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DETERMINATION OF POTASSIUM BROMATE IN BREAD SAMPLES IN JOS METROPOLIS

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ABSTRACT

Jos Metropolis is a town in north central Nigeria, it is the Headquarter of Plateau state. A total of 30 bread samples were selected randomly from ten shops in Jos Metropolis and used for thedetermination of the presence of potassium Bromate in the bread samples. The presence of potassium bromate in the samples was qualitativelyanalysed by the action of potassium bromate on potassium iodide. The change in colour of the test sample from light yellow to purple colourindicated the presence of potassium bromate in the sample. The concentration of the bromate in the samples were spectrophotometrically determined. The results showed that potassium bromate is still used as additive in bread despite the fact that it has been banned. The concentration of the bromate in the bread samples ranged(4.375-0.25 mg/g). This value is reasonably higer than the value reported by other researchers in other part of the country. The mean concentration of the additive in the sample decreases in this other; A = D >E > C > F > B > G > J > H > I. Also, the mean concentration of potassium bromate in all the samples was significantly different ($p<0.05$) from the maximum permissible level of 0.02 mg/Kg established by the United State Food and Drug Administration (US. FDA) for potassium bromated in bread. It is recommended among others that baker shoud use other additives that are not of health concern and also, there is need to educate the consumer on how to identify bromate contaminated bread.

Introduction

Bread is a staple food prepared from dough of wheat flour and water, usually by baking (Grotts, 2011). Throughout recorded history, it has been popular around the world and is one of the oldest artificial foods, having been of importance since the dawn of agriculture. In Nigeria bread is an essential food item because it is readily available and at a very low price. This makes it possible for all income earners to afford it. It is extensively consumed in homes, restaurants and hotels (Emeji*et al.*, 2009).

The Biochemistry of the baking of modern bread from wheat flour is fundamentally a temperature-dependent two step progression, consisting of fermentation, in which CO_2 production linked with yeast activity is manifested in porous dough structure with the development of dough volume during baking where yeast activity is ended and the bread structure is finalized (Gandikota and Ritchie, 2012). During leavening, the metabolism of yeasts chemically transforms assailable car-

bohydrates into carbon dioxide and ethyl alcohol as the principal finished products. As a related amount of alcohol forms, which is water-miscible, it influences the colloidal nature of the wheat proteins and changes the interfacial tension within the dough. In addition, carbon dioxide, which partly dissolves in the aqueous phase of the dough, migrates toward the initial nuclei of the air bubbles formed during kneading causing their increase. (Ahmad, *et al,* 2015)

A typical bread contain Yeast which ferments the carbs in dough and with the help of enzymes converts them to carbon dioxide, which makes the dough rise.Colouring agents are alsoadded because of the sensory appeal they provide and for the purpose of making processed bread look more appetizing.Texture stabilizersstrengthen breads' texture (E.g ascorbic acid, monoglycerides and diglycerides, ammonium chloride, enzymes, DATEM) and dough conditioners (doughimprovers) are also combined with flour to improve baking functionality, increase the speed of dough rising and to improve the strength and workability of the dough. There is wide range of these conditioners/improvers used in factory baking, these fall into four main categories: bleaching agents, oxidizing and reducing agents, enzymes, and emulsifiers (Hui and Corke, 2006). For example Potassium bromate,is a flower improver, a powerful oxidizing agent that ages flour and enhances its elasticity causing bread to rise and become white, fluffy and soft baking (Ahmad*et al*., 2015). Because of its efficient oxidizing properties, it acts as a maturing agent and dough conditioner by oxidizing the sulfurhydryl groups of the gluten protein in flour into disulphide bridges making it less extensible and more elastic; this makes the dough visco-elastic such that it can retain the carbon dioxide gas produced by the yeast. The overall effect is to increase loaf volume and texture (Nakamura *et al.,* 2006). Potassium Bromate acts as oxidizing agents, by helping to improve the dough by giving it long elasticity, rises the bread and better quality of the final product.

