the rate of decrease in protein was measured slightly low (2.15 to 0.97 per cent) at room than refrigerated condition (0.93 per cent) up to 7 months in local cultivar (Table 2) whereas, NB-5 preserve of protein was 6.64 to 1.31 per cent at room temperature and slightly less decrease (1.75 per cent) at refrigerated temperature up to 12 months storage (Table 3). The decrease in protein content during storage of bael preserve 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 was noticed by Reddy and Chikkasubbanna (2009), Singh *et al.* (2014) and Lokendrajit *et al.* (2013) in Local cultivar of potato.

β-Carotene

Results revealed that the â-Carotene values (1482.00 I.U. to 620.89 I.U. and 552.50 I.U.) was found low in decreasing order during storage at room temperature but more in refrigerated condition up to 7 months in local cultivar (Table-2), while in NB-5 preserve was 996.36 I.U. to 253.64 I.U. and 232.45 I.U. during storage at room temperature and refrigerated condition up to 12 months respectively (Table- 3). However, the rate of decrease showed more at refrigerated temperature and the retention of â- Carotene was noticed more at room temperature of cultivar NB-5 than local cultivar. Because, it is light sensitive and more stable in neutral pH. Madan and Dhawan (2005) reported that the retention of â-carotene was 13.29 to 11.25, 13.24 to 11.30 and 11.19 to 8.02 mg/100g in candy in sugar, sugar + coconut powder and jaggery after 2 months storage at room temperature respectively.

Organoleptic quality

The organoleptic quality of standardized alum treated (2%) bael preserve was evaluated at both temperatures and found that the product acceptance score was 4.78 to 2.52 and 2.68 at room temperature and under refrigerated condition up to 7 months respectively in local cultivar (Table 2) while, in NB-5 scores were 4.94 to 3.52 and 3.58 at room temperature and under refrigerated condition up to 12 months respectively. The overall acceptance of NB-5 preserve was found more than local cultivar (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. Similar finding were observed by Rani and Bhatia (1985) in pear candy and Prasad and Singh (2001) in bael products.

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