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Short Communication

Study on the Level of Trace and Toxic Elements in Soft Drinks and Juices Popularly Consumed in Bangladesh and its Influence on Dietary Intake

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Abstract. A study was carried out on trace element levels in locally available 42 brands of soft drink and fruit juice samples. The elements, Si, Cr, Mn, Fe, Zn, Sr and Ba were measured in 29 soft drinks and 13 fruit juices. The average concentrations of these elements, in soft drinks were 16.44, 0.11, 0.05, 0.12, 0.32, 0.17 and 0.01 mg/l, and in fruit juices were 15.42, 0.13, 0.09, 0.38, 0.60, 0.13 and 0.03 mg/l, respectively. Taking 0.5 l of soft drink and fruit juice together into account as the average weekly consumption by a Bangladeshi, and the mean concentrations of Si, Cr, Mn, Fe, Zn, Sr and Ba mg/l measured in both soft drinks and fruit juices, the calculated weekly dietary intake values of these elements were 7.4, 0.05, 0.03, 0.12, 0.22, 0.07 and 0.01 mg, respectively. The present dietary intake values were found to be much lower than the values reported in the literature and seemed to contribute not adequately to our total dietary intake. The average daily dietary intake of Cr from the investigated soft drinks and fruit juices was 7.7 μg, which indicates15% contribution to the National Research Council (NRC) recommended dietary intake value of 50-200 μg/day.

Keywords: trace elements, soft drinks, fruit juices, AAS, ICP-OES

Commercially available various drinks were found to contain essential elements as well as a significant level of toxic elements (Ikem *et al.*, 2002; Al-Saleh *et al.*, 1998; Asubiojo *et al.*, 1997). Though the consumption of these drinks contribute to meet the requirements of essential elements, they may also act as the media through which potentially toxic elements enter the human body. The long-term consumption of these drinks may lead to deposition of toxic elements in the body at a high level leading to malfunctions and chronic illnesses in the body (Prasad, 1976). Besides, the excessive accumulation of even essential elements in the body may also affect the normal functions of our body. There has been an increasing trend of consumption of all kinds of the drinks and juices in urban, semi-urban or even in a rural areas of Bangladesh. No study on the investigation of trace elements in commercially available drinks has so far been carried out in the country. In this paper, we described the levels of some minor and trace elements in some soft drinks and fruit juice available in markets using Atomic Absorption Spectroscopy (AAS) and Inductivity Coupled Plasma Optical Emission Spectroscopy (ICP-OES) methods. We also evaluated its contribution to daily dietary intake of some trace elements for the Bangladeshi population.

Forty-two soft drinks and fruit juices bearing different branded names of the companies were purchased from local markets. Samples were prepared using procedures reported (Lopez *et al.*, 1998). 100 ml of each of the samples was taken in a 250 ml Pyrex beaker containing 2.5 ml of concentrated HNO_3. The sample was heated for an hour on a hot plate, then 1 ml of concentrated H_2SO_4 was added and digested for 6 h. The sample was cooled and the volume of the sample was measured. A 20 ml portion of the sample was taken in a beaker with 4 ml of HNO_3 and heated on a hot plate for 2 h and final volume was made to 10 ml. All samples were prepared in duplicate, and analyzed using a Perkin-Elmer Atomic Absorption Spectrophotometer (AAS model 3110,USA) and Jobin-Yvon Sequential type Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES model JY 2000, France).

In the present study, 29 soft drinks, and 13 fruit juices commonly consumed in Bangladesh were investigated for a number of trace elements and the results are given (only measured elements) in the Table 1. The toxic element (As, Pb, Cd) levels in all types of samples were found below their minimum detection limits (MDL). In soft drinks, Si, Cr, Fe, Mn, Zn, Sr and Ba were measured in 29, 24, 20, 14, 4, 26 and 15 out of 29 samples, and their concentrations were found in the range of 4.04-21.74, 0.044-0.173, 0.045-0.263, 0.007-0.14, 0.02-1.525, 0.105-0.245, and 0.005-0.03 mg/l with the average concentrations of 16.44, 0.11, 0.12, 0.05, 0.32, 0.17, 0.01 mg/l, respectively. In fruit juices, Si, Cr, Fe, Mn, Zn, Sr, Cu and Ba were measured in 4, 12, 12, 13, 10, 7 and 10 out of 13 samples and their concentrations varied in the range of 3.63-28.44, 0.05-0.19, 0.13-0.70, 0.02-0.24, 0.08-1.17, 0.04-0.26, 0.05-0.08 and 0.01-0.06 mg/l with the average concentrations of 15.41, 0.13, 0.38, 0.09, 0.6, 0.13, 0.065 and 0.03 mg/l, respectively. A previous study reported the Cr level

