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Development and evaluation of ready to serve (RTS) beverage from bael (*Aegle marmelose* Correa.)

Udayakumar K.P.[1*], Kanupriya Chaturvedi[2], Swamy G.S.K.[1]
Anuradha Sane[2], Pritee Singh[2] and Suresh G.J.[1]
[1]Department of Fruit Science, College of Horticulture, Bengaluru - 560 065, India
[2]Division of Fruit Crops, ICAR-IIHR, Bengaluru - 560 089, India
*Corresponding author E-mail : udaypkumar2897@gmail.com

ABSTRACT

A research study was carried out to develop a RTS beverage by exploiting the nutritional and organoleptic properties of bael fruit pulp. Six treatment combinationsof bael RTS with 10, 15 and 20% of pulp concentration and 10 and 15°B of TSS were prepared based on the review of literature. The biochemical and organoleptic properties of the prepared RTS were evaluated during storage. The pH, ascorbic acid and antioxidant activity of the RTS decreased with the storage, while acidity and total sugars increased. Results of the sensory evaluation showed that there was a significant difference between treatments in terms of color, flavor, taste, body and overall acceptability. From the results of quality assessments, the formulated bael RTS beverage with 15% pulp and 15°B TSS was found to be superior and suitable for consumption up to 12 weeks without any significant changes in the quality characteristics.

Keywords: Bael, beverage, biochemical, nutritional, organoleptic properties and RTS

INTRODUCTION

The demand for processed tropical fruit products is increasing in domestic and international markets, however less than 15 fruits are commercially processed. As these fruits are seasonal and perishable in nature, their seasonal surpluses in different regions are wasted in bulk due to improper handling, distribution, marketing, and inadequate storage facilities. For this reason, fruits in excess need immediate processing for value-added products to minimize postharvest losses, which are about 30–35% according to National Horticultural Board. (NHB 2016). The bael is increasingly becoming an important crop in functional food production and is of economic importance. Although the pulp is mainly consumed fresh, the juice prepared from bael fruit was rich in bioactive compounds such as carotenoids, phenols, alkaloids, coumarins, flavonoids, terpenoids and other antioxidants (Thakur, 2014). Fruit beverages are processed food products that are conveniently used and liked by all age group consumers. They also provide a better chance of meeting the daily requirement of nutrients in a healthy diet. There are many different product variants marketed in India, such as sweetened carbonated soft drinks, clarified juice beverages, pulpy beverages, and soda water. Among these non-alcoholic beverages, the share of fruit-based beverages is presently very small as compared to synthetic carbonated beverages. Consumers are now gradually shifting towards the consumption of natural fruit-based beverages because of their nutritional quality, medicinal importance, and good calorific value over synthetic beverages). The advantage of RTS beverage is that there is no need to dilute it further with a required quantity of water, unlike other concentrated beverages such as squash, or syrup, which are diluted judiciously with water before consumption. At present, bael is an underutilized fruit in India and has a limited shelf life in fresh form. Therefore, there is a need for processing it into a value-added product like RTS beverage with extended storage life so that the product can be consumed throughout the year and consumers may relish its unique taste and flavour and quench their thirst. The demand for natural fruit-based beverages with high nutritional value and other health-imparting attributes are immense in the global market.

Bael *(Aegle marmelose* Correa.) is one of the ancient, nutritious minor fruit crops that belongs to the family Rutaceae. Indo-Malayan region is believed to be the centre of origin of this tree and it is found growing in many South East Asian countries including Sri Lanka, Pakistan, Nepal, Bangladesh, Myanmar, Vietnam, Thailand, Cambodia, Malaysia, Philippines, Java and Fiji. The tree grows up to 6-8m height, leaves are trifoliate and deciduous in nature, fruits are aromatic, bark is thick, branches are spiny in some varieties and lower branches are drooping. Young leaf of the tree is glossy shiny and pinkish maroon in color, the flowers are bisexual, 4 curved fleshy petals with green outside and yellowish inside, fragrant having sweet aroma, cluster blooming (4-7), and stamens are 50 or more in number. Fruits are hard-shelled berries, greenish yellow inearly immature stage and turn yellow when mature. It consists of thin or hard woody or soft rind dotted with oil glands, a hard central core with triangular segments and dark orange walls. Segments of fruit are filled with aromatic pale orange, pasty, sweet resinous, more or less astringent pulp, seeds are embedded in the pulp, have round-oblong structure bearing woolly hairs and each enclosed in a sac of adhesive, transparent mucilage that solidifies on drying. The shape and size of the fruit varies with varieties and round, pyriform, oval, or oblong fruit shape having 5-20 cm diameter have been reported.

