Appreciation of Residual Bromate in Egyptian Baladi Bread within Cairo Governorate

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ABSTRACT

To determine how much bread consumers in Cairo are exposed to the risk of potassium bromate ($KBrO_3$) through their diet, this study set out to measure the amount of $KBrO_3$ present in a target chosen not financially supported/high-priced Baladi bread samples consumed in the Cario districts of Egypt. Bread was gathered from ten areas within the Egyptian government in Cairo. Standard operating procedures were followed for the preparation and collection of the samples. One hundred thirty breads were purchased straightway from kilns in the designated locations of Egypt's government area of Cairo, and the $KBrO_3$ content was measured. High and low values of $KBrO_3$ detected in bread consumed in Cairo were 480.8 and 33.0 $\mu g\ g^{-1}$, respectively, according to the results of this search. With a spectrophotometer set at 620 nm, the $KBrO_3$ concentrations in the bread pieces were ascertained. The correlation curve generated by the $KBrO_3$ standard solutions was used to determine the concentration. These findings indicated that $KBrO_3$ was present in all of the bread samples analyzed in considerable concentrations, exceeding the amounts acceptable for human consumption and advised in food by all guidelines and specifications. It is imperative to systematically monitor $KBrO_3$ in the current search locations and other Egyptian governments to avoid and manage intake and reduce health concerns.

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FOREWORD

Bread is a basic item widely consumed in many countries worldwide, particularly in African nations (**Maziya-Dixon and Others 2004**). In Egypt, Baladi bread, a traditional staple food consumed by millions daily, is governed by food safety standards set by the **Ministry of Health and Population (2022); and Egyptian Standard Specification (2006)**. However, there is variability in enforcement and monitoring, potentially leading to the existence of banned substances such as $KBrO_3$ in locally produced bread. Therefore, it is essential to continually monitor the $KBrO_3$ levels in Baladi bread to guarantee consumer safety and compliance with legal requirements. Previous studies have highlighted the occurrence of $KBrO_3$ in bread from various regions worldwide, indicating a significant gap between regulation and practice in some cases **(Hama and Coworker 2022); Magomya and Else 2020); Shemishere and Partner 2020).** This underscores the necessity of continuous monitoring and testing to ensure consumer safety and compliance with food safety standards.

Potassium bromate (e number 924) is a food additive widely used in the baking industry, significantly enhances the dough's elasticity and promotes higher bread volume **(Sandhu et al., 2011)**. This additive functions by strengthening the dough and improving its texture, making it an attractive option for commercial bakeries aiming to produce consistent and high-quality bread products (**FAO/ WHO 1992).** When $KBrO_3$ is used only, the expense is just under one-eighth that of ascorbic acid. It is a colorless, odorless, and tasteless white crystal/powder that is used as a food additive and is commonly used as a flour improver and enhancing agent, because of its efficient oxidizing properties (**Emeje and Fellow worker 2010**). When bread is baked, $KBrO_3$ is converted to potassium bromide, which is safe for people to consume. However, using too much $KBrO_3$ could leave bread with residual bromate, which could be detrimental to the consumer **(Oyekunle et al., 2014).** However, the health implications of $KBrO_3$ have raised considerable concern within the scientific community. $KBrO_3$ is classified as a Group 2B hazard by the **IARC (2020**), which means that there is limited human evidence and substantial data from experimental *in vivo* studies to suggest that it may be harmful to humans.

Globally, because of the possible health hazards, the consumption of $KBrO_3$ in food

products has been outlawed or regulated in several countries worldwide. For instance, in the European Union, France, the UK, and Canada, have all implemented bans on their use of food products **(European Commission 2008).** The highest amounts of $KBrO_3$ allowed in bread in China and Japan are 50 mg kg-1 of flour mass and 10 mg kg^{-1}, respectively **(Kurokawa and Collaborator 1990).** According to **ABA/AIBI (2008),** the United States permits an acceptable remaining concentration of 20 ppb in final bread products. **US FDA, (2019)** allows its use only if the end product does not contain detectable chemical levels, reflecting stringent control measures to mitigate associated health risks. Despite these regulations, reports of its continued use in certain regions suggest that enforcement and compliance issues persist, raising public health concerns.

The objectives were

(i) to evaluate these bread' suitability for ingestion by humans in light of $KBrO_3$'s harmful effects.

(ii) To determine the degree of conformance to the Egyptian Standard Specification for Bread and its Additives on the absence of $KBrO_3$ residue in bread.

