



## Laboratory assesment and statistical evaluation of potassium bromate content in bread samples from six states of North-Eastern, Nigeria

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### Abstract

The research studied potassium bromate concentration of twenty selected bread samples sold in north eastern part of Nigeria. The samples were randomly obtained from open markets, bus stops, tea sellers, bread vendors and eateries. Qualitative and quantitative assessments of potassium bromate in the bread samples were carried out. Results showed that quantitative evaluation of potassium bromate ranged from  $0.875 \pm 0.001$  to  $4.051 \pm 0.002$   $\mu\text{g/g}$ . Also, the qualitative and quantitative results for the twenty bread samples correlated very well with only 65 % of the samples containing potassium bromate within the safe limits recommended by SON and National Agency for Food, Drug Administration and Control (NAFDAC). Regulatory authorities should conduct periodic inspections to ensure that bakers are always complying with the rules and regulations governing bread production in Nigeria. This implies that consumers of the bread brands studied and sold in the Northeast face potential health risks associated with ingestion of bromates.

**Keywords:** Potassium bromate, NAFDAC, quantitative and qualitative

### Introduction

Bread is a staple food produced from wheat flour widely consumed by socio-economic groups in Nigeria (Alli *et al.*, 2013 <sup>[6]</sup>; Eke *et al.*, 2013) <sup>[7]</sup>. According to Adebayo-Oyetoro *et al.* (2016) <sup>[2]</sup>, bread has become the second most consumed non-indigenous food after rice in Nigeria. They further reported that bread is consumed in homes, restaurants, construction sites, factories and hotels in both developed and developing countries. It is relatively expensive because it is made from imported wheat, which is not grown in the tropics for climatic reasons (Edema *et al.*, 2005). Bread is always one of the most popular and attractive food products thanks to its outstanding nutritional properties, sensory feel, instant texture as well as its competitiveness in price (Tiimub, 2013) <sup>[16]</sup>. Ibodapo *et al.* (2019) <sup>[11]</sup> stated that bread is an important source of nutrients that are believed to have provided humans with an essential element for many centuries in many parts of the world. bread provides a significant portion of the nutrients required for growth, maintenance of health and well-being (Okafor *et al.*, 2012; Tiimub 2013) <sup>[16]</sup>. It is a grain product that is naturally low in protein and does not constitute a balanced diet because it contains little lysine, an essential amino acid (Nwanekezi, 2013) <sup>[15]</sup>. bread often contains a number of ingredients that can help improve quality. Some of the basic ingredients identified, in addition to flour, are table salt, sugar, flavoring and at least one flour improver such as potassium bromate (Emeje *et al.*, 2010). Potassium bromate (KBrO<sub>3</sub>), is a flower improver and oxidant that improves dough elasticity, it makes bread rise and makes

bread white, soft and chewy (Ekere *et al.*, 2020) <sup>[8]</sup>. It also acts as a ripening agent and dough conditioner by oxidizing the sulfhydryl groups of gluten proteins in flour to disulfide bridges, making it less stretchable and more elastic (Airadion *et al.*, 2019) <sup>[3]</sup>. As a result, the dough becomes more viscous and can retain carbon dioxide produced during the fermentation of sugar by yeast, so it can increase the volume and texture of the bread (Magomya *et al.*, 2020) <sup>[13]</sup>. When baking bread containing potassium bromate, the concentration of KBrO<sub>3</sub> is reduced to potassium bromide (KBr).  $2\text{KBrO}_3 \rightarrow 2\text{KBr} + 3\text{O}_2$ . This reduces the negative effects of bromate. However, if potassium bromate concentrations are high or if bread is baked at low temperatures or for short periods of time (15 to 20 minutes), may consume some of the decomposed bromate and exhibit effects its negative. Gav *et al.* (2019) <sup>[10]</sup> reported that potassium bromate degrades the nutritional quality of bread, such as 3,4-dehydro-retinol (vitamin A2), thiamine (vitamin B1), riboflavin (vitamin B2), trimethyltocol (vitamin E) and niacin. The International Agency for Research on Cancer has classified potassium bromate KBrO<sub>3</sub> as a class 2B carcinogen and may also be mutagenic (Magomya *et al.*, 2020) <sup>[13]</sup>. Abdominal pain, cough, diarrhea, hearing loss, kidney failure, nausea, sore throat, vomiting, bronchial and eye problems are common symptoms of bromate poisoning (Aletan, 2020) <sup>[5]</sup>. This discovery has led to many countries around the world banning the use of bromate in flour and baked goods. Countries that have banned the use of potassium bromate include: Argentina, Brazil, Canada, South Korea, United Kingdom, Australia, Peru and Uganda.

