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A STUDY OF CHEMICAL COMPOSITION OF *COCOS NUCIFERA* L. (COCONUT) WATER AND ITS USEFULNESS AS REHYDRATION FLUID

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Abstract

Coconut water was evaluated as rehydration fluid in diarrhoea. Oral rehydration has been recommended in patients with diarrhoea to replace the fluid loss from gastrointestinal tract. To evaluate the feasibility and effectiveness of the coconut water, the analysis of the electrolytes, Glucose, osmolarity and pH were performed in the local samples. This study showed high variability in coconut water composition during maturation and area of cultivation. On comparison, oral rehydration salt (ORS) and sport drinks would give more sodium and chloride than the coconut water; however, the coconut water would be absorbed more easily than ORS owing to the high level of glucose. The addition of table salt to the coconut water is suggested to compensate for the sodium and chloride deficiency. In conclusion, ingestion of fresh young coconut water, a natural sterilized beverage, could be used for rehydration during mild diarrhoea.

Introduction

Coconut plant (*Cocos nucifera* L.) has long been recognized as a valuable source of various commodities for human life. The water of tender coconut, technically the liquid endosperm, is the most nutritious wholesome beverage that the nature has provided for the people of the tropics to fight the sultry heat. It has caloric value of 17.4 per 100 g. In recent years, coconut water has also assumed great nutritional significance owing to its physio-chemical nature. Dehydration caused by physical excretion, epidemic cholera, diarrhoea etc. not only reduce the quantity of water, but also loss of electrolytes primarily sodium and glucose take place. Coconut water has been used as an oral rehydration in patients with diarrhoea to replace fluid loss from the gastrointestinal tract (Chavalittamrong *et al.*, 1982), as a home glucose electrolyte solution for well-nourished children with mild diarrhoea (Adams-Bratt, 1992) and in an extreme situation such as short-term intravenous hydration fluid in a patient (Campbell-Faick *et al.*, 2000). According to the United Nations Food and Agricultural Organization (FAO) statement (Press Release SAG/84, 2000), "water found inside young coconut as biological pure, tasty and full of the salts, sugars and vitamin that are very beneficial for athletes". Recently an influence of coconut water on plasma coagulation *in vitro* was also investigated (Stefan *et al.*, 2001) and found that the influence of coconut water on haemostasis as assessed by TEG (Thermo-blastography) does not differ from the effect by an identical volume of physiological saline.

The aim of present study was to determine the physio-chemical parameters and amount of minor and trace metals of the coconut water samples collected from the Karachi city and its coastal area and to see its effectiveness as a sport drink and body rehydration fluid.

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Table 1. Amounts of minerals in the coconut water samples (mean ± standard deviation).

[Metal ions] mmol. L^{-1}	L1			L2		L3			L4
	S1	S2	S3	S1	S3	S1	S2	S3	S3
Li	1.06 ± 0.02	0.81 ± 0.02	0.85 ± 0.03	0.74 ± 0.02	0.67 ± 0.01	0.71 ± 0.00	0.92 ± 0.02	0.98 ± 0.02	0.61 ± 0.03
Na	1.43 ± 0.00	4.00 ±0.00	2.08 ±0.00	1.76 ±0.00	3.68 ±0.00	2.88 ±0.00	6.91 ±0.00	2.24 ± 0.00	9.48 ± 0.00
K	102 ± 5	48.6 ± 3	67.2 ± 4	48.6 ± 4	29.9 ± 3	40.6 ± 3	72.5 ± 5	101.8 ± 9	48.6 ± 4
Ca	17.8 ± 1.2	7.69 ± 0.8	9.04 ± 0.5	7.02 ± 0.5	6.01 ± 0.3	6.35 ± 0.11	9.04 ± 1.5	11.7 ± 0.5	6.68 ± 0.4

Table 2. Physio-chemical parameters of the coconut water samples (mean ± standard deviation).

Paeameters	L1			L2		L3			L4
	S1	S2	S3	S1	S3	S1	S2	S3	S3
Chloride mmol. L^{-1}	3.44± 0.94	5.29 ± 0.55	7.01 ± 1.50	3.46 ± 0.80	4.73 ± 1.00	5.29 ± 1.30	10.75 ± 2.10	8.95 ± 2.40	3.60 ± 0.50
Glucose g. L^{-1}	6.2 ± 0.2	4.6 ± 0.3	5.80 ± 0.3	6.3 ± 0.8	5.80 ± 0.5	6.50 ± 0.7	5.50 ± 0.6	4.70 ± 0.1	3.70 ± 0.7
Hardness g. L^{-1}	1.24 ± 0.2	0.80 ± 0.1	1.08 ± 0.3	0.80 ± 0.1	1.09 ± 0.2	0.92 ± 0.1	1.48 ± 0.2	1.52 ± 0.3	1.06 ± 0.00
TDS g. L^{-1}	5.40 ± 0.11	5.80 ± 0.09	10.40 ± 2.10	3.70 ± 0.50	4.40 ± 0.72	4.80 ± 0.80	8.50 ± 1.20	10.80 ± 1.25	4.00 ± 0.09
Osmolarity mOsm. L^{-1}	368 ± 10.8	321 ± 10.0	408 ± 15.2	412 ± 12.5	367 ± 9.6	417 ± 20.2	405 ± 17.5	387 ± 22.3	274 ± 9.3
pH	5.98 ± 0.5	5.08 ± 0.55	5.20 ± 0.65	4.90 ± 0.65	4.82 ± 0.52	5.85 ± 0.32	5.84 ± 0.62	6.06 ± 0.52	6.54 ± 0.56
Vol mL	463 ± 24	280 ± 11	152 ± 5	310 ± 25	230 ± 18	346 ± 24	275 ± 19	150 ± 27	155± 19

