Study on the Preparation and Characterization of Coconut Energy Drink

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***Abstract*: Coconut water, the clear liquid inside immature green coconut, is highly valued due to its nutritional and therapeutic properties. The juice is mostly consumed locally as fresh in tropical areas since it deteriorates easily once exposed to air. Coconut water loses its delicate fresh flavor and some of its nutrients by using ultra high temperature (UHT) technology. The coconut water obtained from tender coconut was immediately filtered to remove solids and particulates. The resulting coconut water was sterilized by ultrafiltration (50nm pore size diameter). It was mixed with (5%, 10%, 15%, 20% and 25%) of glucose, (0%, 0.05%, 0.10%, 0.15% and 0.20%) of potassium metabisufite and (0%, 0.05%, 0.75%, 0.10% and 0.15%) of potassium sorbate. This study showed that a fresh-like tasting coconut water (coconut energy drink)can be obtained by 15% glucose, 0.15% potassium metabisulfite and (0.1% potassium sorbate) with an extended shelf-life of more than one month at 4°C . The physical and chemical characteristics such as pH, soluble solids, moisture content, ash content, protein content, fat content, fibre content, carbohydrate, energy value, sugar content, minerals content, yeast and mould aerobic plate counts (APC) and *Escherichia coli* (E.coli) of tender coconut water and resulting coconut energy drink were also determined.**

***Keywords*- Tender Coconut, Coconut Energy Drink, Ultrafiltration.**

I. INTRODUCTION

Coconut water is extracted from young coconuts, and is almost clear juice that has a slight almond flavor. Naturally low in fat and calories, with no cholesterol, and a balance of sodium, potassium, calcium and magnesium, it makes a healthy electrolyte drink. Usually consumed fresh from the coconut wherever it grows, the water has been used for rehydration and as a health and beauty aids in tropical regions around the world for centuries. Recent studies have confirmed its medicinal and therapeutic uses, and it is poised to enter the international sports drink market [12].

The water of tender young coconut technically is the liquid endosperm. It is one of the purest, most nutritious wholesome waters and beverages with which nature has provided us. The people in tropical regions and countries have been enjoying this drink for centuries. They have used the all-natural coconut water to refresh, refuel, re-hydrate, feed and maintain the proper nourishment and fluid levels in their bodies. The natural water has a caloric value of 17.4 per 100 gm. Energy drink can be prepared using tender coconut water as well as mature coconut water. Considering the available processes, economics of the byproducts it was decided that normal coconut water is the most suitable for such a beverage production. Although the tender coconut water is high in nutritional characteristics, normal coconut water contains almost all essential nutrients which should be available in a sports drink. However, the amount of lipid available in mature coconut water is higher than tender coconut water and a normal sport drink. On the other hand, if tender coconut was used for the beverage production the economic benefits gained from the project is far less than using the mature coconut water. Because the commercial value of by products will be far less. Most commercial production today utilizes a high-technology used in UHT long-life milk. This is a thermal processing technique which eliminates not only the risk of bacteria, but also some of coconut water's nutrients and almost all its delicate flavors. This severely limits the product's market ability. In addition, during canning also most of nutrients and delicate flavors get lost. Micro filtration process for the sterilization of coconut water is straight forward [7].

The objectives are

1. To prepare coconut energy drink
2. To determine the physico-chemical characteristics ofcoconut water and coconut energy drink.

II. LITERATURE REVIEW

A. Coconut

Kingdom : Plantae
Binomial Name : *Cocos nucifera* L.
English Name : Coconut
Myanmar Name : Ohnthee
Family : Arecaceae

Coconuts are known for their versatility of uses, ranging from food to cosmetics. The inner flesh of the mature seed forms a regular part of the diets of many people in the tropics and subtropics. Coconuts are distinct from other fruits because their endosperm contains a large quantity of clear liquid, called "coconut milk" in the literature, and when immature, may be harvested for their potable "coconut water", also called "coconut juice"[11].Coconut water serves as a suspension for the endosperm of the coconut during its nuclear phase of development. Later, the endosperm matures and deposits onto the coconut rind during the cellular phase. It is consumed throughout the humid tropics, and has been introduced into the retail market as a processed sports drink. Mature fruits have significantly less liquid than young, immature coconuts, barring spoilage. Coconut water can be fermented to produce coconut vinegar. Coconut water contains 19 calories and no significant content of essential nutrients per 100-gram [6].

