Original Research Article

Effect of sugar concentration and value addition on Physico-chemical of Bael candy (*Aeglemarmelos* Correa) cv. NB-9

ABSTRACT

The experiment was conducted during the year 2022 at the post-harvest laboratory of the department, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj to study the effect of sugar concentration and value addition on Physico-chemical and sensory evaluation of Bael candy. The experiment was conducted in Completely Randomized Design (CRD) with ten treatments replicated thrice. Total number of treatments were ten viz. (T_0-Control – Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix), (T_1- Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix +Cardamom 0.2%), (T_2- Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix +Cardamom 0.2%), (T_3- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix+Cardamom 0.2%), (T_4- Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix + Saffron 0.2%), (T_5- Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix + Saffron 0.2%), (T_6- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%),(T_7-Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix + Cinnamon 0.2%), (T_8- Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix + Cinnamon 0.2%), (T_9- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix + Cinnamon 0.2%). The treatment (T_6Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) was found superior in respect of parameters like TSS (°Brix), acidity (%), ascorbic acid (mg/100g), Physiological Loss in weight of candy, Moisture percentage of Candy, Color score, texture, flavour, taste, overall acceptability. Maximum Mean shelf life of 65.633 days was found in (T_6- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%).

Keywords:*Value Added BaelCandy, Sugar, Saffron, Cardamom, Cinnamon.*

INTRODUCTION

Aeglemarmelos, commonly known as Bael, also Bengal quince, golden apple, Japanese bitter orange, stone apple or wood apple, is a species of tree native to the Indian subcontinent and Southeast Asia(**Vavilov, 1935**). It is a naturalised species in India, Pakistan, Bangladesh, Sri Lanka, and Nepal. The tree is sacred by Hindus and Buddhists. It is a diploid cross-pollinated species with chromosome number 2=28.The fruit typically has a diameter of between 5 and 10 cm. It is globose or slightly pear-shaped with a thick, hard rind and does not split upon ripening. The woody shell is smooth and green, grey until it is fully ripe when it turns yellow. Inside are 8 to 15 or 20 sections filled with aromatic orange pulp, each section with 6 to 10 flattened-oblong seeds each about 1 cm long, bearing woolly hairs and each enclosed in a sac of adhesive, transparent mucilage that solidifies on drying. The exact number of seeds varies in different publications. The fruit takes about 11 months to ripen on the tree, reaching maturity in December (Anonymous, 2009). It can reach the size of a large grapefruit or pomelo, and some are even larger. The hard shell must be cracked with a hammer or machete. The fibrous yellow pulp is very aromatic. It has been described as tasting of marmalade and smelling of roses. Boning (2006) indicates that the flavour is "sweet, aromatic

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and pleasant, although tangy and slightly astringent in some varieties. Rich in vitamin C, the fruits can be eaten either fresh from trees or after being dried (Kumar, 2020) and produced into candy, toffee, pulp powder or nectar. If fresh, the juice is strained and sweetened to make a drink similar to lemonade. It can be made into sharbat, a beverage called Belapanna. BelaPana made in Odisha has fresh cheese, milk, water, fruit pulp, sugar, crushed black pepper, and ice. Baelpanna, a drink made of the pulp with water, sugar, and citron juice, is mixed, left to stand a few hours, strained, and put on ice. One large Bael fruit may yield five or six litres of sharbat. If the fruit is to be dried, it is usually sliced and sun-dried. The hard leathery slices are then immersed in water. The leaves and small shoots are eaten as salad greens. Bael fruits are of dietary use and the fruit pulp is used to prepare delicacies like murabba, puddings and juices.The fruits of Bael cultivar (NB-9) were used for the preparation of candy and stored in glass jars and polythene pouches at ambient temperature. The changes during storage in quality were judged at monthly interval. It was observed that %TSS, acidity and browning of candy were increased while ascorbic acid was decreased during storage in both types of containers. The study indicated that a good quality of candy can be prepared by Bael cultivar NB-9 and in polythene pouches it can be stored for 4 months without any spoilage of Organoleptic quality (Mishra *et al*., 2013).Toffee is a confection made by caramelizing sugar or molasses along with butter and generally flour. The mixture is heated until its temperature reaches the hard crack stage of 300 to 310°F (100 to 154°C). A recipe for preparation of Bael toffee was formulated by Rakesh*et al*. (2005).

