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# Assessment of the Incidence of Potassium Bromate in Different Brands of Bread Sold in Tarauni, Nassarawa and Kumbotso Local Government Areas of Kano Metropolis, Nigeria

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**ABSTRACT**

Potassium bromate (KBrO3) is an oxidizing agent that has been used as a food additive, mainly in the bread making process. A method is proposed for the determination of bromate based on the oxidation of crystal violet dye in a hydrochloric acid medium. Application of spectroscopy for determining bromate in bread was employed to ascertain the incidence of potassium bromated in bread samples. Thirty samples of bread, made from flour treated with potassium bromate, were collected from tarauni, nassarawa and kumbotso local government areas of Kano Metropolis. The residual bromate level in the analyzed bread samples were in the range of 0.07ppm to 9.53ppm. This shows that all the brands of bread analyzed contain potassium bromate above the specified limit.

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## Introduction

Bread is a home food which is consumed by all and sundries. It is an important food of many countries of the world, especially in African countries, Asia and the western world [1]. It is widely consumed by people of all classes, region, religion, race and sex. It is cheap and easily prepared in almost any community. Despite the fact that consumption has declined significantly over the years, we still eat the equivalent of 220million slices each day, enough to cover the pitch at wembly 51 times over [2]. Bread is a carbohydrate rich food baked from mixed yeast leavened dough obtained from flour (either cassava or wheat) and bromated or phosphate flour or their combination in the presence of Saccharomyces cerevisae yeast and 1% bread bean flour [3]. Bread takes on many shapes and is prepared by many different methods. Bread is convenient as a food because it is ready-to-eat, easy to carry around and not messy to eat [4]. Bread is usually used for sandwiches or eaten by itself with a spread of your choice. Although some of the different ingredients are healthier than others the nutritional facts remain similar across the globe. With the fashion for low–carb diets, food combining and other nutritional foods, bread has undeservedly been cast as a threat [5]. But contrary to popular believes, bread is actually good for us and nutritionist recommends we should all be eating more of it. Admittedly, some types of bread are better than others, but even white slices have a lot to offer [6].

Potassium bromate is widely used by bakers in bread making process because of its slow oxidizing property, availability in the market and low cost [7]. It acts as an oxidizing agent throughout the bread making process; fermentation, proofing and baking affecting the rheological properties of the final product. Potassium bromate is also used in many bakeries as an additive in the raising process and to produce a texture in the finished product that will attract potential buyers [8]. This additive is reduced to potassium bromide during baking process in oven, and this is found to be innocuous in the finished product. The use of potassium bromate results in the production of high value and fine crumb. The bromate voluminises the center of the bread (produced from low protein wheat), and increases the size of the bread artificially; as well as producing bread with a pure crumb structure [9]. It is an established fact that all the added bromate is reduced to bromide as shown in the above reaction; however, this is dependent on the oven temperature, the duration of exposure at that temperature and the quantities of potassium bromate used [10]. It is therefore conceivable that some bromate residue will be left in the finished baked product. However, a lot of studies have shown that potassium bromate has some devastating and catastrophic side effects that range from mild to toxic effects [11].

The use of potassium bromate by bakers was found to be hazardous to consumers because if enough heat was not used during the baking, some of the bromate might not be completely changed to bromide [12]. On account of its deleterious effect and carcinogenicity in humans, certain levels of potassium bromate are not allowed in bread [13]. In course of its potential dangers to the human systems, the use of potassium bromate in bread is banned in many countries including Nigeria [14]. The present study investigated the incidence of potassium bromate in different brands of bread sold in Tarauni, Nassarawa and Kumbotso Local Government Areas of Kano Metropolis in Nigeria.

## Materials and Methods

### Sample Collection

Thirty (30) samples of bread were purchased from different retail outlets and bakeries in Tarauni, Nassarawa and Kumbotso Local Government Areas of Kano Metropolis. The samples were among products that are widely consumed within the three aforementioned Local Government Areas of Kano Metropolis. All the samples obtained were numbered according to where they were obtained for this work.