The bael is well-known for its organoleptic properties with special reference to its unique flavour and color. The pulp is highly nutritious and very good source of vitamins, minerals, fiber and pectin (Table 1). Further, the bael fruit was found to be antispasmodic, diuretic, antiseptic, sedative, and analgesi. Epidemiological studies revealed that increased consumption of bael could lead to lower the risk of developing chronic degenerative diseases (Reddy *et al.,* 2010). Studies indicate that consumption of bael have a significant effect on blood glucose and lipid parameters and bael can alleviate the symptoms of diabetes in a natural manner (Sharma *et al.,* 2016).

Therefore, the present study was focused with an objective to optimize the process conditions for the preparation of RTS beverage from bael fruit and to evaluate the physicochemical and sensory characteristics during storage period.

MATERIALS AND METHODS

Preparation of RTS beverage of bael fruit

The ripe bael fruits were collected from the IIHR field gene bank and washed with tap water in the laboratory. The fruits were opened by hitting with hammer due to its hard outer shell. The fruit pulp along with seeds and fiber was scooped with the help of stainless-steel spoon manually. Amount of water equal to the weight of pulp was added. The mixture was heated up to 70°C for 1min and cooled. The pulp was then passed through stainless-steel sieve (800µm) to separate seeds and fibres. The beverage was prepared by varying the pulp concentration and TSS. Acidity was maintained at 0.3% and KMS was added at 120ppm in all the treatmentsas per the formulations given bellow.

Experimental formulations for RTS preparation

T_1- 10% bael fruit pulp + 10°B TSS with sugar syrup.

T_2- 10% bael fruit pulp + 15°B TSS with sugar syrup.

T_3- 15% bael fruit pulp + 10°B TSS with sugar syrup.

T_4- 15% bael fruit pulp + 15°B TSS with sugar syrup.

T_5- 20% bael fruit pulp + 10°B TSS with sugar syrup.

T_6- 20% bael fruit pulp + 10°B TSS with sugar syrup.

The requisite amount of sugar and citric acid were dissolved in requisite amount of water to prepare sugar syrup in heating condition and then mixed with bael fruit pulp in RTS beverage. It was removed from the gas burner and was allowed to cool for 10 min at room temperature of 28 - 30°C. Subsequently, 70 ppm of KMS was added and mixed well with the solution. Just after addition of KMS, hot filling was done into already oven sterilized (160°C for 45 min) glass bottles and caped with stopper immediately. The sealed bottles were put on the hot water bath at 80°C for 30min for pasteurization. Then bottles were removed from the hot water bath and allowed to cool.

Determination of sensory properties

Sensory evaluation was conducted to evaluate the organoleptic properties of the RTS by semi-trained panelists. The color, taste, flavor, body and overall acceptability was evaluated using 9 points Hedonic scale. Samples were evaluated between 10.00 to 11.00am for morning session and 2.00 to 3.00 pm for evening session for effective assessment by the panelists. Each panelist was asked to evaluate the

samples which were arranged randomly to judge the organoleptic properties. The samples were served to the panelist at 10°C as this temperature is commonly used for serving RTS.

Quality analysis of Ready to Serve (RTS)

pH

The pH of the sample was taken using a pH meter (Model: EUTECH Instruments-pH Tutor, Singapore). Twenty mL of the RTS beverage sample was taken to dip the calibrated electrode of the pH meter and the observations were recorded in triplicate for each sample.

Titratable Acidity

Acidity was determined by titration method (AOAC, 942.15, 2000). Homogenized sample of 5 g was mixed with distilled water, squeezed through a muslin cloth and volume was made up to 50 ml. A known volume of the filtrate (25 ml) was titrated against 0.01N NaOH using 0.5% phenolphthalein (3 to 4 drops) as indicator. Acidity was calculated as percentage of citric acid equivalent using citric acid standard curve.

$$\text{Titratable Acidity (\%)} = \frac{\text{TV. (mL)} \times \text{N NaOH} \times \text{Volume(mL)} \times \text{Eq. Wt. (Citric Acid)}}{\text{Sample Weight (g)} \times \text{Aliquot Taken (mL)} \times 1000} \times 100$$

Ascorbic acid

Ascorbic acid content was determined by 2,6-Dichlorophenol indophenol method (AOAC, 967.21, 2006). About 5ml of sample was mixed with 4% oxalic acid solution and volume was made up to 50 ml and was then estimated by titrating a 25ml of the extract against DCPIP. Vitamin C content was calculated as mg of ascorbic acid per 100ml RTS using a standard curve of L-Ascorbic acid.

