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Residual Bromate Assessment in Bread Samples from Tajoura city bakeries, Libya

H.B. Alhanash[1], N.A. Edriss[2], S.M. Ksheid [1] and R.A.M. Issa[2]

[1]Advanced Lab of Chemical Analysis/ Tajoura-Tripoli, [2]Chemistry Department, Faculty of Education, University of Tripoli Libya.

Corresponding author: email: hana_hanash@yahoo.com

Abstract

A total of 25 randomly purchased bread samples were analyzed in this study from 25 different bakeries in Tajoura city. Bread in Libya is highly consumed among all socioeconomic groups; it is mainly consumed in breakfast, dinner and school meals. Potassium bromate is the most popular additive used in bakery industry worldwide. Bakeries in the US used Potassium bromate as bread improver since 1914 to increase bread volume and texture and improve bread production. The main aim of this study is to assess the safety of bread by the measurement of residual potassium bromate using a rapid and reliable method and to investigate the level of compliance to the ban fourteen years later. This method is based on the reaction between bromate and iodide in acidic medium to produce iodine (I_2). The absorbance of I_2 was measured spectrophotometrically at 488nm.

The calibration curve was linear (R^2=0.9996) over the range 1.0 – 5.0mg/L of potassium bromate. Despite the ban of potassium bromate in Libya since 2005 due to its classification as a potential carcinogen it is still detected in local bread loaves.

All samples showed high levels of potassium bromate to be 300 to 1333 more than the permissible level set by the American Food and Drug Administration (FDA) which is highly toxic for consumers and could threaten their health over prolonged regular consumption. A continuous pursuance and implementation of the ban on use of potassium bromate in baking industry in Libya is recommended.

Key words: Bread, potassium bromate, carcinogen, spectrophotometer

Introduction

Access to safe food is a basic human right worldwide. Bread is classified as ready to eat (RTE) food which is an essential food that does not require further processing before consumption.[1] In Libya bread is one of the most commonly consumed foods in homes restaurants and hotels almost in every meal.

The main constituents of bread are flour (wheat or Barley), salt, yeast, water and flour improvers.[2.3] Bread is categorized as a nutritional source of carbohydrates, vitamins and some minerals such as selenium, iron, magnesium and dietary fibre.[4a]

Potassium bromate is a popular food improver that has been used over a century by the baking industry. There has been an intense debate over the use of bromate. In early 1990's many scientists claimed that the use of potassium bromate is likely to be safe as bread additive assuming that it is completely degraded to less harmful products during baking.[4b] However, when the WHO in 1993 announced that significant amounts of residual bromate were detectable in 75% of the loaves tested in UK, this was followed by its ban in the UK.[4c]

Potassium bromate appears as a white crystalline solid with no taste and odor and is readily soluble in water. It makes the bread stronger, increases its volume [5a] and improves its appearance in addition to this it gives bulkiness to the dough development resulting in more bread loaves. It acts as a slow oxidizing agent affecting the structure and the rheological properties of the dough.

It causes flour maturation and strengthens the gluten network via the oxidation of the sulfhydryl groups in the protein chains forming disulphide bonds, hence it helps with gas retention and product volume.[5b,5c]

Potassium bromate together with the gluten present in bread results in soft bread, when closely investigated has small uniform air cells. Whereas bread with low gluten will result in big air holes, dense and thin bread.[6] It is commonly used by flour millers worldwide because it is cheap[7] and reduces the age cost.[8]

Despite its extensive use globally in bakery industry, studies showed that potassium bromate is deleterious to health and should be banned. It causes cancer, sore throat, kidney failure, abdominal pain and diarrhea,[7] extreme irritation and injury to central nervous system and kidney tissues.[9,10] As a consequence, Potassium bromate has been banned worldwide since 1992 in most European countries when the WHO stated that it is a possible human carcinogen. Although it is still used in the US with restrictions where the allowable maximum level set by the FDA is 50 mg/Kg of flour whilst in Japan it is only 10 mg/Kg of flour mass.[11]

Besides its carcinogenicity it has been reported that potassium bromate affects the nutritional quality of bread. Where it has the ability to degrade the main vitamins present in bread such as vitamin A_2, B_1, B_2 and niacin.[12]

In Libya, the import and use of potassium bromate as flour additive has been banned by the General People's Committee for Economy and Trade since 2005. Despite its ban fifteen years ago, potassium bromate is currently used in Libyan bakeries. Our main issue in Libya nowadays is the implementation of the ban. Crucial and extreme actions are required from the relevant authorities to restrict the use of this food poison.

