American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

American Journal of Food Technology 3 (3): 220-223, 2008
ISSN 1557-4571

Heavy Metal Composition of Some Imported Canned Fruit Drinks in Nigeria

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Abstract: Concentrations of cadmium, lead, chromium, nickel, copper, manganese and zinc in six brands of fruit drinks was investigated. The concentration of the heavy metals showed appreciable ($p<0.05$) variability within a brand except for Pb and Zn in orange brand. However, apparent and significant variability exist when brands are compared. The mean levels of the studied metals varies between 2.29-18.29 ppm for Fe, 1.41-7.19 ppm for Cu, 0.002-0.89 ppm for Cr, 0.06-1.93 ppm for Pb, 0.21-1.00 ppm for Ni, 0.006-11.29 ppm for Mn, 0.69-1.25 ppm for Zn and 0.002-0.49 ppm for Cd, the levels of these metals exceeded statutory safe limits except for Mn, Zn and Fe.

Key words: Fruit drink, heavy metals, contamination, statutory safe limit, Nigeria

INTRODUCTION

Heavy metals occur in all foods as natural or inherent components of plant and animal tissues and fluid and also may be present as a result of contamination or deliberate addition (Underwood, 1973). One form of environmental contamination arises from exposure to water polluted by industrial waste (Mathew, 1986).

Although many heavy metals are essential for animal tissue metabolism, the ranges between beneficial and toxic levels are usually small. There is an increasing concern about the health effects in humans due to continuous consumption of food contaminated with heavy metals. The extent of this contamination depends or several complex factor. One of them being specific metabolic and homeostatic mechanism operating in the type of food and tissue considered.

The compositions of various metals in different food types of various countries have been the subject of many studies (Toro *et al*., 1994; Drury and Hammond, 1979; Jorhem and Sundstroem, 1993; Onianwa *et al*., 1999). Such data are not readily available for most food in developing countries, such as Nigeria, where food composition data are primarily on proximate composition and other nutrients Onianwa *et al*. (1999) reported mean levels of 0.003-0.007 ppm Cd, 0.003-0.032 ppm Co, 0.001-0.030 ppm Cr, 0.001-1.02 ppm Cu, 0.56-6.36 ppm Ni, 0.030-0.070 ppm Pb and 0.020-1.10 ppm Zn.

The objective of the present study is to provide a more detailed determination of the contents of Cd, Cr, Cu, Fe, Ni, Pb and Zn in imported canned fruit drinks in Nigeria market.

MATERIALS AND METHODS

Six brand or types of imported canned fruit drink (6 to 8 in each brand or types) were obtained from local markets in Warri and Agbor, Nigeria. The selection was specially made to reflect the popular brands consumed by different income groups and also influenced by availability at the time of purchase. The samples were stored at almost identical conditions similar to those of retail shops. 300 mL of the liquid samples was heated in evaporating dish on a regulated hot plate until caramelous

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mass was formed. The caramelous mass was formed in most cases was than digested with a mixture of perchloric and nitric acid. The digest was diluted to 25 mL mark using 1 M nitric acid. The sample solutions were subsequently analyzed for the metals using a graphite furnace atomic absorption spectrophotometer (GBC scientific equipment XAA1175, Australia) equipped with D_2 background correction devices.

Appropriate quality assurance procedures and precautions were carried out to ensure reliability of the results. Samples were generally carefully handled to avoid contamination. Glassware was soaked in 1 M nitric acid for 48 h and rinsed with ultra pure water. The reagents (nitric acid, perchloric and distilled water) were of analytical grades. Reagent blank determination was used to correct the instrument reading. Calibration standard were made by dilution of high purity commercial BDH metal standards for atomic absorption analysis. A recovery test of the total analytical procedure was carried for the metals by spiking analyzed samples with aliquots of metal standards and then reanalyzing the samples. The results of recovery studies for the elements were 92.5. 93.4, 96.4, 90, 95, 94 and 89.9% for Fe, Cu, Cr, Pb, Ni, Mn, Zn and Cd, respectively.