Total Sugar

Total sugar was estimated by the standard method of AOAC (1980). The sugar extract was hydrolysed with concentrated hydrochloric acid and titrated against 10ml of mixed Fehling's solution (5ml Fehling A + 5ml Fehling solution B) using methylene blue as indicator. Results were expressed as per cent total sugar.

Total Antioxidant activity

2, 2 – diphenyl-1-picrylhydrazyl (DPPH)assay was done according to the method of Williams *et al.* (1995) with some modifications. The DPPH stock solution was prepared by dissolving 19.7 mg of DPPH in 100 mL of 80% methanol. RTS (200 µL) was allowed to react with 50 µL of DPPH solution for 30 min in dark conditions. Readings were taken at 517 nm. The calibration curve was linear from 50 to 500 µL of Trolox. The results were expressed in µM Trolox equivalents (µM TE/g dry weight). Additional dilutions were made when the values obtained from the samples were outside the linear range of the calibration curve.

Sensory evaluation (9-point Hedonic scale)

Samples of appetizers were presented to a panel of 8 judges. For evaluating the RTS, nine-point hedonic scale was used. The samples were served at room temperature.

Statistical analysis

Biochemical and quality analysis data were subjected to statistical analysis, level of significance (LOS). Critical difference (CD) at 5 per cent level of probability was used for comparison among treatments. The results were presented by way of tables. Analysis of quantitative data (biochemical and quality analysis) was done in statistical tool OPSTAT, Statistical Software.

RESULTS AND DISCUSSION

Qualitative analysis of Ready to Serve (RTS) beverage from fruit pulp of bael

pH

There was a significant decrease in pH during storage (Table 1). This might be due to increase in acidity, as acidity and pH are inversely proportional to each other. It was observed that the maximum pH (3.38) was recorded in T_2 (10% pulp + 15°Brix). The decrease in pH was due to increase in titrable acidity which affects the organoleptic quality of juice. Similar effect of ingredients on pH of the value-added product of fruit was observed by Jain and Nema (2007), Elbelazi *et al.* (2015).

Titratable acidity

There was a significant increase in acidity content during storage (Table 1). It was observed that maximum acidity (0.53%) was recorded in T_5 (20% Pulp + 10° Brix). The minimum increase (0.36%) in acidity was observed in T_1 treatment which might be due to addition of citric acid. Similar effect of ingredients on titratable acidity of value-added product of fruit was observed by Jain and Nema (2007), Elbelazi *et al.* (2015), Asghar *et al.* (2016).

Table 1. Influence of pulp level and TSS on physio-chemical attributes of bael RTS.

Treatments	pH	Titrable Acidity (%)	Ascorbic acid (mg/100 ml)	Total Sugar (%)	Total Antioxidant activity (mg AEAC/100ml)
T_1: 10% Pulp + 10°Brix	3.35	0.28	30.54	22.18	81.58
T_2: 10% Pulp + 15°Brix	3.38	0.31	32.42	22.59	82.60
T_3: 15% Pulp + 10°Brix	3.22	0.34	34.50	23.20	83.52
T_4: 15% Pulp + 15°Brix	3.23	0.38	37.60	23.54	84.52
T_5: 20% Pulp + 10°Brix	3.05	0.45	44.50	24.05	86.90
T_6: 20% Pulp + 15°Brix	3.00	0.42	41.50	24.34	85.50
Mean	3.21	0.36	36.84	23.32	84.10
SEm±	0.070	0.008	0.817	0.074	0.768
CD at 5%	0.211	0.024	2.447	0.221	2.301
4 weeks after storage					
T_1: 10% Pulp + 10°Brix	3.32	0.30	30.00	22.90	81.08
T_2: 10% Pulp + 15°Brix	3.34	0.34	31.95	23.34	82.13
T_3: 15% Pulp + 10°Brix	3.21	0.37	33.94	23.90	83.03
T_4: 15% Pulp + 15°Brix	3.20	0.41	37.15	24.28	84.04
T_5: 20% Pulp + 10°Brix	3.02	0.48	43.98	24.75	86.42
T_6: 20% Pulp + 15°Brix	2.98	0.45	40.97	25.04	84.97
Mean	3.178	0.392	36.332	24.036	83.612
SEm±	0.067	0.008	0.764	0.501	1.741
CD at 5%	0.199	0.024	2.287	N/A	N/A
8 weeks after storage					
T_1: 10% Pulp + 10°Brix	3.29	0.33	29.54	23.65	80.54
T_2: 10% Pulp + 15°Brix	3.30	0.36	31.46	24.15	81.64
T_3: 15% Pulp + 10°Brix	3.17	0.40	33.39	24.65	82.51
T_4: 15% Pulp + 15°Brix	3.18	0.45	36.65	25.00	83.56
T_5: 20% Pulp + 10°Brix	3.00	0.50	43.48	25.40	85.94
T_6: 20% Pulp + 15°Brix	2.95	0.47	40.48	25.81	84.45
Mean	3.149	0.419	35.833	24.777	83.107
SEm±	0.065	0.009	0.752	0.516	1.731
CD at 5%	0.196	0.026	2.252	N/A	N/A
12 weeks after storage					
T_1: 10% Pulp + 10°Brix	3.25	0.36	28.03	24.19	80.02
T_2: 10% Pulp + 15°Brix	3.27	0.39	30.89	24.90	81.06
T_3: 15% Pulp + 10°Brix	3.15	0.43	32.85	25.35	82.00
T_4: 15% Pulp + 15°Brix	3.16	0.48	35.98	25.78	83.08
T_5: 20% Pulp + 10°Brix	2.98	0.53	42.94	26.18	85.48
T_6: 20% Pulp + 15°Brix	2.92	0.49	39.95	26.52	83.97
Mean	3.122	0.447	35.107	25.487	82.602
SEm±	0.065	0.009	0.739	0.531	1.719
CD at 5%	0.195	0.027	2.212	N/A	N/A

