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ORIGINAL ARTICLE

Evaluation of Levels of Potassium Bromate and Some Heavy Metals in Bread and Wheat Flour Sold in Aba Metropolis, South Eastern Nigeria

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Abstract

Background: 32 different brands of bread with 12 different brands of wheat-flour sold in Aba metropolis, South Eastern Nigeria were selected and evaluated for both potassium bromate and some heavy metals contents to determine their safety level of consumption.
Methods: Bromate determination was carried out using spectrophotometric method while heavy metals were done by the flame atomic absorption spectrophotometer.
Results: The results of the analysis revealed that all the bread samples contained potassium bromate at concentrations above the permissible limit allowed by the US FDA while the concentrations in wheat flour samples were within the acceptable limit with ranges from 0.27±0.04 – 3.78±0.26 mg/kg and 00 – 1.52±0.28 mg/kg, respectively. The values of heavy metals in bread ranged as follows: Zn (3.22±0.05 – 7.25±0.24 mg/kg), Pb (0.05±0.01 – 0.45±0.02 mg/kg), Mn (44.28±0.5 – 78.25±1.24 mg/kg), Cu (0.31±0.04 – 0.49±0.12 mg/kg) and Co (0.04±0.01 – 0.24±0.03 mg/kg) while in wheat flour, the ranges were as follows: Zn (3.85±0.04 – 5.03±0.10 mg/kg), Pb (0.06±0.02 – 0.15±0.04 mg/kg), Mn (47.30±0.38 – 70.20±1.02 mg/kg), Cu (0.36±0.02 – 0.46±0.13 mg/kg) and Co (0.07±0.01 – 0.21±0.03 mg/kg).
Conclusion: The values of these metals are within the permissible limits except Pb and Mn which were above the normal limits that can be detrimental to human health.

Keywords: Bread; Heavy Metals; Potassium Bromate; Nigeria

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INTRODUCTION

Bread is a baked staple food made from wheat flour and is widely consumed in all parts of Nigeria among all socio-economic groups. Wheat flour, apart from its use in bread-making, is also used in pastries and confectionaries such as cakes, biscuits, doughnuts, etc (1). It is similarly utilized in the creation of infant nourishments and in brewing professions as a substitution for chipped barley or maize (2). Measurable examination in Nigeria demonstrated that bread is one of the most expended nourishment types in homes, eateries and inns with dominating utilization among poor people (3) and youthful ones who comprise over 70% of more than 150 million individuals in Nigeria. Bread is typically produced using low protein wheat flour and different fixings which are normally joined, including table salts, sugars, flavors, yeast and at the minimum a flour improver such as the potassium bromate (4) to better the quality.

Potassium bromate ($KBr0_3$) is a colourless, odourless and tasteless white crystal/powder used as a food additive and is commonly used as flour enhancing agent in Nigeria (5). This could be due to its efficient oxidizing properties (6). It oxidizes sulfhydryl groups of the gluten protein in flour into disulphide linkage, thus strengthening the protein network, making it less extensible and more elastic; this will make the dough visco-elastic such that it can retain the carbon dioxide gas produced by the yeast. The overall effect is to make bread rise in the oven, increase the loaf volume and texture (7). Furthermore, when bread is baked without potassium bromate, the carbon (1V) oxide produces awfully sized holes in the finished bread: small, large, pleomorphic and since consumers love to have their bread appear appealing to the eyes, potassium bromate becomes important to give fine and uniformly sized holes in bread and other baked products (8). This property has been manipulated by the bakers to make more profit.

Over time, studies have shown potassium bromate to be deleterious to human health and that it can cause other

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adverse effects on nutritional quality of bread (9). It degrades Vitamins A, B1, B2 and niacin which are the main vitamins available in bread and has been classified by the International Agency for Research on Cancer (IARC) as a possible human carcinogen based on sufficient evidence that KBrO3 is carcinogenic and mutagenic in experimental animals (10).

Potassium bromate can cause coughing and sore throat when breathed in by humans. Some other non-malignant growth issues related with ingestion of bromate include: stomach torment, looseness of the bowels, queasiness, regurgitating, kidney malfunction, hearing impairment, bronchial and visual issues (11). Then again, various examinations have demonstrated that potassium bromate can possibly cause malignant growth in both exploratory creatures and people by actuating oxidative stress in tissues (12).

