Toxicology Reports 1 (2014) 224–230

Contents lists available at ScienceDirect

Toxicology Reports

journal homepage: www.elsevier.com/locate/toxrep

Bromate and trace metal levels in bread loaves from outlets within Ile-Ife Metropolis, Southwestern Nigeria

J.A.O. Oyekunle [a,*], A.S. Adekunle [a], A.O. Ogunfowokan [a], G.O. Olutona [b], O.B. Omolere [a]

[a] Department of Chemistry, Obafemi Awolowo University, Ile-Ife, Nigeria
[b] Department of Chemistry and Industrial Chemistry, Bowen University, Iwo, Nigeria

ARTICLE INFO

Article history:
Received 22 February 2014
Received in revised form 8 May 2014
Accepted 8 May 2014
Available online 22 May 2014

Keywords:
Bread
Bromate levels
Trace metals
Ile-Ife
Nigeria

ABSTRACT

Bread loaves randomly sampled from nine outlets and bakeries within Ile-Ife were analysed to determine their safety levels for human consumption with respect to bromate and trace metal contents. Bromate determination was carried out *via* spectrophotometric method while trace metals in the digested bread samples were profiled using Flame Atomic Absorption Spectrophotometer. Bromate levels in the analyzed bread samples ranged from 2.051 ± 0.011 μg/g to 66.224 ± 0.014 μg/g while the trace metal levels were of the order: 0.03–0.10 μg/g Co = 0.03–0.10 μg/g Pb < 0.23–0.46 μg/g Cu < 2.23–6.63 μg/g Zn < 25.83–75.53 μg/g Mn. This study revealed that many bread bakers around Ile-Ife had not fully complied with the bromate-free rule stipulated by NAFDAC contrary to the "bromate free" inscribed on the labels of the bread. The bread samples contained both essential and toxic trace metals to levels that could threaten the health of consumers over prolonged regular consumption.

1. Introduction

Bread is an important staple food in many countries of the world especially the African countries and South Eastern part of Asia [1,2]. Statistical analysis in Nigeria showed that bread is one of the most consumed food types in homes, restaurants and hotels with predominant consumption among the poor [3] and young ones who constitute more than 70% of the over 150 million people in Nigerian.

Bread is made from low protein wheat flour. Some of the basic ingredients, apart from flour, are table salt, sugars, flavours, and at least, a flour improver such as potassium bromate [4–6]. Potassium bromate as a flour improver has been in use for more than 80 years [5,7,8]. 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 [9]. It acts principally as a maturing agent in the late dough stage giving strength to the dough during the late proofing and early baking [5]. It acts as a slow oxidizing agent throughout the fermentation proofing and baking process affecting the structure and the rheological properties of the dough. It is believed to act by oxidizing thiol groups to disulphide linkages, thus strengthening the protein network [10]. It helps bread to rise in the oven and to create a good texture. This property has been manipulated by many Nigerian bakers in profit making.

Toxicological studies have shown that, with respect to human health, consumption of potassium bromate can lead to non-cancer effects, such as degrading vitamins A1,

* Corresponding author. Tel.: +234 08035673017.
E-mail addresses: oyekunle@oauife.edu.ng (J.A.O. Oyekunle), sadekpreto@gmail.com, sadek2k@yahoo.com (A.S. Adekunle).

http://dx.doi.org/10.1016/j.toxrep.2014.05.007

A2, B1, B2, E and niacin which are the main vitamins available in bread [11,12]; causing significant differences in essential fatty acid content of flour treated with bromate [13]; development of cough, sore throat, abdominal pain, diarrhoea, nausea, vomiting, kidney failure, hearing impairment, bronchial and ocular problems, haemolysis, extreme irritation and injury to tissues especially those of the central nervous system and kidneys when inhaled [14,15]. On the other hand, numerous studies [16–19] have indicated that potassium bromate has the potential to cause cancer in both experimental animals and humans by inducing oxidative stress in tissues [12,20–24].

