DETERMINATION OF POTASSIUM BROMATE CONCENTRATION IN SOME BREAD SAMPLES IN JOS METROPOLIS

Supported by tetfund TERTIARY EDUCATION TRUST FUND

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Received: April 7, 2021 **Accepted:** July 12, 2021

Abstract: Potassium bromate is an additive widely employed by bread makers to improve bread quality. On account of its deleterious effect and carcinogenicity in humans, certain levels of potassium bromate are not allowed in bread. Use of potassium bromate in bread has been banned in many countries Nigeria inclusive. In this study the concentration of potassium bromate was determined in nine 'quality' bread samples baked in Jos Metropolis. Quality assessment revealed that, all the brands contained potassium bromate in a quantity that exceeded the minimum allowed by the FDA (0.020 ppm) and WHO (0.025 ppm) by several hundred folds except one sample (code I). In view of these findings, bread makers should be discouraged from using potassium bromate as bread improver. Also regulatory authorities should step up their monitoring activities in order to safe guard the health of the populace.

Keywords: UV-Vis Spectrophotometer, bread, cancer, potassium bromate, flavours

Introduction

Bread is an essential cereal product in human nutrition providing as much as 50-90% of total caloric and protein intake. It is an important source of food in Nigeria and consumed extensively in homes, restaurants and hotels. Bread is made from low protein wheat through a number of processes including milling, mixing, fermenting, molding and baking. It usually contains several ingredients that would help improve the quality of bread. Some of the basic identified ingredients, apart from flour are table salt, sugars, flavours, butter and at least a flour improver such as potassium bromate (Vicki, 1997).

Bakeries use potassium bromate, a strong oxidizing agent for bread improving effects such as to preserve flavour or improve the taste and appearance. The use of potassium bromate has been a common choice among flour miller and bakers throughout the world because it is cheap and probably the most efficient oxidizing agent. When potassium bromate is added to freshly milled flour, it increases the shelf life of the flour. But beyond all the benefits, potassium bromate is toxic above 0.02 ppm (Zeryawkal and Ariaya, 2012).

Potassium bromate has adverse effect on health; the effects are divided into two categories. The first category deals with effects related to non-cancer effect. This includes its effect on the nutritional quality of bread. It degrades vitamin A_2, B_1, E and niacin, which are the main vitamins available in bead (IARC, 1986).

Studies (IARC, 1986) have shown significant differences in essential fatty acid content of flour containing bromate.

In humans potassium bromate can cause cough and sore throat when inhaled (Atkins, 1993). Abdominal pain, diarrhea, nausea, vomiting, kidney failure, hearing loss, bronchial and ocular problems associated with ingestion of the other non-cancer health problems associated with ingestion of potassium bromate (Akunyili, 1993).

In the second category, numerous studies have revealed the potential of potassium bromate to cause cancer in experimental animals and humans. In Nigeria, and in many parts of the world, use of potassium bromate in bread improver has been banned (Ekop *et al.*, 2008). In Nigeria however, some bread makers/ bakeries have continued to include potassium bromate in their bread.

Geographical location of Jos

Jos is a city in the middle belt of Nigeria; it is located on Jos, Plateau at about 1238 Meters or 4062 ft above the sea level (Fig. 1). It is a very large, heterogeneous city whose 900,000 population comes from different parts of the world. Preliminary investigation revealed over fifty (50) different brands of breads produced within Jos metropolis. Some of the bakeries operate under bad hygienic condition and lack certification by regulatory bodies. The quality of water used for bread production by some of the bakeries is also questionable.

Fig. 1: A Google map showing the study area and its environs

The overall aim of this project work is to determine the concentration of potassium bromate in bread samples produced in Jos metropolis. The study covers the effect of potassium bromate in nine (9) samples of standard bread from Jos metropolis.

Materials and Methods

Sample collection

Bread samples were collected from nine (9) different varieties namely; A, B, C, D, E, F, G, H and I located in Jos metropolis of plateau State, Nigeria.

Reagents preparations

Each reagent was prepared using the laboratory standard formula.

Preparation of 10 g of potassium iodide

Preparation of 10 g potassium iodide was weighed and dissolved with distilled water in 100 mL volumetric flask, the water was added up to mark and stirred thoroughly.

Preparation of 0.1M hydrochloric acid

The solution was prepared by measuring 2.5 mL hydrochloric acid and then added to a small quantity of water in 250 mL volumetric flask, shaken thoroughly and then made up to the mark with distilled water.

