

**Comparative Study for Usage of Coconut Water from
Ripe and Unripe Coconut as a Substituent for Oral
Rehydration Fluid**

By

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DECLARATION

“The work described in this thesis was carried out by me under the supervision Dr. Indira Wickramasinghe, Senior Lecturer, Department of Food Science & Technology, Faculty of Applied Science of the University of Sri Jayewardenepura, Dr. Chandani Udawatte, Senior Lecturer, College of Chemical Sciences, Institute of Chemistry Ceylon and Mr. S. C. Dilanka Fernando, Visiting Lecturer, Management & Science Institute, and a report on this has not been submitted in whole or in part to any university or any other institution for another degree/diploma.”



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Date: 23.07.2015

DECLARATION

We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the University for the purpose of evaluation




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ABSTRACT

Coconut (*Cocos nucifera*) is one of the major plantation crops in Sri Lanka which accounts for approximately 12% of all agricultural produce in Sri Lanka. Our country owns the fourth position of world export of all kernel products and there are various other industries producing coconut related products. Coconut water is a clear liquid found in the interior of the coconut. In a healthy and undamaged coconut, the water is considered to be sterile and in spite of being a nutrient and electrolyte rich fluid, coconut water is considered as a waste by most of the coconut related industries. Acute diarrhoeal diseases are one of the leading causes of mortality in infants and young children in many developing countries. In most cases, death is caused by dehydration. This can be easily prevented by the introduction of an electrolyte rich rehydration fluid. Therefore, the major objective of this research was to analyze the feasibility of using coconut water as a rehydration fluid.

A pilot study was conducted prior to the research project to identify the major areas through which coconut enter in to a randomly selected market. As per the results, four areas from four different districts namely, Padiyagampola (Rathnapura), Galle (Galle), Mathugama (Kaluthara) and Kurunegala (Kurunegala) were selected for sample collection. Three maturity states namely pre-matured (6-7 months after flowering), matured (11-12 months after flowering) and over-matured (13-14 months after

flowering) were selected from each area and five coconut water samples were selected randomly from each maturity state. Five rehydration biochemical properties namely glucose content, Sodium content, Potassium content, Chloride content and Osmolality were analyzed for each sample. Glucose content was analyzed by using Glucose oxidase/ Peroxidase colourimetric method. Sodium and Potassium contents were analysed using Flame Atomic Absorption Spectrometry (FAAS), Chloride content was determined using a Chloride Ion Selective Electrode (Chloride ISE) and Osmolality of the samples was analysed using an Advanced Micro freezing point depression Osmometer. Results were statistically analyzed using one-way analysis of variance (ANOVA), at 0.05 probability level with MINITAB-15 software package. According to the statistical analysis, there was a significant difference in the biochemical parameters assessed between the maturity states as well as between the different areas. This can be due to the biochemical changes that occur during the development stages of the coconut and on geochemical differences in the soil where the plants were grown.

Each property was compared with the World Health Organization (WHO) standards for the Production of new Oral Rehydration Salts. The Potassium content and the Osmolality of all the samples were higher than the WHO standard levels and all the other properties namely, Glucose content, Sodium content and Chloride content were lower than the WHO standard.

As some additional nutritional factors, Magnesium content, Calcium content and Anti oxidants content were analyzed by using Flame Atomic Absorption Spectrophotometry (FAAS) and DPPH antioxidant colourimetric assay respectively. The samples were resulted to be containing a considerable amounts of Ca, Mg and Antioxidants.

CHAPTER 1

INTRODUCTION

Coconut (*Cocos nucifera*) is one of the major plantation crops in Sri Lanka which accounts for approximately 12% of all agricultural produce in Sri Lanka. Total land area under cultivation is 395,000 hectares and about 2,500 million nuts are produced per year (Department of Census and Statistics, 2003). Sri Lanka is very popular in world market for Desiccated Coconut and holds the 04th position of world export of all kernel products. Also, there are various other industries producing coconut related products. Coconut water is considered to be one of the major waste products in these industries, (Azam-Ali and Battcock, 1998) despite being a sweet and sterile fluid composed of unique chemicals such as sugars, vitamins, minerals, electrolytes, enzymes and amino acids (Jayalekshmy *et al.*, 1982).