Ascorbic acid content

The ascorbic acid (vitamin C) content of the juice decreased during storage with the advancement of storage period, which was probably due to the fact that ascorbic acid being sensitive to oxygen, light and heat gets easily oxidized in presence of oxygen by both enzymatic and non-enzymatic catalyst. Maximum ascorbic acid content (44.50 mg/100 ml juice) was recorded in T_5 initially, and decreased to 42.94 mg/100 ml juice at the end of the storage. Each ingredient used in preparation of RTS has its own organic acid composition which affect the ascorbic acid of RTS. Jain and Nema (2007) and Abhangrao *et al.* (2017) also reported the similar effect of ingredients on ascorbic acid content of the fruit-based value-added product.

Total sugars

The results revealed that the total sugars content was significantly affected as a result the total sugars content in the juice increased apparently during storage (Table 1), which might be due to hydrolysis of polysaccharides into monosaccharide and oligosaccharides. The minimum increase (24.19%) in total sugar content was recorded in T_1 treatment. The change in total sugar content of beverage was almost negligible during storage, the different ingredients used for RTS preparation vary in their total sugar content which affects the total sugar content of RTS. The effect of ingredients on total sugar of other value-added products was also reported by Asghar *et al.* (2016) in functional bael jam and Chauhan *et al.* (2016) in bael vermouth.

Total antioxidant activity

Decreased antioxidant activity in the juice was observed during storage (Table 1), which might be due to increase in pulp content. The Maximum total antioxidant activity recorded in T_5 (86.90 mg AEAC/100ml); the minimum total antioxidant activity recorded in T_1 (81.58 mg AEAC/100ml). The different pulp concentration used for RTS preparation vary in their antioxidant activity which affects the total antioxidant content of RTS. Similar effect of ingredients on antioxidant activity of the value-added product of fruit was observed by Asghar *et al.* (2016), Bhatt and Verma (2016), Chauhan *et al.* (2016), and Bisen *et al.* (2017).

Sensory evaluation

Sensory assessment is a scientific discipline that uses the concepts of experimental design and statistical analysis to evaluate consumer products through the use of human senses (sight, smell, taste, touch and hearing). It necessitates the use of human assessors, who test the product and keep track of the results. It is therefore feasible to generate insights and judgments about the products under test by using statistical approaches to the results acquired from human assessors. It is the final judge of a product's quality from the consumer's perspective, and it is a significant factor in determining quality. It's all about the product's colour, flavour, taste, texture, and overall acceptability. RTS sensory evaluation is described in depth in the following sections (Table 2).

Table 2. Influence of pulp level and TSS on sensory evaluation (9-point Hedonic scale) scores of bael RTS.

