



Studies on fungal pathogens and potassium bromate associated with some baked products commonly consumed in Bauchi Metropolis, Bauchi State, Nigeria

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Abstract

Bread is one of the basic and popular foods consumed by the majority of the Nigerians irrespective of their ethnic or socioeconomic status. Potassium bromate (KBrO₃) is well known bread enhancer. Because of its negative health effects, it has been banned in Nigeria and other countries. This paper aims to reviews studies on the use of KBrO₃ in bread to ascertain the safety of the bread products and to also evaluate bakers' compliance with specified regulations. The paper also assesses the possible reasons for the use of KBrO₃ by the bread bakers (intentional or unintentional) as well as addressed what regulatory bodies need to do to improve the bakers' compliance. Forty-seven samples (47) of different baked products were analyzed in the laboratory in order to determined for the presence of different fungal pathogens including potassium bromate. However, the total of 35.75% of the baked products were contaminated by different fungal species and this include *Aspergillus niger*, *Fusarium verticillioides*, *Mucor indicus*, and *Rhizopus stolonifera* respectively. While 45.6% of the baked samples were found to contain potassium bromate. The potassium bromate in breads production in Nigeria is very common and breads sold in Nigeria are unsafe for human consumption. This high usage may be attributed to factors such as bromine in wheat flour, adulterated improvers or due to use of brominated flour. Also, economic gain, high cost of ingredients and poor enlightenment and enforcement may also be contributing factors. Therefore, regulatory bodies need to adopt strategies such as Post-marketing Surveillance (PMS), on the spot analysis, effective monitoring and enforcement, stringent regulations, and sustained routine and surveillance inspections to at least reduce, if not eliminate, the use of KBrO₃ as bread enhancer.

Keywords: Fungal pathogens, potassium bromate, baked products

Introduction

Background to the Study

Bread is one of the basic and popular foods commonly consumed by the majority of Nigerians, irrespective of their ethnic or socioeconomic status. Potassium bromate (KBrO₃) is well known bread enhancer. It serves as a staple food due to its affordability, palatability, availability, and convenience. However, concerns have emerged over its microbial safety and chemical composition, particularly regarding fungal contamination and the presence of chemical additives such as potassium bromate.

Fungal contamination in bread can result from poor hygiene during production, improper storage conditions, or contamination of raw materials. Common fungal species such as *Aspergillus*, *Penicillium*, and *Rhizopus* are frequently implicated in spoilage and pose significant health risks to consumers. Mycotoxins produced by certain fungi are carcinogenic and have been linked to a wide range of health issues. Potassium bromate, on the other hand, is a flour improver used in bread-making to enhance dough elasticity and result in higher rise and better texture. Despite its benefits to bread quality, potassium bromate is a known potential carcinogen. Due to these health risks, many countries including Nigeria have banned or regulated its use in bakery products. However, due to weak enforcement of food regulations, some local bakeries continue to use potassium bromate, exposing consumers to serious health hazards.

Bakery products, especially bread, are major components of daily diets in urban areas such as Bauchi metropolis. The

demand for bread has encouraged the proliferation of both registered and unregistered bakeries, some of which may not comply with food safety standards.

Fungal contamination of bread poses a direct threat to consumer health. Mouldy bread may harbor spores and toxins which, when ingested, inhaled, or come into contact with the skin, can cause allergic reactions, respiratory issues, and even long-term chronic illnesses. The warm and humid climate of Nigeria also encourages fungal growth if storage and packaging are inadequate. Additionally, potassium bromate continues to be misused by some bakers in Nigeria despite regulations by the National Agency for Food and Drug Administration and Control (NAFDAC) banning its use. It is imperative to investigate and monitor the concentration of potassium bromate in bread sold in open markets and supermarkets.

Statement of the Problem

Despite public awareness and regulatory efforts, reports of poor bread quality and unsafe additives persist. There is limited local research on the extent of fungal contamination and the presence of potassium bromate in bread sold in Bauchi metropolis.

Thus, the specific problems this research addresses include:

- The presence and types of fungal pathogens associated with bread in Bauchi metropolis.
- The concentration level of potassium bromate in locally consumed bread.
- The compliance of local bakeries with food safety regulations.

Aim of the Study

The aim of this study is to investigate fungal contamination and potassium bromate content in bakery bread products commonly consumed in Bauchi metropolis.

Objectives of the Study

The specific objectives of this study are:

1. To isolate and identify fungal pathogens present in selected bread samples.
2. To determine the concentration of potassium, bromate in bread products.

