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Toxic Bromate Residues in Nigerian Bread

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The bromate ion, BrO^-_3 is a strong oxidizing agent, which exists mainly in the form of sodium bromate and potassium bromate (Weast 1986). Potassium bromate is used in the bakery industry as a quality-improving reagent for wheat flour (IARC 1986). However, based on well established harmful effects of this food additive, the Centre for Science in the Public Interest, CSP1, has petitioned the Food and Drug Administration, FDA to ban its use by bakers (CSP1 1998). Several toxic effects of potassium bromate have been observed in experimental animals, including carcinogenic and mutagenic effects (Ishidate et al. 1984; Kurokawa et al. 1987; IARC 1986; Umemura et al. 1998). Indeed the use of bromate has been outlawed in several countries such as United Kingdom and Canada, thereby forcing bakers to switch to bromate-free operations (CSIP 1998). Although there is some measure of awareness of the harmful effects of bromate in Nigeria, we were alarmed to discover (from preliminary survey of randomly-selected bakeries located in different parts of the country) that the use of potassium bromate is still a standard and regular feature of the bread-making process. There is currently no extant legislation banning its use in Nigeria, the most populous black country in the world.

This study was therefore undertaken to investigate the levels of bromate residues in representative samples of Nigerian bread, with a view to assessing their suitability as confectionery food sources for the teaming population.

MATERIALS AND METHODS

Bread samples from 50 popular brands were purchased fresh from highly populated metropolitan city centres in the 4 geographical regions of Nigeria, viz Onitsha (East), Ibadan (West), Kano (North) and Port Harcourt (South). The extraction and analysis of their bromate residues were carried out according to the official method of analysis of the Association of Official Analytical Chemists (AOAC 1980). 50g of each sample was evenly dispersed, in 2g portions, by stirring in 200mL 0.1 M $ZnSO_4$ solution in a 500 mL beaker. 50 mL of 0.4 M NaOH was then added and the suspension further stirred for 5 min before it was filtered through Whatman filter paper no. 12. Bromate was subsequently estimated

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in the supernatant fraction by iodometric titration (AOAC 1980). To 50mL of the extract in a 250 mL Erlenmeyer flask were added 10mL of 4M H_2SO_4; 1mL of 1.88M KI, I drop of 3% (w/v) ammonium molybdate solution and 50ml of deionized H_2O. While stirring the mixture, 10mL of 0.00359 M $Na_2S_2O_3$ was then added, followed by 5mL of 1% (w/v) starch solution. All solutions were freshly prepared before use. The excess $Na_2S_2O_3$ was then titrated against 0.00359M KIO_3 to the first purple tinge (end point). The titre value was recorded, and titration was continued after further addition of 1mL $Na_2S_2O_3$. At the end point the mean values of the differences between mL of $Na_2S_2O_3$ added and mL of $K1O_3$ consumed in the 2 titrations were calculated. $KBrO_3$ levels were expressed in ppm as 10 x (mL of 0.00359M $Na_2S_2O_3$ – mL of 0.00359 M KIO_3). The results were corrected by recovery factor obtained by repeating the titration on an extract prepared from yam flour (a non – brominated product) after a known amount of $KBrO_3$ was added. The "recovered" bromate was then compared with "added" bromate, obtained by titrating directly, the same amount of bromate used in "recovery".

Table 1. Comparison of "added bromate" and "recovered bromate".

Sample	ppm bromate
Yam Flour	0
Yam Flour + $KBrO_3$ (recovered $KBrO_3$)	51.0
$KBrO_3$ (added $KbrO_3$)	51.3
Recovery Factor (added bromate/recovered bromate)	1.006

