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Evaluation of some heavy metal contaminants in biscuits, fruit drinks, concentrates, candy, milk products and carbonated drinks sold in Ibadan, Nigeria

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ABSTRACT

There is an increasing concern about the health effect in human due to continual consumption of food contaminated with heavy metals gotten from raw materials, manufacturing and packaging processes. It is therefore crucial to know the level of heavy metals in them because of its bio-accumulative property. A total of twelve (12) different brands of sweet and milk sweets, six different brands of biscuits, eleven different brands of fruit and flavoured concentrates and five different types of liquid drinks all of popular brands were collected. All the samples were cold digested using concentrated hydrochloric acid and nitric acid in ratio 1:1. The extracts were analysed for calcium, chromium, copper, iron, lead, and cadmium with Perkin Elmer (A Analyst 200) Flame Atomic Absorption Spectrophotometer. Appropriate quality assurance procedures were followed to ensure accuracy of results. Results showed that calcium and iron were present in all the samples analysed while chromium, copper, lead and cadmium were not detected in some samples. Calcium had higher concentration than other heavy metals in all the samples. Concentrations of these metals in all the samples were found to be lower than their permissible limits, which implied non contamination hence no health threat to human, but continuous consumption may be hazardous to the health.

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INTRODUCTION

Ingestion of food is an obvious means of exposure to metals not only because many are natural components of foodstuff but also because of contamination during processing. Contamination of food products by heavy metals is becoming an unavailable problem. These agents have led to metal depression in the environment and consequently impaired health of the population by ingestion of contaminated victuals (Zukowska and Bizink, 2008). Determination of metals in samples is

to resolve issues such as mineral contents, adulteration of raw materials used, compliance with trade laws and safety of the final product for consumption and its effect if contaminated.

In the present era of industrialization and development, one's concern should be the health of the future generation. Children are the most vulnerable to any kind of contamination in the food chain (Farid and Enani, 2010). Due to economic situation in

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Nigeria, young children between ages 6 months and 13 years had been exposed to different types of snacks majorly sweets, biscuits, carbonated fruit drinks, milk shakes and milk sweets. Most heavy metals are introduced through the packaging when the candies surfaces are sticky allowing the surface of the candy adhere to the inner cover of the package.

Heavy metals occur in foods as natural or inherent components of plant and animal tissue and fluid. The essential metals (e.g. Mn, Cu, Zn, Cd) own their essentiality being constituents of enzymes and other important proteins involved in key metabolic pathways, hence, deficient supply results into metabolic dysfunction causing diseases (Iwegbue, 2008). Although many heavy metals are essential for animal tissue metabolism, the ranges between beneficial and toxic level are usually small. The extent of this contamination depends on several metabolic and homeostatic mechanisms operating in the type of food and tissue considered (Jorhem and Sundstroem, 2000; Chukwujindu et al., 2008).

Heavy metals are persistent as contaminants in the environment and come to the forefront of dangerous substances causing healthy hazard in human. Lead, cadmium, mercury and tin are among the most important of these elements. Industrial and agricultural processes have resulted in an increased concentration of heavy metals in air, water, soil and subsequently, these metals are taken by plants or animals and have their ways into food chain (Ahmad, 2002). Chromium is important in the utilization of glucose, therefore its deficiency causes a decrease in glucose tolerance and increase in cardiovascular diseases. Deficiency in calcium can cause serious structural disorders due to its involvement in the structure of the muscular system.

Food products such as candies that are likely to be consumed frequently by small children are wrapped in colourful packages in order to induce them to purchase the products.

Heavy metals, such as Pb, Cr, Ti, Zn and Cu can migrate from the printed surface to the food contact surface through four mechanisms: blocking, rubbing, peeling and diffusion (Bradley et al., 2005). Contamination of imported food products with heavy metals may cause a serious risk for human health because of the consumption of even small amount of metals can lead to considerable concentrations in human body there leading to bio-toxic effects. Juices are the perfect fast-food for today's eat-on-the-run lifestyle. They contain all the goodness of the whole product in a condensed form. 100% juices are a convenient way for adults and children to get a part of their recommended 4.5 or more cups of fruits and vegetables each day. Milk is an ideal source of microelements and macroelements, additional amount of contaminants metals might enter milk and dairy products reaching levels that are harmful to humans (Qin et al., 2009) through foodstuff, water, manufacturing and packaging processes (Anastasio et al., 2006; Ayar et al., 2009). Fruits and hence fruit juices and vegetables are valuable sources of minerals. Diets high in fruits and vegetables are also linked to decreased risk of diseases (diabetes, cancer, etc.) and their consumption should be encouraged (Simpkins et al., 2000). This study was undertaken to determine the concentrations of some trace elements in fruit drinks, concentrates, candy, milk products and carbonated drinks.