**Table 1: Different Samples of Bread Purchased from Various Local Government Areas**

| S/N | Tarauni Local Government Area | Nasarawas Local Government Area | Kumbotso Local Government Area |
|---|---|---|---|
| 1. | Jibaje | Ultimate | Executive |
| 2. | Ammam | Nassara | Watson |
| 3. | Nakowa | Standard Special | Myson |
| 4. | Gamji | Hafsat | 212 |
| 5. | Oasis | Nagari | Kano special classic |
| 6. | Gidauniya | Selsa | Al-Ihsan |
| 7. | Haiba | Wasila | Al-Yusrah |
| 8. | Beauty Special | Habib | Happy Cheff |
| 9. | Bakers Delight | Smash | Sa'a |
| 10. | Ustaz | Jaiz | Zuma |

### Sample Preparation

The method described by Dennis (1994) was used to prepare the bread samples obtained. A circular sample of 2 cm diameter from the center of a 15 mm thick slice of each bread sample was taken and dried in an oven for 72 hours at 55oC the crust was ground to a fine powder with mortar and pestle. 2.5 g of each powdered samples was weighed into 250 ml beaker, and 25 ml of water was added. The mixture was centrifuged and the liquid fraction was diluted to 50 ml in volumetric flask

### Estimation of Bromate in Bread Samples

The method described by Zakari (2014) was used to estimate bromate in the obtained bread samples. Aliquot (4cm3) of each of the 30 bread samples was measured into 10 separate 25 cm3 calibrated flasks. 5cm3 5x10-4 mol/dm-3 solution of crystal violet dye was added, followed by 10 cm3 of 2M HCl solution. Each flask was diluted to 25 cm3 marks with distilled water; and shaken gently prior to colorimetric analysis. Bromate was then determined using a 752S UV- Visible spectrophotometer at λmax= 485nm. All the measurements were made at room temperature against water as a reference.

### Statistical Analysis

All values were presented as Mean ± Standard deviation (SD). The significant differences in the means of all parameters determined using analysis of variance (ANOVA) and using statistical package for social sciences (SPSS) version 25. Group means were compared for significance at $P<0.05$. Means along the same row having different superscripts are statically significant.

## Results

Concentration of Potassium Bromate in Bread Samples Purchased from Different Bakery Outlets in Nassarawa, Tarauni, and Kumbotso, Local Government Areas of Kano Metropolis

The data in the Table 3 shows the absorbance and concentration of potassium bromate in the 30 studied bread samples. The data showed that the use of crystal violet in determining potassium bromate in a given sample has a higher sensitivity and the limit of quantification. A quantitative agreement between the results was observed.

The concentrations of potassium bromate in the samples were found from the equation: $y=0.043X + 0.235$ for the samples containing crystal violet dye. Where, y=Absorbance and X=Concentration of potassium bromate.

**Table 3: Absorbance and Concentration of Potassium Bromate in Bread Samples Purchased from Different Bakery Outlets in Nassarawa, Tarauni, and Kumbotso, Local Government Areas of Kano Metropolis**

| Local Government Area/ Number | Absorbance | Concentration (ppm) |
|---|---|---|
| **Nassarawa** | | |
| 1 | 0.437 | 4.69 |
| 2 | 0.319 | 1.95 |
| 3 | 0.440 | 4.76 |
| 4 | 0.315 | 1.86 |
| 5 | 0.395 | 3.73 |
| 6 | 0.439 | 4.74 |
| 7 | 0.396 | 3.74 |
| 8 | 0.501 | 6.19 |
| 9 | 0.352 | 2.72 |
| 10 | 0.255 | 0.47 |
| **Tarauni** | | |
| 11 | 0.458 | 5.18 |
| 12 | 0.399 | 3.81 |
| 13 | 0.448 | 4.95 |
| 14 | 0.231 | 0.09 |
| 15 | 0.386 | 3.51 |
| 16 | 0.391 | 3.62 |
| 17 | 0.416 | 4.21 |
| 18 | 0.439 | 4.74 |
| 19 | 0.372 | 3.18 |
| 20 | 0.428 | 4.48 |
| **Kumbotso** | | |
| 21 | 0.583 | 8.09 |
| 22 | 0.496 | 6.07 |
| 23 | 0.550 | 7.33 |
| 24 | 0.240 | 0.12 |
| 25 | 0.229 | 0.14 |
| 26 | 0.527 | 6.79 |
| 27 | 0.530 | 6.86 |
| 28 | 0.232 | 0.07 |
| 29 | 0.645 | 9.53 |
| 30 | 0.592 | 8.30 |

* The absorbance was measured at $\lambda_{max}$ =485 for crystal violet

### Concentration of Potassium Bromate in Bread Samples Purchased from Different Bakery Outlets in Nassarawa Local Government Area of Kano Metropolis

Figure 1 presents a set of different bread brands from Nassarawa LGA of Kano State and their potassium bromate concentration in ppm. The data from figure 1 presents five different bread brands: Standard Special, Ultimate, Nasara, Hafsat and Nagari which were all tested for Potassium bromate with a concentration of 4.49ppm, 1.95ppm, 4.76ppm,1.86ppm, and 3.73ppm respectively. Evidence shows that Ultimate displays lowest concentration value, while Nassara shows the highest concentration of potassium bromate from this set.