RESULTS AND DISCUSSION

Table 1 present the means concentrations of heavy metals while Table 2 presents the range of the levels of heavy metal in the samples. Analysis of variance ($p>0.05$) showed that there is significant variability in the concentration of the studied metals within a brand except for Zn and Pb in the orange brand. However, apparent and significant variation exists when the brands are compared.

Fe had the highest mean levels amongst the metals studied. The levels of Fe in the fruit drinks exceeded the local standard and limits for iron in Nigeria except for mixed fruits and guava brands. The highest level of iron was found in the pineapple brand (Table 1). Contreraslopez *et al*. (1987) reported 15.0 ppm in fruit juice in Spain. The mean levels of Fe this study is comparable to that of Contreraslopez *et al*. (1987). Al-Swaidan (1988) analyzed the levels of Fe in fruit drink using ICP-MS. The author reported concentration range of iron to be 4.49-8.25 ppm. 56% of the total samples have iron concentration within the range reported by Al-Swaidan (1988).

Copper is an essential element for growth, although emetic in large doses, but when present in some beverages such as milk products and fruit juices tends to impair the shelf life or keeping quality of such products, so it expected that fruit juice and milk products should contain relatively low levels

Table 1: Mean±SD of heavy metals (ppm) characteristic of canned fruit drinks

Brand	Fe	Cu	Cr	Pb	Ni	Mn	Zn	Cd
Orange drink	6.72±7.16	1.14±1.03	0.002±0.00	1.12±0.17	0.47±0.54	1.00±0.88	1.25±0.20	0.04±0.03
Apple drink	14.81±8.92	7.19±7.69	0.58±0.33	1.93±1.35	0.21±0.31	0.002±0.00	0.70±0.25	0.01±0.01
Mixed fruits drink	2.29±1.58	2.40±2.04	0.87±0.46	0.85±0.64	0.47±0.52	1.29±0.44	1.16±1.53	0.11±0.17
Guava drink	4.25±4.70	9.08±7.63	0.68±0.45	1.26±1.25	0.56±0.85	0.27±0.34	0.70±0.23	0.40±0.38
Pineapple drink	18.29±10.83	2.68±0.05	0.89±0.65	0.58±0.12	0.93±0.14	0.41±0.00	1.03±0.05	0.002±0.00
Mango drink	12.98±4.54	3.01±0.45	0.002±0.00	0.006±0.002	1.00±0.15	0.006±0.004	0.69±0.14	0.49±0.11

Table 2: Range of heavy metals in canned fruit drinks (ppm)

Brand	Fe	Cu	Cr	Pb	Ni	Mn	Zn	Cd
Orange drink	1.35-14.85	0.40-2.31	nd-0.02	0.52-1.32	0.04-1.02	nd-1.65	1.05-1.27	0.01-0.07
Apple drink	0.37-45.54	2.08-20.51	nd-0.84	0.10-3.72	nd-0.71	nd-0.01	0.46-1.02	nd-0.03
Mixed fruits drink	1.11-5.35	0.71-6.32	nd-1.32	0.39-1.68	nd-1.37	nd-1.02	0.17-4.00	nd-0.43
Guava drink	0.80-11.60	0.88-19.19	036-1.41	nd-2.77	nd-2.05	nd-0.66	0.48-1.09	0.02-0.93
Pineapple drink	1.69-21.49	2.65-2.72	043-1.37	0.50-0.66	0.84-1.03	0.40-0.41	0.99-1.06	nd-0.002
Mango drink	8.44-17.52	2.56-3.45	nd-0.002	0.002-0.006	0.85-1.15	0.002-0.01	0.45-0.83	0.38-0.60

nd = Below detection limit. The detection limit = 0.001 ppm

of copper. Paolo and Maurizio (1978) reported concentration range of 0.87-0.97 ppm in fruit drink in Italy while Contreraslopez *et al*. (1987) reported mean levels of 5.00 ppm for Spain. The levels of Cu found in this study are higher than that of Paolo and Maurizio (1978) but are comparable to the levels reported by Contreraslopez *et al*. (1987). However, the guava and apple brands have mean levels exceeding that of Contreraslopez *et al*. (1987).

