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Standardization of bael [*Aegle marmelos* (Linn.) Corr] fruit squash

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Abstract
The Bael [*Aegle marmelos* (Linn.) Corr] or bilva belongs to the family Rutaceae is an important but neglected wild indigenous fruit of India. The ripe fruits are sweet, aromatic, cooling, laxative, good tonic for heart and brain and cure stomach disease. Bael is one of the most nutritious and have medicinal properties. However, it is not used as table fruit. There is need to develop, popularize and exploiting minor fruit like bael and its products. If the utilization of bael fruit is established in the processing industry, it will give a great fillip to the commercial cultivation of this valuable fruit. Fruits may be processed into various process products. The present study is an effort to explore the possibility of effective utilization of bael fruit, where value added products have been developed and the process parameters have been standardized for its biochemical qualities. To standardize processing technology for preparation of squash addition of 50 percent water to fruit weight found optimum for easy extraction and better recovery of pulp. A combination of 25 percent pulp with 45 percent sugar and 1 percent acidity was organoleptically acceptable with taste, flavor, colour and overall acceptability up to 6 months of storage at ambient temperature (30±2 °C). During storage the significant increase in physico-chemical parameters like TSS, reducing sugar, total sugar and acidity of bael squash where as significant decreased in non-reducing sugar and pH level.

Keywords: Bael squash, nutritional and medicinal properties, physico-chemical parameters and sensory parameters etc

Introduction
Bael [*Aegle marmelos* (Linn.) Corr] belongs to the family rutaceaeis an important but neglected wild indigenous fruit of India. It is commonly known as Belva, Bel, Indian quince, Golden apple, Stone apple, Sriphal, Bengal quince (John and Stevenson, 1979) [1]. Bael is known in India from pre- historic times. All parts of this fruit tree viz. root, bark, leaves, flowers and fruits are used for curing one or the other human disease. Bael fruit is a sub-tropical, deciduous tree and fruit is globuse with yellowish hard woody shell. Inside fruit soft yellow or orange coloured mucilaginous pulp with numerous seeds, which are densely covered with fiberous hairs and are embedded in a thick, gluey, aromatic pulp (Kaushik *et al*. 2002) [2]. The unripe bael fruits are used for pharmaceutical use (Hema and Lalithakumari, 1999; Pattanayak and Mohapatra, 2008) [3, 4], therapeutic use and preparation of jams, marmalade and syrups (Shrestha, 2000) [5]. The ripe fruits are sweet, aromatic, cooling, laxative.
Bael is a richest source of riboflavin (Zinzala *et al.*, 2019) [6]. Bael is one of the most nutritious and have medicinal properties. However, it is not used as table fruit. There is need to develop, popularize and exploiting minor fruit like bael and its products. If the utilization of bael fruit is established in the processing industry, it will give a great fillip to the commercial cultivation of this valuable fruit. Fruits may be processed into preserve, candy, jam, toffee, powder, RTS, squash, Nectar, syrup etc. Because of its hard shell, sticky texture and numerous seeds along with mucilaginous gummy material make it difficult to eat by hand and not popular as a fresh fruit (Shresthra, 2000) [5]. As a result, this has become one of the most neglected wild fruits in the region, which has the potential to provide an excellent source of income generation activities if properly utilized (Mishra, 2000) [7]. But has great potential for processing. A number of acceptable products should be developed, preparation could be standardized and storage requirements should be formulated to enable commercial exploitation, which in turn will add to the rural economy (Kenghe and Zambare, 2009) [8]. The present study is an effort to explore the possibility of effective utilization of bael fruit, where value added products have been developed and the process parameters have been standardized for its biochemical qualities.

Materials and Methods

The present experiment was carried out at Post Harvest Technology Laboratory, ASPEE College of Horticulture, Navsari Agricultural University, Navsari. Fresh, ripe bael fruits were taken, cleaned and cut into two halves using knife. The seed and pulp are removed from the rind, which is boiled with a half quantity of water for a period of time. Then pulp was extracted and filtered by strainer, so seeds and fibre particles were removed. The sugar syrup along with measured quantity of citric acid is mixed with the pulp to prepare squash of specific TSS and pulp percentage as per the FPO standard and sensory acceptance. The following treatments were applied: T_1:15% bael pulp + 40% sugar+ 1% citric acid; T_2:25% bael pulp + 40% sugar+ 1% citric acid; T_3:35% bael pulp + 40% sugar+ 1% citric acid; T_4:25% bael pulp + 45% sugar+ 1% citric acid; T_5:25% bael pulp + 50% sugar+ 1% citric acid; T_6:25% bael pulp + 40% sugar+ 0.8% citric acid; T_7:25% bael pulp + 40% sugar+ 1.2% citric acid. For experiment, observations were recorded at initial 3 months and six months interval. Physico-chemical parameters like TSS, acidity, pH, total sugars, reducing sugars, non-reducing sugars. Bael squash was evaluated organoleptically for taste, flavor, colour and overall acceptability by a panel. TSS measured with hand refractometer (Erma, Japan). Total sugar, Reducing sugars and acidity were estimated as per the procedure of Ranganna (1979) [9]. Non-reducing sugars were obtained by subtracting reducing sugar from total sugar.

