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Determination of trace metals presence in drinking water and fruit juice in Benin City, Nigeria

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ABSTRACT

Objective: To study the levels of trace metals drinking water and fruit juice in Benin City, Nigeria. *Methodology and results:* Fifteen water samples and 10 fruit juice samples were analyzed using Atomic Absorption Spectrophotometry (AAS) and the metallic elements Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn) and Zinc (Zn) measured. Fe was present in all the samples, Cu was present only in the drinking water samples, Mn and Zn were found in all drinking water samples and only three fruit juice samples. Pb and Cr were below the detection limits in all the samples.

Conclusion and application of findings: The trace metal levels in all the samples were below the allowable limits set by the National Research Council and WHO (1996) except in the case of one sample where the concentration of Zn (5.696 mg/L) was above the allowed limit and hence the product is unsafe for human consumption.

Key words: Trace metals, fruit juice; drinking water, Atomic Absorption Spectrophotometry (AAS).

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INTRODUCTION

There has been an increasing trend in the consumption of locally manufactured or imported fruit juice, drinks, bottled and sachet water in both urban and rural areas of Nigeria. The presence of impurities and foreign matter in pharmaceutical preparations and finished products for human consumption is of great concern because they present health hazards when they exceed beneficial limits. Water is one of the most common substances known and it is a good solvent for many substances hence it is rarely in its pure form in nature. Water is important for maintaining the normal physiological activities of the body, e.g. enzymatic and chemical reactions, lubrication of joints, regulation of homeostasis and body weight, proper function of cells and tissues as well as some therapeutic value. (http://www.freedinkingwater.com/water-education/water-health.htm).

The manufacture of juices requires special attention in terms of purity and the source of water and its purification is crucial for maintaining quality and safety. Drinking water, fruit juices and most drinks usually contain small amounts of essential trace elements, which contribute to dietary intakes, and the levels of these elements need to be controlled (Laquatra & Gerlach, 1990; Ikem *et al*., 2002). Some of these elements are important for the normal functions of the body but when their concentrations exceed an

allowable limit (National Research Council, 1989; World Health Organization, 1996], they cause acute and chronic poisoning leading to significant illness, reduced quality of life and even death (Prasad, 1976). It is important to note that deficiencies of these trace elements also cause health problems (Prasad, 1976; Underwood, 1977).

Water from the ground or rivers that are used in the manufacture of fruit juices and preparation of drinking water in Benin City has been reported to be contaminated with higher than allowed levels of lead (Pb) and Zinc (Zn) (Erah *et al*., 2002). In this paper, we report the determination of the quantity of six trace elements in drinking water and fruit juices available in Benin-City, Nigeria.

MATERIALS AND METHODS

Materials: Measurements were made using Atomic Absorption Spectrophotometer (Unicam series, model 969, England) equipped with corresponding hollow cathode lamps (chromium, copper, iron, lead, manganese and zinc) at the time of analysis and flame type consisting of acetylene/air mixture.

Samples: Ten fruit juices (FJ1 – FJ10), five bottled water (DW1 – DW5) and ten sachet water (DW6 – DW15) bearing different brand names were purchased from various shops in Benin-City, Nigeria. Analytical grades of concentrated nitric acid, concentrated sulphuric acid and standard metal samples of BDH were obtained.

Methodology: Samples were prepared in duplicates using the procedures described by Lopez *et al*. (1998). One hundred milliliters of each of the samples were put into 250 ml beaker, 2.5 ml of conc. HNO_3 was added and the solution was heated on a hot plate for 1 h. One ml of concentrated H_2SO_4 was added and digested for 6 h. After cooling, the volume of the solution was measured and 20 ml portion was put in to a beaker containing 4 ml of conc. HNO_3. The resulting mixture was heated on a hot plate for 2 h and final volume was made up to 10 ml with de-ionized water.

The solutions were then analyzed using the Unicam atomic absorption spectrophotometer and the concentration of each metal from each sample was determined from calibration plots earlier prepared for each metal using standard solutions of each metal.

RESULTS AND DISCUSION

The results show that a concentration range of 0.001 – 0.008mg/L of copper (Cu), 0.015 – 0.097 mg/L of iron (Fe), 0.001 – 1.070mg/L of manganese (Mn), 0.028 – 5.969 mg/L of zinc (Zn) were found in the samples while the concentration of lead (Pb) and chromium (Cr) were below their minimum detection limits (table 1). The variation of elemental concentration observed may be due to the difference in the levels of these elements in raw materials especially the water source, the extent and nature of water purification and quality control procedures.

Most of the consumed water in Nigeria is from ground water and boreholes, which do not always give pure water due to the presence of different contaminants. The water obtained from these sources is subjected to various treatments by different manufacturing companies before packaging and sale or use in other manufacturing processes. The levels of tested trace metals in all the samples analyzed were below the allowed limits (National Research council, 1989; World Health Organization, 1996), except for toxic levels of Zn in sample FJ-5. This result suggests that most of the water and fruit juice available in Benin City is safe for consumption, though care is needed to detect and manage isolated cases, e.g. sample FJ-5. This is because toxic levels of Zn has been linked to anaemia, fever, gastrointestinal irritation, nausea and vomiting, drowsiness, impaired immune function and some other illnesses (ATSDR, 1994).

Although there are some other sources of these essential trace metals in food, fruits and vegetables, haematinics, nutritional and food supplements, it is recommended that the concentration of some of these elements should be increased so that adequate levels can be provided through dietary intake of drinking water and fruit juices available in Benin-City, Nigeria.

Table 1: Level of trace metals in drinking water and fruit juices available in Benin-City, Nigeria.

Sample	Concentration of metal (mg/L)					
	Cr	Cu	Fe	Mn	Pb	Zn
DW-1	ND	0.003	0.015	0.009	ND	0.173
DW-2	ND	0.005	0.056	0.006	ND	0.190
DW-3	ND	0.001	0.020	0.005	ND	0.067
DW-4	ND	0.008	0.010	0.005	ND	0.114
DW-5	ND	0.005	0.086	0.003	ND	0.077
DW-6	ND	0.002	0.073	0.008	ND	0.076
DW-7	ND	0.003	0.035	0.009	ND	0.085
DW-8	ND	0.001	0.081	0.002	ND	0.100
DW-9	ND	0.002	0.022	0.003	ND	0.105
DW-10	ND	0.005	0.097	0.009	ND	0.108
DW-11	ND	0.006	0.083	0.001	ND	0.113
DW-12	ND	0.005	0.056	0.007	ND	0.157
DW-13	ND	0.007	0.043	0.002	ND	0.133
DW-14	ND	0.003	0.023	0.003	ND	0.136
DW-15	ND	0.004	0.081	0.006	ND	0.154
FJ-1	ND	ND	0.044	0.014	ND	0.029
FJ-2	ND	ND	0.022	ND	ND	ND
FJ-3	ND	ND	0.044	ND	ND	ND
FJ-4	ND	ND	0.041	ND	ND	ND
FJ-5	ND	ND	0.022	ND	ND	5.969
FJ-6	ND	ND	0.020	1.02	ND	ND
FJ-7	ND	ND	0.032	1.07	ND	ND
FJ-8	ND	ND	0.024	ND	ND	ND
FJ-9	ND	ND	0.044	ND	ND	0.028
FJ-10	ND	ND	0.022	ND	ND	ND

ND= Not detected

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