Evaluation of the Effects of Aqueous Fruit Extract of *Tamarindus indica* on Body Weight, Lipid Profile, Some Electrolytes and Urea of Wistar Rats

Abstract

Objectives: The aim of this study is to evaluate the effects of aqueous extract of *T. indica* on the body weight, lipid profile some electrolytes and urea of Wistar rats.

Design & Methods: Twenty-five Wistar rats were distributed into four groups consisting of six rats each. Group I served as control group, group II was administered 100mg/kg of the Aqueous extract, group III was administered 150mg/kg of the Aqueous extract, and Group IV was administered 200mg/kg of the Aqueous extract. The administration took place for seven days, and on the eight day, The Animals were sacrificed. The blood was collected via cardiac puncture and used for analysis using a visible spectrophotometer.

Results: From the result, there was no significant difference ($p<0.05$) in body weight of Wistar rats. In the Test Groups; Serum cholesterol, low density lipoprotein (LDL), High density lipoprotein (HDL), Very Low-density Lipoprotein and Triglycerides revealed a significant increase ($p<0.05$) compared to Group 1 which is the control Group but had a significant decrease ($p<0.05$) compared within test groups. For electrolytes concentrations, potassium, Sodium, Chloride and Urea concentrations was significant at $p<0.05$.

Conclusion: From the result above, *T. indica* extract may help to maintain healthy weight, may have hypolipidemic properties, may help in body homeostatic and fluid balance and may also prevent renal damages.

Key words: Hypolipidemic properties; Renal damages; Low-density Lipoprotein; Cholesterol; Electrolytes

INTRODUCTION

Tamarind (*Tamarindus indica*) is a leguminous tree that belongs to the family Fabaceae with Subfamily Caesalpiniaceae [1]. The plant is believed to be indigenous to tropical Africa and also described by some botanist as a pan-tropical species which stretches from Senegal to

Eritrea, from Sierra Leone to Cameroon, from Ethiopia and Somalia to Mozambique [2]. According to [3], the tamarind tree was long ago introduced into and adapted to India such that it has often been reported been indigenous from there. They added that, it was apparently from this Asiatic country that it reached the Persians and the Arabs who called it "Tamar Hindi" (Indian date, from the date-like appearance of the dried pulp) traded in it, and thus giving rise to both its common and generic name. Unfortunately, the specific name "indica" also perpetuates the illusion of Indian origin. The genus, *Tamarindus* is monotypic in its taxon, and therefore has only one species (indica).

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According to [4] the major production centres of tamarind are in the Asian countries like India, Sri Lanka, Thailand, Bangladesh, Indonesia and Thailand. Whiles in the Americas, Mexico and Costa Rica are the biggest producers. India is the major country that has broadly utilized the tree, with more than 250,000 tons of the fruit harvested each year. Of this, about 3,000 tons is exported into Europe and North America for use in the food and beverage industries [5]. Africa on the other hand does not produce tamarind on large scale basis, although it is widely utilized by locals in some minor producing countries mostly in West African.

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The tamarind tree is well adapted to semi-arid regions of the tropics and can withstand drought conditions relatively well. It can tolerate a great diversity of soil types but does best in deep, well-drained soils, which are slightly acid or saline. The tree will not tolerate cold and continuous wet soil [2]. The tree is fairly large in size and produces large amount of its fruits. Tamarind fruits mature in late spring to early summer and they are slow-growing, long-lived, evergreen tree.

Generally, there are sweet and sour types and this differ significantly in their morphological characteristics. [6] in a study in Ethiopia found that the sweet tamarind trees produced

significantly more fruit pulp, seed, seed size and weight than the sour trees. They also observed that tamarind fruit vary from curved to straight. The colour of the sour variety pods and fresh pulp are a light brown, while the sweet variety pods and fresh pulp are usually deep brown. Ripe fruits are filled with a yellowish or brown pulp, fibrous with an acid like but pleasant taste. The seeds are hard and shiny with the bark of pod been fragile and easily broken by hand [7].

