Evaluation of the Effect of Heavy Metals in Canned Drinks from Wukari Local Government Area of Taraba State

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Abstract- ***The exposure of heavy metals to human has cause serious health problems. This brings attention of many to hazardous effect of heavy metals on health. Hence it is importance to study some heavy metals in canned drinks consumed daily and the duration it takes to manifest after long time exposure to heavy metals. This research work aimed at assessment of heavy metals in selected canned drinks in wukari market for ten (10) samples of canned drinks (grand malt, life beer, exotic, canned star, guldberg, fayrous, tiger beer, zagg E, amstel malt and maltina) were collected. The concentration of heavy metals was evaluated using AAS (Atomic Absorption Spectrophotometer).The result revealed that concentration of lead (Pb) is the most abundant in all the samples with the range value of 0.062 to 0.432 ppm. This level exceed the safety limit of 0.01ppm by World Health Organization (WHO 2017), cadmium (Cd) ranged between 0.002 to 0.006ppm, though in some canned drinks like (exotic, star, Amstel, and maltina) the values were above the recommended limit of 0.003ppm (WHO 2017) and chromium (Cr) ranged between 0.005 to 0.042ppm which is below the safe limit set by (WHO 2017). This implies that the sample with lead content if consumed in large amount can seriously harm children's health and development such as brain and nervous system. In adult, chronic lead exposure causes kidney failure, hypertension etc. The general public should be enlightened on several on the adverse effect of these heavy metals in canned drink and reduce excessive use of it.***

Indexed Terms- ***Canned Drinks, Heavy Metals, Health Risk, Concentration***

I. INTRODUCTION

Canned drinks contains a wide range of metallic elements (metals) such as Candium, potassium, chromium, calcium, lead, magnesium, selenium, copper and zinc. These elements are essential in trace quantities for maintenance of cellular processes (essential elements). Other metallic elements have no functional effects in the body and can be harmful to health. Deficiency or high concentrations of these metals may have adverse effects on the human health. Therefore, concentration of toxic heavy metals in the environment and canned foods has been an important topic and has received great attention (Majolagbe et al.,2011, Oluwole et al., 2013, Fiamegkos et al.,2015). The majority of metals are natural components of the earth's crust (Paul et al., 2012). Metals and other elements can be naturally present in drinks or can enter food as a result of human activities such as industrial and agricultural processes.

Heavy metal in canned drinks has it source traced to the untreated water, chemical residue from process the drinks, bio accumulation in aquatic animals and industrial emission into drink before packaging or canning (Salako et al., 2016). Other sources of these metals are natural occurrences and man activities doing process handling of raw materials, processing operation, packaging and distribution (Itodo and Itodo., 2010). The neurological aspect of metal poisoning indicated nervous system as target organ. Other target organ includes respiratory tract, blood, kidney, bone, gastrointestinal tract, endocrine (ATSDR., 1993) 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 level levels are Intolerable, while Pb, Cd, Ni, As, and Hg are toxic at very low concentration (Bingol et al., 2010, Nkansah and Amoako, 2010). They have potential hazardous effect not only on compound but human health. Therefore, consistent auditing and monitoring of metals in beverages is very essential.

II. MATERIALS AND METHODS

The study was carried out to investigate the contents of the selected drinks that are alcoholic and non-alcoholic that are heavily consumed largely in Wukari Local Government Area of Taraba State, Nigeria to determine the qualities of these drinks if they constitute health risks to the people.

2.1 Sample Collection

A total sample of 10 different canned drinks (Grand malt, Life, Exotic, Star, Guldberg, Fayrous, Tiger, Zagg E, Amstel Malt, and Maltina) where collected randomly in Wukari L.G.A market of Taraba State, Nigeria. The canned drinks samples were kept on the table for 24 hours at room temperature prior to the experiment. Each can was assigned a sample code and the details on the packaging such as date of manufacture, expiring date, manufacturing date trade name, National Agency for Food and Drug Administration and control (NAFDAC) Registration Number, and country of Origin where recorded.

2.2 Sample Preparation

Wet digestion of the samples was performed with nitric (HNO_3) acid. One fifth of the sample material (0.2g) was weighed into the beaker and 10ml of nitric acid was added. A small glass funnel was inserted to act as a reflux condenser and the mixture was heated for 15-30 min at 150^{o}c until a dens white fume is noticed and a colorless solution was obtained. It was removed from the block and cooled to about 100^{o}c. The solution was filtered into a 100 m volumetric flask and diluted to the mark with water. The blank sample was prepared with the same procedure but without samples and the Heavy metals content was read using Atomic Absorption Spectrophotometer (AAS).

