ESTIMATION OF THE POTASSIUM BROMATE CONTENT IN LOW AND HIGH PRICE BREAD SOLD IN BIRNIN KEBBI

Supported by tetfund

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Received: January 23, 2020 **Accepted:** June 14, 2020

Abstract: In 2003, NAFDAC which is the regulatory body concerned with the regulation of drugs, foods and chemicals in Nigeria banned the use of Potassium Bromate in bread because it poses a risk to human health and has been classified as type 2b carcinogen. In view of the foregoing, studies has been carried out to estimate the different concentration of use by the bakeries. In this study, twenty low price bread and fifteen high price bread were obtained from different bakeries within Birnin Kebbi metropolis. Qualitative and quantitative analysis indicates that, all the bread samples contain Potassium Bromate in quantities that transcend the limit recommended by NAFDAC. Twenty two of both low and high price bread samples are registered by NAFDAC while the remaining thirteen bread samples are not registered. The amount of potassium bromate in different low price bread range from 4.829 – 11.769 µg/g and 4.93 – 8.07 µg/g for the high price bread. It is therefore concluded that, exigent measure is required by the regulatory bodies to ensure that there is strict compliance to the ban of the use of potassium bromate as bread additive.

Keywords: Potassium bromate, bread, carcinogenicity, NAFDAC, Birnin Kebbi

Introduction

In Nigeria, bread is ubiquitous in nature. It is consumed in large amount in many houses, eateries and lodges (Emeje *et al.*, 2009). In spite of the fact that bread is made from diverse sources of carbohydrate like maize and rice, the most used flour in bread making is wheat of low protein. Bread is prepared by baking, and would frequently contain numerous other ingredients that increase the bread quality. The central ingredients in bread are flour, Sugars, table salt, flavors and at slightest a flour improver like potassium bromated (Vicki, 1997). Potassium bromate helps to strengthen the dough, enhancesits elasticity, promotes the swelling of the dough and as well makes the bread to be light and soft; qualities that catch the attention of customers. It is widely accepted that, "the main challenge facing both the bakeries and flour producing industry is the quality of the flour use in baking", and this is known by the extent to which the prepared dough withhold gas. In time past, quite a few bread improvers have been used but research have shown some to be injurious to health, in that way necessitating their ban. For example, in Nigeria, the use of potassium bromate as bread improver was banned by the country's zenithfood and drug regulatory agency; the National Agency for Food and Drug Administration and Control (NAFDAC) in 2003 (Ekop *et al.*, 2008). The war against the depletion of potassium bromate was so intense that, bakers would confidently write "bromate free" on their product labels (Emeje *et al.*, 2015). It became a norm in bread industry to produce bread that do not contain bromate precisely for NAFDAC tests just to secure approval, but subsequently, bakers persist to use this banned compound (Emeje *et al.*, 2015). Besides the carcinogenic effect of potassium bromate (Fisher *et al.*, 1979; Kurokawa *et al.*, 1986; Kurokawa *et al.*, 1990; Watson, 2000), it has shown cause cough and sore throat when inhaled (Atkins, 1993), kidney failure, breakdown of the nutritional quality of bread by its ability to degrade vitamins A_2, B_1, B_2, E and niacin which are the core vitamins in bread. Potassium bromate has also been reported to initiate diarrhea, abdominal pain, vomiting, nausea, hearing loss, kidney failure, bronchial and ocular problems.

Due to its poisonous effects, the abuse of potassium bromate in flour milling and baking was banned in Nigeria by National Agency for Food and Drug Administration and Control (NAFDAC) in 2003, and its use violate the drug and related products registration decree 20 of 1999 and NAFDAC decree 15 of 1993. Abdulla and Hassan (2009) analyzed 15 bread samples from Hawlermunicipality of Iraq by spectrophotometric method and found potassium bromate in each and every one of the bread samples in the range of 11.09 – 67.45 ppm.Bread samples from five bakeries in Addis Ababa, Ethiopia were analyzed by Ergetie and Hymete (2012) by spectrophotometric method. Potassium bromate was present in all the samples ranging from 5.615 – 9.974 mg/Kg. Alli *et al.* (2013) analyzed 20 bread samples of different brands consumed in the Gwagwalada area council of Abuja, Nigeria and found potassium bromate in all the 20 bread samples analyzed in the range of 3.6 – 9.2 µg/g. In a study carried out by Magomya *et al.* (2013) 15 different brands of bread samples produced in Zaria metropolis of Kaduna State were analyzed for the presence of potassium bromate and some heavy metals. The research showed the specter of potassium bromate in all the samples analyzed ranging from 2.46 – 13.60 µg/g.