Figure 2 also shows a set of bread samples from Nassarawa LGA of Kano State: Selsa, Wasila, Habib, Smash, and Jaiz that were tested for potassium Bromate concentration. Among these, Habib exceeds the rest of the samples in both figures, Habib Is clearly dominant in figures 1 and 2. The lowest concentration of potassium bromate was found in Jaiz with about 0.47ppm which makes it the best sample out of both sets from Nassarawa LGA.

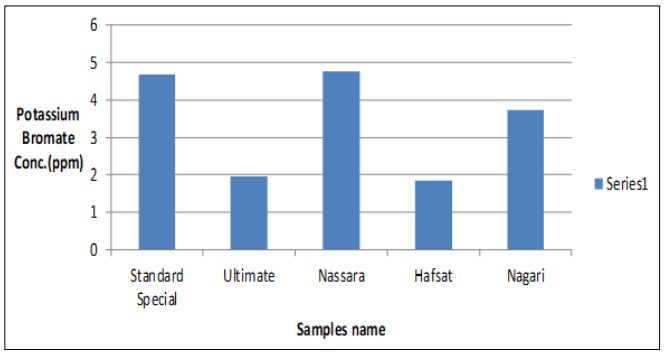


**Figure 1:** Concentration of Potassium Bromate Present in Bread Samples Purchased from Different Bakery Outlets in Nasarawa Local Government Area of Kano Metropolis

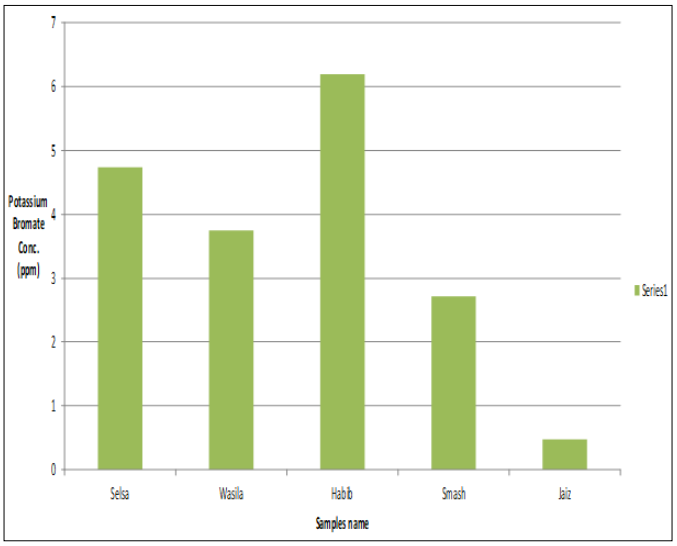


**Figure 2:** Concentration of Potassium Bromate Present in Bread Samples Purchased from Different Bakery Outlets in Nasarawa Local Government Area of Kano Metropolis

### Concentration of Potassium Bromate in Bread Samples Purchased from Different Bakery Outlets in Tarauni Local Government Area of Kano Metropolis

Figure 3 displays five bread samples from Tarauni LGA of Kano State which include Jibaje, Ammam, Nakowa, Oasis, and Gamji. All five samples from this set were evaluated for potassium bromate levels. The most significant presence of potassium bromate was noted in Jibaje and Nakowa, both had concentrations of almost 5 ppm. Oasis had the lowest concentration. Ammam and Gamji had appreciable levels of presence where Ammam's concentration was high compared to Gamji but lower compared to Jibaje and Nakowa.

Also, Potassium bromate levels were further analyzed in a different set of bread samples from Tarauni LGA of Kano State as displayed in Figure 4. Five which included Haiba, Gidanunja, Bakers Delight, Beauty Special, and Ustaz. The highest potassium bromate concentration, was in Baker's Delight, at about 4.8 ppm. Ustaz followed with approximately 4.5 ppm. Concen-

trations from Haiba, Gidanunja and Beauty Special were within these ranges but Beauty Special having the least, though indeed above the permissible range.

When contrasting the two sets from Tarauni LGA, potassium bromate concentration in Bakers Delight from Figure 4, surpasses that of all the other samples while Oasis in figure 3 remains the least.