MATERIALAND METHODS

Matured unripe fruit, fresh and hard shell-covered fruits are taken from AcharyaNarendra Deva University of Agriculture and Technology, Kumarganj, Faizabad. grade white crystalline cane sugar, KMS (Potassium meta bisulphite), big green cardamom, Cinnamon powder, and Saffron was also taken from the local market. Storage: Candies filled in plastic bottles of 250ml capacity were used for storing the Candy; these were purchased from the local market of Allahabad. The data were statistically analysed by the method suggested by **Fisher and Yates, 1936.**The details of treatment used are:- (T_0-Control – Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix), (T_1- Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix +Cardamom 0.2%), (T_2- Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix +Cardamom 0.2%), (T_3- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix+Cardamom 0.2%), (T_4- Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix + Saffron 0.2%), (T_5- Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix + Saffron 0.2%), (T_6- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%),(T_7-Bael flesh 1kg+Sugar 50°Brix increase up to 70°Brix + Cinnamon 0.2%), (T_8- Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix + Cinnamon 0.2%), (T_9- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix + Cinnamon 0.2%).Sensory evaluation was done on a hedonic scale 0-9(Jones, 1955).

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RESULTS AND DISCUSSION

1. **Physico-chemical properties**

TSS [°Brix]

There weresignificant differences between the treatments at Initial, 30, and 60 days, among the treatmentusedT_6(1kgBaelFlesh +Sugar70%maintained70%+Saffron0.2%)with(52.899, 52.972, 52.972) °brix have highest TSS content followed by T_3 (1kg Bael Flesh+Sugar 70%maintained 70%+Cardamom 0.2%) with (52.031, 52.109, 52.109) °brix of were significantly superiorthanT_0(Control)with(42.944, 43.013 and *)°brix. A slightincrease in total soluble solids during storagemightbeduetoconversionofpolysaccharides(presentinfruits)intosugarsduringhydrolysis process. This finding agreed with the finding of Halim*et al.*, (2020) also reportedincrease in TSS of aonla candy for 120 days storage period. TSS gradually increases in storageperiod. The mean score of TSS was found to significantly increase from 69.36 to 71.71°Brix. Themaximum increase in TSS was found in the candy prepared by vacuum syruping method (69.9 to74.15)during 180 daysofstorageat ambientcondition.

Acidity (%)

There was significant differences between the treatments at Initial, 30 and 60 days, among the treatment used T_4 (Bael flesh 1kg+Sugar 50°Brix increase upto 70°Brix + Saffron 0.2%) with (0.189,0.194) have highest Acidity (%) content followed by T_1 (Bael flesh 1kg+Sugar 50°Brix increase upto 70°Brix +Cardamom 0.2%) with (0.182,0.187,-) of were significantly superior than T_3 (Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Cardamom 0.2%) with (0.149,0.155,0.16). Imtiyaz*et al*., (2016) reported that degradation of pectin substances into soluble solids might have contributed towards increase the level of acidity in the during storage period of aonla jam.

Ascorbic acid content

There was significant differences between the treatments at Initial, 30, and 60 days, among the treatment used T_6(Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) with (6.097,4.527,3.927) have highest Ascorbic Acid content followed by T_3(Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Cardamom 0.2%) with (5.927,4.377,3.77) of were significantly superior than T_7- with(4.833,3.35,-). The decrease in Ascorbic Acid was slightlyhigher in storage condition that could be attributed to more rapid hydrolysis of poly saccharides and their subsequent conversion into sugars. Navitha and Mishra, (2015) reported similar finding with Bercandy.

Physiological loss of weight

There was significant differences between the treatments from the Initial day ,after 30 days, and after 60 days, among the treatment used T_6(Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) with (0,2.182,3.966) have Least Physiological Loss in weight followed by T_5(Bael flesh 1kg+Sugar 60°Brix increase upto 70°Brix + Saffron 0.2%) with (0,2.762,4.024) of were significantly superior than T_3- with (0,2.357,4.879). Nagpal andRajyalakshmi (2009) reported a significant decrease in moisture content of BaelRTS from 20.09 to 11.56% during 80 days of storage period. After 120 days of storage of aonla candies the moisture content decreased from an initial range of 18 per cent to a final of 13 percent.

