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Analysis of Potassium Bromate and Hydrocyanic Acid Contents of Commonly Consumed Loaves of Bread and Wheat Flour Samples In Karu,Nasarawa State, Nigeria

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Abstract: *The potassium bromate and hydrocyanic acid contents in commonly consumed fourteen loaves of bread and four most popular wheat flour brands among the bakers in Karu local government of Nasarawa state, Nigeria were assessed for potassium bromate and hydrocyanic acid contents. Potassium bromate in bread samples analyzed ranged between 0.5µg/g to 8.4µg/g and 0.83µg/g to 1.42µg/g in wheat flour samples. The hydrocyanic acid contents of the bread and wheat flour samples analyzed ranged between 1.510 to 3.676 mg/1000g and 0.706 to 1.498 mg/1000g sample respectively. These results implied that all the loaves of bread and wheat flour brands analysed contained potassium bromate in high quantity above safe level for human consumption and various amount of hydrocyanic acid which however, will not lead to the lethal dose of 35 mg hydrocyanic acid per kg body weight but there is need for continuous surveillance and enforcement of the ban on the use of potassium bromate in baking industry in this study area by NAFDAC.*

Keywords: *Bread, Hydrocyanic acid, Picric acid, Potassium bromate, Wheat*

I. Introduction

Bread is an important staple food of many countries of the world especially the African countries, where it is consumed extensively [1]. It is usually made from low protein wheat flour, water and other ingredients which are usually combined with a leavening agent to improve its quality [2, 3].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 supplements or conditioning agents (improvers) are added during mixing and moulding to increase loaf volume, texture and strength [3].

The use of potassium bromate has been a common choice among flour millers and bakers throughout the world because it is cheap and acts as a maturing agent and dough conditioner by oxidizing the sulphydryl groups of the gluten protein in flour into disulphide bridges making it less extensible and more elastic such that it can retain the carbon dioxide gas produced by the yeast. The overall effect is to make bread rise in the oven, increase loaf volume and texture 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 [3, 4]. Over time, it has been discovered that potassium bromate is toxic and can cause abdominal pain, diarrhoea, nausea, vomiting, kidney failure, oligonuria, anuria, deafness, vertigo, and hypotension, depression of the central nervous system, thrombocytopenia and cancer with other related health problems [5, 6]. In addition to these, it affects the nutritional quality of bread by degrading the vitamins and essential fatty acid contents of flour [3].Due to its toxic effects the National Agency for Food and Drug Administration and Control (NAFDAC) in Nigeria has banned its further use in bread, but many Nigerian bakers continue to use it in other to enhance their profits [2].

Many plant species produce and sequester cyanogenic glycosides [7] which is toxic to humans leading to vomiting, exacerbate goitre, cretinism in iodine-deficient regions, nausea, dizziness, stomach pains, weakness, headache, diarrhea, paralysis, neurological disorders, Tropical Ataxic Neuropathy (TAN), stunting of children and occasionally, death [8, 9, 10].The toxic effect is due to the hydrocyanic acid (HCN) released during the hydrolysis of cyanogenic glucosides[11,12,13].

The main objective of this study was to evaluate the potassium bromate and hydrocyanic acid contents in commonly consumed loaves of bread and wheat flour samples in Karu local government of

Nasarawa state ,Nigeria, as most of these products labels only indicates the nutritional attributes and not their safety which is taken for granted in developing countries.

II. Materials and Method

2.1. Survey and collection of bread and wheat flour samples

A survey of available loaves of bread and flour samples in karu, Nasarawa state in Northern part of Nigeria, were carried out in bakeries, fast foods outlets, open markets, bus stops and flour distributors' shops in Karu local government. Fourteen different types of bread samples freshly baked and well packaged by their bakers were selected based on their availability and popularity among the majority of the consumers; also four most popular wheat flour brands among the bakers were selected. The bread samples are represented with alphabets while the flour samples are represented by their National Agency for Food and Drug Administration Control (NAFDAC) numbers.

2.2 Chemicals

Hydrochloric acid (Sigma chemical Co, St Louis USA), Potassium iodide (BDH, England), Potassium Bromate (Sigma chemical Co, St Louis, USA), Potassium cyanide (Sigma chemical Co, St Louis, USA), Picric acid (BDH, England), Sodium hydroxide (Hopkins and Williams Ltd, England).