It was also banned in Sri Lanka in 2001, Nigeria in 2004 (Ekop *et al.*, 2008) [9]. China in 2005 and India in 2016. Countries such as the United States have not imposed a complete ban on for with the use of  $\text{KBrO}_3$  but instead set a maximum limit for its use. used as food additive. The maximum concentration of potassium bromates allowed by the US Food and Drug Administration (FDA) in bread is  $0.02 \mu\text{g/g}$  ( $0.02 \text{ mg/kg}$ ) (Ekop *et al.*, 2008). The Food and Agriculture Organization (FAO)/World Health Organization Expert Committee on Food Additives (JECFA) recommended in 1982 a maximum limit of 75 ppm ( $75 \mu\text{g/g}$ ) for the processing of wheat flour, provided that the bakery products resulting from such processing of wheat flour contain negligible  $\text{KBrO}_3$  residue. Northeastern Nigeria is a region in the northern part of the country. The region covers several states including Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe. These states together form the northeastern region of Nigeria. The research was aimed at laboratory assessment and statistical evaluation of potassium bromate content in bread samples from six states of north eastern Nigeria.

## Materials and Methods

### 1. Study Area

Geographically, the North East is the largest geopolitical zone in the nation, covering nearly one-third of Nigeria's total area. In terms of the environment, the zone is primarily divided between the semi-desert Sahelian savanna and the tropical West Sudanian savanna ecoregions. The region has a population of about 26 million people, around 12% of the total population of the country. Maiduguri and Bauchi are the most populous cities in the North East as well as the fifteenth and seventeenth most populous cities in Nigeria. Other large northeastern cities include (in order by population) Bauchi, Adamawa, Gombe, Taraba, Yobe and Borno States. It is known for its livestock and the growth of crops which contribute greatly to the economy of the country. The region is densely populated as compared to the southern region of the country.

### 2. Sample collection

four (4) different bread samples were purchased from market in Bauchi, Gombe, Adamawa, Taraba, Yobe and Maiduguri States.

### 3. Standard Preparation

Fifty (50 mg) of Potassium Bromate was dissolved in distilled water and diluted to  $1 \text{ dm}^3$ . 3210 mg of promethazine hydrochloric (PTZ) was dissolved in distilled deionized water and diluted to  $1 \text{ dm}^3$  of obtain stock solution of 0.01 M of promethazine hydrochloride (PTZ).

### 4. Sample Preparation

A quantity of 10 g was taken from the Centre of each loaf of bread and dried in oven for about an hour at  $75^\circ\text{C}$ . The dried crust was pulverized and 1 g of each powdered sample was weighed into a clean  $250 \text{ cm}^3$  beaker and  $20 \text{ cm}^3$  of distilled deionized water was added. The mixture was stirred thoroughly using spatula and filtered using a filter paper.  $8 \text{ cm}^3$  of the filtrate solution was transferred into a  $20 \text{ cm}^3$

volumetric tube and mixed with  $1 \text{ cm}^3$  of 0.01 M promethazine.  $0.2 \text{ cm}^3$  of 12 M hydrochloric acid was added; the mixture was shaken for 1 minute and used for analysis (Alli *et al.*, 2013) [6].

### 5. Qualitative Analysis of potassium bromate

A one gram of sample was weighed out and transferred into a test tube. 10 ml of distilled water was added and the mixture was shaken and allowed to stand for 20 minutes. A five (5 ml) volume was decanted from the test tube then 5 ml quantity of freshly prepared 1 % potassium Iodide solution in 0.1 M hydrochloric acid was added. Any color change was noted. The presence of potassium bromate was indicated by a change in color from light yellow to purple.

