African Journal of Advanced Pure and Applied Sciences (AJAPAS)
Online ISSN: 2957-644X
Volume 5, Issue 1, 2026
Page No: 259-263
Website: https://aaasjournals.com/index.php/ajapas/index
ISI 2025: 1.126 SJIFactor 2024: 6.752 معامل التأثير العربي: 1.62

Evaluation of Potassium Bromate Concentration in different types of Bread collected from several bakeries distributed in Kekla- Libya by Spectral Method

Soad Shibani N. Jaida*
Chemistry Department, Faculty of Education- Kekla, Gharyan University, Libya

تقدير تركيز برومات البوتاسيوم في أنواع مختلفة من الخبز المجمع من عدة مخابز بمنطقة ككلة- ليبيا، باستخدام التحليل الطيفي

سعاد الشيباني جعيدة *
قسم الكيمياء، كلية التربية ككلة، جامعة غريان، ليبيا

*Corresponding author: sadalsdyq89@gmail.com

Received: November 20, 2025	Accepted: January 31, 2026	Published: February 10, 2026

Abstract

Arab societies, and particularly Libyan citizens, consume large quantities various types of bread daily. The high level of bread consumption may negatively affect consumers' health due to the presence of several food additives and hazardous chemicals that often exceed the permissible limits in bread products. In this study, nine bread samples including Ciabatta bread, French bread, Barley bread, and Tanour bread were collected from bakeries and markets distributed in the city of Kekla. These samples were analysed to determine the residues of potassium bromate (KBrO3) using a spectrophotometric method depending on the redox reaction between bromate ion in the samples and iodide ion of used reagent solubilized in an acidic medium. The study found that the concentrations of KBrO3 in all studied samples ranged from 10.68 to 35.77 µg/g. This indicated that the levels of KBrO3 in all investigated bread samples exceeded the permissible limit set by the American Food and Drug Administration FDA (0.02 µg/g).

Keywords: Bread types, Potassium bromate, UV-Spectrophotometer.

الملخص

العديد من المجتمعات العربية وخصوصا المجتمع الليبي تستهلك كميات كبيرة من الخبز بأنواعه بشكل يومي. قد يؤثر استهلاك كميات كبيرة منه على صحة المستهلك، لما يحتويه الخبز من مواد مضافة تتجاوز كمياتها الحدود الأمنة المسموح بها من منتجات الخبز بناء على نتائج مجموعة من الدراسات المحلية. لذلك تم في هذه الدراسة تجميع تسعة عينات من الخبز من المخابز ومحلات المواد الغذائية الموجودة بمدينة ككلة شملت خبز محوور, خبز الفرنسي, خبز الشعير, و الخبز المصنع بالبيوت المعروف بخبز التنور . حيث تم تقدير تركيز برومات البوتاسيوم في العينات المدروسة باستخدام تقنية الطيف الضوئي اعتمادا على تفاعل اكسدة واختزال بين البروميد الموجود في الخبز وايون اليود في كاشف يوديد البوتاسيوم المذاب في وسط حامضي. وقد أظهرت النتائج وجود برومات البوتاسيوم في كل العينات المدروسة بتراكيز تراوحت بين10.68- 35.77 ميكوجرام/جرام. وهذا أثبت أن جميع العينات المدروسة بأنواعها الأربعة قد تجاوزت الحدود المسموح بها من قبل إدارة الدواء والغذاء الامريكية (0.02 ميكروجرام/جرام)

الكلمات المفتاحية: أنواع الخبز، برومات البوتاسيوم، جهاز التحليل الطيفي بالأشعة فوق البنفسجية.

Introduction

Bread is a staple food consumed daily by Libyan people, mostly served with breakfast, dinner, and school meals. It is a good source of energy and supplying essential nutrients to human body such as carbohydrates, fibers, vitamins, iron, selenium, and magnesium [1]. Bread is typically made by mixing flour, water, salt, and yeast to form dough, which is often combined with additives to enhance strength, flavor, loaf volume, and texture, resulting in improving overall quality of the bread and its products [2]. These additives include potassium bromate, ascorbic

