



Assessment of Bread in Ogbomoso Metropolis for the Presence of Potassium Bromate

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Authors' contributions

This work was carried out in collaboration among all authors. Author AIA designed the study, performed the statistical analysis and wrote the draft of the manuscript. Author EOA wrote the protocol. Authors OOA and EOO managed the analyses of the study. Authors OCN and CE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study is aimed at evaluating the level of potassium bromate in bread in Ogbomoso metropolis.

Study Design: This study was made to fit a one way Analysis of Variance (ANOVA).

Place and duration of Study: The bread samples were purchased in Ogbomoso metropolis and analyzed in Ibadan, both in Oyo State, Nigeria between July and December, 2018.

Methodology: Twenty five loaves of different brands of bread were purchased in Ogbomoso metropolis and transported to Ibadan for analysis. They were analyzed qualitatively and quantitatively for the presence of potassium bromate. The qualitative test was performed directly on a portion of each bread sample using 2 ml of 0.01 M promethazine and 0.6 ml of 12 M hydrochloric

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acid. The change in colour of each bread sample to purple indicates the presence of potassium bromate. Quantitative determination was done using spectrophotometric method that is based on the redox reaction between bromate and promethazine hydrochloride in an acidic medium. The absorbance of the product was read at 620 nm.

Results: Only one out of the 25 bread samples analyzed in this study representing 4.00 % contain potassium bromate under the permissible level. One of the bread samples contains 10.12 µg/g of potassium bromate which is more than 500 times higher than the permissible level. The quantity of KBrO₃ in each bread sample correlates with the degree of purple colour obtained in the qualitative test.

Conclusion: Since 96.00% of the sampled bread contained potassium bromate in concentrations above safe level for human consumption, bread consumers and bakers are at risk of exposure to potassium bromate with health implications. The need for continuous surveillance and enforcement of the ban on use of potassium bromate in baking industry in Nigeria is recommended.

Keywords: Bread; carcinogenicity; NAFDAC; Ogbomoso; potassium bromate.

1. INTRODUCTION

A bromate is a chemical compound (a salt or ester) containing the reactive group BrO₃ [1]. Bromate anion, (BrO₃⁻) is a bromine–base oxo-anion. Examples of bromates include sodium bromate and potassium bromate. Both sodium bromate and potassium bromate are white crystalline substances that are readily soluble in water [2]. The molecular formula of potassium bromate is KBrO₃, while molecular weight is 167.01 g. It is slightly soluble in alcohol and insoluble in ether. Potassium bromate is produced by passing bromide into a solution of potassium hydroxide. However, for large scale production of potassium bromate an industrial electrolytic process is used. All over the world, where bakery products form a major part of household foodstuff, potassium bromate is used as a flour improver where it acts as a maturing agent. Potassium bromate is a popular food additive which has been used by the baking industry for over a century. It has been in use in baking since 1914 when patent was issued by United states patent office, (Gelroth) [3,4].

Potassium bromate acts principally in the last dough stage giving strength to the dough during late proofing and early baking process, (Mehmet) [5]. It has been reported to reduce the antioxidant power of red cells and also to induce oxidative stress and other related problems [5,6]. World Health Service (WHO) evaluates the bromate moiety under the WHO Guidelines for drinking water quality and again concluded that “The weight of evidence from rat bioassays clearly indicates that bromate has the potential to be a human carcinogen” [7]. The use of potassium bromate in flour milling and baking was banned in Nigeria by National Agency for food, drug and control (NAFDAC) in 2003 and its use infringes

on the drug and related products registration decree 20 of 1990 and NAFDAC Decree 15 of 1993 [8].

Bread is an important source of food prepared by cooking dough of flour and water, and possibly more ingredients. Dough is usually baked but in some cuisines, breads are steamed, fried or baked on an uncoiled skillet. It may be leavened or unleavened salt, fat and leavening agents such as yeast and baking soda are common ingredients. Though bread usually contains several ingredients that would help improve the quality of the bread. Some of the basic identified ingredients apart from flour include: table salt, sugars, flavours and at least a flour improver such as potassium bromate [9]. Other ingredients may also include milk, egg, spice, fruit (such as raisins), vegetables (such as onions), nuts (such as walnuts) or seeds (such as poppy-seeds). The ever-growing popularity of bread may be connected with its convenience, high acceptability, high energy content and low level of blood cholesterol associated with its consumption [10]. Water and flour are the major component in a bread recipe. They affect the bread texture and crumb properties. Over the years, several improvers have been used but studies have shown some to be deleterious to health, thereby necessitating their ban. 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. It acts as a slow oxidizing agent throughout the fermentation proofing and baking process affecting the structure and the rheological properties of the dough. As a result, many bakeries use potassium bromate as an additive to assist in the raising process and to produce a texture in the finished product that is appealing to the public [11]. Using

bromate as bread improver in Nigeria has been banned by NAFDAC in 2003. However, some bread makers have continued to include potassium bromate in their bread. This study is therefore aimed at investigating the level of compliance to this ban by bakery industry in Ogbomoso metropolis.

