



Development of Value-Added Ready-to-Serve Beverage Based on *Garcinia pedunculata*: A Super Fruit

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Abstract

Garcinia pedunculata is an indigenous plant and a seasonal fruit of Assam, North-east India with therapeutic potential. The aim of the present study was to develop a value-added RTS beverage to derive optimum commercial benefit to the local growers of Assam. The study was conducted with the following objectives- to develop and standardize RTS beverage from *Garcinia pedunculata*, to evaluate its organoleptic acceptability, to analyze its nutritional composition and shelf-life stability. Three variations of garcinia RTS beverages were formulated in the study viz., R1, R2 and R3 along with a control (C) and in each variant, different flavours such as chilli powder, jeera powder and ajwain powder were added. Using the standard 9-point hedonic scale, the RTS beverages were evaluated for their acceptability by 30 semi-trained panelists considering their sensory attributes. Also, the nutritional profiles were assessed and shelf-life estimation was done. The results revealed that garcinia RTS (R2 formulation) had maximum sensory attributes which was selected for further analysis and storage study. The TSS and pH value was recorded as 10 and 1.68 respectively which increased during storage. R2 reported a total sugar content of 24.68 g/100 g, Fe- 3.60 mg/100 g, K- 256.56 mg/100 g and vitamin C- 24.65 mg/100 g. The total phenolic content (TPC) and total flavonoid content (TFC) in R2 was



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reported to be 161.20 mg GAE/100 g and 312.86 mg CE/100 g respectively. DPPH and FRAP assay recorded the values of 59.31 (%inhibition) and 4.13 µmol Fe (II/g) respectively in R2. The shelf-life studies indicated no visible microbial growth but presence of colony formation was recorded. Thus, RTS beverage prepared from *Garcinia pedunculata* is highly nutritious and can be commercialized as micronutrient enriched value added drink, thereby making it available throughout the season, which shall further help in sustainable economic status of the local growers. 4.68 g/100 g, Fe- 3.60 mg/100 g, K- 256.56 mg/100 g and vitamin C- 24.65 mg/100 g. The total phenolic content (TPC) and total flavonoid content (TFC) in R2 was reported to be 161.20 mg GAE/100 g and 312.86 mg CE/100 g respectively. DPPH and FRAP assay recorded the values of 59.31 (%inhibition) and 4.13 µmol Fe (II/g) respectively in R2. The shelf-life studies indicated no visible microbial growth but presence of colony formation was recorded. Thus, RTS beverage prepared from *Garcinia pedunculata* is highly nutritious and can be commercialized as micronutrient enriched value added drink, thereby making it available throughout the season, which shall further help in sustainable economic status of the local growers.

Introduction

Garcinia pedunculata is a popular indigenous plant of Assam, North-east India, locally known as Borthekera in Assamese which possess immense medicinal value. It belongs to Clusiaceae family, has great dietary importance and is rich in bioactive compounds.^{1,2} It is also a good source of natural antioxidant as it exhibits significantly higher antioxidant activity which is attributed to its high phenolic and flavonoid, and ascorbic acid content.³ Majority of the rural inhabitants belonging to various parts of Assam use *Garcinia pedunculata* as a medicinal plant for healing different types of gastrointestinal disorders; garcinia juice, prepared from dried pulp mixed with water is used as medicine to treat different stomach related diseases.⁴ Due to lack of awareness of market demand and knowledge of value addition, many of such underutilized fruits remain unexploited despite therapeutic properties.⁵ *Garcinia pedunculata* is one such fruit which is underutilized due to seasonal availability and low shelf life. If utilized properly, this medicinally and nutritionally valuable Garcinia fruit can be processed into a variety of food products.^{1,6} Value-added products developed from underutilized fruits will improve their economic value and marketing opportunities, along with enhancement of shelf-life. Their adoption on commercial level can generate employment opportunities thereby contributing to sustainable economic development of the local

growers.⁷ Being rich in pharmacological properties and bioactive components, garcinia fruit could be standardized in making refreshing drink and other food products which could be commercialized at the large scale and made easily accessible for the consumers.⁸

Therefore, the present investigation was aimed to develop ready-to-serve (RTS) beverage from *Garcinia pedunculata*, keeping in view the therapeutic properties of these fruits. The objective of the study was to develop and standardize RTS beverage from *Garcinia pedunculata*, evaluate its organoleptic acceptability, analyze its nutritional composition and shelf-life stability.

