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Determination of heavy metals in some sweets, chewing gum and chocolate in bauchi metropolis, bauchi state Nigeria

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Abstract
This paper was designed to analyzed level of heavy metals in some imported and local sweets and chewing gums in Bauchi metropolis. Considering the standard permissible limit of the studied metals in the samples, the result shows that these samples contained higher concentration of Ni in both sweets and chewing gums studied. Which are higher than the prescribed limit or exceeded the permissible limit which is 1mg/g for Cu according to FAO/WHO while lower limit was prescribed by the Poland national standard limit (0.3 mg/g). Cr concentration also exceeded the allowable limit of 1mg/g. So also the mean Ni concentration in both samples of sweets and chewing gum (15.78 and 9.35mg/g) were also above the nickel standard level (0.1 – 0.5mg/g) in the food stuffs, set by FAO (2001).

Keywords: chewing, Metropolis, designed, local sweets

1. Introduction

1.2 Sweets

Sweets are usually sweet, brown food prepared of roasted and ground cocoa seeds that is made in the form of liquid, past or in a block: It is consumable but if is in necessary may cause some side effect on human e.g. Diabetics.

Sweets is one of the most popular confectioneries consumed by all age groups. Among them children are the most attracted group of consumer of Sweets and at the same time the most vulnerable for toxic metals. TOXIC metals accumulate in the body; even consumption of small amount of metals can lead to neurotoxic, carcinogenic and brain disorder (Dias and Wickramasinghe, 2013). Sweets are sugar confectionary of Theobroma Cacao Seeds. The flavor of sweets differs depending on the ingredient used and the preparation method of chocolate.

Since chocolate are more popular among children, manufacture are very concern about their competitors in the market. Due to this reason sweets and other confectionaries are sold in a very attractive manner, wrapped in colorful packaging materials.

1.3 Chewing Gum

Chewing gum is a soft cohesive substances designed to be chewed without being swallowed. Its texture is reminiscent of rubber because of the physical, chemical properties of its polymer, plasticizer and resin components which contribute to its elastic plastic, sticky, chewy characteristics.

1.4 Heavy Metals

Heavy metals are substances with a specific gravity of greater than 4.0 or 5.0g/cm3 Heavy metals refer to any metallic element that has a relatively high density and is toxic or poisonous at high concentration. They include mercury, cadmium. Arsenic, Chromium, Thallium and lead. Heavy metals are natural components of the earth's crust; they cannot be destroyed or degraded. To a small extent they enter our bodies via food, drinking water and air.

1.5 Statement of the Problems

The main threats to human health, from heavy metals are associated with exposure to lead, cadmium, mercury and arsenic. These metals have been extensively studied and their effects on human health regularly reviewed by international bodies such as the WHO.

1.6 Justification

The future of any nation depends on the health property and progress of the forth coming generation, presently in the area of industrialization development and inter boundary trades, one concern should be the health of the fourth generation.

1.7 Scope of the study

This research is on the determination of heavy metals in different samples of sweets and chewing gums, in Bauchi metropolis.

1.8 Aim and Objectives

The aim of this study is to determine some heavy metals (Cu, As, Pb, Ni, and Cr) which might be essential at low concentrations in some sweets and chewing gums. This was set to be achieved through the following

1.9 Objectives

i. To determine the heavy metal contents of sweets and chewing gums
ii. To compare the levels of the metals in canned sweets and chewing gum
iii. To determine the risk associated with the consumption of sweets and chewing gums

1.10 Limitations of the study

The study was limited to these brands of sweets and chewing gums due to their availability in different market in Bauchi metropolis. Also, the sampling site was done in

different supermarket.

2. Literature Review

2.1 Environmental contaminants of heavy metals

Food is one of the main sources of heavy metal in take in consumers some heavy metals are essential nutrients (Cu, Ni, Cr. As, Pb) need by our bodies but all of them can be harmful if ingest in heavily metal-contaminated foods or beverage (Gideon et al 2015). Recent trends in food safety issues have generated concern over the presence and level of heavy metals in sweet and chewing gums, FT instance the American environmental safety institute took legal action in 2002 against chocolate manufacture for excessive level of Pb and CC' found in chocolate (Anderson, 2011) [5]. Consequently, international legislative bodies, as well as chocolate manufacture countries have introduce new regulations for the protection of the health of their consumers (Ducos and Godula, 2010; Dickson, 2011) European Food Safety Authority (EFSA, 2011)

Heavy, metals enter into human body by ingestion or inhalation and absorption through skin or mucous membrane, when they ir, not metabolized by the body, get accumulated in soft tissue and become toxic, Due to the industrial revolution, heavy metals easily affect the human health, The presence of relatively high concentration of heavy metal in a consumer product that is marketed to children is an extraordinary concern (Silbergeld, 1997) because children are the most sensitive and vulnerable age group to any kind of contamination in the food chain (Sulbergeld, 1997). While sweets is regularly eaten for gratification, there are potential health effects of eating sweets; the uncontrolled consumption of large quantities of any energy rich food such as sweets without a corresponding increase in activity could increase the risk of obesity and dental complication. Cocoa solid contain alkaloids such as serotonin level in the brain. Some research found that sweets, consumed in controlled quantity, can lower blood pressure. Candy has a high glycemic index (GL) which means that it course a rapid raised in blood sugar level after ingestion. This is of major concern for people with diabetes, but could also be risky to the health of non-diabetics.

2.2 Heavy Metals Toxicity

Toxicity of any metals is governed by several factors; there are interaction with essential metals, formulation of metals protein, and complexes chemical form of the metals element, immune status, age and stage of development of the host. Contamination of food products with heavy metals may cause a serious risk for human health because of the consumption of even a small amount of metals can lead to considerable concentration in human body leading to biotoxic effects. The biotoxic effects of heavy metals the refers to the harmful effect of heavy metals to the body when consumed above the bio-recommended limit. The nature of effect could be acute, chronic or subchronic, neutrotoxic, concinogen:.c. mutagenic or tetratogenic (Ochu et al, 2012) [15].