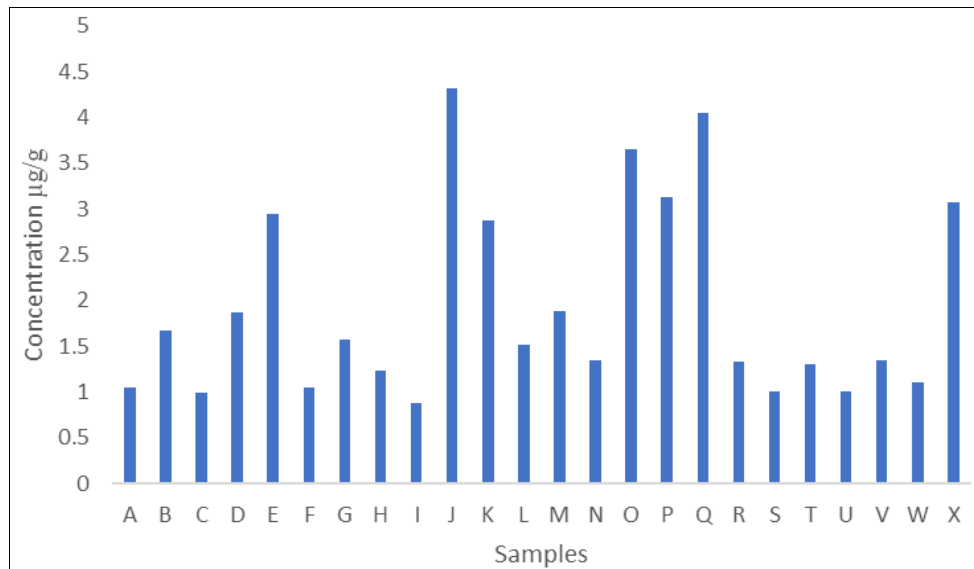
### 6. Quantitative Analysis of potassium Bromate

For quantitative determination of bromate, the absorbance of the samples prepared was taken at 620 nm using a UV-Vis spectrophotometer and converted to concentration via a standard calibration graph of Potassium bromate absorbance against concentration (Alli *et al.*, 2013) [6]. The standard calibration curve was prepared by dissolving 0.25 g of Potassium bromate ( $\text{KBrO}_3$ ) in  $250 \text{ cm}^3$  of distilled water. Different concentrations (0, 10, 20, 30, 40, 50, 60 ppm) were then prepared from the stock solution by serial dilution. A  $5 \text{ cm}^3$  quantity of freshly prepared 1 % of potassium Iodide solution in 0.1 N HCl was added to  $5 \text{ cm}^3$  of each pure sample and the absorbance was taken at 620 nm in accordance with the experimental conditions. The absorbance was plotted against the concentration values. The working graph thus obtained was used to estimate the concentration of bromate in the bread and flour samples.

## Results and Discussion

**Table 1:** Qualitative and Quantitative Determination of Potassium Bromate in Selected Bread Sample Sold in Northeastern Nigeria.

Sample Code	Color Change with Potassium Iodide (Qualitative Test)	Concentration of $\text{KBrO}_3$ ( $\mu\text{g/g}$ )
A	Dark purple	$1.056 \pm 0.001$
B	Light Purple	$1.679 \pm 0.002$
C	No visible change	$0.987 \pm 0.000$
D	Light purple	$1.871 \pm 0.005$
E	Light purple	$2.945 \pm 0.001$
F	No visible chnage	$1.045 \pm 0.004$
G	Dark purple	$1.568 \pm 0.001$
H	Purple	$1.234 \pm 0.000$
I	No visible change	$0.875 \pm 0.002$
J	Purple	$4.321 \pm 0.600$
K	Purple	$2.871 \pm 0.100$
L	Dark Purple	$1.511 \pm 0.008$
M	Dark Purple	$1.890 \pm 0.900$
N	Purple	$1.349 \pm 0.100$
O	Light Purple	$3.661 \pm 0.200$
P	Purple	$3.133 \pm 0.400$
Q	Dark Purple	$4.051 \pm 0.100$
R	Purple	$1.331 \pm 0.400$
S	No visible change	$1.011 \pm 0.500$
T	Purple	$1.301 \pm 0.001$
U	Dark Purple	$1.010 \pm 0.005$
V	Light Purple	$1.349 \pm 0.009$
W	Purple	$1.110 \pm 0.001$
X	Purple	$3.071 \pm 0.008$



