IJST EXPLORE International Journal of Science and Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-7318

International Journal of Science and Technology Volume 2 No. 2, February, 2013

# Potassium Bromate and Heavy Metal Content of Selected Bread Samples Produced in Zaria, Nigeria

**[1]A.M Magomya, [1]G.G Yebpella, , [2]U.U Udiba [3]H.S Amos [2]M.S Latayo**
[1]Department of chemical sciences, Federal University Wukari-Nigeria
[2]National Research Institute for Chemical Technology (NARICT) Zaria- Nigeria
[3]Chemistry Department, PPSMB Yola-Nigeria

## ABSTRACT

Fifteen different bread brands produced in Zaria metropolis of Northern Nigeria were analyzed for potassium bromate content and some heavy metals. The study revealed the presence of potassium bromate in all the samples analysed, the concentrations ranged from 2.46-13.60mg/kg, all the values were above the allowed limit by FDA. The heavy metals determined were Pb, Cd, Cu, Zn and Fe. Results obtained were assessed on the basis of the permissible limits for the respective metals in Foods. The concentrations of Pb and Cd in the samples were in the range of 0.34-3.13mg/kg and 0.013-0.098mg/kg respectively. The levels of these metals in some of the samples suggest a certain degree of contamination. The values for Cu, Zn and Fe in the samples ranged as follows; Cu (0.13-0.098mg/kg), Zn (0.24-1.72mg/kg) and Fe (0.53-8.45mg/kg). Cu and Zn content in all the samples where within permissible limits. The concentration for Fe was above permissible limit in two of the samples (samples 10 and 12, 8.45mg/kg and 7.45mg/kg respectively)

**Keywords:** *Bread, Potassium Bromate, Heavy metals*

***Corresponding Author**: Magomya A. M., Department of Chemical Sciences, Federal University Wukari, PMB 1020, Wukari- Nigeria
Email; amagomya26@gmail.com

## 1. INTRODUCTION

Bread is a kind of food made from flour, water and other ingredients, usually combined with a leavening agent, kneaded, shaped into loaves, and baked. It is an important staple food of many countries of the world especially the African countries and South East part of Asia [1, 2]. In Nigeria, bread is consumed extensively in homes, restaurants and hotels. It is one of the most consumed food type with predominant consumption among the poor [3]. Bread usually contains several ingredients that would help improve its quality.

Potassium bromate is a flour improver that acts as a maturing agent. It acts principally in the late dough stage giving strength to the dough during the late proofing and early baking [4]. In laymen's term, potassium bromate prevents dough from falling. This property has been manipulated by many Nigerian bakers in profit making. Over time, it has been discovered that potassium bromate is toxic and is a possible carcinogen in man [5]. In the early 1990's the World Health Organization (WHO) discovered that potassium bromate if added to dough which subsequently is produced as bread, has the capacity to cause such diseases as cancer, kidney failure and several other related diseases [6]. This led to its ban in several countries. In Nigeria, the use of potassium bromate in bread was banned in 1993. However, despite its ban, many Nigerian bakers continue to use it in bread making.

Heavy metals are potential environmental contaminants with the capability of finding their way into the food we eat and causing human health problems. They are given special attention throughout the world due to their ubiquitous nature and toxic effects even at very low concentrations [7]. Several cases of human disease, disorders, malfunction and malformation of organs due to metal toxicity have been reported [8]. The major route for humans' exposure to heavy metals is through the food pathway [9]. Contamination of bread by heavy metals could arise from flour which may have been produced from contaminated raw materials. Water used for bread making could also be a source of heavy metal contamination. Studies by Ahmed and Fadel [10] revealed that the kind of baking fuel used for bread production could also be responsible for heavy metal contamination.

