

# Coconut Water – Properties, Uses, Nutritional Benefits in Health and Wealth and in Health and Disease: A Review.

<sup>1</sup>E Prabhakar Reddy\*, <sup>2</sup>T.Mohana Lakshmi

## ABSTRACT

Coconut water and coconut meat is one of the natural food products to quench thirst and easily available in most of the countries. Both water and meat of tender coconut refresh the body by providing nutritious content. Health and medicinal applications of tender coconut product gets research interest in recent years. It contains several biologically active components namely sugars, proteins, free amino acids, vitamins, minerals and growth promoting factors. Current research on coconut water is mainly focuses on properties, uses, Nutritional Benefits, so this review concentrated in all these aspects of Health and Wealth and in Health and Disease. It presents its uses, from the traditional to the most sophisticated; details its biochemical composition, influenced by the stage of maturity and the variety; and describes its original properties. This review paper aimed to know the main reported components of coconut water and other studies of their effect in animal and human body. Vitamins, minerals, amino acids and phytohormones are present in coconut water. The recent discovery of other medicinal values of coconut water signifies a good potential in improving human health. The potential anti-cancer properties of specific cytokines could bring encouraging and novel perspectives in finding cures for the different types of cancers. The recent discovery of other medicinal values of coconut water signifies a good potential in improving human health. It is a gift of nature for best remedial for thirst and providing better health. Antioxidant effect and anti cancer properties of different components of it give a better choice for removing the poisoning effect of other food which is part of modern life. Further research is required to understanding of the functions and properties of the individual components of coconut water will help us to better utilize this marvelous and multidimensional liquid with special biological properties from nature.

**KEY WORDS :** Coconut water, Amino acids, vitamins, Cardio vascular diseases, Phytohormone, Inorganic ions,

## Introduction

Coconut water, the clear liquid inside immature green coconuts, is highly valued due

to its nutritional and therapeutic properties. It has been successfully used in several parts of the world for oral rehydration, treatment of childhood diarrhea, gastroenteritis and cholera. This juice is mostly consumed locally as fresh in tropical areas since it deteriorates easily once exposed to air. Commercially, it is thermally processed using ultra high temperature (UHT) technology. However, coconut water loses its delicate fresh flavor and some of its nutrients during heating. A non-thermal process is desirable to protect the fresh flavor and nutrient content of coconut water,

<sup>1</sup>Associate Professor of Biochemistry and Central Laboratory Head,

<sup>2</sup>Assistant Professor of Microbiology, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry.

### \*Corresponding Author

Dr. E.Prabhakar Reddy,  
Associate Professor of Biochemistry and Central lab Head,  
Sri Lakshmi Narayana Institute of Medical Sciences,  
Osudu, Agaram Village, Puducherry-605502, India.  
E-mail: drpebyreddy@yahoo.com  
Telephone Number: +919159186879

which would increase marketability of this healthy drink and availability to consumers throughout the world. It is high in electrolyte content and has been reported as an isotonic beverage due to its balanced electrolytes like sodium and potassium that help restore losses of electrolytes through skin and urinary pathways. Coconut water was claimed as a natural contender in the sports drink market with its delicate aroma, taste and nutritional characteristics together with the functional characteristics required in a sports drink (Food and Agricultural Organization [FAO]). The constituents of coconut water are water 94%, sugars such as glucose, fructose and sucrose around 5%, proteins around 0.02% and lipids only about 0.01%. It is rich in minerals such as potassium, calcium, magnesium and manganese, and low in sodium.

Most coconut water is consumed fresh in tropical coastal areas due to its short Shelf-life. Once exposed to air, it loses most of its sensory and nutritional characteristics and deteriorates. Commercially, juice production is carried out mostly in Indonesia, the Philippines, and Thailand using ultra high temperature (UHT) sterilization while some of Coconut water's nutrients and its delicate flavor are lost during this thermal processing, which limits the product's marketability. In India coconut water is consumed fresh juice production and Coconut oil is used as cooking oil only in Kerala, certain areas of Karnataka, Tamil Nadu and in some parts of North Eastern states. But coconut oil and virgin coconut oil do have a worldwide market in health care, skin care, baby oil and cosmetic industries.

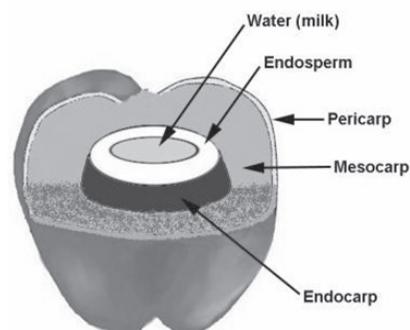
Coconut water is far more effective in relieving symptoms associated with these conditions than either plain water or fruit juice. Over the past two decades coconut water has been used extensively as a treatment for cholera, dysentery, influenza, and other infectious

diseases that promote dehydration. Coconut water has saved thousands of lives, especially of children in underdeveloped countries. Ordinary water is not effective in treating severe dehydration caused by vomiting and diarrhea, but because of coconut water's unique chemical composition it is able to rehydrate the body and give it the strength and energy it needs to fight off the infection.

### Coconut Water: Composition and Characteristics

The coconut (*Cocos nucifera* Linn.) fruit, egg-shaped or elliptic, consists of a fibrous outer layer called coconut husk (mesocarp), which covers a hard layer called shell (endocarp). Inside the shell is a kernel (endosperm), which is considered the most important part of the fruit. It is the source of various coconut products such as copra, i.e. the dried meat of mature fruit with 5% water content, coconut oil, coconut milk, coconut water and coconut powder. The cavity within the kernel contains coconut water (Figure: 1). This part begins to form as a gel when the coconut is about 5 to 6 months old, becomes harder and whiter as coconut matures, and the inside is filled with coconut water. An immature coconut between 6 to 9 months contains about 750 mL of water that eventually becomes the flesh (FAO ).

