PREPARATION OF READY-TO-SERVE (RTS) BEVERAGE FROM PALMYRAH (*Borassus flabellifer* L.) FRUIT PULP

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ABSTRACT

A study was conducted to develop a ready-to-serve (RTS) beverage using palmyrah fruit pulp at different concentrations of 8, 10, 12, 14 and 16% with sugar, citric acid, distilled water and potassium metabisulphite, considering the recommendations of Sri Lanka standards for RTS fruit beverages. The results of physico-chemical analysis revealed that titrable acidity, ascorbic acid and total sugar increased while the pH decreased and total soluble solids remained same as 15^{o}Brix with the increase in the pulp concentration from 8 to 16%. The findings of microbial studies showed no total plate counts in the formulated beverages. Samples subjected to sensory evaluation showed that there were significant differences between treatments with respects to colour, aroma, taste, consistency and overall acceptability. From the results of quality assessments, the formulated beverage with 12% of pulp concentration was found to be superior in quality and could be stored at 30±2°C for a minimum period of six months without any significant changes in quality.

Keywords: *Palmyrah, Physico-chemical analysis, Ready-to-serve beverage, Sensory evaluation.*

INTRODUCTION

Palmyrah (*Borassus flabellifer* L.) is an ancient palm belonging to the family Palmae and it is widely distributed throughout the tropics, mainly in the arid zones. It is a feature of the landscape in Northern and Eastern regions of Sri Lanka where it is called the tree of life. The palm is very versatile and it can produce several utilizable products. The fruit pulp of Palmyrah is rich in non-crystallisable sugar both in the form of sucrose and invert sugars. It is a good source of vitamin A and C. The pulp also contains appreciable amounts of pectin. The total production of palmyrah fruit pulp (PFP) is a fraction of its total potential of 10-15 kilo tonnes annually (Jansz *et al.*, 2002). It is clear that only a fraction of PFP is utilized and a major part is under-utilized. The main reason for under-utilization of the fruit pulp is its characteristic bitter taste which limits the extensive use of the PFP as a beverage (Jansz *et al*., 1994). However, the presence of natural colour pigments, its volatile constituents and the sweet taste serves as positive factors in formulating a beverage of high organoleptic properties after removing the bitterness from the PFP.

A research on the fruit pulp indicated that the bitter taste is due to a steroidal saponin of Flabelliferin II (Theivendirarajah, 1992). It contains 2 glucoses and 2 rhamnoses in its carbohydrate molecule and has a molecular weight of 1030 (Jansz *et al.*, 1994). Debittering is a key step for wider utilization of PFP in the form of drinks, jams, cordials etc. There are traditional methods, including heating the PFP over hot coals as well as scientific methods, using enzymes namely *naringinase* (mixture of *β-glycosidase* and *β-rhamnosidase*) or heat stable *α-amylase* (Ariyasena, 2002). A variety of soft drinks are being presently produced in the

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country, e.g. sweetened carbonated soft drinks, still beverages containing fruit juice/pulp and soda water. Among these, the share of fruit juice based beverages is presently quite small as compared to synthetic carbonated drinks. Gradually there is a distinct shift towards consumption of fruit juice based beverages for obvious advantages of the higher nutritional, medicinal and calorie values over the synthetic aerated beverages.

The process of manufacture is simple and standardized. Under commercial condition, preserved fruit pulps, sugar syrup, citric acid, preservatives, colouring agents and flavours are blended according to the formulation, homogenized and bottled. Afterwards the bottles are processed in heating retorts and cooled.Ready-to-serve (RTS) fruit drink is a type of fruit beverage which contains at least 10% fruit and 10% total soluble solids besides approximately 0.3% 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. Colouring matter and clarifying agents can be added to the product, to increase attractiveness and addition of flavouring ingredients is allowed only in the product prepared using mango. During the season, the pulp or juice of the fruits can be preserved suitably and utilized later for preparing RTS beverages.

Based on the above, this study aims to prepare an acceptable quality of RTS beverage having increased shelf life by using palmyrah fruit pulp at different concentrations and to determine the most suitable concentration of pulp for the commercial preparation of palmyrah RTS beverage with longer shelf life.