Elements such as Cd, Cr and Pb as are considered carcinogenic, while Fe, Cu, Zn, Ni and Mn are considered as essential metals, however, if the concentrations of the later elements are higher than their permissible limits they may create toxic effects in humans [11]. Many workers have carried out studies on the levels of heavy metals in various nutrient sources in many parts of the world [12, 13, 11, 14, 16, 17, 18, 19, and 20]. Despite being a major

staple food in many homes, there have been little or no information on the levels of heavy metals in breads produced in different parts of the world.

Zaria is a major city in Kaduna state, it is located on the high plains of Northern Nigeria, 652.6 Meters above the sea level, some 950km away from the coast (112 031N 7Q 42E). It is a very large, heterogeneous city whose 1,490,000 population comes from different parts of the world. Preliminary investigations revealed over thirty (30) different bread brands produced within Zaria. Some of the bakeries operate under bad hygienic conditions and lack certification by regulatory bodies. Also, many parts of Zaria lack portable water supply. The quality of water used for bread production by some of the bakeries is therefore questionable.

The aim of this study is to assess the safety of bread produced in Zaria, Nigeria. Selected bread samples produced Within Zaria metropolis will be investigated for the presence of potassium bromate and some heavy metals. The heavy metals to be determined include Cd, Pb, Cu, Fe, and Zn. Monitoring of heavy Metals in food sources is necessary for issues of public health concerns.

## 2. EXPERIMENTAL

### 2.1 Sample Collection and Preparation

Bread samples were purchased from open markets, bus stops and from bread vendors in Zaria, Kaduna State, Nigeria. Only bread brands produced in Zaria were purchased. A total of fifteen (15) different brands of bread were used in this study. A circular sample of 2 cm in diameter from the centre of each bread sample was taken and dried to constant weight in an oven at 55$^{o}$C. The crust was ground to a fine powder and stored in air tight containers for the various analysis.

### 2.2 Analysis of Potassium Bromate in Bread

Potassium bromate in the bread samples was qualitatively analyzed using previously reported methods [21]. A 1.0 g quantity was weighed out from each bread sample and transferred into a test tube. Ten milliliter (10 ml) of distilled water was added; the mixture was shaken and allowed to stand for 20 min at 28 ± 10°C. A 5.0 ml volume was decanted from the test tube and 5.0 ml quantity of freshly prepared 0.5% potassium iodide solution in 0.IN hydrochloric acid was added. . The presence of potassium bromate was indicated by change in colour from light yellow to purple. Quantitative determination of bromate was carried out using the iodometric titration method described by Armstrong [22].

### 2.3 Determination of Heavy Metals in the Bread Samples

1g of each bread sample was digested with concentrated nitric acid and perchloric acid in a ratio of 3:1 on a hot plate. At the end of complete digestion it was filtered using a Whatman filter paper No. 1 into a 50mL volumetric flask and made up to mark with distilled water.

Metals concentrations were determined by Atomic Absorption Spectrophotometer (Shimadzu AA-6800) with graphite furnace and background correction (SR-BDG). The flame conditions were optimised for maximum absorbency and linear response while aspirating known standards. The standards were prepared from individual 1000ppm stock solution of the respective metals initially prepared from their respective salts.

## 3. RESULTS AND DISCUSSIONS

Results of this study revealed that all the bread samples analysed contained potassium bromate (Table 1). The concentration ranged from 2.46-16.46mg/kg.

**Table 1: concentration of potassium bromate in selected bread samples produced in Zaria (mg/kg)**

| Bread samples | Bromate content (mg/kg) |
|---|---|
| 01 | 4.33 ± 0.02 |
| 02 | 10.47± 0.04 |
| 03 | 8.64 ± 0.12 |
| 04 | 11.31± 0.20 |
| 05 | 6.25 ± 1.32 |
| 06 | 2.46 ± 0.35 |
| 07 | 9.96 ± 1.50 |
| 08 | 2.67 ± 0.02 |
| 09 | 9.26 ± 0.50 |
| 10 | 8.00 ± 0.15 |
| 11 | 12.35 ± 0.55 |
| 12 | 13.60 ± 1.00 |
| 13 | 12.78 ± 0.50 |
| 14 | 7.54 ± 2.20 |
| 15 | 16.46 ± 0.02 |