2.3 Lead and Chromium Toxicity

Lead absorbed from the food and the atmosphere is retained in tissue like lungs, liver, kidney, and bones. The short term and long term exposure to high level of lead can course brain damage, paralysis, abdominal pain, anerilia, renal diseases, memory loss, damage to kidney, reproductive and immune system (Toxicology fact sheet series Food Safety Authority of Ireland, 2009). Chromium can exist as Cr (Ill) or Cr (VI). Cr (IV) form is highly toxic. Cr (IV) exposure has been known to be associated with cancer induction in humans, especially bronchial carcinoma and lung cancer (Kim, Ogunfowokm et al, 2005).

2.4 Nickel Toxicity

Nickel is also a well known carcinogen to human. by altering the D:-JA functions. Even through their DNA-damaging potentials are rather weak, they interfere with the nucleotide and base excision repair at low, nontoxic c6ncentrations. For example both water-soluble Ni (ii) and particular black NiO greatly reduced the repair of DNA. Ni (ii) disturbed the very first step a nucleotide excision repair (Hartmann and Hartwig, 1998) [11].

Many different studies and techniques for heavy metals determination in different food stuffs have been reported in the literature. Concentration of selected metals in candies and chocolate consumed in southern Nigeria ware analyzed, the result in chocolate level of Ca, Cd, Ni, Cr, Cu, Pb, Mn, Zn, Fe, Co. and Mg, in sweets and chewing gums with mean concentration of metals in both confectionaries which ranged between 7.7' 1405 flg/g. (Chukwujundu 2013; Milour et al. 2011).

Dias and Wickrymasingle (2013 determined toxic metals in chocolate confectionaries and their "Tappers used by the chocolate manufacture in srilendu the result showed Cr concentration in the range 0.78- 388ppm. Ni (not detected - 37ppm), As (not detected), CO (not detected), Sb (not detected-28PPivf) and Pb (0.53-6.86ppm).

Assessment of hem') metals contamination (Nickel and Arsenic) using Gf _ AAS in local brand sweets and chewing gums from tiruchirappali India was carried out by Prakish et al 2015), it was found that Nickel level in the sample ranged from 0.77 to 5.47 flg/g with an average of2.75~g/g and arsenic it level range from 0.01 to 4.38 µg/g with an average of 0.81 µg/g, the results showed significant Ni, contamination in the collected confessionary samples which is frequent consumption and courses serious health effect in children and adult as well.

Chukwyjindu el al(2013). Investigates the concentration of selected metals in some Ready- to eat food consumed in southern Nigeria; Estimation of Dietary intakes and target Hazard Quotients, the concentration of metals (mgkg-1) in these ready-to-eat foods are in the range of 2.4 - 2.5 for Cu; 0.1 - 0.8 for Cd; 0.7 - 4.0 for Ni; 0.1 - 53.7 for Fe; 8.9 - 20.0 for Zn; 0.1 - 3.8 for Pd; 5.1 - 14.4 for Mn; 0.83 - 21.4 for Cr and 0.10 - 1.32 for Co. The concentration and estimated intake of Cd, Ni and Pb in some of these food types exercise the permissible limit and tolerable daily intake respectively.

Cost-effective method of analysis for the determination of Cadmium. copper, nickel and zinc in cocoa beans and chocolates was analysis by Gidon Ramtahal et al (2015). The aim of this study is to assess the concentrations of Lead, Chromium and Nickel in some brand of sweets and chewing gums commonly available in Kano metropolitan. This is to evaluate the extent to which some commonly consumed sweets and chewing gums in Bauchi metropolitans conformed to safety guidelines with respect to their heavy metals content.

2.5 Heavy Metals in Sweets and Chewing Gums

Although the effects of acute heavy metal poisoning from

food and industrial exposure have been described for over four thousand years, the first reports of chronic lead poisoning weren't observed until 1892, in Brisbane, Australia. These original reports were met with pervasive disbelief that lead toxicity could cause chronic damage when ingested by children (Gibson, 1982). As evidence continued to mount, this misconception was finally discarded in 1943 with the first long-term study of children who had recovered from acute lead poisonings. Survivors of childhood exposure to lead were found to exhibit ongoing behavioral disorders, learning difficulties, and difficulty in school (Byers and Lord, 1943).

As protective policies regarding industrial lead exposure in the United States improve, the occupational exposure was reduced to lesser chronic exposures, especially for those in children (Needleman, 2004). In 2002, the Centers for Disease Control (CDC), United States, reported that 890,000 American children had elevated blood lead levels. Most likely resulting from low-level chronic exposure to lead-contaminated products (CDC, 2006). Although lead-based paint is the major contributor, research also indicates several other possible contributing culprits for lead poisonings. One of these factors is lead-contaminated candies, imported into the United States from countries all over the work, (CDC, 2006).

There are two possible sources of lead contamination in imported candies which can include either the candy itself, or the packaging it is housed in. Some examples of where lead has been previously found include tamarind candy in lead-glazed pottery, printed cellophane candy wrappers, and chili powder (Carter-Pokras et aI., 2007). Contamination can occur through different phases of manufacturing. For instance, several potential contamination sources of the chili powder have been reported to originate from soil residue from fields, air-drying or storage where the chilies can accumulate dust from exhaust emissions, metal particles accumulated during the grinding process, and drying over open petrochemical fires (Carter-Pokras et al., 2007).

