Evaluation of Heavy Metal Contaminations of Selected Alcoholic and Non-Alcoholic Drinks Sold in Nigeria

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Abstract - Toxic metals contamination is an important environmental problem that was mainly manifested in the growing industrial cities where the levels in toxic metals exceeded the recommended levels leading to the increase of several health problems varying from memory disorder to carcinogenic diseases. The study was aimed at evaluating heavy metal contamination from selected alcoholic and non-alcoholic drinks sold in Nigeria. Ten (10) alcoholic and non-alcoholic drinks were purchased in Yenagoa and standard wet digestion procedure was adopted in the sample preparation. Heavy metals were analyzed using the Atomic Absorption Spectrophotometer technique and the results were compared with World Health Organization (WHO) standards. The result showed the contamination of heavy metals for non-alcoholic drinks were PBC>PBCM>PBO>PCC>PF while Alcoholic drinks were BH>BL>BE>BS>BB. When compared to WHO standards, the levels of Cd, Ni, Pb were above the permissible limits. These results suggest that both alcoholic and non-alcoholic drinks sold in Nigeria may be contaminated with heavy metals which constitute a major public health problem. Thus, quality control is recommended during the production process especially at the stages of sterilization and purification.

Keywords - Heavy metal, Alcoholic drink, Non-alcoholic drink, Public health, Toxicity.

I. INTRODUCTION

Heavy metals contamination is a major problem of our environment and they are also one of the major contaminating agents of our food supply [1], [2]. The knowledge of metals in foods is essential for calculating the dietary intakes of essential metals and evaluation of human exposure to toxic elements [3]. This problem is receiving more and more attention all over the world, in general and in developing countries in particular. The excessive intake of these toxic heavy metals can lead to several diseases such as organ failure, cancers, retardation of mental development in children and pregnant women [4]. Therefore it is important to monitor the level of such pollutants in the environments especially the foods and drinks consumed [5]. Heavy metal composition of foods is of interest because of their essential or toxic nature. For example, Fe, Zn, Cu, Cr, Co, and Mn are essential though very high levels are intolerable, while Pb, Cd, Ni, As, and Hg are toxic at very low concentration [6], [7]. They have shown to be harmful and toxic to the human body [8] and constitute a major public health concern [6], [9]. These metals have the potential of causing acute and chronic toxicity by various modes of action in both children and adults [10]. Therefore, consistent monitoring of metals in drinks is very essential.

Alcoholic drinks are drinks that contain ethanol and are divided into the general classes; beers, wines and spirits while non-alcoholic drinks are drinks that contain less than 0.5% alcohol by volume [11]. Non-alcoholic drinks include many drinks such as carbonated drinks, juices, energy drinks, bottled water, coffee, tea and probiotic drinks. Carbonated drinks represent the highest portion of non-alcoholic consumed drinks. However, bottled water and juices are in the second and third grades, respectively [12]. Non-alcoholic drinks have turned out to be a drink preferred in most social gathering, for health and or religious belief [13]. They are quickly absorbed than water, providing to human body hydration and energy while replenishing all the key vitamins and mineral that the body losses during exercises.

Manufacturers of these drinks should require unusual caution to ensure the purity of constituents used in the industry such as untreated sources of water and packaging materials, chemical residue in process drink, bioaccumulation in aquatic animals and industrial emission into drink before packaging [14]. It is agreed that non-alcoholic drinks are admittedly vital vehicles of a balance diet. The neurological aspect of metal poisoning indicated nervous system as target organ. Other target organ includes respiratory tract, blood, kidney, bone, gastrointestinal tract, endocrine [15].

The aim of this study was to evaluate heavy metal contaminations of selected alcoholic and non-alcoholic drinks sold in Nigeria.

