

DEVELOPMENT AND QUALITY EVALUATION OF READY-TO-SERVE (RTS) FUNCTIONAL BEVERAGE PREPARED FROM Bael (*Aegle marmelos* L.) FRUIT

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ABSTRACT

A research study was carried out to develop a RTS functional beverage by exploiting the medicinal, nutritional and organoleptic properties of bael fruit pulp. Six treatments of bael RTS beverage such as 2, 4, 6, 8, 10 and 12 % (w/w) of pulp concentration were prepared with sugar, citric acid, distilled water and 70ppm of potassium metabisulphite (KMS), considering the findings of preliminary studies and Sri Lankan Standards (SLS 729) for RTS fruit beverage. The prepared RTS were assessed to determine the physico-chemical properties, organoleptic characteristics and microbial safety. The results of the physico-chemical analysis revealed that ascorbic acid and total sugar contents increased from 3.63 to 11.9 mg/100 ml and 11.92 to 15.04 % respectively while the titratable acidity and total soluble solids remained constant; at 0.5 %, 10° Brix, respectively with the increase in the pulp concentration from 2 to 12 %. Results of the sensory evaluation showed that there were significant differences ($p < 0.05$) between treatments in terms of colour, aroma, consistency, taste and overall acceptability. There were no microorganisms observed in the RTS beverages. From the results of quality assessments, the formulated bael fruit pulp RTS beverage with 6% of pulp concentration was found to be superior and could be suitable for consumption up to a minimum period of 12 weeks without any significant changes in the quality characteristics.

Keywords: Bael fruit, RTS drink, functional beverage, microbial safety, quality attributes.

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1.0 INTRODUCTION

Now-a-days, consumers are becoming increasingly conscious of the health and nutritional aspects of their food basket. The current tendency is to avoid chemicals and synthetic foods and preference for nutrition through natural resources. The underutilized fruits, namely, bael (*Aegle marmelos*), anola (*Emblica officinalis*), jamun (*Syzygium cumini*), passion fruit (*Passiflora edulis*), phalsa (*Grewia asiatica*), pomegranate (*Punica granatum*), pumpkin (*Cucurbita pepo*), tamarind (*Tamarindus indica*), wood apple (*Limonia acidissima*), etc. are a major source of livelihood for the rural poor and play an important role in overcoming the problem of malnutrition [1]. They are generally accepted as being rich in vitamins, minerals and dietary fiber and, therefore, are an essential ingredient of a healthy diet.

Of the wide variety of processed foods available in the market, RTS beverages are very popular. They are nutritionally rich and are also well-liked by the consumers due to their refreshing flavors and taste. Recognition of the nutritional benefits of the fruit based beverages has led to a gradual but distinct shift of the customer preference from aerated drinks to fruit beverages. The bael fruit pulp contains many functional and bioactive compounds such as carotenoids, phenolic, alkaloids, coumarins, flavonoids, terpenoids, and other antioxidants which may protect us against chronic diseases such as, cancers, cardiovascular diseases, asthma and inflammation [2].

The bael fruit is more popular as medicine than as food [3]. The ripe fruit is of considerable medical value when it just begins to ripen. The ripe fruit is aromatic, astringent, cooling and laxative. The unripe or half ripe fruit is stomachic, anti-scorbutic, and digestive. Ripe bael fruit is considered as the best of all laxatives [4]. It cleans and tones up the intestines. Its regular use for two or three months can throw out even the old accumulated fecal matter. The pulp of the ripe fruit can also be taken without the addition of milk or sugar and about 60 g of fruit will suffice for an adult [5]. The unripe or half ripe fruit is perhaps, the most effective food remedy for chronic diarrhoea and dysentery. The unripe dried fruit is digestive, stomachic and used to cure diarrhea, dysentery hepatitis and tuberculosis, sweet drink prepared from the pulp of fruits produce a soothing effect on the patients who have just recovered from bacillary dysentery. The ripe fruit is a good and simple cure for dyspepsia [6]. Dried bael fruit or its powder provides the better results. An infusion of bael leaves is regarded as an effective food remedy for peptic ulcer. The bael fruit taken in the form

