Development and Sensory Assessment of Ginger (*Zingiber officinale*), Lime (*Citrus aurantifolia*) and Palmyra Sugar Candy incorporated Ready-to-Serve Functional Beverage

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Abstract
Production and consumption of functional beverages has gained much attention as they offer a health benefits apart from the basic nutritional functions. A study was conducted to assess the physico-chemical and organoleptic characteristics of ginger varieties (*Local: Sidda* and *Chinese*) to select the most suitable variety for ready-to-serve (RTS) functional beverage preparation and to develop RTS functional beverage using ginger and lime juices in different concentrations, sweetened by 15% of palmyra sugar candy. The study revealed that local ginger variety is more preferred than the Chinese variety to formulate RTS beverages. Freshly made RTS beverage formulations showed increasing trend in titratable acidity from 0.22 to 0.52% (as % of citric acid), Total Soluble Solids from 12.6 to 16.8°Brix, ascorbic acid from 12.4 to 56.9 mg/100 ml, total sugar from 16.6 to 20.39% and decreasing trend in pH from 6.63 to 3.10 with increase in lime juice extract from 2 to 10%. There was no microbial colony formation observed in freshly prepared and stored treatments. The colour, aroma, pungency, taste and overall acceptability were significantly differ ($p<0.05$) among treatments with increasing the lime juice extract from 2 to 10%. RTS beverage with 12% of ginger juice blend with 8% lime juice, sweetened by Palmyra sugar candy was concluded to be superior in quality. The product can be stored at 30±1°C temperature and 70-75% of RH for a period of 12 weeks without any significant changes in quality.

Keywords: Ginger, Palmyra sugar candy, Physico-chemical analysis, RTS functional beverage, Sensory evaluation
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Introduction
Nowadays, most of the people in the world prefer to reduce the consumption of general synthetic beverages due to diabetes, hypertension, *atherosclerosis,* obesity etc. As people become health conscious, they seek for health promoting and disease preventing functional foods. Among functional foods, functional beverages have high possibility of containing phyto-chemicals, anti-oxidants and beneficial components extracted from fruits, vegetables and spices. There is a large market for functional beverages and the development of health beneficial beverage is a demand of time (Bhuiyan *et al.,* 2012).Ginger (*Zingiber officinale* Roscoe.) has been used as a spice from ancient times and due to its medicinal properties it also has been used in traditional and modern medicine to prevent infectious and non-infectious diseases. Hence, apart from its medicinal properties, ginger can also be used as an anti-oxidant supplement. The aroma of ginger is pleasant and spicy which make it indispensable in the manufacture of food and beverages in the food industry. Lime *(Citrus aurantifolia*) is a fruit, acidic in nature and serves as rich source of vitamin C, citric acid, sugar, certain minerals like calcium and phosphorus. Lime has citric acid which acts as a natural preservative. Palmyra sugar candy is the direct product obtained from processing of unfermented Palmyra sap and can be used as a sweetener in functional beverage while it has medicinal properties and low glycaemic index compared to cane sugar. It is clear that the use of natural ingredients in the functional beverages makes them more acceptable to health conscious customers. Juice blending is one of the best methods to improve the nutritional quality of the juice. Therefore, physico-chemical and sensory assessment of ginger varieties and blends with various proportions of ginger and lime juices were carried out to select the best ginger variety for formulation of RTS beverages and to determine the most acceptable blend with better organoleptic properties and shelf-life of the combinations.

Materials and Methods
Materials Collection
Rhizomes of ginger (*Local* and *Chinese* variety) and lime fruits were obtained from commercial grower in the Batticaloa district. Palmyra sugar candy was purchased from Palmyra Research Institute (PRI), Jaffna, Sri Lanka.

Physico-chemical, Microbial and Sensory Analysis
Physico-chemical analysis was done using recommended standard AOAC methods (2002).