II. MATERIALS AND METHODS

Sample Collections Procedure

Ten (10) samples of alcoholic and non-alcoholic drinks comprises of five samples each were purchased at Yenagoa, Bayelsa State, Nigeria. The alcoholic drink samples were designated as; BB, BH, BL, BE and BS while the non-alcoholic drink samples were designated as; PCC, PBCM, PBC, PBO and PF.
**Samples Preparation Procedure**

Wet digestion method was used in the preparation of the drinks for heavy metal analysis. 5 ml of analytical unit was weighed into digestive tube and 10 ml of concentrated H\(_2\)SO\(_4\) and HClO\(_4\) at ratio 1:1 was added. This was latter digested using FOSS TECATOR Digestor Model 210 at 250°C for 1 hour at the first instance and continued until a clear solution was obtained in a fume cupboard. The clear solution was filtered into a 100 ml volumetric flask and completed to the mark with de-ionised water.

**The Determination of heavy metal**

Metal analysis Cu, Ni, Pb, Cd, and Cr were determined using Atomic Absorption Spectrophotometer (Buck 210). Standards for each element under investigation was prepared in part per million (ppm) and the limit standard concentration for each element was adhered to according to the BUCK Scientific instruction and the results obtained were compared with World Health Organization standards for the metals limits for human consumption.

**Quality assurance protocol**

Precision and accuracy of the analytical procedure was investigated by carrying out recovery experiments. Samples were handled carefully to avoid contamination. All glassware and other containers were properly cleaned and the reagents were of analytical grade. Accuracy of the digestion procedures was verified by examination of the recovery data, spiking analyzed samples with aliquots of metal standards and then reanalyzing the samples. The percentage recoveries lay within the range 89.5-104.70% with the percent relative standard deviations less than eleven, indicating good accuracy and precision.

### III. RESULTS

**Heavy metal concentrations of non-alcoholic drinks**

Cadmium concentrations ranged from 0.003±0.0006 – 0.131±0.05 ppm, Ni concentrations ranged from 0.222±0.10 – 0.478±0.2 ppm, Pb levels ranged from 0.381±0.03 – 0.729±0.10 ppm, Cu levels ranged from -0.043±0.001 – 0.123±0.10 and Cr was not detected on the samples as shown in Table 1.

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>Heavy metals (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cd</td>
</tr>
<tr>
<td>PCC</td>
<td>0.074±0.01</td>
</tr>
<tr>
<td>PBCM</td>
<td>0.131±0.05</td>
</tr>
<tr>
<td>PBC</td>
<td>0.249±0.02</td>
</tr>
<tr>
<td>PBO</td>
<td>0.102±0.04</td>
</tr>
<tr>
<td>PF</td>
<td>0.003±0.0006</td>
</tr>
<tr>
<td>WHO</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Values are Mean±SD triplicate determination

**Note:** ND- not detected, WHO- World Health Organization, ppm- parts per million

**Heavy metal concentrations of alcoholic drinks**

Table 2 shows heavy metal concentrations of Alcoholic drinks, Cd levels ranged from 0.034±0.006 – 0.131±0.03 ppm, Ni concentrations ranged from 0.222±0.08 – 0.478±0.2 ppm, Pb levels ranged from 0.479±0.2 – 0.701±0.3 ppm, Cu concentrations ranged from 0.020±0.01 –0.142±0.02 ppm and Cr was not detected on the samples.

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>Heavy metals (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cd</td>
</tr>
<tr>
<td>BB</td>
<td>0.034±0.006</td>
</tr>
<tr>
<td>BH</td>
<td>0.131±0.03</td>
</tr>
<tr>
<td>BL</td>
<td>0.084±0.03</td>
</tr>
<tr>
<td>BE</td>
<td>0.120±0.09</td>
</tr>
<tr>
<td>BS</td>
<td>0.093±0.01</td>
</tr>
<tr>
<td>WHO</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Values are Mean±SD triplicate determination