Materials & Methods

For carrying out the present study, fresh samples of *Garcinia pedunculata* were procured from the local growers of Guwahati, Assam during the month of February to April, 2022. The fresh fruit of *Garcinia pedunculata* was sorted and graded manually and stored at room temperature for product development. For the preparation of RTS beverage, freshly dried Garcinia rinds were soaked in water for about 30 mins, pulp along with skin was blended in a mixer grinder and strained with a sieve (20 mesh) for smooth pulp. Sugar syrup (sugar+water in the ratio of 1:1) and jaggery syrup (jaggery+water in the ratio of 1:1) were prepared

along with that. The clear juice obtained from Garcinia pulp was utilized for preparation of RTS beverage with addition of equal quantity of sugar and jaggery followed by pasteurization and cooling (Figure 1). Three variations of RTS beverages were developed viz. R1, R2, R3 with a control formulation 'C' and were evaluated for their organoleptic acceptability by 30 semi-trained panelists for different sensory attributes, using the 9-point hedonic scale (Table 1). The RTS beverage with maximum sensory acceptability was further selected for nutritional analysis and shelf-life studies at ambient and refrigerated temperatures. Hand refractometer (ERMA) was used to measure total soluble solids (TSS) and digital pH meter (SYSTRONICS) was used to measure pH value of the sample. Total sugar was determined using standard method,⁹ anthrone reagent was used for determination of sugar. Vitamin

C was determined as per standard method¹⁰ in which 2,6-dichloroindophenol indicator dye and ascorbic acid standard solution were used, potassium and iron were determined using Atomic Absorption Spectrophotometer (SpectrAA 220, Varian, USA) according to standard methods.¹¹ The total flavonoid content (TFC) was determined using colorimetric method¹² and the absorbance was recorded at 510 nm using a spectrophotometer (Analytikjena U-2800 SPECORD S.600, Germany). The total phenolic content (TPC) was determined according to the Folin–Ciocalteu Spectrophotometric method.¹³ The antioxidant capacity was determined by the modified free radical DPPH (2,2-Diphenyl-1-picrylhydrazyl) method¹² and was calculated as % inhibition:

DPPH antioxidant activity (% inhibition) = $(1 - (A \text{ of sample } t=30 / A \text{ of control } t=0)) \times 100$.

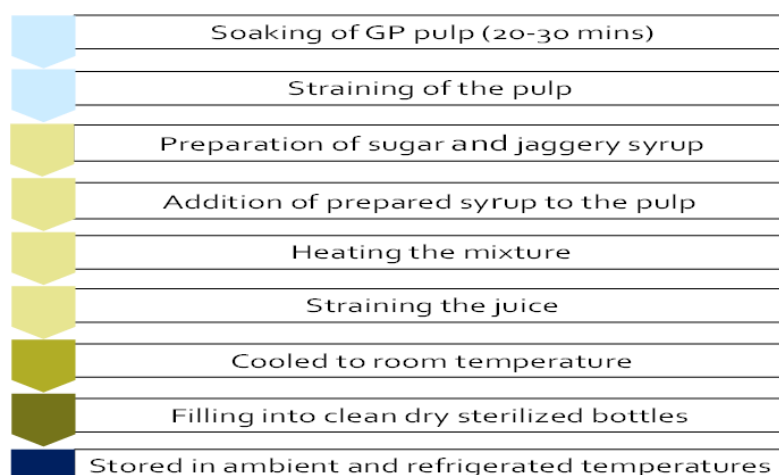


Fig. 1: Flow chart for the preparation of RTS beverage using dried slices of garcinia

Table 1: Formulation of the RTS variations

Formulations	Additional ingredients with amount		Ingredients with amount			
			Sugar syrup	Jaggery syrup	Black salt	Garcinia juice
R1	Chilli powder	½ tsp	50 ml	50 ml	½ tsp	100 ml
R2	Jeera powder	½ tsp	50 ml	50 ml	½ tsp	100 ml
R3	Ajwain powder	½ tsp	50 ml	50 ml	½ tsp	100 ml

Note: ½ tsp=2.5 g

The antioxidant capacity was also determined by FRAP (Ferric reducing antioxidant power) assay.¹⁴ Shelf-life study of RTS beverage was done by preserving the product in two different types of packaging material, viz. airtight glass bottle and airtight PET (Polyethylene Terephthalate) bottle for 2 months in two different conditions i.e. in refrigerated storage condition and in ambient storage condition.

Microbial analysis was measured by total plate count method.¹⁵ All the data of the sensory evaluation were further statistically analyzed in replicates of three; according to descriptive statistics, means were evaluated and represented as mean \pm SD. Paired t-test was performed to examine significant differences between TSS and pH values.