In addition, candy wrappers are often printed with leaded paint and although not consumed, there are four mechanisms by which substances used in printing inks can migrate from the printed surface to the food contact surface: blocking, rubbing, peeling, and diffusion (Bradley et aI., 2005; Kim et aI., 2008). If the packaging is poorly designed, the inner coating will not maintain structural integrity thereby allowing ink components from the outer layer to migrate into the candy. Candies in general are sticky' and can adhere to its wrapper which suggests that children
come into contact with the wrapper either through licking or sucking the wrapper (CDC, 2002). Furthermore, candy contact surfaces of the packages have a potential for contamination because finished packaging films are frequently distributed to manufacturers in reel form in which the outer printed surface and food contact surfaces of the packages are in contact with each other (Kim et al., 2008). As a result, candy wrappers cannot be ignored when dealing with contaminated candies. The popularity and consumption of a specific candy grows day by day and an acquired taste for them develops in the children (Duran et al., 2009). Accordingly, cases of elevated blood lead levels in children following the consumption of contaminated candies have been documented by the Center for Disease Control and Prevention (CDC, 2002). In 2000, a Hispanic child born in Los Angeles County, California, was identified through a routine screening program of having a blood lead level of 22flg/dL (CDC, 2002). Tests of the boy's home showed no significant dust, soil, or paint lead levels. There was no reported use of home remedies or imported cooking pottery but it was reported that the child had been eating Mexican candies repeatedly for three years (CDC, 2002). After suggesting that the child stop consumption of the candies, the boy's blood lead levels was reduced to Ll ug/dl. the following year (CDC, 2002). In another example of the same year, a Hispanic boy aged 2 years in Orange County was identified through routine screening with a blood lead level of 26 ug/dl. (CDC, 2002). The family's house was built in 1963 but tests on soil, paint, and dust on the home did not reveal high lead levels (CDC, 2002). It was noted that the child had been given greta and azarcon (folk remedies that usually contains lead) and had eaten various imported tamarind fruit candies from Mexico (CDC, 2002). Testing of a Dulmex-brand Bolirindo lollipop the child had eaten revealed 404 parts per million (ppm) and 21, 000ppm of lead in the stick and wrapper, respectively, and
0.2ppm and 0.3ppm in the candy and seed, respectively (CDC, 2002). Verification tests by the
Food and Drug Administration (FDA) confirmed high lead levels in the wrapper of products and issued a public health warning (CDC, 2002).

The southwest is abundant with Hispanic communities due to its close proximity to Mexico. The city of Las Vegas alone (Las Vegas and North Las Vegas) has roughly 250,000 residents who are of Hispanic or Latino origin (U. S. Census Bureau, 2008). This makes these areas especially at risk for elevated blood lead levels through the consumption of imported candies. In fact, from May, 2001 to January, 2002, approximately 1000 cases of elevated blood lead levels among children in California, 150 of them were linked to possible exposures to candies produced in Mexico (CDC, 2002). The dangers of consuming a single contaminated piece of candy is intensified with the fact that a single piece of candy can exceed the FDA's provisional tolerable daily intake level for lead of 6, µg in a typical 30 gram serving (CDC, 2002). This becomes more dangerous as a child consumes additional pieces of candy.

An elevated blood lead level is classified as having a blood lead level of 10 µg/dl. or greater (CDC, 2002). Yet deficits in cognitive and academic skills have been reported in children with blood lead concentrations lower than Sµg/dl, (Pokras and Kneeland, 2008). This suggests that there is no safe level of lead in it child's body. Furthermore, with lead's ability to accumulate in the body, eating contaminated candies continuously can lead to dangerously excessive levels. In a study done on contaminated tamarind candies in Oklahoma by Lynch et al (2000), consuming the candy containing the mean concentration of lead at the rate of once per day was predicted to result in a more than five-fold increase in the prevalence of blood lead levels among those that consumed the candy. Due to the known adverse health effects of lead, the rates of consumption of candies are just as an important measure as the lead content itself. However, other than Pb, other essential metals such as Cu, Ni, Mn, Fe, Cr and Ti should be investigated, since they are known to cause lethal effect at higher concentrations. Therefore, all measurements of these metals, whether large or small in this study, will be vital to assess the current status of imported candies in Nigeria.

3. Material Methods

3.1 Materials

- Atomic absorption spectrophotometer
- Heating mantle
- Electronic weighing balance
- Filter paper
- Sample container
- Funnel
- Conical flask

3.2 Chemical/Reagents

- Nitric acid (HN03)
- Hydrogen peroxide (H202
- Distilled ionized water

3.3 Sample Collection

Thirty-six different confectioneries which include twenty nine brands of sweets and seven brands of chewing gums were purchased from retails stories and from hawkers on the major street in Bauchi metropolitan and stored in polythene bags.

3.4 digestion of the sweets and chewing gums sample

1g of each of the homogenized sweets and chewing gums were weighted into 50cm^3 conical flask. 25cm^3 Conc. $HN0_3$ and 5cm^3 H_2 O_2 were added to the flask. The mixture was allowed to digest at 100°c for 10 minutes in heating mantle until

Solubilisation of the samples was complete. After cooling the flask, the resulting solutions were evaporated to semi dried mass to remove the excess acids. The disgusted solutions were dilute with distilled ionized water, and then filtered through filter paper. A blanks was also prepared using the same procedure but without the sample. All digest sample were analyzed using atomic absorption spectrophotometer (AAS 460 model). The black and the calibrated working standard solution were also analyzed in the same way as the sample. Calibration graphs were plotted using the concentration of the standard working solutions against absorbance.

4. Result

Table 4.1 Illustrate the result of the mean concentration of Ni, Cu and As in sweets and chewing gum samples

The mean concentration of nickel in sweets and chewing gum samples ranged from 4.04 - 30 Mg/g, the highest mean concentration of Ni was found in Ep sweet and Gb chewing gum. The minimum and maximum concentrations of Cu in the analyzed sweet and chewing gum sample were found to be 3.18 and 1.27 mg/g respectively. The maximum Cu concentration was observed in Dr. D sweet samples while the minimum Cu concentration observed in Y g sweet samples.