Values are presented as mean ± Standard deviation (S.D.) for three (3) replicate determinations

**Table 2: heavy metal content of some bread samples produced in Zaria, Nigeria ((mg/kg)**

| Bread samples | Pb | Cd | Cu | Zn | Fe |
|---|---|---|---|---|---|
| 01 | 1.25±0.02 | 0.023±0.10 | 0.45±0.05 | 1.72±0.05 | 1.08±1.10 |
| 02 | 3.13±0.00 | 0.020±0.05 | 0.27±0.00 | 0.87±1.26 | 0.62±0.11 |
| 03 | 1.36±1.00 | 0.032±0.20 | 0.17±0.04 | 0.94±0.10 | 0.53±1.60 |
| 04 | 1.88±0.25 | 0.013±0.00 | 0.13±0.03 | 1.25±0.40 | 1.06±0.05 |
| 05 | 0.97±0.50 | 0.016±0.02 | 0.31±0.17 | 2.11±0.00 | 0.82±0..75 |
| 06 | 0.34±0.02 | 0.015±0.12 | 0.18±0.35 | 0.81±0.02 | 1.07±0.12 |
| 07 | 0.97±0.01 | 0.056±0.01 | 0.33±0.40 | 0.31±0.04 | 2.56±0.15 |
| 08 | 0.57±0.15 | 0.098±0.15 | 0.22±0.08 | 0.24±0.20 | 3.76±0.12 |
| 09 | 0.34±0.12 | 0.068±1.20 | 0.34±2.00 | 0.26±1.00 | 4.81±0.05 |
| 10 | 0.91±0.00 | 0.081±1.00 | 0.18±0.01 | 0.34±0.60 | 8.45±1.12 |
| 11 | 1.99±1.20 | 0.076±0.01 | 0.36±1.20 | 0.33±1.15 | 4.51±1.26 |
| 12 | 1.94±0.16 | 0.078±0.10 | 0.25±0.95 | 0.42±1.50 | 7.05±0.14 |
| 13 | 0.67±0.05 | 0.038±1.50 | 0.15±0.05 | 1.31±1.08 | 1.48±0.62 |
| 14 | 1.17±0.20 | 0.056±1.10 | 0.66±1.15 | 0.62±1.26 | 1.83±0.19 |
| 15 | 0.58±0.01 | 0.082±0.4 | 0.28±0.40 | 0.41±0.04 | 0.97±0.50 |

Values are presented as mean ± Standard deviation (S.D.) for three (3) replicate determinations

Toxicological studies have convincingly shown that potassium bromate affects the nutritional quality of bread by degrading the main vitamins available [23]. Carcinogenic and mutagenic effects of potassium bromate have been reported in experimental animals [5]. Oral doses of 185–385 mg/kg body weight results in irreversible toxic effects like renal failure and deafness in humans while lower doses are associated with vomiting, diarrhea, nausea and abdominal pain [24]. The maximum amount of potassium bromate allowed in bread by the FDA is 0.02 mg $kg^{-1}$ [25]. All the samples analysed in this study had potassium bromate in excess of the allowed concentration. Similar Studies by Emeje et al [26] carried out in the eastern part of the country also revealed similar findings. The presence such levels of potassium bromate in bread is highly undesirable considering its deleterious effects.

Table 2 shows the concentrations of the metals Pb, Cd, Cu, Zn and Fe in the bread samples analysed. Lead and cadmium are among the most abundant heavy metals and are particularly toxic [27]. Excessive content of these metals in food is associated with a number of diseases, especially of the cardiovascular, renal, nervous and skeletal systems [8]. These heavy metals are also implicated in carcinogenesis, mutagenesis and teratogenesis [27]. The highest concentration of Pb was observed for sample 02(3.03 mg $kg^{-1}$) while the lowest was for samples 07and 09 (0.34 mg/kg). Permissible level of Lead in food is in the range of 0.2-2.5 mg $kg^{-1}$[28]. Among the bread samples analysed, only sample 02 had lead content above permissible limit, although the Pb contents in the other samples were within the acceptable limits, they may still have toxic potentials, with detrimental impact becoming apparent only after decades of exposure. The main sources of lead in the environment are: Industrial production processes and their emissions, road traffic with leaded petrol, smoke and dust emissions of coal and gas-fired power stations, the laying of lead sheets by roofers as well as the use of paints and anti-rust agents.