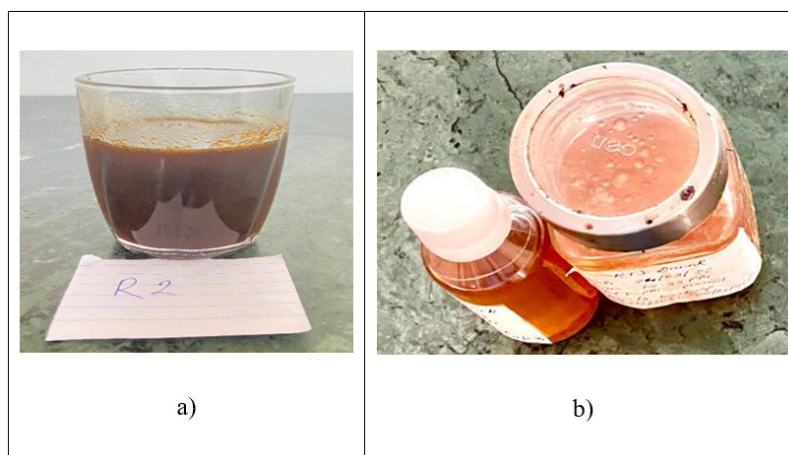


Fig. 2: a) R2 formulation; b) R2 beverage stored in different packaging materials

Table 2: Mean hedonic test scores of RTS beverages

Product	Formulation	Quality attributes					Overall
		Colour (Mean \pm SD)	Appearance (Mean \pm SD)	Mouthfeel (Mean \pm SD)	Flavour (Mean \pm SD)	Taste (Mean \pm SD)	
RTS beverage	C	7.5 \pm 0.68	7.7 \pm 0.63	7.5 \pm 0.85	7.5 \pm 0.82	7.6 \pm 0.93	7.6 \pm 0.76
	R1	7.7 \pm 0.62	7.8 \pm 0.57	8 \pm 0.64	7.9 \pm 0.71	7.9 \pm 0.85	7.9 \pm 0.69
	R2	8.2 \pm 0.77	8.1 \pm 0.87	8.2 \pm 0.80	8.3 \pm 0.83	8.3 \pm 0.83	8.5 \pm 0.62
	R3	7.5 \pm 0.82	7.6 \pm 0.72	7.6 \pm 0.81	7.5 \pm 0.86	7.5 \pm 0.93	7.7 \pm 0.83

Results & Discussion

In the assessment of organoleptic acceptability, R2 variation (Figure 2a) was the most preferred with highest score of sensory attributes (color: 8.2 \pm 0.77, appearance: 8.1 \pm 0.87, mouth feel: 8.2 \pm 0.80, flavour: 8.3 \pm 0.83, taste: 8.3 \pm 0.83 and overall acceptability: 8.5 \pm 0.62) (Table 2). During the storage period of 60 days, no significant change was observed in TSS of the developed RTS, although a change in pH was recorded (Table 3). Although no significant differences were found in TSS values recorded on day 1 and day 30, however, highly significant differences was observed among pH values (t=

1E+08) recorded for day 1 and day 30 of the developed RTS beverage. Garcinia RTS recorded a total sugar content of 24.68 g/100 g, iron content (Fe)- 3.60 mg/100 g, potassium (K)- 256.56 mg/100 g and vitamin C- 24.65 mg/100 g. TPC and TFC was reported to be 161.20 mg GAE/100 g and 312.86 mg CE/100 g respectively. DPPH and FRAP assay reported the values of 59.31 (%inhibition) and 4.13 μ mol Fe (II/g) respectively. The nutritional analysis results revealed that RTS beverage prepared from *Garcinia pedunculata* is highly nutritious in terms of micronutrients, phytochemicals and antioxidant properties (Table 4). The RTS beverage was

stored in two different conditions viz. ambient and refrigerated in different packaging materials (PET bottles and glass bottles) (Figure 2b) without adding any preservative. During storage, shelf-life studies by pour plate technique recorded microbial growth in the developed RTS beverage after 60 days although no visible growth was observed. The CFU values

of the RTS beverage were recorded to be lowest at refrigerated conditions in both PET bottles and glass bottles followed by ambient conditions (Table 5).