MATERIALS AND METHODS

Samples:

- **Study sample:**

Local not financially supported Baladi bread items from bakeries were included in the sample, as per the Central Agency for Public Mobilization and Statistics **(CAPMS, 2017)**. According to **Thompson's (2012)** equation, the total samples are 130 with the same percentage from all bakeries in each area.

Inclusion criteria:

All local products will be including

- All not financially supported Baladi bread samples are prepared in selected areas of bakeries
- The sample will be taken from the low socio-economic department to the high one in the same region.

Exclusion criteria:

- All duplication in products will be excluded
- All samples imported or manufactured in factories, not bakeries, and packaged are excluded.

Sample type:

According to **CAPMS, (2017),** there are ten (10) distinct

bakeries in the Cairo government area of Egypt. Not financially supported Baladi bread (130 samples) was gathered in the low socioeconomic departments to the high ones in the same territory of Cairo from five regions: Samples of bread were purchased directly from bakeries in the following Cairo regions: El Zeitoun- Shubr in the North; El Maadi- El Sayeda Zeinab in the South; El Salam Owl-Misr Al-Jadidah in the East; El-Zamalek- Boulaqu Abo-El-Ala in the West; and Wade Hofe- El-Masara in the Helwan Cairo Region. Standard operating procedures were followed for the preparation and collection of the samples. Three months of research were done (October, December 2023 and February 2024). Bread samples were gathered from the study regions, and the amounts of $KBrO_3$ were measured.

Methodology:

Setting up a reference curve

250 milliliters of purified water were used to dissolve 0.25 grams of purified $KBrO_3$ to provide a pure sample for the calibration curve. The needed concentration of pure $KBrO_3$ for blanking was calculated from the original volume (which are values between 0, 50, 100, 150,200,250,300,350,400,450, and 500 ppm). Each diluent was then adjusted to meet the different required concentrations (Cr). Ten duplicates of these contents were used to calibrate the spectrophotometric curve (Fig. 1). Using the absorbance at each concentration of pure $KBrO_3$, a calibration curve (absorbance against concentration) for $KBrO_3$ was produced (Fig. 1) **(Pearson 1976).**

Sample preparation

The current research utilized a random sample of ten different distinct bakeries in Cairo, Egypt. **El Harti et al., (2011)** described a spectrophotometric approach for analyzing residual bromate levels in these samples. In summary, each dried in air at room temperature and ground with an electric blender, the bread sample was weighed out to yield 10 g in an electronic weighing scale, which was then combined with 200 mL of distilled water. The combination was then agitated with a shaker and left to stand at 28 ± 5°C for 20 minutes before filtering using Whatman no. 41 filter paper. After being decanted into a 15 ml centrifuge tube, the sample was centrifuged for 10 minutes at 3000 rpm. After the centrifuge tube's volume was decanted, 5.0 ml of newly made 0.5% potassium iodide solution in 0.IN

hydrochloric HCl was added. If the hue shifts from pale yellow to purple, it suggests the existence of $KBrO_3$. The sample's absorbance was measured in a UV spectrophotometer at 620 nm. Concerning the $KBrO_3$ calibration curve created using the pure sample, the absorbance of the samples (N=130) was transformed to concentration, and the calibration solutions were analyzed in triplicate.

Analytical statistics

Researchers used the SPSS version 21.0 package (SPSS, Chicago, USA) for statistical analysis. The t-test was used to perform the mean comparison. A 0.05 alpha risk was chosen. ANOVA, a one-way analysis of variance, was used to determine whether the levels of bromate in various regions varied. As stated by **Chan (2003).**

RESULTS

The table shows that out of the 130 high-priced Baladi bread samples analyzed for three months, $KBrO_3$ was detected in 122 and was not detected in 8 bread samples, which was in the Misr Al-Jadidah from East Cairo Region. Table 1 and Figure 2 present data on $KBrO_3$ concentrations (in parts per million, µg/g) across various districts within different regions of Cairo. Each district is characterized by its mean concentration, standard deviation (SD), minimum, maximum, and median values. The findings of $KBrO_3$ in bread in this study were 480.8 µg g^{-1} for the highest level and 33.0 µg g^{-1} for the lowest level, which was found in not financially supported Baladi bread consumed in Cairo, Egypt. According to the data in Table 1 and Figure 2, El Sayeda Zeinab as a district of the south Cairo region had the highest concentration of $KBrO_3$ in Baladi bread (480.8 ± 93.2 µg g^{-1}), followed by the west Cairo region as **"**El-Zamalek, Boulaqu Abo-El-Ala", and Helwan Cairo region in El-Masara area. The lowest concentration was found in the east Cairo region, especially in the Misr Al-Jadidah (33.0±11.6 µg g^{-1}) area. Eight out of the thirteen samples in the Misr Al-Jadidah region—more than half—did not contain $KBrO_3$ in the bread. The result showed a highly significant difference ($F = 11.74$, $P = 0.000$) in the amount of bromate detected in different districts of Cairo. These findings underscore the importance of monitoring and managing $KBrO_3$ pollution, particularly in high-concentration areas, to safeguard public health and environmental quality in Cairo. The amount of $KBrO_3$ used, baking temperature, and baking duration all affect how much bromate residue remains in bread. In this instance, the overuse of