The level of Cd in the bread samples ranged from 0.013-0.098. Permissible limit for Cd in food is 0.05mg/kg [29]. From the results obtained eight (8) out of the fifteen (15) samples analysed had Cd concentration above the permissible limit this. These results are of concern as cadmium is highly toxic and is regarded as the most serious contaminant of modern age. High concentration of cadmium exerts detrimental effects on human health and causes severe diseases such as tubular growth, kidney damage, cancer, diarrhea and incurable vomiting [30].

Cu, Zn and Fe are nutritionally essential metals. They are referred to as trace elements and are commonly found naturally in foodstuffs. However, these metals are toxic when taken in excess of requirements. The concentration of Cu in the different bread brands ranged from 0.13-0.66 mg/kg. These concentrations are far below the permissible level of Cu in foods (10 mg/kg) 27]. The samples can therefore be considered free from Cu contamination.

The average daily intake of zinc has been estimated to be maximally 20 mg/day for adults. In human, high levels of zinc has been associated with acute effects such as vomiting and gastrointestinal irritation (nausea, cramps, diarrhea). The highest Zn concentration in the bread samples analysed was observed for sample 05 (2.11

mg/kg) while the lowest was in sample 08 (0.24mg/kg). These values are within the permissible level of Zn in foods (50mg/kg) (31).

Iron is an essential trace element required by all forms of life. In man it is required for the synthesis of haem proteins and in many enzyme systems. Various groups (male, female, children, pregnant, lactating) differ in requirement for iron, iron deficiency is one of the most common nutritional deficiencies in children, women of child bearing age, and pregnant women. It rarely occurs in adult men, except in cases of chronic bleeding. The concentrations of Fe in the bread samples studied ranged from 0.62-8.45 mg $kg^{1}$. The permissible limit for Fe in food is in the range of 2.5-5.0 mg/kg depending on the foodstuff [28]. Samples 10 and 12 had iron concentrations above the permissible level (8.45 mg/kg and 7.45 mg/kg) respectively. However, in human, acute toxicity of iron ingested from normal dietary sources has not been reported.

Metal containers used for kneading of dough during bread making may be responsible for high levels of such metals. Atmospheric deposition from urban and industrial areas may result in contamination of agricultural produce with heavy metals which are in turn transferred to the finished products. Fig 1 shows possible sources of heavy metal contamination during bread production.