Aside from the bromate content, materials utilized in bread making and the conditions where these pastry shops are found, are not free from fluctuating degrees of heavy metals pollutions. Heavy metal pollution could come from the crude materials utilized in bread making, or they could be included because of unhygienic states of the preparing conditions or on the grounds that sufficient careful steps are not taken to thwart cross-pollutions from other ambient sources (3). The major route for humans' exposure to heavy metals is through the food pathway (13). Contamination of bread by heavy metals could arise from flour which may have been produced from contaminated raw materials. The wheat used in the production of the flours may have been grown on farmlands with high concentration of heavy metals (14), the source of irrigation water may be polluted by metals (15, 16), and equipment and utensils in use during processing may also contribute (3).

Heavy metals receive specific consideration all over the world because of their universal nature and poisonous impacts even at low fixations (17). There are accounts of a few instances of human infections, issues, failure and abnormality of organs because of metals' poisonous quality (18).

Elements such as Cadmium (Cd), Chromium (Cr) and Lead (Pb) are considered as carcinogenic, while Iron (Fe), Copper (Cu), Zinc (Zn), Nikel (Ni) and Mangenese (Mn) are considered as fundamental metals. Be that as it may, if the groupings of the later components are higher than their reasonable breaking points, they may make lethal impacts in people (13). Individual metals show explicit indications of their poisonousness. Poisoning in Pb, Arsenic (As), Mercury (Hg), Zn, Cu and Aluminum (Al) have been involved with gastrointestinal issues, looseness of the bowels, stomatitis, tremor, hemoglobinuria causing a rust-red color to stool, ataxia, loss of motion, retching and spasm, gloom, and pneumonia (19). The nature impacts can be poisonous (acute, chronic or sub-chronic), neurotoxic, cancer-causing, mutagenic or teratogenic (19).

Numerous examinations have been done on the degrees of heavy metals in different supplement sources in countless places around the world (13). Regardless of being a significant main nourishment in numerous homes, there have been almost no data on the degrees of potassium bromate and heavy metals in breads and flours made in various spots of South Eastern Nigeria.

Aba metropolis comprises Aba North, Aba South and part of Osisioma all in Aba, a city in Abia state, South East geopolitical zone of Nigeria. Aba is located on latitude 05^0 10' N and longitude 07^0 19' E with an average area of 9,400 square kilometres and a population estimated at 1,020,900 as of 2014 census. It is a cosmopolitan town of the state and the second largest commercial city in the South Eastern Nigeria.

The aim of this study was to evaluate the levels of potassium bromate and heavy metals in bread and flour in order to determine the levels of exposure of these products by the people living in Aba metropolis to the risk of potassium bromate, Zn, Pb, Mn, Cu and Co.

METHODS

Study Area

A cross sectional survey of available loaves of bread and wheat flour samples was carried out in bakeries, fast food outlets, open markets, bus stops, and flour distributors' shops in Aba metropolis. The study areas covered are Aba North, Aba South and part of Osisioma that make up Aba metropolis. Ethical approval to conduct this study was obtained from the Abia State University research committee that issued the letter of introduction for good ethical conduct.

Sampling

There were approximately one hundred and sixty-two different types of bread and sixty different types of wheat flour found. Out of which 20% size of the total bread and wheat flour making thirty-two (32) different brands of bread and twelve (12) different brands of wheat flour samples purchased in triplicates from the different designated zones of Aba metropolis making a total of ninety-six (96) bread and thirty-six (36) wheat flour samples that were analysed. The samples examined were the most commonly consumed in the respective locations. All the representative samples were labelled properly.

Standard Preparation

Potassium bromate content of bread and wheat flour was analysed using the previously reported method (20). 50mg of potassium bromate was dissolved in distilled deionized water and diluted to 1 litre. 3210mg of promethazine hydrochloride (PTZ) was dissolved in distilled deionized water and diluted to 1 litre to obtain stock solution of 0.01M of PTZ. Or, 2840mg of promethazine was similarly dissolved in 1 litre of distilled deionized water to obtain stock solution of 0.01M promethazine.

Working Standard Preparation

Aliquots of $0.1cm^3$, $0.2cm^3$, $0.6cm^3$ and $0.8cm^3$ from the primary stock solution of potassium bromate were placed in $20cm^3$ capacity tubes, and $1cm^3$ of 0.01M promethazine hydrochloride was added. Mixtures were diluted with distilled deionized water up to $10cm^3$ and $0.2cm^3$ of 12M hydrochloric acid was added and mixtures were well shaken for 1 minute and the absorbance was measured at 515nm against a blank reagent. Results were used to plot the calibration graph to obtain a final concentration of bromate in the range of 0.5µg/ml – 5µg/ml (21).