2.3 The Determination of Mineral Analysis

All chemicals and reagents used were of analytical grade. Materials and reagents used were including standard solutions of 1000ppm of each tested element Cd, Cr, As, Pb and Ni. 70% (v/v) HNO_3.The working standard solution of each examined metal where freshly prepared by diluting an appropriate aliquot of the stock solutions using 0.1% (v/v). For the detection of the metals in AAS (Model Type AS 51S, U 24 V DC APP-Nr-402071), characteristic wavelength of electromagnetic radiation from the light source was passed through the prepared samples and the various metal elements were detected

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 standard practice and the results obtained by compared with World Health Organization standards for the metals limits for human consumption, with the chemicals sourced from Central Laboratory of the Federal University Wukari, Taraba State, Nigeria. The standard solutions were aspirated and the graph obtained. The samples concentrations of various metals were read and calculated using the expression (Salako et al., 2016) in equation 1.

$$\text{Mineral (i.e Pb, Cd, Cr ...)ppm} = \frac{\text{machine reading in ppm}}{\text{weight of sample}} \times 100(\text{dilution factor}) \quad (1)$$

2.4 Estimated Daily Intake (EDI): The EDI can be calculated using the procedure reported by (Cherfiet al., 2014 and Abbasi et al., 2020) as in equation 1

$$EDI = \frac{C_m X D_i}{B_w} \quad (2)$$

where; 'C_m' is the metal concentration in canned drinks (mg/kg), and 'D_i' is the daily intake of the product which is pegged at 33cL.

2.5 Health risk index (HRI) is the ratio estimated daily intake (EDI) of heavy metal to the reference oral dose (RFD) for each metal and body weight (BW) of the consumers. The HRI less than 1 for any metal consider safe for consumers (Parveen et al., 2020). The equation for HRI is:

$$HRI = \frac{EDI}{RfD} \quad (3)$$

2.6 Hazard index (HI) is the sum of hazard quotient for trace metals and can be calculated using the equation reported by (USEPA, 2007; USEPA, 2001).

$$HI = THQ_1 + THQ_2 + \ldots + THQ_n \quad (4)$$

Where; THQ1-n is the Target hazard quotient for 1-n metals.

$$THQ = \left[\frac{(EFrXED_{total}F_{IR}XC_m)}{RfDXBWXATC}\right] X10^{-3} \quad (5)$$

Where,
F_{IR} is the ingestion rate of canned drink per day, which is pegged at 33cl, ATC is average time carcinogens

2.7 Target Cancer risk (TCR): This is used to calculate the cancer risks posed on consumers of canned drinks. The equation by (USEPA, 2007; USEPA, 2017) can be used to calculate Target cancer risks:

$$TCR=\left(\frac{EF_rXC_mED_{total}XCPS}{BWXATc}\right) X10^{-3} \quad (6)$$

Where ATC is average time carcinogens; carcinogens potency slope oral (Mg/kg/day) is CPS; EFr is the exposure frequency (days/year); ED_{total} is the total exposure duration (year); BW is the average body weight; and C_m is metal concentration.

III. RESULT AND DISCUSSION

3.1 Sample Concentration

Candium (Cd)

The values of cadmium in the samples as shown in Table 1, were within the range of 0.002 to 0.006 ppm. The result shows that some of the canned drinks (Exotic, Star, Amstel malt and Maltina) were found to be above the recommended safe limit of 0.003 ppm (WHO, 2017). Cadmium is one of the metals considered non-essential and bio toxic even at very low activity concentrations. Cadmium has been found to cause nausea, vomiting, diarrhea, and so on (Magomya et al., 2015). The main organ damaged following long-term exposure is the kidney, the primary site of action being the proximal tubules being (Oyekunle et al., 2019). Cadmium is primarily toxic to the kidney, especially to the proximal tubular cell, the main site of accumulation.

Once cadmium is absorbed into the body, it is efficiently retained in the human body and accumulates throughout life. Cadmium can also cause bone demineralization either through direct bone damage or indirectly as a result of renal dysfunction.

Lead (Pb)

Lead is well known to cause toxicity and poisoning in individuals exposed to it, which can lead to various disease conditions such as high blood pressure, anemia (Garba et al., 2015). The concentration of lead detected in the canned drinks samples were in the range 0.062 to 0.432 ppm. This level exceeded the set safe limits of 0.01 ppm by the World Health Organization. In non-alcoholic drinks, some high concentrations of lead up to 0.432 ppm, this was in conformity with the findings of (Salakoet al., 2016). This high level of lead detected in this present study is of great concern as this could lead to lead toxicity and some diseases associated with high concentration of lead in the body.