Potassium bromate though a bread quality improver but at high amount, is highly carcinogenic, causes low libido and renal damage. In some countries like India, Sri Lanka, Germany and Ugandan the use of potassium bromate as bread improver is highly prohibited and an offence. The world health organization and National Agency for Food and Drug Administration Control (NAFDAC) has stipulated the amount of bromate that should be used as bread improver, which they put at 0.02mg/Kg of bread produced (FAO/WHO, 1992; Akunyili, 2005). Though this limit has been set, bread producers sometimes still go beyond the set standard. Several studies have shown that potassium bromate has many dangerous effects; it exerts nephrotoxic and ototoxic effects in experimental animals as well as in man. It is a carcinogen that has been shown to induce renal cell tumors, mesotheliomas and thyroid follicular cell tumors in rats (Achukwu*et al.*, 2009). Studies have also shown that $KBrO_3$ can induce multiple organ toxicity in humans and experimental animals (Kujawska*et al*., 2013; Ahmad *et al*., 2015). $KBrO_3$ is extremely irritating and injurious to tissues especially those of the central nervous system (CNS) and kidneys (Robert and Williams, 1996). Mutagenic effects of $KBrO_3$ have been also reported in experimental animals (Airaodion*et al*., 2019).

In Nigeria, the use of potassium bromate in bread and related products is banned, yet a search of related literatures shows that compliance is very low in many cities in the country (Emeje*et al*., 2015; Airaodion*et al.*, 2019; Magomya*et al*., 2013; Oyekunle*et al*., 2013; Obunwo*et al.*, 2014; Kelle, 2017 and Ojo et al., 2013). Therefore, this study determined the presence of bromate in bread sample from Jos Metropolis since such study (with regard to the study area) had not been re-

ported in any literature recently.

Materials and Method

Sample Collection

Bread samples were purchased from shops, supermarket and open markets in different areas/location within the Jos metropolis, plateau State Nigeria. Exactly 30 bread samples were collected randomly from ten different (three from each) bread vendours cited at different locations and sites of production within Jos metropolis. The samples were crumbed and dried in an oven at (75 ± 10^0C) for 24 hours and crushed into powder which was accurately weighed and used for the analysis.

Preparation of Standard Solution

Exactly 1.57g of potassium bromate crystal of analytical grade (BDH Chemicals Ltd, Poole, England) was weighed and dissolved in 1000 ml of dstilled water in a 1000 ml capacity conical flask to prepare the standard solution of $KBrO_3$. And 250ml of distilled water was measured into volumetric flask and 2.2 mlof Conc. HCl was added to form an acidified water, after which 5.0 g of potassium iodide crystal of analytical grade (Burogyne, Germany) was weighed accurately using the electronic weighing balance (Adventurer-OHAUS, Julabo, USA) and was added to the acidified water and mixed to form 5 % KI solution. Aliquots of 0.1 ml, 0.2 ml, 0.3 ml, 0.4 ml and 0.5 ml of $KBrO_3$ weremeasure form the primary standard solution of $KBrO_3$ prepared into five test tubes labeled 1-5**.** An Aliquot of 5 ml of the 5 % KI was added to each tube, the mixtures were shaken vigorously for 1 minute and the absorbance were taken at 620 nm on a spectrophotometer (JENAY-6300 S UV/Vis, Chelmsfeld. England) using the blank solution prepared. The absorbance obtained was used to plot the standard calibration curve for the experiment.

Analysis of the bread samples

Potassium bromated in the bread samples were qualitatively and quantitatively analyzed using the potassium iodide method of Emeje*et al.* (2009).

Potassium bromate; a powerful oxidizing agent, in an acidic medium oxidizes potassium iodide to liberate iodine and producing a purple violet colouration. This is shown in the reaction below:

$$BrO_3^- + 6I^- + 6H^+ \longrightarrow Br^- + 3I_2 + 3H_20$$

The absorbance of the coloured substance was measured at 620 nm using a spectrophotometer following the Beer-Lambert's law "This law states that the concentration of a solute is proportional to the absorbance". The concentration of the potassium bromated present in each sample is obtained from the straight line calibration curve obeying the Beer-Lambert's Law.

In the qualitative analysis of the bread sample for the presence of potassium bromate, 1.0 g of the bread powder was weighed accurately into different test tubes and 10 ml of distilled water was added to each. The mixtures were shaken and allowed to stand in a water bath at 28 ^{o}c for 20 minutes. The temperature in the water bath was monitored using a thermometer after which the samples were removed and cooled. And 5.0 ml of the freshly prepared 5 % potassium iodide solution in 0.1 M hydrochloric acid was added, the change in colour of the solution from the light yellow colour of the potassium iodide to purple colour of the oxidized potassium iodide indicates the presence of potassium bromate.