MATERIALS AND METHODS

Preparation of Palmyrah RTS Beverage

RTS beverages with pulp concentrations of 8, 10, 12, 14 and 16% were prepared from the palmyrah fruits. Before the preparation of RTS beverage blends, the total soluble solids (TSS) and acidity of palmyrah pulp were determined and maintained as 15°Brix and 0.3% respectively at the time of preparation in all the formulated blends. Five recipes were prepared (recipe one – 8% pulp, recipe two – 10% pulp, recipe three – 12% pulp, recipe four – 14% pulp and recipe five – 16% pulp) with 15% of sugar, 0.3% of acidity as % of anhydrous citric acid and 70 ppm of potassium metabisulphite (KMS) in one litre of distilled water. The undamaged, disease free, mature and ripe palmyrah fruits (variety AL-08) were obtained from Palmyrah Development Board in the Batticaloa District.

The collected fruits were washed and peeled. The pulp was extracted from the fruits manually with distilled water to the ratio of 1:1 (v/v). The extracted pulp was passed through a strainer of 300 µ mesh and treated with gelatin at the rate of 0.45 g/100 ml to clarify the pulp by precipitating the pectin (Inayang and Abah, 1997). The pulp was then filtered with a muslin cloth to obtain the clarified pulp. The clarified palmyrah pulp was weighed and heated at 40°C for 20 minutes to reduce the bitterness and astringent taste.

The requisite amount of sugar and citric acid dissolved in distilled water were added to beverage blends, and heated at 85^{o}C for 20 minutes for pasteurization. It was removed from the fire and allowed to cool for 10 minutes. Subsequently KMS was added and mixed well with the solution. Just after addition of KMS, hot filling was done into already sterilized

glass bottles and capped with crown cork immediately. The sealed bottles were put in the hot water bath at 80^{o}C for 30 minutes. Then bottles were removed from the water bath and allowed to cool. At the end of the preparation, the physico-chemical, microbial and sensory analyses were carried out for each sample.

Table 01: Concentration of Palmyrah Pulp in RTS Beverages

Treatment	Palmyrah Pulp (%)
T_1	08
T_2	10
T_3	12
T_4	14
T_5	16

Physico-Chemical Qualities

Physico-chemical qualities of the RTS beverage were analyzed using recommended standard AOAC methods (2002). The titrable acidity was determined by titrating the RTS beverages of various pulp concentrations with standard alkaline and the results were expressed as percentage of anhydrous citric acid. Ascorbic acid content of beverages was titrimetrically estimated by indophenol dye method. The pH was determined by an Electronic pH meter (Mettler Toledo, UK). Lane-Eynon method was performed to determine the total sugar content of the beverages. Hand-held refractometer (ATAGO-S-28E model) was used to estimate the total soluble solids (TSS) and the values were expressed as °Brix. The analyses were replicated thrice.

Microbial Test

The microbial assessment was carried out by estimating total plate count according to the method described by Arachchi (2003) in raw mango RTS. The total plate count was determined by observing the colonies formed especially bacteria.

Sensory Evaluation

In sensory evaluation, the samples were subjected to seven-point hedonic scale test and the acceptability of samples was judged by 200 untrained members to determine consumer preference. The sensory characteristics such as colour, aroma, taste, consistency and overall acceptability of the RTS beverages were judged by the panelists.

Shelf Life Evaluation

The prepared RTS beverage samples were stored at room temperature of 30±2°C for shelf life evaluation. The observations were made on samples to evaluate the duration taken for spoilage and off-flavour development.

Statistical Analysis

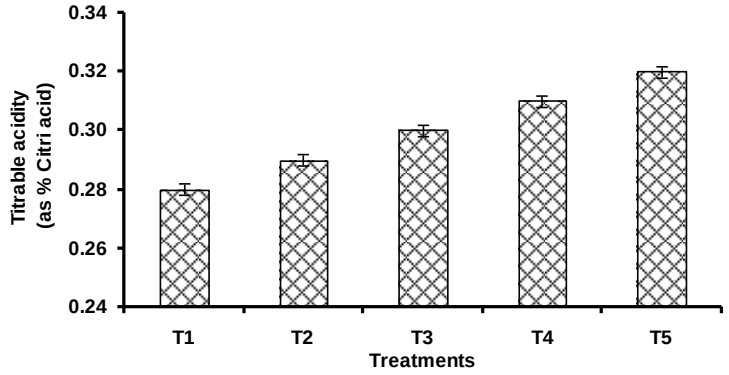
Data obtained in physico-chemical analysis were subjected to Analysis of Variance (ANOVA) and mean separation was done with Duncan's Multiple Range Test (DMRT). Descriptive statistics was done on sensory attributes and the means were compared using the Tukey's test ($p<0.05$).