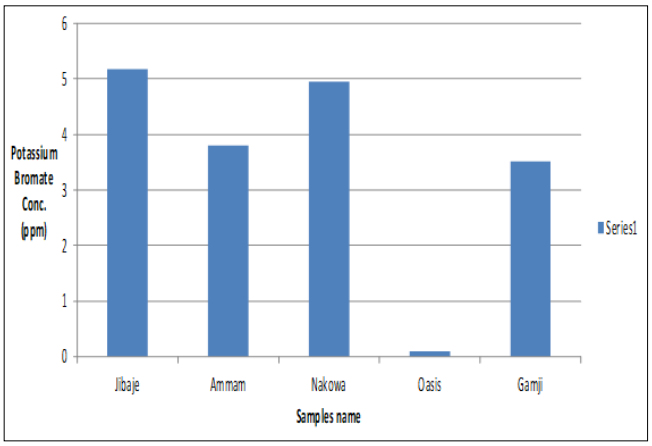


**Figure 3:** Concentration of Potassium Bromate present in Bread Samples Purchased from Different Bakery Outlets in Tarauni Local Government Area of Kano Metropolis

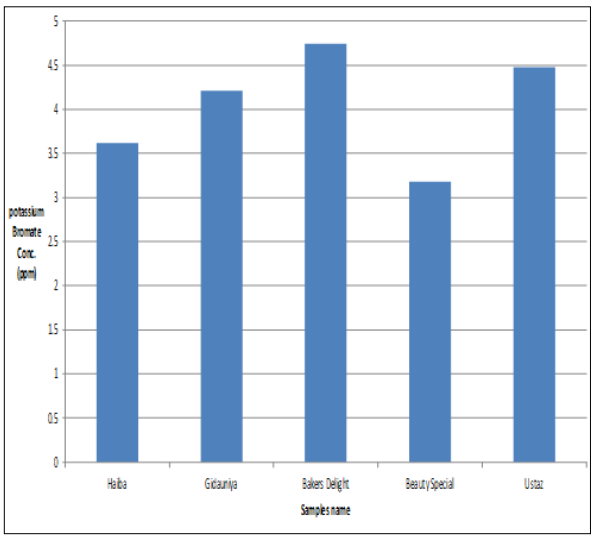


**Figure 4:** Concentration of Potassium Bromate present in Bread Samples Purchased from Different Bakery Outlets in Tarauni Local Government Area of Kano Metropolis

**Concentration of Potassium Bromate in Bread Samples Purchased from Different Bakery Outlets in Kumbotso Local Government Area of Kano Metropolis**

Figure 5 illustrates a set of five samples of bread from Kumbotso LGA of Kano State: Al-Yusrah, Al-Ihsan, Executive, Watson and 212 breads. "Al- Yusrah" and" Executive" brands sample have the greatest amounts of potassium bromate at almost 8 ppm and 7 ppm respectively. "Al-IHsan", which is in third place has a concentration a little over 6 ppm. These concentrations are quite high, which raises the suspicion that these brands may be using potassium bromate in excess of the limits set by the U.S. FDA and NAFDAC. On the other hand, having values near zero for "Watson" and "212 Bread" samples suggest rather the absence of, or very low concentration of, potassium bromate in these brands.

Figure 6 illustrates another set of bread samples from Kumbotso LGA of Kano State with different potassium bromate concentrations. Myson shows the highest concentration value of above 10 ppm followed by Saka with a value just above 8 ppm. Zuma and Happy Cheff have less, but significant values at around between 6 to 7 ppm. Most significant difference is that "Kano Special Classic" has the lowest value of Potassium Bromate in Kumbotso LGA, which is nearly zero, in the same way as what Watson and 212 Bread had in Figure 5.

Based on the data presented in Figures 5 and 6, "Myson" indicated to have the highest concentration of potassium bromate in Kumbotso LGA, which exceeds 10 ppm. "Kano Special Classic", on the other hand has the least concentration of potassium bromate, which is as good as absent.

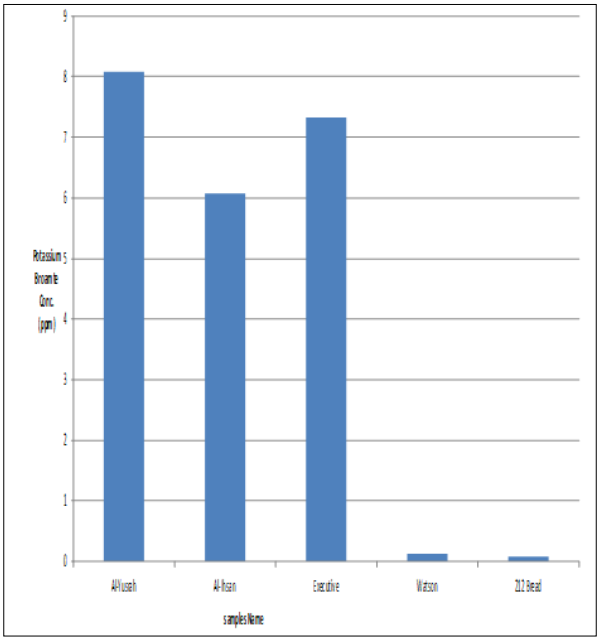


**Figure 5:** Concentration of Potassium Bromate present in Bread Samples Purchased from Different Bakery Outlets in Kumbotso Local Government Area of Kano Metropolis

