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Evaluation of Quality Attributes during Storage of Ready-To-Serve (RTS) Beverage Prepared from Bael (*Aegle marmelos* L.) Fruit

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Abstract

A research was carried out to formulate the ready-to-serve functional beverage using different pulp concentration and to assess the quality of beverages during storage. Bael fruit pulp concentrations of 2, 4, 6, 8, 10 and 12 % of were used with sugar, citric acid, distilled water and 70ppm of potassium metabisulphite, considering the findings of preliminary studies and Sri Lankan Standards (SLS 729) for RTS fruit beverage. Based on the physico-chemical, microbial and sensory analysis, and the most preferred bael RTS beverage with fruit pulp concentrations of 4, 6 and 8% combinations were selected for storage studies. The formulated beverages were stored at ambient temperature of 30±1°C and relative humidity of 70-75% for 12 weeks. Beverages were subjected to quality assessments at two weeks interval for the entire storage period. Among the treatments, beverage prepared from 6% of pulp concentration contained 3.48mg/100ml of ascorbic acid, 0.91% of titratable acidity, 11.61% of total sugar and 9.50% of total soluble solid at the end of 12 weeks of entire storage period. The results of organoleptic assessment showed that there were significant differences ($p<0.05$) among the treatments in terms of colour, taste, consistency, aroma and overall acceptability. From the results of quality assessments, beverage produced with 6% of pulp concentration could be stored at 30±1°C of temperature and 70-75% relative humidity for a minimum period of 12 weeks without any significant changes in the quality characteristics

Keywords; Bael fruit; Functional beverage; Physico-chemical analysis; Sensory qualities

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1. Introduction

Fruits and their value added products plays an crucial role in human diet because they provide most of the vital nutrients especially vitamins, carbohydrates, protein and minerals required for normal growth and development of the human body which leads to maintain healthy physique and mind. Normal consumption of fruits significantly reduces the risk of heart diseases, stress, and premature aging due to the antioxidant properties of fruits (Sindumathi *et al*., 2015). Nowadays people prefer food or beverage which has physiological benefits besides basic nutrition to reduce the risk of chronic diseases. RTS beverages have been increasingly gaining popularity throughout the country due to their health and nutritional benefits, apart from pleasant flavour and taste. Fruit based RTS beverages are not only rich in essential minerals, vitamins and other nutritive factors but also are delicious and have a universal appeal.

Bael (*Aegle marmelos* L.) is one of the most useful medicinal fruit. The common name of Bael is stone apple. It contains many vitamins like vitamin C, vitamin A, thiamine, riboflavin, niacin, and minerals like calcium, and phosphorus (Bag *et al*., 2011). Bael fruit is very rich in vitamins, amino acids and minerals when compared to other fruits (Charoensiddhi and Anprung, 2010), and it can contribute significantly to the daily nutrient needs of the individual. In addition, it can be used advantageously to supplement deficiencies of other foods (Baliga *et al*., 2011).

People have a preference for value added products than for consuming it as a completely edible fruit. The different parts of bale plant contain number of coumarins, alkaloids, sterols and essential oils. Various parts of this plant such as leaves, fruit and seed possess hypoglycaemic, hypolipidemic and blood pressure lowering property (Lmbole *et al*., 2010). The peel of the fruit which is a very hard shell and green to brown in colour depends on ripening stage. The appearance of yellow or orange edible pulp is like a boiled pumpkin, possesses a slightly sweet taste and a characteristic floral, terpene-like aroma, very fragrant and pleasantly flavored. Seeds are surrounded by slimy transparent mucilage (Suvimol and Pranee, 2008).

Ready-To-Serve (RTS) fruit drink is a type of fruit beverage which contains at least 10% fruit and 10% TSS besides about 0.5% acid intended for consumption without dilution and prepared from unfermented pure fruit juice with or without some of the pulp and containing any soluble carbohydrate and water (SLS 729:1985). Adding preservatives such as sulphur dioxide and benzoic acid can increase the shelf life of RTS beverages. In this research, Ready-To-Serve (RTS) beverage was prepared using bale fruit juice at different pulp concentrations and kept in ambient conditions in order to study the quality and shelf life during storage.

2. Materials and Methods

2.1 Preparation of RTS beverages of Bael fruit

The ripe bale fruit was taken. The fruit pulp along with its seeds and fibers was scooped with the help of stainless steel spoon. Amount of water equal to the weight of pulp was added. The mixture of pulp and water was then heated up to 70°C for 1 minute and cooled. The amount of bale fruit pulp was changed to prepare different pulp concentration of RTS beverage.

