International Journal of Science and Technology Research Archive

ISSN: 0799-6632 (Online)

Journal homepage: https://sciresjournals.com/ijstra/

(RESEARCH ARTICLE)

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Determination of potassium bromade in bread samples from Gashua and Nguru communities of Yobe state, Nigeria

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International Journal of Science and Technology Research Archive, 2022, 03(01), 058–065

Publication history: Received on 02 June 2022; revised on 16 July 2022; accepted on 18 July 2022

Article DOI: https://doi.org/10.53771/ijstra.2022.3.1.0062

Abstract

This study was aimed at determining the level of potassium bromate in some selected bread samples consumed in Gashua and Nguru areas council of Yobe State-Nigeria, with the view of ascertaining the level of dietary exposure of consumers of bread in Gashua and Nguru to the risk of Potassium bromate.

Breads was collected from fourteen (14) different bakeries in Two local government (Nguru and Bade local government area): Bread samples were bought directly from the bakeries in the selected areas of Gashua (Bade) and Nguru local government area) of Yobe State.

Sample collection and preparations were conducted using standard procedures. Studies were conducted between the period of three months (October, December and March). Bread sample from study areas were collected and the levels of potassium bromate ($KBrO_3$) was determined. The results of potassium bromate in bread samples obtained in this study were 12.16 µg/g and 0.0001µg/g for highest and the lowest level of KBrO3 found in bread samples consumed in Nguru and Gashua town. The potassium bromate levels in the bread samples were determined using a spectrophotometer at 620 nm. The concentration was calculated from the linear regression curve obtained from the standard solutions of Potassium bromate.

The overall Results of the studies for the three months showed that potassium bromate was detected in all the months and was highest among samples collected in Gashua having 0.75±1.76 mg/g and Nguru 0.66 ±1.98 mg/g. For the three month not detected the highest value was found in Gashua with -0.23 ±0.41 mg/g, while the least value is found in Nguru -0.33 ±0.41 mg/g. The mean and standard deviation showed the following values in Nguru 3.01 ±3.41 mg/g and 2.47 ± 2.54 mg/g in Gashua for the first month and 0.00 ±0.00 mg/g for both Nguru and Gashua for the third month. The quality of bread in Gashua and Nguru local government area of Yobe state have not been monitored, thus there is no information concerning the level of potassium bromate in this area, since there is high rate of consumption of bread. Routine monitoring of potassium Bromate in these study areas is necessary for the prevention, and control of the intake, so as to minimize health risks.

Keywords: Potassium Bromate; Bread; Health risk; Routine monitoring

1. Introduction

Potassium bromated or simply called bromate is an oxidizer used to strengthen dough and enhance its elasticity. This helps bake uniform and whitened bread. Potassium bromate is also used as a flour improver which means that it allows the dough to rise higher. The cost of using potassium bromate solely is less than one sixth of using glucose oxidase and

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one eighth of using ascorbic acid solely [1]. One of the challenges in bakeries is the baking quality of flour, which is determined by the capacity of dough prepared from it. As a result of wide variations in the composition of flour, various supplements or conditioning agents (improvers) are added during mixing and moulding to increase loaf volume, texture and strength [2]. Bread is made by bulk fermentation and mechanical development from dough containing amounts of added potassium bromate ranging from (0 to 200) ppm. When the added potassium bromate level was less than (50) ppm, the residual level will be too small to be detected, but at higher levels of increasing amount of residual potassium bromate began to appear. Apart from its use in bread and confectionaries, potassium bromate is also used in production of fish paste, fermented beverages and making cold wave hair lotion [3]. It is generated as a contaminant in drinking water due to the conversion of bromide found naturally in water to bromate by ozone which is used as water disinfectant [4, 5].

In fact, statistical analysis in Nigeria showed that bread is one of the most consumed food type predominant consumption among the poor [6]. It is a carbohydrate source made from flour and yeast with the flour fortified with potassium bromate for aesthetic purposes [7].