The most outstanding characteristic of tamarind as indicated by [4] is its sweet acidic taste due to the presence of tartaric acid (10%). The author describes tamarind to be simultaneously the most acidic and sweetest fruit. According the World Health Organization (WHO) tamarind can be considered a source of all essential amino acids, with the exclusion of tryptophan. It contains also other organic acids as tartaric, succinic and malic acid [8].

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The tree plays major and important roles in many aspects of life from food, pharmaceutical, and textile industries, to being used as timber, fodder, and as a source of fuel [9]. The fruit pulp of tamarind is edible and is considered more appealing and palatable, as it becomes sweeter and less sour (acidic) as the fruit matures. It is rich in vitamins, minerals and other proximate elements [10]. According to [4] in most growing areas, processed tamarind beverage drink is among the most popular flavoured drinks and the brand name “Jarritos” is a well-known tamarind export traded soda drink. This plant is mostly consumed in Nigeria without adequate knowledge of its pharmacological effects in the body. This study is aim at evaluating its effects on body weight, lipid profile and some electrolytes parameters in wistar rats.

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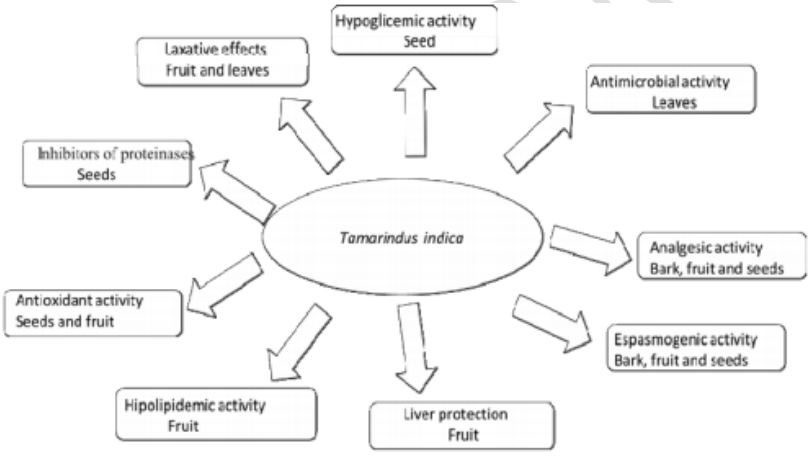

Fig 1: Properties of leaves, fruit and seed of *T. indica*.

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Figure 2: Tamarind shoot with hanging fruit pods and leaves.

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MATERIALS AND METHODS

Chemicals and reagents

- chloroform

- Assay kits for triglyceride (TAG)

- Total Cholesterol and High density lipoproteins (HDL-cholesterol) kits were gotten from Randox Laboratories Ltd.

Equipment and glassware

The underlisted equipment and glassware were used in the course of this research:

- Test tubes

- Table centrifuge

- Dessicator

- UV Visible Spectrophotometer

- Syringes

- cotton wool

- Refrigerator

- Surgical mask

- Surgical gloves

- Automated micropipettes (0.5-50ul and 100-1000ul)
- Beakers(250ml)
- Generator/alternate power supply (Honda, 3500Kva)
- Plain bottles

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Identification of fruit and Preparation of aqueous extract

The fruit of *T. indica* was purchased from Suleja market in Niger state, Nigeria. The fruits were validated by a botanist from the department of microbiology, Veritas University Abuja. Aqueous extract was prepared by maceration process. Fruits of T. indica were washed, and soaked with boiling water of 100℃ water overnight in a cleaned covered vessel for up to 12 hours at room temperature. Then the residue was discarded and the extract was filtered out and put into storage vessels and kept in the refrigerator at 2-5℃ until when used.

Handling and Grouping of Animals

Wistar rats weighing around 100-150kg were purchased from an animal farmhouse in Kaduna state. The Animals were divided into four groups and each group comprised of 6 animals. Group 2, 3 and 4 were administered with *T. indica* orally morning and night for 7 days.