2. Sensory Evaluation

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Colour and appearance

There was significant differences between the treatments at Initial, 30 and 60 days, among the treatment used T_6 (Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) with (8.42, 8.58, 8.11) have highest colour and appearance mean value followed by T_5 (Bael flesh 1kg+Sugar 60°Brix increased up to 70°Brix +Saffron 0.2%) with (8.38,7.92,7.56) which were significantly superior than T_0 (Control) with (5.92,5.82,*). Deterioration of colour due to enzymatic and nonenzymatic reactions on pigment during storage of fruit products impair the quality of the products. It could be attributed to non-enzymatic reactions, which occur between nitrogenous compounds and sugars or organic acid and organic acids with sugars. Similar results were reported by Sujata*et al*. (2011)in Bael products.

Taste and Flavour

There was significant differences between the treatments at Initial, 30, and 60 days, among the treatment used T_6 (Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) with (8.33,8.21,8.06) have highest Flavour mean value followed by T_5 (Bael flesh 1kg+Sugar 60°Brix increase up to 70°Brix + Saffron 0.2%) with (7.9,7.39,7.12) which were significantly superior than T_0 (Control- Bael flesh 1kg+Sugar 50°Brix increase upto 70°Brix) with (6.05,5.73,-). The decreasing trend was observed for flavour, taste, and texture with increase storage period. This might be due to degradation of volatile substance and flavour constituents. Similar result was reported by Nagpal andRajyalakshmi (2009) in Bael segments-in-syrup prepared from stored fruits.

Texture

There was significant differences between the treatments at Initial, 30, and 60 days, among the treatment used T_6 (Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) with (8.42,8.34,8.19) have highest Aroma mean value followed by T_5 (Bael flesh 1kg+Sugar 60°Brix increase upto 70°Brix + Saffron 0.2%) with (8.36,8.22,8.07) which were significantly superior than T_0 (Control) with (5.88,5.56,-). The decreasing trend was observed for flavour, taste, and texture with increase storage period. This might be due to degradation of volatile substance and flavour constituents. Similar result was reported by Nayak*et al*., (2011) in aonla segments-in-syrup prepared from stored fruits. Nagpal andRajyalakshmi (2009) in Bael segments-in-syrup prepared from stored fruits.

Overall acceptability

There was significant differences between the treatments at Initial, 30, and 60 days, among the treatment used T_6 (- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) with (8.51,8.39,7.93) have highest Overall Acceptability mean value followed by T_5 (Bael flesh 1kg+Sugar 60°Brix increase upto 70°Brix + Saffron 0.2%) with (7.91,7.67,7.52) which were significantly superior than T_0 (Control) with (6.23,5.91,-). Overall acceptability scores were decreased in all the treatments during storage due to decline in colour, consistency, and flavour scores. Similar results were reported by Singh*et al*. (2019) The results on changes in overall acceptability of Bael candy during storage were found statistically significant at 0, 20, 40, 60 and 80 days of storage. However, the organoleptic characters showed a gradual decrease during the storage period up to 80 days.

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Shelf-life

Maximum Mean shelf life of 65.633 days was found in (T_6- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%).

Table 1 Changes in Physico-chemical properties of Value added Bael Candy at different days interval during Storage