$KBrO_3$ during the not financially supported Baladi bread-making process is the primary cause of the high bromate concentration in Cairo bread.

DISCUSSION

It is important to understand that humans can become poisoned by $KBrO_3$ primarily through two routes: ingestion when it is ingested in food items like bread, or inhalation when it is in the powdered form. As a result, both workers in bakeries and bread consumers who consume bread that has been improved with bromate are not safe (**Shemishere et al., 2020**). **Giesecke and Taillie, (2000)** have documented the harmful effects of $KBrO_3$ on the liver and kidneys in rodents.

As per **Egyptian Standard Specification (2006),** bread is deemed unsafe for human eating if the amount of $KBrO_3$ in it is not detected. The study's findings showed that, out of 130 samples, 122 had residual bromate levels in their bread that were measured using a spectrophotometer. These levels ranged from 33.0 to 480. 8 µg g-1 of $KBrO_3$, which is higher than the levels allowed by law in the country. so that not financially supported Baladi bread in Cairo City might be unsafe for human consumption.

Based on data from other parts of the world, the present findings showed that bread samples had comparatively high concentrations of remaining bromate. $KBrO_3$ is as yet permitted in the USA, with an upper restriction of 0.02 µg g−1 for the remaining concentration in prepared-to-eat goods **(ABA/AIBI 2008).** But in some states (like California), it's advised that products with this oxidizing agent have a particular warning label. Better conditions can be found in Europe, where several nations have outlawed potassium bromate **(CCE 1992)**, including the UK, which passed a statute **(SI. No/399 1990).** Four years after this law was passed, a large-scale survey revealed that there was no discernible residual bromate in the bread samples that were analyzed **(Dennis et al., 1994).** In a similar vein, several nations across the globe have outlawed the usage of $KBrO_3$, such as Nigeria **(Ifiora et al. 2015)**, Colombia **(USDA 2004),** and Canada **(CAS 2010).** Smaller investigations conducted in other countries indicate that $KBrO_3$ is still utilized in the processes required to create bread, in contrast to the situation in Europe. According to reports, the government's efforts to remove bromate from bread have not been

successful, as evidenced by the elevated levels of the additive in certain bread samples (varying from 2.01 to 66.22 µg g^{-1}) in Nigeria **(Ifiora et al., 2015; Oyekunle and Other 2014). Abdulla and Hassan (2009)** found in fifteen bread samples of Hawler City, Iraq, with higher levels (varying from 11.09 to 67.45 µg g^{-1})**.** Using a spectrophotometric technique, the amount of $KBrO_3$ in bread samples from 5 Addis Ababa bakeries was found in Ethiopia at 5.61 to 9.97 µg $g^{-}1$ was the range of bromate levels **(Ergetie and Hymete 2012).** The quantities of this $KBrO_3$ in 12 bread samples from Morocco did not surpass 5 µg g−1 **(El Harti et al., 2011)**. The present finding in this study is the highest from prior results because the bread was dried in the air at room temperature instead of in drying ovens at higher temperatures, as was done in previous research. Ascorbic acid has the potential to replace potassium bromate, as demonstrated by **Ayo et al., (2002).** They found that whereas $KBrO_3$ can produce a higher loaf volume on an equivalent weight basis, ascorbic acid was a more effective flour improver when compared on an equivalent cost basis. In light of the current situation, it is imperative to move swiftly to implement a mechanism that will shut down any bakeries that are still employing $KBrO_3$ and guarantee non-toxic alternatives, like ascorbic acid.