Table 1. Animal Grouping

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SN	Groups	Number of rats	Administration
1	Control Group	6	Feed and distilled water
2	Test Group 1	6	100mg/kg of *T. indica* extract by oral gavage
3	Test Group 2	6	150mg/kg of *T. indica* extract by oral gavage
4	Test Group 3	6	200mg/kg of *T. indica* extract by oral gavage

Collection and analysis of blood

The animals were anaesthetized with chloroform, twenty-four hours after last day of extract administration, and dissected for blood collection. Blood samples were collected from the heart by cardiac puncture using a 2ml syringe and needle into a set of plain sample tubes. Each sample of blood was centrifuged at 3000rpm for 10 minutes, the serum was collected and distributed into labelled plain bottles. The serum was refrigerated and was used to carry out biochemical analysis.

The biochemical tests carried out was on lipid profile, includes: Cholesterol, Triglycerides, High density lipoproteins, Low-density lipoproteins, Very low-density lipoproteins and serum electrolytes (sodium, chloride, urea and potassium) using Randox test kits.

Statistical Analysis

The results obtained from this study were analysed by one-way analysis of variance (ANOVA), followed by Student's T-test to evaluate the significance of the difference between the mean value of the measured parameters in the respective control and test groups using SPSS windows. A significant change was considered acceptable at $P<0.05$.

RESULTS

Table 2: **Effects of *Tamarindus indica* aqueous extract on Body weight**

Group	Initial Body weight	Final Body weight
1	199.85 ± 4.62	200.57 ± 6.50
2	177.33 ± 16.82	173.92 ± 20.45
3	160.04 ± 15.23	162.28 ± 19.37
4	171.71 ± 16.52	174.50 ± 21.11
Total	177.23 ± 7.16	177.82 ± 8.90

Consumption of tamarind fruit extract with doses of 100mg/kg, 150mg/kg, and 200mg/kg has no significant difference ($p<0.05$) on Body weight.

Table 3. Effects of aqueous extract *Tamarindus indica* on Lipid Profile

Group	Triglycerides mg/dl	Cholesterol mg/dl	High-density lipoprotein mg/dl	Ver low-density lipoprotein mg/dl	Low-density lipoproteins mg/dl
1	90.62 ± 43.75[a]	108.66 ± 31.02[a]	21.72 ± 9.19[a]	18.124 ± 8.75[a]	50.77 ± 29.55[a]
2	179.76 ± 32.82[b]	137.85± 15.25[b]	39.40 ± 4.27[b]	35.94 ± 6.56[b]	52.41 ± 28.54[b]
3	116.26 ± 29.88[c]	119.70 ± 32.64[c]	34.82 ± 3.62[c]	23.60 ± 5.97[c]	58.18 ± 23.38[c]
4	116.52 ± 31.22[d]	121.07 ± 21.06[d]	38.20 ± 2.32[d]	23.30 ± 6.24[d]	55.016 ± 24.89[d]

Values are Expressed as mean ± SEM at significant level of $p<0.05$.

a = values are significantly different down and within groups at $p<0.05$

b = values are significantly different down and within groups at $p<0.05$

c = values are significantly different down and within groups at $p<0.05$

d = values are significantly different down and within groups at $p<0.05$

Table 4. Effect of *Tamarindus indica* aqueous extract on Serum Electrolytes; Potassium, Chloride, Urea and Sodium Concentration

Group	Potassium (k^+)mEq/L	Chloride (Cl^-) mEq/L	Urea (BUN)mmol/L	Sodium (Na^+) MEq/L
Group 1 (Control group)	4.15 ± 1.56^a	59.92 ± 39.87^a	50.71 ± 14.92^a	118.19 ± 94.67^a
Group 2 (Test group 1)	6.03 ± 1.02^b	171.27 ± 71.82^b	124.05 ± 65.69^b	20.72 ± 15.41^b
Group 3 (Test group 2)	3.61 ± 0.41^c	146.43 ± 46.26^c	348.17 ± 161.29^c	341.72 ± 161.14^c
Group 4 (Test group 3)	2.49 ± 1.55^d	148.31 ± 45.52^d	57.00 ± 34.22^d	106.94 ± 61.41^d

Values are expressed as Mean ±SD at significant level of $p<0.05$.

a = values have significant difference within and down the groups at $p>0.05$

b = values have significant difference within and down the groups at $p>0.05$.