Literature Review

Bread is a popular food consumed widely amongst all socioeconomic sets in the world (Alli *et al.*, 2013). Bread is a formulation of different ingredients such as wheat flour, sugar, salt, water, improvers and preservatives (Magomya *et al.*, 2013), via different processes comprising milling, mixing, fermenting, molding and baking (Emeje *et al.*, 2010). Bread is a good source of nutrients such as proteins, vitamins (Thiamin-B1, Niacin-B3, Folic acid-B9, Vitamin E and to some extent vitamin A, fibre and complex carbohydrate. It has a low level of fat and cholesterol (Alli *et al.*, 2013). Similarly, bread contains significant amounts of mineral elements such as calcium, magnesium, phosphorous and potassium but others like iodine, iron and sodium are present in minute amounts (Shanmugavel *et al.*, 2019). Potassium bromate (KBrO₃) is a good and well-known bread improver that has been used for many years by different bakers around the world (Nakamura *et al.*, 2006). The use of this compound has been completely banned by different countries across the globe due to its deleterious health effects (Magomya *et al.*, 2013). In addition to bread consumers, bakery workers are also considered to be exposed to this compound via inhalation because of its hepatotoxic and nephrotoxic effects (Oloyede and Sunmonu, 2009). The joint committee of Food and Agricultural Organization (FAO) and the World Health Organization (WHO) has completely banned the use of potassium bromate in bread, due to its long-term toxicity and carcinogenicity (FAO/WHO, 1999). Potassium bromate is a potential class II carcinogen for humans (IARC, 1999) and has also proved to cause severe toxic effects to critical human organs such as kidney, liver, and brain (Ahmad *et al.*, 2015; Ben Saad *et al.*, 2016a&b). The chapter also discusses the factors influencing contamination and food safety practices in the bakery industry.

Bread as a Staple Food

Bread is a staple food product that is widely consumed across the world, including Nigeria. It is made from flour, water, yeast, and other ingredients, and it provides a rich source of carbohydrates, proteins, and some vitamins. The increasing urbanization and changing lifestyles in Nigerian cities, including Bauchi, have made bread a popular food for breakfast and snacks.

According to Akobundu and Akinrele (2006), the demand for bread has increased rapidly in Nigeria, resulting in the growth of both small-scale and industrial bakeries. However, this expansion often occurs with little or no regulatory oversight, particularly among informal producers, raising concerns about food safety and hygiene.

In Nigeria, despite the ban on the use of the compound and the high burden of fatalities from chronic diseases such as

chronic kidney disease (CKD), chronic liver disease (CLD), cardiovascular disease (CVD), and other cancer-related death, it was discovered that 92% of bread samples in the country contained potassium bromate (Emeje *et al.*, 2010). Seven (7) different population-based cross-sectional studies alone reported the incidence of CKD in Nigeria to be within 2.5% to 24.3% (Chukwuonye *et al.*, 2018). Both CKD and CLD have enormous financial burdens on the families of subjects (Ulasi and Ijoma, 2010; Chukwuonye and Oviasu, 2012). Therefore, it is believed that a good knowledge of the health consequences associated with the use of potassium bromate in food products, particularly bread and other confectionaries, will drastically reduce the incidence of these chronic diseases. It is considered that maintaining good health as well as prevention of diseases is an essential tool for consumers of food, particularly breads and other flour-based products, thus the need for healthier bread products free from potassium bromate or any other banned substances.

Research Methodology

Research Design

The study adopted an experimental and descriptive survey design. Bread samples from various bakery outlets and vendors in Bauchi metropolis were collected and subjected to laboratory analysis to detect fungal contamination and the presence of potassium bromate. The survey also documented the sources and storage conditions of the samples.

Study Area

The research was conducted in Bauchi metropolis, the capital of Bauchi State, Nigeria. The area was chosen due to its large population, significant bread consumption, and the high number of registered and unregistered bakeries operating within the city.

Sample Collection and Preservation

Each bread sample was purchased in its original packaging and handled aseptically using sterile gloves. Samples were labeled appropriately and stored in sterile polythene bags. The samples were immediately transported to the microbiology and chemistry laboratories at the Federal Polytechnic Bauchi for analysis. Samples were analyzed within 24 hours of collection to avoid external contamination or spoilage.

Isolation and Identification of Fungal Pathogens

Media Used: Sabouraud Dextrose Agar (SDA), acidified with lactic acid to suppress bacterial growth.