The weight of randomly selected ginger rhizomes was weighted by using Electric balance (METTER PJ 300). Juice percentage was determined by using following formula.

$$\text{Juice \%} = \frac{\text{Weight of the juice}}{\text{Weight of peeled ginger rhizomes}} \times 100$$

The Total Soluble Solids (TSS) was measured using the hand held refractrometer (ATAGO-S-28E). The pH was measured using Digital pH meter (HANNA HI 98130). The titratable acidity was determined by titrating the juices with standard NaOH and the results were expressed as % of citric acid. Ascorbic acid was estimated by indophenol dye method and total sugar was determined by Lane-Eynon method. The total plate count method was performed to find out the microbial load of treatments and the counts were taken at day on preparation and the end of storage period. Each parameter was triplicated during analysing. Sensory evaluation was conducted using 30 semi-trained panellists in a seven point hedonic scale testing using a questionnaire.

Juice extraction and preparation of RTS beverage formulations

Peeled ginger rhizomes were cut into small pieces and ground by electrical blender (Model Smeeth) and the juice was filtered through muslin cloth as per said by (Ahammed *et al.*, 2014) and lime juice was extracted by squeezing the lime by hand and it was filtered using muslin cloth. Experimental formulations for Ginger blend with Lime RTS functional beverage is shown below in Table1.

For the preparation of 100 ml functional beverage, requisite amount of palmyra sugar candy (15 g) was dissolved in 65 ml of portable water and it was mild heated to get palmyra sugar candy solution (PSCS). PSCS was strained by using muslin cloth and the ginger and lime juices were added with PSCS, and it was heated at 85°C for 20 min for pasteurization. Hot filling was done into already sterilized glass bottles.

Table 1: Experimental Formulations for RTS Beverage Preparation

Ingredients	Treatments					
	C	T_1	T_2	T_3	T_4	T_5
Ginger juice (%)	20	18	16	14	12	10
Lime juice (%)	0	2	4	6	8	10
Palmyra sugar candy (%)	15	15	15	15	15	15
Water (%)	65	65	65	65	65	65

C-Control, T1-Treatment 1, T_2-Treatment 2, T_3-Treatment 3, T_4-Treatment 4 and T_5-Treatment 5.

Statistical Analysis

The experiment was of a Complete Randomized Design. Data of the physico-chemical analysis was statistically analysed by Analysis of Variance ($\alpha = 0.05$) and mean separation was done with Ducan's Multiple Range Test (DMRT). Data related to sensory evaluation were analysed using the Friedman's Test. Both Physico-chemical and organoleptic analyses were done through Statistical Analysis System software version 9.1.

Results and Discussion

Physico-chemical Characteristics of Freshly Made RTS functional Beverages

Titratable acidity and pH

The titratable acidity increased with increasing concentration of lime juice in all RTS beverage treatments and the pH reduced significantly ($p<0.05$). The treatment Control (20% of ginger juice only) had lowest mean value for titratable acidity (0.22%) and highest mean value for pH (6.63) and the treatment with 10% ginger juice and 10% lime juice (T_5) had the highest mean value for titratable acidity (0.52%) and the least mean value (3.10) for pH immediately after preparation. This can be attributed partly to the contribution of the inherent acid naturally present in the lime juice. Similar trend has been reported by Daramola and Asunni (2007) in the experiment on preparation, physico-chemical and sensory assessment of pawpaw-red drink.

Ascorbic acid

The ascorbic acid content increased significantly ($p<0.05$) from 12.4 to 56.8 mg/100 ml with an increase in the concentration of lime juice from 2 to 10% in the RTS beverage as shown below in

