

ELECTROLYTES, SUGAR, CALORIES, OSMOLARITY AND pH OF BEVERAGES AND COCONUT WATER

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INTRODUCTION

Oral rehydration has been recommended in patients with diarrhoea to replace diarrhoeal fluid loss and reduce the need for intravenous fluid (Hirschhorn *et al.*, 1972; Varavithya, 1979). Glucose-electrolytes solutions, taken by mouth, has been used in order to rehydrate the dehydrated patients (Gray, 1975). Beverages and coconut water, which are relatively hygienic, may be used as sources of oral fluid when glucose-electrolyte solution is not available (Varavithya, 1979). These can be bought in any community and also practical for use at home. The basic data of these fluids electrolytes, sugar, calories, osmolality and pH were determined to evaluate their usefulness in rehydration therapy.

MATERIALS AND METHODS

During March to October 1981, determinations for electrolytes, including sodium, potassium, carbonate, chloride, calcium, phosphate and magnesium, sugar, calories, osmolality and pH of the beverages and coconut water were performed. A total of 102 samples, consisting of 77 samples of beverages and 25 samples of coconut water, were determined. The beverages were 55 samples of carbonated drinks, 11 samples each of Pepsi-Cola, Coca-Cola, Team, Sprite and Seven-Up, and non-carbonated drinks, 11 samples each of Bireley and Green Spot. The 25 samples of coconut water were obtained from ripe coconut from different species of coconut palm obtained from the local markets.

The bottle beverages were opened for 30 minutes to avoid interference of the bubbles in the carbonated drinks before the determinations were performed.

Sodium, potassium and chloride were determined by Autoanalyzer Technicon (Simultaneous Electrolytes N-21 a : Technicon Instruments Co.) Carbonate was measured by CO₂ Apparatus Set 64887 (Harleco). Calcium and inorganic phosphate were determined by Autoanalyzer Technicon (Simultaneous calcium/ Inorganic Phosphate N-26 : Technicon Instruments Co.). Magnesium contents were estimated by the method of Neil and Neely (1956). Sugar was determined according to the method of Cooper and McDanile (1970). Osmolality was measured by Osmometer Manual (Fiske Associates, Inc.). The pH determination was performed by the pH meter Zeromatic SS-3 (Beckman Instruments, Inc.).

RESULTS

The analysis of the beverages is shown in Table 1. The carbonated drinks have a higher sodium and chloride content but lower potassium than non-carbonated drinks. Colored carbonated drinks (Pepsi-Cola and Coca-Cola) have more calcium and phosphate than colorless drinks (Team, Sprite and Seven-Up) and non-carbonated drinks. Sugar was high in non-carbonated drinks. The determinations of other parameters were unremarkable.

The results of findings in coconut water, average of carbonated drink and non-carbonated drinks are summarized in Table 2. The

Table 1
Findings of the electrolytes, sugar, calories, osmolarity and pH of the beverages.

	Carbonated drinks					Non-carbonated		Average
	Color		Colorless			Drinks		
	Pepsi-Cola	Coca-Cola	Team	Sprite	Seven-Up	Bireley	Green-Spot	
Sodium (mEq/l)	12.2	9.4	7.4	8.4	5.3	5.4	8.1	8.1
Potassium (mEq/l)	0.5	0.3	0.3	0.5	0.7	1.1	1.4	0.7
Carbonate (mEq/l)	32.1	32.4	32.0	29.5	31.6	2.5	3.4	23.4
Chloride (mEq/l)	9.4	6.5	4.6	6.0	5.1	2.3	3.5	5.4
Calcium (mg/dl)	2.0	4.1	0.9	1.6	1.5	1.7	1.1	1.6
Phosphate (mg/dl)	14.4	14.9	1.4	2.3	0.9	1.5	1.7	5.3
Magnesium (mEq/l)	2.2	2.6	1.1	1.0	1.2	2.2	2.0	1.8
Sugar (gm/dl)	8.6	8.0	9.4	8.3	8.3	9.1	9.2	8.7
Calories/L	344	320	376	332	332	364	368	348
Osmolarity(mOsm/l)	692.7	688.2	750.9	658.3	650.2	678.9	734.1	693.3
pH	2.25	2.68	3.25	3.45	3.48	3.0	3.05	3.1

Table 2
The electrolytes, sugar, calories, osmolarity and pH of coconut water, carbonated drinks and non-carbonated drinks.

	Coconut water	Carbonated drinks	Non-carbonated drinks
Sodium (mEq/l)	32.5*	9.2	5.4 ⁺
Potassium (mEq/l)	51.4*	0.5 ⁺	1.3
Carbonate (mEq/l)	19.4	31.5*	2.9 ⁺
Chloride (mEq/l)	51.5*	6.3	2.9 ⁺
Calcium (mg/dl)	17.5*	1.7	1.4
Phosphate (mg/dl)	7.6	6.8	1.6 ⁺
Magnesium (mEq/l)	16.0*	1.6 [‡]	2.1
Sugar (gm/dl)	1.1 ⁺	8.5	9.1*
Calories/L	44 ⁺	340	364*
Osmolarity(mOsm/l)	288.2 ⁺	688.0	706.5
pH	5.43*	3.12	3.03

* Significantly higher, $p < 0.001$.