The quantitative analysis was carried out by measuring the absorbance of the coloured solution in a spectrophotometer at

620 nm using the blank solution to set the machine to zero. The various concentrations of potassium bromate present in the samples were obtained by the plot of absorbance against concentration in the standard curve.

Result and Discussion

The geographical distribution of the bread samples collected from areas within Jos metropolis is shown in the table below

Table I: Samples and their geographical distributions.

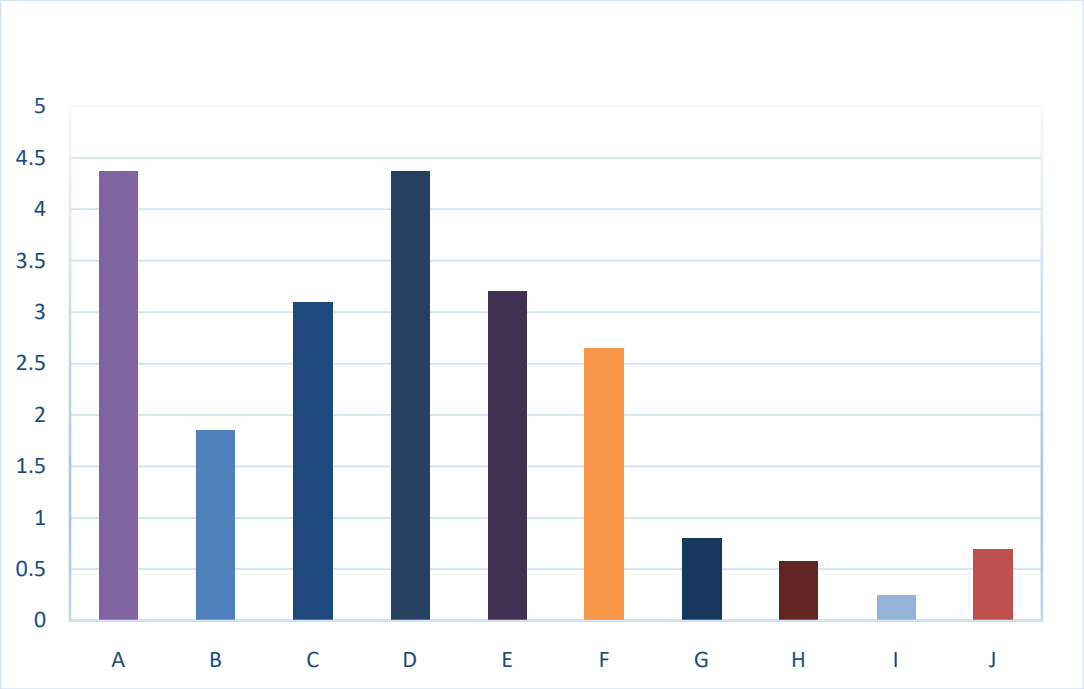
Sample No.	Brand/Baker	Retail Outlet	Location of Retail Outlet
A	Santa Bread	Open shop	Zaria-By-Pass
B	Gift Super Loaf	Super Market	Tafawa-Balewa
C	Kingdom Tip-Top Bread	Open Shop	JentaMakeri
D	Peez Bread	Open Market	JentaMakeri
E	Day-to-Day Bread	Super Market	JentaMakeri
F	Ultimate Bread	Super Market	Jenta Mango
G	Family Choice	Open market	JentaAdamu
H	Oxford Loaf	Open Market	JentaAdamu
I	Grace Super Loaf	Provision Shop	Farin-Gada
J	Glady Bread	Provision shop	Farin-Gada

Table II: Potassium Bromate content of Various Bread Samples Analyzed

Sample No.	Brand/Baker	Location of Retail Outlet	Concentration (mg/g)
A	Santa Bread	Zaria-By-Pass	4.3750±0.0256
B	Gift Super Loaf	Tafawa-Balewa	1.8500±0.0197
C	Kingdom Tip-Top Bread	JentaMakeri	3.1000±0.0185
D	Peez Bread	JentaMakeri	4.3750±0.0409
E	Day-to-Day Bread	JentaMakeri	3.2050±0.0172
F	Ultimate Bread	Jenta Mango	2.6500±0.0328
G	Family Choice	JentaAdamu	0.8000±0.0143
H	Oxford Loaf	JentaAdamu	0.5750±0.0135
I	Grace Super Loaf	Farin-Gada	0.2500±0.0081
J	Glady Bread	Farin-Gada	0.7000±0.0195