Preparation of 1 g starch ($C_{12}H_{25}NO_{11}$)

The 1 g starch was weighed using analytical weighing balance and dissolved in 2 ml of distilled water and then warmed in the water bath.

Preparation of 2M hydrochloric acid

42.9 mL concentrated hydrochloric acid was measured using calibrated measuring cylinder and transferred into a 250 mL volumetric flask containing small amount of distilled water, then shaken vigorously and made up to the mark with distilled water.

Preparation of Congo red dye solution ($C_{32}H_{22}N_6Na_{206}S_2$)

0.174 g of Congo red dye (696.67 g/dm^3) was weighed and transferred into a 50 mL volumetric flask, dissolved with 2 mL of distilled water, shaken thoroughly and made up to the mark with distilled water.

Preparation of potassium bromate stock solution

0.25 g of potassium bromate crystal was weighed and dissolved in 5 250 mL of distilled water. This was shaken thoroughly to dissolve and then made up to the mark.

Qualitative analysis of potassium bromate in bread

Small sample from each bread brand was cut out into different Petri dishes. The Petri dishes were labeled. Distilled water was added to wet the sample. 2 – 3 drops of starch solution was added then 0.5 ml of potassium Iodide solution was also added followed by 3-6 drops of 0.1M HCl, and allowed to stand for about 5-10 minutes. The appearances of black spots on the sample indicate the presence of potassium bromate in the samples A, B, C, D, E, F, G, H. there was however no color charge in sample I implying the absence of bromate in this bread.

Quantitative determination of bromate in bread using UV-Visible spectrophometer determination

After cooling, a 5.0 mL volume was decanted from each five samples into five separate 25 mL calibrated flask. 5 mL of 5×10-4 moldm^{-3} solution of Congo red was added followed by 10 mL of 2MHCl solution. Each flask was diluted to 25 mL mark with distilled water and shaken gently. The absorbance of the samples was taken at 620 nm using UV-Visible spectrophotometer.

Standard curve preparation

Required concentration of pure potassium bromate for baking was prepared in the range; 0, 10, 20, 30, 40, 50, 60, 70 and 80. From the above value, determination was used to calibrate the spectrophotometer. The original values were calculated by using the formula:

$$CoVo = CrVr_{,,} \qquad Vo = \frac{CrVr}{Co}$$

Where: Co = original concentration (mL); Vo = original volume; Cr=Required concentration (0-1000 mL); Vr = required volume (50 mL). From the calibration curve, the unknown concentration can be calculated using the afore mentioned relationship;

Results and Discussion

The result obtained from the qualitative determination of bromate is shown in Table 1. The spot tests revealed that of the nine (9) bread samples used, eight samples showed black spot which indicates the presence of bromated; while one sample showed no colour change indicating no presence of bromate in the bread (Table 1).

Table 1: Results for spot test (qualitative analysis)

Sample	Observation
A	Black spot was observed
B	Black spot was observed
C	Black spot was observed
D	Black spot was observed
E	Black spot was observed
F	Black spot was observed
G	Black spot was observed
H	Black spot was observed
I	No colour change observed

Table 2: A table showing the various samples, their absorbance and bromate concentrations

Samples	Absorbance	Conc. (mg/kg)	Number of folds with respect to limits by:	
			FDA	WHO
A	0.336	13.6629	683.15	546.52
B	0.588	18.4944	924.72	739.78
C	0.299	11.4157	570.79	456.63
D	0.199	9.3933	469.67	375.73
E	0.202	11.0787	553.94	443.15
F	0.316	13.4501	672.51	538.00
G	0.346	13.6702	683.51	546.81
H	0.401	14.5510	727.55	582.04
Permissible level (mg/kg)			0.02	0.025

Table 3: Calibration curve for the determination of bromate in bread sample

Concentration (mg/kg)	Absorbance
0	0.000
10	0.085
20	0.168
30	0.235
40	0.261
50	0.275
60	0.321
70	0.401
80	0.415

The results obtained shows that the concentration of bromate varies from one sample to another (Table 2). The result revealed the following concentrations of bromate in samples A, B, C, D, E, F, G, H respectively 13.6629, 18.4944, 11.4157, 9.3933, 11.0787, 13.4501, 13.6702, 14.5510 mg/kg. This result reveals that the maximum concentration of bromate was found in sample B while the minimum was in sample D. The use of bromate as an oxidizing agent to give a fine dough structure in bread production but it is also adangerous additive as noted by Cogswell (1997). The presence of bromate in bread can cause cancer, renal failure, loss of hearing, respiratory tract diseases and so on. From the results of this study, the concentration of potassium bromate exceeds the permissible limit of 0.02 ppm set by the US Food and Drug Agency (FDA) (Ekop *et al*. 2008) and it also contravenes the NAFDAC ban on use of bread for human consumption.

