SOME CHEMICAL CONSTUENTS OF SELECTED W A TER SOURCES IN AND AROUND ADDIS ABABA AND AMBO

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ABSTRACT: Water samples were collected from the following Sources: 1. rawand treated water from Gefersa and Legadadi upstream dams as well as tap water from Addis Ababa, 2. Ambo mineral water,3. two rivers that flow through Addis Ababa and 4. Lake Aba Samuel. The sample collection was carried out at the end of the rainy season (September 1993) except for Ambo mineral water which was obtained in mid-June 1994.

Analytic data of seven anions(HCO3-,P- ,Ct, Br, 1,NO3- ,SO42) and nine cations (Na+,K+,Mi+,Ca2+, Fe2+i3+,Zn2+,pb2+Cd2+,Cr6+) were compiled. Samples from all sources revealed the following: 1.the concentration of all ions is far below the toxic level, 2. all ions exist at concentrations of less than 8% of Man's daily requirement except for the sodium concentration (2OOmg/L) of Ambo mineral water .Ambo water and tap water from Addis Ababa are found to be chemically safe. The same can be said about water from Aba Samuel and city rivers although more work is necessary to determine the microbial exposure of animals and irrigations that depend on these sources. [Ethiop. i. Health Dev. 1994;8(2):97-102]

INTRODUCTION

Since water has a very high solvent capacity for polar molecules, it dissolves many compounds from soils and rocks .The resulting mineral content of drinking water can contribute to the maintenance or deterioration of health. In this context minerals in drinking water and food provide the following essential functions to organisms: sustain the electrochemical activity of cells (H+, Na+, K+ etc.), form catalytic parts of enzymes (Mg2+,Zn2+,etc.) and serve as structural units of molecules (Ca2+ ,HPO4 = ,t) (I). Their subnormal concentration would lead to various deficiency diseases while high concentration cause numerous toxicity diseases (2,3).

Drinking water is an important source of minerals. Consequently, data on its chemical composition can enable health workers to estimate the mineral consumption of individuals or communities from a daily average water intake of two liters per person per day with an additional intake of 0.75 liter from food (4,5).

Furthermore, such information is important to monitor community water sources for their toxic concentration of ions (1,3,6).While assessment of minerals to maintain health or cause toxicity require information on concentration of several ions(1,2,14) shortage of analytic resources restricted this report to focus only on Na+,K+, Mg2+ Ca2+ Fe2+/3+ Zn2+ Pb2+ Cd2+Cr6+ HC03- ,P- , Ct, Br, t, N03- & S042-. Forinstance, although Hg2+ could be a major pollutant of industrial waste,no analysis was made for it due to lack of vapour generator . Chemical analysis was conducted on water from the following four different sources: first, raw and treated water of two upstream dams as well as tap water from Addis Ababa; second, Ambo mineral water; third, two rivers that pass through Addis Ababa and, finally Aba Samuel, an artificial lake at a lower altitude to the city . The two rivers carry Addis Ababa's domestic as well as industrial waste to lake Aba Samuel. The first two sources of water supply are for human consumption while the other two are used for animals and irrigation systems.

METHODS

Sample sites were Gefersa and Lagadadi dams that supply tap water to Addis Ababa; Ambo mineral water bottling factory; Akaki and Bulbula rivers that flow through Addis Ababa and lake Aba Samuel(fig. la&b). Moreover tap waters of Addis Ababa were collected from six weredas selected by lottery , while the precise location was decided by convenience (fig. la). The dates for sample collection are shown in tables 1 and 2.

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These water samples were collected in polyethylene bottles thoroughly cleaned and fmally rinsed with deionized water . The samples were then filtered and stored at 4°C until analysis was carried out.

Temperature was taken during sample collection. Information on the odour, taste and colour of each sample was obtained from five assessors. The pH was read on calibrated Beckman's 050 pH meter. Conductivity(con.) was read on microprocessor LF 2000/C conductivity meter of GmbH W .Germany, which
was caliberated using 10,25,50, 75 and l00mM standard KCI solutions. Both Beckman's 050 pH meter and LF 2000/C possess inbuilt programme that calculate and display readout at 25°C. The total dissolved solids (TDS) of a sample that was evaporated by a steam bath and dried at 105°C was measured using an analytical balance.