Six formulations of 4, 6, 8, 10, 12 and 14% of pulp were prepared with one kilogram in each concentration for the final product. The requisite amount of sugar and citric acid were dissolved in requisite amount of water to prepared sugar syrup in heating condition and then mixed with bale fruit pulp in RTS beverage. Same amount (0.07g) of potassium metabisulphite was added for all the six recipes as a preservative, considering the standard limit specified by the Sri Lankan standards institute (SLS.729:1985) for the RTS fruit beverages. Just after addition of KMS, hot filling was done into already sterilized glass bottles and capped with stopper immediately. The sealed bottles were put in the hot water bath at 80°C for 30 minutes for pasteurization.

The treatment formulations are given below:

T_1 - 2% Bael fruit pulp concentration
T_2 - 4% Bael fruit pulp concentration
T_3 - 6% Bael fruit pulp concentration
T_4 - 8% Bael fruit pulp concentration
T_5 - 10% Bael fruit pulp concentration
T_6 - 12% Bael fruit pulp concentration

2.2 *Storage Studies*

Based on the physico-chemical and sensory analysis, the most preferred bael RTS beverage with 4, 6 and 8% combinations were selected for storage studies. They were stored at ambient temperature 30±1°C and relative humidity70-75% for 12 weeks and were assessed to shelf life. Three replications were prepared per each treatment. The physico-chemical characteristics such as titrable acidity, ascorbic acid, total soluble solid and total sugar were analyzed in two weeks interval and observations were also carried out to evaluate the samples during storage.

3. Results and Discussion

3.*1 Shelf Life Evaluation of Bael Pulp RTS Beverages*

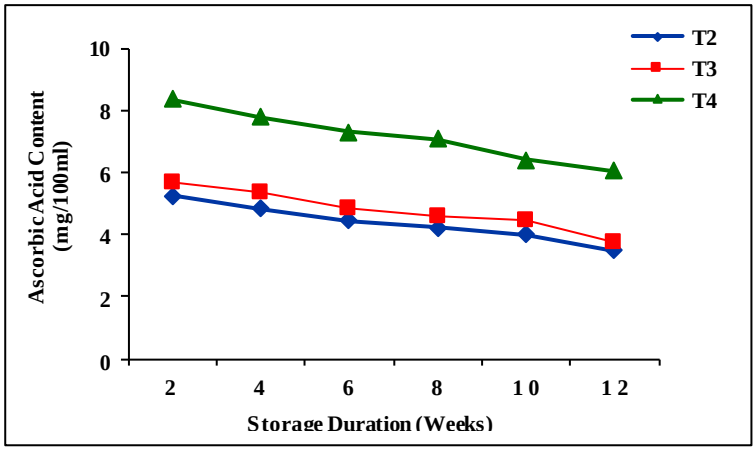
Based on the Physico-chemical and sensory analysis of freshly made bael pulp RTS beverages, the most preferred three RTS treatments were selected for storage studies. They were stored at the existing temperature of 30±1°C and relative humidity of 70-75% in storage room condition.

The most preferred treatments are,
T_2 - 4% of Bael fruit pulp
T_3 - 6% of Bael fruit pulp
T_4 - 8% of Bael fruit pulp

3.2 Changes of Physico-Chemical Qualities of Bael RTS Beverage during Storage

3.2.1 Ascorbic acid

The ascorbic acid content of the bael pulp RTS beverages was decreased with the advancement of storage period. Changes in ascorbic acid content of RTS formulations during storage are shown in Figure 1.



The values are means of triplicates

Figure 1: Changes in Ascorbic Acid content of Bael RTS Beverage during Storage

Our findings were in agreement with Singh *et al*. (2015) and they have reported decline in the ascorbic acid content of bael-aonla RTS beverage during six months storage. Similar reduction in ascorbic acid was also reported by Nagpal and Rajyalakshmi (2009) in bael-citrus fruit blends. The reason for ascorbic acid reduction during storage period was due to the fact that ascorbic acid being sensitive to oxygen, light and heat is easily oxidized in presence of oxygen by both enzymatic and non-enzymatic catalyst from ascorbic acid to dehydroascorbic acid. The similar finding was given in jamun beverages (Das, 2009). According to Srilakshimi (2001), if fruits are bruised, peeled, cooked or exposed to air, alkali or copper large amounts of the ascorbic acid may be oxidized.

3.2.2 Total Soluble Solids (TSS)

The changes in TSS of different formulations along with the storage period are given in the Table 1. The maximum (9.93°Brix) and minimum (9.46°Brix) mean values of TSS was observed in treatment which had 6% bael pulp and 4% bael pulp in respectively 2nd, 12th weeks of storage period.

