# PREPARATION OF SHELF STABLE READY TO SERVE (RTS) BEVERAGE BASED ON TENDER COCONUT (*Cocos nucifera* L.)

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## *Abstract*

*Tender coconut is commercially underutilized tree nut for beverage production. This research was conducted to find out the best formulation for preparation of RTS tender coconut beverage and to evaluate its composition and the shelf life.Differentformulations of beverage were prepared using varying proportion of7-month maturity coconut kernel and coconut water with pectin and sugar as main ingredients. Best kernel: water ratio and sugar level were selected by using sensory evaluation. Suitable pectin level was selected by visual observation of the sediment height. Microbial stability of the product was evaluated for a range of selected pasteurization temperatures and time. Best formula for the tender coconut RTS beverage was 1:7 kernels to coconut water, 10% total soluble solids and 0.3% pectin and the best selected processing conditions were 13000rpm for 2 minutes homogenization pressure and pasteurization for 5minutes at 100ºC temperature. Proximate analysis and sensory evaluation were carried out for the selection of best treatment that was identified by above preliminary trials. Sensory evaluation for the final product was conducted using 50 untrained panelistswith 7-point hedonic scale. Result was analyzed according to Freidman test at 95% significant level. In proximate analysis of the final product, total solid, protein, fat, sugar, crude fiber and total ash contents were found to be 10.35%,0.3%, 0.45%,8.67%, 0.31% and0.49% respectively. Moreover, results show that the beverage contains 364.52 mg $K^+$, 28.31 mg $Na^+$, 23.49 mg $Mg^{2+}$ and 44.21 mg $Ca^{2+}$ per 100 mL. In accordance with the shelf life studies, it was found that the formulated product can be kept for minimum of 8 weeks and it was sterile throughout the storage period. Results revealed that an organolepticallyaccepted tender coconut based RTS beverage with its kernel can be formulated.*

**Key words**: Tender coconut, proximate analysis, ready to serve beverage, sensory evaluation, shelf life

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## 1. INTRODUCTION

The coconut palm (*Cocosnucifera* Linn.), the" Tree Heaven" is one of the most important of all cultivated palms in the world and it is grown in more than 80 countries of the tropics. Millions of people in the tropical regions depend on the coconut palm for their livelihood.Tender coconut is very popular among people due to both coconut water and gelatinous coconut meat. Coconut water and kernel are liquid and solid endosperm of a tender coconut (Raghavendra, 2001). The kernel of seven to eight month old coconut nut is consumed either as such or along with the sweet tender nut water. At this stage, the kernel will be very soft with the maximum content of protein and sugar. The tender coconut water or green coconut water is sterile and is used as an oral rehydration medium for children suffering from gastroenteritis (Saat et al., 2002). Further yender coconut water has some cardioprotective effects (Anurag and Rajamohan, 2003) and hypotensive properties (Alleyne et al., 2005). In addition, it contains approximately 64 k Cal of energy and rich in amino acids such as glutamic acid, aspartic acid, arginine and alanine.Further, it contains high amounts of electrolytes that needs for the fluid balance. Most recently, it was identified as a sport drink due to its rehydration and refreshing properties.

Though thattender coconuts have high nutritional benefits, it cannot keep for long time in the fresh form. After opening the nut, it undergoes to rapid microbial and enzymatic degradation and loses all the nutritional and sensory properties. Production of RTS beveragehelped to reduce this wastage. Therefore, an effort was made to develop a shelf stable RTS beverage with acceptable quality parameters from tender coconut water with its kernel.

## 2. MATERIALS AND METHODS

### 2.1 Location and harvesting

Seven month maturity, red draft tender coconut nuts were harvested from the Bandirippuwa estate of Coconut Research Institute, Lunuwila,Sri Lanka. The entirenut was visually observed for diseases, damages and maturity level andcoconut nuts were transported to the laboratory soon after harvesting for the preparation of beverage.

### 2.2 Materials

Lime juice, Pectin (food grade), Sugar, KMS (Potassium metabisulphite) and all the chemicals used for the analysis were of analytical grade.

### 2.3Kernel to tender coconut water ratio

Threeblends were prepared by mixing the coconut kernel and coconut water ratio (14.3% kernel-1:7, 11.1%-1:9, 9.1%-1:11).These blends were evaluated by using a ranking test with 15 semi trained panelists.