The high level of heavy metals in alcoholic canned drinks observed in the result may be related to the uptake from contaminated soil and such contamination may occur during technological processes. High concentration of lead indicates that the control of contamination was of low quality or as a result of adulteration or ill practices by producers.

Chromium (Cr)

Chromium concentration results as shown in Table 1 ranged between 0.005 to 0.042 ppm, which is below the standard safety limits set by (WHO, 2017) for the alcoholic and non-alcoholic canned drinks. The two major prevalent forms of chromium are Cr 214 (III) and Cr (VI), however it is only Cr (VI) that is deleterious to health when amount above limit is consumed (Salako et al., 2016). The consistent finding of lung cancer in workers exposed during 216 chromate and chromate pigment production and chromium plating has led to the identification of Cr (VI) compounds as a known human carcinogen by number of authoritative institutions (Salako et al., 2016). The use of chromium as alloy in the

preparation of cans and electroplating process might contribute to the status of their presence in the canned drinks.

However, chromium at low concentration performs many functions such as catabolism of fats and carbohydrates; it maintains the blood glucose in the body this helping the diabetic.
The activity concentration of Pb is higher in all the canned drinks as shown in Figure 1 particularly in star and Life beer, this level must be checked as long accumulation of such drinks can increase the dose in human body which could result to health challenges.

Table 1: Activity concentrations of some canned drinks within Wukari L.G.A

S/N	Sample ID	Pb(ppm)	Cd (ppm)	Cr (ppm)
1.	Grand malt	0.062±0.001	0.002 ±0.0001	0.007±0.0002
2.	Life	0.370±0.002	0.002 ±0.0002	0.006 ±0.0001
3.	Exotic	0.124±0.001	0.006±0.0001	0.006 ±0.0001
4	Star	0.432±0.002	0.004±0.0001	0.005±0.0001
5	Guldberg	0.062±0.001	0.002±0.0002	0.042±0.0002
6	Fayrous	0.309±0.002	0.002±0.0001	0.017±0.0002
7	Tiger	0.185±0.001	0.002±0.0001	0.007±0.0001
8	Zagg E	0.247±0.001	0.002±0.0001	0.007±0.0001
9	Amstel Malt	0.309±0.002	0.004±0.0001	0.016±0.0002
10	Maltina	0.062±0.001	0.004±0.0002	0.020±0.0002
	WHO	0.01	0.003	0.05

3.2 Estimated daily intake (EDI) of heavy metals through canned drinks:
The EDIs of three metals (Pb,Cd, and Cr) were evaluated according to the average concentration of each metal in each canned drinks and the respective consumption rates. The EDI and maximum tolerable daily intake (MTDI) of studied metals from consumption of canned drinks, consumption rates of trace metals in adult were shown in Table 2. The Estimated daily intake of Pb,Cd, and Cr were within 0.2923 – 2.0366, 0.00943 – 0,02829 and 0.2357 – 0.198 mg/day, respectively (Table 2).The total EDIs ofPb, Cd, and Cr, from all examined canned drinks were lower than the Maximum Tolerable Limit values recommended by the international regulatory bodies (Table 2), indicating that these drinks does not pose any health risks to consumers at the moment

Table 2: Estimated Daily intake (EDI) of toxic metals (mg/kg) for consumption of some canned drinks produced in Nigeria.

Type of canned drinks	Estimated daily intake (EDI) (mg/kg)x10^{-3}		
	Pb	Cd	Cr
Grand malt	0.29229	0.00943	0.0330
Life	1.74429	0.00943	0.02829
Exotic	0.58457	0.02829	0.02829
Star	2.03657	0.01886	0.02357
Guldberg	0.29229	0.00943	0.19800
Fayrous	1.45671	0.00943	0.08014
Tiger	0.87214	0.00943	0.03300
Zagg E	1.16443	0.00943	0.03300
Amstel Malt	1.45671	0.01886	0.07543
Maltina	0.29229	0.01886	0.09429
(MTDI) WHO	1.1	0.82	0.2

3.3 Health Risk Index (HRI)
The HRI for all the selected canned drinks ranges as follow; Cd (0.0186 – 0.05658), Pb (0.0835 – 0.5818), and Cr (0.00265 – 0.00795) (Table 3). The result of HRI for Cd, Pb, and Cr from this study shows that HRI is less than one. This shows that there is no significant health risk in consuming these canned drinks in the appropriate portion

Generally, HRI less than one means that the exposed population is safe of metals health risk while HRI greater than one means the reverse.