Coconut water is the juice of the endosperm found within the cavity of the coconut, which begin to form around 2 months after the natural opening of the inflorescence (Vigliar *et al.*, 2006). Even though a number of researches have been carried out internationally regarding the rehydration properties of coconut water, there are a small number of studies that have related the composition of coconut water to the stage of maturation of the coconut or with the area where the coconut palms grow. Therefore this research was decided to be carried out in order to analyze the biochemical profile of coconut water from coconut palms planted in four different areas of the country and also in three different maturity stages namely pre- matured, matured and over-matured to assess its' suitability to be used as an Oral Rehydration fluid.

Acute diarrhoeal diseases are one of the leading causes of mortality in infants and young children in many developing countries. In most cases, death is caused by dehydration. It can be treated simply, effectively, and cheaply in all age-groups and in all but the most severe cases by oral administration of a glucose- containing electrolyte solution (World Health organization, 2005). Since coconut water contains those essential nutrients, it can be used as an oral-rehydration fluid.

Major objective

To analyze the feasibility of using coconut water as a possible rehydration fluid.

Specific objectives

To analyze the biochemical profile of coconut water from coconut palms planted in four different areas of the country.

CHAPTER 2

LITERATURE REVIEW

2.1 Coconut (*Cocos nucifera*)

Cocos nucifera, the coconut palm, is a monocot perennial member of the Arecaceae (palm - family), cultivated in tropical areas worldwide mainly in Asia, South America and Africa (Moore and UHL, 1982). The coconut fruit is a fibrous drupe. It consists of a thin hard skin (exocarp), a thicker layer of fibrous husk (mesocarp), the white kernel (endosperm) and a large cavity filled with liquid (Chan and Elvitch, 2006).

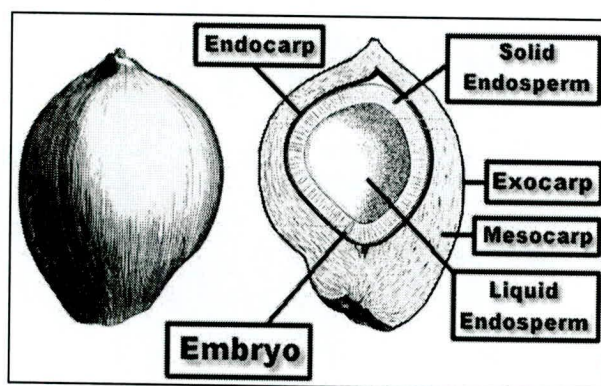


Figure 1. Cross section of *C. nucifera*

Table 1. Biological taxonomy of Coconut palm in Sri Lanka

Kingdom:	Plantae
Order:	Arecales
Family:	Areaceae
Subfamily:	Arecoideae
Tribe:	Cocoeae
Genus:	<i>Cocos</i>
Species:	<i>C. nucifera</i>
Variety	<i>Typica</i> (Sri Lankan tall)

2.2 Coconut maturity

The coconut palm starts to bear fruits 3 to 5 years after planting. A normal-bearing, adult palm produces at least one mature ready-to-harvest bunch of coconuts every month (Mathes and Marikkar, 2004). Depending on the variety, the number of nuts per bunch can vary from 5 to 15. Mature trees continue to produce fruit regularly throughout the year (United States Agency for International Development, 2004).

The coconut fruit takes between 11 to 12 months after flowering to reach complete maturity. (Harries, 2012)

2.3 Coconut water

Coconut water is a clear liquid found in the interior of coconut. In a healthy and undamaged coconut, the water is sterile. Its sodium and potassium content makes it an ideal drink for rehydration. The characteristics of the coconut water changes as the nut ages. (Prades, *et al.*, 2012)

The edible part of the coconut fruit consists of the endosperm tissue. Endosperm tissues undergo one of the three main modes of development, ie; nuclear, cellular and helobial modes. The development of coconut endosperm occurs in the nuclear development mode (Cutter *et al.*, 2009). Initially, the endosperm is a liquid containing free nuclei generated by a process, in which the primary endosperm nucleus undergoes several cycles of division without cytokinesis. Cytokinesis then occurs, progressing from the periphery towards the center, thus forming the cellular endosperm layer. At first, the cellular endosperm is translucent and jelly-like, but it later hardens at maturity to