Results and Discussion

Heating and addition of certain amount of water is required for easy and proper recovery of pulp from certain fruits like bael. In present result addition of 50% water to fruit weight found optimum for easy extraction and better recovery of pulp. A combination of 25 percent pulp with 45 percent sugar and 1 percent acidity was organoleptically found best for preparation of quality squash of bael fruit. The levels of pulp, sugar and acidity below or beyond this combination reduced the palatability of squash.

Physical parameters of the fresh bael fruit are presented in table-1. In general, TSS content in bael squash increased significantly throughout the period of storage of 6 months, similar increasing trend in TSS was recorded in blended bael RTS (Kenghe and Zambare, 2009) [8], mixed fruit squash (Jothi *et al.* 2014) [10], bael nectar (Mandal *et al*, 2021) [11]. TSS increase in the product during storage might be due to enzymatic hydrolysis of polysaccharides into sugars. Titrable acidity also increased gradually with the storage period that is supported by mixed fruit squash (Jothi *et al.* 2014) [10] and and in blended squash using banana pseudostem sap with mango, papaya and *Aloe vera* (Brunda *et al*, 2022) [12]. The increase in titrable acidity might be due to conversing of some amount of sugar to acids (Baskey *et al*., 1986) [13] and also due to degradation of pectic substances. A progressive significant increase in total and reducing sugars percent and decrease in non reducing sugar content of bael squash were estimated during storage period under the influence of treatments. Similar trend in change of different sugars content was also observed in mulberry squash (Thakur and Hamid, 2017) [14]. and papaya and mango squash (Prabha *et al*, 2019) [15]. The increase in total and reducing sugars of processed fruit products could be due to inversion of non reducing sugars into reducing sugars. The pH level was declined during storage. It might be due to increase in titrable acidity similar variations observe in mixed fruit squash (Jothi *et al.* 2014) [10]. (Table 2, 3 and 4)

Organoleptic quality is one of the important factors which determines the storage period of fruit products. In present findings organoleptic score of bael squash was significantly maximum for taste, flavour, colour and overall acceptability was recorded in T_4 but organoleptic score was decreased with storage similar decreasing trend found in carambola-guava blended nectar (Sangani *et al.*, 2021) [16]. The decrease in colour score during storage might be due to breakdown of free amino acids and their utilization in NEB caused by Maillard's reactions (Raj, 2004) [17]. Temperature plays an important role in inducing certain biochemical changes in product that leads to development of discoloration and masking of the original colour of the product resulting loss in organoleptic quality. (Table 5 and 6)

Table 1: Physical Parameters of bael fruit

Physical Parameters of fruit:	
Pulp recovery :	48%
Peel : Seed Ratio :	3:1
Peel : Pulp Ratio :	0.8:1

Table 2: Effect of various treatments on TSS (%) and Acidity (%) of bael squash

Treatments	TSS (%)				Acidity (%)			
	Initial	3 Months	6 Months	Mean	Initial	3 Months	6 Months	Mean
T_1	40.00	40.26	41.15	40.47	1.14	1.18	1.38	3.70
T_2	40.00	40.37	41.23	40.53	1.05	1.15	1.32	3.52
T_3	40.00	40.63	41.72	40.78	1.08	1.17	1.26	3.51
T_4	45.00	45.55	46.50	45.68	1.06	1.09	1.22	3.37
T_5	50.00	51.62	52.45	51.36	1.02	1.07	1.16	3.25
T_6	40.00	40.82	41.92	40.91	0.68	0.83	0.95	2.46
T_7	40.00	40.22	40.10	40.11	1.26	1.39	1.62	4.27
Mean	42.14	42.78	43.58		1.04	1.13	1.27	
S.E.m+	0.093	0.119	0.131		0.007	0.012	0.016	
C.D. at 5%	0.12	0.08	0.05		0.04	0.05	0.07	
C.V. %	0.38	0.48	0.52		1.13	1.89	2.22	