RESULTS AND DISCUSSION

Physico-Chemical Qualities

The results of physico-chemical analysis with respects to titrable acidity, ascorbic acid, pH, total sugar and total soluble solids conducted in the formulation of palmyrah RTS beverages are given below.

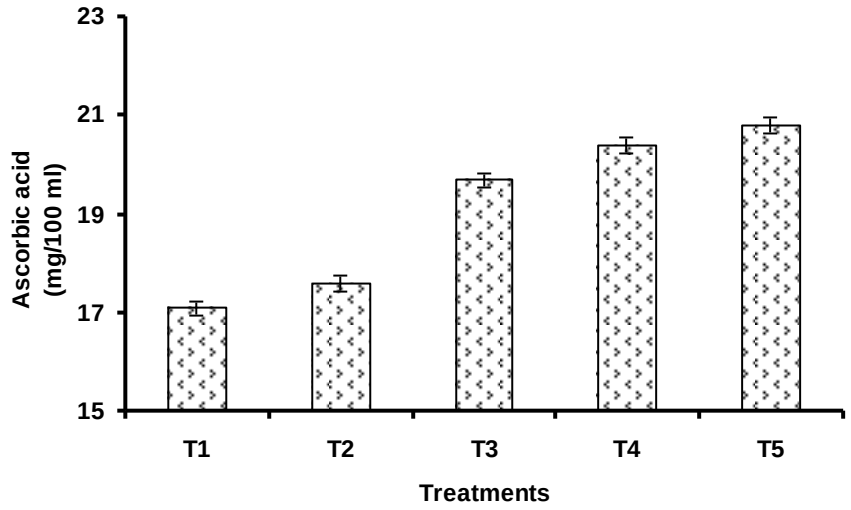
The titrable acidity of samples ranges between 0.28-0.32% citric acid equivalent of beverage. Acidity value increased with the increase in the concentration of palmyrah pulp from 8 to 16% as shown in Figure 01. This can be attributed partly to the contribution of the inherent acid naturally present in the palmyrah pulp. According to Theivendirarajah (1992), the inherent acidity of palmyrah pulp is mainly attributed to tartaric acid at the concentration of 2.35 g/litre. Titrable acidity of the RTS beverage having 12% of palmyrah pulp was found to be 0.3% which is similar to the commercial recommendation of acidity (0.3%) for RTS preparation (Srivastava and Kumar, 1998).



Values are means of triplicates.
Vertical bars indicate the standard errors.
(T_1 - RTS beverage with 8% of pulp concentration; T_2 - RTS beverage with 10% of pulp concentration; T_3 - RTS beverage with 12% of pulp concentration; T_4 - RTS beverage with 14% of pulp concentration; T_5 - RTS beverage with 16% of pulp concentration)

Figure 01: Titrable Acidity of the Prepared Palmyrah RTS Beverages

The Figure 02 indicates the changes in ascorbic acid content of the treatments as the concentration of pulp increased from 8 to 16%. The ascorbic acid content increased significantly from 17.1 mg/100 ml in the RTS beverage formulated using 8% of pulp concentration to 20.8 mg/100 ml in the RTS beverage made with 16% of pulp concentration. The increasing trend of ascorbic acid content was observed with the increasing concentration of palmyrah pulp in the beverages because the palmyrah pulp is rich in vitamin C (ascorbic acid). The pulp contained an ascorbic acid content of 27.5 mg/100 ml. This was supported by Jeyaratnam (1986) that the ascorbic acid content of palmyrah pulp ranges from 27.0 to 28.5 mg/100 ml. Nidhi *et al*. (2008) also observed this same trend in their study on bael-guava blended beverage.