MATERIALS AND METHODS

Sample collection

A total of twelve (12) different brands of sweet and milk sweets, six different brands of biscuits, eleven different brands of fruit and flavoured concentrates and five different types of liquid drinks was selected. The selection was specially made to reflect the popular brands consumed by different age groups especially children. The samples were stored at almost identical conditions similar to those of retail shops prior analysis.

Sample preparation and digestion

The solid samples were ground with a pre-cleaned porcelain mortar and pestle. Cold digestion (i.e. digestion was done without application of heat) was used for all the samples.

Solid and liquid samples

For solid samples, an accurately measured weight of 5 g of each sample was transferred into a flask; 10 ml of concentrated hydrochloric acid and 10 ml of nitric acid were added and allowed to stay for 18 hours in a fume cupboard. For liquid samples, a volume of 5 ml of each sample was accurately measured and transferred into a flask; 10 ml of concentrated hydrochloric acid and 10 ml of nitric acid were added and allowed to stay for 18 hours in a fume cupboard.

The digested samples were filtered. The filtrate was transferred into a 100 ml standard flask and made up to mark with distilled water which was later transferred into a plastic sample bottles. All the filtrates were analysed for calcium, chromium, copper, iron, lead, and cadmium with Perkin Elmer (A Analyst 200) flame atomic absorption spectrophotometer. A fuel clean Air-Acetylene flame was used. The metals were determined at the most sensitive spectral lines of the metals.

RESULTS

Table 1 showed the varying levels of the heavy metals in the sweet samples. Highest Cadmium concentration was found in sample A11 (0.09 ± 0.010 mg/L) while the lowest was recorded in sample A1 (0.00 ± 0.008 mg/L). Cadmium was not detected in samples A2, A3, A4, A5, A6, and A7.

Table 2 showed the concentration of heavy metals in biscuit samples analysed, with the highest concentration of Cadmium found in B2 (0.09 ± 0.047 mg/L) while B6 (0.003 ± 0.038 mg/L) recorded the lowest concentration. Lead concentration was not detected in sample B1 and B2. Table 3 showed the concentration of heavy metals in milk candy and fruit concentrate samples analysed. Chromium was not detected in samples C9 and C10, lead was not detected in C8 and C9 while cadmium was not detected in sample C11.

Table 4 shows the concentration of the heavy metals detected in juice and milk shakes samples with the lowest concentration observed in copper for all the samples analysed.

Table 1: Concentration (mg/l) of heavy metals in sweets samples.

Sample	Ca	Cr	Cu	Fe	Pb	Cd
A1	34.0±0.12	0.04±0.061	0.01±0.002	3.42±0.52	0.90±0.069	0.00±0.008
A2	10.9±0.033	ND	0.04±0.002	1.52±0.003	0.39±0.052	ND
A3	14.9±0.12	ND	0.04±0.002	1.00±0.000	0.17±0.054	0.00±0.018
A4	5.50±0.013	ND	0.04±0.002	1.67±0.010	0.16±0.031	ND
A5	14.6±0.016	0.02±0.027	ND	0.67±0.062	0.03±0.041	ND
A6	29.4±0.11	0.06±0.073	ND	1.01±0.005	0.04±0.054	ND
A7	7.40±0.036	0.07±0.018	0.11±0.074	1.58±0.005	0.01±0.008	ND
A8	3.90±0.009	0.02±0.067	0.17±0.001	2.21±0.022	ND	0.04±0.032
A9	16.3±0.015	ND	ND	0.91±0.017	ND	0.03±0.005
A10	20.9±0.005	0.21±0.034	ND	0.52±0.009	ND	0.09±0.026
A11	13.1±0.007	0.50±0.017	0.02±0.004	1.76±0.009	ND	0.09±0.010
A12	32.6±0.021	0.25±0.004	0.01±0.001	0.71±0.013	ND	0.06±0.038

Mean ± SD, ND: Not Detected

Table 2: Concentration (mg/L) of heavy metals in biscuit samples.

Sample	Ca	Cr	Cu	Fe	Pb	Cd
B1	3.2±0.028	0.25±0.022	0.51±0.012	1.36±0.006	ND	0.07±0.028
B2	2.90±0.011	0.18±0.017	0.13±0.006	1.58±0.031	ND	0.09±0.047
B3	1.4±0.004	0.17±0.007	0.13±0.001	1.41±0.005	0.06±0.031	0.01±0.007
B4	6.8±0.16	0.12±0.026	0.15±0.001	2.07±0.040	0.08±0.024	0.05±0.036
B5	8.9±0.012	0.16±0.010	0.12±0.001	1.64±0.019	0.06±0.015	0.03±0.004
B6	10.1±0.006	0.13±0.002	0.08±0.001	1.02±0.012	0.01±0.022	0.003±0.038

Mean ± SD, ND: Not Detected

Table 3: Concentration (mg/L) of heavy metals in milk candy and fruit concentrate samples.

