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Determination of the Presence of Potassium Bromates in Bread Samples Produced in Azare

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Abstract

Background: To improve bread texture, taste, elasticity of the dough, appearance and sometimes aroma, some ingredients are usually added. However, these ingredients are known to produce adverse health effects over a period of time or if taking in large quantities. One of the commonest food additives is potassium bromate, due to its low cost and one of the most effective oxidizing agent, it has been the common choice among bakers and flours millers to raise the dough elasticity and improve texture. Repeated exposure to potassium bromate is associated with reproductive damage, bronchitis, irritability, impaired thinking, personality changes and damage to the kidneys. Larger than recommended quantities should therefore be avoided in processed foods such as bread.
Objectives: The aim of this study was to determine the presence and the level of potassium bromate in some bread samples produced in Azare, the headquarter of Katagum Local government area of Bauchi state Nigeria.
Methods: Bread samples were collected from nine different bakeries that were sited within Azare. And these are the major breads produced and consumed in Azare town and neighboring villages. The bread samples were subjected to both qualitative and quantitative assay to determine the presence and level of the potassium bromate. The qualitative assay was conducted using simple qualitative method where color change (yellow to purple) produces when potassium bromates react with potassium iodide indicate presence of the potassium bromate. While the concentration of the potassium bromate in the samples was determine using spectrophotometric analysis measured at absorbance of 620 nm. The standard solutions of potassium bromate was used to plot the linear regression curve, and the curve was used to calculate the concentration of potassium bromate in the bread sample
Results: The results indicated that bread produced in 5 of the 9 bakeries used in this study contained potassium bromate level within the recommended FDA and NAFDAC permissible level of 0.02ug/g and below. While the remaining four samples contained potassium bromate level higher than the NAFDAC recommended level. Overall, the potassium bromate level across the selected bakeries in this study conducted in Azare town Katagum local government of Bauchi state Nigeria was found in range between -0.91ug/g to 0.40ug/g.

Keywords: *Bread samples, potassium bromate, food additives, permissible level, regulatory bodies*

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1. Introduction

Bread is a staple food prepared by baking dough which consists of flour, leavening agents and water. The type of bread depend on its formulation which include final colour, texture and flavour, health benefits required, potential calorie reduction, fat and sugar replacement, fortification with required nutrients, and baking duration (Alhazza *et al.,* 2020).

The major determinants of bread as a staple food are simplicity of ingredients, mode of preparation, and multiplicity of cereals used in baking. Many cereals can be used to produce bread, namely maize, probably the most used cereal are rice, wheat, barley, sorghum, millet, Oat, rye and others (Carocho *et al.,* 2020).

The major ingredients of bread after flour include: table salt, sugars, flavours but some products contain additional ingredients such as milk, egg, spice, fruit, vegetables, nuts or seeds (Ezirim *et al.,* 2022)

Flour is the main material in making of bread and wheat is the only cereal whose flour has the ability to form dough when contacted with water. The constituents of flour include proteins, starch and other carbohydrate lipids, fiber, water and ash as well as low levels of vitamins, minerals and enzymes (Kourkouta *et al*., 2018).

Usually in commercial bread, additives were incorporated in order to enhance bread qualities such as color, flavor, shelf life and also to ease the time and cost of production (Airaodion *et al.,* 2019).

Over the years, dough enhancers have been used but most of them were found to have adverse health effects which led to their restriction or ban. But its cheapness, ease of access and efficiency make potassium bromate a common choice among bakers and flour millers throughout the world. It is used as additive to help raise the dough and improve the texture (Ezirim *et al.,* 2022).

Potassium bromate (KBrO3) is a colorless, odorless, tasteless crystalline chemical substance. It improves the elasticity of the dough by oxidizing the sulfhydryl groups of the gluten protein in the flour, it helps the bread rise in the oven, preserve the aroma, and improve the taste and appearance and also increase the volume and texture of the bread. The various adverse health problems linked to potassium bromate was because it reducing the nutritional quality of bread by degrading or interfering with the structures of vitamins, minerals and fatty acids in bread (Yalçin and Çavuşoğlu, 2022).

