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An Assay of Heavy and Trace Metals in Selected Packaged Fruit Juice Commonly Consumed in Enugu, Enugu State, Nigeria

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Abstract: The levels of Lead (Pb), Nickel (Ni), Manganese (Mn), Iron (Fe), Zinc (Zn) and Copper (Cu) in two brands of packaged fruit juices were determined using Atomic Absorption Spectroscopy – AAS (Analyst 20 model). From the results obtained, the mean concentration of the investigated metals increased in the order Mn < Fe < Cu < Pb < sample 1 and Mn < Zn < Fe < Cu in sample 2. Lead was not detected in sample 2 while Ni was not detected in either of the samples. All the investigated metals were within the Recommended Daily Allowance (RDA) range of the metals except Pb in Juice sample 1 and Mn in Juice sample 2. High level of Pb automatically makes sample 2 unfit for human consumption. Regular evaluation of metals in soft drinks is a vital for monitoring health implications of consumption of the drinks.

Key words: Heavy Metal · Trace metals · Soft drink · Juice · Enugu

INTRODUCTION

Non alcoholic drink such as fruit juice is soft drinks which is gradually dominating the beverage market in Nigeria. Fruits are mostly derived from citrus fruits. After expression in a reamer the juice is strained, flash pasteurized, filled into bottles and sealed [1]. Soft drinks, also called ready-to-drink beverages are sweetened water-based non-alcoholic beverages, mostly with balanced acidity [2]. Soft drinks are mostly carbonated usually prepared from a concentrated syrup containing sugar, fruit juice or flavouring essence, citric acid and sodium benzoate as preservative [1]. Soft drinks also contain trace metals such as Fe, Mn, Cu and Zn which are also known as micronutrients and they are needed in minute amounts for normal growth and development of living organisms. On basis of density, trace metals can be heavy metals. Heavy metals have density at least five times heavier than that of water and they are stable elements that cannot be metabolized by the body. Heavy metals such as Pb and Ni could be present in fruit juice and they are toxic even at low concentrations in human body. Unlike other pollutants, heavy metals are non-biodegradable and they have the tendency to bioaccumulate and biomagnified from one tropic level to another [3]. This happen when heavy metals enter and accumulate in body tissues faster than the body's detoxification pathways can dispose of them, hence a gradual build up of these toxins will occur. High-concentration exposure is not necessary in order to produce a state of toxicity in the body [4]. In the last 50 years human exposure to heavy metals has risen dramatically. This is the result of an exponential increase in the use of heavy metals in industrial processes and products. Toxic metals can induce impairment and dysfunction in the blood cardiovascular system detoxification pathways (colon, liver, kidney, skin endocrine (hormonal) system, energy production pathways, enzymatic pathways gastrointestinal tract, immune system, nervous system (both central and peripheral) reproductive system and urinary system pathways [5]. The sources of metals into food substances such as fruit juice include agricultural fertilizers, herbicides and other anthropogenic activities of man. Heavy metals contamination has become a matter of public health concern but this has not received much research attention in Nigeria especially fruit juice contamination through heavy metals. In this present study, levels of Pb, Ni, Zn, Cu, Fe and Mn in fruit juice bought from retail markets in Enugu, Enugu State, Nigeria in December 2013 were determined using Flame Atomic Absorption Spectrophotometer (FAAS).

MATERIALS AND METHODS

Different types of fruit juices were selected based on fruit used in preparation of the juice and their samples

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Table 1: Mean Concentration of metals (in mg/L) in fruit juice

Metals	Cu	Zn	Pb	Mn	Fe	Ni
Sample 1	0.10±0.02	0.68±0.05	0.06±0.02	0.02±0.01	0.05±0.03	ND
Sample 2	0.20±0.02	0.06±0.01	ND	0.03±0.01	0.10±0.01	ND
RDA (mg/day)	1.2 – 1.6	3.0 – 15	0.03 – 0.05	0.003 – 0.26	10 - 15	

ND = Not detectable

RDA = Recommended Daily Allowance

were collected and labeled accordingly. The samples were analyzed "as received" using AAS (Analyst 20 model). The samples were analyzed without any further chemical treatment. The experiments were carried out at a room temperature of 23.8°C. This was done by preparing standard solutions which were used to calibrate the instrument prior to analysis of the samples. The sample solutions as well as those of standard solutions were aspirated into the flame of the spectrophotometer via the aspiration tube. Ions of the investigated metals present in the flame absorb light produced by the lamp and the amount of light absorbed depends on the concentration of the metal present in the sample. The AAS read out unit reports the mean concentration of each element, standard deviation and relative standard deviation of each metal in the samples.

RESULTS

Table (1) presents the mean concentration of the metals in the investigated fruit juices and the Recommended Daily Allowance (RDA).

DISCUSSION

From the results obtained, metals concentration was found to be Cu (0.10±0.02), Zn (0.68±0.05), Pb (0.05±0.17), Mn (0.02±0.01), Fe (0.05±0.03) in sample 1 while in sample 2 the concentration was found to be Cu (0.2±0.02), Zn (0.06±0.01), Mn (0.03±0.01), Fe (0.10±0.01). Lead was not detected in sample 2 while Ni was not detected in either of the samples. The levels of Zn and Cu were the highest concentrations in sample 1 and 2 respectively, while Mn had the least concentration in both samples. The mean concentration of the investigated metals increased in the order Mn < Fe < Cu < Pb < sample 1 and Mn < Zn < Fe < Cu in sample 2.

All the investigated metals were within the Recommended Daily Allowance range of the metals except Pb in sample 1 and Mn in sample 2. high level of lead may be connected to the presence of Pb in the soil from where the fruits were grown moreover contamination from lead could also arise from the metal can from which the sample was packaged hence high density carton is preferred to metal cans as a package. Todd (1996), emphasized that most of the accumulated Lead is sequestered in the bones and teeth. This causes brittle bones and weakness in the wrists and fingers. Lead that is stored in bones can re-enter the blood stream during periods of increased bone mineral recycling (i.e., pregnancy, lactation, menopause, advancing age, etc.). Mobilized lead can be red posited in the soft tissues of the body and can cause musculoskeletal, renal, ocular, immunological, neurological, reproductive and developmental effects [7]. At low concentration, Mn is not known to be toxic rather it is required by the body for proper enzyme functioning, nutrient absorption, wound healing and bone development. Manganese (Mn) deficiency is rare and can been seen expressed in poor bone health, joint pain and fertility problems [8]. According to results from Bouchard *et al.* [9], the higher levels of exposure to manganese in human body is associated with increased intellectual impairment and reduced intelligence quotients in school-age children. Chronic exposure to excessive Mn levels can lead to a variety of psychiatric and motor disturbances, termed manganese and ultimately to Mn-induced symptoms [10].

CONCLUSION

From this study the levels of all the investigated metals were found to be within the Recommended Daily Allowance except for Pb in sample 1 and Mn in sample 2. Presence of Pb in sample 1 automatically makes it unfit for human consumption. Over time bioaccumulation of Pb in human tissue will inevitably lead to health consequences.

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