Figure: 1. Cross section of coconut (*Cocos nucifera*) fruit



Coconut water is not only a tropical beverage but also a traditional medicine [1],

a microbiological growth medium [2] and a ceremonial gift [3], and can be processed into vinegar [4] or wine [5]. These various uses are possible thanks to the original biochemical composition of the juice. The particular mineral composition and reasonable total sugar content make coconut water a natural isotonic liquid. The characteristics of coconut water make it an ideal rehydrating and refreshing drink after physical exercise [6].

Current research on coconut water is rare and mainly focuses on i) specific uses (10%), ii) biochemical composition (50%) and iii) preservation techniques (40%). This review on coconut water is the first part of a global synthesis on the topic. It presents its uses, from the traditional to the most sophisticated; details its biochemical composition, influenced by the stage of maturity and the variety; and describes its original properties.

## Uses

### As a religious symbol:

As it is a sterile and pure liquid, coconut water has been a religious symbol for a long time. In Asia, especially in India, tender, i.e., immature, coconuts are offered as ceremonial gifts and serve as purification media at traditional events [3].

### As a natural beverage:

Centuries ago, Polynesian, Melanesian and Micronesian mariners used coconut fruits as reserves of food and drink [7]. Thanks to this “naturally canned” beverage, they survived on their journeys from one island to the next and colonised the entire Pacific Ocean. Nowadays, coconut water from immature nuts is still consumed as a refreshing drink by thousands of inhabitants of tropical regions.

### As medicine:

Apart from its consumption as a natural drink,

one of the most important uses of coconut water is medicinal [8]. In the Indian ayurvedic medicine, it is described as “unctuous, sweet, increasing semen, promoting digestion and clearing the urinary path” [3]. There are numerous references to medicinal uses of coconut in Sri Lanka, a country where coconut is consumed on a daily basis [1]. Out of the 40 raw or processed parts of the coconut plant cited by Ediriweera [1], five involve coconut water.

Coconut water is traditionally prescribed for burning pain during urination, dysuria, gastritis, burning pain of the eyes, indigestion and hiccups or even expelling of retained placenta. In case of emergency in remote regions of the world and during World War II, coconut water was used as a short-term intravenous hydration and resuscitation fluid [9-10]. Sugars are the main fraction of soluble solids in coconut water [11-12]. The main sugars in mature coconut water are sucrose, sorbitol, glucose and fructose [13-14], followed by minor sugars including galactose, xylose and mannose. Besides sugars, minerals and proteins, a minor fraction is composed of aromatic compounds. Coconut water has a specific taste and flavour, different from the well-known fragrance of the coconut kernel. This beverage has a typical aroma per se which has never been fully characterised. Like organic acids composed of malic, succinic citric, acetic and tartaric acids [15-16], which contribute to the taste of coconut water, volatile compounds contribute to the aroma of the fresh liquid.

The antioxidant ability of coconut water was recently studied by a few authors [2-6] the increasing interest in the nutraceutical properties of natural products. Among 27 tropical fruits purchased in supermarkets and wholesale outlets in Singapore, coconut water had the lowest AEAC (L-ascorbic acid equivalent antioxidant capacity): 11.5 AEAC

(mg·100 g<sup>-1</sup>) and an ascorbic acid (AA) content of 0.7 mg·100 g<sup>-1</sup> [14]. The coconut kernel had higher values than the coconut water. The proportion of ascorbic acid in the AEAC of fruits varied greatly among species, from 0.06% in ciku (*Manilkara zapota*) to 70.2% in rambutan; it was only 6.1% for coconut water.

Coconut water was significantly sweeter, caused less nausea, fullness and no stomach upset. It was also easier to drink in large quantities than the carbohydrate-electrolyte beverage and plain water. Concerning blood pressure, a mixture of coconut water and Mauby bark syrup (*Colubrina arborescens*) from Trinidad and Tobago could have a beneficial effect on human hypertension [17]. Similarly, the presence of L-arginine (300 mg·L<sup>-1</sup>) in coconut water could have a cardio protective effect through its production of nitric oxide, which favours vasorelaxation [18]. A similar hypolipidemic effect of coconut water and lovastatin (a lipid-lowering drug) was detected in rats fed a fat/cholesterol-enriched diet [19].

Concerning nutraceutical effects, coconut water reduced histopathological changes in the brain induced by hormonal imbalance in menopausal women [20]. A patented freeze-dried product, named Cococin, was the main component of a dietary supplement and an anti-ageing skin cream [21]. Finally, the anti-cancer properties of cytokinins previously isolated from coconut water [20-21] recently been the subject of medical research [22-27]. One of these cytokinins, kinetin, shows an antithrombotic activity [28] and a real potential power to reduce certain types of mammalian tumors [29].

Coconut water is not a common fruit juice. Its low acidity combined with well-balanced sugar content and isotonic mineral composition makes it a potential rehydration and sport drink. Quality criteria such as the water per

nut ratio, Total Soluble Solids content (TSS), total sugar per nut, [reducing sugars / total sugars] ratio, and, to a lesser extent, potassium content, are good indicators for estimating the suitability of coconut cultivars for the production of coconut water as a beverage. From the synthesis of biochemical data, it is clear that dwarf coconut varieties, with their small nuts, high volume of water, high sugar contents and good organoleptic scores, are the most suitable cultivars to obtain a sweet and tasty product.