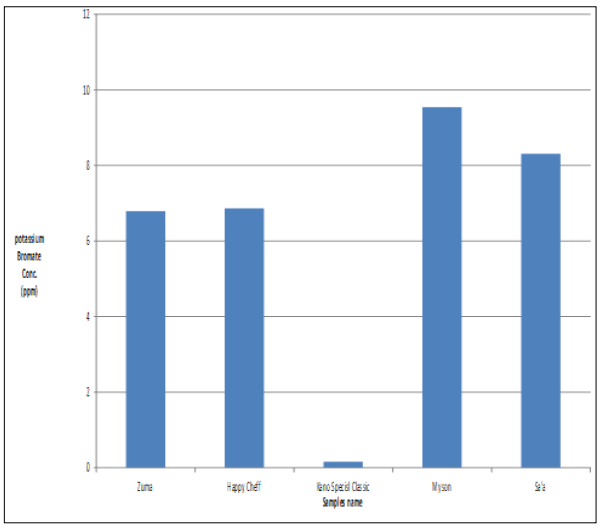


**Figure 6:** Concentration of Potassium Bromate Present in Bread Samples Purchased from Different Bakery Outlets in Kumbotso Local Government Area of Kano Metropolis

## Discussion

Potassium bromate is widely used by bakers in bread making process because of its slow oxidizing property, availability in the market and low cost [7]. It acts as an oxidizing agent throughout the bread making process; fermentation, proofing and baking affecting the rheological properties of the final product. Potassium bromate is also used in many bakeries as an additive in the raising process and to produce a texture in the finished product that will attract potential buyers [8]. In spite of the numerous benefits of potassium bromate, a lot of studies have shown that potassium bromate has some devastating and catastrophic side effects that range from mild to toxic effects [11]. This research investigated the concentrate of potassium bromate in bread samples purchased from three Local Government Areas in Kano Metropolis, Nigeria.

The results obtained from this research work shows noncompliance of bread bakers with the National Agency for Foods and Drugs administration and Control (NAFDAC) and the World Health Organisation (WHO) directives of using at most 0.025ppm of potassium bromate.

Table 2 showed the residual potassium bromate level present in all the 30 bread samples investigated showing the lowest concentration to be 0.07ppm and highest concentration to be 9.53ppm. The concentration of potassium bromates detected in all the 30 bread samples analyzed were far greater than the provisional guideline value of at most 0.025ppm recommended by the World Health Organization (WHO). The result from the table also showed the noncompliance with the outright ban by NAFDAC on the use of potassium bromate by bakers. Potassium bromate is a mutagen and has been shown to be a potential cause of cancer. The presence of detectable residual level of potassium bromate in breads is therefore undesirable considering the long-term effects. The use of potassium bromate in flour milling and baking was banned in Nigeria by National Agency for Food, Drug Administration and Control (NAFDAC) in 1993; and it's use infringes on the drug and related products (registration) decree 20 of 1999 and NAFDAC Decree 15 of 1993 [1].

Committee's initial recommendation of acceptable level of 0 to 60 mg KBrO3/kg flour was withdrawn because long term toxicity and carcinogenicity studies in vitro and in vivo revealed renal cell tumors in hamsters [2,15]. Also, toxicity studies showed that potassium bromate affects the nutritional quality of bread by degrading vitamins A1, B1, B2, E and niacin - the main vitamins in bread [2,16]. Bakers are encouraged to comply with set standards of good manufacturing practices and Hazard Analysis Critical Control Points guidelines acceptable worldwide. In addition, they should explore other natural bread improvers other than potassium bromate which have no detrimental effects on human health on long term consumption.

## Conclusion

Conclusively, consumers are advised to be cautious of the brand of breads they consume, regulatory agencies are urged to intensify their vigilance and put more efforts in fishing out perpetrators that don't comply with the laid down rules and regulations. Bakers are advised to stop using harmful additives in bread baking all in the name of maximizing profits but jeopardizing the health of the public.

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## Conflicts of Interest

All authors declare that they have no conflict of interest associated with this research work.

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