**Note:** ND- not detected, WHO- World Health Organization, ppm- parts per million
IV. DISCUSSION

The cadmium concentration in the alcoholic drinks ranged between 0.034±0.006 – 0.131±0.05 ppm. All the alcoholic drink samples were observed to be above the WHO permissible limits of 0.055ppm (Cd) except BB (0.034ppm) which was below WHO permissible limits. The results obtained for the non-alcoholic drinks were also above WHO Standard except PF (0.003ppm) which was totally below the standard maximum limit (0.055 ppm). The incidences of cadmium contaminations are mostly from the sources of raw materials for the production. Food contamination is the most important pathway of Cd and it is more readily taken up by plants than other metals, such as lead [16]. Another major source is related to the use of cadmium in several industrial processes such as protective coating (Often applied by electroplating for some metals such as iron [17]. Thereby, the rusting process of canned drinks and the cover of bottled drinks can serve as sources of cadmium contamination.

The range of Nickel was from 0.222±0.08 - 0.478±0.2 ppm for alcoholic drinks while 0.222±0.10 - 0.893±0.09 ppm for non – alcoholic drinks. Alcoholic and non-alcoholic drinks analyzed in this study were above WHO permissible limits (0.002ppm). The findings are in agreement with the reports of references [18], [19]. The major use of Nickel is in the preparation of alloys because of its strength, ductility and resistance to corrosion and heat. The use of Nickel in cans preparation can result to a means of contamination. Nickel can accumulate in the kidneys, bones, and thyroid glands and cause toxicity. In small quantities nickel is essential, but when uptake is too high it can be a danger to human health. An uptake of two large quantities of nickel causes lung embolism, lung cancer, sickness and dizziness after exposure to nickel gas, asthma and chronic bronchitis, heart disorders, and allergic reactions [20].

The lead concentration in the alcoholic and non-alcoholic drinks was above the standard limit set by World Health Organization (0.001 ppm). These results revealed that alcoholic and non-alcoholic drinks could prove risk of lead toxicity to the public. The findings are in accord with works of reference [21]. Heavy metals in beer may have different sources. Its presence in beer may be related to the uptake from contaminated soil and such contamination may occur during technological processes [22]. High concentration of lead indicates that the control of contamination was of low quality or as a result of adulteration or ill practices of processing or proliferation of low quality of product in the industry. Lead plays no biological role in living organisms. According to the Royal commissions of Environmental Pollution (UK), the consumption of wine and beer raises blood lead concentrations [23].

The concentration of copper in alcoholic and non-alcoholic drinks was below the World Health Organization (WHO) standard (1.0 ppm). The results are in agreement with the findings of reference [24]. Copper is an essential trace mineral that cannot be formed by the human body but it must be ingested from dietary sources. It is very essential for the proper functioning of organs and metabolic processes. However, like all essential element and nutrients, too much or little of copper ingestion can result in a corresponding condition of copper excess or deficiency in the body, each of which has its own unique set of adverse health effects. Chromium was not found on the drink samples both alcoholic and non-alcoholic and the result is in concordance with the works of reference [19].

V. CONCLUSION

The presence of sugar, carbon dioxide, phosphate, acidity and alcohol in the drinks in Nigeria gives the characteristic taste which justifies their frequent consumption. However, this high consumption gives room for the risk of heavy metal contamination and intoxication as cadmium, lead and nickel were found to be present in all the drink samples and the values were above the acceptable WHO limits for consumption. And as such, alcoholic and non-alcoholic drink consumption may constitute a major public health concern for heavy metal contamination in Nigeria and thus, there is need for regulatory bodies to monitor and control the quality of the alcoholic and non-alcoholic drinks in order to ensure safe consumption and minimize the possible underlying risk.
Quality control should be ensured during production and the quality of sugar, water, alcohol, etc. used for the production of these drinks be evaluated for the presence of heavy metals at the level of purification and sterilization to reduce or prevent subsequent health effects of intoxication. Therefore, it is recommended to regularly check the raw materials of the alcoholic and non-alcoholic drinks as well as the processing procedures to reduce the transfer of these toxic metals in final products as much as possible.

REFERENCES


