Local soft drinks - do they replace oral rehydration solutions?

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ABSTRACT

Objectives: To determine pH, electrolytes, sugar composition and osmolality of local soft drinks in comparison to World Health Organization - Oral Rehydration Solution.

Methods: Samples of local soft drinks were analyzed biochemically by pH Meter, ion selective electrode, specific glucose oxidase and thin layer sugar chromatography and freezing point depression at the Research Laboratory, Department of Biochemistry, Faculty of Medicine, Al-Fateh University, Tripoli, Libya.

Results: All local soft drinks were acidic with low sodium and low potassium content, except grape juice which contains high potassium. Glucose content varies, is lowest in barley water and highest in grape juice. All local soft drinks have high osmolality.

Conclusion: Knowledge of the content of local soft drinks is essential for local medical staff. Local soft drinks in this study should not be used as an Oral Rehydration Solution.

Keywords: Soft drinks, pH, electrolytes, sugar, thin layer chromatography, osmolality.

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In dehydration secondary to gastroenteritis, fluid and electrolyte loss can be replaced by oral or parenteral fluid solution. Orally administered fluid and electrolyte solutions have been used effectively throughout the world to treat children with acute diarrhoea.¹

The World Health Organization (WHO) adopted a formula for a glucose electrolyte solution which has unquestioned success in reducing morbidity and mortality from acute diarrhoeal diseases in the developing world.

The vast majority of non-hospitalized children suffering episodes of acute diarrhoea, were fasted and received a variety of clear liquids. In Finland, UK, and Italy, home made solutions of table sugar and fruit juices are most often used: these lack adequate sodium and are likely to produce osmotic overload. In Libya the picture is similar to that of Italy where light tea with added sugar, local Pepsi or local 7-UP are very popular.² The efficacy of these have been attributed to the inhibitory effect of sugar and potassium on gastric motility. The local manufacturers of these soft drinks in Tripoli do not give the proper composition of their products.

In this study we present the results of some biochemical analysis i.e. pH, electrolytes, osmolality, glucose and sugar chromatography of some local soft drinks produced in Tripoli, Libya.

Methods: Two samples from 2 bottles of each local soft drink available on the market in November 1993 and 3 different samples of drinking water were collected and analyzed for the following: pH, sodium, potassium and glucose were measured using standard techniques.

Osmolality was measured by freezing point depression using an "ORION" Osmometer.

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Osmolality was calculated using the formula $2\text{Na} + 2\text{K} + \text{Glucose}$.

Thinner layer sugar chromatography (TLC) was used for qualitative analysis of different sugars in each soft drink using; TLC aluminum sheets, silica gel 60 F 254 'Merck' with Ethylacetate = Isopropanol: Water: Pyridine (26:14:7:2), as a solvent. Aniline-Diphenylamine with phosphoric acid was used as a location reagent. Standard known sugars were used for qualitative identification. The results are presented as the average of at least 2 measurements. No attempts has been made to look at the different dyes used in the soft drinks.

**Results.** The pH of all local soft drinks in the present study was found to be acidic; the lowest pH was 2.5 for Pepsi (Kawther) and the highest was 4.5 for Barley water. All local soft drinks showed very low sodium content (12.4 - 23.8 mEq/L) when compared to WHO - Oral Rehydration Solution (ORS) (90 mEq/L). The highest sodium was recorded in local Bitter Soda (Teiber) 23.8 mEq/L. Potassium concentration varied considerably from 0.37 - 1.57 mmol/L with moderate levels in Barley water (6.8 mmol/L) and grape juice (7.7 mmol/L) with very high concentration in local orange juice (17.4 mmol/L) and local Apple juice (28.3 mmol/L).

Local soft drinks in this study contain various concentrations of glucose, only few have a glucose concentration near to that of WHO - ORS i.e. Miranda (MRADA) (102.2 mmol/L), Kitty black (Al-Ghiet) 106.5 mmol/L and Bitter Soda (Teiber) (115.8 mmol/L). The highest glucose concentration was found in grape juice (332.4 mmol/L) and the lowest in barley water (3.6 mmol/L).

The ratio of Sodium to glucose ranged from (1 : 2 to 1 : 26.8) except for barley water where it was (1 : 0.2) (Table 1).

The osmolality of all local Soft drinks in this study was found to be higher than that of WHO - ORS when determined by freezing point depression (473.0 - 1102.0 mosmol/L) except for barley water (159.7 mosmol/L).

The calculated osmolality, using this formula ($2\text{Na} + 2\text{K} + \text{Glucose}$) was found to be lower than the measured one (Table 2).

To identify the presence of sugars other than glucose which may explain this discrepancy, TLC was used which showed the presence of at least one more sugar other than glucose i.e. sucrose, fructose and galactose. No attempt has been made to quantify these sugars.