The mean concentration of As in the analyzed sweet and chewing gum samples ranged from O. J 3 - 18.75 mg/g, the higher mean concentration of As was observed in Bg sample chewing gum and the lowest mean level concentration of As was found in Kc samples.

Table 1: Mean concentration of Ni, Cu, and as in sweets and chewing gums (Mg/g)

S/N	PRODUCT NAME	SAMPLE CODE	CONC. Ni	CON. Cr	CONC. Cu	CON. Pb	CONC. As	S.D. OF As
1.	Extra pinger	Ep	0.50	0.01	0.18	0.02	0.75	0.16
2.	Centre fruit	Cf	0.22	0.00	0.49	0.06	0.03	0.01
3.	Ice mint	Im	0.21	0.01	0.49	0.06	0.53	0.09
4.	Tom Tom	Tt	0.16	0.01	0.57	0.04	0.77	0.03
5.	Alpine	Ai	0.18	0.00	0.83	0.06	0.91	0.05
6.	Splash	Sp	0.13	0.02	0.29	0.04	0.67	0.01
7.	Butter mint	Bm	0.15	0.02	0.02	0.08	0.45	0.06
8.	Topmint	Tm	0.19	0.01	0.11	0.02	0.12	0.05
9.	Yogurt	Yg	0.21	0.02	0.07	0.01	0.31	0.01
10.	Tender joy	Tj	0.46	0.00	0.82	0.01	0.28	0.08
11.	Tamarin	Tr	0.33	0.03	0.96	0.05	0.77	0.06
12.	Tamaruld	Ta	0.44	0.02	0.81	0.10	0.51	0.01
13.	Knockout	Ko	0.35	0.02	0.00	0.10	0.70	0.02
14.	Exotic guava	Eg	0.33	0.00	0.51	0.00	0.17	0.02
15.	Eclairs	Ec	0.10	0.00	0.91	0.00	0.89	0.09
16.	Melody	Md	0.23	0.00	0.16	0.02	0.62	0.04
17.	Crazy	Ch	0.14	0.00	0.07	0.10	0.23	0.03
18.	Super star	Ss	0.25	0.00	0.03	0.49	0.17	0.05
19.	Extra pop	Ex	0.21	0.02	0.00	0.05	0.72	0.10
20.	Milkee fun	Mf	0.54	0.02	0.50	0.26	0.26	0.04
21.	Bubble gum	Bg	0.13	0.01	0.96	0.19	0.95	0.08
22.	Milkrick	Mr	0.39	0.04	0.17	0.20	0.40	0.01
23.	Ibon fruit	If	0.10	0.00	0.81	0.05	0.50	0.05
24.	Milkose	Mi	0.23	0.03	0.25	0.05	0.15	0.10
25.	Kona café	Kc	0.10	0.00	0.05	0.28	0.21	0.02
26.	Gum ball	Gb	0.18	0.00	0.69	0.06	0.25	0.02
27.	Dr. dairy	Dr. D	0.40	0.00	0.22	0.16	0.60	0.05
28.	Tubor	Tu	0.33	0.04	0.75	0.02	0.71	0.10