Samples Preparation

A quantity of 10g was taken from the centre of each loaf

of bread and dried in oven for about an hour at 75 ºC. The dried crust was pulverized and 1g of each powdered sample and wheat flour were weighed into a clean 250cm^3 beaker and 20cm^3 of distilled deionized water was added. The mixture was stirred thoroughly using a spatula and filtered using Whatman no. 1 filter paper. A measured volume of the filtrate (8.8cm^3) was transferred into a 20cm^3 volumetric tube and mixed with 1cm^3 of 0.01M promethazine and 0.2cm^3 of 12M hydrochloric was added. The mixture was shaken for 1 minute and used for analysis.

Sample Analysis

Quantitative determination of potassium bromates content of the bread and flour samples were done following the spectrophotometric method described by (20).

Prior to the quantitative determination of bromate contents of the bread and flour samples, preliminary qualitative tests were performed directly on a portion of each bread and flour samples with 2cm^3 of 0.01M promethazine and 0.6cm^3 of 12M hydrochloric acid. The change in colour of each sample to pink indicates the presence of potassium bromate (20).

Absorbance of the coloured solution obtained was measured using spectrophotometer (Cam-Spec M350 United Kingdom) at 515nm. The concentration of bromate was calculated from the linear regression curve obtained from the working standards.

Heavy metals analysis in bread and flour

The modified method of (3) was adapted for this procedure. Accurately weighed 1.0g of the solid powdered sample of each of bread and flour samples was weighed into a 100 ml. Teflon beaker; 10 ml of concentrated HNO_3 was added and the mixture was mixed gently and placed on a thermostatic heating mantle maintained at 120 – 150 ºC for about 1hr. Thereafter, 2ml of perchloric acid ($HClO_4$) was added to the mixture and digested further for about 30 min. The mixture was removed from the heating mantle and the digested sample was quantitatively transferred into a 25 ml volumetric flask and filled to the mark with doubly distilled water in readiness for Atomic Spectroscopy analysis. The digested sample solutions were determined by Flame atomic Absorption Spectrophotometer (Bulk Model 205). The standards were prepared from individual 1,000 ppm stock solution of the respective metals initially prepared from their respective salts.

Statistical Analysis

The results collected in this study area were expressed as mean±SD. Results were compared using the one-way ANOVA analysis and independent sample test. Statistical analysis was performed using SPSS (Version 20). A level of $P<0.05$ at 95% confidence limit was considered to be significant.

RESULTS

Table 1 showed the potassium bromate and some heavy metal contents of bread samples. The mean value of $KBrO_3$ in bread samples was 1.34±0.92 mg/kg. The mean values of heavy metals were as follows; Zn (7.44±2.36 mg/kg), Pb (0.2±0.17 mg/kg), Mn (59.03±15.22 mg/kg), Cu (0.40±0.03 mg/kg) and Co (0.11±0.05 mg/kg). Table 2 expressed both the potassium bromate and heavy metals contents found in wheat flour and the mean value of $KBrO_3$ content was 0.49±0.22 mg/kg. The following were the mean values of the heavy metals; Zn (4.70±1.44 mg/kg), Pb (0.1±0.02 mg/kg), Mn (61.51±9.23 mg/kg), Cu (0.4±0.02 mg/kg) and Co (0.09±0.03 mg/kg).

DISCUSSION

The study evaluated the levels of potassium bromate and some heavy metals in bread and flour sold in Aba metropolis. It was found from this study that millers and bakers did not comply with the bromate-free rule stipulated by both the National Agency for Food and Drug Administration and Control (NAFDAC) and the World Health Organisation (WHO) despite the bromate-free indication on their labels in Aba metropolis.

The levels of potassium bromate content in the analysed 32 different brands of bread samples showed that the $KBrO_3$ content of each of the samples was higher than 0.02mg/kg which is the permissible safe level of potassium bromate allowed in bread by the US Food and Drug Agency (FDA) [22] but lower than the levels permitted by China 50 mg/kg and Japan 10 mg/kg (23).