CONCLUSION:

Baladi bread remains a vital part of Egyptian meals, but the use of $KBrO_3$ necessitates rigorous monitoring to safeguard public health. The findings showed that, in comparison to Egyptian standard guidelines, the residual bromate range in not financially supported Baladi bread from several bakeries in Cairo, Egypt, was higher. Between the bakeries, there were noticeable differences. However, the study's lowest measured bromate content in bread is about higher than what is permitted in Egypt, a country where bromate additive use is regulated. Thus, to ensure consumer safety and regulatory compliance, it is imperative to continuously monitor the $KBrO_3$ levels in all bread.

RECOMMENDATION:

The current data on the prevalence of $KBrO_3$ in high-priced Baladi local bread, this research:

- seeks to inform policy decisions
- enhances food safety practices and nutrition awareness campaigns within the region to

contribute to the improvement of food safety standards, among consumers and bakeries in Egypt regarding the risks of banned food additives. To prevent and control intake and lessen health issues

- it is essential to regularly monitor KBrO3 in these study regions and other Egyptian administrations.

Potential Conflicts of Interest

The authors have stated that there isn't any disclosed conflict of interest in this work.

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Figure (1) Calibration curve for potassium bromate.

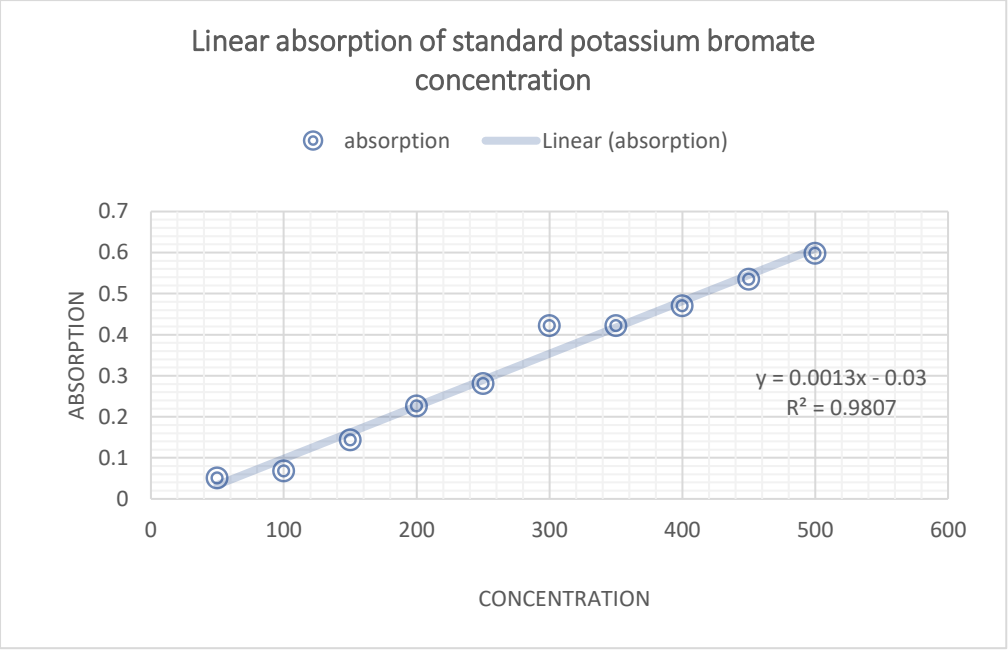

Figure (2) shows the $KBrO_3$ concentration in µg g-1 of not financially supported Baladi bread throughout several Cairo districts.