acid, calcium salt, ammonium chloride, azodicarbonamide, and several enzymes [1]. Potassium bromate (KBrO3) has been commonly used for decades as a bread improver, it is a white, odorless, crystalline powder, water-soluble material [2,3]. KBrO3 is widely used as a dough improver due to its ability to oxidize the sulfhydryl (thiol) groups in flour proteins, converting them to disulfide bonds. This process enhances the dough's elasticity, making it more stable and capable for retaining carbon dioxide gas that is produced during leavening by the yeast [4]. Potassium bromate smut be completely converted into potassium bromide (KBr) which is non-toxic compound this process has happened when the dough is exposed to high temperatures during the baking process. However, this transformation depends on the quantity used of potassium bromate and the baking conditions. Specifically, if the dough does not expose to the optimum baking temperature, then the decomposition of KBrO3 will not be completely processed leaving some residues of this material in the produced bread [5]. Despite the benefits of Potassium bromate for enhancing dough, it has several negative effects, such as degrading essential vitamins (vitamin A, thiamine, riboflavin, and niacin), and reducing the level of essential fatty acids in the bread [6]. However, potassium bromate exposure has been associated with various toxic health effects on human body, including sore throat, nausea, vomiting, abdominal pain, coughing, nephrotoxicity, renal insufficiency, and anemia [2,7,8]. In 1999, the International Agency for Research on Cancer (IARC) classified potassium bromate as a Group 2B carcinogen, indicating it is possibly carcinogenic to humans [9]. Due to these health concerns, many countries have banned the use of potassium bromate in flour and bakery products, including Argentina, Brazil, Canada, South Korea, the UK, Australia, Peru, and Uganda [10]. Furthermore, specific bans have been enacted in Sri Lanka (2001), Nigeria (2004), China (2005), and India (2016) [11]. However, in some countries, such as the USA and Japan, potassium bromate has not been completely banned; instead, its use is strictly regulated, with a maximum allowable concentration set at 0.02 mg/kg, 10 mg/kg, respectively, in bread products industry [12,13]. The American Food and Drug Administration (FDA) has established a maximum permissible concentration of potassium bromate in bread at 0.02µ g/g [14]. In Libya, the Ministry of Economy officially banned the importation of Potassium bromate in 2005, with the ban reaffirmed in 2021 [2,15]. Despite these legal restrictions, several studies reported the detection of potassium bromate residues in bread and other bakery products within the country [2]. Therefore, this study aimed to investigate the presence and levels of potassium bromate in different types of bread sold in the Kekla region in the northwestern of Libya.

MATERIAL AND METHOD

Samples, Collection and Preparation

Nine bread samples including Ciabatta bread, French bread, Barley bread, and homemade bread named Tanour bread were collected from markets and bakeries distributed in the Kekla region. The bread samples were dried in an oven at 60°C for approximately 2 hours. The dried samples were finely ground into powder using a ceramic mortar and stored in clean containers labelled from B1 to B9.

Reagents

The used chemicals are hydrochloric acid(0.1N) , potassium bromate, and potassium iodide solution 1%.

Preparation of Standard Solutions

The standard stock solution (1000 ppm) was prepared by dissolving 0.52 g of Potassium bromate in 500 mL of distilled water. Working diluted standard solutions (1 - 2- 3- 4- 5 µg/ml) were then prepared from the stock solution.

Qualitative Determination

A 1.0 g quantity of each grounded bread sample was transferred into a 15ml centrifuge tube. Then, 10 ml of distilled water was added, and the mixture was shaken using a shaker for 10 minut. After shaking, the mixture was then heated at 38°C using a water bath for 30 minutes. Then, the sample was centrifuged at 5000rpm for 30 min, and 5.0 mL of the centrifuged sample was transferred to test tube. A 5.0 mL of freshly prepared 1% potassium iodide solution in 0.1N hydrochloric acid was added to the test tube. Any change in observed color was taken as evidence of the potassium bromate presence, specifically from light yellow to purple [16]. Immediately, the absorbance measurements for both standard solutions and the studied samples was performed using a double-beam spectrophotometer (SPECORD-210 plus, Analytik Jena, Germany) at a wavelength of 620nm [16]. The concentration of $KBrO_3$ (µg/g) in bread samples was calculated curve using a standard calibration by using equation (1), which was created by plotting absorbance value against standard solutions of $KBrO_3$ as shown in figure (1)