Previous studies [28-29] have shown that it's great for post-exercise rehydration, has anti-inflammatory properties, protects heart and urinary tract, is a digestive tonic, improves skin and eyes, supports good immune function and can even help balance blood glucose and insulin levels. It is a great source of cytokinins plant hormones that have anti-cancer, anti-ageing, and anti-thrombolytic benefits in humans. Coconut water is the liquid part of the endosperm (kernel) of the coconut fruit. When coconuts are immature, the endosperm is semisolid and jelly-like. When it matures, the endosperm becomes more solid and fibrous and develop into firmer coconut meat. As the coconut matures, the water inside is replaced by more coconut meat and air.

### Opportunities in Research for Development

Medicinal uses of coconut oil and the effect of lauric acid Clinical tests are required to understand the benefits of consuming virgin coconut oil and the recommended intake levels required.

#### Anti-Infective Action:

In a series of papers published [16-18] in the study the anti-microbial activity of various fatty acids. They found that the medium chain fatty acids (MCF A) with 6 to 12 carbons, possessed significant activity against

gram positive bacteria, but not against gram negatives; they were also active against lipid coated viruses as well as fungi and protozoa. Saturated fatty acids, longer than 14 carbons long had no such activity. And of the MCFA, lauric acid (C12:0) was most potent, particularly in its monoglyceride form (monolaurin); it was more active than caprylic acid (C-8) capric acid (C-10) or myristic acid (C-14). The dilaurin and trilaurin (di and triglycerides) had no activity. This finding has found use in the incorporation of monolaurin in cosmetic products and mouth washes; but although classified by the USFDA as GRAS (Generally Regarded as Safe), its oral use for systemic infections has not been tried.

### HIV-AIDS Patients and the Coconut

According to previous study [30], the AIDS organization, Keep Hope Alive, has documented several HIV -AIDS patients whose viral load fell to as low as undetectable levels, when they took coconut oil or ate coconut (half a coconut a day) or when they added coconut to their anti-HIV medication (anti protease and/or antiretrovirals) that had previously not been effective. The amount of coconut oil consumed (50 ml or 3 1/2 tablespoonfuls) or half of a coconut, would contain 20-25 grams of lauric acid, which indicates that the oil is metabolized in the body to release lauric acid and/or monolaurin.

Coconut water's rich enzyme systems include very effective and selective reductase [31], polyphenol oxidase (PPO) and peroxidase (POD). These are involved in its development of a brownish colour when it is exposed to air for a long time [30]. Based on its content and properties, coconut water has been used in the treatment of child and adult diarrhoea, and gastroenteritis as well as for urinary stone dissolution, short-term intravenous hydration and protecting against gastrointestinal tract infections [32].

### Chemical Composition of Coconut Water

#### Phytohormones:

Phytohormones are a group of naturally occurring organic compounds that play crucial roles in regulating plant growth in a wide range of developmental processes. Initially, the term phytohormone was synonymous with auxin. Later on, the other plant growth regulators such as gibberellins (GAs), ethylene, cytokinins, and abscisic acid (ABA) were categorized together with auxins as the "classical five" hormones [33]. Coconut water contains auxin, various cytokinins, and gibberellins. [30-33].

#### Auxin

Coconut water contains indole-3-acetic acid (IAA), the primary auxin in plants [34,35]. IAA is a weak acid (pKa = 4.75) that is synthesized in the meristematic regions located at the shoot apex and subsequently transported to the root tip in plants [36]. For many years, tryptophan was assumed to be the precursor of IAA and this was later confirmed using experiments involving seedlings of *Phaseolus vulgaris* subjected to stable isotope labeling studies [37]. IAA occurs not only in the free form, but is also conjugated to various amino acids, peptides, or carbohydrates. These IAA conjugates are biologically inactive and appear to be the IAA storage forms in seeds and are probably involved in hormonal homeostasis [38].

Auxin is implicated in many regulatory processes in plants especially those relating to plant growth and development [39-40]. Auxin functions in the relay of environmental signals such as light and gravity, the regulation of branching processes in shoots and roots, and as discovered more recently, the patterned differentiation of cells in meristems and immature organs [39]. Undoubtedly, it is

a versatile spatial-temporal signal. Auxin transport generates auxin concentration maxima and gradients within tissues that are instrumental in the diverse regulation of various plant developmental processes, including embryogenesis, organogenesis, vascular tissue formation and tropisms. The unique signal molecule transport mechanism of auxin to a large extent underlies the remarkable developmental plasticity of plants that allows their growth and architecture to fit the environment changing [41].

### Cytokinins

Cytokinins, being able to induce plant cell division, were discovered in the 1950s [42–44]. Natural cytokinins are N<sup>6</sup>-substituted adenine derivatives with various substituted groups, and the physicochemical behaviour of cytokinins is a function of side chain(s), sugar, phosphate and degree of purine ring and/or side chain modification [44].

### Vitamins

Vitamins, which are essential for the normal functioning of the human body, are also found in coconut water. Greater consumption of fruits and vegetables is associated with the reduced risk of cardiovascular disease, stroke, and cancers of the mouth, pharynx, esophagus, lungs, stomach, and colon [45–48], because they contain vitamins and minerals vital for normal physiological functions [49]. Coconut water contains vitamins B1, B2, B3, B5, B6, B7 and B9. The B vitamins are water-soluble and are required as coenzymes for enzymatic reactions essential for cellular function [50]. Vitamin B6 (which includes pyridoxal, pyridoxine and pyridoxamine) serves as a coenzyme in various enzymatic reactions, such as the transamination and decarboxylation reactions [51]. For example, it is the coenzyme of  $\gamma$ -cystathionase [52], which catalyses the cleavage of cystathionine,

releasing  $\alpha$ -ketobutyrate and cysteine [53]. The  $\alpha$ -ketobutyrate molecule is subsequently converted into succinyl-CoA and fed to the tricarboxylic acid (TCA) cycle while cysteine is involved in protein and glutathione biosynthesis [54–55]. Vitamin B6 deficiency can affect various processes of the body, such as inflammation and renal function [50].