The cations,(Sodium, Potassium, Magnesium, Calcium, Iron, Cadmium, Chromium, Lead and Zinc) were determined by atomic absorption spectrometer (Varian's SP-20) using their respective hollow cathode lampes(7) . Carbondioxide and Bicarbonate were measured by titration using phenolphthalein and methyl orange indicators, respectively (8). However, estimation of CO2 in carbonated beverage (bottled Ambo water) which is not based on manometery is probably a lower estimate. Chloride was titrated by 10mM AgNOJ to K2CrO4 endpoint(9). Halogens(P- ,Br,t) were assayed by their specific ion selective electrodes (10). Sulphate was determined as BaSO4 particles in a turbid solution (11). Nitrate was estimated using Beckman's DU-64 spectrophotometer set at two different wave lengths. The absorption at 22Onm is for nitrate and organic nitrogen whereas the absorption at 275nm is only for the latter. Optical density due to nitrate was then obtained by subtracting double the reading at 275nm from the reading at 22Onm (12).

RESULTS

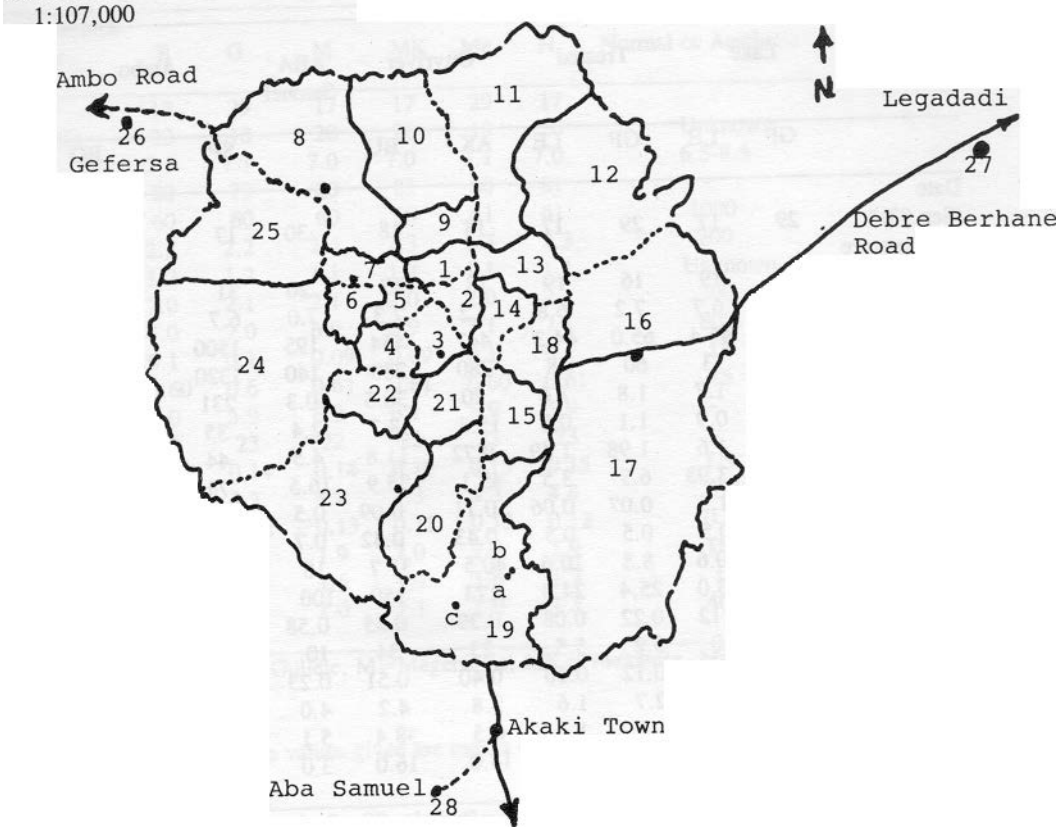
All filtered water samples were colourless. However, unfiltered water samples of Gefersa and Legadadi were brownish yellow. None of the samples, including that of Aba Samuel, had any detectable odour although the lake gave offensive smell (which could be attributed to volume difference between the lake and the sample and/or to organic decay at the bottom of the lake). The taste of Akaki, Bulbula and AbaSamuel waters was not determined. The rest were tasteless except Ambo water. The concentration of ions in samples from lake Gefersa, lake Legadadi, Ambo water and tap waters of Addis Ababa are far below toxicity levels. However, ion concentration in Ambo mineral water is generally higher than tap waters of Addis Ababa, though these values are within WHO's guidelines. Likewise, the concentration of Ca2+ ,Mg2+ , SO4= and NO3- in City rivers