29.	Alpenliebe	Ap	0.11	0.02	0.74	0.20	0.52	0.08
30.	3D jelly bubble gum	3D	0.0	0.01	0.18	0.08	0.16	0.10
31.	Coffee black	Cb	0.24	0.01	0.53	0.01	0.72	0.05
32.	Camelio	Co	0.05	0.01	0.37	0.02	0.55	0.06
33.	My love	M1	0.09	0.00	0.87	0.04	0.23	0.07
34.	Time bomb	Tb	0.31	0.00	0.51	0.12	0.51	0.08
35.	Minta	Mn	0.32	0.02	0.44	0.01	0.37	0.06
36.	Big bomb	Bi	0.00	0.00	0.44	0.00	0.21	0.00
37.	Extra pinger	Ep2	0.50	0.01	0.18	0.02	0.75	0.16
38.	Centre fruit	Cf2	0.22	0.00	0.49	0.06	0.03	0.01
39.	Ice mint	Im2	0.21	0.01	0.49	0.06	0.53	0.09
40.	Tom Tom	Tt2	0.16	0.01	0.57	0.04	0.77	0.03
41.	Alpine	Ai2	0.18	0.00	0.83	0.06	0.91	0.05
42.	Splash	Sp2	0.13	0.02	0.29	0.04	0.67	0.01
43.	Butter mint	Bm2	0.15	0.02	0.02	0.08	0.45	0.06
44.	Topmint	Tm2	0.19	0.01	0.11	0.02	0.12	0.05
45.	Yogurt	Yg2	0.21	0.02	0.07	0.01	0.31	0.01
46.	Tender joy	Tj2	0.46	0.00	0.82	0.01	0.28	0.08
47.	Tamarin	Tr2	0.33	0.03	0.96	0.05	0.77	0.06
48.	Tamaruld	Ta2	0.44	0.02	0.81	0.10	0.51	0.01
49.	Knockout	Ko2	0.35	0.02	0.00	0.10	0.70	0.02
50.	Exotic guava	Eg2	0.33	0.00	0.51	0.00	0.17	0.02
51.	Eclairs	Ec2	0.10	0.00	0.91	0.00	0.89	0.09
52.	Melody	Md2	0.23	0.00	0.16	0.02	0.62	0.04
53.	Crazy	Ch2	0.14	0.00	0.07	0.10	0.23	0.03
54.	Super star	Ss2	0.25	0.00	0.03	0.49	0.17	0.05
55.	Extra pop	Ex2	0.21	0.02	0.00	0.05	0.72	0.10
56.	Milkee fun	Mf2	0.54	0.02	0.50	0.26	0.26	0.04
57.	Bubble gum	Bg2	0.13	0.01	0.96	0.19	0.95	0.08
58.	Milkrick	Mr2	0.39	0.04	0.17	0.20	0.40	0.01
59.	Ibon fruit	If2	0.10	0.00	0.81	0.05	0.50	0.05
60.	Milkose	Mi2	0.23	0.03	0.25	0.05	0.15	0.10
61.	Kona café	Kc2	0.10	0.00	0.05	0.28	0.21	0.02
62.	Gum ball	Gb2	0.18	0.00	0.69	0.06	0.25	0.02
63.	Dr. dairy	Dr. D2	0.40	0.00	0.22	0.16	0.60	0.05
64.	Tubor	Tu2	0.33	0.04	0.75	0.02	0.71	0.10
65.	Alpenliebe	Ap2	0.11	0.02	0.74	0.20	0.52	0.08
66.	3D jelly bubble gum	3D2	0.0	0.01	0.18	0.08	0.16	0.10
67.	Coffee black	Cb2	0.24	0.01	0.53	0.01	0.72	0.05
68.	Camelio	Co2	0.05	0.01	0.37	0.02	0.55	0.06
69.	My love	M12	0.09	0.00	0.87	0.04	0.23	0.07
70.	Time bomb	Tb2	0.31	0.00	0.51	0.12	0.51	0.08
71.	Minta	Mn2	0.32	0.02	0.44	0.01	0.37	0.06
72.	Big bomb	Bi2	0.00	0.00	0.44	0.00	0.21	0.00
73.	Extra pinger	Ep3	0.50	0.01	0.18	0.02	0.75	0.16
74.	Centre fruit	Cf3	0.22	0.00	0.49	0.06	0.03	0.01
75.	Ice mint	Im3	0.21	0.01	0.49	0.06	0.53	0.09
76.	Tom Tom	Tt3	0.16	0.01	0.57	0.04	0.77	0.03
77.	Alpine	Ai3	0.18	0.00	0.83	0.06	0.91	0.05
78.	Splash	Sp3	0.13	0.02	0.29	0.04	0.67	0.01
79.	Butter mint	Bm3	0.15	0.02	0.02	0.08	0.45	0.06
80.	Topmint	Tm3	0.19	0.01	0.11	0.02	0.12	0.05
81.	Yogurt	Yg3	0.21	0.02	0.07	0.01	0.31	0.01
82.	Tender joy	Tj3	0.46	0.00	0.82	0.01	0.28	0.08
83.	Tamarin	Tr3	0.33	0.03	0.96	0.05	0.77	0.06
84.	Tamaruld	Ta3	0.44	0.02	0.81	0.10	0.51	0.01
85.	Knockout	Ko3	0.35	0.02	0.00	0.10	0.70	0.02
86.	Exotic guava	Eg3	0.33	0.00	0.51	0.00	0.17	0.02
87.	Eclairs	Ec3	0.10	0.00	0.91	0.00	0.89	0.09
88.	Melody	Md3	0.23	0.00	0.16	0.02	0.62	0.04
89.	Crazy	Ch3	0.14	0.00	0.07	0.10	0.23	0.03