Potassium bromate ($KBrO_3$) is a colourless, odourless and tasteless white crystal/powder that is used as a food additive and is commonly used as flour improver and enhancing agent in Nigeria, because of its efficient oxidising properties [8]. It acts as a maturing agent and dough conditioner by oxidizing the sulfhydryl groups of gluten protein in flour into disulphide bridges making it less extensible and more elastic; this will make the dough visco-elastic such that it can retain the carbon dioxide gas produced by the yeast. The overall effect is to make it rise in the oven, increase loaf volume and texture [9]. In Nigeria, the National Agency for Food and Drug Administration and Control [10] announced the dangers associated with the use of Potassium bromate and banned its further use in bread. The maximum concentration of potassium bromate allowed in bread by the US Food and Drug Agency is 0.02µg/g (0.02mg/kg) [11]. Despite the ban on use of bromate in bread by NAFDAC, and the fact that there are other non-toxic, flour-enhancing alternatives such as ascorbate [12], many bakers are still using Potassium bromate to enhance the quality of their bread thereby putting the life of the consuming public at risk. Potassium bromate is a flour enhancer that acts as a maturing agent. It acts mainly in the late dough stage by giving strength to the dough during late proofing stage of baking [13]. During the preparation of the bread, the formation of protein molecules joined together by disulphide linkages arises. The strength and elasticity of this network which gives the bread its characteristic properties is best when it comprises of long chain proteins such as gluten. Short chain peptides such as glutathione (a tripeptide) which are present as well react with gluten molecules breaking down the dough structure. This structural breakdown can be prevented by the addition of oxidizing agents [14], and [2]. Potassium bromate is the most commonly used oxidizing agent. Where potassium bromate is no longer used, bread of good value can be made using Vitamin C (ascorbic acid) as the oxidizing agent together with amylases. In presence of any of these oxidizing agents, the glutathione is oxidized to glutathione disulphide and therefore cannot interfere with disulphide bonds of gluten molecules[15]. But in the absence of these oxidizing agents, the reverse is the case. In addition, potassium bromate reduces the nutritional quality of bread by degrading essential vitamins such as vitamin A, B and E [16, 17]. In 1996, The Association of Official Analytical Chemists (AOAC) committee [18], recommended continued study of bromates in baked products because of its suspected carcinogenic potential. So, it is important for bakers to be able to analyze bread additive and flour rapidly in order to determine bromate content.

This study was aimed at determining the level of potassium bromate in some selected bread samples consumed in Gashua and Nguru areas council of Yobe State-Nigeria, with the view of ascertaining the level of dietary exposure of consumers of bread in Gashua and Nguru to the risk of Potassium bromate. The objectives were (i) to assess the safety of these breads for human consumption in view of the adverse effects of $KBrO_3$. (ii) to determine the level of compliance with NAFDAC directive of non-inclusion of potassium bromate in bread.

2. Material and methods

2.1 Study Area

The survey was conducted in Bade and Nguru local government area of Yobe State, Nigeria. Its headquarters are in the town of Gashua. It has an area of 772km^2 and Coordinates: 12°52′5″N 11°2′47″E with population of 139,782 at the 2006 census. The postal code of the area is 631(NIPOST 2009). The Bade and Duwai languages are spoken in Bade LGA.

Gashua is a community on the Yobe River, a few miles below the convergence of the Hadejia River and the Jama'are River. Average elevation is about 299 m. The hottest months are March, April and May with temperature ranges of 39-44^o Celsius. In the rainy season, June-September, temperatures fall to 23-28^o Celsius, with rainfall of 500 to 1000mm.