are significantly higher than what was observed in tap waters of Addis Ababa (tables 1 & 2). Finally, effort to detect lead, Cadmium and Chromium titer of Akaki, Bulbula and Aba Samuel samples revealed these ions exist at concentrations that are below detection limit (<O.O5mg/I).

DISCUSSION

Information on man's daily requirement of various ions is available in many standard text- Books of nutrition (15,16). Assuming a daily water intake of two litres (4) 1ap water from Addis Ababa provides 1.2% of Mg2+'s and 8% of Zn's daily requirement. The contribution of tap water to daily requirement of other essential ions is only 2-8%(table 2). This observation suggests that the concentration of certain essential ions in tap water of Addis Ababa is far below the daily requirement of man so that the difference ought to be obtained from food. Ambo mineral water has a high concentration of dissolved solutes (1.32 grn/l). Most of this is due to Na+,K;+,Mg2' ,Ca2+ and HCO-3.This mineral water contains sufficient Na+ (approx.230mg/lt) to meet man's daily requirement of 200mg/day (13). It is also within wHO's broad guideline values for Na+ concentration in drinking water (15). On the

1. Map of Sample Collection Sites
a. Addis Ababa
1:107,000



Note: The numbers within Addis Ababa are code numbers of Weradas (Councils). The black dots are sampling sites.

3-Blaklion: From an MU Laboratory, 7-Merkato: Near Yekatit 23 School by Provincial bus terminal, 8-Gullele: A Pharmacy infront of National Institute of Health, 17-Megenagna: A tyre repair shop by kebele 17/24's office, 19a-Nifas-Silk: Near Addis Amba School, 19b-Bulbula: About O.3km down stream from St. Yoseph's Cemetary, 19c-Akaki: at Saris Mill Bridge and 23-Mekanisa: At Institute of Geological Survey.

Table 1. Some Physical and Chemical measurements obtained on selected water sources in and around Addis Ababa and Ambo. (September 1993*)

Sample source parameter	Lake	Treated		Cityriver		ABC Samuel		Ambo	
	GF	LE	GF	LE	AK	BU		SP	BO
Date (Sep.93)*	29	17	29	17	18	18	30	17	17
Temperature (^{0}C)	16	19	16	19	18	17	20	31	22
PH	7.1	6.7	7.2	6.8	7.2	7.3	7.0	6.7	6.1
Con.	62.6	45.4	65.0	44.3	447	454	195	1500	1496
TDS	71	53	60	48	280	280	140	1320	1312
Na+	1.8	1.7	1.8	1.6	20	30.5	10.3	231	238
K+	2.2	0.9	1.1	0.8	15.3	8.7	2.4	35	35
Mg^{2+}	2.75	1.6	1.98	1.49	9.72	11.8	4.5	44	46
Ca^{2+}	8.0	3.93	6.9	3.5	45.1	35.9	16.5	74	73
$Fe^{2+/3+}$	3.8	1.5	0.07	0.06	0.11	0.09	0.5	0.09	0.09
Zn^{2+}	0.5	0.5	0.5	0.5	0.43	0.42	0.7	0.4	0.45
CO_2	11.4	10.6	8.8	10.6	40.5	31.7	18	805	2653
HCO_3	35.1	23.0	25.4	24.0	173	150	100	1116	1092
F-	0.22	0.12	0.22	0.08	0.39	0.55	0.58	0.76	0.76
CI-	2.1	2.0	5.2	5.5	23	34	10	32	33
Br-	0.12	0.11	0.12	0.10	0.40	0.51	0.23	0.33	0.34
I	2.8	2.4	2.7	1.6	3.8	4.2	4.0	1.0	1.0
NO_3	2.6	1.95	1.0	1.4	6.5	38.4	5.1	3.0	3.0
SO_4	1.0	0.6	0.5	0.5	14.0	16.0	3.0	0.9	0.9