of beverage has also great healing properties because of its mucilage content. This substance forms a coating on the stomach mucosa and thus helps in healing of ulcers [4]. The different parts of bael tree are used for various therapeutic purposes, such as treatment of asthma, anemia, fractures, healing of wounds, swollen joints, high blood pressure, jaundice, diarrhoea healthy mind and brain typhoid troubles during pregnancy [7]. Roots have anti-diarrhoeic, antidote to snake venom, anti-inflammatory and wound healing properties. Therefore, the present research study was undertaken to formulate a Ready-To-Serve (RTS) beverage using bael fruit juice at different pulp concentrations and to evaluate the physico-chemical, sensory and microbial properties in order to study the quality of RTS beverages.

2.0 MATERIALS AND METHODS

2.1 Preparation of RTS beverages of Bael fruit

The ripe bael fruits (*Variety Rampuri*) were washed with tap water and broken by hammering due to its hard outer shell. 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 by using a burner up to 70 °C for 1 min and cooled. Pulp free from seeds and fibers were then obtained by passing through 800µm stainless steel sieve. The amount of bael fruit pulp was changed to prepare different pulp concentration of RTS beverage. The experimental formulations are given below:

2.2 Experimental Formulations

T₁ - RTS beverage with 2 % (w/w) bael fruit pulp concentration

T₂ - RTS beverage with 4 % (w/w) bael fruit pulp concentration

T₃ - RTS beverage with 6 % (w/w) bael fruit pulp concentration

T₄ - RTS beverage with 8 % (w/w) bael fruit pulp concentration

T₅ - RTS beverage with 10 % (w/w) bael fruit pulp concentration

T₆ - RTS beverage with 12 % (w/w) bael fruit pulp concentration

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 bael fruit pulp in RTS beverage. It was removed from the gas burner and was allowed to cool for 10

min at the room temperature of 28-30 °C. Subsequently, 70 ppm of potassium metabisulphite (BDH Chemicals Company, UK) were added and mixed well with the solution. Just after addition of potassium metabisulphite, hot filling was done into already oven sterilized (160 °C for 45 min) glass bottles and capped with stopper immediately. The sealed bottles were put on the hot water bath at 80°C for 30 min for pasteurization. Then bottles were removed from the water bath (YCW-010E, Gemmy Industrial Corp, Taiwan) and allowed to cool.

2.3 Determination of physico-chemical properties

The Nutritional characteristics were analyzed using the recommended AOAC [8] methods. Titratable acidity, ascorbic acid, total soluble solids (TSS) and total sugars were analyzed after formulation of the beverages. Total sugar of RTS beverages were assessed by Lane-Eynon method. Analysis were carried out for three replicates for each parameter.

2.4 Determination of sensory properties

Sensory evaluation was conducted to evaluate the organoleptic properties of the sample using a sensory panel consisting of 30 semi-trained panelists. The colour, aroma, taste, consistency and overall acceptability were evaluated using a seven-point hedonic scale. A questionnaire was used for the sensory evaluation. Tests were conducted between 10.00 to 11.00 am for morning session and 2.00 to 3.00 pm for evening session for the effective assessment by the panelists. Each panelist was asked to evaluate the samples from different treatment which were arranged randomly to assess the organoleptic properties. The samples were served to the panelists at 10 °C as this temperature is commonly used for cold drinks.

2.5 Determination of microbial properties

Total plate count method was performed for the Ready-To-Serve bael fruit beverage samples after the formulation. Standard plating on Nutrient Agar (Foodchem International Corporation, USA) known as total plate count method was carried out to study the microbial properties of the prepared RTS beverages. The RTS beverage formulations were used to prepare the dilutions of 10^{-1} and 10^{-2} and microbial counts were triplicated. The total plate count was determined by counting the colonies formed with microorganisms.

2.6 Statistical Analysis

Data of the physico-chemical parameters were analyzed by Analysis of Variance (ANOVA) ($\alpha = 0.05$) and mean separation was done with Duncan's Multiple range Test

(DMRT). Data related to sensory evaluation were analyzed using the Tukey's Studentized Range test. Both physico-chemical and organoleptic analysis was done through Statistical Analysis System (SAS 9.1) software statistical package.

