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Khushboo Kumari
Department of HPHT, Palli Sikhsha Bhavana (Institute of agriculture), Sriniketan, Visva - Bharati, West Bengal, India

Goutam mandal
Department of HPHT, Palli Sikhsha Bhavana (Institute of agriculture), Sriniketan, Visva - Bharati, West Bengal, India

Shwet Prabha
Department of HPHT, Palli Sikhsha Bhavana (Institute of agriculture), Sriniketan, Visva - Bharati, West Bengal, India

Sneha
Department of HPHT, Palli Sikhsha Bhavana (Institute of agriculture), Sriniketan, Visva - Bharati, West Bengal, India

Correspondence
Khushboo Kumari
Department of HPHT, Palli Sikhsha Bhavana (Institute of agriculture), Sriniketan, Visva - Bharati, West Bengal, India

Study on processing and quality attributes of bael (*Aegle marmelos* Correa.) preserve

Khushboo Kumari, Goutam mandal, Shwet Prabha and Sneha

Abstract
Bael is an important and indigenous fruit of India.Nutritionally bael is one of the most nutritious fruit which is rich in vitamins and antioxidant and widely known for their immense medicinal properties. Therefore, preserve is prepared from this fruit to increase the utilization of unripe bael fruit among peoples. A laboratory experiment was conducted to study on processing and quality attributes of bael preserve. The experiment was conducted on department of Horticulture and Post harvest technology, Palli Siksha Bhavana, Visva Bharati University, West Bengal during 2016-2017.The experiment was laid out in completely randomised design. Preserve is prepared by using 5 treatment (80˚B,75º B,70ºB,65ºB,60ºB) sugar concentration.It was observed that TSS(75.40%), total sugar(31.05%), reducing sugar(13.54%), non reducing sugar(17.52%), ash content (1.22%) increased by increase in sugar concentration while free moisture content(29.67%),titrable acidity(0.22%),ascorbic acid(1.82 mg/100g) and beta-carotene(267.87 µg/100g) decrease. Analysis of data showed that preserve of 70ºBrix is organoleptically best among preserve.

Keywords: Bael, Preserve, Sugar concentration, Quality, Acceptability

Introduction
Bael is an indigenous crop of India with chromosome no 2n=2x=18.It belongs to Kingdom: Plantae, Order: Sapindales, Family: Rutaceae, Sub family: Aurantioideae, Genus: Aegle, Species: A. Marmelos and is known by the several different names throughout different parts of the country and also outside of the country viz Hindi (Bel, bael, sriphal), English (stone apple, Bengal quince), Sanskrit (Bilva, sriphal), Bengali (Bel). It is cultivated in dry forests on hills and plains of central and southern India, Burma, Pakistan and Bangladesh, also in mixed deciduous and dry dipterocarp forests. A. marmelos is a subtropical species and grow all over India. It grows up to an altitude of 1,200 m, where the temperature rises to 48.89º C in the shade in summer and descends to-6.67º C in the winter, and prolonged droughts occur. We know about importance of fruit in human diet. Among fruits bael is recognized as most nutritious and less expensive fruit. Which is suffecient to minimize te malutrition of people to their inadequate and imbalance diet. The fruit of bael is a hard-shelled many seeded berry with its yellowish orange mucilaginous sweet pulp being the edible portion, the seeds embedded in it which is covered with fibrous hairs (Kaushik *et al*., 2002). It contains 61.5 g water, 1.8 g protein, 0.39g fat, 1.7 g minerals, 31.8 g carbohydrates, 55 mg carotene, 0.13 mg thiamine, 1.19mg riboflavin, 1.1 mg niacin, and 8 mg per 100 g of edible portion vitamin C (Gopalan *et al*., 1971). No other fruit has such a high content of riboflavin. Bael is useful to cure or prevention of diarrohea, dysentery, diabetes, dyspepsia, vitiated or debased condition of vata, vomiting, cardiopalmus, stomachalgia, intermittent fever, seminalweakness, swelling, uropathy and gastric irritability in infants. The unripe fruits are acrid, astringent, bitter, digestive, sour, stomachic and are useful in dysentery-diarrheaand stomachalgia however ripe fruit also posses hypoglycaemia activity, anti-spermatogenic activity and anticancerous effect (Dahanukar *et al*.; 2000). The fruit has excellent aroma which is not destroy during processing. Therefore, there is tremendous potential for processing this fruit into various products and ripe and unripe both types fruit are used. When ripe, the fruit's pulp can be consumed either fresh or processed into high value and extremely popular products such as preserve, candy, jam, RTS, nectar, squash/leather/slab, powder etc. The bael fruit have high nutritious value and keeps medicinal properties, which easily attractes consumers because consumers behaviour is enhanced by 13.7% by healthy factors (jaisam and utama-ang, 2008). This study was planned keeping in view the nutritional importance of bael, to utilize them by preserving them as preserve (murraba). Preserve prepare from vitamin, mineral and anti-oxidant rich bael (*Aegle marmelos* Corr.) fruits; which contain huge or vast medicinal properties and generally prepared by using unripe fruit pulp, sugar, acid, water, blanching and preservatives.