GF= Gefersa, LE = Legadadi, AK = Akaki, BU = Bulbula, SP= Spring, BO = Bottled. Cond. In :- mho/Cm. TDS and concentration in mg/l except iodide which is in (:g/L). The values given are mean of three measurements and their standard error of the mean is < 5% of the mean.

*Except Ambo wate which was resampled in june, 1994.

Table 2. Physical and Chemical measurements of tap-water from six sites in Addis Ababa

Sample Source parameer	B	G	M	MK	Me	N	Normal or Aesthetic
Date	17	29	17	17	29	17	
Temp (^{o}C)	20	18	20	20	19	20	Unknown
pH	7.1	7.1	7.0	7.0	7.1	7.0	6.5-8.5
Con.	80	79	80	81	80	81	-
TDS	60	60	60	60	61	61	1000
Na+	2.3	2.2	2.4	2.3	2.3	2.3	200
K+	1.2	1.2	1.1	1.2	1.1	1.1	Unknown
Mg^{2+}	2.0	2.1	2.1	2.0	2.0	2.1	300
Ca^{2+}	7.0	7.0	6.9	6.9	7.1	7.1	800
$Fe^{2+/3+}$	0.1	0.1	0.09	0.09	0.1	0.1	18
Zn^{2+}	0.60	0.6	0.61	0.61	0.60	0.61	15
CO_2	6.0	5.9	6.0	6.1	5.9	5.9	-
HCO_3	23	23	22	22	23	23	-
F^-	0.15	0.14	0.14	0.15	0.15	0.15	1.5
CI^-	4.3	4.3	4.2	4.3	4.3	4.4	250
Br^-	0.13	0.12	0.13	0.11	0.13	0.12	0.1
I^-	2.0	1.9	1.9	2.0	2.0	1.9	150
NO_3^-	1.6	1.5	1.6	1.5	1.6	1.7	10
$SO_4^=$	1.0	1.0	1.0	1.1	1.0	1.1	400

B= Balacklion Hospital, G=Gullele, M=Megenagna, MK=Mekanisa, Me=Merkato, N=Nifas Silk.
See table-1 for units. The values given are means of three measurements.

other hand, essential minerals such as Ca2+, Mg2+ , Fe2+ and texist in tap water in insignificant amount compared to man's daily requirement (13).

Mineral waters that contain very high concentrations of certain chemicals are said to possess curative value. For instance, water containing iron at > 10mg/litre improves oxygen transport and oxidative processes (16). Looking at the constituents of Ambo mineral water from a medical perspective, it is impossible to speculate any curative value; hence the need for more work to identify the significance of Ambo mineral water other than for its role as beverage.

The concentration of chemicals in the two rivers passing through Addis Ababa and in lake Aba Samuel(table 1) is below the toxicity cut off level (1). Further more, the concentrations of Lead, Cadmium and Chromium in Akaki, Bulbula and Aba Samuel samples taken at the end of rainy season is below detection limit (< 0.05rng/l), which may be compared with the normal daily adult level of 0.05 mg/L of Pb;0.005mg/L of Cd and 0.05mg/L of Cr or toxic levels of 3mg/L for Cd and 2OOmg/L for Cr(l, 15). Although this work has not dealt with only organic or inorganic chemicals(particularly Hi+) exhaustively, the data indicates that the level of chemical pollution of lake Aba Samuel and the city rivers immediately after the rainy season, is not serious. Nevertheless there is a big difference in the concentrations of some ions such as Mg2+ , Ca2+, S04- and No_3, between water in lakes at higher altitude and water from City rivers (tables 1,2). It is, therefore, necessary to initiate preventive measures that minimize chemical pollution by discouraging all concerned from damping waste in urban rivers. By the same logic, it is even more pressing to prevent urban expansion towards lakes Gefersa and Legadadi.

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