Locations: L1 = Hub Chowky, L2 = Gider Nasay (Malir District), L3 = Karachi University Campus, L4 = Sri Lankan
Maturation Stages: S1 = 4 – 6 months, S2 = 7 – 9 months, S3 = 10 – 12 months

Table 3. Levels of some trace metals in coconut water samples (mean ± standard deviation).

[Trace Element] mg. L^{-1}	L1			L2		L3			L4
	S1	S2	S3	S1	S3	S1	S2	S3	S3
Cr	0.01 ± 0.00	0.01 ±0.00	0.12 ± 0.01	0.02 ± 0.00	0.01 ± 0.00	0.02 ± 0.00	0.12 ± 0.02	0.14 ± 0.01	0.12 ± 0.02
Fe	0.01 ± 0.00	0.02 ± 0.00	0.01 ± 0.00	0.03 ± 0.00	0.12 ± 0.01	0.13 ± 0.02	0.22 ± 0.03	0.39 ± 0.01	0.02 ± 0.00
Mg	0.69 ± 0.03	1.09 ± 0.05	1.22 ± 0.05	1.11 ± 0.04	1.52 ± 0.04	0.12 ± 0.00	0.38 ± 0.03	0.69 ± 0.04	0.71 ± 0.05
Cu	0.11 ± 0.01	0.09 ± 0.00	0.21 ± 0.01	0.01 ± 0.00	0.21 ± 0.01	0.21 ± 0.01	0.31 ± 0.02	0.41 ± 0.02	0.09 ± 0.00
Zn	0.41 ± 0.02	0.52 ± 0.01	0.59 ± 0.02	0.29 ± 0.01	0.39 ± 0.02	0.32 ± 0.02	0.51 ± 0.02	0.52 ± 0.01	0.20 ± 0.00
Cd	0.01 ± 0.00	0.05 ± 0.00	0.14 ± 0.01	0.04 ± 0.00	0.06 ± 0.00	0.01 ± 0.00	0.15 ± 0.00	0.21 ± 0.01	0.01 ± 0.00
Pb	0.21 ± 0.02	0.31 ± 0.03	0.42 ± 0.02	0.04 ± 0.02	0.49 ± 0.01	0.31 ± 0.02	0.42 ± 0.02	0.53 ± 0.02	0.03 ± 0.00
Hg	0.02 ± 0.00	0.02± 0.00	0.02± 0.00	0.01± 0.00	0.01± 0.00	0.01± 0.00	0.02± 0.00	0.03± 0.00	0.02± 0.00

Abbreviations = same as in Table 2.

Materials and Methods

***Sample collection*:** Sampling was based on area of cultivation and the stages of maturation S1, S2 and S3. The origin of the samples L1, L2, and L3, namely Hub Chowky, Gidar Nasay and Karachi University campus respectively. One sample L4 was purchased from local market having Sri Lankan origin. On arrival at the laboratory, outer husk was removed and water was transferred into a beaker through an eye of middle hard shell. Filtered through glass wool, placed into a polythene bottle and kept cool in a refrigerator (4°C).

***Analytical methods*:** All chemicals were AR grade and use without further purification. Each analysis was performed in triplicate. Two different techniques were used for the analysis of metals: flame emission spectrophotometer (Sherwood 410) was used for the determination of the minerals (Na, K, Li) and Perkin-Elmer 3100 atomic absorption spectrophotometer for the determination of the trace elements (Cr, Fe, Mn, Cu, Zn, Cd, Pb) following AOAC procedure (974.27; AOAC, 2000) and for Hg (977.22; AOAC 2000). Calcium was determined by gravimetric method (920.199; AOAC, 2000). Hardness was found by EDTA titration (973.52; AOAC, 2000). Chloride was estimated by Volhard's method. pH measured by Orion-710 pH meter (973.41, AOAC, 2000). Glucose content was analyzed by using Abbe-refractometer, Osmolarity through osmometer (based on depression of freezing point) and TDS by Jenway-4320 conductivity meter.