2. MATERIALS AND METHODS

2.1 Study Area

Ogbomoso is a city in Oyo State, south-western Nigeria, on the A₁ highway. It was founded in the mid-17th century. The population was approximately 645,000 in 2006 census. The majority of the people are members of the Yoruba ethnic group [12]. Ogbomoso is an urban centre and the production and consumption of bread is very high.

2.2 Methods

A total of twenty-five brands of breads were used in this study. They were purchased randomly from bakeries, bus stops, and markets in Ogbomoso metropolis and transported to Ibadan for analysis. Potassium bromate in the bread samples was qualitatively and quantitatively analyzed using previously reported methods [13]. A 1.0 g quantity was weighed out from each bread sample in an electronic weighing balance. This was transferred into a 250 ml test tube. 10 ml of distilled water was added; the mixture was shaken with a vortex mixer for 1 minute and allowed to stand for 20 minutes at $28 \pm 10^\circ\text{C}$. A 5.0 ml volume was decanted from the test tube. A 5.0 ml quantity of freshly prepared 0.5 % potassium iodide solution in 0.1 N hydrochloric acid was added. Any colour change was noted. The presence of potassium bromate was indicated by change in colour from light yellow to purple [13]. The absorbance of the sample was taken at 620 nm in a spectrophotometer (CAM-Spec. M330). Absorbance of the sample was converted to concentration with reference to Beer's calibration curve previously constructed for potassium bromate using the pure sample [13]. Values presented are mean of five replicate determinations.

3. RESULTS AND DISCUSSION

Bread is a baked staple food made from wheat flour. It is widely consumed in all parts of Nigeria among all socioeconomic groups. Potassium

bromate complexed with potassium iodide to give a purple colouration. Potassium bromate in bread reacts with promethazine hydrochloride in the acidic medium to form a pink colour product [14]. The colour change ranged from light purple to dark purple with increase in concentration. The intensity of colour change correlates with the concentration of potassium bromate present in the sample [15]. A result showing the qualitative analyses (colour identification) of potassium bromate of the twenty-five bread samples is presented in Table 1. Three of the twenty-five bread samples (samples A, J and O) analyzed representing 12.00 % did not show any visible colour change when they were treated with potassium iodide. It is possible that they contained no potassium bromate or that potassium bromate was present in the samples in residual amount that could not be detected by the reagent. Four of the 25 bread samples (samples F, L, U and X) analyzed representing 16.00% showed light purple when treated with potassium iodide. This might be due to minute level of KBrO_3 in them and cannot react with the reagent extensively [16]. All the other samples indicated positive result for the presence of potassium bromate to varying degrees. Table 1 also shows the quantitative amount of potassium bromate found in each sample. The amount of potassium bromate in twenty-four out of the twenty-five bread samples analyzed representing 96.00 % is higher than $0.02 \mu\text{g/g}$, which is the permissible safe level of potassium bromate allowed in bread by the United States' Food and Drug Agency (FDA) [17] and it also contravenes the NAFDAC ban on use of potassium bromate in bread [8]. Only one out of the 25 bread samples analyzed in this study representing 4.00% contain potassium bromate under the permissible level. This implies that, only one out of the 25 bread samples in Ogbomoso analyzed in this study is safe for human consumption as far as potassium bromate content is concerned. One of the bread samples contains $10.12 \mu\text{g/g}$ of potassium bromate which is more than 500 times higher than the permissible level. This could really be dangerous to human health.

One interesting but contradicting finding of this study is that the bread samples with "bromate free" in their labels actually contain higher potassium bromate concentrations than those without such inscription on their labels. This is similar to the study of Airaodion et al. [18] who reported the evaluation of potassium bromate in bread in Ibadan Metropolis fifteen years after ban

Table 1. Qualitative and quantitative determination of potassium bromate in some brands of bread produced and/or sold in Ogbomoso, Nigeria