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Table 1. Metals content in soft drinks and juice available in Bangladesh market

Sample ID	Concentration of elements in mg/l							
	Fe	Mn	Cr	Cu	Zn	Sr	Si	Ba
SD-1	0.076±0.008	<0.01	<0.03	<0.02	<0.02	<0.1	21.74±0.4	<0.005
SD-2	0.060±0.009	<0.01	<0.03	<0.02	<0.02	0.116±0.05	16.55±0.2	<0.005
SD-3	0.068±0.008	<0.01	0.087±0.03	<0.02	<0.02	0.130±0.06	18.87±0.1	<0.005
SD-4	0.073±0.004	<0.01	0.142±0.03	<0.02	<0.02	<0.1	20.78±0.2	0.008±0.001
SD-5	<0.03	<0.01	0.082±0.03	<0.02	<0.02	0.105±0.03	20.92±0.1	0.014±0.002
SD-6	<0.03	0.140±0.02	0.044±0.01	<0.02	<0.02	0.190±0.08	16.13±0.1	<0.005
SD-7	<0.03	0.020±0.001	0.085±0.005	<0.02	1.525±0.31	<0.1	4.07±0.02	<0.005
SD-8	0.068±0.004	0.038±0.08	0.073±0.03	<0.02	<0.02	0.186±0.03	16.72±0.2	<0.005
SD-9	<0.03	0.121±0.08	0.062±0.02	<0.02	<0.02	0.166±0.05	16.59±0.1	<0.005
SD-10	<0.03	0.058±0.02	0.109±0.05	<0.02	<0.02	0.197±0.06	17.59±0.1	0.010±0.002
SD-11	0.045±0.008	<0.01	0.091±0.05	<0.02	<0.02	0.172±0.05	18.13±0.1	0.005±0.001
SD-12	<0.03	<0.01	0.080±0.06	<0.02	<0.02	0.186±0.04	15.47±0.2	<0.005
SD-13	0.135±0.03	0.034±0.002	0.138±0.02	<0.02	0.02±0.009	0.190±0.05	16.49±0.5	0.014±0.002
SD-14	0.072±0.009	0.030±0.003	0.098±0.009	<0.02	<0.02	0.132±0.04	18.74±0.2	<0.005
SD-15	0.170.090±	0.047±0.007	0.142±0.005	<0.02	0.03±0.005	0.113±0.03	17.38±0.2	0.006±0.001
SD-16	0.171±0.11	0.007±0.001	<0.03	<0.02	0.02±0.005	0.116±0.05	20.12±0.4	0.007±0.001
SD-17	<0.03	<0.01	<0.03	<0.02	<0.02	0.143±0.06	12.93±0.3	<0.005
SD-18	0.167±0.004	<0.01	0.107±0.009	<0.02	<0.02	0.159±0.09	13.58±0.1	0.006±0.001
SD-19	0.212±0.14	<0.01	<0.03	<0.02	0.02±0.005	0.128±0.03	16.20±0.2	<0.005
SD-20	<0.03	<0.01	0.136±0.09	<0.02	<0.02	0.127±0.03	13.70±0.2	<0.005
SD-21	<0.03	<0.01	0.107±0.09	<0.02	<0.02	0.207±0.09	14.60±0.3	0.018±0.002
SD-22	0.063±0.001	0.072±0.01	0.175±0.005	<0.02	<0.02	0.178±0.05	17.94±0.2	0.018±0.002
SD-23	0.153±0.009	<0.01	0.097±0.01	<0.02	<0.02	0.173±0.07	18.43±0.4	0.008±0.002
SD-24	0.153±0.009	<0.01	0.105±0.01	<0.02	<0.02	0.175±0.07	16.20±0.3	0.006±0.001
SD-25	0.149±0.07	0.021±0.002	0.111±0.05	<0.02	<0.02	0.245±0.05	15.96±0.2	<0.005
SD-26	0.263±0.04	<0.01	0.107±0.00	<0.02	<0.02	0.130±0.03	18.26±0.1	0.015±0.002
SD-27	0.081±0.004	0.017±0.001	0.116±0.06	<0.02	<0.02	0.240±0.05	11.85±0.2	0.024±0.002
SD-28	0.094±0.004	0.033±0.005	0.102±0.01	<0.02	<0.02	0.218±0.03	11.37±0.1	<0.005
SD-29	0.084±0.01	0.021±0.002	0.116±0.01	<0.02	<0.02	0.160±0.05	19.57±0.2	0.024±0.002
FJ-1	0.429±0.01	0.122±0.02	0.188±0.04	0.050±0.002	0.30±0.02	N/A	N/A	N/A
FJ-2	0.620±0.02	0.106±0.09	0.149±0.01	<0.02	<0.02	0.262±0.02	17.41±0.2	0.060±0.003
FJ-3	N/A	0.240±0.02	<0.03	<0.02	0.35±0.01	<0.1	3.63±0.4	<0.005
FJ-4	0.272±0.02	0.039±0.01	0.136±0.01	<0.02	<0.02	0.100±0.02	23.56±0.2	0.009±0.001
FJ-5	0.263±0.03	0.021±0.009	0.126±0.02	<0.02	<0.02	<0.1	24.14±0.1	0.020±0.003
FJ-6	0.163±0.02	0.102±0.004	0.145±0.09	<0.02	0.69±0.05	<0.1	5.06±0.12	<0.005
FJ-7	0.227±0.004	0.028±0.002	0.174±0.07	<0.02	1.17±0.21	N/A	N/A	N/A
FJ-8	0.127±0.02	0.102±0001	0.097±0.01	<0.02	0.08±0.005	0.037±0.003	5.68±0.11	<0.005
FJ-9	0.514±0.04	0.098±0.09	0.066±0.002	<0.02	0.47±0.2	N/A	N/A	N/A
FJ-10	0.317±0.03	0.056±0.002	0.052±0.005	<0.02	1.06±0.2	N/A	N/A	N/A
FJ-11	0.339±0.01	0.065±0.008	0.085±0.009	<0.02	1.13±0.3	N/A	N/A	N/A
FJ-12	0.703±0.08	0.154±0.02	0.104±0.009	<0.02	0.64±0.2	N/A	N/A	N/A