### 2.3 Pectin level, homogenization pressure and time

Selected 1:7 kernel and coconut waterblendevaluated for further studies.Three levels of pectin as stabilizer(0.2%, 0.3% and 0.4%) and four homogenization pressures and time combinations(11000 and 13000rpm for 1 and 2 min) were evaluated for the stability of the beverage.Treatments were kept for 3 days and sediment height was measured in cm.

### 2.4 Optimum KMS level

Selected kernel blends (1:7) wereevaluated forthe four levels of$SO_2$ levels as preservatives (0ppm, 30ppm, 50ppm and 70 ppm). Based on the microbial stability, the best level of $SO_2$was selected for the formulation by using the total plate count of the formulations.

### 2.5 Sugar level

In order to determine the level of sugar in the formulations, fourlevels of total soluble levels(8$^o$, 10$^o$,12$^o$) were evaluated and composition of the beverage was 1:7 ratio, 50ppm KMS, 0.3% pectin and lime juice until reach to pH 4.4.Then the mixture was heated until boiling. Then it was hot filled into 200mL sterilized bottles and sealed.Then it was evaluated by using a ranking test by using 15 sensory panelists.

### 2.6 Pasteurization time and temperature

In order to determine the optimum pasteurization condition for the formulation, bottled formulation was pasteurized at100$^o$C for 5, 10, 15 and 20 min under atmospheric pressure. Microbial analysis was done by standard total plate count method to for the efficacy of the pasteurization conditions.

### 2.7 Proximate analysis of the product

Moisture, fat, protein and ash of the selected best tender coconut beverage estimated according to the AOAC (1999) method with 3 replicates.Fiber content was evaluated using Weende'smethod(AOAC, 1999).

### 2.8 Sensory evaluation

Sensory evaluation was conducted for the final formulations for itsappearance, smell, taste and overall acceptability, using trained panelists with a ranking test according to Meilgaard et al. (1991).

### 2.9 Statistical analysis

Results of the sensory evaluation were analyzed using computer aided MINITAB 15 statistical analysis package according to Friedman test at 95% level. Data obtained from proximate analysis subjected to analysis of variance (ANOVA) and mean separation was done with Duncan's Multiple Range Test at 95% significant level.

## 3. RESULTS AND DISCUSSION

### 3.1 Selection of suitable Kernel: Water ratio for the beverage

1:7, 1:9 and 1:11 kernel-water ratios were used to determine the best kernel water ratio for the product. Simple ranking test were performed for degree of preference and results were shown in Table 01.

According to the Table 01, 1:7 kernel ratio gives better flavor and overall acceptability compared to the other ratios used. However, smell and the texture were not much altered among treatments. Therefore, 1:7 ratio gives better sensory properties compared to other treatments. Further, it was found that with the use of this ratio, nearly, two bottles of tender coconut beverage (250mL) can be preparedusing 1 coconut. Hence, 1:7 ratio was selected for further analysis.

### 3.2 Selection of optimum KMS level for the beverage

Threedifferent $SO_2$ levels with control were observed by measuring the microbial content and the perceiving odor of product after one week. Results were shown in Table 02.

According to the results, 30 ppm $SO_2$ level (50 ppm KMS) was the most suitable preservative amount to improve the microbial stability while reducing off flavors. Even though 30 ppm of KMS gave 2 CFU per mL, optimization of pasteurization time-temperature combination gave the microbial sterility for the product.

This beverage has citric acid as an acidulantand it react with KMS to liberate $SO_2$. Apart from that, Tri-potassium citrate is produced as a byproduct. Potassium citrate is known as a food buffer and it maintains the pH of the product. Therefore, this reaction has an advantage of producing buffers and thus maintains the pH of the beverage at microbiologically safe range.

### 3.3Selection of effective Pectin level, Homogenization speed and time for the product

A series of experiment was conducted for measure the pectin level, homogenization conditions (speed and duration). By combining these three parameters, 12 different samples were prepared with three controls. Effects of these combinations were analyzed by measuring the sedimentation height of the product. Results were shown in Table 03.