Bread samples	Colour change (qualitative test)	Quantity of KBrO ₃ (µg/g)
A	No Visible Colour Change	0.96 ± 0.12
B	Purple	4.96 ± 0.40
C	Dark Purple	9.88 ± 1.38
D	Purple	5.76 ± 0.25
E	Purple	7.89 ± 0.39
F	Light Purple	3.46 ± 0.70
G	Purple	6.00 ± 0.89
H	Purple	5.69 ± 0.28
I	Purple	3.66 ± 0.23
J	No Visible Colour Change	1.08 ± 0.15
K	Purple	5.66 ± 0.25
L	Light Purple	2.53 ± 0.28
M	Purple	5.46 ± 0.30
N	Dark Purple	8.82 ± 0.93
O	No Visible Colour Change	0.02 ± 0.05
P	Dark Purple	10.12 ± 1.53
Q	Purple	6.24 ± 0.31
R	Purple	5.18 ± 0.22
S	Dark Purple	8.12 ± 0.25
T	Purple	5.48 ± 0.37
U	Light Purple	3.82 ± 0.18
V	Purple	6.03 ± 0.33
W	Purple	6.00 ± 0.91
X	Light Purple	2.34 ± 0.52
Y	Purple	3.98 ± 0.29

Values are presented as mean ± standard deviation. n = 5.

Letter A to Y represents the code for different loaves of bread sample analyzed

in Nigeria. This shows the level of insincerity in the bakery industry not just in Ogbomoso metropolis but in Nigeria at large.

Eleven of the twenty-five bread samples used in this study representing 44.00 % are not registered with the National Agency for Food, Drug Administration and Control (NAFDAC), the agency responsible for regulating drugs, foods and chemicals in Nigeria as they had no NAFDAC registration number on their label while some had no label at all. Since they are not registered with the regulatory body, there is no way they could comply with the regulations of the body. Four of the twenty-five bread samples used in this study representing 16.00% had no label in them. This might also mean that they are not registered with NAFDAC [18].

The level of potassium bromate in bread samples obtained in this study is similar to the 1.2 µg/g and 10.4 µg/g for the lowest and highest level of KBrO₃ obtained from bread samples analyzed in Eastern part of Nigeria by Emeje et al. [19]. It is also similar to the finding of 1.24 µg/g and 9.31

µg/g for the lowest and highest level of KBrO₃ obtained from bread samples analyzed in Ibadan metropolis by Airaodion et al. [18]. However, it is lower than the values of 3.7 µg/g and 12.6 µg/g, minimum and maximum quantity of potassium bromate respectively, found in bread samples consumed in Kaduna metropolis as reported by Ojeka et al. [15]. 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 Ogbomoso irrespective of their socio-economic status, we can conclude that there is high dietary exposure of Ogbomoso residents to potassium bromate through bread consumption. Also the workers in the bakery where these breads 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 Ogbomoso. Apart from deliberately adding potassium bromate to bread to improve the product, potassium bromate is also found to be present in water. Bakery industry should be

mindful of the source of water used in bread production.

The presence of bromate in bread samples also implies that the compliance of bakery industry with NAFDAC ban on the use of potassium bromate in bread after fifteen years is poor and the regulatory agency need to step up their surveillance and enforcement of this rule. Potassium bromate added to bread is harmful to consumers of bread because it has been associated with neurotoxicity and nephrotoxicity [20], as well as ototoxicity [21], and it poses additional risk to the health of bakery workers as potassium bromide, a heat decomposition product of potassium bromate, is also toxic [22]. In addition, potassium bromate reduces the nutritional quality of bread by degrading essential vitamins such as vitamin A, B and E [23].

Oloyede and Sunmonu [24] also reported adverse effects on liver and kidney functions of rats fed on diet formulated with bread containing potassium bromate. In a study by Ayo et al. [25], ascorbic acid compared favourably with potassium bromate in improving the loaf volume of bread. On an equivalent cost basis, ascorbic acid can be considered a more effective improver even though bromate can achieve a higher loaf volume on equivalent weight basis. In view of the many adverse effects of $KBrO_3$, other oxidizing agents, such as ascorbic acid, that is non-toxic and equally enhances the quality and value of bread can be used in place of $KBrO_3$. Also enzymes such as hemicellulases (volume enhancing), glutathione oxidase (protein strengthening) and exopeptidase (improves colour and flavour) can equally be used [16].

4. CONCLUSION

It was observed in this study that 96.00 % of the bread samples analyzed contain potassium bromate above permissible limit, therefore bread consumers and bakers in Ogbomoso metropolis and indeed Nigeria are at risk of exposure to potassium bromate with health implications. Bakers should ensure that appropriate hygiene and proper water treatment are maintained in and around facilities where bread is produced. This study also underscores the importance of routine checks by the regulatory authorities in order to ensure that bakers always comply with rules and regulations in order to safe guard the life of unsuspecting Nigerians.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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