Biochemical and sensory analyses were conducted to study the proximate and sensory attributes of the preserve. Further product was stored at room (25-37 ^{0}C) and refrigerated temperatures (8-10 ^{0}C) for 3-8 months. Preserve prepared from unripe bael fruit pulp having great prospects for commercializat ion as a medicinal preserve to minimize the malnutrition. Keeping in mind the above problems of preserve and squash preparation by bael the title Studies on Processing and value added product of bael (Aegle marmelos Correa) has been carried out to overcome the problem with the objective, To study the quality attributes of the preserve of bael and standardize the method of preserve.

Material and methods

The experiment was conducted in the laboratory of the Department of Horticulture and postharvest technology, Institute of Agriculture, Palli Siksha Bhavana, Sriniketan, Visva -Bharati University(West Bengal).The fresh unripe bael fruit was collected from different part of university.

Bael preserve methodology

Total five treatments was taken for the preserve and total replication was three. The field experiment was laid out in complete randomized design (CRD)consisting of five levels of sugar concentrations (1) 60^{0}Brix (sugar concentration) (2) 65^{0}Brix (sugar concentration) (3)70^{0}Brix (sugar concentration) (4)75^0 Brix (sugar concentration) (5)80^0 Brix (sugar concentration)observation recorded was. TSS (%), Total sugar (%), Reducing sugar (%), Non reducing sugar (%), Titrable Acidity (%), Sugar acid ratio (%), Moisture (%), Ascorbic acid (mg /100g), Beta carotene (µg /100g), Overall acceptability.

Standardization of bael preserve

Unripe mature bael fruit were taken for preparation of preserve. Break the Shell of bael and pulp is cut into slices 3cm x 2cm x 1.5cm.slices are washed with water and pricking by fork then treated with 2% alum for 2-3 hrs for removal of astringency after that blanching is done in boiling water for 12 -15 minutes for softening purpose. The slices is were steeped in sugar syrup containing 2g/litre citric acid of 40^{0}brix for 24 hours. The pieces are drained out and the strength of syrup was raised upto 60^{0}brix and kept the slices for 24 hrs after that strength of syrup raising by 50^{0}brix upto 80^{0}brix. At different concentration slices were steeped for a week. Finally filled in bottles with fresh sugar syrup of previous concentration.

Physico-chemical analysis

The total soluble solids (TSS) content in sample was analysed by hand refractometer (Erma, Japan). While total sugar, reduing sugar is determined by Lane and Eynon (1923). Percentage acidity is determined by AOAC method, ascorbic acid by 2,6-dichlorophnol indophenol (Dye)titration. while beta carotene is determined by use of spectrophotometer. Moisture % is determined with the help of dessicator while ash content % with the help of furnace by A.O.A.C method (2007).

Statistical analysis

The experiment was laid out in Complete Randomized Design. Data obtained on various characters were analyzed statistically according to the analysis is of variance techniques. The analysis of variance for different parameters is presented in appendices. The critical difference (CD) was calculated to access the significance or non-significance of difference between treatment means. Wherever, it was found significant through 'F' test at 1 per cent level of significance, marked as star in ANOVA Tables.

Organoleptic evaluation

The organoleptic /sensory evaluation of bael preserve and was carried out by a panel of 9 judges. The Mixed fruit leather of different combinations were evaluated for various sensory quality attributes like texture, colour, flavour, taste, texture and overall acceptability. Sensory method evaluation method was given by Amerine *et al*., (1965) was adopted with a 9 point hedonic scale.