Although, most of the bread produce in Birnin Kebbi are labeled "bromate free", scores of the bread industries persist with its use so as to increase their profits. This work was therefore necessary in order to estimate the bromate content of bread sold in Birnin Kebbi metropolis of Kebbi State to confirm the bakers' claims.

The overall aim of the research was to analyze the levels of potassium bromate in bread produced in Birnin Kebbi metropolis of Kebbi State, which are focal with interest to individual healthas well as the food quality control perspective.

Materials and Method

All reagents used are of analytical grade purchased from recognized chemical companies. Hydrochloric acid (Sigma chemical Co, St Louis USA), Potassium iodide (BDH, England), Potassium Bromate (Sigma Chemical Co, St Louis, USA). A total of 35 bread samples were purchased from different bakeries and outlets in Birnin Kebbi metropolis, Birnin Kebbi Local Government Area of Kebbi State. Twenty of the bread samples were low price (Sold in the range of N100 to N150) bread while 15 bread samples were high price (Sold in the range of N250 to N450) bread. The low and high

prices bread were represented with alphabet and numbers in the following format B1, B2, B3… B20 and H1, H2, H3… H15, respectively (Tables 1 and 2).

Table 1: Qualitative analysis of potassium bromate in low price bread

Bread Samples	Bread samples with Black spot	Regulatory NAFDAC status
	With Potassium Iodide	
B1	++	Registered
B2	+	Nil
B3	+	Registered
B4	+	Registered
B5	+	Registered
B6	+	Registered
B7	++	Registered
B8	+	Registered
B9	+	Registered
B10	+	Nil
B11	+	Nil
B12	+	Nil
B13	++	Registered
B14	++	Registered
B15	++	Nil
B16	+	Nil
B17	+	Nil
B18	+	Nil
B19	++	Registered
B20	+	Registered

++ = highly present; + = Present

Table 2: Qualitative analysis of potassium bromate in high price bread

Bread Samples	Bread samples with Black spot	Regulatory NAFDAC status
	With Potassium Iodide	
H1	++	Registered
H2	++	Nil
H3	+	Registered
H4	+	Nil
H5	+	Registered
H6	++	Registered
H7	++	Nil
H8	++	Registered
H9	+	Registered
H10	++	Registered
H11	+	Nil
H12	+	Registered
H13	+	Registered
H14	++	Registered
H15	++	Nil

++ = highly presence; + = Presence

Qualitative analysis of potassium bromate in bread

One gramme (1 g) from each bread brand was measured out into different test tubes. Water was added to wet the samples. 0.5 mL of 1% potassium iodide solution in 2M HCl was added. The test tubes were labeled, covered with foils and allowed to stand for a day. The appearances of black spots on the samples indicate the presence of potassium bromate in the bread samples.

Quantitative analysis of potassium bromate in bread

The approach reported by Emeje *et al.* (2009) was adopted with slight modification. One grams (1 g) of each of the 35 bread sample was weighed and transferred into a test tube, 10 mL of distilled water was added into each test tube, shaken vigorously and allowed to stand for 20 min at a temperature of 28 ± 10ºC. 5 mL of the solution was decanted into another test tube via a Whattman No 1 filter paper; then 5 mL of 0.5% prepared potassium iodide solution in 0.1N HCl was added to the solution. Any color change was noted. The presence of potassium bromate was indicated by change in color from light yellow to purple. The absorbance of the sample was taken at 620 nm in a UV-vis spectrophotometer (UV 1200, Japan). Absorbance of the sample was converted to concentration with reference to Beer's calibration curve previously constructed for potassium bromate using the pure sample. Values reported here are mean of three replicate determinations. The other bread samples were similarly treated.