Figure 1 Map of Nigeria Showing Bade and Nguru Town

The Bade language is spoken in Gashua and in an area fanning out east and south of Gashua. Bade is one of seven languages of the Chadic family indigenous to Yobe State. The town lies near the Nguru-Gashua Wetlands, an economically and ecologically important ecological system. The town is the location of the court of Mai Bade, the Emir of Bade. Bade is well-known for its fishery, Agricultural production is, however, not large-scale nor is it mechanized, Bakeries and other commercial activities. There are 10 wards under Bade LGA, these are Sugum/Tagali, Dagona, Sarkin Hausawa, Lawan Fannami, Zango, Katuzu, Lawan musa, Gwio-Kura, Usur/Dawayo and Sabon Gari wards.

Nguru is a local government in Yobe State, Nigeria with its headquarter in the same town and river Komadugu to its western, southern and eastern part. Nguru is geographically located at $12^{0}52^{1}5^{11}$N, $10^{0}27^{1}09^{11}$E / $12^{0}87917$N- 10.45 250^{0}E. The town probably dates from around the 15th century, there are variety of landscape in the area including the protected Hadejia-Nguru wetland of Komadugu river and the sand dunes a semi-desert area. The local government Nguru, has many wards among which are Sabon gari ward, Tsohon Nguru wards, Hausari ward and Bulabulin ward. The major languages spoken are Kanuri, Hauwa, Fulani and Yoruba. The major occupation of the people of Nguru is fishing, Agricultural production, Bakeries and other commercial activities.

2.2 Preparation of bread sample

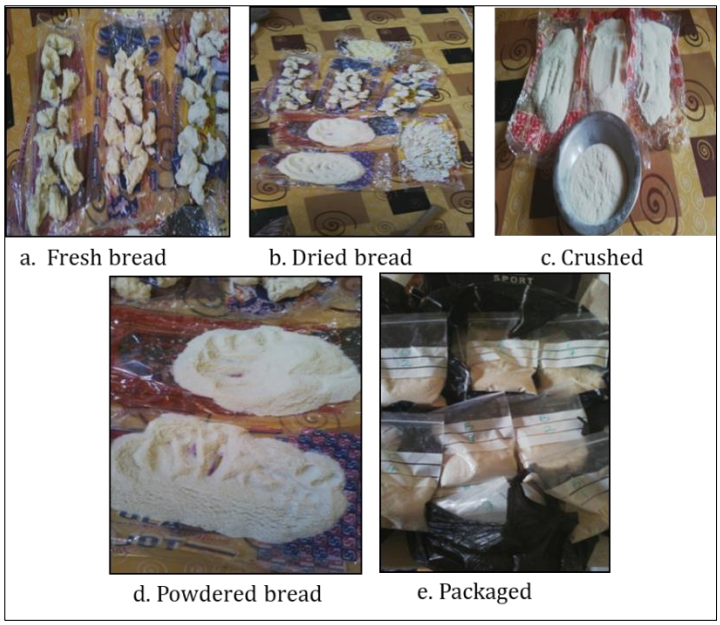

Figure 2 Processes of Bread sample preparation

2.3 Lab equipment's used

Weighing balance (Ohaus PA214), Oven (Mermet UNB 300), UV Vis (Unico UV2150), Centrifuge (Desktop TDL-50B), Shaker ((IKA HS501D), Hydrochloric acid, Sulphuric acid, Potassium iodide, Potassium bromate. Distilled water.

2.4 Preparation

Bread samples were collected from fourteen selected bakeries in the two different local government area (Bade and Nguru local government area) of Yobe state, which means seven bakeries were sampled for each local Government. Bread samples were bought directly from the bakeries in the choice area of Bade and Nguru local government area.

Studies were conducted between the periods of three Months from the month of October, December and March, in each month the breads were bought for five days for both Bade and Nguru, making a total of 70 bread samples for each month. After the purchase of the breads, 25 g was taken from the centre of each loaf of bread and dried for three to four days under room temperature to dry in the absence of sunlight. After drying the bread, dried crusts was pulverized into powdery form using mortar and pestle and finally sieve to obtain the powder. 10 g of the powdered sample were then packaged into a sampling polythene bag and taken for further analysis. Levels of potassium bromate ($KBrO_3$) was determined.