The finding in this study was similar to the result obtained in Uyo metropolis with the level (1.08 – 3.8 mg/kg) in bread samples analysed (22) and closely similar to the result obtained in Karu Nasarawa state where Shuaibu and Aliyu (24) reported a level of 2.18±0.26 – 8.25±0.35 mg/kg. Alli et al. (21) reported a higher value of 3.6±0.40 – 9.20±0.20 mg/kg in Gwagwalada, Abuja while Oyekunle et al. (3) found a range between 10.029±0.007 and 66.224±0.014 mg/kg for minimum and maximum values respectively in Ile-Ife metropolis which has a wide margin of difference from the present study.

High levels of potassium bromate in bread are harmful to the consumers because it has been associated with neuro and nephro toxicity and ototoxicity (25-27). The workers in the bakery and mill industries are equally exposed to additional risk from inhaled bromate and the potassium bromide – a heat decomposition product from potassium bromate is also toxic (21). In addition, $KBrO_3$ degrades essential vitamins such as vitamin A, B and E present in bread. Oloyede and Sunmonu (11) reported adverse effects on liver and kidney functions of rats fed on diet formulated with bread containing $KBrO_3$.

On the other hand, the flour which bakers claimed to have baked their loaves of bread from, has lower potassium bromates levels compared to the bread samples and it is a known fact that potassium bromate evaporates during the baking process (23). The values of $KBrO_3$ in flour samples analysed in this study were in the range of 00.0 – 1.52±0.28 mg/kg and it was found to differ slightly from the levels of flour analysed in Uyo metropolis with values 0.5 – 2.0 mg/kg (22) as well as in Nasarawa state which had the range of 0.83±0.01 – 1.42±0.01 mg/k (23). It can be averred therefore from the results of this analysis that bakers add more $KBrO_3$ to their flour in order to increase their bread volume and maximize profit.

The level of zinc in the range of 3.22±0.05 – 7.25±0.24 mg/kg found in this study was similar to the range values of

Table 1. Bromate and Heavy Metals Content of Bread Samples in mg/kg

Aba North	Bromate content	Zn	Pb	Mn	Cu	Co
01	0.68 ± 0.18	6.75±0.28	0.09±0.01	73.54±1.02	0.40±0.39	0.09±0.02
02	1.23 ± 0.45	4.99±0.15	0.10±0.03	52.80±0.25	0.36±0.03	0.07±0.02
03	0.89 ± 0.06	3.84±0.06	0.06±0.03	52.70±0.24	0.37±0.01	0.12±0.03
04	1.40 ± 0.27	5.32±0.11	0.08±0.02	66.42±1.15	0.36±0.02	0.05±0.03
05	0.42 ± 0.08	3.22±0.05	0.08±0.02	54.15±0.23	0.35±0.06	0.04±0.01
06	1.42 ± 0.11	5.06±0.32	0.18±o.03	75.40±1.03	0.48±0.12	0.13±0.02
07	2.23 ± 0.26	7.24±0.36	0.25±0.10	71.30±0.09	0.41±0.08	0.08±0.02
08	0.62 ± 0.17	6.68±0.27	0.09±0.02	70.48±0.10	0.35±0.09	0.06±0.02
09	0.85 ± 0.03	3.88±0.05	0.05±0.01	44.28±0.50	0.31±0.04	0.06±0.01
10	1.73 ± 0.08	5.38±0.12	0.26±0.02	47.48±2.15	0.42±0.06	0.13±0.02
11	2.97 ± 0.18	5.68±0.15	0.34±0.06	56.42±1.18	0.39±0.04	0.09±0.02
12	0.68 ± 0.18	3.98±0.08	0.17±0.03	46.65±0.25	0.36±0.03	0.07±0.01
13	1.23 ± 0.45	7.25±0.24	0.45±0.02	78.25±1.24	0.42±0.02	0.18±0.02
14 Aba South	1.27 ± 0.30	6.64±0.26	0.25±0.03	58.24±1.18	0.49±0.12	0.12±0.02
15	0.66 ± 0.09	4.86±0.05	0.12±0.02	48.25±1.25	0.39±0.02	0.13±0.02
16	2.89 ± 0.25	6.14±0.12	0.38±0.03	52.20±1.20	0.41±0.05	0.15±0.03
17	1.46 ± 0.23	5.28±0.35	0.19±0.02	61.40±1.30	0.39±0.03	0.12±0.02
18	2.58 ± 0.14	5.03±0.03	0.42±0.03	62.45±1.30	0.42±0.06	0.24±0.03
19	0.72 ± 0.11	4.88±0.12	0.15±0.01	49.75±1.30	0.39±0.20	0.09±0.02
20	0.75 ± 0.09	4.75±0.03	0.18±0.02	60.15±1.20	0.45±0.25	0.19±0.02
21	2.40 ± 0.33	5.38±0.12	0.41±0.31	56.40± 1.06	0.39±.04	0.06±0.02
22	0.40 ± 0.04	4.98±0.12	0.08±0.01	64.20±2.15	0.38±0.02	0.09±0.02
23	2.29 ± 0.15	6.24±0.21	0.43±0.32	67.10±2.75	0.42±0.06	0.10±0.02
24 Osisioma	0.27 ± 0.04	3.88±0.08	0.08±0.01	47.45±1.37	0.44±0.10	0.09±0.01
25	2.99 ± 0.14	5.82±0.21	0.33±0.03	60.56±2.14	0.42±0.12	0.21±0.03
26	0.28 ± 0.06	4.98±0.12	0.17±0.02	61.15±1.72	0.40±0.03	0.11±0.03
27	1.11 ± 0.12	5.15±0.31	0.15±0.03	54.20±1.18	0.42±0.04	0.09±0.02
28	0.30 ± 0.07	4.99±0.12	0.09±0.03	51.10±1.45	0.46±0.12	0.09±0.02
29	0.87 ± 0.09	5.06±0.31	0.12±0.04	70.20±2.05	0.42±0.04	0.12±0.03
30	1.05 ± 0.62	5.38±0.11	0.14±0.03	60.35±1.40	0.40±0.03	0.17±0.03
31	0.81 ± 0.06	5.14±0.08	0.13±0.03	61.40±1.20	0.38±0.02	0.08±0.02
32	0.76 ± 0.09	5.03±0.03	0.08±0.02	52.50±1.30	0.41±0.03	0.11±0.03