Coconut water contains folate, also known as vitamin B9. It was identified in the late 1930's as the nutrient required to reduce anemia during pregnancy [56]. It can prevent mitochondrial toxicity induced by methanol metabolites. In addition, the active form of folate, 5-methyltetrahydrofolate is believed to be one of the central methyl donors required for mitochondrial protein and nucleic acid synthesis [57]. Lower blood levels of vitamin B6 and folate can increase the risk for atherosclerosis and other vascular diseases [58]. Another study found that high plasma levels of vitamin B6 and folate may reduce the risk for breast cancer [57–58]. In addition to vitamin B, coconut water also contains vitamin C, which is an important dietary antioxidant [57–59].

Furthermore, micronutrients (nutrients needed in small quantities) such as inorganic ions and vitamins in coconut water play a vital role in aiding the human body antioxidant system [60]. Hyper metabolism gives rise to an increased production of reactive oxygen species (or free radicals), as a result of increased oxidative metabolism. Such increase in free radicals will cause oxidative damage to the various components of the human cell, especially the polyunsaturated fatty acids in the cell membrane, or to the nucleic acids in the nucleus [60]. Fortunately, living organisms have well developed antioxidant systems to neutralize the most detrimental effects of these oxidizing species. Micronutrients have important functions in this aspect. For

example, they act directly to quench free radicals by donating electrons, or indirectly as a part of metallo enzymes (a diverse class of enzymes that require a catalytic metal ion for their biological activity) such as glutathione peroxidase (selenium) or superoxide dismutase (zinc, copper) to catalyse the removal of oxidizing species [61].

Nutritional Benefits in Health and Wealth and in Health and Disease

### **Coconut water has five electrolytes that the body needs**

**Potassium** -The most important positive ion (cation) inside your cells. Potassium regulates heart beat and muscle function

**Sodium**- The most important positive ion in fluid outside your cells, and also the one most depleted with exercise, as you lose sodium through sweat and urine

**Magnesium**- Important for maintaining the electrical potential of your cells, proper muscle function and preventing calcium overload

**Phosphorous**-Play important roles in bone health in transferring energy throughout your body, helping your muscles contract and regulating nerve function (partners with calcium)

**Calcium**- Important for bone health (partners with phosphorous)

Cytokinins are phytohormones or plant hormones. These hormones regulate the growth development and aging of a plant. Coconut water has been an important horticultural resource used in the propagation of several plants including orchids and traditional Chinese medicinal herbs. The cytokinins found in coconut water support cell division and promote rapid growth. Cytokinins have actually been found to

exert an antiaging effect on human cells and tissues. When human cells are exposed to cytokinins aging slows down considerably. Cells treated with cytokinins don't undergo normal degenerative changes. Researchers have suggested that if you consume a diet rich in cytokinins, you may experience anti-aging effects and have less risk for degenerative and age-related diseases. Coconut water is the richest natural dietary source of cytokinins. Cytokinins have also been found to have anti-thrombolytic properties so may lower your risk for blood clots. But coconut's health benefits doesn't stop there. They have also been shown to have anti-cancer effects.

Coconut development board of India reported the following effect of tender coconut water, Good for feeding infants suffering from intestinal disturbances, Oral rehydration medium,• Contains organic compounds possessing growth promoting properties, Keeps the body cool, Application on the body prevents prickly heat and summer boils and subsides the rashes, caused by small pox, chicken pox, measles, etc., Kills intestinal worms, Presence of saline and albumen makes it a good drink in cholera case, Checks urinary infections, Excellent tonic for the old and sick, Cures malnourishment, Diuretic. Effective in the treatment of kidney and urethral stones, Can be injected intravenously in emergency case, Found as blood plasma substitute because it is sterile, does not produce heat, does not destroy red blood cells and is readily accepted by the body, Aids the quick absorption of the drugs and makes their peak concentration in the blood, easier by its electrolytic effect, Urinary antiseptic and eliminates poisons in case of mineral poisoning.

### **Components in tender coconut water**

**Sugars:** Tender coconut water has glucose, fructose and sucrose sugars which are main

energy provider in the metabolism of human body. Concentration of sugar in coconut water increases with maturity of nut. When compared to other sugars, sucrose quantity is more in matured nut

#### **Minerals:**

Minerals such as potassium, sodium, calcium, phosphorous, iron, copper, sulphur and chlorides are present in coconut water. Potassium rich tender coconut water increases the urinary output [62].

#### **Iron:**

Iron is needed for a number of highly complex processes that continuously take place on a molecular level and that are indispensable to human life, e.g. the transportation of oxygen around human body. Iron is also involved in the conversion of blood sugar to energy [63].

#### **Copper:**

Copper is a trace element present in all tissues and is required for cellular respiration, peptide amidation, neurotransmitter biosynthesis, pigment formation, and connective tissue strength [64].

#### **Chlorides:**

Chloride ions (Cl<sup>-</sup>) are important in joining with hydrogen ions to make HCl in stomach acid. Chloride (Cl<sup>-</sup>) and bicarbonate (HCO<sub>3</sub><sup>-</sup>) are used to help maintain the blood's pH level. Different concentrations of Cl<sup>-</sup> are either aide or hinder the passing of signals from one nerve cell to another[65].

