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Full Length Research paper

Assessment of bread safety in Nigeria: Quantitative determination of potassium bromate and lead

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Potassium bromate is an additive widely employed by bread makers to improve bread quality. On account of its deleterious effect and carcinogenicity in humans, certain levels of potassium bromate are not allowed in bread. Use of potassium bromate in bread is banned in many countries including Nigeria. The present evaluation was carried out in eastern part of Nigeria where consumption of bread is high. Twenty-three different brands of breads were sampled. Quality assessment shows that, all the brands contained potassium bromate in a quantity that exceeded the minimum allowed by the FDA. In addition, all the sampled breads contained trace amount of lead, a substance which is harmful to health. On the basis of these, all twenty three bread brands sampled were considered unsafe for human consumption and bread makers should be discouraged from using potassium bromate as bread improver.

Key words: Bread, safety, potassium bromate, lead.

INTRODUCTION

Bread is an important source of food in Nigeria. It is consumed extensively in homes, restaurants and hotels. Bread is made from low protein wheat. It usually contains several ingredients that would help improve the quality of the bread. Some of the basic identified ingredients, apart from flour are table salt, sugars, flavors and at least a flour improver such as potassium bromate (Vicki, 1997). The major challenge in both flour milling industry and bakeries is the baking quality of flour, which is determined by the capacity of the dough prepared from it to retain gas. As a result of wide variations in the composition of flour, various treatments and supplements/ conditioning agents (flour/bread improvers) are added for strength during mixing, extensibility for molding and also to increase loaf volume and texture. Over the years, several improvers have been used but studies have shown some to be deleterious to health, thereby necessitating their ban. The use of potassium bromate has been a common choice among flour miller and bakers throughout the world because it is cheap and probably the most efficient oxidizing agent. It acts as a slow oxidizing agent throughout the fermentation proofing and baking process affecting the structure and the rheological properties of the dough. As a result, many bakeries use potassium bromate as an additive to assist in the raising process and to produce a texture in the finished product that is appealing to the public.

Potassium bromate has adverse effect on health and its health effects are divided into two categories. The first category deals with effects related to non cancer effect. This includes its effect on the nutritional quality of bread. It degrades vitamins A2, B1, B2, E and niacin which are the main vitamins available in bread (IARC, 1999). Studies (IARC, 1999) have shown significant differences in essential fatty acid content of flour treated with bromate or in bread made from flour containing bromate. In humans, potassium bromate can cause cough and sore throat when inhaled (Atkins, 1993). Abdominal pain, diarrhea, nausea, vomiting, kidney failure, hearing loss, bronchial and ocular problems, are some of the other non cancer health problems associated with ingestion of potassium bromate (Atkins, 1993). In the second category, numerous studies have revealed the potential of potassium bromate to cause cancer in experimental animals and in humans (CSPI, 1999; Watson, 2000). In

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Nigeria, and in many parts of the world, use of potassium bromate as bread improver has been banned (Ekop et al., 2008; http://www.compassnews.net). In Nigeria however, some bread makers/bakeries have continued to include potassium bromate in their bread.

Furthermore, a preliminary survey revealed that some other materials employed in bread making (e.g. water) and the environments where these bakeries are located are not free from contamination by heavy metals such as lead. It is against this background that this investigation was undertaken in eastern part of Nigeria where bread consumption is very high and where many of the bakeries are located in the midst of slums and squartments. This study therefore is aimed at assessing the safety of bread being marketed in the Nigerian market.

MATERIALS AND METHODS

Materials

The following reagents were used: hydrochloric acid, sulphuric acid, potassium iodide, dithisone, lead, potassium bromate (Sigma. Chem. Co, USA). Distilled water used was double distilled. Bread samples were purchased from open markets, bus stops and from bread vendors in the eastern part of Nigeria. A total of twenty three different brands of bread were used in the study.

Method

Analysis of potassium bromate in bread

Potassium bromate in the bread samples was qualitatively and quantitatively analyzed using previously reported methods (David, 1976). A 1.0 g quantity was weighed out from each bread sample in an electronic weighing balance. This was transferred into a test tube. Ten milliliter (10 ml) of distilled water was added; the mixture was shaken and allowed to stand for 20 min at 28 ± 10°C. A 5.0 ml volume was decanted from the test tube. A 5.0 ml quantity of freshly prepared 0.5% potassium iodide solution in 0.IN hydrochloric acid was added. Any colour change was noted. The presence of potassium bromate was indicated by change in colour from light yellow to purple (David, 1976). The absorbance of the sample was taken at 620 nm in a colorimeter (CAM- Spec. M330). 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 presented are mean of five replicate determinations. The other bread samples were similarly treated.

Analysis of lead in the bread samples

The qualitative and quantitative analysis of lead in the bread samples were done in two stages. The first stage involved ashing of the bread samples and the second stage involved the actual analysis of lead in the samples. A 2.0 g quantity of each bread sample was placed in a crucible. The crucible was placed in a furnace set at temperature of 700°C and allowed to stay for 2 h. The samples were removed, cooled and analyzed for the presence and quantity of lead as follows: To each sample in a crucible, 45.0 ml of distilled water was added. The mixture was stirred for 5 min. A 5.0 ml volume was transferred to a test tube from each crucible and 3 drops of dithiozone solution were added. An immediate change of color from green to pink indicated the presence of lead in the sample (HHDEIFT, 1998). The absorbances of the samples were taken in a colorimeter (CAM-Spec. M 330) at 520 nm. Absorbances were converted to concentrations in micrograms from Beer's calibration curve obtained with pure lead sample.