Results and Discussion

The concentration levels of the elements measured in the coconut samples, expressed as mmol l^{-1}, of the minerals Na (1.43-9.48), K (29.9-101.8), Li (0.61-1.06) and Ca (6.01-17.8) show a good agreement with the data reported by other authors (Fagundes *et al.*, 1993). Data about the volume of water, pH, glucose content, TDS, hardness, chloride and osmolarity are presented in (Table 2). Wide variation was observed in the volume of water obtained from fruit ranges from 150-463 mL owing to the maturation stages. The values of pH, glucose level and osmolarity are significantly higher than the reported one (Chavalittamrony, 1982), but closed to the published values (Fagundes *et al.*, 1993). The TDS values are found to be increasing with maturity (Fig. 1). The levels of Cr and Fe are generally lower than Mn, Cu and Zn. Chromium and iron are totally absent in the early stage of development but found, although in very low level, at the later stage (Table 3). On the other hand the concentration level of Pb, Hg and Cd are present in the following ranges: Pb (0.21-0.52 mg. L^{-1}), Cd (0.00-0.21 mg. L^{-1}), Hg (7.00-28.00 µg. L^{-1}). The presence of these toxic metals although at low level, shows the ability of coconut palm to either transport from the soil or adsorption from the polluted air. Little data are available about the trace metals concentration levels in the coconut water samples.

Previous investigations have indicated the positive and negative impact on the use of the coconut water as an oral rehydration fluid (Kuberski *et al.*, 1979) and in a short-term intravenous hydration fluid (Campbell *et al.*, 2000). It was also advisable that young coconut water can be used in the early stages of mild diarrhoeal disease (Adams *et al.*, 1992). The results of our work shows that coconut water available in the Karachi region contains low levels in Na^+ and Cl^- and fairly high level in glucose and osmolarity.

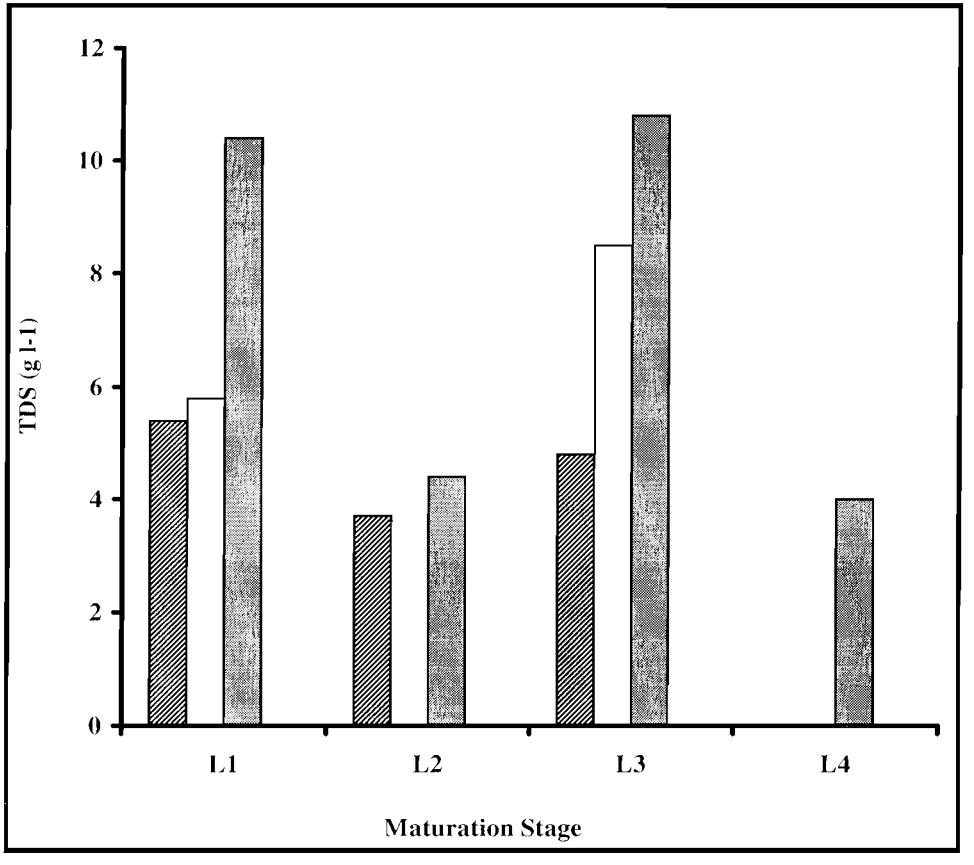

Fig. 1. Effect of location and maturation on TDS concentration.

However, the concentration of Na^+ and glucose level are fairly different in sample 4.This might be due to its origin. These characteristics are close to the qualities of an ideal sport drink (Press Release SAG/84, 2000). Due to its palatability, it is also easier to consume a large amount of coconut water. However, low level of Na^+ and Cl^- compared to the recommended values (UNICEF/WHO, ORS), the use of coconut water for rehydration cannot be suggested (Yartey *et al.*, 1993; Fagundes *et al.*, 1993). Although a low sodium content is ineffective in rehydration due to its reduced stimulus to drink but on the other hand a high Na^+ concentration in drinks makes the taste undesirable resulting in reduced consumption (Shirreffs & Maughan, 2000). The analysis also shows that coconut water of our region contains adequate K^+ and glucose. Therefore, addition of table salt (one half-tea spoon per liter) to the coconut water is suggested to compensate for Na^+ and Cl^- deficiency and make it feasible for the oral rehydration and as a sport drink.

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