#### **Amino Acids:**

Small amounts of amino acids are present in coconut water. The percentage of arginine, alanine, cystine and serine in the protein of tender coconut water are higher than those in cow's milk. Trace amount of amino acid such as aspartic acid, glutamic acid, histidine,

leucine, lysine, proline, phenylalanine and tyrosine are reported in tender coconut water. Amino acid is important not only as building material for animal body, it has major other property such as energy source (body converts amino acid into glucose), helps produce lymphocytes, which are cells in human lymph fluid and bloodstream that are vital to immune system. It may help regulate blood sugar; helps reduce symptoms of prostate enlargement in men, helps adrenal gland function etc. [62,66].

#### **Vitamins:**

Tender coconut water contains both ascorbic acid and vitamins of B group those are Nicotinic acid, Pantothenic acid, Biotin, Riboflavin, Folic acid and Thiamine. The concentration of ascorbic acid ranges from 2.2 to 3.7mg per ml, which gradually diminishes as the kernel surrounding the water begins to harden. Vitamins play a vital role in many metabolic pathways, healthy cellular activity which therefore can guide against infections. It is also essential for the structure of bones, cartilage, muscle and blood vessels, and maintenance of capillaries and gums and the absorption of iron [62,67]. Vitamin containing fruits helps to reduce risk of cardiovascular disease, stroke, and cancer [66-67].

Coconut oil kept at room temperature for many months does not turn rancid as against other oils. It has been established that coconut oil reduces the need for Vitamin E. Coconut oil does not produce atherosclerosis. There are dozens of animal and human studies in world literature to disprove allegations about coconut oil enhancing the risk of a CAD. There is not even one paper in the whole literature directly showing that coconut oil increases cardiac diseases. In fact, coconut oil is neutral with respect to atherogenicity.

Coconut water has a therapeutic effect on the urinary and reproductive systems. It is reported

to clear-up bladder infections, remove kidney stones, and improve sexual vitality. Medical research has shown that the consumption of coconut water can be very effective in dissolving kidney stones. Dr. Eugenio Macalalag [68], director of the urology department of the Chinese General Hospital in the Philippines, says that coconut water has demonstrated its effectiveness in patients suffering from kidney and urethral stones. He reports that consuming coconut water only 2 to 3 times a week results in a significant reduction in stone size and expulsion, eliminating the need for surgery [68].

In Jamaica coconut water is known as a heart tonic and is used to strengthen the heart and improve circulation. Research bears this out. Animal studies show that coconut water consumption reduces plaque formation in arteries, thus reducing risk of heart attack and stroke. High blood pressure is one of the primary risk factors associated with heart disease and stroke. The minerals potassium and magnesium are known to help reduce high blood pressure. Human studies show that coconut water, which is a good source of both of these minerals, is effective in reducing high blood pressure and increasing circulation [69]. Studies also demonstrate that coconut water consumption reduces the risk of heart failure in heart disease patients [70]. The evidence is so convincing that the FDA allows coconut water to carry the claim that it —may reduce the risk of high blood pressure and stroke. Because coconut water improves blood circulation, it is of benefit to diabetics. Coconut water helps dilate blood vessels, improves blood flow, and reduces plaque formation. Coconut water also contains certain forms of dietary fiber and amino acids that help moderate sugar absorption and improve insulin sensitivity. However, more research is needed to clearly understand the many good effects of the oil.

Coconut and coconut related products help in maintaining wellness with a range of health benefits. There are an array of medicines, creams and ayurvedic oils which are made with coconut oil as basic medium. Virgin Coconut Oil (VCO) contains lots of vitamins, minerals and anti oxidants. VCO is a major source of lauric acid and Vitamin E. Coconut is a good source of dietary fiber known to be valuable in digestive function. Desiccated coconut contains the highest percentage of dietary fiber and due to this there is increasing demand for the desiccated coconut in many developed countries.

### **Summary of the Nutritional Benefits of Coconut Water**

Coconut water contains a complex blend of vitamins, minerals, amino acids, carbohydrates, antioxidants, enzymes, health enhancing growth hormones, and other important nutrients. Because its electrolyte (ionic mineral) content is similar to human plasma, it has gained international acclaim as a natural sports drink for oral rehydration. As such, it has proven superior to commercial sports drinks. Unlike other beverages, it is completely compatible with the human body, in so much that it can be infused directly into the bloodstream. In fact, doctors have used coconut water successfully as an intravenous fluid for over 60 years. Published medical research and clinical observation have shown that coconut water:

Makes an excellent oral rehydration sports beverage - replaces electrolytes from exercise, heat stress and illness, Aids in exercise performance, Natural isotonic beverage - contains the same level of electrolytes found in human blood, Has 15 times the amount of potassium as most sports and energy drinks (264 mg vs. 12.5 mg /100 ml), Reduces problems for infants suffering from intestinal disturbances.

**Cardio protective:** helps regular blood pressure (due to high potassium); improves circulation, Reduces swelling in hands and feet, Prevents abnormal blood clotting, Aids in kidney function including those with kidney stones; Nutritional support for those with urinary tract/bladder problems, Helps balance blood sugar in diabetics, Improves digestion, Reported by some people to reverse cataracts, Contains nutrients that feed friendly gut bacteria, Helps relieve constipation or diarrhea, Possesses anti-aging properties, Nutritional support for healthy skin: restores strength and elasticity to skin; reduces age spots; reduces wrinkles and sagging, Regulates the functioning of the intestine which promotes smoother, more hydrated skin, Enhances healing of wounds and lesions, Supports good vision and provides nutritional support in those who have a tendency towards glaucoma, Contains potent antioxidants, Nutritionally supports immune function, Provides nutrients important in preventing osteoporosis.