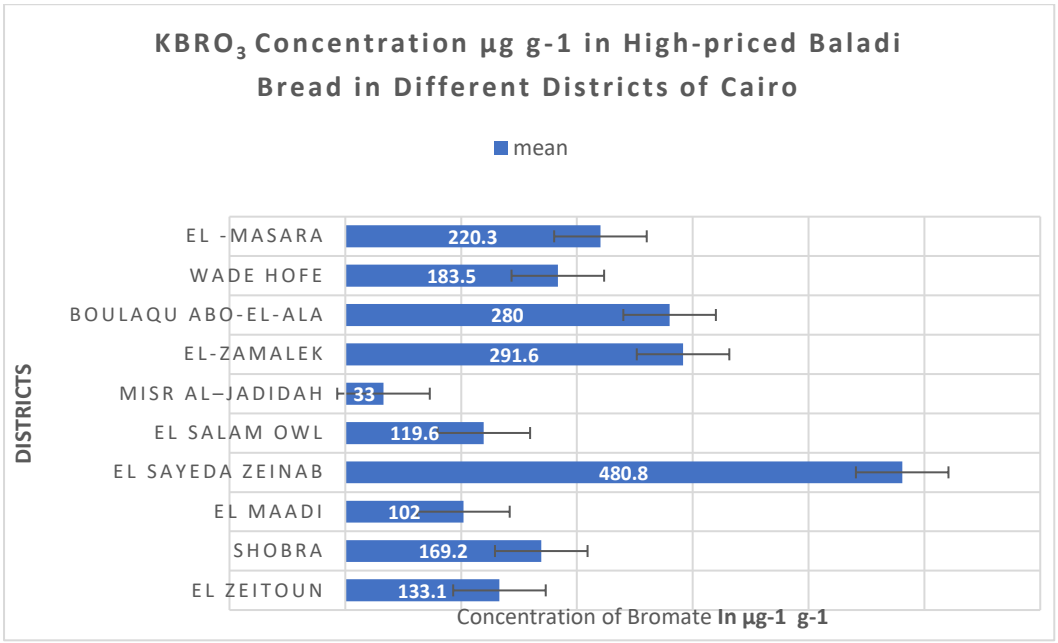

Table 1: shows the $KBrO_3$ concentration in µg g-1 of not financially supported Baladi bread throughout several Cairo districts.

Districts	**North Cairo Region**		**South Cairo Region**		**East Cairo Region:**		**West Cairo Region**		**Helwan Cairo Region**		***P* value**
Region	**El Zeitoun (n=13)**	**Shobra (n=13)**	**El Maadi (n=13)**	**El Sayeda Zeinab (n=13)**	**El Salam Owl (n=13)**	**Misr Al–Jadidah (n=13)**	**El-Zamalek (n=13)**	**Boulaqu Abo-El-Ala (n=13)**	**Wade Hofe (n=13)**	**El - Masara (n=13)**	
mean±SD ppm (µg/g)	133.1±15.0	169.2±37.7	102±17.0	480.8±93.2	119.6±21.8	33.0±11.6	291.6±38.3	280.0±32.3	183.5±22.7	220.3±26.3	**<0.000**
min	20.4	8.2	9.3	119.6	27.6	ND	102.9	87.3	81.4	46	
max	210.1	429.3	198.2	1187.2	284	127.1	542.7	532	430.4	381.8	
median	128	118.7	94.7	391.1	74.9	0	292.6	278.9	162.4	213.6	

Non-detected (ND) $P \leq 0.05$ is considered significant.

تقدير نسبة البرومات المتبقية في الخبز البلدي المصري بمحافظة القاهرة

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قسم كيمياء التغذية والتمثيل الغذائي – المعهد القومي للتغذية – القاهرة – مصر

الملخص العربي

لتقييم درجة التعرض الغذائي لمستهلكي الخبز في القاهرة لخطر برومات البوتاسيوم، هدفت هذه الدراسة قياس كمية برومات البوتاسيوم الموجودة في عدد محدد من عينات الخبز البلدي غير مدعم/ عالي الثمن التي تم اختياره والتي يتم استهلاكه في مناطق القاهرة المختلفة في مصر. تم جمع الخبز من عشر مناطق داخل محافظة القاهره بمصر. تم شراء مائة وثلاثين عينة خبز من المخابز في المواقع المحددة في مناطق محافظة القاهره بمصر. تم اتباع الإجراءات القياسية لإعداد العينات وجمعها. تم جمع عينات الخبز من مواقع البحث، وتم قياس محتوى برومات البوتاسيوم بها. كانت أعلى وأدنى قيم برومات البوتاسيوم المكتشفة في عينات الخبز المستهلكة في القاهرة 480.8 ميكروجرام/جرام و33.0 ميكروجرام/جرام على التوالي، وفقًا لنتائج هذا البحث. باستخدام مطياف ضوئي مضبوط على 620 نانومتر، تم التأكد من تركيزات برومات البوتاسيوم في الخبز. تم استخدام منحنى الارتباط الناتج عن محلول برومات البوتاسيوم القياسي لتحديد التركيز. أشارت هذه النتائج إلى وجود برومات البوتاسيوم بتركيزات كبيرة في جميع أنواع الخبز المستهدفه، متجاوزة ما يعتبر آمنًا للاستهلاك البشري. من الضروري إجراء مراقبة منتظمة لـبرومات البوتاسيوم في مواقع البحث الحالية والمحافظات المصرية الأخرى لامان تناوله والحد وتجنب المخاوف الصحية.

الكلمات المفتاحية: المواد المضافة ؛ محسنات الدقيق ؛ المراقبة الروتينية ، الصحة