90.	Super star	Ss3	0.25	0.00	0.03	0.49	0.17	0.05
91.	Extra pop	Ex3	0.21	0.02	0.00	0.05	0.72	0.10
92.	Milkee fun	Mf3	0.54	0.02	0.50	0.26	0.26	0.04
93.	Bubble gum	Bg3	0.13	0.01	0.96	0.19	0.95	0.08
94.	Milkrick	Mr3	0.39	0.04	0.17	0.20	0.40	0.01
95.	Ibon fruit	If3	0.10	0.00	0.81	0.05	0.50	0.05
96.	Milkose	Mi3	0.23	0.03	0.25	0.05	0.15	0.10
97.	Kona café	Kc3	0.10	0.00	0.05	0.28	0.21	0.02
98.	Gum ball	Gb3	0.18	0.00	0.69	0.06	0.25	0.02
99.	Dr. dairy	Dr. D3	0.40	0.00	0.22	0.16	0.60	0.05
100	Tubor	Tu3	0.33	0.04	0.75	0.02	0.71	0.10
101	Alpenliebe	Ap3	0.11	0.02	0.74	0.20	0.52	0.08
102	3D jelly bubble gum	3D3	0.0	0.01	0.18	0.08	0.16	0.10
103	Coffee black	Cb3	0.24	0.01	0.53	0.01	0.72	0.05
104	Camelio	Co3	0.05	0.01	0.37	0.02	0.55	0.06
105	My love	M13	0.09	0.00	0.87	0.04	0.23	0.07
106	Time bomb	Tb3	0.31	0.00	0.51	0.12	0.51	0.08
107	Minta	Mn3	0.32	0.02	0.44	0.01	0.37	0.06
108	Big bomb	Bi3	0.00	0.00	0.44	0.00	0.21	0.00
109	Extra pinger	Ep4	0.50	0.01	0.18	0.02	0.75	0.16
110	Centre fruit	Cf4	0.22	0.00	0.49	0.06	0.03	0.01
111	Ice mint	Im4	0.21	0.01	0.49	0.06	0.53	0.09
112	Tom Tom	Tt4	0.16	0.01	0.57	0.04	0.77	0.03
113	Alpine	Ai4	0.18	0.00	0.83	0.06	0.91	0.05
114	Splash	Sp4	0.13	0.02	0.29	0.04	0.67	0.01
115	Butter mint	Bm4	0.15	0.02	0.02	0.08	0.45	0.06
116	Topmint	Tm4	0.19	0.01	0.11	0.02	0.12	0.05
117	Yogurt	Yg4	0.21	0.02	0.07	0.01	0.31	0.01
118	Tender joy	Tj4	0.46	0.00	0.82	0.01	0.28	0.08
119	Tamarin	Tr4	0.33	0.03	0.96	0.05	0.77	0.06
120	Tamaruld	Ta4	0.44	0.02	0.81	0.10	0.51	0.01
121	Knockout	Ko4	0.35	0.02	0.00	0.10	0.70	0.02
122	Exotic guava	Eg4	0.33	0.00	0.51	0.00	0.17	0.02
123	Eclairs	Ec4	0.10	0.00	0.91	0.00	0.89	0.09
124	Melody	Md4	0.23	0.00	0.16	0.02	0.62	0.04
125	Crazy	Ch4	0.14	0.00	0.07	0.10	0.23	0.03
126	Super star	Ss4	0.25	0.00	0.03	0.49	0.17	0.05
127	Extra pop	Ex4	0.21	0.02	0.00	0.05	0.72	0.10
128	Milkee fun	Mf4	0.54	0.02	0.50	0.26	0.26	0.04
129	Bubble gum	Bg4	0.13	0.01	0.96	0.19	0.95	0.08
130	Milkrick	Mr4	0.39	0.04	0.17	0.20	0.40	0.01
131	Ibon fruit	If4	0.10	0.00	0.81	0.05	0.50	0.05
132	Milkose	Mi4	0.23	0.03	0.25	0.05	0.15	0.10
133	Kona café	Kc4	0.10	0.00	0.05	0.28	0.21	0.02
134	Gum ball	Gb4	0.18	0.00	0.69	0.06	0.25	0.02
135	Dr. dairy	Dr. D4	0.40	0.00	0.22	0.16	0.60	0.05
136	Tubor	Tu4	0.33	0.04	0.75	0.02	0.71	0.10
137	Alpenliebe	Ap4	0.11	0.02	0.74	0.20	0.52	0.08
138	3D jelly bubble gum	3D4	0.0	0.01	0.18	0.08	0.16	0.10
139	Coffee black	Cb4	0.24	0.01	0.53	0.01	0.72	0.05
140	Camelio	Co4	0.05	0.01	0.37	0.02	0.55	0.06
141	My love	M14	0.09	0.00	0.87	0.04	0.23	0.07
142	Time bomb	Tb4	0.31	0.00	0.51	0.12	0.51	0.08
143	Minta	Mn4	0.32	0.02	0.44	0.01	0.37	0.06
144	Big bomb	Bi5	0.00	0.00	0.44	0.00	0.21	0.00
145	Extra pinger	Ep5	0.50	0.01	0.18	0.02	0.75	0.16
146	Centre fruit	Cf5	0.22	0.00	0.49	0.06	0.03	0.01
147	Ice mint	Im5	0.21	0.01	0.49	0.06	0.53	0.09
148	Tom Tom	Tt5	0.16	0.01	0.57	0.04	0.77	0.03
149	Alpine	Ai5	0.18	0.00	0.83	0.06	0.91	0.05
150	Splash	Sp5	0.13	0.02	0.29	0.04	0.67	0.01