B. Membrane Separation Process

Membrane is a thin layer of semi-permeable material that separates substances when a driving force is applied across the membrane. Membrane processes are increasingly used for removal of bacteria, microorganisms, particulates, and natural organic material, which can impart color, tastes, and odour to water and react with disinfectants to form disinfection byproducts [13].

Membrane separation processes take a very important role in the separation industry. Membrane separation processes differ based on separation mechanisms and size of the separated particles. The widely used membrane processes include microfiltration, ultrafiltration, nano-filtration, reverse, osmosis, electrolysis, gas separation, vapor permeation, perevaporation, membrane distillation, and membrane contactors. Microfiltration and ultrafiltration is widely used in food and beverage processing (beer microfiltration apple juice ultrafiltration), biotechnological applications and pharmaceutical industry, water purification and wastewater treatment, the microelectronics industry, and others. Nano-filtration and reverse osmosis membranes are mainly used for water purification purposes [17].

Table (1) Four Classes of Filter Membrane

Pore size	Process	Removal of
>0.1 µm	Microfiltration	Large bacteria, yeast, particles
100-2 nm	Ultrafiltration	Bacteria, macromolecules, proteins, larger viruses
2-1 nm	Nano-filtration	Viruses, 2-valent ions
<1 nm	Reverse osmosis	Salts, small organic molecules

Ultrafiltration

Ultrafiltration (UF) is the process of separation extremely small particles and dissolved molecules from fluids. Materials ranging in size from 1K to 1000K molecular weight are retained by certain ultrafiltration membranes, while salts and water will pass through. Materials significantly smaller than the pore size rating pass through the filter and can be dehydrogenated, clarified and separated from high molecular weight contaminants. Materials larger than the pore size rating are retained by the filter and can be concentrated or separated from low molecular weight contaminants [9].

An ultrafiltration filter has a pore size around 0.01 microns. A microfiltration filter has a pore size around 0.1 microns, so when water undergoes microfiltration, many microorganisms are removed, but viruses remain in the water. Ultrafiltration would remove these larger particles, and may remove some viruses. Neither microfiltration nor ultrafiltration can remove dissolved substances unless they are first adsorbed (with activated carbon), or coagulated (with alum or iron salts). Ultrafiltration removes bacteria, protozoa and some viruses from the water. Ultrafiltration is typically used to separate proteins from buffer components for buffer exchange, desalting, or concentration. Ultra-filters are also ideal for removal or exchange of sugars, nonaqueous solvents, the separation of free from proteinbound ligands, the removal of materials of low molecular weight, or the rapid change of ionic and pH environment precipitation [10].

C. Glucose

Glucose, also called dextrose, one of a group of carbohydrates known as simple sugars (monosaccharides). Glucose has the molecular formula $C_6H_{12}O_6$. It is found in fruits and honey and is the major free sugar circulating in the blood of higher animals. It is the source of energy in cell function, and the regulation of its metabolism is of great importance. Molecules of starch, the major energyreserve carbohydrate of plants, consist of thousands of linear glucose units [14].

D. Potassium Metabisulfite

Potassium metabisulfite, $K_2S_2O_5$, also known as potassium pyrosulfite, is a white crystalline powder with a pungent sulfur odour. The main use for the chemical is as an antioxidant or chemical sterilant. It is a disulfite and is chemically very similar to sodium metabisulfite, with which it is sometimes used interchangeably. Potassium metabisulfite is generally preferred out of the two as it does not contribute sodium to the diet. Potassium metabisulfite has a monoclinic crystal structure which decomposes at 190 °C, yielding potassium sulfite and sulfur dioxide:

$$K_2S_2O_5(s) \rightarrow K_2SO_3(s) + SO_2\,(g)$$

It is used as a food additive. It is restricted in use and may cause allergic reactions in some sensitive persons. Potassium metabisulfite is an inhibitor of the polyphenol oxidase enzyme. Potassium metabisulfite is sometimes added to lemon juice as a preservative. It is used as a bleaching agent in the production of Coconut cream. It is used in some pickles as a preservative. It is used in tint etching iron based metal samples for microstructural analysis [15].