## Conclusions

Coconut water, being a refreshing beverage, provides important health benefits. The chemical components which contribute to its bioactivity are essential to the plant industry, biotechnology and biomedical fields. Undoubtedly, cytokinins are currently the most important components in coconut water. Significant advances were made in understanding the biological functions of the various cytokinins in both plant and human systems. The potential anti-cancer properties of specific cytokinins could bring encouraging and novel perspectives in finding cures for the different types of cancers. The recent discovery of other medicinal values of coconut water signifies a good potential in improving human health. Better insights and understanding of the functions and properties

of the individual components of coconut water will, therefore, help us to better utilize this marvelous and multidimensional liquid with special biological properties from nature. Coconut and coconut related products help in maintaining wellness with a range of health benefits. It is a gift of nature for best remedial for thirst and providing better health. Antioxidant effect and anti cancer properties of different components of it give a better choice for removing the poisoning effect of other food which is part of modern life. There is increasing scientific evidence that supports the role of coconut water in health and medicinal applications.

## References

1. Ediriweera E.R.H.S.S. 2003. Medicinal uses of coconut (*Cocos nucifera* L.), *Cocoinfo Int.* 10: 11–21.
2. Osazuwa O.E, Ahonkhai I. 1989. Coconut water as growth medium for micro-organisms, *Niger. J. Palms Oil Seeds.* 10–11:91–95.
3. Rethinam P, Kumar T.B.N. 2001. Tender coconut –an overview, *Indian Coconut J.* 32 :2–22.
4. Sanchez P.C, Collado L.S, Gerpacio C.L, Lapitan H. 1985. Village level technology of processing coconut water vinegar, *Philipp. Agric.* 439–448.
5. Augustine S.P. 2007. Wine produced using tender coconut and product, Patent US2007/ 017897 A1, Inde.
6. Saat M, Singh R, Gamini Sirisinghe R, Nawawi M. 2002. Rehydration after exercise with fresh young coconut water, carbohydrate electrolyte beverage and plain water, *J. Physiol. Anthropol. Appl. Hum. Sci.* 21: 93–104.
7. Bourdeix R, Konan J.L, N'Cho Y.P. 2005. Coconut: a guide to traditional and improved varieties, Ed. *Diversiflora*, Montpellier, France. Editions *Diversiflora.* 104 p.
8. Nanda Kumar T.B. 1990. Tender coconut water: nature's finest drink, *Indian Coconut J.* 21: 14–18.
9. Campbell-Falck D, Thomas T, Falck T.M, Tutuo N, Clem K. 2000. The intravenous use of coconut water, *Am. J. Emerg. Med.* 18: 108–111.
10. Pummer S, Heil P, Maleck W, Petroianu G. 2001. Influence of coconut water on hemostasis, *Am. J. Emerg. Med.* 19: 287–289.