Table 3 and Fig. 2 showed the calibration curve for the determination of bromate in bread sample. Similarly, Fig. 3 displays the graphical presentation of concentration of bromate in bread from the study area.

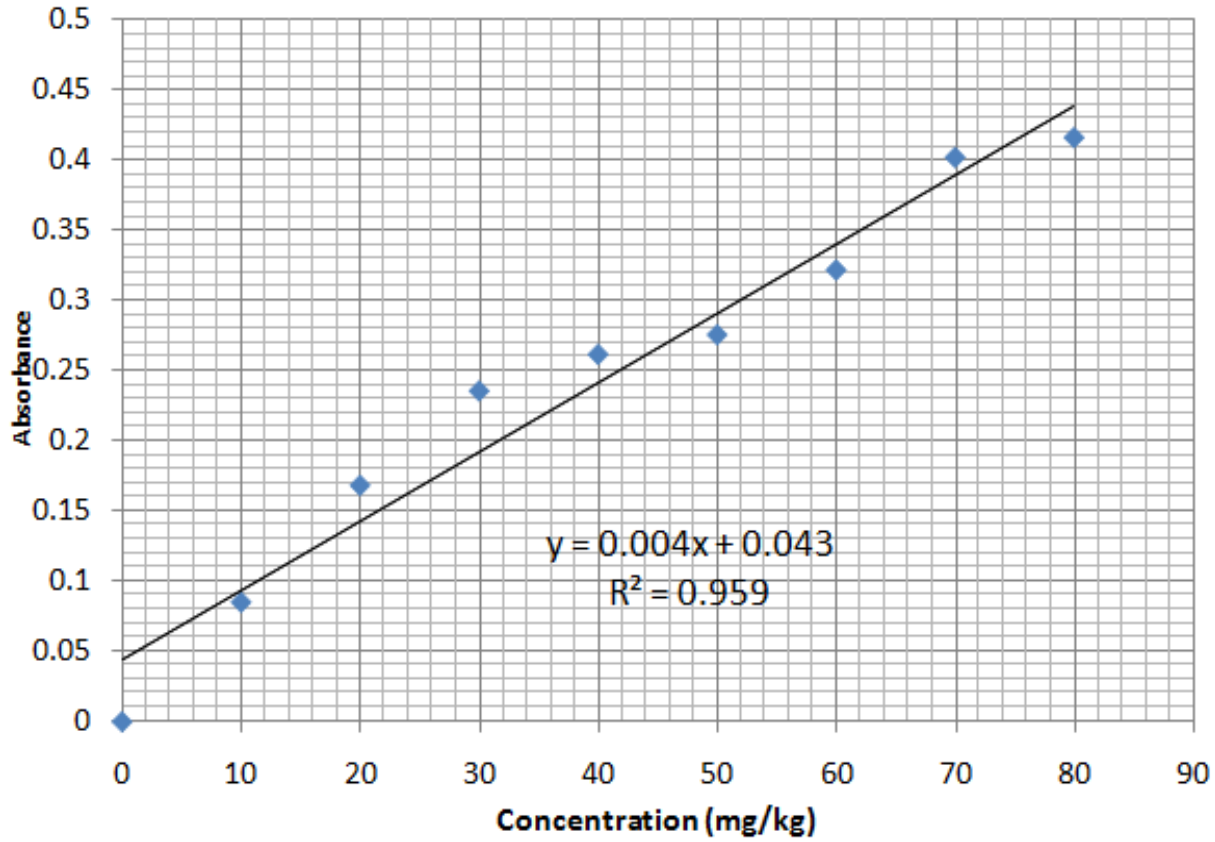

Fig. 2: Calibration curve for the determination of bromate

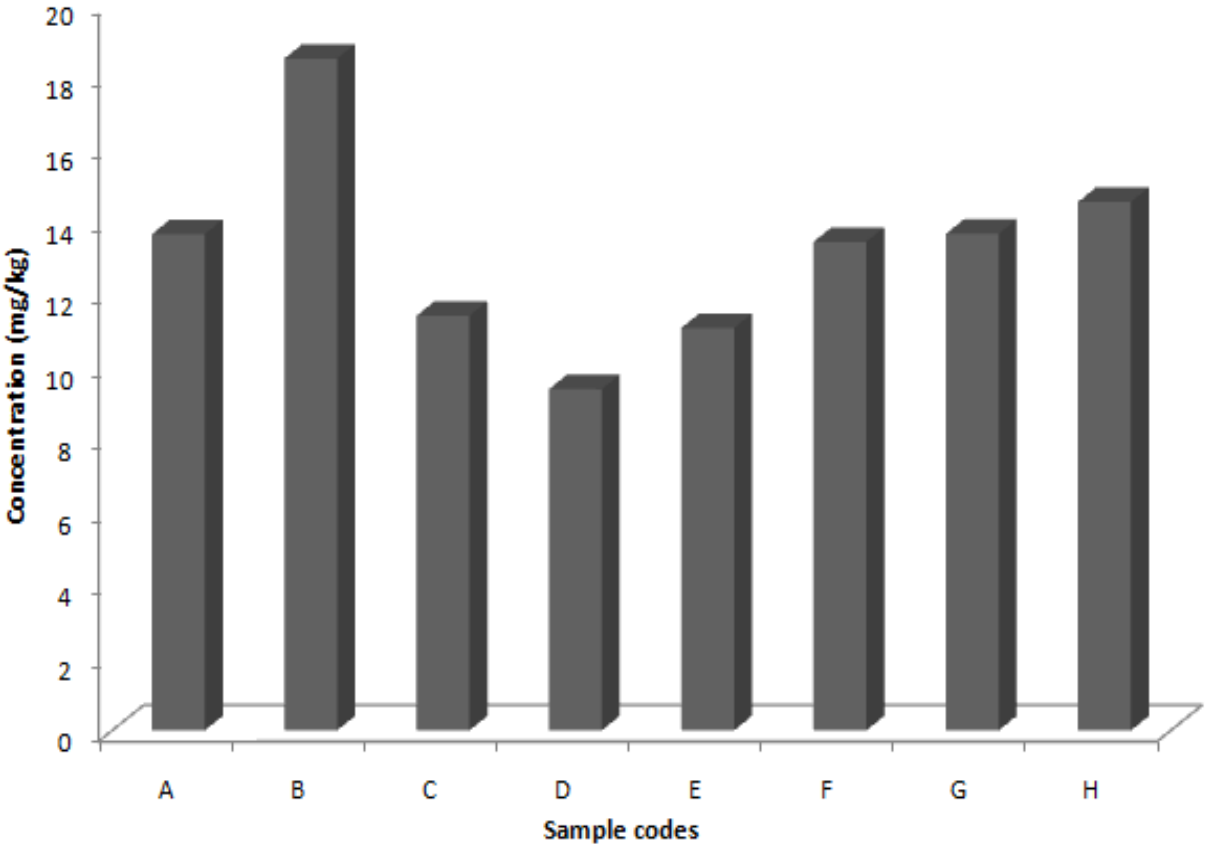

Fig. 3: Graphical presentation of concentration of bromate in bread

The level of potassium bromates in the bread samples obtained in this study is similar to the 3.7 and 12.0 µg/g for the lowest and highest level of potassium bromate found in bread samples consumed in Kaduna metropolis as reported by Ojeka *et al.* (2006). However, it is slightly different from the values of 1.2 and 10.4 µg/g minimum and maximum quantity of potassium bromate respectively, obtained from bread samples analyzed in Eastern part of Nigeria by Emeje *et al*. (2009). Considering the high amount of potassium bromate found in the analyzed bread samples and coupled with the fact that bread is a staple food consumed on a daily basis by residents of Jos irrespective of their socio economic status, we can conclude that there is high dietary exposure of Jos residents to potassium bromate through bread consumption. Also the workers in the bakery where these bread loaves are baked are also exposed to additional risk from inhaled bromate.

Consequently there may be future occurrence of carcinogenicity and other symptoms associated with chronic exposure to high level of potassium bromate in this community. The presence of bromate in bread samples also implies that the compliance with NAFDAC ban on the use of potassium bromate in bread is poor and the regulatory agency need to step up their surveillance and enforcement of this law.