E. Potassium Sorbate

Potassium sorbate is the potassium salt of sorbic acid, chemical formula $CH_3CH{=}CH{-}CH{=}CH{-}CO_2K$. It is a white salt that is very soluble in water (58.2% at 20 °C). It is primarily used as a food preservative. Potassium sorbate is effective in a variety of applications including food, wine, and personal-care products. While sorbic acid is naturally occurring in some berries, virtually all of the world's production of sorbic acid, from which potassium sorbate is derived, is manufactured synthetically. It is effective up to pH 6.5 but effectiveness increases as the pH decreases. The lower the pH value of the product the lower amount of the potassium sorbate is needed for preservation. Typical culinary usage rates of potassium sorbate are 0.025 % to 0.1 % which in a 100 g serving yields an intake of 25 mg to100 mg. No more than 0.1 %

is allowed in fruit butters, jellies, preserves and related products [16].

III. MATERIALS AND METHODS

A. Raw Materials

Tender coconuts were purchased from Thingangyun Township, Yangon Region. Glucose was purchased from Sanpya market. Potassium metabisulfite and potassium sorbate (Analar grade) were purchased from Academy chemical group, (28th) Street, Pabedan Township, Yangon Region.

B. Preparation of Coconut Energy Drink

The tender coconut water was filtered, treated with ultrafiltration. And then it was mixed with glucose (15 %, w/v), potassium metabisulfite (0.15 %, w/v) and potassium sorbate (0.1 %, w/v). This mixture was stored at refrigerator. The physico-chemical characteristics of coconut energy drink were determined.

C. Determination of pH

The pH value was measured by using pH meter (pH 300, HANA). About 2g of sample was added into 150 mL beaker and dissolved in 100 mL of distilled water. The glass electrode assembly was first standardized by using buffer solution of pH 4 and pH 7 and the pH meter was adjusted to those values. After the pH meter was calibrated, the pH value of coconut soft drink was measured. The results are described in Tables (2, 3 and 4).

D. Determination of Soluble Solids Content

The soluble solids content was measured by using a refractometer. A small quantity of the prepared coconut soft drink was placed on the prism of refractometer. Then, the prism was closed and the instrument was directed towards a light source. The soluble solids content (°Brix) was read at the line which divides the light and dark parts of the surface on the vertical scale. The results are presented in Tables (2, 3 and 4).

E. Determination of Moisture Content [4]

5 g of prepared sample was weighed accurately in a clean, dried and tarred porcelain basin. The basin was placed in a hot air oven maintained at 105 ± 2 ºC and dried at least for 2 hours. Then, the sample was cooled in a desiccator and weighed. The process of heating, cooling and weighing were repeated until a change in weight between the successive drying at 1hour intervals was not more than 2 mg. Moisture content was calculated as follows:

$$\text{Moisture content (\% w/w)} = \frac{\text{Weight loss of sample}}{\text{Weight of the sample}} \times 100$$

The results are shown in Tables (5 and 6).

F. Determination of Ash Content [2]

5 g of coconut soft drink was weighed in a previously well-dried and tarred porcelain crucible. The sample was then placed inside the muffle furnace. Incineration was done at 600 ºC for about 3 hour until a white ash was obtained. After ashing, the crucible was cooled in a desiccator and weighed. The total ash percent of the sample was calculated as follows:

$$\text{Ash content (\% w/w)} = \frac{\text{Weight of the ash}}{\text{Weight of the sample}} \times 100$$

The results are shown in Tables (5 and 6).

G. Determination of Protein Content

1 g of prepared sample was taken in 500 mL Kjeldahl digestion flask. 10 g of anhydrous potassium sulfate, 0.5 g of copper sulfate and 20 mL of sulphuric acid were added. It was digested by placing the flask in an inclined position. It was heated gently at the beginning and then strongly until the solution was clear. It was continued for further one to two hours. Then, it was cooled and 200 mL distilled water was slowly added and mixed. The content was transferred into one-liter distillation flask washing with additional 100 mL distilled water. It was made alkaline by pouring 70 mL of sodium hydroxide (1:1) by the side of the flask without disturbing the liquid. A pinch of zinc dust was immediately added to prevent bumping and the still head of the condenser was connected with the distillation flask. The tip of the condenser trap must be dipped into 50 mL 0.1N sulphuric acid containing 1 mL methyl red indicator in a conical flask immersed in ice water. The tip of the trap from the acid was removed and distillation was continued for further 5 minutes. The tip was rinsed with water into the receiver and the residual acid left was titrated with 0.1 N hydroxide solution. A blank determination was carried out in a similar manner using the same reagents.

$$\text{Nitrogen}\left(\%\frac{w}{w}\right) = \frac{(T - B) \times N \times 14.007}{\text{Weight of sample}} \times 100$$

$$\text{Protein}\left(\%\frac{w}{w}\right) = \text{Nitrogen}\,\% \times 100$$

Where, N = exact normality of 0.1 N standard HCl solution

T = titrant volume for sample (mL)

B = titrant volume for sample (mL)

The results are shown in Tables (5 and 6).