c = values have significant difference within and down the groups at $p>0.05$

d = values have significant difference within and down the groups at $p>0.05$

DISCUSSION

The effects of *T. indica* extract on the body weight, lipid profile, some electrolytes concentration (Potassium, Chloride and Sodium) and Urea of Wistar rats are shown above. Although tamarind fruit extract did not exhibit a significant weight loss effect in this study, given the huge reduction in BMI compared to baseline, it is feasible that higher doses given for longer periods of time could result in significant weight loss. The amount of High-density lipoprotein, Low-density lipoprotein, and Triglycerides in the body is measured in a full Lipid Profile test. Cardiovascular disease, primarily owing to atherosclerosis, is a major consequence of obesity and a leading cause of death worldwide (hardening of the arteries). Abnormal blood lipids are a CVD risk factor (NIH, 2000). Wistar rats were given *T. indica* fruit extracts in this study, and it was discovered that *T. indica* caused a considerable rise in HDL-C and other blood lipid profile markers. I learned from past research investigations that the amount and duration of administration should be over a longer period of time in order to produce observable results. The protective role has been postulated to occur in a variety of ways. High-density lipoproteins counteract the oxidation of low-density lipoproteins, for example. Recent studies also show that HDL promote the reverse cholesterol transport pathway by inducing an efflux of excess accumulated cellular cholesterol and prevent the generation of an oxidatively modified Low-density lipoprotein [11] Furthermore, High-density lipoprotein inhibits the oxidation of LDL by transition metal ions, but also prevent 12-lipooxygenase-mediated formation of lipid hydroperoxides. On the basis of this result, *T. indica* play a role in the elevation of HDL-C. People with higher levels of HDL-C seem to have fewer problems with CVD, while those with low HDL-C have increased rate of Cardiovascular disease. The data generated in this study, indicates that, fruits of *T. indica* has a diversified effect on total lipid profile.

Comment [E9]: Refer to tables.

High-density lipoprotein and Low-density lipoprotein are two of the four main groups of plasma lipoproteins that are involved in lipid metabolism and the exchange of cholesterol, cholesterol esters and triglycerides between tissues. According to [12] Hypercholestimia has been identified as primary risk factor in development of CVD. In contrast, HDL-C plays a direct role in atherogenic process. Therapeutic raising of HDL-C is widely encouraged.

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The High-density lipoprotein concentration in group 2, 3 and 4, (39.40 ± 4.27) (34.82 ± 3.62) (38.20 ± 2.32) respectively show significant increase ($p<0.05$) from the High-density lipoprotein concentration of group 1 (21.72 ± 9.19) which indicates the fruit extract generates favourable results as High-density lipoprotein (good cholesterol) increased. The Low-density lipoprotein concentration in group 2, 3 and 4 (104.41 ± 28.54) (58.18 ± 23.38) (55.016 ± 24.89) respectively showed significant decrease ($p<0.05$) within groups but showed significant increase ($p<0.05$) from Low-density lipoprotein concentration of group 1 (50.77 ± 29.55), which explains that the more the amount of extract is administered, the lower the LDL-C gets. Therefore, Tamarind significantly reduced LDL-C compared to baseline. However, none of these effects were statistically significant compared to control group. , HDL-c plays a direct role in the atherogenic process. Therapeutic raising of HDL-c is widely encouraged [13]

The association between a low level of HDL-C and an increased risk of Cardiovascular disease has been well established through epidermological and clinical studies. Low-density lipoprotein is a primary target of CVD risk reduction therapy. LDL-C transports cholesterol mainly to the arterial wall. This results in the build up of insoluble lipid on the wall of the arteries thereby reducing blood flow and increasing the pressure on the arterial wall of the arterial wall as well as the heart. The deposition of the cholesterol on the arterial wall results in a condition known as arteriosclerotic plaque which is the major cause of death.

The serum electrolyte concentrations of Potassium, Sodium, Chloride and Urea was significant at $p<0.05$.

The electrolytes blood test is a test done to assess the levels of the major electrolytes. It is routinely ordered to give an insight into a possible electrolyte imbalance, which could be causing a variety of health conditions.