Values are means of triplicates.
Vertical bars indicate the standard errors.
(T_1 - RTS beverage with 8% of pulp concentration; T_2 - RTS beverage with 10% of pulp concentration; T_3 - RTS beverage with 12% of pulp concentration; T_4 - RTS beverage with 14% of pulp concentration; T_5 - RTS beverage with 16% of pulp concentration)

Figure 02: Ascorbic Acid Content of the Developed Palmyrah RTS Beverages

The pH reduced significantly ($p<0.05$) with increase in concentration of pulp in RTS beverages as shown in Table 02. The highest pH 3.17 was obtained in the RTS beverage with 8% of pulp. The RTS beverage formulated using 16% of palmyrah pulp had the least mean value of 3.12. The results generally showed that higher the acidity, lower the pH of the palmyrah RTS beverages. A similar study conducted by Abbo *et al*. (2006) revealed that there is a corresponding reduction in pH as the acidity increased in Soursop juice. The pH of prepared palmyrah RTS beverages was below 4. This was supported by Cole *et al*. (2000) that the pH of most soft drinks and juices is less than 4.

Table 02: The pH, Total Sugar and TSS of the Formulated Palmyrah RTS Beverages

Values are means of triplicates ± standard error.

Treatments	pH	Total Sugar (%)	TSS (°Brix)
T_1	3.17 ± 0.003^{a}	16.6 ± 0.03^{e}	15.0 ± 0.03^{a}
T_2	3.16 ± 0.003^{a}	17.2 ± 0.07^{d}	15.0 ± 0.09^{a}
T_3	3.14 ± 0.006^{b}	18.9 ± 0.03^{c}	15.0 ± 0.09^{a}
T_4	3.13 ± 0.003^{bc}	20.1 ± 0.07^{b}	15.0 ± 0.06^{a}
T_5	3.12 ± 0.003^{c}	21.9 ± 0.06^{a}	15.0 ± 0.03^{a}

Means in the each column followed by the same letters are not significantly different at $p<0.05$.
(T_1 - RTS beverage with 8% of pulp concentration; T_2 - RTS beverage with 10% of pulp concentration; T_3 - RTS beverage with 12% of pulp concentration; T_4 - RTS beverage with 14% of pulp concentration; T_5 - RTS beverage with 16% of pulp concentration

Total sugar significantly ($p<0.05$) differed between the treatments as given in Table 02. The highest mean value of 21.9% was obtained in the RTS beverage with 16% of palmyrah pulp and the RTS beverage with 8% of palmyrah pulp had the lowest mean value of 16.6% at 5% level of significance. Therefore, total sugar content of samples increased as the amount of added pulp increased. According to the report by Wills *et al*. (1996) the TSS:Acid ratio is often better related to palatability of the fruit products than either sugar or acid levels alone. The recommended TSS for commercial RTS production is 15°Brix (SLS 729:1985). The TSS of RTS beverage formulations was adjusted at the time of preparation. The mean values for different treatments were 15^{o}Brix is shown in the Table 02. In this study, TSS was found to be non-significant among treatments, not changed with an increase in the concentration of palmyrah pulp from 8 to 16%.

Microbial Test

The deterioration of fruit products is caused by physical, chemical and biological factors. Most significant changes in fruit products are due to biological factors especially micro-organisms.

The results of microbial test revealed that quality of formulated palmyrah RTS beverages was not deteriorated with microbial contamination. No bacterial growth was observed in the RTS beverages. Therefore, there was no total plate count found in these samples. The heat treatment was sufficient to destroy initial microbial load in the fruit beverages. 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. The sulphites inhibit yeasts, moulds and bacteria (Doughari and Elmahmood, 2007).

Sensory Qualities

The sensory evaluation of the formulated RTS beverage revealed that there were significant differences between the treatments as the concentration of palmyrah pulp was increased from 8 to 16% 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 03.