The calibration curve was prepared by weighing out 1.0 g of potassium bromate using a weighing balance, and dissolved in 1000 ml of distilled water. Different concentrations were made by solving for original volume (V_1) using the formula $V_1 = C_2V_2 / C_1$. With Required volume (V_2) and original concentration (C_1) constant (10 and 1000 ml, respectively), different values were obtained for the original volume (V_1) with each of the values obtained for V_1 corresponding to the varying required concentration (C_2). They were all made up to 10 ml with 0.5 and 10 ml having the lowest and highest concentration, respectively.

A 5 ml quantity of freshly prepared 1 g of potassium iodide solution in 0.1N HCl was added to each pure sample. The absorbance of the sample was taken at 620 nm in a colorimeter. The result was used to plot a graph of absorbance against concentration. Hence, a calibration curve for potassium bromate was constructed using the concentration; 0.2, 0.4, 0.6, 0.8, 1.0 µg/g (ppm) (Fig. 1).

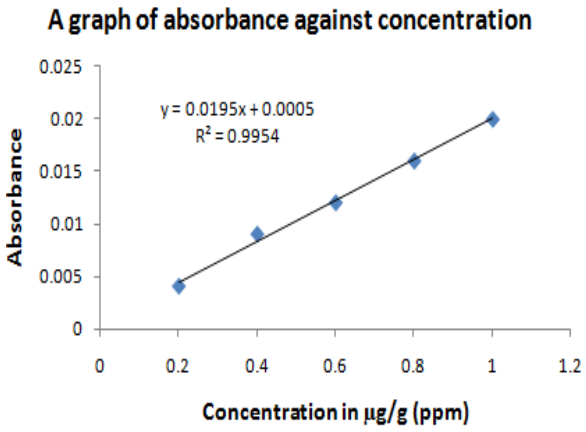

Fig. 1: Calibration curve for potassium bromate

Statistical analysis

Statistical analysis was done using excel software and the results were presented as mean ± SEM (Standard error of mean) for triplicate measurements where necessary.

Results and Discussion

Once Potassium Bromate forms a complex with potassium iodide, a purple colour is produced (Ojeka *et al.*, 2006). The intensity of the color depends on the concentration of potassium bromate in the reacting medium. In this research, a span of color reactions was observed which ranges from light purple to dark purple.

Table 3 and 4 show the color identification, registration status and the calculated concentration of potassium bromate based on the absorbance generated from UV/Vis spectrophotometer for the 35 bread samples. All bread samples analyzed for the presence of potassium bromate produced positive result to

varying degrees. The levels wereat values greater than the permissible limit set by World Health Organization, and NAFDAC. As shown in Table 3, the least and highest quantity of potassium bromate detected in low price bread was 4.829 and 11.769 µg/g, respectively. Table 4 shows that the least quantity of potassium bromate is 4.93 µg/g and the highest quantity is 8.07 µg/g for the high price bread. According to NAFDAC, the permissible amount of potassium bromate in bread is ≤0.02 µg/g. The effect of this result therefore is that, all the bread samples are unsafe for consumption. This is due to the fact that, the quantity of potassium bromate present in each of the 35 bread samples exceeds 0.02 µg/g. The result of this study is in accordance with those of Ojeka *et al.* (2006) published 2 years after the use of potassium bromate in bread has been banned in Nigeria, as well as Alli *et al.* (2013) and Ojo *et al.* (2013).

