



## Comparison of Potassium bromate (KBrO<sub>3</sub>) Content in Bread of Nigeria and Niger Republic

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### ABSTRACT

It is estimated that 92 % of Nigerian bread contains potassium bromate (KBrO<sub>3</sub>) despite its banned in bread in 2004. However, many bakers still use it as an additive in bread although it's harmful on human health. It is, therefore, worthy of evaluating and comparing the KBrO<sub>3</sub> content of Nigerian bread and that of Niger republic. The method of evaluation used to estimate the content in this research was the spectrophotometric method. The result of qualitative test revealed that none of the bread contained KBrO<sub>3</sub> from Niger republic while all the Nigerian samples showed positive to the test. The quantitative analysis on the Nigerian bread sample further reveals significant variations ( $p < 0.05$ ) in the concentration of bread from different bakeries in Kamba metropolis, Kebbi State, Nigeria. The concentrations of bread sample A – E obtained in Kamba are 20.32, 11.67, 11.13, 9.86 and 5.54 µg/g, respectively. The bromate content in the Nigerian bread is above permissible level (0.02µg/g) set by the National Agency for Food Drug Administration and Control (NAFDAC).

**Keywords:** Bread, Potassium bromate, Spectrophotometer, Carcinogen and Mutagen

### INTRODUCTION

Potassium bromate (KBrO<sub>3</sub>), is a flour improver and an oxidizing agent that improves the elasticity of dough, it cause bread to rise and become white, fluffy and soft baking (Ekere *et al.*, 2020). It also acts as a maturing agent and dough conditioner by oxidizing the sulfhydryl groups of the gluten protein in flour into disulphide bridges, making it less extensible and more elastic (Airadion *et al.*, 2019). As a result, the dough becomes more visco-elastic and can retain carbon dioxide gas produced during the fermentation of sugar by the yeast, such that it can increase loaf volume and texture (Magomya *et al.*, 2020). During baking of bread containing potassium bromate, the concentration of KBrO<sub>3</sub> is reduced to potassium bromide (KBr).

$2\text{KBrO}_3 \xrightarrow{200-250^\circ\text{C}} 2\text{KBr} + 3\text{O}_2$ . This reduced the negative effect of the bromate. However, if the concentration of potassium bromate is high or the bread is baked at low temperature or at short period of time (15 to 20 min.), un decomposed quantity of the bromate can be consumed and manifest its negative effect (Mahmud *et al.*, 2021). Gav *et al.* (2019) reports potassium bromate to degrade nutritional quality of bread such as 3,4-dehydro-retinol (Vitamin A<sub>2</sub>), thiamin (Vitamin B<sub>1</sub>), riboflavin (vitamin B<sub>2</sub>), trimetyltocol (vitamin E) and niacin. International Agency for Research on Cancer classified potassium bromate KBrO<sub>3</sub> as a category 2B carcinogen and also a mutagen (Magomya *et al.*, 2020). Abdominal pain, cough, diarrhoea, hearing impairment, kidney failure, nausea, sore throat, vomiting

bronchial and ocular problems are common symptoms of bromate poisoning (Aletan, 2020). The lethal dose of KBrO<sub>3</sub> has not been precisely determined but Muhmud *et al.* (2021) estimated lethal (5 to 500 mg/kg body weight) dose for human.

Nigeria banned the use of potassium bromate above the concentration of 0.02 mg/Kg in 2004. However, it is estimated that, 92 % of the bread produced in Nigeria contained potassium bromate above standard limit. It is therefore, worthy to compare between the bromate content of Nigerian bread (Kamba Local Government, Kebbi State, Nigeria) and the neighbouring country (Gaya, Doso Local Government, Niger Republic), to evaluate the level of compliance in the use of Potassium bromate in both countries. The aim of this research is to evaluate the level of the potassium bromate content of bread of two neighbouring countries (Nigeria and Niger Republic) using spectrophotometric method.

### MATERIALS AND METHODS

Five bread samples (three each) from different bakeries were purchased from Kamba Local Government Area, Nigeria and the other five from Gaya, Doso area Council, Niger Republic. Each bread sample was transported to the Pure and Industrial Chemistry Department, Federal University, Birnin-Kebbi for analysis. The Nigerian bread was coded A, B, C, D and E, while the

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Niger Republic bread was coded F, G, H, I and J. The centre (whitish part) of each bread was taken and dried in an Oven at 105 °C, to a constant mass, pulverized with porcelain motor and pestle to powder and kept in a polythene bag till required for analysis.

The method of Alli *et al.* (2013) was used for the quantitative and qualitative analysis. The qualitative test was performed by directly adding to the (inner portion) of each sample a mixture of promethazine (C<sub>17</sub>H<sub>20</sub>N<sub>2</sub>S) solution (0.01 M) and Conc. hydrochloric acid (HCl) in the ratio of 2:1. The change in colour to Pink indicates the presence of potassium bromate.

A quantity of potassium bromate (0.1 g) was dissolved in 100 cm<sup>3</sup> of distilled water to obtain stock solution of 1 mgcm<sup>-3</sup>. Series standards were prepared by taking 0.00, 1.00, 2.00, 3.00, 4.00, and 5.00 cm<sup>3</sup> of the stock solution in a test tube and made each test tube to the level of 8 cm<sup>3</sup> using distilled water. 1 cm<sup>3</sup> of each promethazine solution

(0.01 M) and 0.2 cm<sup>3</sup> (12 M) conc. HCl was added, and finally, complete the volume to 10 cm<sup>3</sup> by adding distilled water. The absorbance of the mixtures was measured at 515 nm against a blank reagent. The result obtained was used to plot the calibration curve.