$$y = 0.0377X + 0.0094 \qquad R^2 = 0.9478 \qquad (1)$$

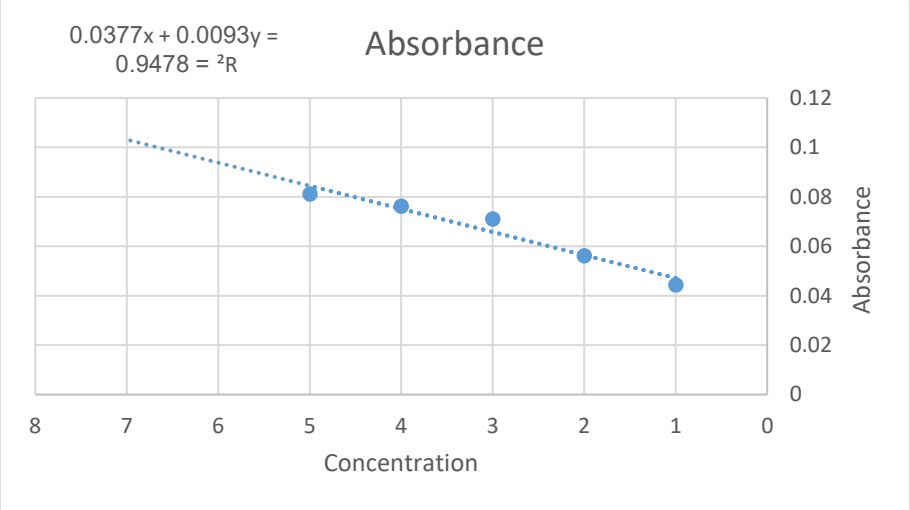

Figure 1: Calibration curve for standard potassium bromate solutions

After that, the concentration of potassium bromate by (µg/g) in each sample was calculated by following equation(2) [17].

$$\text{KBrO3 } (\frac{\mu g}{g}) = \frac{KBrO3\ Cocen(\frac{\mu g}{ml})}{\frac{Sample\ weight(g)}{volume\ filtrate(ml)}} \times dilution\ factor \qquad (2)$$

The practical work was conducted in the laboratory of the Chemistry Department at Alassaba Faculty of Science - Gharyan University.

RESULTS AND DISCUSSION

Table 1 shows the concentration of potassium bromate in the investigated bread samples, which was determined by the spectrophotometer method based on the reaction of bromate ions with iodide ions in the potassium iodide reagent in an acid medium, as equation (3) shows.

$$BrO_3^- + 6I^- + 6H^+ \rightarrow 3I_2 + 3H_2O + Br^- \qquad (3)$$

It was found that all the investigated samples contain different levels of potassium bromate. The concentration of potassium bromate ranged from 10.68 to 35.77 µg/g, exceeding the permissible limit set by FDA (0.02 µg/g) as illustrated in Figure 2. The highest value was recorded in one of the Tanour bread samples (35.77µg/g), while the other two Tanour samples and Barley bread had lower concentrations of $KBrO_3$. This variation can be attributed to the origin of the bread; as the Tanour bread sample with the highest potassium bromate content was produced in a commercial bakery, while the other two samples with lower-concentration of $KBrO_3$ were homemade. This suggests that potassium bromate is more likely to be used by the bakers in commercial sector to attract the consumer's attention due to its effectiveness as a dough improver and the desire to enhance bread volume and texture. In contrast, homemade products tend to exclude such additives. Also, the barley bread prepared using pure barley flour may contain no additives.

Table 2: illustrates the concentrations of potassium bromate (µg/ml and µg/g) in studied bread samples.

Bread Types	Sample code	Absorbance	Concentration (µg/ml)	Concentration (µ g/g)
Ciabatta bread	B1	0.05949	2.318	23.18
	B2	0.06455	2.856	28.56
French bread	B3	0.06050	2.426	24.26
	B4	0.05455	1.793	17.93
	B5	0.06659	3.0734	30.734
Barley bread	B6	0.04774	1.068	10.68
Tanour bread	B7	0.07132	3.577	35.77
	B8	0.05286	1.606	16.06
	B9	0.04797	1.0925	10.92