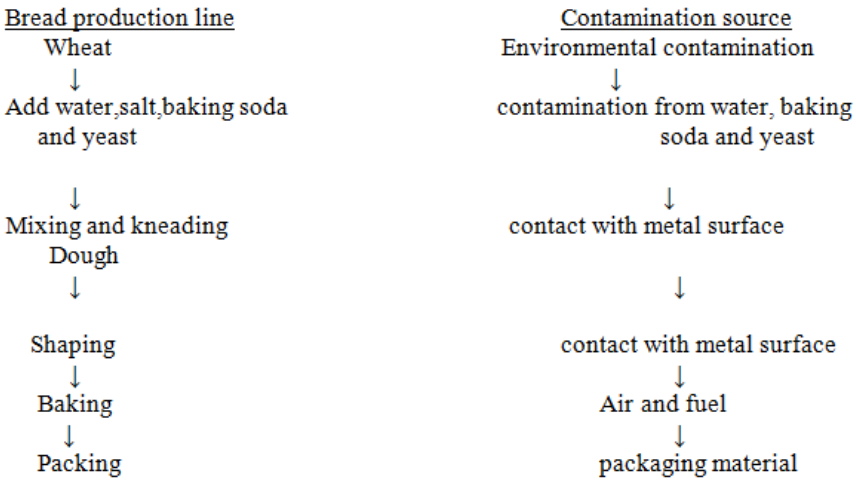


**Fig.1. Possible sources of heavy metal Contamination during bread production**

## 4. CONCLUSION

The results of this study supply valuable information about the heavy metal and potassium bromate contents of bread brands produced in Zaria, Nigeria. All fifteen bread samples investigated contained potassium bromate in quantities that exceeded the allowed limits by FDA. These findings imply that Bakers in Zaria, Nigeria still use potassium bromate for bread making despite its ban in 1993 by the Nigerian National Agency for Food, Drug Administration and Control (NAFDAC) [33]. Results of the heavy metal analysis showed that the levels of Cu and Zn are generally within safe limits. However, the concentrations of Fe and Cd in some of the samples were above permissible levels. All the samples contained traces of lead; the content was notably high in one of the bread samples.

There is need for relevant regulatory bodies in Nigeria to establish stricter conditions regarding bread production and carry out regular monitoring of bakeries to ensure that the bakers do not flout the laws and that the environment and indeed the materials used by these bakeries are devoid of contamination of any kind so as to safeguard the health of the consumers.

## REFERENCES

[1] Pomeranz, Y., 1987. Bread around the world. In: Pomeranz, Y. (Ed.), Modern CerealScience and Technology. VCH Publishers Inc., New York, NY, pp. 258–333

[2] Owens, G., 1997. China: handled with care. Cereals Int. September–October, 14–16.

[3] Maziya-Dixon, B., I.O. Akinyele, E.B. Oguntona, S. Nokoe, R.A. Sanusi, E. Harris, 2004. Nigeria food consumption and nutritional survey 2001–2003. IITA,Ibadan, p. 67.

[4] Vadlamani, K.R.,P.A. Seib, 1999. Effect of zinc and aluminium ions in bread making. *Cereal Chem.* 76 (3), 355–360.

[5] Kurokawa, Y., A. Maekawa, M.Takahashi, Y.Hayashi, 1990. Toxicity and Carcinogenicity of Potassium Bromate: A New Renal Carcinogen.*Environ. Health Perspect.* 87: 309-335
.

[6] FAO/WHO 1999. Expert Committee on Food Additives, Summary and conclusions, 53rd Meeting, Rome.

[7] Das, A., 1990. Metal ion induced toxicity and detoxification by chelation therapy. In: 1st(ed) A text book on medical aspects of bioinorganic chemistry, CBS, Delhi, p. 17-58

[8] Jarup, L., Hazards of heavy metal contamination. *Br Med Bull* 2003; 68: 167-82.

[9] Hubbard, A.W. and D.G. Lindsay, 1979. Dietary intakes of heavy metals by consumers in the UK, *In*: Proceeds of the international conference on management and control of heavy metals in the environment, London

[10] Ahmed, A., and W. Fadel, 2012.The Influence of Baking Fuel Types on the Residues of Some Heavy Metals in Jordanian Bread *Jordan Journal of Chemistry* Vol. 7 No.1, pp. 81-85

[11] Gulfrazi, M., Y. Mussaddeq, R. Kahnum and T. Ahmad, 2003. Metal contamination in wheat's crops irrigated with industrial efficient. *J. Biol. Sci., 3: 335-339.*

[12] Yebpella G.G., A..M. Magomya, U.U. Udiba, I. Gandu, S.M Amana, V.C Ugboaja, N.L Usman 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.*, 1(5)84-89, 2011

[13] Fubara, E.P. and M. Christian, 2006. Bioaccumulation of heavy metals in perinwinkle and oyster from Okpoka River. *Int. J. Sci. Technol*., 5: 51-54.