Each sample of powdered bread was dried in an oven at 70^0C for two hours. 1.0 g quantity was weighed out from each bread sample in an electronic weighing balance. This was transferred into a test tube. 10 ml of distilled water was added; the mixture was shaken using IKA universal shaker and allowed to stand for 20 min at 28 ± 10°C. The sample was decanted into a 15ml centrifuge tube and centrifuged at 3000rpm for 10 minutes. A 5.0 ml volume was decanted from the centrifuge tube and 5.0 ml quantity of freshly prepared 0.5% potassium iodide solution in 0.IN hydrochloric acid was added. Any colour change from light yellow to purple indicates the presence of potassium bromate. The absorbance of the sample was taken at 620 nm in UV spectrophotometer. Absorbance of the sample was converted to concentration with reference to calibration curve constructed for potassium bromate using the pure sample.

2.5 Statistical analysis

We ran a two way analysis of variance (ANOVA) to find out if there was any difference in the amount of bromate in Gashua and Nguru. The result showed a highly significant difference (F = 22.424, P = 0.000) in the amount of bromate detected in Gashua and Nguru. Similarly, there was highly significant difference (F = 23.01, P = 0.000) in the amount of bromate in kilograms detected in Gashua and Nguru.

3. Results and discussion

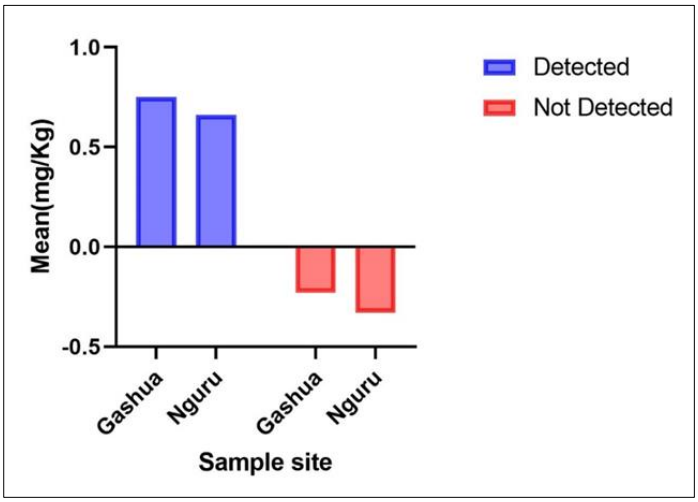

Figure 3 Overall results for three months

The overall Results from table 1 for the studies of three months shows that potassium bromate was detected in all the months and is highest in Gashua having 0.75±1.76 and Nguru 0.66 ±1.98 and can also be seen in figure 1 and 2. For the three month not detected the highest value is found in Gashua with -0.23 ±0.41 value, while the least is in Nguru -0.33 ±0.41.

Table 1 Mean standard deviation (±) of detected and not detected bromate according to sampling site

Sample Site	Detected	Not Detected
Gashua	0.75±1.76	-0.23 ±0.41
Nguru	0.66 ±1.98	-0.33 ±0.41
Total	0.71 ± 1.86	-0.28±0.41