Table 3: Effect of various treatments on pH, Total sugar (%) of bael squash

Treatments	pH				Total sugar (%)			
	Initial	3 Months	6 Months	Mean	Initial	3 Months	6 Months	Mean
T_1	3.18	2.99	2.69	2.95	32.18	32.99	33.87	33.01
T_2	3.29	3.05	2.81	3.05	32.42	33.25	34.36	33.34
T_3	3.37	3.11	2.92	3.13	32.71	34.00	34.74	33.82
T_4	3.52	3.31	3.07	3.30	34.32	35.20	36.91	35.48
T_5	3.43	3.22	2.99	3.21	36.53	37.50	39.19	37.74
T_6	4.39	4.18	3.97	4.18	33.39	34.75	35.92	34.69
T_7	2.96	2.62	2.50	2.69	31.82	31.21	32.36	31.80
Mean	3.45	3.21	2.99		33.34	34.13	35.34	
S.E.m+	0.015	0.017	0.018		0.095	0.122	0.130	
C.D. at 5%	0.06	0.07	0.07		0.11	0.07	0.06	
C.V. %	0.78	0.92	1.04		0.49	0.62	0.64	

Table 4: Effect of various treatments on Reducing sugar (%), Non-reducing sugar (%) of bael squash

Treatments	Reducing sugar (%)				Non-reducing sugar (%)			
	Initial	3 Months	6 Months	Mean	Initial	3 Months	6 Months	Mean
T_1	17.41	19.83	21.35	19.53	14.81	13.22	12.50	40.53
T_2	17.62	19.95	21.86	19.81	14.98	13.36	12.80	41.14
T_3	17.84	20.33	22.20	20.12	15.06	14.90	12.78	42.74
T_4	18.42	22.54	25.08	22.01	15.98	12.72	11.89	40.59
T_5	19.58	24.66	27.64	23.96	17.12	13.12	11.80	42.04
T_6	18.04	22.10	23.34	21.16	15.65	12.82	12.75	41.22
T_7	15.38	21.72	22.28	19.79	16.52	9.80	10.70	37.02
Mean	17.76	21.59	23.39		15.73	12.85	12.17	
S.E.m+	0.096	0.122	0.138		0.062	0.059	0.066	
C.D. at 5%	0.11	0.08	0.04		0.13	0.12	0.13	
C.V. %	0.94	0.98	1.02		0.68	0.79	0.94	

Table 5: Effect of various treatments on sensory parameters (10 Point Scale basis) of bael squash

Treatments	Taste				Flavour			
	Initial	3 Months	6 Months	Mean	Initial	3 Months	6 Months	Mean
T_1	8.35	8.10	7.25	7.90	8.30	8.12	7.05	7.82
T_2	8.59	8.22	7.32	8.04	8.43	8.32	7.25	8.00
T_3	8.72	8.40	7.60	8.24	8.65	8.42	7.48	8.18
T_4	9.48	9.00	8.30	8.93	9.50	9.10	8.33	8.98
T_5	9.30	8.85	7.75	8.63	9.25	8.70	7.75	8.57
T_6	6.32	6.15	6.50	6.32	6.30	6.15	6.00	6.15
T_7	7.45	7.30	7.00	7.25	7.35	7.20	6.90	7.15
Mean	8.32	8.00	7.39		8.25	8.00	7.25	
S.E.m+	0.062	0.077	0.086		0.090	0.101	0.101	
C.D. at 5%	0.13	0.13	0.12		0.12	0.11	0.11	
C.V. %	1.29	1.67	2.02		1.90	2.19	2.41	

Table 6: Effect of various treatments on sensory parameters (10 Point Scale basis) of bael squash

Treatments	colour				Overall acceptability			
	Initial	3 Months	6 Months	Mean	Initial	3 Months	6 Months	Mean
T_1	8.45	8.30	7.25	8.00	8.87	8.69	7.92	8.49
T_2	8.68	8.47	7.44	8.20	9.12	8.83	8.14	8.70
T_3	8.75	8.52	7.75	8.34	9.28	8.99	8.21	8.83
T_4	9.49	9.20	8.33	9.01	9.66	9.24	8.54	9.15
T_5	9.28	8.82	7.81	8.64	9.41	9.02	8.32	8.92
T_6	6.45	6.30	6.70	6.48	7.08	6.58	6.26	6.64
T_7	7.50	7.25	6.95	7.23	7.38	6.89	6.47	6.91
Mean	8.37	8.12	7.46		8.69	8.32	7.69	
S.E.m+	0.087	0.091	0.119		0.056	0.074	0.101	
C.D. at 5%	0.12	0.12	0.08		0.12	0.13	0.11	
C.V. %	1.81	1.94	2.76		1.11	1.53	2.27	

Conclusion

Bael is a richest source of riboflavin. However, it is not used as table fruit. Because of its hard shell, sticky texture and numerous seeds along with mucilaginous gummy material make it difficult to eat by hand and not popular as a fresh fruit. The pulp of the bael fruit can be extracted by heating the fruit with 50 percent water at 70 °C for 5 minutes for squash development. A combination of 25 percent pulp with 45

percent sugar and 1 percent citric acid was best for standardized of quality bael squash. The squash can be stored at ambient temperature for 6 month with best organoleptic quality and can be popularized as natural health beverage in market because of its nutritive and medicinal properties.

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