Electrolytes plays significant role in several body processes, such as controlling fluid levels, acid-base balance (pH), nerve conduction, coagulation and muscle contraction [13] Fluid and electrolytes homeostasis are usually maintained within narrow limits [14] and therefore, it must be kept at a level that is suitable for normal biochemical and physiological functions [15]

Electrolyte imbalance, or water-electrolyte imbalance, is an abnormality in the concentration of electrolytes in the body. Electrolytes play a vital role in maintaining homeostasis in the body. Electrolyte imbalances can develop by consuming too little or too much electrolyte as well as excreting too little or too much electrolyte.

Electrolyte disturbances are involved in many disease processes, and are an important part of patient management in medicine.[16][17] The causes, severity, treatment, and outcomes of these disturbances can differ greatly depending on the implicated electrolyte. [18]. The most serious electrolyte disturbances involve abnormalities in the levels of sodium, potassium or calcium. Other electrolyte imbalances are less common and often occur in conjunction with major electrolyte changes.

Chronic laxative abuse or severe diarrhea or vomiting can lead to dehydration and electrolyte imbalance. People suffering from malnutrition are at especially high risk for an electrolyte imbalance. Severe electrolyte imbalances must be treated carefully as there are risks with

overcorrecting too quickly, which can result in arrhythmias, brain herniation, or refeeding syndrome depending on the cause of imbalance [19][20][21].

The kidney is a principally responsible organ for retention and excretion of electrolytes and fluid in healthy individuals. [22] But other mechanisms like hormonal interactions of antidiuretic hormone, aldosterone and parathyroid hormone and other factors such as physiological stress is said to play an important role in regulating fluid and electrolyte balance in humans [17]. Studies about the clinical prevalence of electrolyte imbalances often report that these disorders are frequently seen in elderly and critically ill patients, and occur in the progression of diseases such as diabetes mellitus, acute or chronic renal failures, severe cardiovascular events like myocardial infarctions.

It is observed from this study that the fruit extract from *Tamarindus indica* showed their potential in maintaining body weight and regulating renal marker (some electrolytes and urea).

Conclusion

This present research has shown that this is a promising fruit if used for a long duration of time and the results confirms its use in traditional medicine may help in the management of body weight with respect to its hyperlipidemic activity, may possesss hypolipidemic properties, may help in maintaining homeostasis and fluid in the body.

Comment [E11]: In my opinion, the results obtained are not extrapolated to a prolonged period of time and can only be conclusive based on the period of 7 days studied.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCE

[1] Stege CVD, Prehsler S, Hartl A, Vogl CR . Tamarind (Tamarindus indica L.) in the traditional West African diet: not just a famine food. 2011; 66(1):171-185.

[2] Bhadoriya SS, Ganeshpurkar A, Narwaria J, Rai G, Jain AP. *Tamarindus indica*: Extent of explored potential. Pharmacognosy Reviews. 2011; 5(9):73-81.

[3] Abubakari ZA, Muhammad A. Breaking seed dormancy in tamarind (Tamarindus indica) A case of the Gombe Local Government Area. *Journal Applied Science Environment and Management . 2013;* 17(1):83.

[4] El-Siddig K, Gunasena HPM, Prasa BA, Pushpakumara DKNG, Ramana KVR, Vijayanand P, Williams JT. Tamarind – *Tamarindus indica* L. Fruits for the future 1. Southampton Centre for Underutilized Crops, Southampton, UK. 2006; 188-191.

[5] Abdelrahman GH, Mariod AA. Tamarindus indica: Phytochemical Constituents, Bioactive Compounds and Traditional and Medicinal Uses. In: Mariod A. (eds) Wild Fruits: Composition, Nutritional Value and Products.2019; *Springer, Cham*. DOI https://doi.org/10.1007/978-3030-31885-7_19.

[6] Hailay G, Sarah TB, Hadgu H, Zemede A, Morgan R, Alison P. Use and management of tamarind (Tamarindus indica L., Fabaceae) local morphotypes by communities in Tigray, Northern Ethiopia, Forests, Trees and Livelihoods. 2020; 29(2):81-98.