151	Butter mint	Bm5	0.15	0.02	0.02	0.08	0.45	0.06
152	Topmint	Tm5	0.19	0.01	0.11	0.02	0.12	0.05
153	Yogurt	Yg5	0.21	0.02	0.07	0.01	0.31	0.01
154	Tender joy	Tj5	0.46	0.00	0.82	0.01	0.28	0.08
155	Tamarin	Tr5	0.33	0.03	0.96	0.05	0.77	0.06
156	Tamaruld	Ta5	0.44	0.02	0.81	0.10	0.51	0.01
157	Knockout	Ko5	0.35	0.02	0.00	0.10	0.70	0.02
158	Exotic guava	Eg5	0.33	0.00	0.51	0.00	0.17	0.02
159	Eclairs	Ec5	0.10	0.00	0.91	0.00	0.89	0.09
160	Melody	Md5	0.23	0.00	0.16	0.02	0.62	0.04
161	Crazy	Ch5	0.14	0.00	0.07	0.10	0.23	0.03
162	Super star	Ss5	0.25	0.00	0.03	0.49	0.17	0.05
163	Extra pop	Ex5	0.21	0.02	0.00	0.05	0.72	0.10
164	Milkee fun	Mf5	0.54	0.02	0.50	0.26	0.26	0.04
165	Bubble gum	Bg5	0.13	0.01	0.96	0.19	0.95	0.08
166	Milkrick	Mr5	0.39	0.04	0.17	0.20	0.40	0.01
167	Ibon fruit	If5	0.10	0.00	0.81	0.05	0.50	0.05
168	Milkose	Mi5	0.23	0.03	0.25	0.05	0.15	0.10
169	Kona café	Kc5	0.10	0.00	0.05	0.28	0.21	0.02
170	Gum ball	Gb5	0.18	0.00	0.69	0.06	0.25	0.02
171	Dr. dairy	Dr. D5	0.40	0.00	0.22	0.16	0.60	0.05
172	Tubor	Tu5	0.33	0.04	0.75	0.02	0.71	0.10
173	Alpenliebe	Ap5	0.11	0.02	0.74	0.20	0.52	0.08
174	3D jelly bubble gum	3D5	0.0	0.01	0.18	0.08	0.16	0.10
175	Coffee black	Cb5	0.24	0.01	0.53	0.01	0.72	0.05
176	Camelio	Co5	0.05	0.01	0.37	0.02	0.55	0.06
177	My love	M15	0.09	0.00	0.87	0.04	0.23	0.07
178	Time bomb	Tb5	0.31	0.00	0.51	0.12	0.51	0.08
179	Minta	Mn5	0.32	0.02	0.44	0.01	0.37	0.06
180	Big bomb	Bi5	0.00	0.00	0.44	0.00	0.21	0.00
181	Extra pinger	Ep6	0.50	0.01	0.18	0.02	0.75	0.16
182	Centre fruit	Cf6	0.22	0.00	0.49	0.06	0.03	0.01
183	Ice mint	Im6	0.21	0.01	0.49	0.06	0.53	0.09
184	Tom Tom	Tt6	0.16	0.01	0.57	0.04	0.77	0.03
185	Alpine	Ai6	0.18	0.00	0.83	0.06	0.91	0.05
186	Splash	Sp6	0.13	0.02	0.29	0.04	0.67	0.01
187	Butter mint	Bm6	0.15	0.02	0.02	0.08	0.45	0.06
188	Topmint	Tm6	0.19	0.01	0.11	0.02	0.12	0.05
189	Yogurt	Yg6	0.21	0.02	0.07	0.01	0.31	0.01
190	Tender joy	Tj6	0.46	0.00	0.82	0.01	0.28	0.08
191	Tamarin	Tr6	0.33	0.03	0.96	0.05	0.77	0.06
192	Tamaruld	Ta6	0.44	0.02	0.81	0.10	0.51	0.01
193	Knockout	Ko6	0.35	0.02	0.00	0.10	0.70	0.02
194	Exotic guava	Eg6	0.33	0.00	0.51	0.00	0.17	0.02
195	Eclairs	Ec6	0.10	0.00	0.91	0.00	0.89	0.09
196	Melody	Md6	0.23	0.00	0.16	0.02	0.62	0.04
197	Crazy	Ch6	0.14	0.00	0.07	0.10	0.23	0.03
198	Super star	Ss6	0.25	0.00	0.03	0.49	0.17	0.05
199	Extra pop	Ex6	0.21	0.02	0.00	0.05	0.72	0.10
200	Milkee fun	Mf6	0.54	0.02	0.50	0.26	0.26	0.04
201	Bubble gum	Bg6	0.13	0.01	0.96	0.19	0.95	0.08
202	Milkrick	Mr6	0.39	0.04	0.17	0.20	0.40	0.01
203	Ibon fruit	If6	0.10	0.00	0.81	0.05	0.50	0.05
204	Milkose	Mi6	0.23	0.03	0.25	0.05	0.15	0.10
205	Kona café	Kc6	0.10	0.00	0.05	0.28	0.21	0.02
206	Gum ball	Gb6	0.18	0.00	0.69	0.06	0.25	0.02
207	Dr. dairy	Dr. D6	0.40	0.00	0.22	0.16	0.60	0.05
208	Tubor	Tu6	0.33	0.04	0.75	0.02	0.71	0.10
209	Alpenliebe	Ap6	0.11	0.02	0.74	0.20	0.52	0.08
210	3D jelly bubble gum	3D6	0.0	0.01	0.18	0.08	0.16	0.10
211	Coffee black	Cb6	0.24	0.01	0.53	0.01	0.72	0.05