The International Agency for Research on Cancer (IARC) has classified potassium bromate as a class 2B carcinogen (a possible human carcinogen) based on sufficient evidence that potassium bromate induces cancer in experimental animals [25,26]. This led to the proposal for its ban in the United States and several other countries including the United Kingdom in 1990, Canada in 1994, Sri Lanka in 2001 and China in 2005. The FDA and China permit the use of potassium bromate up to a maximum level in bread of 50 mg/kg of flour mass, but Japan permits its inclusion only up to 10 mg/kg of flour [27]. In California a warning label is required when bromated flour is used and currently, it is recognized that it is inappropriate to use potassium bromate in any product or production method which cannot be formulated without residues below the level of 20 ppb (*i.e.* 0.020 mg/kg or 0.020 μg/g) in the finished product [28]. Joint FAO/WHO [11] committee's initial recommendation of acceptable level of 0–60 mg $KBrO_3$/kg flour was withdrawn because long term toxicity and carcinogenicity studies *in vitro* and *in vivo* revealed renal cell tumours in hamsters.

The use of potassium bromate in flour milling and baking was banned in Nigeria by National Agency for Food, Drug Administration and Control (NAFDAC) in 2003, and its use infringes on the drug and related products registration decree 20 of 1999 and NAFDAC Decree 15 of 1993 [29]. However, since the ban, it is not certain to what extent Nigerian bakers have complied with the ban imposed by NAFDAC with respect to the use of potassium bromate in bread baking.

Apart from the bromate content, materials employed in bread making and the environments where these bakeries are located are not free from varying degrees of trace metal contaminations. Trace metal contamination could be from the raw materials employed in bread baking, or they could be added as a result of unhygienic conditions of the baking environments, or because adequate precautionary measures are not taken to forestall cross-contaminations from other environmental sources. Several trace metals, at elevated levels, have been implicated in the aetiology of a myriad of ill health cases [30,31]. For example, Cd causes renal dysfunction, obstructive lung disease, lung cancer, damage to human respiratory system. Lead leads to acute or chronic damage to the nervous system of humans and other behavioural disorders. Exposure to elevated levels of Zn can result in loss of appetite, decreased sense of taste and smell, slow wound healing, over exposure can lead to stomach cramps and skin irritations. High doses of Cu cause anaemia, liver and kidney damage, stomach and intestinal irritation. Associated to high levels of Fe are conjunctivitis, choroiditis, retinitis and so on Low-level Cr exposure can irritate the skin and cause ulceration while long term exposure can cause kidney or liver damage. Exposure to Ni causes lung cancer, respiratory failure, birth defects, heart disorders and asthma, among others. Aluminium at elevated levels can lead to loss of memory, severe trembling, damage to central nervous system. Manganese causes manganese poisoning, fatness, neurological symptoms, birth defects, while Co causes asthma, pneumonia, heart problems, thyroid damage, vomiting and nausea at elevated levels [32].

The aim of this study was to evaluate the levels of bromate and trace metals in the bread loaves sold within Ile-Ife and its environs. This would help to evaluate the extent to which the bread loaves conformed to safety guidelines with respect to their bromate and trace metal contents.

2. Experimental

2.1. Sampling

Nine widely consumed commercial bread samples were purchased from different outlets and bakeries within Ile-Ife and its environs. These samples were transported as bought to the laboratory for immediate preliminary treatment and subsequent analysis.

2.2. Sterilization of apparatus

All glassware and vials used were scrupulously cleaned by soaking overnight in a detergent solution in a wash basin. The glassware and vials were scrubbed clean with a nylon brush, rinsed with hot distilled water until no more soap was observed. They were then rinsed in cold distilled water, and soaked in 10% HNO_3 for 48 h, rinsed properly with acetone and distilled water. They were finally oven-dried at 105 °C. Prior to use, the glassware and vials were stored in clean polythene bags that were securely sealed to prevent contamination by fallout from laboratory air.

2.3. Sample preparation and pre-treatment

Four slices of each bread samples were dried in an oven at 55 °C for 24 h. The crust formed was ground to fine powder using agate mortar and pestle. Accurately weighed 5 g powder of each sample was placed in a 250 mL beaker, and 2×10 mL distilled water was added and stirred thoroughly. The mixture was filtered into a 25 mL flask and was made up to the mark with distilled water.

2.4. Bromate determination

For this study, the method reported by Ojeka et al. [33] was adopted with slight modifications. With the aid of a calibrated pipette, 4 mL aliquot of each of the 9 bread samples was measured into 3 separate 25 mL calibrated flask. Added separately to this was 5 mL of 5×10^{-4} M solution of Congo Red or 5 mL of 5×10^{-4} M of Crystal Violet dye followed by 10 mL 2 M HCl solution. Dilution to 25 mL mark was made with distilled water, and gentle but thorough shaking was