2.23±0.16 – 6.63±0.25 mg/kg in bread loaves within Ile-Ife metropolis (5) but above the mean value of 0.24 – 2.11 mg/kg found in Zaria and the range of 0.1±0.02 – 3.15±3.15 mg/kg reported in cereal based products in Akure (1).

For appropriate taste and smell, Zinc is an essential element (3). An everyday admission of Zn is necessary to keep up a consistent state on the grounds that the body has no particular Zn stockpiling framework. Additionally, Zn lessens the lethality of Cd and Cu. Significant levels of Zn in human have been related with intense impacts like heaving and gastrointestinal annoyance (queasiness, painful and involuntary contraction of muscles, and loose bowels) (13). Zinc insufficiency is portrayed by development hindrance, loss of hunger and impeded immune function. In more extreme cases, zinc insufficiency causes balding, postponed sexual development, feebleness, hypogonadism in men and eye and skin injuries, weight reduction, deferred recuperating of wounds, taste variations from the norm, and mental laziness (3). Akunyili (28) reported a permissible level of zinc in food to be 50mg/kg while WHO stated the daily requirement for adult humans is 15 – 22mg per day (29). The levels of zinc in the bread and flour samples found in this study fell below the WHO recommended level of consumption for humans.

Lead is a highly poisonous metal affecting almost every organ and system in the body. The FAO/WHO Joint Expert

Table 2. Bromate and heavy metals content of flour samples in mg/kg

SN	Bromate content	Zn	Pb	Mn	Cu	Co
01	0.17±0.07	3.85±0.04	0.09±0.03	70.20±1.02	0.38±0.03	0.09±0.02
02	00.00	4.96±0.13	0.06±0.02	64.10±1.06	0.41±0.15	0.08±0.02
03	0.32±0.04	4.25±0.11	0.12±0.03	68.40±1.25	0.38±0.04	0.07±0.01
04	0.73±0.25	5.03±0.10	0.15±0.04	52.75±0.26	0.44±0.15	0.21±0.03
05	0.87±0.13	4.98±0.12	0.08±0.02	64.10±2.15	0.46±0.13	0.08±0.02
06	0.75±0.15	4.92±0.11	0.07±0.02	52.70±0.29	0.39±0.06	0.07±0.04
07	0.67±0.15	5.03±0.03	0.12±0.04	54.10±0.45	0.42±0.13	0.12±0.02
08	0.46±0.29	4.98±0.12	0.08±0.02	52.75±0.30	0.41±0.15	0.09±0.02
09	0.54±0.20	5.00±0.13	0.09±0.02	47.30±0.38	0.40±0.01	0.09±0.02
10	0.45±0.10	4.98±0.12	0.07±0.01	49.62±0.39	0.38±0.03	0.08±0.02
11	0.20±0.05	4.28±0.08	0.09±0.02	52.42±0.24	0.36±0.02	0.07±0.01
12	0.22±0.08	4.15±0.06	0.12±0.03	48.31±0.21	0.39±0.02	0.08±0.02

Values are presented as mean±Standard Deviation (SD) for three (3) replicate determinations.