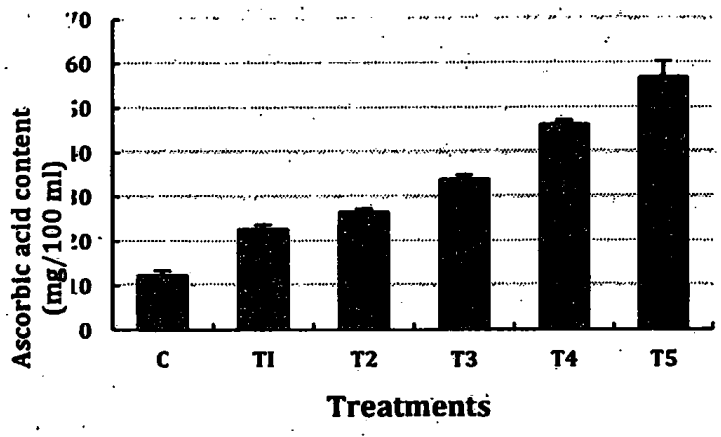

Figure 1: Ascorbic acid content of freshly made RTS functional beverage

The values are means of triplicates. Vertical bars indicate the standard errors.

the Figure 1. This increasing trend of ascorbic acid content is may be due to the high ascorbic acid content of lime juice compared to ginger juice.

Total Soluble Solids

The highest TSS value of 16.8°Brix was obtained in the treatment T_5 (RTS beverage with 10% of ginger juice and 10% of lime juice). The control treatment (C) had the least mean value of 12.6°Brix as the initial TSS content was high in lime juice than the ginger juice.

Total Sugar

The total sugar significantly ($p<0.05$) differed among treatments. The treatment T_5 had highest mean value (20.39%) and the treatment Control (RTS beverage with 20% ginger juice only) had a least mean value (16.6%) at 5% level of significance according to DMRT.

Sensory Analysis of Freshly Made RTS Beverages

According to Friedman's Test, compared to Control sample all other tested treatments had highest mean scores in sensory analysis (Table 2). There were significant differences ($p<0.05$) among treatments as the concentration of lime juice increased from 2% to 10% for colour, pungency, aroma, taste and overall acceptability Also increased. The RTS beverage with 20% ginger juice only (Control) had the lowest mean value for pungency which may be due to the absence of lime juice make the formulation more pungency. Taste and overall acceptability assessment showed that T_4 which had 12% of ginger juice with 8% of lime juice appeared to be most superior among the tested treatments.

Microbial Analysis

No any microbial colony formation was observed in freshly made and stored treatments at 30±1°C temperature and 70-75% of RH for a period of 12 weeks. This may be due to the anti-microbial properties of ginger and lime.

Conclusions

The physico-chemical and sensory studies of selected ginger varieties revealed that rhizomes of local ginger variety was the best for formulating ginger based beverages. RTS beverage with 12% of ginger juice and 08% juice is the best combination for the commercial preparation of ginger blend with lime, sweetened by palmyra sugar candy. To maintain the physico-chemical and organoleptic qualities without any significant changes it could be stored at 30±1°C room temperature and 70-75% of RH for 12 weeks without any added preservatives.

Table 2: Sensory evaluation scores of freshly made RTS formulations

Treatments	Colour	Aroma	Pungency	Taste	Overall Acceptability
C	4.1±0.23^{b}	4.2±0.15^{c}	2.2±0.11^{d}	3.2±0.16^{c}	4.0±0.14^{d}
T_1	4.3±0.18^{b}	5.1±0.13^{b}	4.3±0.12^{c}	5.4±0.12^{c}	4.7±0.19^{bc}
T_2	5.1±0.10^{a}	5.2±0.13^{b}	4.9±0.14^{ab}	5.9±0.10^{b}	5.7±0.13^{b}
T_3	5.1±0.12^{a}	5.1±0.09^{b}	5.5±0.10^{a}	6.3±0.09^{ab}	6.2±0.16^{a}
T_4	5.3±0.11^{a}	5.8±0.09^{a}	5.3±0.13^{a}	6.6±0.10^{a}	6.6±0.08^{a}
T_5	4.6±0.12^{ab}	4.8±0.10^{b}	4.7±0.15^{bc}	5.3±0.12^{c}	4.4±0.14^{b}

The values are means of 30 replicates ±standard error.
Sensory parameters were measured using a seven point hedonic scale.
The means with same letters in same column are not significantly differed from each other at 5% of level based on Friedman's Test.

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