Bromate was quantitatively determine from each powdered bread by taking 5 g in a clean 250 cm<sup>3</sup> followed by the addition of 20 cm<sup>3</sup> distilled water. The mixture was stirred thoroughly using a spatula and filtered using a Whatman No.1 filter paper. 8 cm<sup>3</sup> of the filtered solution were transferred into a 20 cm<sup>3</sup> volumetric flask, followed by the addition of 1.0 cm<sup>3</sup> promethazine (0.01 M) and 1.0 cm<sup>3</sup> conc. HCl (12 M). The mixture was shaken for a minute, and the absorbance of the coloured solution obtained was measured using a spectrophotometer at 515 nm. The concentration of the bromate content was calculated from the equation of the standard curve of potassium bromate. The concentration of BrO<sub>3</sub><sup>-</sup> content in the sample is calculated according to equation 1.0

$$\text{BrO}_3^- (\mu\text{g/g}) = \frac{\text{Conc. of Aliquot } (\mu\text{g}) * \text{Aliquot } (\text{cm}^3)}{\text{Volume of Solution } (\text{cm}^3) * \text{Sample Weight } (\text{g})} \dots\dots\dots 1.0$$

The results obtained from the analyses were reported as mean ± standard deviation of triplicate values. One way ANOVA was performed to identify significance differences among means at 5% confidence level.

**RESULTS AND DISCUSSION**

The qualitative and quantitative results of the analysis are presented in Table 1. The concentration of bromate in Kamba (Nigeria) bread significantly differ (p < 0.05) from one another.

**Table1:** Result of qualitative and quantitative tests of the bread samples

Sample	Quantitative Test (µg/g)	Inference
A	20.32±0.12 <sup>a</sup>	Positive
B	11.67±0.07 <sup>b</sup>	Positive
C	11.13±0.12 <sup>c</sup>	Positive
D	9.86±0.17 <sup>d</sup>	Positive
E	5.54±0.05 <sup>e</sup>	Positive
F	Not Detected	Negative
G	Not Detected	Negative
H	Not Detected	Negative
I	Not Detected	Negative
J	Not Detected	Negative

The result is expressed as the mean ± standard deviation of triplicate analysis. Values in the same column with the same superscripts are not significantly different (p>0.05).

Table 1 indicates the result of qualitative and quantitative tests of the bread samples. The qualitative test indicates positive (pink colour) to all Nigerian bread sample while the Niger republic samples (f–J) show negative results, indicating the absence of potassium bromate or presence at very low concentration. However, some Nigerian bread was reported to contained bromate. The study confirms the report of Emeje *et al.* (2010) that, 92 % of the Nigeria bread samples contained potassium bromate.

The quantity of bromate in Nigerian bread was estimated using the spectrophotometric method. The estimated quantity of the bromate (20.32 µg/g) in sample A was significantly higher (p < 0.05) than all the four samples. The least (5.54 µg/g) quantity was noticed in sample E. The

range (5.54 to 29.32 µg/g) of values obtained in this research is greater than the range (1.4 to 5.1 µg/g) reported by Kelle (2017) and (0.5 to 8.4 µg/g) Johnson *et al.* (2013) but less than the range (11.3 to 24.62 ppm) reported by Singh *et al.* (2020). The result is above (0.02 µg/g) the standard limits of the National Agency for Food Drug Administration and Control (NAFDAC) for potassium bromates in bread (Ugochukwu *et al.*, 2019). The presence of detectable levels of potassium bromate in bread is undesirable due to its long-term effect (Ojeka *et al.*, 2006). Joint Food and Agriculture of United Nation and World Health Organization (FAO/WHO, 1992) committee’s initial recommendation of an acceptable level of 0 to 60 mg KBrO<sub>3</sub>/kg flour was withdrawn because long term toxicity and carcinogenicity-based studies of *in vitro* and *in vivo* revealed renal cell tumours in hamsters. Nigeria banned the use of potassium bromate in 2004 (Singh *et al.*, 2020).

However, many kinds of literature reveal the use of  $KBrO_3$  as an additive in Nigerian bread. The level of the bromate content in this research may cause harm to the consumers.

The results of this study indicate that  $BrO_3^-$  content of Nigerian bread is above the permissible limit of NAFDAC; it is, therefore, unsafe for consumption. It also indicates that many bakeries in Nigeria do not comply with the law that stop the use of  $BrO_3^-$  in bread which its negative effect may be noticed to the consumers while in the bread of Niger republic, the  $BrO_3^-$  is either not added or is use below the detectable level.

The regulatory agency of Nigeria NAFDAC is recommended to intensify efforts to ensure bakeries stop using potassium bromate in bread making by employing of staff to regular inspection of bakeries. The use of non-toxic alternatives that can improve the quality of bread, such as glutathione oxidase (protein strengthening), enzymes such as hemicellulases (volume-enhancing), ascorbic acid, and exo-peptidase (improves colour and flavour), should be encouraged in Nigeria.

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