H. Determination of Crude Fibre Content [3]

The defatted samples were treated with sulphuric acid (1.25 %, v/v) and sodium hydroxide solution. The digested matter was then filtered, washed with hot water and then ignited. Crude fibre content was determined by calculating the loss in weight after ignition. The results are shown in Tables (5 and 6).

I. *Determination of Crude Fat Content [5]*

Crude fat present in the sample was extracted by n-hexane. Fat was dissolved in the solvent. After the extraction, solvent was evaporated and fat content was determined. The data are shown in Tables (5 and 6).

J. *Determination of Carbohydrate*

The carbohydrate content of sample was calculated as follows

Carbohydrate = 100 - (Moisture+ Ash+ Protein+ Fiber +Fat)

The results are shown in Tables (5 and 6).

K. *Determination of Energy Value*

The energy value of sample was calculated as follows

Energy Value = (4 kcal/g × Protein) + (4 kcal/g × Carbohydrate) + (9 kcal/g × Fat)

The results are shown in Tables (5 and 6).

L. *Determination of Mineral Content*

The mineral contents such as calcium, magnesium, potassium, iron and phosphate of the prepared samples were determined by Atomic Absorption Spectrophotometer, using the instrument of Perkin Elmer Analyst 800 (Winlab 32 Software). The results are shown in Table (5 and 6).

M. *Determination of Escherichia Coli [1]*

25 g of sample was aseptically weighed into sterilized plastic bag and each pieces of sample was cut into pieces in it. 225 mL of phosphate buffer was added and blended for 20 minutes at a high speed. Dry film coliform count plate was placed in a flat surface. Top film was lifted an inoculated 1mL portion on to center of film base. Top film was carefully placed on inoculums. Inoculums over prescribed growth area were distributed with down ward pressure in center of plastic spreader. Plate was left undistributed 2 - 5minutes to allow gel to solidify. Plate was incubated for 24 ± 2 hours at 35 °C. After incubation, E.Coli appears as blue colonies with one or more gas bubbles associated with them and they were counted. The results are shown in Table (5 and 6).

Fig (A) Tender Coconut

Fig (B) Coconut Energy Drink

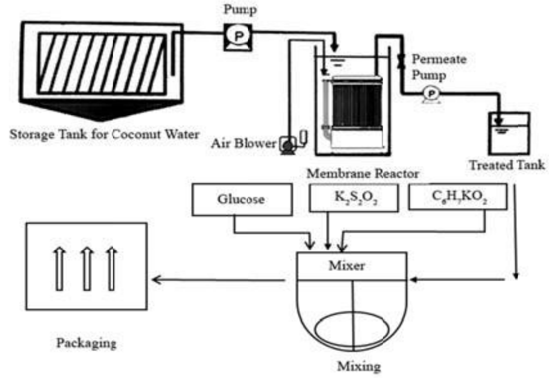

Fig (C) Schematic Diagram of Preparation of Coconut Energy Drink

IV. RESULTS AND DISCUSSIONS

In the preparation of coconut energy drink, the tender coconut water was pasteurized by ultrafiltration. In Table (2), pasteurized coconut water was mixed with different amount of glucose. The pH of samples was 4.8 and soluble solids of samples were different. The taste of samples (1) and (2) was tasteless and the taste of samples (3), (4) and (5) was sweet. In this study, the glucose was used to improve the energy but the glucose was able to grow microorganisms. 15% of glucose was the most suitable amount because its amount was to produce the energy and the growth of microorganisms was least. In Table (3), the shelf-life of coconut energy drink with various amount of potassium metabisulfite and potassium sorbate was determined. The maximum shelf-life (two weeks) was obtained by using (0.15%, w/v) of potassium metabisulfite as preservative. In Table (4), glucose (15%), potassium metabisulfite (0.15%) and various amount of potassium sorbate were conducted. 0.1 % of potassium sorbate, it was found that the shelflife was increased to one month. In Table (5), other characteristics of tender coconut water was carried. In Table (6), the characteristics of the resulting coconut energy drink was conducted and its characteristics were compared with energy drink (100plus). The mineral contents, sugar, carbohydrate and energy value of coconut energy drink were more moderate than energy drink (100plus).