**Fig 1:** Quantitative Concentration Potassium Bromate

Potassium bromate concentrations in the analyzed bread samples as presented in (Table 1). The observed values presented are the average of three replicate determinations. The sample with the lowest concentration of potassium bromate was sample C 0.875 µg/g to 4.051 µg/g sample A. the highest concentration of potassium was observed at Sample (4.051 µg/g). The Observed Potassium bromate level in bread samples from selected areas are much lower than reported literature values of 0.767 to 6.342 µg/g in Kwara Nigeria (Alege *et al.*, 2018) [4] and 0.945 to 11.876 µg/g in bread samples from Jalingo Nigeria (Abba *et al.*, 2019) [1], the experimental values of bread samples analyzed contained Bromate concentrations far exceeding the FDA's maximum permissible limits 0.02 µg/g (CSE, 2016). Sample I had the lowest bromate concentration (0.875 µg/g) which is higher than the FDA recommended level, while sample Q had the highest concentration (4.051 µg/g) which higher than FDA safety limits. This is therefore shows that bread samples obtained from these locations are not safe for human consumption. High concentration of bromate in bread is of concern because it poses a high risk to consumers of bread brands. Some of the harmful effects that can occur from consuming high amounts of bromate are abdominal pain, diarrhea, nausea, vomiting, kidney failure, oliguria, anuria, deafness, dizziness, hypotension, nervous system depression central nervous system and cancer (Alli *et al.*, 2013) [6].

Potassium bromate forms a complex with potassium iodide forming purple. The color change varies from light purple to dark purple with increasing concentration of potassium bromate. Only (I, S, F and C) four sample out of twenty-four bread samples analyzed representing 10 % showed no obvious color change when treated with potassium iodide, indicating the possibility that they do not contain potassium bromate or trace amounts of potassium. The residual bromate present in the samples was undetectable by the reagent. This finding supports the report by Kelle (2017) [12] that the bread samples showed no obvious color change does not contain potassium bromate or may be present in concentrations as low as below the limit of detection. Samples B, D, E, O and V representing 15% of the bread samples studied showed a light purple color when treated with potassium iodide. This may be due to the low content

of potassium bromate in the bread samples. Wordu and Akusu (2020) [17] reported that bread sample that had a light purple color after reaction with potassium iodide contained trace amounts of potassium bromate and could not react with reagent, largely supporting this finding. Six (A, L, U, G, Q and M) and Eight samples (J, K, N, O, P, R, T and W) out of 24 bread samples, were purple and dark purple, respectively, when treated with Potassium iodide. This finding indicates high levels of potassium bromate in bread samples.

### 1. Statistical Analysis

Single factor analysis variance (one-way analysis of variance) was carried out on each sample taken into consideration the sampling locations of Bauchi, Gombe, Adamawa, Taraba, Maidugu and Yobe States. The statistical analysis revealed that all the potassium bromates in the six location have no statistical significant difference at 95% confidence level. This is because the F computed was less than the F critical and therefore the results were not subjected to post-hoc test (LSD).

### Conclusion

Apparently potassium bromate is still widely used as a bread improver by Nigerian bakers. This study showed the presence of bromate in all bread samples analyzed. The main reason why  $KBrO_3$  is preferred over other alternatives is probably because is a cheap and very effective oxidizer that produces high quality bread. There is a need for regulatory agencies in Nigeria to conduct regular monitoring and enforce the ban on bromate in bread. In addition to enforcing the ban, it is important to educate bakers about safer alternatives. There are a number of other flour improvers and processors that are considered safer alternatives from a health perspective for example, ascorbic acid was considered a healthy alternative by experts Glucose oxidase is also a safer alternative known to function similarly to potassium bromate. There are a number of other flour processing additives that have been approved by law in many countries, these include ammonium persulfate, ammonium chloride and amylase. Bakers should be encouraged to use these alternatives to protect human health.

### Recommendations

1. All baking industries should ensure proper hygiene at all times
2. The use of pure sugar (Glucose) should be employed during mixing and baking process.
3. The use of potassium bromate must be totally avoided
4. Because they are carcinogenic in nature. Meaning that they causes cancer.
5. Proper sterilization method must be fully observed at all levels.
6. The use of recommended and certified ingredients and preservatives should be considered regularly.

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