11. Lapitan O.B, Mabesa R.C. 1983. Chemical and sensory characteristics of Laguna and Golden coconuts (*Cocos nucifera* L.), *Philipp.Agric.* 66: 144–150.
12. Pue A.G, Rivu W, Sundarrao C, Singh K. 1992. Preliminary studies on changes in coconut water during maturation of the fruit, *Sci. New Guin.* 18: 81–84.
13. Del Rosario J.E, Bergonia H.A, Flavier M.E, Samonte J.L, Mendoza E.M.T. 1984. Chromatographic analysis of carbohydrates in coconut water, *Trans. the Natl. Acad. Sci. Technol.* 6: 127–151.
14. Ogundiya M.O. 1991. Glucose content of nut water in four varieties of coconut palm (*Cocos nucifera*), *J. Sci. Food Agric.* 56: 399–402.
15. Unagul P, Assantachai C, Phadungruengluij S, Suphantharika M, Tanticharoen M, Verduyn C. 2007. Coconut water as a medium additive for the production of docosahexaenoic acid (C22:6 n3) by *Schizochytrium mangrovei* Sk-02, *Bioresour. Technol.* 98: 281–287.
16. Santoso U, Kubo K, Ota T, Tadokoro T, Maekawa A. 1996. Nutrient composition of kopyor coconuts (*Cocos nucifera* L.), *Food Chem.* 57: 299–304.
17. Alleyne T, Roache S, Thomas C, Shirley A. 2005. The control of hypertension by use of coconut water and mauby: two tropical food drinks, *West Indian Med. J.* 54: 3–8.
18. Anurag P, Sandhya V, G, Rajamohan T. 2007. Cardioprotective effect of tender coconut water, *Indian Coconut J.* 37: 22–25.
19. Sandhya V.G, Rajamohan T. 2008. Comparative evaluation of the hypolipidemic effects of coconut water and lovastatin in rats fed fatcholesterol enriched diet, *Food Chem. Toxicol.* 46 :3586–3592.
20. Radenahmad N, Saleh F, Sawangjaroen K, Rundorn W, Withyachumnarnkul B. 2009. Connor J.R., Young coconut juice significantly reduces histopathological changes in the brain that is induced by hormonal imbalance: a possible implication to postmenopausal women, *Histol. Histopathol.* 24 :667–674.
21. Prakash L. 2008. Natural ingredients nurture skin health from the inside and out, *NutraCos.* 7:6–9.
22. Ge L, Peh C.Y.C, Yong J.W.H, Tan S.N., Hua L, Ong E.S. 2007. Analyses of gibberellins by capillary electrophoresis–mass spectrometry combined with solid–phase extraction, *J. Chromatogr. A.* 1159: 242–249.
23. Ge L, Yong W.H, Tan S.N, Yang X.H, Ong E.S. 2004. Analysis of some cytokinins in coconut (*Cocos nucifera* L.) water by micellar electrokinetic capillary chromatography after solidphase extraction, *J. Chromatogr. A.* 1048: 119–126.
24. Ge L, Yong J.W.H, Goh N.K, Chia L.S, Tan S.N, Ong E.S. 2005. Identification of kinetin and kinetin riboside in coconut (*Cocos nucifera* L.) water using a combined approach of liquid chromatography–tandem mass spectrometry, high performance liquid chromatography and capillary electrophoresis, *J. Chromatogr. B.* 829: 26–34.
25. Ge L, Yong J.W.H, Tan S.N., Hua L, Ong E.S. 2008. Analyses of gibberellins in coconut (*Cocos nucifera* L.) water by partial filling micellar electrokinetic chromatography mass spectrometry with reversal of electroosmotic flow, *Electrophoresis.* 29: 2126–2134.
26. Ge L, Yong J.W.H, Tan S.N, Ong E.S. 2006. Determination of cytokinins in coconut (*Cocos nucifera* L.) water using capillary zone electrophoresis–tandem mass spectrometry, *Electrophoresis.* 27 :2171–2181.
27. Ge L, Yong J.W.H, Tan S.N, Yang X.H, Ong E.S. 2006. Analysis of cytokinin nucleotides in coconut (*Cocos nucifera* L.) water using capillary zone electrophoresis–tandem mass spectrometry after solid–phase extraction, *J. Chromatogr. A.* 1133: 322–331.
28. Hsiao G, Shen M.-Y, Lin K.-H, Chou C.-Y, Tzu N.-H, Lin C.-H, Chou D.-S, Chen T.-F, Sheu J.-R. 2003. Inhibitory activity of kinetin on free radical formation of activated platelets in vitro and on thrombus formation in vivo, *Eur. J. Pharmacol.* 465: 281–287.
29. Vermeulen K, Strnad M, Krytof V, Havlíck L, Van der Aa A, Lenjou M, Nijs G, Rodrigus I, Stockman B, van Onckelen H, Van Bockstaele D.R, Berneman Z.N. 2002. Antiproliferative effect of plant cytokinin analogues with an inhibitory activity on cyclindependent kinases, *Leukemia* 16: 299–305.
30. Matsui KN, Gut JAW, de Oliveira PV, Tadini CC. 2008. Inactivation kinetics of polyphenol oxidase and peroxidase in green coconut water by microwave processing, *Journal of Food Engineering,* 88:169–176.
31. Fonseca AM, Monte FJQ, da Conceic M, de Oliveiraaão F. 2009. Coconut water (*Cocos nucifera* L.) – A new biocatalyst system for organic synthesis. *Journal of Molecular Catalysis B: Enzymatic.* 57:78–82.