2.3. Determination of potassium bromate in bread and wheat flour samples

Potassium bromate contents of the bread and wheat flour samples were analyzed using previously reported method [14]. 1.0 g was weighed out from each bread or wheat flour sample in an electronic weighing balance. This was transferred into a test tube. Ten milliliter (10 ml) of distilled water was added and the mixture was shaken and allowed to stand for 20 min at 28 ± 5°C. 5.0 ml was decanted from the test tube into another test tube and 5.0 ml 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 [14]. The absorbance of the sample was taken at 540 nm in a spectrophotometer (Spectrum Lab 752S). Absorbance of the sample was converted to concentration with reference to Beer's calibration curve previously constructed for potassium bromate using the pure sample.

2.4 Determination of hydrocyanic acid in bread and wheat flour samples

The hydrocyanic acid of the samples was determined using the alkaline picrate method with modifications [15].1.0 g of the sample was weighed out from each bread or wheat flour sample in an electronic weighing balance. This was transferred into a 100ml volumetric flask. Ten milliliter (10 ml) of distilled water was added; the mixture was shaken and allowed to stand for 30 mins at 28 ± 5°C. The supernatant was collected and measured with measuring cylinder and was used for cyanide analysis. For this analysis, 1ml of the sample was pipette into test tube followed by 1ml of 0.04M picric acid and 1ml of 0.75M NaOH .The solution in the test tube was mixed and incubated for 15 minutes at room temperature. In this method, hydrocyanic acid (HCN) released during hydrolysis of the cyanogenic glycosides reacts with picric acid to produce a yellow colored solution. Sodium hydroxide preserves the HCN released. Colour intensity was measured spectrophotometrically at the wavelength of 540nm.The same process above was used for all other samples and the reference standard.

Calculation:

$$CONC_{HCN} = \frac{O.D_{TEST}}{O.D_{STD}} \times \frac{CONC_{STD} \times \text{Volume obtained}}{\text{Volume of sample used}} \times 1000$$

O.D = Optical Density/Absorbance
STD= standard
Conc= Concentration

2.5 Statistical analysis

The data are expressed as mean ± SD. Readings were compared using the one-way ANOVA analysis and Independent sample test. Statistical analysis was performed using SPSS (Version 17). A level of $p < 0.05$ was considered to be significant

III. Result and Discussion

Potassium bromate in bread samples analyzed is shown in (Table 1). The sample with the least concentration of potassium bromate is sample G (0.5µg/g) while the highest concentration was found in sample N (8.4µg/g). These levels are higher than 0.02µg/g, permitted by the US Food and Drug Agency (FDA) [17] but lower than the levels permitted by China (50µg/g) and Japan (10µg/g). These high concentrations are in

agreement with other findings which showed that most loaves of bread in Nigerian cities have high potassium bromate contents [3, 16, and 18].

Table 1: Concentration of potassium bromate (µg/g) in bread samples

Bread samples	Potassium bromate (µg/g)
A.	7.4 ± 0.01^{c}
B.	2.4 ± 0.06^{b}
C.	6.0 ± 0.01^{c}
D.	7.2 ± 0.01^{c}
E.	6.4 ± 0.25^{c}
F.	6.3 ± 0.17^{c}
G.	0.5 ± 0.05^{a}
H.	8.3 ± 0.02^{c}
I.	6.0 ± 0.18^{c}
J.	4.2 ± 0.01^{b}
K.	3.2 ± 0.01^{b}
L.	5.2 ± 0.21^{c}
M.	6.5 ± 0.03^{c}
N.	8.4 ± 0.12^{c}
O.	0.9 ± 0.04^{a}

Results are expressed as mean $\pm$ standard deviation of three observations. Values with similar alphabet do not show significant differences at $p<0.05$

The flour samples (Table 2) from which most of the bakeries in the study areas claimed to have baked their loaves of bread from have lower Potassium bromate levels compare to the bread samples and it is a known fact that potassium bromate evaporates during the baking process. The high amount of potassium bromate found in the analyzed bread samples is an indication that the compliance with NAFDAC ban on the use of potassium bromate in bread is poor and there is high dietary exposure to potassium bromate through bread consumption in this area which is an indication that the regulatory agency need to step up their surveillance and enforcement of this rule. Potassium bromate added to bread is harmful to consumers of bread because it is toxic and can cause 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 [5,6]. In addition it affects the nutritional quality of bread by degrading its vitamins and essential fatty acid content of flour [3]