**Discussion.** Oral rehydration solutions are widely employed in the treatment of acute diarrhoea in children, such management is well established in
developing countries.\textsuperscript{1} The ideal composition of ORS should be optimized for each age group and geographical location taking into account the nutritional status and the etiology of acute diarrhoea,\textsuperscript{4,5} which can have a major effect on stool electrolyte output. The majority of acute diarrhoea among Libyan infants is caused by rota virus,\textsuperscript{8} which is usually a mild illness.

Local soft drinks in this study in comparison to standard WHO - ORS were acidic; this acidity although theoretically may reduce the proliferation of E.coli by denying it from Iron.\textsuperscript{7} However, E.coli is not the commonest cause of acute diarrhoea in Libyan children.\textsuperscript{4} This acidity may have deleterious effect on the mucosa which is already damaged by the inflammatory process. It may also aggravate the metabolic acidosis, inhibit sodium and water absorption.\textsuperscript{8,9,10}

Potassium concentration was very low in comparison to WHO-ORS, but slightly higher than that of equivalent drinks in Switzerland,\textsuperscript{10} Canada and America\textsuperscript{1,12} but, in contrast to that reported by Vaughan et al\textsuperscript{13} which reflects the potassium content of local water supply. This observation speaks against the postulated effect of high potassium on gastric motility. Local apple juice contains the maximum quantity of potassium recorded in our study which is consistent with that reported by Head et al.\textsuperscript{10} However, to our surprise local orange juice contains only a moderate quantity of potassium (17.4 mmol/L) in contrast to 46.0 mmol/L reported in UK\textsuperscript{10} which, is a clear indication that our local orange juice was markedly diluted.

The sodium content of local soft drinks was found to be lower than that of WHO-ORS but was higher than that reported for equivalent drinks elsewhere\textsuperscript{12} (Table 3). This concentration is not far from that of drinking water (Table 1) which is a reflection of partially treated local water supply used for preparation of soft drinks.

The present study showed that glucose concentration varies considerably with very low levels (3.6 mmol/L in barley water) to modest amount 27.5 mmol/L in local 7-UP “Sabaa,” 53.1 mmol/L in Kitty orange (Al Ghiet). In the rest of the drinks it was found to be higher than 100 mmol/L (102-332 mmol/L). These variations of glucose in local soft drinks make them unsuitable as ORS. Recent evidence showed that high sugar is worse than high sodium.\textsuperscript{14,15} Sodium - Glucose ratio varies from (1:2 to 26.8) except for barley water (1:0.2) which is far away from the recommended ratio of 1:1 for maximum absorption of both sodium and glucose.\textsuperscript{16,17,18}

All local soft drinks in this study are hyperosmolar with the exception of barley water. Hyperosmolar solution is well known to stimulate water efflux and may even induce intestinal mucosal damage.\textsuperscript{19,20} An Osmolality within physiological isotonic range has been shown to decrease water absorption rates even when other factors such as sodium and sodium glucose ratio were constant.\textsuperscript{21,22} The calculated osmolality is much lower than the measured osmolality (Table 2). This osmotic gap indicates the presence of other chemical osmotic substances which require further elucidation. Part of it could be related to other sugars than glucose (see TLC) and partly due to other chemical preservatives and or stabilizers. Until the powdered soft drink base\textsuperscript{3} with bactericidal and antiviral activities, is commercially available to the public for use as an adjuvant to help reduce risks of water-borne diarrhoeal illnesses, and as the basis for oral rehydration solutions in future, WHO-ORS remains the recommended way of treating acute diarrhoea with mild-moderate dehydration in developing countries.

In conclusion, the local soft drinks in this study in comparison to WHO-ORS are acidic, too low in sodium with variable glucose concentration and abnormal sodium-glucose ratio with high osmolality, this make them harmful and unsafe if used as oral rehydration solution for children with acute diarrhoea.

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References


| Table 3 - Comparison of the content of Pepsi and seven-up in several countries. |
|------------------|---------|---------|---------|---------|
| **Brand**       | **pH**  | **Osmolality MOSMOL/L** | **MMOL/L Sodium** | **MMOL/L Potassium** |
| Pepsi           | 2.64    | 665     | 1.50    | 1.00    |
| **British**     | 2.70    | 576     | 1.00    | 0.00    |
| **Swiss**       | 2.62    | 624     | 1.40    | 0.00    |
| Libya           | 2.50    | 599     | 15.0    | 0.48    |
| Seven-up        | 3.37    | 464     | 5.00    | 0.20    |
| **U.S.A**       | 3.50    | 388     | 4.00    | 0.00    |
| **British**     | 3.50    | 388     | 4.00    | 0.00    |
| **Swiss**       | 3.28    | 485     | 4.50    | 0.15    |
| Libya           | 3.30    | 473     | 13.60   | 0.37    |