Potassium bromate was found to be carcinogenic in rats and nephrotoxic in both man and experimental animals when given orally (Kurokawa *et al*., 1990). It is known to irritate and burn the skin and eyes, can also irritate the nose, throat and lungs causing cough, wheezing and/or shortness of breath. Chronic exposure has been shown to cause kidney, thyroids and gastrointestinal cancer in animals. Other long-term effects include persistent headache, irritability, impaired thinking, personality changes and damage to the kidney (EPA, 2001).

The use of potassium bromate as food additive has been banned in many countries since early 1990s. In Nigeria, National Agency for Food, Drug Administration and Control (NAFDAC), banned the use of potassium bromate in bread because of its many adverse effects. Despite such warnings and ban some bakers still use potassium bromate in bread (Chavan *et al.,* 2019).

Therefore, the maximum potassium bromate concentration allowed in bread by the US Food and Drug Administration (FDA) is 0.02 µg/g (Yalçin and Çavuşoğlu, 2022).

This study therefore aimed to determine the presence and the level of potassium bromate in some bread samples produced in Azare, Katagum Local government area of Bauchi state Nigeria and to advise appropriate authorities responsible for regulating food and drug in Nigeria.

2. Materials and Methods

2.1 Study area

The study was conducted at Azare. Azare is the headquater of Katagum LGA, Bauchi state, it is bordered to the east by Dambam LGA and Potiskum Yobe State, and to the south by Misau Local Government, to the west it is bordered by Jamaare Local Government and to the north by Itas/Gadau Local Government Area of Bauchi State. Azare is located at $11^0$40’27’’N and 10^0 11’ 28’’ E at an altitude of 436 meters.

The estimated value of the population from 2007 population census was 110,452, it is the largest town in Bauchi State and region. The people of Azare are predominantly Muslim, and are primarily of Hausa-Fulani ethnicity. The town’s primary economic activity is agriculture.

2.2 Sample Collection

Nine (9) samples of different breads were purchased random from different location such as bakeries, petrol station, shops and bus stops within Azare town. The quantitative and qualitative assay of Potassium bromate in the bread samples was carried out by the methods described by David (1976).

The samples were broken into small pieces, dried in an oven at (75±10ºC) for 24 hours and grounded into powder. The powdered material was weighed and subjected for further analysis (Ekere and Odoh, 2020).

2.3 Preparation of Standard Solution

Preparation of standard solution was done according to the method employed by 2.0g of potassium bromate crystal (Qualikems Fine Chem Pvt. Ltd., Vadodara, India) was weighed and dissolved in 1000 ml of distilled water in a 1000 ml conical flask to form a standard solution of $KBrO_3$. About 2.2 ml of Conc. HCl was added in a volumetric flask containing 250 ml of distilled water to form an acidified water, followed by addition of 5.0 g of potassium iodide crystal to the acidified water to form 5% KI solution. Aliquots of 0.1 ml, 0.2 ml, 0.3 ml, 0.4 ml and 0.5 ml of $KBrO_3$ were placed in five test tubes labeled 1-5 and then An

Aliquot of 5 ml of the 5% KI was added to each test-tube and shaken vigorously for 1 minute and the absorbance were taken at 620 nm on a spectrophotometer using the blank solution prepared. The absorbance obtained was used to plot the standard calibration curve for the experiment.

2.4 Analysis of the bread samples

10 ml of distilled water was added to different test tubes containing about 1.0 g of bread powder. After shaking the mixture sufficiently, it was placed in a water bath at a temperature of about 30ºC and for almost 20 minutes, and allowed to cool. Then a fresh 5% potassium iodide solution was prepared in 0.1 M hydrochloric acid, and it was added to each test tube containing the solution of bread sample in water. The presence of potassium bromate will be indicated by the change in colour from the light yellow to to purple

The quantitative analysis was carried out using a blank solution at 620 nm absorbance in a spectrophotometer. The absorbance was plot against concentration in the standard curve, and the concentrations of potassium bromate was calculated.