Result and discussion

Sugar (%)

(Reducing, Non-reducing and Total sugar) It is evident from Table1 there was significant difference over the reducing sugar of bael preserve at different level of sugar treatments. Reducing sugar percentage were varies from 9.95-13.54%. With increasing level of sugar treatment increased content of reducing and non-reducing was found. The maximum reducing sugar was noticed in T_5 (13.54%) which is followed by T_4 (12.33%) and T_3 (11.52%). The minimum reducing sugar was noticed in T_1 (9.95%) followed by T_2 (11.18%).There was significant difference over the non reducing sugar of bael preserve at different level of sugar treatments (Table1). Non-reducing sugar found maximum in T_5 (17.52%) followed by T_4 (16.31%) while, minimum non-reducing sugar was noticed in T_1 (13.52%) followed by T_2 (14.55%).Highest value of total sugar was observed in T_5 (31.05%), which is followed by T_4 (28.64%), different level of sugar treatment have significant effect on total sugar content of preserve. Lowest total sugar recorded in T_1 (23.47%) followed by T_2 (25.73%).

These variations among reducing sugar, non-reducing sugar and total sugar of preserve might be due to different level of sugar concentration. Similar finding were observed by Kumar and Kirad, 2013, Jothi *et al.* 2014, in pineapple candy. Anitha and Tiwari2007, also reported that increase in sugar syrup concentration increase in content of total sugar in guava slices. All these findings is in agreement with the result of this study.

Total soluble solid

The mean value of total soluble solid(TSS) of preserve through various treatments are tabulated in (Table1). According to that table, it is found that TSS content in the processed preserve varied significantly by increase in sugar concentration. The preserve prepared by various treatments retain more amount of TSS than TSS of fresh fruit. Range of total sugar observed after completion of preparation of preserve was (56.60-75.40ºB). The TSS found maximum in T_5 (75.40ºB) followed by T_4 (71.47ºB) and T_3 (65.43ºB) while, minimum was observed in T_1 (56.60ºB) followed by T_2 (61.67ºB).

Table 1: Effect of different level of sugar concentration treatment on total sugar, non reducing and reducing sugar(%),Total soluble solid(ºBrix), Titrable acidity(%), Beta-carotene (µg/100g) of bael preserve

Treatments	Total sugar (%)	Non- reducing sugar (%)	Reducing sugar (%)	TSS (ºBrix)	Titrable acidity (%)	Beta-Carotene(µg/100g)
T_1:60ºB	23.47	13.52	9.95	56.60	**0.35**	**315.74**
T_2:65ºB	25.73	14.55	11.18	61.67	0.30	295.70
T_3:70ºB	27.19	15.67	11.52	65.43	0.28	283.86
T_4:75ºB	28.64	16.31	12.33	71.47	0.25	275.84
T_5:80ºB	31.05	17.52	13.54	75.40	0.22	267.87
S.E.(m)±	0.32	0.39	0.11	0.14	0.02	1.83
CD	1.02	1.24	0.34	0.45	0.05	5.77
CV (%)	2.05	4.38	0.98	0.38	10.31	1.10

Table 2: Effect of different level of sugar concentration treatment on moisture content%, ascorbic acid(mg/100)and total ash content(%) of bael preserve

Treatments	Moisture Content (%)	Ascorbicacid (mg/100g)	Total ash content (%)
T_1:60ºB	**34.83**	**2.91**	0.68
T_2:65ºB	33.50	2.64	0.84
T_3:70ºB	32.17	2.49	0.85
T_4:75ºB	31.20	2.06	1.06
T_5:80ºB	29.67	1.82	**1.22**
S.E.(m)±	0.18	0.14	0.03
CD	0.58	2.38	0.10
CV (%)	0.98	10.30	5.91

The reason behind this difference is that the processing employed for preparation of preserve has forced out water content to give place to the soluble solids in terms of sugar and other soluble ingredients present in the various treatment. This is reported by Bhat *et al.* (1982) in the experiment of aonla candy.

Titrable Acidity

Acidity was calculated on the basis of titrable acidity based on citric acid. Acidity for all the formulations were observed and determined. Mean value of titrable acidity of different preserves are given in Table 1. There was significant difference among treatment due to increase in level of sugar concentration. Maximum titrable acidity of preserve was recorded in T_1 (0.35%) followed by T_2 (0.30%) and T_3 (0.28%) and minimum in T_5 (0.22%).Acidity decreases with increase in sugar concentration, because osmotic process which makes water to move out of the food into the solution and leach out the natural solutes (organic acid) from the food into the solution and acidity is ultimately reduced. Khan *et al.* (2016), Hasanuzzaman*et al.* (2014).Other factor of general loss in acidity during the preparation of fruit preserve through various treatments and processing.