Procedure

- Each bread sample was aseptically cut and blended in sterile distilled water.
- Serial dilution was performed up to 10⁻³ dilution.
- One milliliter from each dilution was plated on SDA using the pour plate method.
- Plates were incubated at 25–28°C for 5–7 days.
- Fungal colonies were examined for macroscopic features (color, texture, growth pattern).
- Slide mounts stained with Lactophenol Cotton Blue were prepared and examined microscopically for identification of spores and hyphae.

Identification: Fungi were identified based on standard morphological characteristics using fungal identification manuals (e.g., Barnett and Hunter, 2000).

Determination of Potassium Bromate Content

Method Used: Spectrophotometric method based on the International AOAC guidelines.

Reagents

- Potassium iodide (KI)
- Starch indicator
- Hydrochloric acid (HCl)

Procedure

- A known quantity (5 g) of each bread sample was homogenized in distilled water.
- The solution was filtered and reacted with KI and HCl.
- Liberated iodine was titrated against sodium thiosulphate or measured spectrophotometrically at 620 nm after adding starch as an indicator.
- The concentration of potassium bromate was determined from a standard calibration curve.

Results

Table 1: Percentage distribution of fungi isolated from bread in bauchi

Fungi Isolated	Number	Percentage (%)
<i>Fusarium spp.</i>	1	6.25
<i>Rhizopus spp.</i>	2	12.5
<i>Penicillium spp.</i>	2	12.5
<i>Mucor spp.</i>	3	18.75
<i>Aspergillus spp.</i>	8	50
Total	16	100

The key findings are: Dominant Fungus: *Aspergillus spp.* is the most prevalent fungus, accounting for 50% of all isolates (8 out of 16). Species of *Aspergillus* are common spoilage organisms and are concerning because some strains produce mycotoxins, which can be harmful to human health. Next Most Prevalent: *Mucor spp.* is the second most common, making up 18.75% of the isolates (3 out of 16). *Mucor* is a fast-growing mold often associated with the spoilage of bakery products.

Table 3: Determination of Potassium Bromate in the Sample Bread

Sample code	Potassium bromate concentration(mg/kg)
S1	0.8 ± 0.1
S2	1.5 ± 0.2
S3	2.1 ± 0.3
S4	0.3 ± 0.5
S5	1.8 ± 0.2

Detection in All Samples: Potassium bromate was detected in all five samples (S1-S5), as the mean concentration for every sample is greater than zero. Exceeding Regulatory Limits, Since the permissible limit for potassium bromate in bread is zero in many regions (including Nigeria, based on regulatory standards), the detected levels in all samples—ranging from 0.3 to 2.1 (mg/kg) represent a significant violation of food safety standards.

Highest Concentration: Sample S3 showed the highest concentration at 2.1 ± 0.3 (mg/kg), while S4 showed the

lowest at 0.3 ± 0.5 (mg/kg). The high ± value for S4 suggests a higher degree of uncertainty or variability in that specific measurement.

Conclusion

The findings of this research indicate that bread sold in Bauchi Metropolis may be contaminated with both fungal pathogens and potassium bromate, posing significant public health risks to consumers. The presence of toxigenic fungi and banned chemical substances undermines the nutritional benefits of bread as a staple food.

The continued use of potassium bromates despite its ban, coupled with unhygienic production practices, reflects a lack of strict compliance with food safety regulations. It also indicates a need for increased surveillance, public health education, and enforcement by relevant authorities. If left unchecked, the consumption of such contaminated bread could contribute to foodborne illnesses, mycotoxicosis, and chronic health issues including cancer.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Enforcement of Food Safety Regulations

Regulatory agencies such as NAFDAC and the Standards Organisation of Nigeria (SON) should intensify routine inspections of bakeries to ensure compliance with hygiene standards and the ban on potassium bromate.

2. Public Awareness Campaigns

Consumers should be educated on the dangers of consuming contaminated bread. Awareness programs through media, schools, and community forums can help increase demand for safer bakery products.

3. Training for Bakers and Food Handlers

Bakers should undergo regular training on Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) to improve hygiene and reduce contamination risks during production.

4. Promotion of Safer Additives

Bakers should adopt safe alternatives to potassium bromate, such as ascorbic acid and enzymes, which are approved for improving dough quality without harmful health effects.

5. Improved Storage and Packaging

Bakeries and vendors should ensure proper cooling, use of clean and moisture-resistant packaging, and storage under hygienic conditions to reduce fungal growth.

6. Regular Monitoring and Research

Continuous research and monitoring programs should be conducted to track the levels of contaminants in bread and to evaluate the effectiveness of control measures over time.

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