3.0 RESULTS AND DISCUSSION

Bael pulp is a good source of protein, fat, minerals, crude fibre and energy. They are rich source of carbohydrates and dietary fibre. Results of nutritional composition of bael fruit pulp are given in Table 1. Nutritional composition of Bael fruit pulp are closely related with the results obtained by [9] in the experiment on physico-chemical analysis of bael (*Aegle Marmelos*) fruit pulp, seed and pericarp. In their study, they have reported that moisture, fibre, titratable acidity and ascorbic acid content of the fruit pulp respectively, 61.06%, 4.8%, 0.6% and 7.96%.

Table 1: Nutritional Composition of Bael Fruit Pulp

Nutritional Composition	Amount
Moisture (%)	62.1±0.43
Protein (%)	4.62±0.13
Fat (%)	0.48±0.06
Fibre (%)	5.97±0.12
Ash (%)	2.62±0.11
pH	5.78±0.02
Total Soluble Solids (TSS) (° Brix)	16.0±0.2
Titrate Acid (as % citric acid)	0.80±0.01
Ascorbic acid (mg/100 g)	8.89±0.03
Total sugar (%)	31.2±0.4

The values are means of triplicates± Standard error

3.1 Physico-Chemical properties of freshly prepared RTS Beverages

The results of physico-chemical analysis with respects to titratable acidity, ascorbic acid, total sugar and total soluble solids conducted in the formulation of freshly prepared RTS beverages using bael fruit pulp are given below.

3.1.1 Ascorbic acid content

The importance of ascorbic acid in human health is well understood, particularly as an antioxidant and in collagen synthesis [10]. The ascorbic acid content increasing significantly from 3.63 to 11.9 mg/100 ml with an increase in the concentration of bael pulp from 2 to 12 % in the RTS beverage as shown in the Figure 1. This increasing trend while blending of two different fruit juices is in agreement with a similar study [11] who also observed increasing ascorbic acid content in their study on bael-guava blended beverage as the bale fruit pulp concentration increased. The highest mean value for ascorbic acid content was observed in freshly made T₆ Treatment (12 % of bael pulp) followed by T₅ (10 % of bael pulp) and T₄ (8 % of bael pulp) whereas the lowest mean value was observed in freshly made T₁ Treatment (2 % of bael pulp).

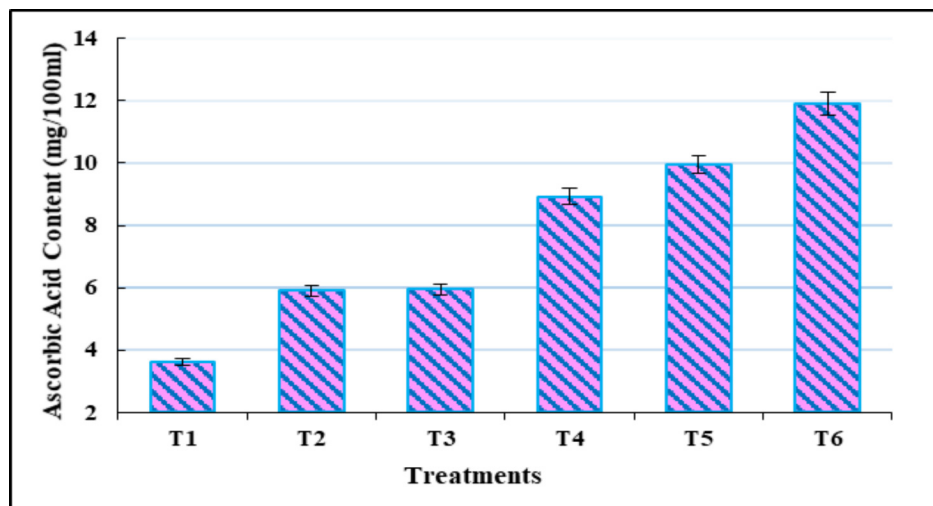


Figure 1: Ascorbic Acid Content of Freshly made Bael RTS Beverages

The values are means of triplicates

Vertical bars indicate the standard errors

(T₁-RTS beverage with 2 % bael fruit pulp concentration; T₂-RTS beverage with 4% bael fruit pulp concentration; T₃-RTS beverage with 6 % bael fruit pulp concentration; T₄-RTS beverage with 8% bael fruit pulp concentration; T₅-RTS beverage with 10 % bael fruit pulp concentration; T₆-RTS beverage with 12% bael fruit pulp concentration)