Table 1: Changes in Total Soluble Solids of Bael RTS Beverage during Storage

Storage Duration (Weeks)	T_2	T_3	T_4
2	9.87±0.09^a	9.93±0.09^a	9.80±0.16^a
4	9.80±0.16^a	9.87±0.09^a	9.73±0.09^a
6	9.73±0.10^a	9.73±0.10^a	9.73±0.10^a
8	9.60±0.30^a	9.70±0.10^a	9.67±0.00^a
10	9.53±0.10^a	9.73±0.10^a	9.53±0.10^a
12	9.50±0.10^a	9.50±0.01^a	9.46±0.01^a

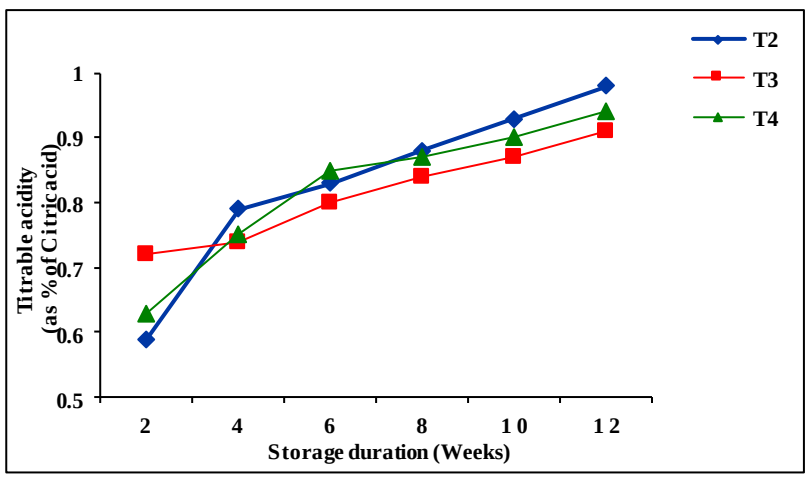
Values are means of triplicates ± Standard error

The TSS of RTS beverages decreased slightly with the increase in storage duration. Similarly, Saklani *et al*. (2012) indicated that the TSS of the Sea buckthorn RTS Beverage decreased with increased period of storage in all the treatments for 120 days. Similarly also reported by Puranik *et al*. (2013) in herbal functional RTS beverage. The TSS reduced gradually which might be due to the chemical interactions taking place among the organic constituents of the beverage (Ghorai and Khurdiya, 1998).

3.2.3 Titrable acidity

The changes in titrable acidity of bael fruit RTS functional beverages during storage are shown in Figure 2. The changes in titrable acidity of bael pulp RTS beverages during storage period had increasing trend throughout the storage period in all treatments but the acidity values were within the standard limits specified by the Sri Lankan Standards Institute (SLS 729:1985) for the RTS fruit beverages.

The increase in acidity during storage of bael-aonla beverage blends might be due to formation of organic acids by the degradation of ascorbic acid (Singh *et al*., 2015). Similar results were in conformity with findings of Sharma *et al*. (2012) in overall acceptability of guava-jamun blends RTS drink and squash, Joshi *et al*. (2012) in the preparation of tamarind RTS beverages.