RESULTS AND DISCUSSION

Potassium bromate complexed with potassium iodide to give a purple colouration. The colour change ranged from light purple to dark purple with increase in concentration. The degrees of colour change correlates with the level of potassium bromate present (HHDEIFT, 1998). A results showing the colour identification of potassium bromate in the 23 bread samples is presented in Table 1. Two of the bread samples (samples D and E) did not show any visible colour change when they were treated with potassium iodide. It is possible that they contained no potassium bromate or that potassium bromate was present in the samples in residual amount that could not be detected by the reagent. All the other samples indicated positive result for the presence of potassium bromate to varying degrees. Table 1 also shows the quantitative amount of potassium bromate found in each sample. The least quantity of potassium bromate detected was 1.16 µg/ml (1.16 µg/g) and the maximum quantity was 10.44 µg/ml (10.44 µg/g). The maximum amount of potassium bromate allowed in bread by the FDA is 0.02 µg/g (Ekop et al., 2008). The amount of potassium bromate found in each of the 23 bread samples was more than 0.02 µg/g, implying that, none of the 23 bread brands marketed in eastern part of Nigeria is safe for human consumption (Atkins, 1993). There are basically two ways by which humans may get poisoned with potassium bromate; by ingestion when it is present in food such as bread and by inhalation. It is therefore, not safe for the bread consumer and the factory worker who works in a bakery where the substance is used a bread improver.

Potassium bromate is a flour improver that acts as a maturing agent. It acts principally in the late dough stage giving strength to the dough during late proofing and early baking (Fisher, 1996). During the preparation of the dough, 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. Short chain peptides such as glutathione 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 such as potassium bromate (Cogswell, 1997). In the presence of any of this oxidizing agent, the glutathione is oxidized to glutathione disulphide and therefore can not interfere with disulphide links of the gluten molecules (Kent, 1984). In a study by Ayo et al. (2002), Ascorbic acid compared favourably with potassium bromate in improving the loaf volume of bread. On an equivalent cost basis ascorbic acid can be

Table 1. Qualitative and quantitative determination of lead and potassium bromate in some bread samples.

	Bread samples color reaction with potassium iodide	Quantity of potassium bromate found (µg/g)	Quantity of lead found (µg/g))
A	Purple	3.3333 ± 0.004	0.6020 ± 0.062
B	Purple	4.1067 ± 0.012	0.5775 ± 0.001
C	Light purple	2.7600 ± 0.001	0.4970 ± 0.037
D	No visible color	1.6000 ± 0.011	0.7770 ± 0.034
E	No visible color	1.1600 ± 20.006	0.5040 ± 0.041
F	Dark purple	6.2800 ± 0.010	0.7490 ± 0.012
G	Dark purple	4.9067 ± 0.000	0.7490 ± 0.011
H	Dark purple	10.4400 ± 0.003	0.7420 ± 0.021
I	Purple	3.3467± 0.011	0.5810 ± 0.025
J	Purple	4.7800 ± 0.015	0.5775 ± 0.036
K	Dark purple	6.6800 ± 0.002	0.5390 ± 3.038
L	Light purple	3.600 ± 0.020	0.4585 ± 0.013
M	Light purple	1.3333 ± 0.33	0.0875 ± 0.016
N	Purple	1.3333 ± 0.023	0.7420 ± 0.013
O	Dark purple	4.2133 ± 0.021	0.4270 ± 0.031
P	Purple	4.2133 ± 0.021	0.4270 ± 0.028
Q	Purple	3.5333 ± 0.018	0.4550 ± 0.001
R	Purple	2.8267 ± 0.011	0.5040 ± 0.051
S	Purple	4.3467 ± 0.016	0.5810 ± 0.066
T	Light purple	2.4400 ± 0.080	0.4760 ± 0.041
U	Light purple	2.3400 ± 0.023	0.4270 ± 0.013
V	Light purple	2.7800 ± 0.052	0.7840 ± 0.013
W	Purple	2.9067 ± 0.050	0.5200 ± 0.06

considered a more effective improver even though bromate can achieve a higher loaf volume on equivalent weight basis.

The quantity of lead found in the bread samples ranged from 0.0875 - 0.7840 g/g (Table 1). All bread samples contained traces of lead. Lead is toxic to humans and kidney damage due to lead poisoning can occur at exposure of about 40 µg/dl. Nerve damage and anemia can occur at levels of 60 µg/dl. Long term exposure to lead has been linked to hypertension and stroke (Cogswell, 1997). Levels of 150 µg/dl and above are associated with acute lead encephalopathy whose warning signs include joint paints, irritability, headaches, constipation and abdominal pain (Kurokawa et al., 1990). Even though the levels detected in the bread samples are relatively low, long exposure to lead can lead to accumulation and subsequent health hazard. Bread or flour can be contaminated by lead through peeling, chipping, chalking or cracking of lead based paints on the walls of the bakery or the factory where the flour is produced. It is possible that the wheat from where the flour is made is grown on soil contaminated with lead such that the resulting flour is contaminated with lead from source. Water and water stored in lead based tanks and pipes are another source of lead in bread. It is therefore suggested that alternative bread improvers such as ascorbic acid should replace potassium bromate which is currently being used by some bakeries (Ayo et al., 2002). Potassium bromate is used in small amounts and disappears during baking.

Conclusion

The results of this study show that, all the 23 bread samples analyzed contain potassium bromate above limit and some traces of lead. Bakers should ensure that appropriate hygiene and proper water treatment are maintained in and around facilities where bread is produced. This study also underscores the importance of routine checks by the regulatory authorities in order to ensure that bakers always comply with rules and regulations in order to safe guard the life of unsuspecting Nigerians.

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