Committee on Food Additives has established a Provisionally Tolerance Weekly Intake (PTWI) at 0.025mg/kg body weight (3). The range of lead contents of bread and flour found in this study (0.05±0.01 – 0.45±0.02) and (0.06±0.02 – 0.15±0.04) were clearly greater than the PTWI levels for human intake but within the permissible level of 0.2 – 2.5mg/kg recommended by Codex Alimentarius Commission (CAC) (3). Lead when absorbed into the body can be deposited for a long period of time in some tissues where it is later released into the blood stream and distributed within the body. Excessive content of lead in food is associated with a number of diseases especially of the cardiovascular, renal, nervous and skeletal system (30). Lead and Cadmium (Cd) are also implicated in carcinogenesis, mutagenesis and teratogenesis (31).

The manganese levels in the bread and flour samples were in the ranges of 44.28±0.50 – 78.25±1.24mg/kg and 47.30±0.38 – 70.20±1.02 mg/kg, respectively. These values were similar to the range of 25.83±0.59 – 75.53±1.02 mg/kg found in Ile-Ife metropolis [3]. Manganese plays a role in bone mineralization, protein and energy metabolic regulation, cellular protection from damaging free radical species, and the formation of glycosaminoglycans. The main contributors of Mn to the diet are cereals (10 – 30mg/kg), vegetables and fruits (0.5 – 5mg/kg) while nuts may have a higher content. The levels of Mn found in bread and flour samples in this study far exceeded the daily intake of 2 – 3mg/kg recommended by WHO. It implies that bread and flour samples contribute to the ill effects and that excess Mn in meal may affect consumers in this area of study over time.

The levels of Cu in the bread and flour samples used in this study were in the ranges of 0.31±0.04 – 0.49±0.12 mg/kg and 0.36±0.02 – 0.46±0.13 mg/kg, respectively. These values were similar to the levels obtained in Ile-Ife with values 0.23±0.06 mg/kg and 0.46 mg/kg for the minimum and maximum values respectively but lower than 0.03±0.01 – 2.55±0.25 mg/kg in cereal based products found in Akure metropolis (1, 3).

Notwithstanding the sum that originated from cereal crude materials utilized for flour creation, the pollution of Copper may likewise be because of the corruption and decay of some copper composite instruments utilized during flour making and bread preparing. Similar to Co, Cu is a fundamental mineral found all through the body; it contributes to making red platelets in the body and makes sure that nerve cells and the immune system are healthy. Copper insufficiencies are uncommon, because the human body reliably stores copper and needs a midget amount of copper so as to work adequately (3). Notwithstanding, there are definite gatherings of people that have a higher hazard living. People who should devour huge measures of zinc, vitamin C, otherwise fructose might be in danger of Cu insufficiencies given that these minerals will in general exhaust Cu volumes. Late examinations have demonstrated that newborn children who are only nourished dairy animals milk recipe may start to experience Cu insufficiencies because the milk has a low level of Cu itself (32). Various nourishment studies have shown that diets of roughly 25% of youths, grown-ups, and individuals older than 65, do not meet the suggested ingestion of Cu on a daily basis (32).

Level of Co (0.04±0.01 – 0.24±0.03 mg/kg) in bread and flour (0.07±0.01 – 0.21±0.03 mg/kg) was similar to the range of 0.03±0.01 – 0.10± 0.03 mg/kg obtained by Oyenkunle *et al.* (1) in bread samples in Ile-Ife metropolis but lower than 0.05±0.01 – 0.59±0.07 mg/kg obtained in Akure metropolis (1). Cobalt is essential to life in only minute amounts. Food and Agricultural Organisation (FAO) and WHO recommend a 2.4 µg/day of vitamin B12 which is equivalent to 0.1µg/day of cobalt as safety levels in adult diet (3). It should be noted however, that regular eaters of bread and other products from flour may exceed the normal value recommended by joint FAO/WHO considering the rate of consumption of this staple food and suffer the harmful effects over time. The LD50 value for soluble cobalt salt has been estimated to be between

150 and 500mg/kg (33).