Table 2: Concentration of potassium bromate (µg/g) in wheat flour samples

Wheat flour samples	potassium bromate(µg/g)
01-2137	0.83 ± 0.01^{a}
01-5189	0.86 ± 0.01^{a}
01-1007	1.23 ± 0.01^{b}
01-74883	1.42 ± 0.01^{b}

Results are expressed as meant standard deviation of three observations. Values with similar alphabet do not show significant differences at $p<0.05$

For the analysis of the hydrocyanic acid contents of the samples, hydrocyanic acid (HCN) released during hydrolysis of the cyanogenic glycosides when it reacts with picric acid was quantified .The hydrocyanic acid contents of the bread and flour samples analyzed were in the range 1.510 to 3.676 mg/1000g and 0.706 to 1.054 mg/1000g respectively(Tables 3 and 4). The result showed a low hydrocyanic acid content compare with the observation of Ekop *et al. [*17]. There was a significant difference ($P\leq0.05$) between the hydrocyanic acid content of bread sample with lowest hydrocyanic acid content and flour with lowest hydrocyanic acid content .This same relationship was observed with samples with highest concentration in each group(Tables 3 and 4) . This suggest that the bakeries in the study area must have probably added another substance containing hydrocyanic acid or cyanogenic glucoside of which the commonest in this area is cassava flour to enhance their profit and reduced the cost of production. The toxic effect of cyanogenic glycosides in food is linked to the hydrocyanic acid (HCN) released during the hydrolysis of cyanogenic glucosides[11,12,13],this leads to inhibition of cellular oxidation and the activity of vitamin K dependent carboxylase of the liver in addition to exacerbate goitre , cretinism, nausea, dizziness, stomach pains, weakness, headache, diarrhea , paralysis, neurological disorders, Tropical Ataxic Neuropathy (TAN), stunting of children and occasionally death associated to its consumption in large quantity through food [8,9,10] . Consumption of these bread samples however, will not lead to the lethal dose of 35 mg hydrocyanic acid per kg body weight reported by Eneobong[19],because the consumers consume far lower quantity of bread than the quantity that can give this dose, in addition to this, the body has a way of detoxifying small doses of cyanide in food by converting it to thiocyanide, which is excreted in the urine[17]

Table 3: Concentration of hydrocyanic acid (mg/1000g) in bread samples

Bread samples	Cyanide Concentration (mg/1000g)
A.	1.628±0.01
B.	2.291±0.37
C.	2.078±0.22
D.	1.709±0.15
E.	2.623±0.01
F.	1.510±0.29[a]
G.	3.433±0.51
H.	1.849±0.07
I.	2.696±0.88
J.	2.505±0.01
K.	1.680±0.67
L.	1.952±0.01
M.	1.849±0.08
N.	3.676±0.32[b]
O.	1.967±0.11

Results are expressed as meant standard deviation of three observations.
a = significant difference at $p<0.05$ compare with wheat flour sample with lowest hydrocyanic acid content. b = significant difference at $p<0.05$ compare with wheat flour sample with highest hydrocyanic acid content

Table 4: Concentration of hydrocyanic acid (mg/1000g) in wheat flour samples

Wheat flour samples	Cyanide Concentration (mg/1000g)
01-2137	1.059±0.014
01-5189	1.498±0.325[b]
01-1007	1.054±0.205
01-74883	0.706±0.007[a]

Results are expressed as meant standard deviation of three observations. a = significant difference at $p<0.05$ compare with bread sample with lowest hydrocyanic acid content. b = significant difference at $p<0.05$ compare with bread sample with highest hydrocyanic acid content.

IV. Conclusion

The results showed that all the loaves of bread and wheat flour brands analysed contained potassium bromate in high quantity above safe level for human consumption and various amount of hydrocyanic acid which however, will not lead to the lethal dose of 35 mg hydrocyanic acid per kg body. Therefore, there is need for continuous surveillance and enforcement of the ban on use of potassium bromate in baking industry in this study area by the regulatory agency.

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