3.1.2 Total sugar content

Sugars, acids and their interactions are important to sweetness, sourness and overall acceptability in RTS beverages. The total sugar increased significantly ($p < 0.05$) with the increase in the concentration of bael pulp from 2 to 12 % in the RTS beverage as

shown in the Figure 2. According to DMRT, the total sugar was significantly ($p < 0.05$) different among formulations.

The formulation T_6 had the highest sugar content of 15.04 % and the formulation T_1 had the lowest value of 11.92 %. These finding was closely related with that of [12] in the preparation of ready-to-serve (RTS) beverage from multi-fruit juice and storage study at room and refrigeration condition in which total sugar content increased from 11.41 to 15.22 % when the bale fruit pulp concentration increased from 5 to 15 %.

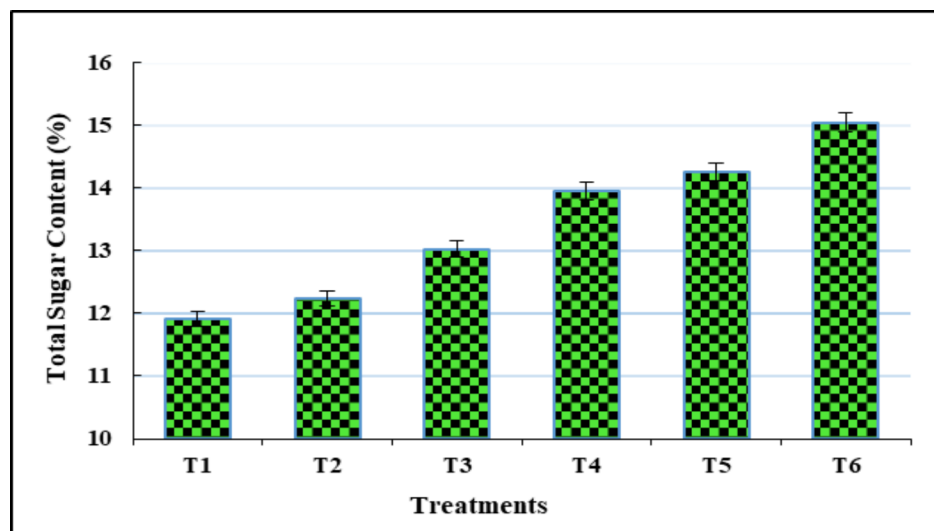


Figure 2: Total Sugar Content of Freshly made Bael RTS Beverage

The values are means of triplicates

Vertical bars indicate the standard errors

(T_1 -RTS beverage with 2% bael fruit pulp concentration; T_2 -RTS beverage with 4 % bael fruit pulp concentration; T_3 -RTS beverage with 6 % bael fruit pulp concentration; T_4 -RTS beverage with 8 % bael fruit pulp concentration; T_5 -RTS beverage with 10 % bael fruit pulp concentration; T_6 -RTS beverage with 12 % bael fruit pulp concentration)

3.1.3 Titratable acidity

Titrateable acidity is a direct proportional measure of shelf-life of the product and guard against the attack of microorganism [13]. The titrateable acidity of RTS beverage formulations was adjusted at the time of preparation by adding water and citric acid. The mean values for different treatments were 0.5 %. According to the Sri Lanka Standard Institute Specifications, the limits of acidity for RTS preparation are 0.5-1 %

as anhydrous citric acid [14]. In the present study, the titratable acidity was found to be non-significant ($p>0.05$) among treatments, not changed with an increase in the concentration of bael pulp from 2 to 12 %. Similar results were reported in which the titratable acidity was not changed during the formulations by [15] in the experiment on preparation, physico-chemical and sensory assessment of papaw-red ginger food drink.