[14] Nicoleta, M., L. Ramona, G. R and E. Muntean, 1996. Heavy metals content in some Food products. Instituite of public health Nopoca, Romania

[15] Adediran, G., O. Oloyede and J.A. Oyindoye, 1990. Some heavy metal composition of some Nigerian soup condiments. *Nig. Food J.*, 9: 13-14.

[16] Osu, C.J. and S.A. Odeemelamo, 2007. Heavy metals (Pd, Cd, As and Ag) contamination of Edible grain grown and marketed in Nigeria. *Resource. J. Applied Sci., 2: 192-195.*

[17] Onyedika, G.O. and G.U. Nwosu, 2008. Lead, Zinc and Cadmium in Root crops from Mineralized Galena- Sphalerite mining Area and Environment. *Pak. J. Nutr., 7: 418-420.*

[18] Mannino, S., 1996. Determination of heavy metals in fruits juices and vegetables by potentiometer stripping analysis. The Analyst., 107: 1466-1470.

[19] Tahoven, I., 1998. Lead and cadmium in food additives and contaminants, 15: 446-450

[20] Edem,C A., I. Grace , O.Vincent, E. Rebbeca, and O. Matilda, 2009. A Comparative Evaluation of Heavy Metals in CommercialWheat Flours Sold in Calabar-Nigeria. *Pakistan Journal of Nutrition* 8 (5): 585-587,

[21] David, 1976 .The chemical Analysis of Foods 7th Ed. Longman group Ltd, London

[22] Armstrong, A W (1952). *Analyst vol*. 77 pp 460-4

[23] Sai, K., A. Takagi, T. Umemura, 1991. Relation of 8-hydrogen guanosine formation in rat kidney to lipid peroxidation, glutathione level and relative organ weight after a single dose administration of potassium bromate. *Jpn. J. Cancer Res*. 82(2), 165–169.

[24] Mark, J.E., 1988. Cataractogenic potential of bromate mediated oxidative stress in rat. *Animal Biol.* 45, 567–660

[25] Ekop, A.S., I.B.Obot, E.N Ikpatt, 2008. Anti-Nutritional Factors and Potassium Bromate Content in Bread and Flour Samples in Uyo *E-Journal of Chemistry* 5, (4), pp. 736-741.

[26] Emeje M.O., S.I. Ofoefule, A.C. Nnaji, A.U. Ofoefule and S.A. Brown , 2010. Assessment of bread safety in Nigeria: Quantitative determination of potassium bromate and lead Journal of Food Science Vol. 4(6) pp. 394 – 397.

[27] Salama, A.K. and M.A. Radwan, 2005. Heavy metals (Cd, Pb) and trace elements (Cu, Zn) contents in some foodstuff from the Egyptian market. *Emirate J. Food Agric., 17: 34-42*

[28] Codex Alimentarius Commission(CAC). 2003. Evaluation of certain food additives and contaminants.FAO/WHO, Codex stan. 230-2001,Rev, 1-2003, Rome.

[29] Walker, J. M. 1988. Regulation by other countries in foods and the human environment, Proceeding, No.2 "Cadmium Accumulation in Australian Agriculture". National Symposium, Canberra, 1-2 March 1988, Australian Government Publishing Service, Canberra, 176-85

[30] Sabine,M and G.Wendy, 2009. Human health effects of heavy metals. CHSR Environmental science and technology briefs Issue (15)

[31] USDA 2003. Zinc in foods-draft for comments. Foreign Agricultural Service (GAIN Report) CH3043,

[32] Gholam R., J. Khaniki, M. Yunesian, A.H.Mahvi and S. Nazmara 2005. Trace Metal Contaminants In Iranian Flat Breads. *Journal Of Agriculture & Social Sciences*/01(4)301–303

[33] Akunyili, D. N. (2004). Medical Nigeria: Potassium bromate in bread… what are the implications.? Sensitization and Interactive workshop for flour millers and bakers.Vanguard Media Limited Online.