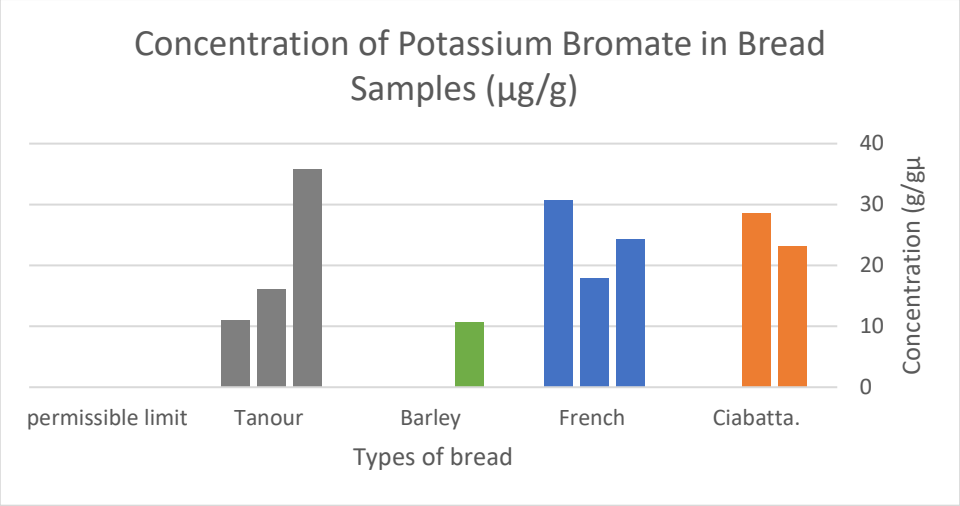

Figure (2): Concentration of Potassium Bromate in Bread Samples (µg/g).

The results obtained in the present study are comparable to those reported in several previous studies. For example, Alhanash et al. (2020) reported concentrations ranging from 6.0 to 26.67 µg/g in bread samples collected from Tajoura city in Libya [18]. While, El Ati-Hella et al. (2017) reported a range of 5.95 to 49.31 µg/g of $KBrO_3$ in bread made in Tunisia [19]. Similarly, Rana et al. (2020) found levels of potassium bromate ranged between 10.72 to 39.73 µg/g in bread produced in India [20], which is in agreement with the results obtained in the current study. In other regions of Libya, Hasan et al. (2022) detected potassium bromate levels in bread samples sold in El-Beida city that ranged from 0.38 to 13.72 ppm [21], and Busaadia et al. (2022) recorded concentrations in some samples of bread collected from several shops and bakeries in Benghazi ranging from 0.6138 to 1.558 µg/g [22]. In Jos Metropolis, Nigeria, Ekere et al. (2020) [23] found levels ranging from 0.25 to 4.375 mg/g in different types of bread. Notably, all of these studies, including the present study, reported that the potassium bromate concentrations exceed the permissible limit set by international health authorities such as the FDA.

Conclusion

In conclusion, it was found that the concentration of potassium bromate in bread samples collected from Kekla city exceeded its permissible limit set by the FDA, with levels ranged from 10.68 to 35.77 µg/g. These results highlight a lack of regulatory oversight in the use of potassium bromate, even though there were several regulations have been issued to control the trade and usage of $KBrO_3$ over Libya since 2015. Therefore, this study recommended stricter control over the use of potassium bromate in bakeries and markets. It also stresses the importance of raising consumer awareness and encourages further research in this field, as well as the use of safe alternatives of $KBrO_3$ in the bread industry such as ascorbic acid to protect public health.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

References

[1]- O, E. Omotoso "Assessment of Bread Safety: A Review of Potassium Level in Breads Sold and Consumed in Nigeria" APJMT, 10(4): pp140-144. 2021

[2] - Irhema, S.I.S. and El-Nakeib, S.M.,. "The Environmental, Human and Animal Effects of Using Potassium Bromate in Bread Industry and Chemical Analytical Methods". Journal of Basic Sciences "Special issue for the 1st International Conference on Basic Sciences and its Applications" ,37, pp.1-14. 2024.

[3] - O. C.S, Okeke, C.C Okoli "Determination of the levels and Hepatic Effects of Potassium Bromate in Bread Samples Sold in Awka Metropolis, Nigeria", Res J Sin IT Manag. 2(3). 2013

[4] - E.O Dada, M.O. Akinola, O.L. Adewole, P.T Ayobami and B.E Braimoh "Comparative Level of Bromate and Metals in Bread Loaves Obtained From Corporate and Local Bakeries in two Communities of Lagos -Nigeria" FUW Trends Sci Technol J, 2(2) 861- 865. 2017

[5] - M.O Emeje, S.I, Ofoeule,. A.C. Nnaji, A.UOfoeule and S.A Brown " Determination of potassium bromate and lead. Afrinan journal of food science, 4(6): 394-397. 2010