2.5 Statistical Analysis

The data were analyzed by descriptive statistics and expressed as mean ± standard deviation, using SPSS version 23 software.

3. Results and Discussion

This study was conducted to investigate the presence of potassium bromate in nine different bread samples produced in Azare. The results obtained were presented in Table 1 and Figure 1. The highest potassium bromate level in this study was 0.40 µg/g while the lowest level was -0.91 µg/g. The recommended permissible level by US Food and Drug Agency and National Agency for Food and Drug Administration and Control of 0.02µg/g (Yalçin and Çavuşoğlu, 2022).

Table 1: Potassium Bromate content of Various Bread Samples Analyzed

S/N	Brand/Baker	Mean Concentration of $KBrO_3$ (µg/g)
1	A	-0.8950 ± 0.0212
2	B	-0.9100 ± 0.0424
3	C	0.4000 ± 0.1131
4	D	-0.5500 ± 0.0707
5	E	0.1150 ± 0.0354
6	F	-0.1450 ± 0.0636
7	G	-0.5700 ± 0.0990
8	H	0.1200 ± 0.0283
9	I	0.0400 ± 0.0141

$KBrO_3$ = potassium bromate, SD = standard deviation, ug/g = microgram per gram

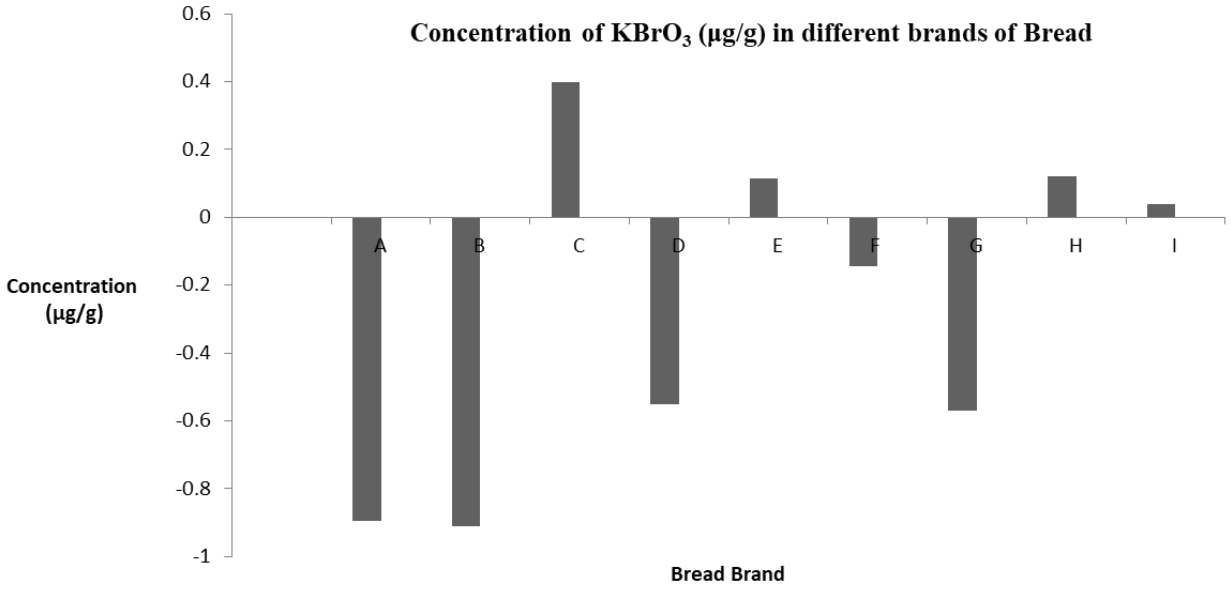

Figure 1: Concentration of potassium bromate in bread samples

From the results of this study, five samples (A, B, D, F,G), of the breads used in this study were found to contained potassium bromates concentration within the lowest permissible level of 0.02 ug/g and below, while four of the samples (C, E, H, I), contained potassium bromates level higher than the lowest permissible level. This shows that majority of the breads produced and consumed in Azare contained safe amount of potassium bromate and thus safe for consumption. It is worthy to note that even those that deviate from the lower permissible concentration might be said to contain safe concentration as the deviation is not very significant from the lower permissible level as observed in many studies. The result of the study agreed with the finding of Dagari *et al.* (2022) who recorded negative potassium bromate level in all 60 bread samples. Also Adebiyi *et al*. (2021) found similar results in which potassium bromate was absent in all the bread samples under study. The absence of potassium bromate in some of the bread samples in Azare

shows that those brands are very safe to consume since there are no carcinogenic health concern of bromate in those bread samples. And according to Adebiyi *et al*. (2021), some negative results were because, if the bromate added to the bread was very small it quickly degraded and lost during the baking process.

The bread samples that contain potassium bromate levels that are higher than the lowest permissible level of 0.02 μg/g, the results agreed with most of the research findings obtain in different part of the world with regards to potassium bromate usage in bakeries. The notable among them include the study by (Airaodion *et al.,* 2019) in their study in Ibadan in south western part of Nigeria in which 30 bread samples were investigated, also the range obtained was, 1.24 μg/g and 9.31 μg/g which is higher than the one obtained in this study.