Sample	Ca	Cr	Cu	Fe	Pb	Cd
C1	7.70±0.014	0.001±0.035	1.17±0.016	0.61±0.016	0.05±0.003	0.04±0.020
C2	35±0.014	0.001±0.012	0.07±0.005	0.91±0.006	0.23±0.00	0.02±0.001
C3	32±0.067	0.0005±0.027	0.05±0.005	1.42±0.026	0.21±0.020	0.02±0.010
C4	34.1±0.012	0.0007±0.007	3.68±0.009	1.94±0.012	0.11±0.007	0.02±0.00
C5	26.8±0.073	0.0009±0.013	0.10±0.006	0.72±0.033	0.20±0.030	0.07±0.038
C6	20.2±0.013	0.0007±0.004	0.09±0.003	0.70±0.010	0.25±0.014	0.07±0.053
C7	8.00±0.006	0.0003±0.000	0.08±0.013	0.46±0.022	0.01±0.033	0.03±0.014
C8	20.6±0.006	0.0004±0.034	0.59±0.11	0.97±0.015	ND	0.02±0.042
C9	49.1±0.013	ND	0.02±0.010	1.99±0.008	ND	0.04±0.025
C10	44.9±0.086	ND	0.01±0.002	0.94±0.010	0.06±0.89	0.06±0.003
C11	14.3±0.13	0.0003±0.023	0.02±0.010	0.61±0.004	0.08±0.0041	ND
C12	6.40±0.13	0.0005±0.001	0.01±0.00	0.94±0.23	0.28±0.028	0.04±0.003

Mean ± SD, ND: Not Detected

Table 4: Concentration (mg/L) of heavy metals in juice and milk shake samples.

Sample	Ca	Cr	Cu	Fe	Pb	Cd
D1	3.0±0.074	0.57±0.001	0.03±0.003	1.88±0.031	0.37±0.038	0.03±0.026
D2	7.4±0.001	0.18±0.013	0.02±0.000	0.88±0.003	0.29±0.032	0.11±0.013
D3	0.18±0.013	0.09±0.001	0.03±0.004	0.66±0.002	0.20±0.052	0.12±0.029
D4	34.1±0.012	0.08±0.004	0.01±0.002	0.50±0.013	0.39±0.007	0.08±0.001
D5	26.8±0.073	0.06±0.013	0.02±0.000	0.55±0.023	1.21±1.04	0.11±0.015

DISCUSSION

The result showed that calcium and iron which are part of the microelements that are necessary as components of enzymes involved in major metabolic processes were present in all the samples analysed. Chromium, copper, lead and cadmium were not detected in some samples. It was also observed that calcium has higher

concentration than other heavy metals present in the samples (Table 1-4).

Also the results showed that cadmium concentration in all the samples did not exceed the permissible level of 1.5 mg/kg (CAC, 2003). Although the concentration present may be attributed to sachet used in the sweet packaging which is in accordance with Ki-Cheol et al. (2008), whose results

demonstrated that harmful pigments such as lead chromate, which have been prohibited by law from being used in packaging materials are still being used. Highest lead concentration was found in sample A2 (0.39 ± 0.052 mg/kg) while sample A7 (0.01 ± 0.008 mg/kg) recorded the lowest lead concentration. Lead concentration in all the samples did not exceed the maximum permissible limit of 2.5 mg/kg (CAC, 2003). Calcium and iron were found to be present in all the samples and the result were found to be in line with Iwegbue (2012).

Varying levels of calcium, chromium, copper, and iron was recorded in all the samples while lead levels were not detected in sample B1 and B2. The results revealed that all the heavy metals concentrations were within the acceptable limit of food (CAC, 2003), while heavy metals concentrations in fruit concentrates, milk candies and milk shakes were also below the permissible limits (JEFCA, 2010).

Possible explanation for the presence of heavy metals in the samples analysed are contamination of the raw materials used, manufacturing and packaging processes (Ashraf, 2006).

Conclusion

This study was able to establish that all heavy metals tested for were below permissible limit in all the samples analysed. These indicated that the samples were not contaminated and pose no damage to human health, though consistent intake of these products can be hazardous due to the bio-accumulative property of heavy metals. The results also showed that calcium and iron which are part of the microelements necessary as components of enzymes involved in major metabolic processes were present in all the samples analysed. It is recommended that constant monitoring of raw materials used should be carried out during manufacturing and also packaging process should be

monitored in order to avoid the levels exceeding permissible limits.

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