RESULTS AND DISCUSSION

Figure 1 depicts the frequency distribution of residual $KBrO_3$ levels in the 50 bread samples investigated. Values ranged from 1–16 ppm. There were wide variabilities in bromate levels within and between the geographical zones, suggesting absence of uniformity in standards and procedure among the bakeries. This may be attributed to the fact that bakery business in Nigeria is operated mostly by semi-literate entrepreneurs using unskilled labour, manual operations and crude technology. There was a very good agreement between "added bromate" and "recovered bromate", giving a recovery factor of 1.006 (Table 1). This indicates that the iodometric titration method used was very sensitive and reproducible. Bread samples containing 1 – 3 ppm $KBrO_3$ were most prevailent, followed by those having 4 – 6 ppm $KBrO_3$. These values represent respectfully, 40 – 120, and 160 – 240 times the provisional guideline value of 0.025ppm recommended by World Health Organisation (WHO 1996). Thus Nigerian bread contains unacceptable levels of $KBrO_3$. Surveys conducted by FDA on bakery products obtained from brominated flours sometimes reveal values 1000 times above normal (CSP1 1998). The presence of high levels of residual bromate in baked products, viewed against the well documented carcinogenic and mutagenic

effects of bromate, has led to persistent calls by CSP1 for the outright ban on the use of bromate as a flour improver. Lethal oral doses of bromate in humans are estimated as 154-385 mg/kg body wt, but serious poisoning can result from ingestion of 46–92mg bromate /kg body wt (Mack 1988). Oral doses of bromate in the range 185–385mg/kg body wt bring about irreversible toxic effects such as renal failure and deafness in humans, while lower doses are associated with reversible effects like nausea, abdominal pain, vomiting and diarrhea (Mack 1988). A cursory look at the levels of bromate residues in the Nigerian bread samples investigated may suggest that relatively large quantities of bread will have to be consumed at once to achieve the toxic oral dose of bromate (46–92mg/kg body wt). However in view of the carcinogenicity of bromate in experimental animals (IARC 1986), the FAO/WHO Joint Expert Committee on Food Additives, JECFA has recommended that there should be no bromate residues in food when bromate is used in food processing (JECFA 1989). Indeed the accepted provisional standard value of 0.025ppm for drinking water as recommended by WHO is said to be associated with a lifetime excess cancer risk of $7x10^5$ (WHO 1996). Thus the residual bromate levels seen in this study are indeed potentially deleterious to health.

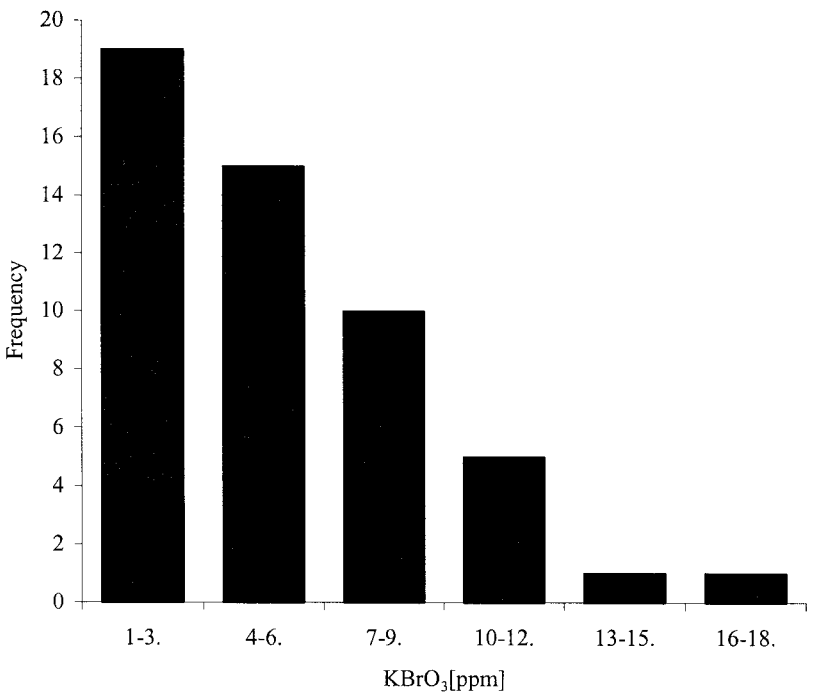

Figure 1. Frequency distribution of $KBrO_3$ levels in the bread.

Consequently our results suggest the need for stringent legislation by FDA against the use of bromate by bakers, as well as support for CSP1 campaigns to rid the confectionary industry of the potential scourge of bromate.

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