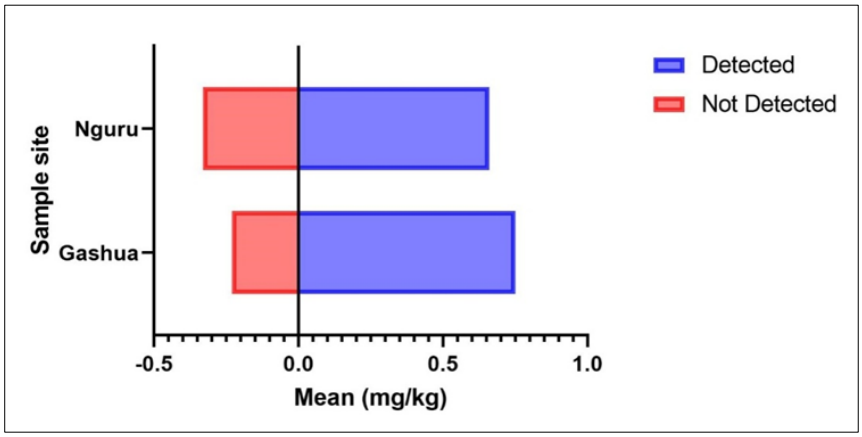

Figure 4 Summary of the overall results for three months

From table 2, Result for the mean and standard deviation shows higher value in Nguru 3.01 ±3.41mg/g and 2.47 ± 2.54mg/g in Gashua for the first month and 0.00 ±0.00 mg/g for both Nguru and Gashua for the third month.

Table 2 Mean and standard deviation of bromated detected and not detected for months of sampling

Sample site	Detected			Not Detected		
	Months of sample collection					
	First	Second	Third	First	Second	Third
Gashua	2.47 ± 2.54	0.22 ±0.86	0.00 ±0.00	-0.36 ±0.56	-0.16 ±0.21	-0.02 ±0.02
Nguru	3.01 ±3.41	0.02 ±0.05	0.00 ±0.00	-0.58 ±0.45	-0.10 ±0.14	-0.33±0.02
Total	2.69±2.88	0.13±0.64	0.00±0.00	-0.48 ±0.51	-0.13±0.18	-0.02±0.02

Table 3 Number of bromated detected (D) and not detected (ND) bromate according to months of sampling

Sample site	Detected			Not Detected		
	Months of sampling					
	D-First	D-Second	D-Third	ND-First	ND-Second	ND-Third
Gashua	18	18	29	17	17	6
Nguru	13	15	26	22	20	9
Total	31	33	55	39	37	15