Table 3: Quantitative analysis of potassium bromate in high price bread

Bread Samples	Regulatory NAFDAC status	Quantity of $KBRO_3$ (µg/g)
H1	Registered	6.77±0.06
H2	Nil	8.07±0.02
H3	Registered	6.53±0.02
H4	Nil	6.49±0.02
H5	Registered	7.72±0.02
H6	Registered	7.26±0.02
H7	Nil	7.00±0.02
H8	Registered	7.00±0.05
H9	Registered	5.27±0.04
H10	Registered	7.77±0.03
H11	Nil	4.93±0.04
H12	Registered	5.51±0.03
H13	Registered	7.29±0.07
H14	Registered	7.53±0.04
H15	Nil	6.97±0.04

Results were in triplicates; n=3, (Mean ±SEM)

Table 4: Quantitative analysis of potassium bromate in low price bread

Bread Samples	Regulatory NAFDAC status	Quantity of $KBRO_3$ found in (µg/g)
B1	Registered	7.427 ±0.091
B2	Nil	6.692±0.107
B3	Registered	8.333±0.030
B4	Registered	7.445±0.074
B5	Registered	7.069±0.062
B6	Registered	8.060±0.017
B7	Registered	7.479±0.062
B8	Registered	7.376±0.045
B9	Registered	9.359±0.059
B10	Nil	4.829±0.075
B11	Nil	7.479±0.090
B12	Nil	5.735±0.017
B13	Registered	7.513±0.059
B14	Registered	11.769±0.089
B15	Nil	7.940±0.045
B16	Nil	11.479±0.045
B17	Nil	9.069±0.034
B18	Nil	8.880±0.062
B19	Registered	8.282±0.051
B20	Registered	9.427±0.045

Results were in triplicates; n=3, (Mean ±SEM)

The result obtained from this study indicated that, there is zero changes in terms of the attitude of bread industries to the use of potassium bromate in Nigeria nearly 16 years after its ban. Previous studies aimed to look for proof of approval by regulatory agency, which is depicted by NAFDAC registration number in Nigeria. Surprisingly, every bread samples in their study containing above the permissible limit of potassium bromate possessed NAFDAC registration number (Alli *et al.*, 2013; Ojo *et al.*, 2013).

There is a grim inference to this; it is either NAFDAC does not in reality examine the breads before registering them or that, once registration number is given, there is no device in place to observe the acquiescence by the bakers. NAFDAC has a functional section of pharmacovigilance and one would anticipate that, apart from drugs, foodstuffs should also be constantly monitored to guarantee the safety of life of the consumer. The manner in which bakers and business men use every means to defraud is of no help. It is eminent to recognize that, there are principally two means by which humans get poisoned with potassium bromate; by inhalation in its powdery form and by ingestion when it is used in food such as bread. Therefore, it is not safe for the bread consumer and the factory worker who works in a bakery where bromate is used as bread improver. The toxic effects of potassium bromate have been expressed in literature (Giesecke and Taillie, 2000). Recently *et al.* (2009) also described hepatotoxic and nephrotoxic adverse effects potassium bromate in rodents.

Potassium bromate is a flour enhancer that acts as a dough strengthener. It principally acts in the late dough stage giving strength to the dough. During dough preparation, a network of protein molecules linked together by disulphide bonds is formed. The strength and elasticity of the network which gives the dough its characteristic properties is best when the network comprises of long chain proteins such as gluten. Ayo *et al.* (2002) have showed the prospect of replacing potassium bromate with ascorbic acid. In their study, they showed that, on an equivalent cost basis, ascorbic acid was a more potent flour improver even though potassium bromate can achieve a greater loaf volume on equivalent weight basis. Due to the present circumstance and with the increasing cases of cancer in Nigeria, the need for NAFDAC to quickly set in motion device to shut down all bakeries still using potassium bromate and to ensure that, non-toxic bread improver such as ascorbic acid substitute for potassium bromate.

Conclusion

Potassium bromate is a mutagen and has been classified as class 2b carcinogen. The presence of detectable residue levels of potassium bromate in bread is therefore undesirable considering its health hazard. In this study, potassium bromate was found to be above the permissible limit of 0.02. All the 35 bread samples had an extraordinarily high content of $KBrO_3$, which is very hazardous to health. Bakers are therefore strongly advised against the use of potassium bromate as bread improver for the safety of the consumers and the factory workers. They should source alternative bread improvers such as potassium iodate (KIO_3), ascorbic acid etc. This study also emphasized the importance of routine checks by NAFDAC in order to ensure that industries are in compliance with rules and regulations, thereby safe guarding the life of ignorant Nigerians.

Conflict of Interest

Authors have declared that there is no conflict of interest reported in this work

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