3.4 Target Cancer Risk (TCR)

Non-carcinogenic risk: The potential health effects were assessed from risk assessment which explained exposure pathways of different contaminant to human body. The health risks from consumption of contaminated canned drinks by adult were determined from THQ, which is the ratio of determined dose of a pollutant to a reference dose level. If the ratio is greater than 1, the exposed population is likely to experience obvious adverse effects. The estimated THQ values of metals are shown in Table 3. Cumulative risk of the studied metals (TTHQs) are lower than 1 for all the canned drinks examined, indicating that the people are not in any way subjected to carcinogenic risks from trace metals by ingesting the canned drinks. The THQ for Pb, Cd and Cr were ranged 0.08007 to 0.5580, 0.00258 to 0.005166 and 0.00904 to 0.02583 respectively (Table 3).

The hazard index (HI) value expresses the combined non carcinogenic effects of multiple elements. It was investigated that the highest hazard index were in canned life beer (0.48822) and star beer (0.5696) which is far less than one. This shows that there is no significant carcinogenic effect.

3.5 Carcinogenic Risk of Pb: The carcinogenic risk derived from the intake of Pb which was calculated as the metals may promote both carcinogenic and noncarcinogenic effects that depend on the exposure dose. The carcinogenic risks of Pb due to exposure from different canned drinks examined are showed in Table 3. Carcinogenic risk of Pb ranged from $1.1873x10^{-6}$ and 16.5995×10^{-6}. Targeted cancer risk is less than 10^{-4}, this suggest that there is no threat to life.

Table 3: Target hazard quotient (THQ), Hazard index (HI) and Targeted Cancer Risk for adultexposed to some canned drinks contaminatedwith toxic metals.

canned type	THQ-Pb	THQ-Cd	THQ-Cr	HI	TCR X10^{-6}
Grand malt	0.080078	0.002583	0.009041	0.091703	2.38233
Life	0.477886	0.002583	0.00775	0.488219	14.2171
Exotic	0.160157	0.00775	0.00775	0.175656	4.76466
Star	0.557965	0.005166	0.006458	0.569589	16.5995
Guldberg	0.080078	0.002583	0.054247	0.136908	2.38233
Fayrous	0.3991	0.002583	0.021957	0.42364	1.18732
Tiger	0.238943	0.002583	0.009041	0.250568	7.10856
Zagg E	0.319022	0.002583	0.009041	0.330646	9.49089
Amstel Malt	0.3991	0.005166	0.020665	0.424932	1.18732
Maltina	0.080078	0.005166	0.025832	0.111076	2.38233

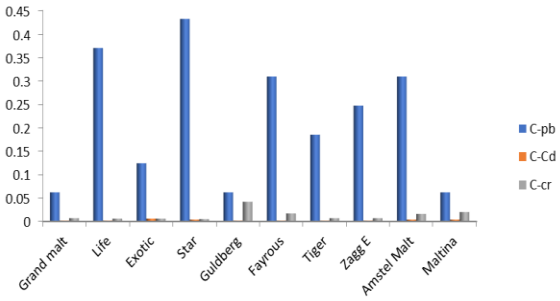

Figure 1: Activity concentration of Heavy metals in some canned drinks from Wukari L.G.A

Figure 1 illustrate the variation that take place in the activity concentration in all the selected canned drinks. Figure 1 shows that the activity of Pb leads other heavy metals followed by Cr and then Cd in all the canned drinks. This results shows that the quantity of lead (Pb) in the drinks are higher than other heavy metals especially in star and life beer followed by Amstel malt.

CONCLUSION

From the results obtained, the concentration of heavy metals in canned drinks sample in wukari market was investigated. The cumulative risk of the studied metals (TTHQs) are lower than 1 for all the canned drinks examined, indicating that the people are not in any way subjected to carcinogenic risks from trace

metals by ingesting the canned drinks. The THQ for Pb, Cd and Cr were ranged 0.08007 to 0.5580, 0.00258 to 0.005166 and 0.00904 to 0.02583 respectively (Table 4). The hazard index (HI) value expresses the combined non carcinogenic effects of multiple elements. It was investigated that the highest hazard index were in canned life beer (0.48822) and star beer (0.5696) which is far less than one. This shows that there is no significant carcinogenic effect. Also the Health Risk Index (HRI) for all the selected canned drinks ranges as follow; Cd (0.0186 – 0.05658), Pb (0.0835 – 0.5818), and Cr (0.00265 – 0.00795) (Table 3). The result of HRI for Cd, Pb, and Cr from this study shows that HRI is less than one. This shows that there is no significant health risk in consuming these canned drinks in the appropriate portion.

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