Beta-carotene

The perusal of data showed that different concentration of sugar had a significant effect on beta-carotene of prepared preserve. Beta-carotene was maximum in T_1 (315.74µg/100g) which was followed by T_2 (295.70µg/100g) and minimum value was observed in T_5 (267µg/100g). All the values are given in Table 1.

This findings is in agreement with Kenghe *et al.* (2009) who reported that the beta -carotene content decreased with the increase in sugar level during processing of wild bael. Another reason for lost of beta-carotene is reported by Sethi and Anand (1983) who conducted an experiment over aonla preserve and reported that the peroxidise enzyme inactivated due to blanching and there was decrease in amount of beta-carotene.

Free moisture content

Data of Table 2 shown that, the free moisture content was maximum in T_1 (34.83%) which is followed by T_2 (33.50%) while minimum free moisture content was found in T_5 (29.67%). This result agrees with the finding of Teaotia *et al.* (1976) and Hasanuzzaman *et al.* (2014), reported that the higher sugar concentration and processing time decrease moisture content of processed product.

Ascorbic acid

In the Table 2, comprised the mean value of ascorbic acid content of various preserves prepared through various treatments. Maximum ascorbic acid found in T_1 (2.91 mg/100g) followed by T_2 (2.64mg/100g) and minimum ascorbic acid noticed in T_5 (1.82mg/100g), there was found significant difference in ascorbic acid among treatments.

This difference is may be due to loss in ascorbic acid is increase with increase in concentration of sugar and cooking temperature owing to the presence of high amount of dissolved solids Khan *et al*. (2016). The reduction in ascorbic acid content also due to oxidation, this finding is similar to those of Barvathi and Anby (1997) in aonla candy. Similar findings were reported by Bhuiyan and Easdani (2013). Another reason for the loss of vitamin C is due to change in the tissue structure of fruit and additional higher sugar solution lead to more water molecules to move (diffuse) out of the material and water to dissolve the vitamin C and ultimately reduce the Vitamin C content (Hasanuzzaman*et al.* 2014).

Ash content

Ash content of food stuffs represents inorganic residue remaining after destruction of organic matter (Rao, Van Buren, & Cooley, 1993). Ash content found maximum in T_5 (1.22%) which is followed by T_4 (1.06%) and T_3 (0.85%) and minimum ash content was found in T_1 (0.68%). There is significant difference in ash content among the treatments (Table 2).

This variation is might be due to different level of sugar concentration. This findings match with Buntaran *et al*., 2010 and Khan *et al*., 2016. It is found that ash content of fresh fruit is lower than processed preserve and maximum ash content found fruit treated with higher concentration of sugar syrup (Jothi *et al*., 2014)

Organoleptic evaluation of preserve

Mean sensory scores of preserve with different sugar solution concentration.

Sensory character	Types of sugar solution(^{0}brix)	Average scores given by panel of judges
Colour	60	4.97
	65	7.00
	70	8.50
	75	8.17
	80	5.37
Flavour	60	5.67
	65	6.83
	70	7.67
	75	6.50
	80	5.87
Taste	60	5.67
	65	7.03
	70	8.27
	75	7.83
	80	7.33
Overall acceptability	60	5.5
	65	7.0
	70	8.2
	75	7.5
	80	6.2

Organoleptic scoring was done to work out the overall acceptability of the product by consumer. The sensory evaluation of the product was undertaken by a panel of judges considering the sensory attributes like colour and appearance, taste, flavour and overall acceptability on 9 point hedonic score ranging from like extremely to dislike extremely as narrated in the materials and methods.

The mean score for colour, flavour, taste and overall acceptability of the bael preserves are presented in Table 3. In which T_3 obtained maximum score among colour (8.50out of 9), flavour (7.67 out of 9), taste (8.27 out of 9) and finally in overall acceptability (8.2 out of 9),while T_1 showed minimum score on sensory point of view with respect to colour, flavour and taste.

Conclusion

Soaking in a solution of sugar concentration of 60^0 brix, 65^0 brix, 70^0 brix, 75^0 brix and 80^0 brix affects on moisture content, ash content, vitamin C, the results of organoleptic test taste, flavour, aroma and taste. Preserve of 70^0brix sugar solution produced bael preserve with the best characteristics. Taste sweet enough and the aroma is not lost and the colour is not broken.

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