Table 3: TSS and pH value of RTS beverage (R2) throughout storage

Parameters	Day 1	Day 60	Paired t-test
TSS	10	10.5	NS*
pH	1.68	2.55	-1E+08

*NS: Not significant

Table 4: Nutritional composition and antioxidant properties of Garcinia RTS (R2)

Parameters	Amount
Total sugars (g/100 g)	24.68
Fe (mg/100 g)	3.60
K (mg/100 g)	256.56
Vit C (mg/100 g)	24.65
TPC (mg GAE/100 g)	161.20
TFC (mg CE/100 g)	312.86
DPPH assay (%inhibition)	59.31
FRAP ($\mu\text{mol Fe(II/g)}$)	4.13

Table 5: Microbial analysis of RTS beverage (R2) after 60 days of storage

Product	Packaging material	No. of days	Total plate count (cfu/ml)
RTS beverage (R2)	Glass bottle (refrigeration)	60	0.25×10^7
	Glass bottle (ambient)	60	1.25×10^7
	PET bottle (refrigeration)	60	0.35×10^7
	PET bottle (ambient)	60	1.45×10^7

Ready to serve (RTS) beverages prepared from fruit juice blends with addition of spice extracts can be utilized as value added drinks with high sensory acceptability and better nutritional aspects. The current study results for overall acceptability are in agreement with other studies¹⁶ in which kokum RTS blended with cumin had the best flavour and taste with an overall acceptability score of 7.75. In another study,¹ the overall consumer acceptability score of garcinia fruit juice (8.5) was similar to the current study results. The slight increase in TSS of the developed RTS during storage could be due to hydrolysis of the polysaccharides (such as starch and pectin) into simple sugars (such as glucose and fructose) and oligosaccharides (sucrose) and other constituents. The reduction in moisture content of the product during storage might also attribute to increase in TSS.¹⁷ Similar findings were also reported in kokum RTS^{16,18} and in blended jamun RTS.¹⁹ A change in pH was recorded in the present study during storage. The observed changes in pH might be affected by the storage conditions,

leading to chemical and enzymatic changes in RTS beverage properties.²⁰ The results are in consonance with other findings¹⁸ where an increase in pH was observed during storage of kokum. At low pH, fruit products are being effectively preserved. Similar studies^{18,21} also reported total sugar content of 15.45 and 16.32 g/100ml respectively in Kokum RTS which gradually increased during storage. Other studies^{18,21} recorded vitamin C content of 29.25 mg/100 ml and 20.15 mg/100ml respectively. There might be slight variations in the values recorded in the current study due to effect of temperature and processing method adopted. With an increase in temperature, there is loss of ascorbic acid.¹⁸ In other studies, TPC of 21.83 ± 0.12 mg (GAE)/100 ml was reported in cape gooseberry RTS²⁰ and 43.80 ± 5.07 mg/100 g in dragon fruit based RTS.²² These studies recorded lower TPC values than the current study that might be owing to lower amount of phenolics in fruit pulp of developed RTS.²² Similar results on antioxidant values were also stated in

kokum RTS²¹ and in RTS beverages from traditional medicinal plants.²³

According to PFA standards, the microbial load should be less than 50 cfu/ml¹⁸ but the current study recorded a higher level of microbial load on 60th day as no preservatives were added in the garcinia RTS. As the developed RTS was only pasteurized but not sterilized, there might be multiplication of available fermenting microbes in the beverage.²⁴ Few colonies of microbial growth (cfu/ml) were also reported in kokum based RTS beverage after 60 days of storage in both ambient (3×10^1) and refrigerated conditions (2×10^1) with addition of preservative.¹⁶ Another study¹⁸ also recorded cfu values of 17 cfu/ml in kokum RTS which was within acceptable limit. A cfu value of 3210 CFU/ml was also recorded in beetroot RTS over 4 weeks of storage. Thus, microbial fermentation is supported with increase in acidity of the stored samples over time with susceptibility to acid tolerant bacteria and wild yeasts.²⁴

Conclusion

The developmental strategy was to produce nutritional health drink from the indigenous fruit of *Garcinia pedunculata*. Based on the findings of the current study, it can be said that RTS beverage prepared from *Garcinia pedunculata* is highly nutritious. It can be used as micronutrient enriched value added drink. Hence, it can be concluded that Garcinia RTS is widely acceptable with high values of micronutrients and antioxidant capacity, making it a suitable nutritious beverage which is healthy for consumption by different age groups and commercially viable novel value-added product. Further, this indigenous nutraceutical fruit can be

utilized fully to produce value added products and their commercialization, thereby making it available throughout the season, which shall further help in sustainable economic status of the local growers. Future studies may attempt in commercialization of the developed product which could be a better alternative to synthetic soft drinks because of its nutritional quality and functional properties.

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Conflict of interest

The author(s) declares no conflict of interest.

Authors' Contribution

All the authors have significantly and directly contributed intellectually to the project and have given their approval for its publication. The authors are responsible for the content and writing of the paper.

Data Availability

Data will be made available on request.

Ethics Statement

Not applicable.

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