**Table 01: Sum of ranks of sensory attributes obtained for different kernel ratios**

| Kernel ratio | Texture | Flavor | Smell | Overall acceptability |
|---|---|---|---|---|
| **1:07** | $35^a$ | $41^a$ | $22^a$ | $41^a$ |
| **1:09** | $29^a$ | $30^b$ | $24^a$ | $30^b$ |
| **1:11** | $26^a$ | $19^c$ | $25^a$ | $19^c$ |

*The sum of ranks with different superscripts in a column differ significantly ($p \leq 0.05$)*

**Table 02: Microbial content and odor for different $SO_2$ levels after one week**

| | $SO_2$ levels | | | |
|---|---|---|---|---|
| | **Control (0 ppm)** | **30 ppm** | **50 ppm** | **70ppm** |
| **Microbial content (CFU/mL)** | 43 | 2 | Less than one | Less than one |
| **Odor** | Acidic odor | Mild off odor | Moderately strong off odor | Strong off odor |

**Table03: Sedimentation height of the product according to combinations of pectin level, homogenization speed and time**

| Pectin | **homogenization** | **1 min** | **2 min** | **control** |
|---|---|---|---|---|
| 0.2 % | 11000 rpm | 3.5 cm | 2.5 cm | 4.0 cm |
| | 13000 rpm | 3.5 cm | 2.0 cm | |
| 0.3 % | 11000 rpm | 3.0 cm | 3.0 cm | 2.5 cm |
| | 13000 rpm | 2.0 cm | 1.5 cm | |
| 0.4 % | 11000 rpm | 2.5 cm | 3.0 cm | 3.5 cm |
| | 13000 rpm | 3.0 cm | 2.0 cm | |

According to the result, all the treatments showed lower levels of sedimentation heightcompared to the control. Applying of higher rpm and time for homogenization gave better results. According to Figure 04, 0.3 % pectin level and the 13000 rpm homogenization speed and 2 min homogenization time gave the lowest sedimentation height with compared to other treatments.

**Homogenization combinations; 1- 11000 rpm for 1 min, 2- 11000 rpm for 2 min, 3- 13000 rpm for 1 min, 4- 13000 rpm for 2 min*

### 3.4 Selection of sugar level for the product

An experiment was conducted to find the suitable sugar content for the product and the three treatments were used to determine the suitable total soluble solids (Brix) level. A range of total soluble solids (5°, 8°, 10° and 12°) samples were prepared by using the results which were obtained from above experiments. Simple ranking test was performed and the results are shown in Table 04.

According to the results obtained from Friedman test, there is significant difference between three treatments (p values- 0.00) for sweetness and flavor acceptability. According to Mann- Whiteny U test, all the treatments are significantly differ from each other for sweetness and flavor acceptability.

According to the Table 04, treatment 3 (12° Brix) has the highest sweetness, but treatment 2 (10° Brix) gave the best flavor compare to other treatments. Flavor acceptability of a sour product is depends on acidity and sweetness. It can be determined by Brix: acid ratio (Ranganna, 1979). At Brix 10, this product has 50:76 Brix: acid ratio. This ratio gives the best flavor acceptability for the formulated product.

### 3.5 Selection of effective pasteurization time and temperature

**Table 04: Sum of ranks of sensory attributes, obtained for different brix levels**

| Brix level | Sweetness | flavor acceptability |
|---|---|---|
| **Control (5 Brix)** | $15^{a}$ | $16^{a}$ |
| **8 Brix** | $30^{b}$ | $31^{b}$ |
| **10 Brix** | $45^{c}$ | $60^{c}$ |
| **12 Brix** | $60^{d}$ | $43^{d}$ |

*The sum of ranks with different superscripts in a column differ significantly (p≤0.05)*

**Table 05: CFU of diluted beverages, which pasteurized at different time- temperature combinations**

| T°and t / Dilution | Hot filled | Hot filled & 100°C, 5 min | Hot filled & 100°C, 10 min | Hot filled & 100°C, 15 min | Hot filled & 100°C, 20 min |
|---|---|---|---|---|---|
| **$10^{-1}$** | 10 colonies | - | - | - | - |
| | 1 colony | F* | - | F* | - |
| **$10^{-2}$** | - | - | - | - | - |
| | - | - | - | - | - |
| **$10^{-3}$** | - | - | - | - | - |
| | - | - | - | - | - |
| **$10^{-4}$** | - | - | - | - | - |
| | - | - | - | - | - |
| **$10^{-5}$** | - | - | - | - | - |