Strength of Study

The strength of this study is on the cross sectional survey and analysis of commonly consumed products for contaminations by potential toxic substances at high levels in a metropolitan region.

LIMITATION

The study did not involve the use of high technology equipment such as ion chromatography for more accurate and reliable results.

CONCLUSION

The high levels of potassium bromate present in the analysed samples of bread and wheat flour showed that there was a high dietary exposure of potassium bromate through bread consumption and other confectionaries in this area of study.

Potassium bromate has adverse effects on health which are divided into two categories. The first category deals with non-cancer effects. In the second category, numerous studies have revealed the potential of potassium bromate to cause cancer in experimental animals and in humans.

In addition, the results of heavy metals analysis showed that all the samples analysed contained Zn, Pb, Mn, Cu, and Co at levels that were at wide variance with those specified by such bodies as NAFDAC and WHO. From a general point of view, some of these metals such as Pb, Cd and As show cumulative toxic effects and may be carcinogenic.

The result of this study requires that the regulatory agencies step up surveillance and be more proactive in their duties to save mankind from avoidable health risks.

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REFERENCES

1. Tomori WB, Onibon VO. Health risk assessment of metal content in wheat based snacks from three different kitchen types in Akure metropolis. *Futa J Res Sci* 2015;1: 157-70.
2. Doe ED, Awua AK, Gyamfi O.K, Bentil NO. Levels of Selected HeavyMetals in Wheat Flour on the Ghanaian Market: A Determination by Atomic of Applied Chemistry. *Am J Appl Chemist* 2013;1:17-21.
3. Oyekunle JAO, Adenkunle AS, Ogunfowokan AO, Olutona GO, Omolere OB. Bromate and Trace Metal Levels in bread loaves from outlets within Ile-Ife Metropolis, Southwestern Nigeria. *Toxicol Rep* 2014;1:224-30.
4. Buddrick O. Wholegrains and traditional bread making processes to enhance health benefit of baked good. A theises submitted in fulfilment of the requirement for the degree of Doctor of philosophy, school of applied Sciences, Engineering and Health, RMIT University, 2014.
5. Emeje MO, Ofoefule S I, Nnaji AC, Ofoefule AU, Brown SA. Assessment of bread safety in Nigeria: Quantitative determination of bromate and lead. *Afr J Food Sci* 2010; 4:394-7.
6. Gandikota S, MacRitche F. Expansion capacity of doughs: Methodology and applications. *J Cereal Sci* 2005;42:157-9.
7. Nakamura M, Murakami T, Himata K, Hosoya S, Yamada Y. Effects of reducing agents and baking conditions on potassium bromate in bread. *Cereal Foods World*;2006:69-72
8. Echebiri P. Purity of Food Additives and Issues relating to their Toxicological andSafetymargin. Available from:http://medikkjournal.com/potassiumbromate.html
9. Afaf I, Abuelgasim R, Elmahdi B. Serrobiochemical Effects of Potassium Bromate on Wistar Albino Rats. *Am J Food Tech* 2008;3:303-9.
10. Fawell J, Walker M. Approaches to regulatory values for carcinogenswith particular reference to bromate. *Toxicology* 2006;221:149-53
11. Oloyede OB, Sunmonu TO. Potassium bromate content of selected bread samples in Ilorin, Central Nigeria and its effect on some enzymes of rat liver and kidney. Food Chemical. *Toxicology* 2009;47:2067-70
12. Kakehashi A, Wei M, Fukushima S, Wanibuchi H. Oxidative stress in the carcinogenicity of chemical carcinogens. *Cancers (Basel)* 2013;5:1332–54.
13. Magomya AM, Yebpella GG, Udiba UU, Gandu I, Amana SM, Ugboaja VC, et al. Assessment of Cd, Cu, Mn and Zn Levels in Soil, Water and Vegetable Grown in Irrigated Farm along River Kubani, Zaria, Nigeria. *J Appl Environ Biol Sci* 2011;1:84-9.
14. Onyedika GO, Nwosu GU. Lead, zinc and cadmium in root crops from mineralized galena-sphalerite mining areas and environment. *Pakistan J Nutr* 2008;7:418-20.
15. Osu CJ, Odeemelamo SA. Heavy metals (Pd, Cd, As and Ag) contamination of Edible grain grown and marketed in Nigeria. *Res J Appl Sci* 2007;2:192-5.
16. Hassan NU, Mahmood Q, Waseem A, Irshad M, FaridullahianPervez A. Assessment of heavy metals in wheatplants irrigated with contaminated wastewater. *Pol J Environ Stud* 2013;22:115-23.
17. Tchounwou PB, Yedjou CG, Patlolla AK, Sutton DJ. Heavy metal toxicity and the environmentxp. *Suppl* 2012;101:133-64.
18. Duruibe JO, Ogwuegbu MDC, Egwurugwu JN. Heavy metal pollution andhuman biotoxic effects. *Int J Phys Sci* 2007; 2:112–118.
19. Singh A, Sharma R, Agrawai M, Marshall MF. Health risk assessment of heavy metals via dietary intake of food stuffs from the wastewater irrigated site of a dry tropical area of India. *Food Chem Toxicol* 2010;48:611-9.
20. El harti J, Rahali Y, Benmoussa A, Ansar M, Benziane H, Lamsaouri J et al. A simple and rapid method for spectrophotometric determination of bromate in bread. *J Mater Environ Sci* 2011;2:71-6.
21. Alli LA, Nwegbu MM, Inyang BI, Nwachukwu KC, Ogedengbe, JO, Onadepo O, et al. Determination of potassium bromate content in selected Bread samples in Gwagwalada, Abuja-Nigeria. *Int J Health Nutr* 2013;4:15-20.
22. Ekop AS, Obot IB, Ikpatt EN. Anti-Nutritional Factors and Potassium Bromate Content in Bread and Flour Samples in Uyo Metropolis, Nigerian. *E-J Chem* 2008;5:736-41.
23. Johnson OR, Daniel KD, Iyabo AG, Oloruntoba AC. Analysis of Potassium Bromate and Hydrocyanic Acid Contents of Commonly Consumed Loaves of Bread and Wheat Flour Samples InKaru, Nasarawa State, Nigeria. *J Environ Sci Toxicol Food Tech* 2013;6: 42-46.
24. Shuaibu L, Aliyu Y. Spectrophotometric determination of bromate in breads using promethazine. *Int J Curr Res* 2013;5:2236-8.
25. Bayomy NA, Soliman GM, Abdelaziz EZ. Effect of potassium