[7] Okello J, Okullo JBL, Eilu G, Nyeko P, Obua J (2018). Physicochemical composition of Tamarindus Indica L (Tamarind) in the agro-ecological zones of Uganda. *Food Science and Nutrition. 2018; (* 6)1179-1189.

[8] Ferrara L. Nutritional and Pharmacological Properties of Tamarindus Indica L. Journal of Nutrition Food and Science Forecast. 2019; 2(2):1012

[9] Pugalenthi M, Vadivel V, Gurumoorthi P, Janardhanan K . Composative nutritional evaluation of little known legumes, Tamarindus indica, Erythirna indica and Sesbania bispinosa, Tropical and Subtropical Agroecosystem. 2004; (4)107-123

[10] Emmy C, Kate ina H, Patrick VD. Tamarindus indica L. –A review of traditional uses. Phytochemistry and Pharmacology . 2010; 23(1):53-83.

[11] Yokozawa T, Cho EJ, Sasaki S. The protective role of Chinese prescription Kangen-Karyu extract on diet – induced hypercholesterolemia in rats. Biological Pharmacology. 2006; 29 : 760-765.

[12] Amaechi D, Udosen EO, Edet EE, Asanga EE, Mbakwe IE. Lipid profile status of streptozotocin induced diabetic rats t with ethanolic leaf extract of Solenostemon monostachyus. Journal of Medicinal Plants Research. 2015; 9(8), 289-293.

[13] Amaechi D, Etu AF, Ekpe IP, Udosen GE, Yisa BN. The Ameliorative Effects Of Solanum Melongena (Garden Egg), Solanum Lycopersicum (Tomatoes) And Daucus Carrot Sub.Sativus Extracts On Lipid Profile Against Lead Induced Toxicity In Wistar Rats. European Journal Of Pharmaceutical And Medical Research. 2020; 7(11), 70-73

[14] Hosona NA, Elasbali A . Evaluation of electrolytes imbalance and dyslipidaemia in diabetic patients. Med Sci. 2016;4(2): 1-4.

[15] Roberts KE. Pediatric fluid and Electrolytes Balance: Critical Care Case studies. Critical Care Nursing Clinic Norway. 2005; 17(4): 361-373.

[16] Kaneko JJ, Harvey JW, Bruss ML, (2008). Clinical Biochemistry of Domestic AnimalS, 6th Ed. 2008; 117-138.

[17] Alfarouk KO, Ahmed SBM, Ahmed A, Elliott RL, Ibrahim ME, Ali HS, Wales CC, Nourwali I, Aljarbou AN, Bashir AH, Alhoufi TS, Alqahtani SS Cardone, Stephan J. "The Interplay of Dysregulated pH and Electrolyte Imbalance in Cancer". Cancers. 2020; 12 (4): 898.

[18] Balcı AK, Koksal O, Kose A, Armagan E, Ozdemir F, Inal T, Oner N."General characteristics of patients with electrolyte imbalance admitted to emergency department". World Journal of Emergency Medicine. 2013; 4 (2): 113–116.

[19] Walls RM, Hockberger RS, Gausche-Hill.. Rosen's Emergency Medicine: Concepts and Clinical Practice. Philadelphia, PA: Elsevier. 2018;1516–1532. ISBN 978-0-323-35479-0.

[20] Bockenhauer, D; Zieg, J (2014). "Electrolyte disorders". Clinics in Perinatology. 2014; 41 (3): 575–90.

[21] Tsuda, T, Watanable M, Ohshima K, Yamamoto A, Kawakishi S, Osawa T. Antioxidative components isolated from the seed of tamarind (Tamarindus indica L.). Journal of Agricultural and Food Chemistry. 1994; 42: 2671–2674.

[22] Moritz ML, Ayus JC. "Disorders of water metabolism in children: hyponatremia and hypernatremia". Pediatrics in Review. 2002; 23 (11): 371–80.

[23] Bockenkamp B, Vyas H . Understanding and managing acute fluid and electrolyte disturbances. Current Paediatrics. 2003; 13:520–528.