Treatments	TSS [°Brix]			Acidity (%)			Ascorbic acid			Physiological loss in weight (g)		
	Initial	30 DAS	60 DAS	Initial	30 DAS	60 DAS	Initial	30 DAS	60 DAS	Initial	30 DAS	60 DAS
T0	42.944	43.013	*	0.174	0.179	*	4.937	3.473	*	99.863	96.565	*
T1	43.066	43.139	*	0.182	0.187	*	5.133	3.687	*	99.923	96.432	*
T2	47.248	47.338	47.338	0.158	0.163	0.169	5.473	4.02	3.24	99.9	97.026	95.478
T3	52.031	52.109	52.109	0.149	0.155	0.16	5.927	4.377	3.77	99.92	97.463	95.041
T4	43.281	43.36	*	0.189	0.194	*	5.107	3.35	*	99.963	96.569	*
T5	47.44	47.533	47.533	0.162	0.17	0.175	5.563	4.433	3.733	99.933	97.171	95.909
T6	52.899	52.972	52.972	0.134	0.141	0.147	6.097	4.527	3.927	99.943	97.761	95.977
T7	42.856	42.947	*	0.178	0.184	*	4.833	3.35	*	99.97	96.321	*
T8	48.013	48.131	48.131	0.169	0.175	0.181	5.407	4.253	3.42	99.95	96.814	95.25
T9	51.837	51.922	51.922	0.139	0.145	0.152	5.847	4.487	3.83	99.957	97.284	95.782
F test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S. Ed. (±)	**0.017**	**0.018**	**0.001**	**0.001**	**0.002**	**0.001**	**0.041**	**0.085**	**0.070**	**0.024**	**0.018**	**0.024**
C.D. at 5%	**0.036**	**0.037**	**0.002**	**0.002**	**0.004**	**0.002**	**0.086**	**0.178**	**0. 148**	**0.049**	**0.038**	**0.050**

CV	**0.045**	**0.046**	**0.004**	**0.836**	**1.385**	**1.338**	**0.925**	**2.592**	**3.937**	**0.029**	**0.023**	**0.051**

*(The symbol mentioned on this treatments shows, it has spoiled during this storage period of time).

Table 2Changes in Sensory evaluation and Shelf lifeof Value added Bael Candy at different days interval during Storage

Treatments	**Colour and Appearance**			**Flavor and Taste**			**Texture**			**Overall acceptability**			**Shelf life**
	Initial	**30 DAS**	**60 DAS**	**Initial**	**30 DAS**	**60 DAS**	**Initial**	**30 DAS**	**60 DAS**	**Initial**	**30 DAS**	**60 DAS**	
T0	5.92	5.82	*	6.05	5.73	*	5.88	5.56	*	6.23	5.91	*	34.833
T1	6.203	6.103	*	6.31	6.197	*	6.14	6.027	*	6.49	6.377	*	36.517
T2	6.44	6.49	6.34	6.57	6.457	6.3	6.4	6.287	6.137	6.75	6.637	6.42	62.267
T3	6.53	6.58	6.43	6.66	6.527	6.377	6.49	6.357	6.207	6.84	6.707	6.557	65.233
T4	6.38	6.28	*	6.51	6.37	*	6.34	6.2	*	6.69	6.55	*	36.433
T5	8.38	7.92	7.56	7.9	7.39	7.12	8.36	8.22	8.07	7.91	7.67	7.52	61.433
T6	8.42	8.58	8.11	8.33	8.21	8.06	8.42	8.34	8.19	8.51	8.39	7.93	65.633
T7	7.36	7.26	*	7.503	7.383	*	7.333	7.213	*	7.683	7.563	*	34.367
T8	7.47	7.52	7.37	7.593	7.473	7.323	7.423	7.303	7.153	7.773	7.653	7.503	61.433
T9	7.55	7.603	7.43	7.683	7.563	7.413	7.513	7.393	7.243	7.863	7.43	7.593	66.600
F test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S. Ed. (±)	**0.034**	**0.035**	**0.026**	**0.034**	**0.199**	**0.08**	**0.016**	**0.095**	**0.01**	**0.034**	**0.199**	**0.069**	0.87
C.D. at 5%	**0.016**	**0.016**	**0.013**	**0.016**	**0.095**	**0.011**	**0.034**	**0.199**	**0.022**	**0.016**	**0.095**	**0.033**	1.828

CV	**0.274**	**0.303**	**0.354**	**0.271**	**1.63**	**0.304**	**0.277**	**1.67**	**0.299**	**0.266**	**1.590**	**0.912**	2.031

*(The symbol mentioned on this treatments shows, it has spoiled during this storage period of time).

Conclusion

The treatment (T_6Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%) was found superior in respect of parameters like TSS (°Brix), acidity (%), ascorbic acid (mg/100g), Physiological Loss in weight of candy, Moisture percentage of Candy, Color score, texture, flavor, taste, overall acceptability. Maximum Mean shelf life of 65.633 days was found in (T_6- Bael flesh 1kg+Sugar 70°Brix maintained 70°Brix +Saffron 0.2%).

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