Potassium bromates added to bread is harmful to consumers because it has been associated with neuro- and nephro-toxicity (Kurokawa *et al*. 1990), Ototoxicity (Diachenko and Warner 2002), and it poses additional risk to the health of bakery workers as potassium bromide, which is a productof thermal decomposition of potassium bromate is also toxic.

In addition, potassium bromate reduces the nutritional quality of bread by degrading essential vitamins such as vitamin A, B and E (Joint FAO/WHO, 1992). Oloyede and Sunmonu (2009) also reported adverse effects on liver and kidney function of rats fed on diet formulated with bread containing potassium bromate.

In view of the many adverse effects of potassium bromate, other oxidizing agents such ascorbic acid, that is nontoxic and equally enhances the quality and value of bread can be used in place of potassium bromate. Also, an enzyme such as hemicellulase (volume enhancing), glutathione oxidase (protein strengthening) and exo-pepptidase (improves colour and flavour) can also be used.

Conclusion

In conclusion, it has been established that bakeries are still using bromate to bake bread inJos metropolis. Therefore, there is a need for routine check by the regulatory authorities in order to ensure that bakers always comply with the rules and regulations so as to safeguard the lives of theirconsumers.

This research was carried out on bread considered to be of high quality in Jos. To obtain a more extensive results, researchers should further look at other lower quality bread in Jos metropolis and beyond to enable them identify the bromate contents of common bread in Nigeria with a view to alert the Federal Ministry of Health on a more strict enforcement of the law prohibiting the use of bromate in bread making and continuous monitoring to enhance the safety of consumers. The general public should also be sensitized about the health implications associated with the consumption of potassium bromate, this will make them patronize only bromate free bread like sample (I) and even possibly choose homemade bread.

The Federal Government through its regulatory agencies such as the Standard Organization of Nigeria (SON), the National Agency for Food and Drug Administration and Control (NAFDAC) should wake up to their responsibilities by sanctioning erring bakers to serve as a deterrent to others and to safeguard the lives of the citizens.

Conflict of Interest

The authors declare that there is no conflict of interest related to this work.

References

Akunyili N. D. (2005). Eradication of potassium nitrate from Nigeria bakery industry. *NAFDAC* 5: 1-6.

Atkins DP 1993. Potassium Bromate in Bread. Index to MAFF-UK Food Surveillance Information Sheets.

Cogswell T 1997. The use of potassium bromate. *Am. Soc. Bakery Eng. Bull*., 240: 5-7.

Diachenko GW & Warner CR 2002. Potassium bromate in bakery products: Food technology, toxicological concerns, and analytical methodology. In: Bioactive Compounds in Foods. ACS Symp. Ser. 816.p 218.T.-C Lee and C.-T Ho eds. American Chemical Society, Washington, DC.

Ekop AS, Obot IB & Ikpat EN 2008. Anti-nutritional factors and potassium bromated content in bread and flour samples in Uyo Metropolis, Nigeria. *E-Journal of Chemistry*, 5: 736-741.

Emeje MO, Ofoefule SI, Nnaji AC, Ofoefule AU & Brown SA 2009. Assessment of bread safety in Nigeria: Quantitative determination of potassium bromate and lead. *Afr. J. Food Sci.*, 4(6): 394-397.

IARC 1986. Potassium bromate. International Agency for Research on Cancer (IARC): Monograph Evaluating Carcinogenic Risk to Humans, 40: 207–220.

Joint FAO/WHO 1992. Expert Committee on Food Additives.Evaluation of certain food additives and contaminants. World Health Organization, Geneva, pp. 25-30.

Kurokawa Y, Maekawa A & Takahashi M 1990. Toxicity and carcinogenicity of potassium bromate: A new renal carcinogen. *Environ. Health Perspectives*, 87: 309-315.

Ojeka EO, Obidiaku ML & Enukorah C 2006. Spectrophotometric determination of bromate in bread by oxidation of dyes. *J. Appl. Sci. Envtal. Mgt*., 10(3): 43-46.

Oloyede OB & Sunmonu TO 2009. 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, 47(8): 2067-70.

Vicki S 1997. Bromate Analysis. *Food Sci. Technol. Bull.*, p. 240.

Zeryawkal E & Ariaya H 2012. Determination of potassium bromate in bread samples from five bakeries in Addis Ababa, Ethiopia. *Int. J. Pharmacy and Ind. Res.*, 2(4): 397-399.