The high sensory scores for the sample implied higher preference of the particular sample. In term of colour, there were significant differences ($p<0.05$) between the treatments. However, the RTS beverage made with 12% of pulp (T_3) was rated as higher than the other treatments. Besides, there were no significant changes detected in the RTS formulations having 8 and 16% of pulp concentrations with respect to aroma due to lowest concentration of palmyrah pulp (8%) used in this preparation and highest concentration of palmyrah pulp (16%) was used in this RTS formulation respectively. The RTS formulations having 8 and 16% of pulp concentrations were also not significantly differed between them in term of taste however, the RTS beverage containing 16% of palmyrah pulp (T_5) was rated as poorest in taste because of astringent taste and off-flavor imparted to this formulation. In the case of consistency, the RTS beverage with 12% of palmyrah pulp (T_3) had the highest mean value and the least score found in the RTS beverage with 8% of palmyrah pulp (T_1) and significantly differed from the RTS beverage prepared using 10, 12 and 14% of pulp concentrations (T_2, T_3 and T_4) except the RTS having 16% of pulp (T_5). Overall acceptability assessment showed that the RTS formulation which had 12% of palmyrah pulp appeared to be the most superior among the samples while the RTS beverage made with 10 and 14% of pulp

were rated sub-superior to the RTS beverage having 12% of pulp. A similar study conducted by Priyanthi (2008) showed that RTS veralu drink could be produced using 12% of pulp was more acceptable than other combinations.

Table 03: Sensory Characteristics of Developed Palmyrah RTS Beverages

Treatments	Colour	Aroma	Taste	Consistency	Overall Acceptability
T_1	5.03 ± 0.18^{c}	4.97 ± 0.19^{c}	5.13 ± 0.21^{b}	4.80 ± 0.24^{b}	5.13 ± 0.22^{b}
T_2	5.73 ± 0.21^{abc}	5.73 ± 0.19^{ab}	5.63 ± 0.16^{ab}	5.30 ± 0.12^{ab}	5.67 ± 0.17^{b}
T_3	6.30 ± 0.14^{a}	6.20 ± 0.11^{a}	6.00 ± 0.14^{a}	5.80 ± 0.13^{a}	6.43 ± 0.11^{a}
T_4	5.93 ± 0.18^{ab}	5.50 ± 0.16^{bc}	5.40 ± 0.15^{ab}	5.43 ± 0.13^{ab}	5.47 ± 0.18^{b}
T_5	5.37 ± 0.21^{bc}	4.90 ± 0.21^{c}	5.03 ± 0.33^{b}	4.90 ± 0.30^{b}	5.03 ± 0.24^{b}

Values are means of 200 replicates ± standard error.
Means in the each column followed by the same letters are not significantly different at $p<0.05$.
(T_1 - RTS beverage with 8% of pulp concentration; T_2 - RTS beverage with 10% of pulp concentration; T_3 - RTS beverage with 12% of pulp concentration; T_4 - RTS beverage with 14% of pulp concentration; T_5 - RTS beverage with 16% of pulp concentration)

Shelf Life

The formulated palmyrah RTS beverages could be stored for six months at room temperature of 30±2°C without any significant changes in the quality characteristics. According to the microbial studies during shelf life evaluation, microbial colonies were not observed in the samples. Therefore, the formulated RTS beverage is safe for consumption for a minimum period of six months.

CONCLUSIONS

This research was designed to utilize the palmyrah fruit pulp (PFP), which is still largely regarded as an under-utilized product and there by increasing the shelf life of PFP through the process of development of ready-to-serve beverage (RTS). The findings of the study showed that the RTS beverage prepared using 12% of palmyrah pulp was selected as most preferred treatment based on the physico-chemical, microbial and organoleptical point of view. Palmyrah RTS beverage formulated with 12% of pulp found to contain optimum level of titrable acidity, total soluble solids and pH which are similar to the commercial recommendations for RTS fruit drinks specified by Sri Lanka Standard Institution. According to the microbial test, there were no bacterial colonies found in the products. Therefore, it is safe for human consumption. The overall acceptability rating stated that the RTS beverage made with 12% of palmyrah pulp was most preferred among the tested treatments. Based on the shelf life evaluation, the palmyrah RTS beverage

could be kept at 30±2°C for a period of six months without any significant quality changes. Therefore, the formulation of palmyrah RTS beverage is an economically feasible method which enables the consumers to purchase good quality products without any significant changes in the quality characteristics with extend the shelf life.

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