32. Mandal SM, Dey S, Mandal M, Sarkar S, Maria-Neto S, Franco OL. 2009. Identification and structural insights of three novel antimicrobial peptides isolated from green coconut water. *Peptides*. 30:633–637.
33. Kende, H, Zeevaart. J. 1997. The five “Classical” plant hormones. *Plant Cell*. 9: 1197–1210.
34. Ma, Z, Ge, L, Lee, A.S.Y, Yong, J.W.H Tan, S.N, Ong, E.S. 2008. Simultaneous analysis of different classes of phytohormones in coconut (*Cocos nucifera* L.) water using high-performance liquid chromatography and liquid chromatography-tandem mass spectrometry after solid-phase extraction, *Anal. Chim. Acta*. 610: 274–281.
35. Wu, Y, Hu, B. 2009. Simultaneous determination of several phytohormones in natural coconut juice by hollow fiber-based liquid-liquid-liquid microextraction-high performance liquid chromatography, *J. Chromatogr. A*. 1216: 7657–7663.
36. Blakeslee, J.J, Peer, W.A, Murphy, A.S. 2005. Auxin transport. *Curr. Opin. Plant Bio*. 8; 494–500.
37. Bialek, L, Michalczyk, L, Cohen, J.D. 1992. Auxin biosynthesis during seed germination in *Phaseolus vulgaris*. *Plant Physiol*. 100,: 509–517.
38. Jakubowska, A, Kowalczyk, S. 2005. A specific enzyme hydrolyzing 6-O(4-O)-indole-3-ylacetyl- $\beta$ -d glucose in immature kernels of *Zea mays*. *J. Plant Physiol*. 162 :207–213.
39. Berleth, T, Krogan, N.T, Scarpella, E. 2004. Auxin signals - turning genes on and turning cells around. *Curr. Opin. Plant Bio*. 7: 553–563.
40. Dharmasiri, N, Dharmasiri, S, Weijers, D, Lechner, E, Yamada, M, Hobbie, L, Ehrismann, J.S, Jurgens, G, Estelle. 2005. M. Plant development is regulated by a family of auxin receptor F Box proteins. *Dev. Cell*. 9:109–119.
41. Robert, H.S, Friml, J. 2009. Auxin and other signals on the move in plants. *Nat. Chem. Biol*. 5: 325–332.
42. Miller, C.O, Skoog, E, Von Saltza, M.H, Strong, F.M. Kinetin. 1955. a cell division factor from deoxyribonucleic acid. *J. Am. Chem. Soc*. 77: 1392–1393.
43. Werner, T, Motyka, V, Strnad, M, Schmulling, T. 2001. Regulation of plant growth by cytokinin. *Proc. Natl. Acad. Sci. USA*. 98: 10487–10492.
44. Amasino, R.M. 2005. Kinetin arrives. The 50th anniversary of a new plant hormone. *Plant Physiol*. 138: 1177–1184.
45. Gillman, M.W, Cupples, L.A, Gagnon, D, Posner, B.M, Ellison, R.C, Castelli, W.P, Wolf, P.A. 1995. Protective effect of fruits and vegetables on development of stroke in men. *J. Am. Med. Assoc*. 273: 1113–1117.
46. Joshipura, K.J, Hu, F.B, Manson, J.E, Stampfer, M.J, Rimm, E.B, Speizer, F.E, Colditz, G, Ascherio, A, Rosner, B, Spiegelman, D, Willett, W.C. 2001. The effect of fruit and vegetable intake on risk for coronary heart disease. *Ann. Intern. Med*. 134: 1106–1114.
47. Bazzano, L.A, He, J, Ogden, L.G, Loria, C.M, Vupputuri, S, Myers, L, Whelton, P.K. 2002. Fruit and vegetable intake and risk of cardiovascular disease in US adults: The first national health and nutrition examination survey epidemiologic follow-up study. *Am. J. Clin. Nutr*, 76: 93–99.
48. Riboli, E, Norat, T. 2003. Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk, *Am. J. Clin. Nutr*. 78: 559–569.
49. Tucker, G.A, Roberts, J.A. 2000. *Plant Hormone Protocols*; Humana Press Inc.: Totowa, NJ, USA. pp 200
50. Depeint, F, Bruce, W.R, Shangari, N, Mehta, R, O’Brien, P.J. 2006. Mitochondrial function and toxicity: Role of B vitamins on the one-carbon transfer pathways. *Chem. Biol. Interact*, 163: 113–132.
51. Garrett, R.H. Grisham, G.M. 2005. *Biochemistry*, 3rd ed.; Thomson Brooks/Cole: Belmont, CA, USA.
52. Matsuo, Y, Greenberg, D.M. 1958. A crystalline enzyme that cleaves homoserine and cystathionine: III. Coenzyme resolution, activators, and inhibitors. *J. Biol. Chem*. 234: 507–515.
53. Carroll, W.R, Stacy, G.W, du Vigneaud, V. 1949.  $\alpha$ -Ketobutyric acid as a product in the enzymatic cleavage of cystathionine. *J. Biol. Chem*. 180: 375–382.
54. Conn, E.E, Stumpf, P.K. 1972. *Outlines of Biochemistry*, 3rd ed.; John Wiley & Sons, Inc.: New York, NY, USA; pp. 436–437.
55. Lieberman, M, Marks, A.D, Smith, C. 2007. *Mark’s Essentials of Medical Biochemistry. A Clinical Approach*; Lippincott Williams & Wilkins: Baltimore, MD, USA.
56. Goh, Y.I, Koren, G. 2008. Folic acid in pregnancy and fetal outcomes. *J. Obstet. Gynaecol*. 28: 3–13.
57. Shenkin, A. 2006. The key role of micronutrients. *Clinical Nutr*. 25: 1–13.

58. Robinson, K, Arheart, K, Refsum, H, Brattström, L, Boers, G, Ueland, P, Rubba, P, Palma- Reis, R, Meleady, R, Daly, L, Witteman, J, Graham I. 1998. Low circulating folate and vitamin B6 concentrations: Risk factors for stroke, peripheral vascular disease, and coronary artery disease. *Circulation*. 97: 437–443.
59. Rattan, S.I.S. 1994. Method and composition for ameliorating the adverse effects of aging. US Pat. 5371089.
60. Evans, P, Halliwell, B. 2001. Micronutrients: Oxidant/antioxidant Status. *Br. J. Nutr.* 85: S67–S74.
61. Matsui KN, Gut JAW, de Oliveira PV, Tadini CC. 2008. Inactivation kinetics of polyphenol oxidase and peroxidase in green coconut water by microwave processing. *Journal of Food Engineering*. 88:169–176.
62. W.H. Jean Yong, Liya Ge, Yan Fei Ng and Swee Ngin Tan. 2009. “The Chemical Composition and Biological Properties of Coconut (Cocos nucifera L.) Water, Molecules. 14: 5144– 5164.
63. C. Nancy. Andrews. 2000. “Iron metabolism: Iron Deficiency and Iron Overload”, *Genomics and Human Genetics*. 1:75–98.
64. Vishal Desai and Stephen G Kaler. 2008. “Role of copper in human neurological disorders”, *Am J Clin Nutr*. 88: 855–858.
65. J. Franz. 1971. “Gastric Function”, *Nutrition Today*. 6: 2–11.
66. Ewan Haa, Michael B. Zemelb. 2003. “Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people (review)”, *The Journal of Nutritional Biochemistry*. 14: 251–258.
67. M. Edward Brown, Martin Pollak, E. Christine, J.G, Seidman Seidman, Ya-Huei Wu Chou. 1995. “Calcium-Ion-Sensing Cell-Surface Receptors”, *The New England Journal of medicine*. 333: 234–240.
68. Macalalag, E.V. and Macalalag, A.L. Bukolysis. 1987. young coconut water renoclysis for urinary stone dissolution. *Int Surg*. 72:247.
69. Alleyne, T. 2005. The control of hypertension by use of coconut water and mauby: two tropical food drinks. *West Indian Med J*. 54:3–8.
70. Shah, N.J. 1956. Use of coco-nut water in treatment of congestive cardiac failure. *Ind Jour Med Res* ;44:341–351.