Concentration reported in mean ± standard deviation

Figure I: Graphical representation of concentration of $KBrO_3$ in bread samples



Discussion

The result of the concentration of $KBrO_3$ in bread samples obtained from Jos Metropolis shows that all the samples (A-J) contain detectable concentration of potassium bromate. The highest concentration of potassium bromated was observed for sample 'A' and 'D' while sample 'I' had the lowest concentration of the additive under consideration. Considering the overall result, the mean concentration of potassium bromated in all the brands decreased in the order of A = D >E > C > F > B > G > J > H > I. however, the mean concentration of potassium bromate in all the samples was significantly different ($p<0.05$) from the maximum permissible level of 0.02 mg/Kg established by the United State Food and Drug Administration (US. FDA) for potassium bromated in bread.

The results of this research shows that the bread samples analyzed were highly contaminated with bromate. This is in agreement with the study of Airaodion*et al.* (2019), which reported that all the loaves of bread sampled analyzed had potassium bromate in concentration above safe level for human consumption, therefore bread consumers and bakers are at risk of exposure to potassium bromate with health implications. Independent researchers had consistently reported the presence of $KBrO_3$ in bread samples. The concentration of $KBrO_3$ ranges from 0.036 -0.092 mg/g as reported by Alli*et al.* (2013), and 0.012 – 0.093 mg/g as reported by Airaodion*et al.* (2019), in the studies carried out in Gwagwalada Abuja and Ibadan respectively. A similar study by Emeje*et al.* (2015), which analysed bromate levels in bread brands sold in Abuja reported a concentration range of 1.01 – 11.33µg/g. Similarly, Magomya*et al*. (2013), reported bromate concentration range of 2.46 – 13.60 µg/g in a study of bread samples sold in Zaria Nigeria. Oyekunle *et al*. (2014), also reported that the bromate concentration range of 6.33 – 41.336 µg/g was obtained in their study of bread brands sold in Ile-ife metropolis of south-western Nigeria. Obunwo*et al.* (2014),Kelle*et al.* (2017) and Ojo*et al.* (2013) reported 0.12 – 7.28 µg/g, 1.4 – 5.1 µg/g and 0.5 -8.4 µg/g, as the concentration ranges of bromate in bread brands sold in port-harcourt, Asaba and Karu, Ni-

geria respectively .

It has become so serious that the regulatory agencies should no longer keep quiet but act towards enforcing the law against the use of bromate as additive in bread especially in Jos metropolis where this study was carried out. It is clear from the study that the concentration of bromate in bread samples is high and this pose a lot of health challenge to the society as bread is one of the food that is consumed by almost all households in Nigeria, being poor or rich notwithstanding. Bromate induce cancer by reacting intracellular with glutathione or other thiols in target tissues to generate reactive bromine-containing species that result in the formation of 8-Hydroxy-2-deoxyguanosine adducts in DNA (IARC, 1992). It also inhibits certain proteolytic enzymes thereby affecting the nutritional quality of the baked products. This leads to degradation of vitamin A, $B_{1,}$ $B_{2,}$ E and niacin which are the major vitamins in Baked Bread (Ekop*et al.*,2008).And hence its consumption is a threat to national development as the wealth of any nation depends on the health her citizens

Conclusion

This research work confirmed that Bakers in the Jos Metropolis, despite the ban placed on the use of the toxic potassium bromate has refused to comply as all the bread samples analyzed, tested positive for the presence of bromate and with a very high concentration of bromate residues.

Recommendation

I enjoin NAFDAC to organize a nationwide consumer sensitization on the possible effect of consuming a bromate bread and to provide information on how consumers can make a quick physical identification of suspected bromated bread pending laboratory confirmation, this will eradicate ignorance among consumers and possibly contribute to NAFDAC's effort in curtailing the abuse. Bakers are also enjoined to restrain from the use of bromate and return to the use of l-ascorbic acid (E300) as a good alternative (Ayo, 2002).

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