3.1.4 Total Soluble Solids (TSS)

The recommended TSS for commercial RTS production is 10° Brix [14]. The TSS of RTS beverage formulations was adjusted at the time of preparation by adding water. The mean values for different treatments were 10°Brix. In this study, TSS was found to be non-significant ($p>0.05$) among treatments, not changed with an increase in the concentration of bael pulp from 2 to 12 %. Similar trend was observed and reported by [16] in the study on preparation of ready-to-serve (RTS) beverage from palmyrah fruit pulp RTS beverages.

3.2 Sensory properties of freshly made RTS beverages

The sensory evaluation of the RTS beverage revealed that, there were significant differences ($p<0.05$) between the treatments as the concentration bael pulp was increased from 2 to 12 % for colour, aroma, taste, consistency and overall acceptability at 5% level of significance according to General Linear models (GLM). Mean values of treatments according to Tukey's Studentized Range Test are shown in Table 2.

Scores of overall acceptability of freshly made formulations showed that, the treatment with 6 % bael pulp (T_3) had the highest mean value of 6.17. The RTS beverage prepared from 12 % bael pulp (T_6) had the lowest mean value of 3.97. There were no significant differences ($p>0.05$) between the treatments T_5 and T_6 as shown in the Table 2, the treatment T_3 had the highest score in aroma, taste, consistency and overall acceptability among the other treatments. Therefore, the most preferred treatment was T_3 which consists of 6 % bael pulp concentration. Our findings are in agreement with the research of [12].

Table 2: Sensory Qualities of Freshly made Bael RTS Beverage

Formulations	Colour	Aroma	Consistency	Taste	Overall acceptability
T ₁	3.03±0.18 ^c	2.07±0.25 ^d	3.77±0.43 ^c	3.10±0.31 ^d	3.97±0.32 ^c
T ₂	6.07±0.25 ^b	6.03±0.18 ^{ab}	5.13±0.35 ^b	5.73±0.45 ^c	5.90±0.31 ^b
T ₃	6.93±0.25 ^a	6.13±0.43 ^a	6.97±0.18 ^a	6.87±0.85 ^a	6.17±0.38 ^a
T ₄	5.97±0.18 ^b	5.87±0.35 ^b	5.90±0.31 ^c	5.03±0.31 ^b	6.10±0.31 ^{ab}
T ₅	5.07±0.25 ^c	3.10±0.31 ^c	3.07±0.25 ^d	4.13±0.35 ^e	3.83±0.38 ^c
T ₆	4.07±0.25 ^d	3.13±0.35 ^c	3.73±0.45 ^d	4.03±0.18 ^d	3.93±0.25 ^c

The values are means of 30 replicates ± standard error

The means with the same letters in same column are not significantly different from each other at 5 % level based on Tukey's Test

(T₁-RTS beverage with 2 % bael fruit pulp concentration; T₂-RTS beverage with 4 % bael fruit pulp concentration; T₃-RTS beverage with 6 % bael fruit pulp concentration; T₄-RTS beverage with 8% bael fruit pulp concentration; T₅-RTS beverage with 10 % bael fruit pulp concentration; T₆-RTS beverage with 12 % bael fruit pulp concentration)

3.3 Microbial properties

The results of microbial analysis revealed no microbial growth in freshly made RTS beverages. This may be due to the inhibition of microbial growth by potassium metabisulphite and the low pH levels of 2-4 of RTS fruit beverage. Due to their low pH value of soft drinks and fruit juices, pH 2.5-3.8 inhibits most bacteria [17]. Acidified foods require heat treatment sufficient to kill the non-spore forming bacteria (*Acetobacter*) and fungi (*Saccharomyces* spp.) that could spoil the product as the temperature of the heat treatment increases population of microbes decreases [18].

4.0 CONCLUSIONS

This research was designed to utilize the bael fruit pulp to formulate value added Ready-To-Serve (RTS) beverage. The range of bael pulp concentration used for the development of RTS beverage was 2-12 %. RTS beverage formulates with 6 % of bael pulp consists of 5.95 mg/100ml ascorbic acid, 13.02 % total sugar, 0.5 % titratable acidity and 10° Brix total soluble solid. The RTS beverage with 6 % bael pulp which was found to be the best treatment in physico-chemical and organoleptic quality and microbial analysis compared to other combinations.

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