Another study by Lawal and Aliyu (2013) conducted in Katsina shows that the potassium bromate level ranges from 2.18 to 8.25μg/g, which is also higher than the range obtained in this study. Also Obunwo and Konne (2014) investigated potassium bromate levels from 10 bread samples in Port Harcourt metropolis, the range was 0.12 ±0.08 μg/g to 7.28 ±2.14 μg/g. Only one sample of the bread samples analyzed was close to what was obtained in this study that was 0.12. The result obtained by Ekere and Odoh. (2020), also indicated that the bromates level range was 4.375-0.25 mg/g relatively higher than the ones obtained in this study.

From the results of this study, we found that in 5 of the samples investigated, the potassium bromate levels were below the lowest permissible level of 0.02 μg/g, which shows that majority of the bakers in Azare comply with the NAFDAC's directives on the utilization of Potassium Bromate.

But for the remaining samples which contain higher levels, indicated the poor attitudes of bakers in most part of the world for neglecting the warnings against addition of higher limits of Potassium Bromate in food. And many studies revealed the adverse health effects of Potassium Bromate.

Nkwatoh and Fon (2023) investigated the health risk of potassium bromate and symptoms developed by bakers in Bamenda, Cameroon, they found that all the bakers had developed serious symptoms due to chronic potassium bromate exposure such as sore throat, cough, diarrhea and painful eyes.

A study conducted by Alhazza *et al.* (2020) showed that potassium bromate could induce renal toxicity in Wistar rats, as it exerts its various toxic effects in dose-and –time-dependent manner in vivo. Potassium Bromate causes decrease in renal markers such as urea, creatinine, albumin, glutathione-S-transferase.

according to Ezirim *et al.* (2022), exposure of animals to higher doses of potassium bromate decreases the concentration of various testicular parameters, such as MDA, total cholesterol and total protein but it increases the testicular levels of SOD, CAT and ALP.

On its effect on haematological parameters, potassium bromate causes thrombocytopenia as it reduces the platelet count in rats (Achukwu *et al.,* 2009).

4. Conclusion

Based on the result obtained in this study, the potassium bromates level of majority of the bread samples produced in Azare were found to be within the lowest recommended level of 0.02 ug/g. This shows that there are some levels of compliance with the banning against the use of potassium bromate as an additive in bread bakery in Azare. However there is still need for additional monitoring by the regulatory bodies to enhance compliance.

Conflict of Interests

Authors have declared that no competing interests exist.

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