Table (2) Effect of the Amount of Glucose on the Characteristics of Coconut Energy Drink

Amount of tender coconut water =100 mL

Sr. No.	Sample	Amount of Glucose (g)	Characteristics		
			pH	Soluble Solids (°Brix)	Taste
1.	I	5	4.8	8.8	Tasteless
2.	II	10	4.8	12.5	Tasteless
3.	III	15*	4.8	16.9	Sweet
4.	IV	20	4.8	20.2	Sweet
5.	V	25	4.8	22.0	Sweet

* the most suitable amount of glucose

Table (3) Effect of the Amount of Potassium Metabisulfite on the Shelf-life of Coconut Energy Drink

Amount of tender coconut water=100 mL

Amount of glucose = 15g

Sr. No.	Sample	Amount of Potassium Metbisulfite (g)	Characteristics		Shelf-life
			pH	Soluble Solids (°Brix)	
1.	I	0.00	4.8	4.6	5 hours
2.	II	0.05	4.8	6.2	5 days
3.	III	0.10	4.8	7.0	one week
4.	IV	0.15*	4.8	5.1	two weeks
5.	V	0.20	4.8	5.3	two weeks

* the most suitable amount of potassium metabisulfite

Table (4) Effect of the Amount of Potassium Sorbate on the Shelf-life of Coconut Energy Drink

Amount of tender coconut water = 100 mL

Amount of potassium metabisulfite= 0.15 g

Amount of glucose = 15 g

Sr. No.	Sample	Amount of Potassium Sorbate (g)	Characteristics		Shelf-life
			pH	Soluble Solids (°Brix)	
1.	I	0.00	4.8	4.6	two weeks
2.	II	0.05	4.8	5.0	two weeks
3.	III	0.075	4.8	4.8	two weeks
4.	IV	0.10*	4.8	4.9	one month
5.	V	0.125	4.8	5.0	one month

* the most suitable amount of potassium sorbate

Table (5) Characteristics of Tender Coconut Water

Sr. No.	Characteristics	Nutritional Value	
		Tender Coconut Water	*Literature Value
1.	Moisture content (% w/w)	95.39	94.99
2.	Ash content (% w/w)	0.23	0.39
3.	Protein content (% w/w)	0.59	0.2
4.	Fiber content (% w/w)	N.D	1.1
5.	Fat content (% w/w)	N.D	0.72
6.	Sugar (% w/w)	3.66	2.61
7.	Potassium (% w/w)	0.17	0.312
8.	Calcium , mg	101.75	24
9.	Sodium , mg	256.04	105
10.	Magnesium , mg	47.93	25
11.	pH	4.81	4.78
12.	Carbohydrate (% w/w)	3.78	3.71
13.	Energy value (kcal)	20.43	19

*Ref: [18]

Table (6) Characteristics of Coconut Energy Drink and Energy Drink

Sr. No.	Characteristics	Nutritional Value	
		Prepared Coconut Energy Drink	Energy Drink (100 plus)
1.	Moisture content(% w/w)	86.65	94.3
2.	Ash content (% w/w)	2.74	-
3.	Protein content (% w/w)	0	0
4.	Fiber content (% w/w)	0	-
5.	Fat content (% w/w)	0.34	0
6.	Sugar (% w/w)	13	5.4
7.	Potassium , mg	ND	25
8.	Calcium , mg	25.28	2
9.	Sodium , mg	64.1	42
10.	Magnesium , mg	5.27	-
12.	Carbohydrate (% w/w)	10.27	5.7
13.	pH	4.8	-
14.	Energy value (kcal)	42.44	22
15.	Aerobic Plate Counts (APC)	< 1 cfu per mL	-
16.	Yeast and Mould	< 1 cfu per mL	-
17.	*Escherichia coli* (E.coli)	< 1 cfu per mL	-

V. CONCLUSION

This study indicated that ultrafiltration method was more effective in the preparation of coconut energy drink because of longer shelf-life. 15% glucose, 0.15% potassium metabisulfite and 0.1% potassium sorbate were to increase the shelf-life of coconut energy drink. The resulting coconut energy drink has superior characteristics and ready to drink as a sport drink. The coconut energy drink was produced based on tender coconut. It was better than the artificial energy drink because it was obtained from fresh tender coconut water.

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