The concentration of lead in the fruit drink follows the order: Apple > Guava > orange >mixed fruit > pineapple> mango brands. The levels of Pb report in this study are above the guideline value for Pb in foods drinking water except for mango brands. The major source of Pb in canned fruits drinks is the leaching of Pb from the canning. Pb toxicity causes many sign and symptoms such as abdominal pains, anemia, anoxia, bone pair, brain damage, convulsion, dizziness, inability to concentrate etc. (Kocak *et al*., 2005).

Adraiano (1984) reported Pb levels of 0.01 ppm for beverage drink in Canada. Paolo and Maurizio (1978) reported mean levels of 0.38 ppm Pb for fruit drinks while Contreraslopez *et al*. (1987) reported 0.15 ppm Pb in fruit drinks in Spain. The mean levels of Pb in the various brands were above the levels reported by these investigators except for the mango brands. However, some samples have levels comparable to levels reported by these authors.

The mango brand had the highest concentrations of Ni compared to another other brand. Most of the brands have elevated Ni levels. The mean levels of Ni reported in this study are higher than mean values reported by for fruit drink by Onianwa *et al*. (1999).

The level of manganese found in this study is generally low compared to any other metal examined. The highest concentration of Mn was found in the mixed fruits while the apple brands have the lowest concentration of Mn. The order of concentration of Mn in the various brands of fruit drinks follow the order: mixed fruits>orange>pineapple>guava>mango>apple brands. The levels of manganese found in this study is are below permissible limits food and drinking water. Hence, Mn do not constitute contamination hazard in the brands of fruits drinks. The highest mean levels of cadmium were found in mango. Apart from the pineapple brand, all other brand have mean concentrations of Cd exceeding the WHO permissible limit for drinking water (WHO, 1984). Adraiano (1984) reported 0.003 ppm Cd in beverage drinks in Canada. The level of cadmium found in the various brands was higher than the value reported by Adraiano (1984), except for the pineapple brand.

The concentration pattern of zinc follows the order: orange> mixed fruits >pineapple > apple guava> mango brand. Contreraslopez *et al*. (1987) reported 5.0 ppm Zn in fruit juice in Spain while Paolo and Maurizio (1978) reported 0.41 ppm Zn in fruit in Italy. The levels of zinc found in this study were less than mean levels reported by Contreraslopez *et al*. (1987). Sixty two percent of the samples of fruit drinks examined are comparable to that of Paolo and Maurizio (1978). Table 3 shows the estimates of the doses of the metals, which may be derived from the ingestion of 1 L quantities of the fruit drinks. The estimated dose was found to be generally high for the eight metals studied. The estimated doses derived from the ingestion of 1 L quantities of the fruit drink follows the order Fe>Cu > Pb > Zn > Ni > Cr > Mn > Cd (Table 3). The estimated doses reported herein in this study are higher than estimated doses previous reported for fruit drinks (Onianwa *et al*., 1999).

Table 3: Estimated dose of heavy metals from 1 L volume of fruit drink

Brand	Fe	Cu	Cr	Pb	Ni	Mn	Zn	Cd
Orange drink	6720	1140	2	1120	170	1000	1250	40
Apple drink	14810	7190	580	1930	210	2	700	10
Mixed fruits drink	2290	2400	870	840	470	290	1160	110
Guava drink	4250	9080	680	1260	560	270	700	400
Pineapple drink	13290	2680	890	580	930	410	1030	2
Mango drink	12980	3010	2	6	1000	6	690	490

Overall, the study shows that the levels of the eight heavy metals studied are generally above safe limits and except for iron, zinc and manganese compared well with levels in similar foods from the parts of the world. The data reported herein will be valuable in complementing available food composition data and estimating dietary intakes of heavy metals in Nigeria.

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