bromate on the liver of adult male albino rat and a possible protective role of vitamin C: histological, immunohistochemical, and biochemical study. *Anat Rec (Hoboken)* 2016;299:1256–69.
26. Ajarem J, Altoom NG, Allam AA, Maodaa SN, Abdel-Maksoud MA, Chow BK. Oral administration of potassium bromate induces neurobehavioral changes, alters cerebral neurotransmitters level and impairs brain tissue of Swiss mice. *Behav Brain Funct* 2016;12:14.
27. Campbell KCM. Bromate-induced ototoxicity. *Toxicology* 2006:221;205–11.
28. Akunyili DN. Medical Nigeria: Potassium bromate in bread… what are the implications? Sensitization and Interactive workshop for flour millers and bakers. 2004; Vanguard Media Limited Online. WHO. Zinc in Drinking Water, Background Document for Development of WHO Guidelines for Drinking Water Quality, World Health Organization; Geneva: 2003.
29. Mahamudul H, Laboni B, Shahadat H, Pinku P, Alaudin C, Farhad A. Study on heavy metals (Zinc and Lead) in drinking water of Tannery area, adjacent areas and outside village areas. *J Environ Anal Toxicol* 2017;7: 433.
30. Kalia K, Flora SJ. Strategies for safe and effective therapeutic measures for chronic arsenic and lead poisoning. *J Occup Health* 2005;47:1–21.
31. Salama AK, Radwan MA. Heavy metals (Cd, Pb) and trace elements (Cu, Zn) contents in some foodstuff from the Egyptian market. *Emirate J Food Agric* 2005;17:34-42.
32. Stern R, Bonnie R. Essential and toxicity in copper health risk assessment overview, update and regulatory consideration. *J Toxicol Environ Health* 2010;73:114-27.
33. Donaldson JD, Beyersmann D. Cobalt and cobalt compounds in Ullmann'sEncylopedia of industrial Chemistry. Wiley-VCH, Weinhem: 2005.