⁺ Significantly lower, $p < 0.001$.

[‡] Significantly lower, $p < 0.025$.

COMPOSITION OF BEVERAGES AND COCONUT WATER

Table 3

Comparison of electrolytes, sugar and calories of beverages obtained from Thailand and U.S.A.

	Pepsi-Cola		Coca-Cola		Seven-Up	
	Thailand	U.S.A. ¹	Thailand	U.S.A. ²	Thailand	U.S.A. ²
Sodium (mEq/l)	12.2	6.5	9.4	0.4	8.6	7.0
Potassium (mEq/l)	0.5	0.1	0.3	13.0	0.7	0.5
Carbonate (mEq/l)*	32.1	7.3	32.4	13.4	31.6	0
Sugar (gm/dl)	8.6	12.0	8.0	10.9	8.3	10.2
Calories/L	344	480	320	436	332	408

* The method for determination of carbonate in U.S.A. beverages is not known.

¹ Winkelstein and Swick (1969).

² Waring and Jeansonne (1975).

electrolytes such as sodium, potassium, chlorides, calcium and magnesium, of the coconut water were significantly higher than the electrolytes of the beverages ($p < 0.001$). The potassium was remarkably very low in the beverages. The coconut water sugar was significantly lower than the beverages ($p < 0.001$). Thus, the calories, calculated from the sugar, of the coconut water would also be low. The osmolarity of the beverages was significantly higher than the coconut water ($p < 0.001$). The pH of the coconut water was significantly less acidic than the beverages ($p < 0.001$).

The electrolytes, sugar and calories of beverages obtained from Thailand and U.S.A. were compared and summarized in Table 3. Sodium was found to be higher in Thai beverages than in U.S.A. beverages. Potassium was very high in Coca-Cola of U.S.A., while sugar and calories were lower in Thai beverages than U.S.A. beverages.

DISCUSSIONS

The electrolytes in beverages of carbonated drinks are relatively the same, except calcium and phosphate, which are high in colored carbonated drinks. The sugar, calories, osmolarity and pH in carbonated drinks are

not significantly different in each brand. The findings in non-carbonated drinks are relatively similar in Bireley and Green Spot.

The coconut water in comparison with the beverages has significantly high sodium, potassium, chloride, calcium and magnesium. While the coconut water has significantly lower sugar, calories and osmolarity than the beverages. A significant less acid was found in the coconut water than the beverages.

The suggested ideal composition of an oral therapy solution is that glucose and sodium are absorbed at close to a 1 : 1 molecular ratio (Schedl and Clifton, 1963; Goldner *et al.*, 1969). Therefore, the ratio of NaCl to glucose would be 58.5 to 180 or 1 to 3 by weight. The ratio of NaCl to glucose of beverages is approximately 1 to 6,500 due to the very low salt. When sodium concentration is considerably below that of the normal jejunal contents, secretion occurs even in the presence of glucose (Sandle *et al.*, 1978). The beverages, which are very low in sodium, would produce secretion in the intestine before they can be absorbed. The maximal water and sodium absorption takes place at administered glucose concentrations between 56 to 140 mMol/l or 1 to 2.5 gm/l (Pierce *et al.*, 1968; Sladen and Dawson, 1969). The

sugar in the beverages is too high to achieve immediately high absorption, while the sugar in the coconut water is in the appropriate range. Furthermore, it has been reported that the coconut water can be given as intravenous infusion without complications (Eiseman *et al.*, 1952). Thus, the coconut water should be more suitable to be used as an oral rehydration, than the beverages which are not easily absorbed, unless they can be modified. The modification of the beverages require further investigation.

The electrolytes, sugar and calories in each brand of the beverages are not the same when obtained from different countries (Table 3). Coca-Cola in Thailand has potassium of 0.3 mEq/l, while Coca-Cola in U.S.A. has potassium of 13 mEq/l. Therefore, it is essential to obtain the data in each place for physicians to make recommendations, especially for patients who have renal diseases which required low salts.

SUMMARY

Oral rehydration has been recommended in patients with diarrhoea to replace fluid loss from the gastrointestinal tract and reduce the need for intravenous therapy. Beverages (i.e. Cola, Sprite etc.) and coconut water may be used as sources of oral fluid when glucose-electrolyte solution is not available. To evaluate the usefulness and effectiveness of these soft drinks, the basic data such as electrolytes, sugar, calories, osmolarity and pH were determined. The electrolytes of the beverages were significantly lower ($p < 0.001$) than the coconut water, especially potassium. The osmolarity of the beverages, which were 693 mOsm/l, was significantly higher ($p < 0.001$) than the coconut water (288 mOsm/l); pH of the beverages (3.1) was more acidic ($p < 0.001$) than the coconut water (5.4). While the sugar content of the beverages, which were 8.7 gm/dl, was significantly higher

($p < 0.001$) than the coconut water (1.1 gm/dl). On comparison, all brands of beverages would give more calories than the coconut water however the coconut water would be absorbed more easily than any brand of soft drink beverage.

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COMPOSITION OF BEVERAGES AND COCONUT WATER

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