* F- fungus

According to the data, 5 minutes at 100 ºC gives microbial stability at lowest time.
Pasteurization is an essential process in food processing. Heat treatment is the most common procedure for the beverage formulationstion. Pasteurization time and temperature combination depend on the highest heat tolerant microorganism. As this product has no issue with the *C. botulinum*, which acts as thermophilic food pathogen, temperature- time combination can reduce significantly. According to the Gunathilake and Rathnayake (2012), 100 ºC for 5 min has been used for pasteurization of tender coconut beverage. According to many research based on coconut water, 100 ºC temperature was used as pasteurization temperature for the product. According to the data represent in (Table 05), 5 min at 100 ºC gives commercial sterility but fungus development was observed at some time - temperature combinations. To prevent that, lids of bottles were dip in KMS - citric solution and then washed with hot water. Acidified KMS solution releases $SO_2$ and it act as powerful fungicide in food processing industries.

### 3.6 Composition analysis of the product

The best-selected sample from the sensory evaluations was analyzed for proximate composition and mineral content. The results obtained from analytical methods were mentioned in Table 06.
Composition and physiochemical analysis of the product is conducted to find the available nutrient content in the product and to characterize the features of the product. According to the Table 06, formulated beverage has TSS and acidity within the range that is accepted by Sri Lankan Standards. According to the data the beverage containshigh amount of electrolytes,especially potassium which have significant effect on rehydration of the body.

### 3.7 Self-life evaluation of the product

According to the data obtained from the one way ANOVA test (Table 07) Brix value was not significantly changed with the time. However, pH and acidity was changed significantly with the time.pH was increased and acidity was decreased with the storage time.

**Table 06: Physicochemical and proximate compositions of the tender coconut beverage**

| Component | Amount % (g /100 mL) |
|---|---|
| Total solids | 10.35±0.033 |
| Total soluble solids | 10.00 ±0.77 |
| Total ash | 0.499±0.002 |
| Fiber | 0.26±0.05 |
| Crude fat | 0.45±0.01 |
| Crude protein | 0.31±0.03 |
| Total sugar | 8.67 |
| Carbohydrate(except fiber and sugar) | 0.211* |
| **Minerals** | **Amount (mg/100 mL)** |
| Sodium | 28.31±0.02 |
| Potassium | 364.52±0.06 |
| Magnesium | 23.49±0.07 |
| Calcium | 44.21±0.04 |

*The values are mean ± SD of three independent determinations. * Calculated by difference method*

**Table 07: Changes of physicochemical and microbial parameters with the storage period**

| Duration | pH | Acidity (Citric acid %) | TSS level Brix$^0$ | Microbial analysis |
|---|---|---|---|---|
| **01$^{st}$week** | 4.40$^a$ | 0.197$^a$ | 10.1$^a$ | - |
| **02$^{nd}$week** | 4.41± 0.006$^a$ | 0.179$^b$ | 10.1$^a$ | - |
| **03$^{rd}$week** | 4.45 ±0.01$^b$ | 0.128$^c$ | 10.1$^a$ | - |
| **04$^{th}$week** | 4.50 ±0.01$^c$ | 0.089$^d$ | 10.1$^a$ | - |

**yeast and mold count and total plate count. The sum of ranks with different superscripts in a column differ significantly (p≤0.05)*

Generally, shelf life is the period over which a food product can be relied upon to retain its equal characteristics. There are intrinsic parameters and extrinsic parameters to evaluate the shelf life of a product. pH, acidity and TSS level are intrinsic quality parameter of a beverage which are highly indicated the changes of shelf life. The product have minimum 2 month of shelf life period based on physicochemical and microbial parameters. When consider about the pH, it is significantly change with the storage time (Table 07). However, product is microbiologically safe until pH reached to 4.6. Acidity of the product is comparatively reduced and Brix remains unchanged.

## 4. CONCLUSION

The present study concluded that tender coconut beverage can be successfully formulated by using 1:7 tender coconut water to kernel ratio and 10 Brix. Best processing conditions were homogenization at 13,000 rpm for 2 minutes and pasteurization at 100 ˚C for 5 minutes.

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