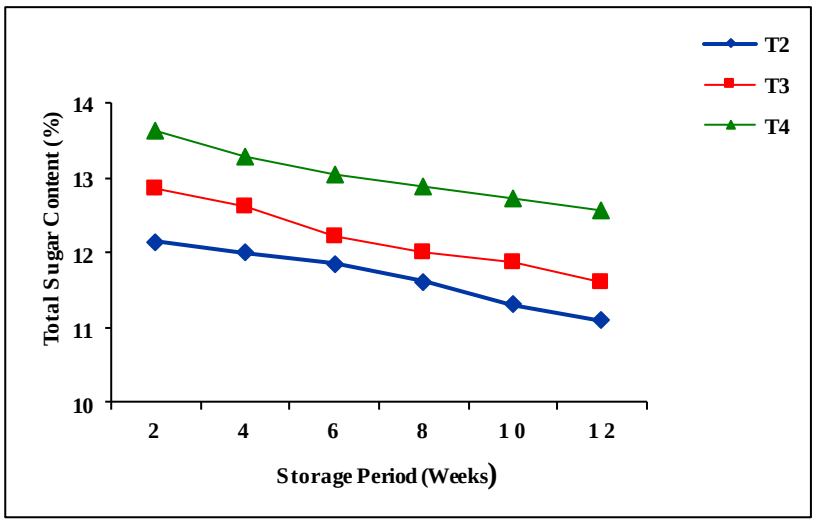


Values are means of triplicates

Figure 2: Changes in Titrable Acidity of Bael RTS Beverage during Storage

3.2.4 Total sugar

The changes in total sugar of bael pulp RTS beverages during storage are shown in Figure 3. According to DMRT, total sugar decreased significantly ($p<0.05$) throughout the storage period. This could be due to high polymerization of sugars at high temperature as discusses by Fennema (1996). Total sugar in all treatments had the decreasing trend with the storage period because hydrolysis of polysaccharides and oxidation of sugars took place during the storage period. Nilugin and Mahendran (2010) found that the significant reduction in total sugar throughout the storage period at ambient temperature in the RTS beverages.



Values are means of triplicates

Figure 3: Changes in Total Sugar Content of Bael Pulp RTS Beverage during Storage

The declining trends of total sugar was reported by Saranyah and Mahendran (2015) in pineapple blend watermelon RTS beverage. Similar, results have also been reported by Saklani *et al*. (2012) indicated that the total sugar of the Sea buckthorn RTS Beverage decreased with increased period of storage in all the treatments for 120 days.

3.3 Sensory qualities of bael pulp RTS Beverages during Storage

Sensory evaluation was done for three selected bael pulp RTS beverage after a period of 12 weeks through a panel of 30 semi-trained panellists. The panel evaluated colour, aroma, consistency, taste, and overall acceptability. A 7-point hedonic scale was used for this purpose. Organoleptic quality determines the storage stability of any prepared product. Organoleptic characters of bael pulp RTS Beverages stored at ambient conditions were changed slightly apart from freshly made RTS beverages during the storage period. This is due to increase in acidity and reduction in total sugar content by oxidation reactions.

The sensory scores of sensory evaluation after 12 weeks of storage are given in the Table 2. Similar findings have been reported by Jain *et al*. (2011) in guava and papaya fruit mixed RTS beverages.

Table 2: Sensory Evaluation of Bael pulp RTS Beverage following Storage

Sensory Attributes	T_2	T_3	T_4
Colour	5.83 ± 0.37^{b}	5.83 ± 0.37^{b}	5.83 ± 0.37^{b}
Aroma	5.46 ± 0.49^{b}	5.46 ± 0.49^{b}	5.46 ± 0.49^{b}
Consistency	4.96 ± 0.17^{c}	4.96 ± 0.17^{c}	4.96 ± 0.17^{c}
Taste	4.93 ± 0.99^{b}	4.93 ± 0.99^{b}	4.93 ± 0.99^{b}
Overall Acceptability	5.40 ± 0.48^{b}	5.40 ± 0.48^{b}	5.40 ± 0.48^{b}

Values are means of 30 replicates ± standard error
Means with the same letters in same column are not significantly different from each other

The statistical analysis of sensory scores showed significant difference ($p<0.05$) for overall acceptability of drinks during the storage of 12 weeks. From the overall acceptance rating, maximum mean score was attained by T_3 (6% of bael pulp) followed by T_4 (8% of bael pulp) while minimum score was recorded in T_2 (4% of bael pulp). 6% of bael pulp containing RTS beverage was selected as the most preferred formulation according to the sensory evaluation.

3.4 Microbial Studies

There was no bacterial growth was observed in the RTS beverage samples which were stored at ambient condition after 12th weeks of storage. This may due to the inhibition of microbial growth by Potassium metabisulphite and the low pH levels of RTS fruit beverage. The sulphites inhibit yeasts, moulds and bacteria (Doughari and Elmahmood, 2007). Carter *et al*. (2007) reported that many products that could safely be maintained sterile by a pasteurization process alone could be doubly preserved by the addition of potassium metabisulphite. Pasteurization to prevent foodborne illness also provides higher quality and a longer shelf life because of the simultaneous reduction in spoilage microflora. Therefore, the heat treatment was sufficient to destroy initial microbial load in the fruit drinks.

4. Conclusions

The bael fruit is known for its medicinal properties and is one of the most nutritious fruits. This research was done to utilize the bael fruit pulp to increase the shelf life through the development of Ready-To-Serve (RTS) beverage. The results of the study showed that 6% of bael pulp RTS beverage was selected as most preferred treatment at the end of preparation based on the chemical and organoleptic point of view. This ready to serve beverage can be stored at 30±1°C of temperature and 70-75% relative humidity up to 12 weeks without any significant changes, which also has no deleterious effect on consumers.

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