Treatments	Colour	Flavour	Taste	Body	Overall acceptability
T_1: 10% Pulp + 10°Brix	6.45	6.40	6.45	6.10	6.60
T_2: 10% Pulp + 15°Brix	6.65	6.65	6.70	6.90	7.05
T_3: 15% Pulp + 10°Brix	6.80	6.25	6.10	6.65	6.85
T_4: 15% Pulp + 15°Brix	7.60	7.30	7.6	7.10	7.70
T_5: 20% Pulp + 10°Brix	7.60	7.00	7.20	7.05	7.30
T_6: 20% Pulp + 15°Brix	7.65	6.90	6.85	6.95	7.15
Mean	7.13	6.75	6.81	6.79	7.10
SEm±	0.065	0.062	0.142	0.141	0.148
CD at 5%	0.196	0.185	0.425	0.423	0.443

Appearance/Colour

Appearance/colour differed significantly among the treatments with mean value of 7.13 (Table 2). Maximum appearance/ colour recorded in T_6 (7.65) which was on par with T_4 (7.6) and T_5 (7.6). The minimum appearance/ colour recorded in T_1 (6.45).The colour attracts the consumers towards the product and can help in impulse purchases. At the point of purchase, consumers use mostly appearance factor as an indication of quality. Colour is derived from the natural pigments present in fruits. The primary pigments which impart colour are the fat-soluble chlorophylls (green), carotenoids (orange, yellow and red) and the water-soluble anthocyanins (red, blue), flavonoids (yellow), and betalains (red). An effect of ingredients on colour of product was reported by Kaur and Kochhar (2017), Thukral (2017) and Ullikashi *et al.* (2017). The best product with respect to colour was obtained when 50% level of aonla pulp and 50% of bael pulp were used for preparation of mixed fruit leather by Uttarwar *et al.* (2018).

Flavour

Flavour differed significantly among the treatments with mean value of 6.75 (Table 2). Maximum flavour was recorded in T_4 (7.3) and the minimum flavour was recorded in T_3 (6.25). Flavour is a mingled but a unitary experience which includes sensations of taste, smell, and pressure. Flavour is typically described by aroma and taste. Similar findings on effect of ingredients on flavour of bael based value added product was reported by Kaur and Kochhar (2017), Thukral (2017) and Ullikashi *et al.* (2017). Similar effect was also reported by Uttarwar *et al.* (2018) in preparation of mixed fruit leather and the highest score obtained from 50% level of aonla pulp and 50% of bael pulp with respect to flavour.

Taste

Taste differed significantly among the treatments with mean value of 6.81 (Table 2). Maximum taste recorded in T_4 (7.6) was on par with T_5 (7.2). The minimum taste was recorded in T_3 (6.1). The sensation that is perceived in the mouth and throat on contact with a substance is called as taste. It includes the sweet, sour, salty and bitter quality of a thing that can sense when it is in the mouth. Taste is important for acceptability of any product. Similar effect of ingredients on the bael based value added product was reported by Liyanaduragc *et al.* (2007), Kaur and Kochhar (2017),

Body

Body differed significantly among the treatments with mean value of 6.79 (Table 2). Maximum body recorded in T4 (7.1) which was on par with T5 (7.05), T-6(6.95) and T-2(6.9). The minimum value for an attribute body was recorded in T1 (6.1). Body is another important sensory parameter to judge the quality of product. The body parameters are perceived with the sense of touch or either when the product is picked up by hand or placed in the mouth and swirled. Similar effect on body of different bael based value added product was found by Liyanaduragc *et al.* (2007), Pingale and Dighe (2015),

Overall acceptability

Overall acceptability differed significantly among the treatments with mean value of 7.1 (Table 2). Maximum overall acceptability recorded in T4 (7.7) which was on par with T5 (7.3). The minimum overall acceptability recorded in T1 (6.6).The colour and appearance decides the first purchase of the product but ultimately the overall acceptability of the product is the most important factor for its further future purchase. A similar effect on overall acceptability of different bael based value added product was found by Liyanaduragc *et al.* (2007), Pingale and Dighe (2015),

CONCLUSION

This research was designed to utilize the bael fruit pulp to formulate RTS beverage. The range of pulp and sugar concentration used for the development of RTS beverage was in combination of 10, 15 and 20% pulp and 10 and 15ºB TSS. RTS beverage formulation with 15% pulp and 15ºB having pH 3.23, acidity 0.38%, ascorbic acid 37.60 mg/100g, total sugar 23.54%, and total antioxidant activity of 84.52 mg AEAC/100ml was found best. The RTS beverage T_4 with 15% pulp and 15ºB showed highest overall acceptability (7.7) along with colour 7.60, flavour 7.30, taste 7.6 and body 7.10.

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