in soft drinks and fruit juices in the range of 0.003 to 0.0 60 mg/l and from not detectable to 0.017 mg/l, respectively (Garcia *et al.*, 1999). One of the raw materials usually used is groundwater, that can significantly, contribute to the trace metal composition of soft drinks, and fruit juices. The average groundwater levels of Fe, Mn, Cr, Cu and Zn in Bangladesh were found in the range of 2.03, 1.18, 0.14, 0.06, 0.26 mg/l, respectively (Islam, 2001). The variation of elemental concentrations observed in soft drinks and fruit juices of different companies might be due to the composition of raw materials used for their preparation.

The WHO guideline values for Fe, Mn, Cr, Cu and Zn in drinking water are 1.0, 0.1, 0.05, 1.0 and 5.0 mg/l, respectively. It is evident from the above mentioned data that the average

concentrations of these elements in both soft drinks and fruit juices are below the WHO recommended values except Cr which in soft drinks and fruit juices was about 2.0 and 2.5 times higher, respectively. Taking 0.5 liter of soft drink and fruit juice together into account as the average weekly consumption by a Bangladeshi, and the mean concentrations of Si, Cr, Mn, Fe, Zn, Sr and Ba in mg/l measured in both soft drinks and fruit juices, the calculated weekly dietary intake values of these elements were 7.4, 0.05, 0.03, 0.12, 0.22, 0.07 and 0.01 mg, respectively, which were much lower than the reported total dietary weekly intake of these elements (Bowen, 1982). According to National Research Council (NRC), an estimated safe and adequate daily dietary intake (ESADDI) for Cr is 50-200 µg/day (NRC, 1989). The average daily dietary intake of Cr from the investigated soft drinks and fruit juices was 7.7 µg, which indicates 15% contribution to the NRC recommended dietary intake value.

From this investigation, it was found that concentrations of trace elements in soft drinks and fruit juices seemed to be very low. Consequently the nutrients input from these drinks to the daily diatary intake is inadequate to make a significant contribution. A very good aspect of Bangladeshi drinks was that presence of toxic elements in samples was too low to be detected by the present method. It may be suggested that the concentrations of essential elements be increased in the drinks to adequate levels so that the nation can be benefited through consumption of these drinks.

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