

Research Paper

HEAVY METAL ANALYSIS OF SELECTED SOFT DRINKS IN NIGERIA

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Abstract

There have been reports of the presence of heavy metals at a concentration above the limit specified by the World Health Organization (WHO) for food and drink products in Nigeria. This work was designed to compare the levels of zinc, copper, lead, cadmium, iron and arsenic in selected Nigerian soft drinks with the specified recommended limits by the World Health Organization. These heavy metals in selected Nigerian soft drinks were estimated by Atomic Absorption Spectroscopy after digestion of soft drinks with nitric acid. The results obtained showed that 30% of the selected drinks conformed to WHO specifications for the heavy metals analyzed while the remaining 70% had heavy metal contents which exceeded the maximum limits specified by WHO.

Key words: Nigerian Soft Drinks, Arsenic, Cadmium, Lead, Zinc, Copper, Iron, Heavy Metals.

INTRODUCTION

Human exposure to heavy metals is primarily through food and water intake [1]. Heavy metals are largely used in commercial and industrial applications, due to this, exposure can occur from indirect and direct paths. These exposures may be associated with such processes as smelting, electroplating, welding, grinding, soldering, printing, oil spillage and many other product manufacturing processes. Heavy metals are ubiquitous and resistant to natural degradation. Even though their concentration may vary from one location to another, they occur naturally in the ecosystem [2]. Although excessive levels can be damaging to living organisms, iron, cobalt, copper, manganese, molybdenum, and zinc are required by humans at acceptable levels [3]. While other heavy metals such as mercury, plutonium, and lead are toxic heavy metals that have no known vital or beneficial effect on organisms, and their accumulation over time in the bodies of animals can cause deleterious effects [3].

Heavy metals are able to impair mental and neurological functions, neurotransmitter production and utilization, and alter numerous metabolic body processes [4]. They are also able

to induce impairment and dysfunction of biological pathways for the blood, colon, liver, kidney, skin and cardiovascular systems. Current studies have reported that even minute levels of toxic elements can have negative health consequences however these vary from person to person [5]. Nutritional status, metabolic rate, the integrity of detoxification pathways, mode and degree of heavy metal exposure and age can influence individual responses to heavy metals [5]. This work was designed to determine the levels of iron, arsenic, copper, zinc, cadmium, and lead non-alcoholic beverage drinks of different income levels sold in Nigeria and to evaluate their compliance to the Who health Organization provisional guidelines.

MATERIALS AND METHODS

A total of 10 soft drinks each collected by stratified randomization, under ten different trade names, from various places in Nigeria. The collection was specially classified to reflect the popular brands consumed by high and low income earners in Nigeria. The sample drinks were stored at conditions similar to those of retail shops. Absorption Spectrophotometer (AAS) was used to determine the heavy metal contents of these soft drinks. The concentration of Zinc (Zn), Copper (Cu), Lead (Pb), Iron (Fe), Cadmium (Cd) and Arsenic (As) were determined.

Preparation of samples

The samples for analysis were digested by the addition of 5ml of the samples to 5ml distilled water and 5ml concentrated nitric acid in a conical flask and heated till the total volume was reduced to about 5ml to break the complex bonds and release the sample into solution. Red fumes were observed indicating the release of nitric acid. The solution was filtered into another beaker, made up to 50ml with distilled water and mixed thoroughly. The samples were left to settle and taken to AAS machine for analysis.

Statistical analysis

The data were presented as mean \pm standard deviation of ten replicate values. The statistical analysis was done using Excel 2007.

RESULTS AND DISCUSSION

This study assessed the heavy metal concentrations of some selected Nigerian beverages. It revealed that 60 % of the selected beverages mostly taken by children and young adults in Nigeria have either/both lead and arsenic levels above the recommended limits while 10% of the samples have both lead and cadmium concentrations above the recommended limits. All sampled beverages had acceptable zinc, copper and iron concentrations when compared with WHO limits.