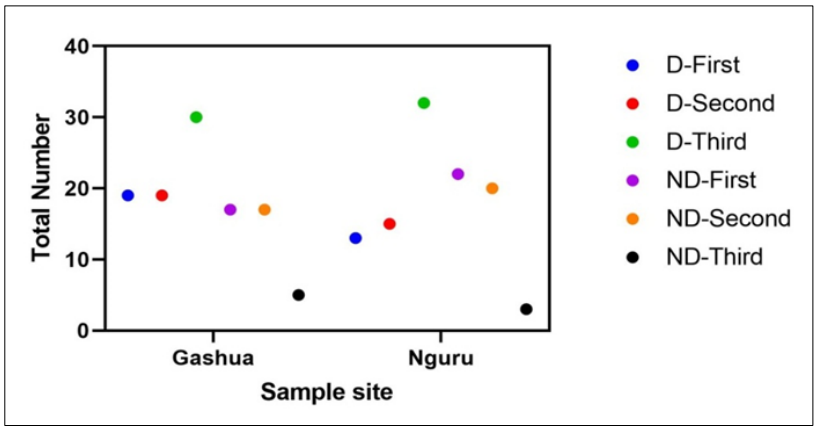

Figure 5 Results indicating each month of sample collection

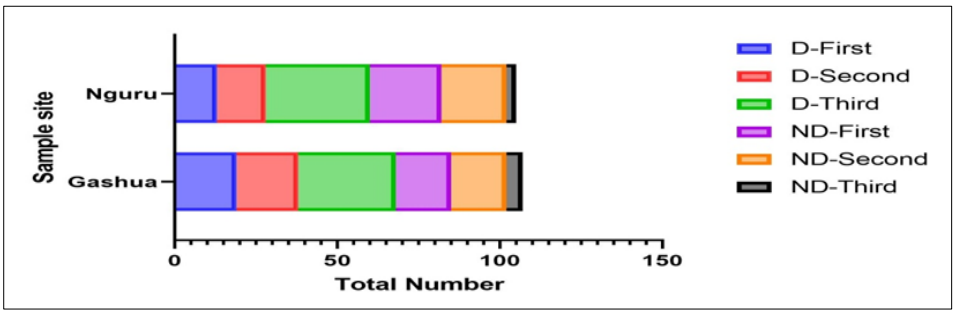

Figure 6 Months of sample collection

3.1 Sample Analysis

The analysis in figure 4 shows that the potassium bromate was detected in all the months both in Gashua and Nguru. The highest concentration was found in the third month and that was in Nguru. The least concentration was also found in Nguru in the first month.

Table 3 shows that out of the 210 bread samples analysed for the period of three months, potassium bromate was detected in 119 and was not detected in 91 bread samples. Out of the 119 bread samples that contained potassium bromate, 35 samples were above the permissible limit and 84 samples were lower than 0.02µg/g, which is the permissible safe level of potassium bromate allowed in bread by the US Food and Drug Agency (FDA) [11], and it also contravenes the NAFDAC ban on use of potassium bromate in bread. This implies that, most of the bread samples from Gashua and Nguru local government area of Yobe State analyzed in this study, were not safe for human consumption as far as potassium bromate content is concerned. The colour change of light-pink to dark-pink in the qualitative test correlates with the concentration of potassium bromate in the quantitative test. Potassium bromate in bread reacts with promethazine hydrochloride in the acidic medium to form a pink colour product [15]. The level of potassium bromate in bread samples obtained in this study is 12.16µg/g and 0.0001µg/g for highest and the lowest level of KBrO3 found in bread samples consumed in Nguru and Gashua town, but lower than the levels permitted by China (50µg/g). However, Similar studies conducted in Ibadan Metropolist [19], has value of least concentration of $KBrO_3$ to be 1.24 µg/g (which is 60 times higher than the permissible safe level) and the highest concentration contains 9.31 µg/g (which is 465 times higher than the permissible safe level). [2]. The values obtained from other studies is slightly different from the values of 1.2µg/g and 10.4 µg/g, minimum and maximum quantity of potassium bromate respectively, obtained from bread samples analyzed in Eastern part of Nigeria. Similar studies also conducted [20, 21] also shows the level of potassium bromate in bread samples to be 3.6 µg/g and 9.2 µg/g, 3.7µg/g and 12.6µg/g for the lowest and highest level of KBrO3 found in bread samples consumed in those areas.

Potassium bromate added to bread is unsafe to customers of bread because it is toxic and can cause severe abdominal pain, diarrhea, nausea, vomiting, kidney failure, oligonuria, anuria, deafness, vertigo, hypotension, depression of the

central nervous system, thrombocytopenia and cancer with other related health problems [22, 23]. It affects the nutritional quality of bread by degrading its vitamins and essential fatty acid content of flour [2].

4. Conclusion

In conclusion out of the 210 bread sampled, though potassium bromate was detected in most of the samples but only 36 were above the permissible limit and the concentration was above safe level for human utilization but all the rest were below permissible limit or not detected at all in all the bread sampled for potassium bromate in Gashua and Nguru, therefore bread consumers and bakers are at risk of contact 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. It should also be noted that since other alternatives are available in the market, the use of these alternatives should be encouraged which are healthy. Also a strict labeling for flour treatment agents in pre packaged bakery food should be applied so that the consumer can know what they are consuming. By so doing the general public should know that potassium bromate should not be used as improver/flour treatment agents in bread and bakery products.

Compliance with ethical standards

Acknowledgments

The authors acknowledged the grant received from The Tertiary Education Trust Fund (TetFund) through the Federal University, Gashua, Nigeria that made it possible to carry out this study.

Disclosure of conflict of interest

The author declare that they are no competing personal or financial interest that could have influenced the output of this work reported in this paper.

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