[6] -A .Uduak, "Potassium bromate Content of bread samples in Lagos City- Nigeria" J Pharm Appl Sci Res, 8(2):6-33
[7] - A. B.K, Ewa O, O. U, Agunbiade A, A. Oloruntoba " Evaluation of potassium bromate in bread in Abadan Metropolitan: fifteen years after ban in Nigeria " asian food sci 7(4), 1-7, 2019
[8] - J. El harti, Y, Rahali, A. Benmouss, .M. Ansar, H, Benziane, J. Lamsaouri, M.O.B. Idrissi, M. Draoui, A. Zahidi, J. Taoufi " A Simple and rapide method for spectrophotometric determination of bromatr in bread". J. Mater Environ. Sci 2(1) 71-76. 2011
[9]- IARC (1999). Potassium Bromate, summaries, and Evaluations International Agency for Research on Cancer September.
[10]- CSE Study, "Potassium Bromate or Potassium Iodate in Bread and Bakery Products," (PML/PR-49/2015). www.cseindia.org. 2016.
[11]- S.A. Uneis, W. K. Amhimmid, R. A. Salem, T. Mosbah " Qualitative and Spectrophotometric Analysis of Potassium Bromate in Bread and Flour Consumed in Tarhuna, Libya" African Journal of 2023
[12]- Uwah EI, Ikwebe ED. Trace Metals , Potassium Bromate and Nutritional Potentials in Bread from Bakeries in Uyo , Akwa Ibom State , Nigeria. Am J Appl Chem. 2020;8(3):63–73.
[13]-]Y. Kurokawa, A. Maekawa, M. Takahashi, Y. Hayashi, Toxicity and carcinogenicity of potassium bromate–A new renal carcinogen, Environ. Health Perspect. 87
(1990) 309–335.
[14 Yalçin, E., & Çavuşoğlu, K. (2022). Toxicity assessment of potassium bromate and the remedial role of grape seed extract. **Scientific Reports, 12**, Article 20529
[15]- Libya Observer. (2021, August 15). Libyan Food and Drug Control Center denies potassium bromate presence in bread. The Libya Observer. https://libyaobserver.ly/life/libyan-food-and-drug-control-center-denies-potassium-bromate-presence-bread
[16]- Z. l Ergetie, A. Hymete.(2012). DETERMINATION OF POTASSIUM BROMATE IN BREAD SAMPLES FROM FIVE BAKERIES IN ADDIS ABABA, ETHIOPIA, Int. J. Pharm & Ind. Res., Vol.–02 (04), [408 - 410]
[17]- Analytik Jena GmbH+Co. KG. "Spectrophotometric Determination of Potassium Bromate Concentration in Bread Based on the Redox Reaction Between Potassium Bromate and Promethazine in an Acidic Environment" Version 1.0, Analytik Jena GmbH+Co. KG, 2024.
[18]- H.B. Alhanash, N.A. Edriss, S.M. Ksheid, and R.A.M. Issa, "Residual Bromate Assessment in Bread Samples from Tajoura city bakeries, Libya," Academic Journal of Research and Scientific Publishing, Vol. 2, Issue 13, 2020.
[19]- R. Rana, P. Mehtani, & C. Sharma "Analysis of potassium bromate in bread samples of Jaipur City, India". Annals Food Science and Technology, Mansarovar, 21(1):109-116. 2020
[20]- El Ati-Hellal, M., Doggui, R., Krifa, Y., & El Ati, J."Potassium bromate as a food additive: a case study of Tunisian breads". Environmental Science and Pollution Research (Environ SciPollut Res),25(3):2702- 2706. 2017
[21]- H. M. A. HASAN, A .S.A.MOHAMED, K. A. ABDELGHANI ALTHAFRY and G. F. MOHAMMED."Determination the levels of potassium bromate beside some heavy metals (Fe,
Ni and Cu) in Tost and bread samples collected from some local markets in Al –Beida City by using spectrophotometer".LCCA 1:2 pp 881-123. 2022
[22]- M. A. S. Busaadia et al., "Bromate Residual Contents in Some Brands of Bread and Bakery Products Collected from Benghazi`s Bakeries, Libya," The Libyan Conference on Chemistry and Its Applications (LCCA 2021), pp:28-33, December, 2021.
[23]- A. S1. Ekere , T. T. Odoh, C .Mkurzurum and G. O .Ekere) "Determination of potassium bromate in bread samples in Jos Metropolis". GSJ 8(4): 768-774. 2020.