212	Camelio	Co6	0.05	0.01	0.37	0.02	0.55	0.06
213	My love	M16	0.09	0.00	0.87	0.04	0.23	0.07
214	Time bomb	Tb6	0.31	0.00	0.51	0.12	0.51	0.08
215	Minta	Mn6	0.32	0.02	0.44	0.01	0.37	0.06
216	Big bomb	Bi6	0.00	0.00	0.44	0.00	0.21	0.00

4.2 Concentration of Ni Mg/g

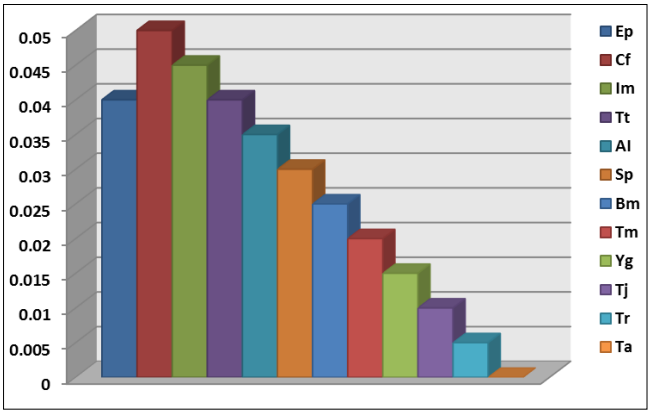

Fig 1

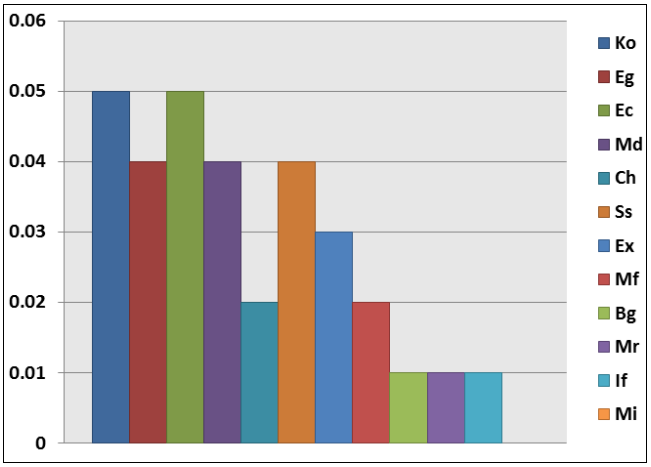

Fig 2

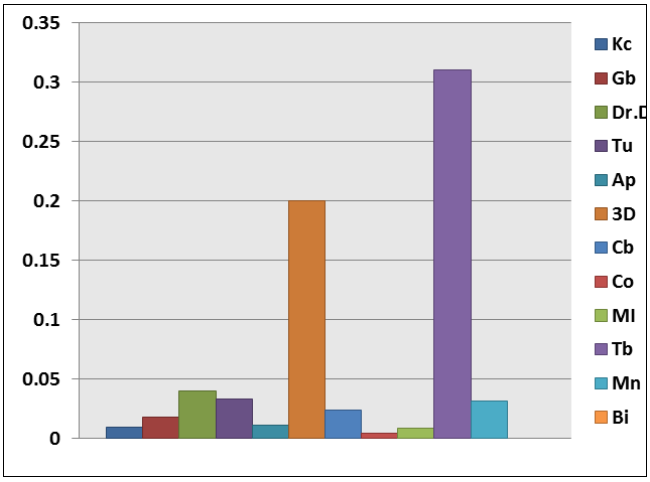

Fig 3

4.3 Concentration of Cu Mg/g

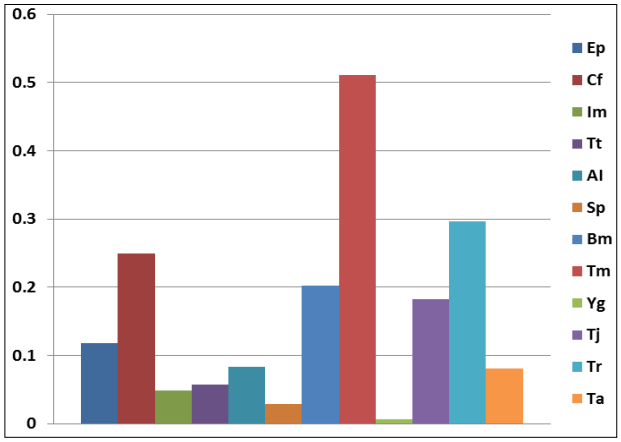

Fig 4

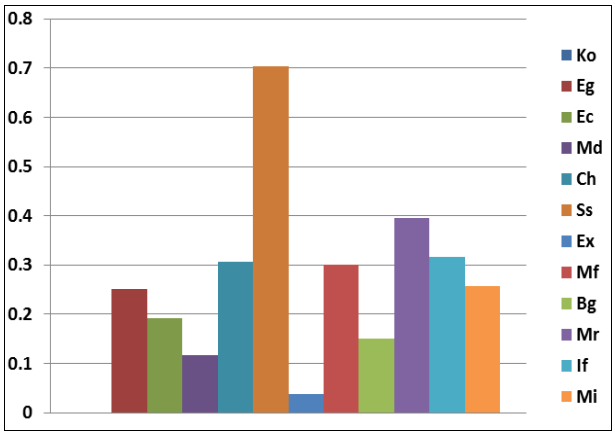

Fig 5

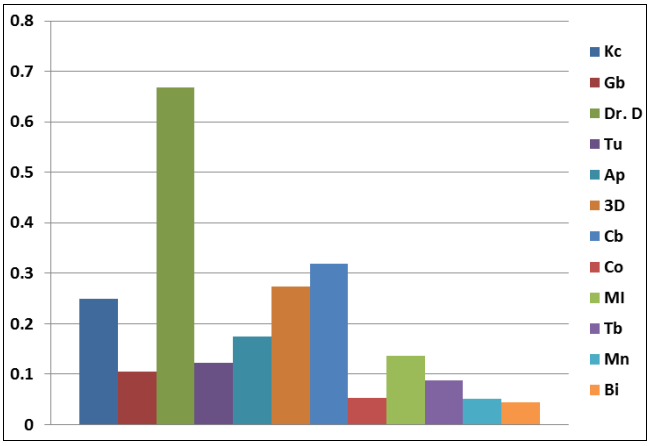

Fig 6

4.4 Concentration of as mg/g

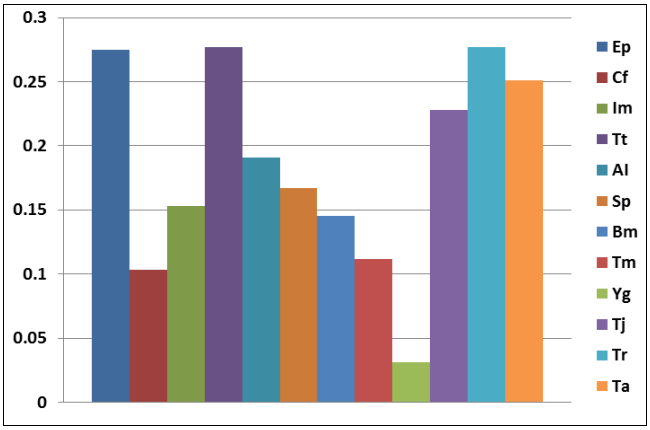

Fig 7

The comparison between the standard limits for heavy metals in confectionaries and the present study. considering the standard permissive limit of the studied metals in the samples, the result shows that these samples contained higher concentration of Ni in both sweets and chewing gums studied. Which are higher than the prescribed limit or exceeded the permissible limit which is 1mg/g for Cu according to FAO/WHO while lower limit was prescribed by the Poland national standard limit (0.3 mg/g). Cr concentration also exceeded the allowable limit of 1mg/g. So also the mean Ni concentration in both samples of sweets and chewing gum (15.78 and 9.35mg/g) were also above the nickel standard level (0.1 – 0.5mg/g) in the food stuffs, set by FAO (2001).

Table 1: Standard Limits for heavy Metals in Concentration (mg/g)

Regulatory bodies/country limit	Permissible limits	Metals	Present study	
			Sweets	chewing gums
FAO/WHO 1.0mg/g 1.0mg/g 7.39mg/g 2.4mg/g	0.4-1.4mg/g	Cu	0.8mg/g	0.7mg/g
FAO (2001)	0.1-0.5mg/g	Ni	0.6mg/g	0.5mg/g
China Standard	0.1-0.5mg/g	As	0.2mg/g	0.25mg/g

5. Conclusion and Recommendations

5.1 Conclusion

On the bases of the results obtained in this study it can be concluded that Ni, Cu and As were detected at higher concentration in the studied sweets and chewing gums sold in retail stores and by hawkers in Bauchi metropolitan. Consumption of these products may likely cause health implication. Hence, there is need to exercise caution in Consumption of these products.

5.2 Recommendations

- Laws should be enforced to regulate the consumption of these products due to higher concentration of these metals above the recommended limit.
- It is suggested that people should avoid consumption of such products, more especially children which are more susceptible to these metals contamination.
- Public awareness be made to avoid the excess consumption of chewing gums and chocolates which nowadays become a passion without recourse the health implications.

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