Zinc is an essential trace element found in virtually all food and portable water in form of salts or organic complexes. It has the highest mean levels, 0.190 to 2.280 mg/L among the metals studied (Table 1). The levels of zinc conform within the provisional regulatory limits [6]. The report on zinc concentration in soft drinks was comparable to the reported zinc analysis of canned fruit drinks and soft drinks from Nigeria [7, 8]. Iron is one of the most abundant metals in the earth crust. Its analysis in the selected beverages showed compliance to the acceptable regulatory limit at concentration range of 0.08 to 0.550 (Table 1). The concentration of iron, 2.92 to 18.29 mg/L, above acceptable limit in fruit drinks purchased from Nigeria as reported by [8] was not comparable with the present study. Copper is an essential element for growth as well as drinking water contaminant [6]. The copper levels in selected soft drinks in this study are within acceptable regulatory limit (Table 1).

The levels of arsenic or/and lead were elevated when compared with recommended limit in about 60 % of the selected sampled beverage drinks. Elevated arsenic levels (0.001 to 0.19 mg/L) have been reported in bottled minerals sold in some European countries several years ago. Elevated arsenic level above regulatory limit was also reported in about 46 % beverages from a Nigerian market [9]. Mass poisoning by inorganic arsenic in Japan has been reported with associated symptoms such as fever, insomnia and anorexia within few weeks of exposure leading to several deaths. In 1977, the prevalent rate of skin cancer to a population of about 40,000 inhabitants of Tseng, Province of Taiwan and China has been linked to high level of arsenic in their well water [9]. Elevated level of lead (0.006 to 1.93 mg/L) above acceptable

limit in fruit drinks from Nigerian market has been reported [8]. The level of cadmium above regulatory limit was present in 10% of the analyzed beverages. Elevated level of cadmium (0.002 to 0.49 mg/L) above acceptable limit in fruit drinks from Nigeria has been reported by [8] while the cadmium level in all analyzed soft drinks by [7] were within acceptable limit.

Arsenic, lead and cadmium present in water or other soft drinks beyond acceptable limit can accumulate thereby progressing from acute to chronic intoxication with serious health issues. Hence, the result of the present study calls for serious public health concern on the part of both the consumers and the Nigerian regulatory agencies. The habitual intake of beverage drinks especially in dry season by the aged, children, and pregnant women can lead to over accumulation of toxic heavy metal in the body and hence toxicity.

Table 1: Heavy metal concentration in soft drinks

Sample	ZINC (mg /L)	COPPER (mg /L)	LEAD (mg /L)	CADMIUM (mg /L)	IRON (mg /L)	ARSENIC (mg/ L)
A	1.620±0.04	0.500±0.01	*0.020±0.00	<DL	0.240±0.01	*0.016±0.00
B	2.280±0.02	0.040±0.01	0.010±0.00	<DL	0.090±0.00	0.009±0.00
C	2.260±0.01	0.790±0.01	*0.030±0.001	<DL	0.140±0.00	*0.018±0.00
D	0.540±0.04	0.650±0.01	<DL	<DL	0.100 ±0.00	*0.014±0.00
E	0.510±0.02	0.220±0.01	*0.040±0.01	<DL	0.220±0.00	0.003±0.00
F	1.920±0.03	0.310±0.01	<DL	<DL	0.090±0.01	*0.011±0.00
G	0.900±0.01	0.580±0.01	0.010±0.00	<DL	0.110±0.00	<DL
H	0.190±0.00	0.560±0.01	<DL	<DL	0.200±0.00	0.007±0.00
I	0.520±0.02	0.570±0.01	<DL	<DL	0.550±0.00	<DL
J	0.430±0.01	0.560±0.01	*0.020±0.00	*0.010±0.00	0.080±0.00	0.010±0.00

The data were presented as mean±standard deviation of ten replicate values. (<DL) represents value less than the detection limit of 0.001 mg/L while (*) represents values above the WHO acceptable range.

Table 1 shows the concentration of zinc, arsenic, cadmium, copper, iron and lead in selected soft drinks from Nigeria. Zinc, arsenic, cadmium, copper, iron and lead levels in selected beverages range from 0.190 to 2.280, < 0.001 to 0.016, < 0.001 to 0.010, 0.040 to 0.790, 0.080 to 0.550, < 0.001 to 0.040 mg/L respectively.

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