2. Materials and methods

2.1 Reagents used were: Hydrochloric acid (Merck, 5N), Potassium iodide (Merck, 99.5%), potassium bromate (Scharlau, 99.8%) and deionized water. The following apparatus were used, DR3900 HACH laboratory Spectrophotometer, electronic balance and ordinary glass ware.

2.2 Sampling

Twenty five samples were purchased randomly from 25 different bakeries in Tajoura city.

2.3 Sample Preparation

Bread loaves were thinly sliced and dried in an oven at 75°C for 1 hr. The crust was finely ground manually using mortar, pestle and stored in sealed containers.

Accurately 3 separate 5g portions of the finely ground sample were triturated into 50.0ml of warm deionized water (3 replicates). The mixture was kept at 28°C for 20min and filtered. 5ml of the clear aliquot of each sample were transferred into 3 separate 25ml measuring flasks, 5ml of KI (1%) was added followed by 10ml HCl (2N). The absorbance was measured after mixing for each sample. Three runs were needed for each sample.

2.4 Determination of bromate

Spectrophotometric measurements were done on DR3900 HACH laboratory Spectrophotometer at λ_{max}= 488nm at room temperature against deionized water as a reference. A calibration curve (Fig. 1) was obtained using bromate standard concentration ranging from 1 to 5ppm maintaining the same matrix as that of the sample. This resulted in a calibration curve with the relationship as shown in Figure 2 with a limit of detection (LOD) of 0.147 and limit of quantification (LOQ) of 0.491.

$y = 0.3036x + 0.0004$, ($R^2 = 0.9996$).

Where y= absorbance and x= concentration of bromate.

The reaction undertaken is:-

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

Results and Discussion

As Table 1 shows, all tested samples indicated the presence of high bromate content. The residual bromate level (µg/g) in the bread sample N recorded the least amount 6.00±0.82 whereas sample V recorded the highest amount 26.67±0.94.

These values are 300-fold and 1333-fold in excess over the allowable permissible level of residual potassium bromate value set by the FDA 0.02µg/g. These values imply that none of the bread samples tested in this study are safe for humans and are hazardous on consumption. These values are higher than 2.4 – 13.60, 1.24-9.31, 1.01-12.66 or 0.28-2.99 µg/g bromate levels in bread respectively obtained by A.M. Magomya et al[3]., A.I. Airaodion et al.[13] , O.M. Emeje et al.[14] or L.A. Irogbeyi et al.[15] , but agreed closely with bromate level in bread reported by

V. Dhanda et al with 1.15 – 22.54 µg/g [16]. The bromate values of this study are lower than those reported by M. Saeed et al. to be in the range 19.4 - 41.7 µg/g.[17]

Table 1 Bromate levels in bread samples.

Sample code	[$KBrO_3$] µg/g
A	6.83 ± 0.62
B	17.83 ± 0.62
C	15.67 ± 0.24
D	12.17 ± 0.47
E	22.50 ± 0.71
F	18.00 ± 0.94
G	13.83 ± 0.71
H	11.67 ± 0.24
I	8.83 ± 0.47
J	18.50 ± 0.94
K	21.67 ± 0.24
L	14.00 ± 0.82
M	14.33 ± 0.71
N	6.00 ± 0.82
O	19.67 ± 0.24
P	23.50 ± 0.71
Q	21.17 ± 0.24
R	19.83 ± 0.94
S	20.67 ± 0.71
T	21.00 ± 0.24
U	15.50 ± 0.41
V	26.67 ± 0.94
W	22.67 ± 0.62
X	22.50 ± 0.47
y	23.67 ± 0.24

Potassium bromate during the baking process is converted into the harmless bromide under optimum conditions and enough baking time provided that the amount of bromate does not exceed 50mg/Kg flour mass.

$$2KBrO_3 \rightarrow 2KBr + 3O_2$$

Bakeries should be aware and make all necessary actions to reduce any possible bromate residues in their baked bakery products to the safe level set by the FDA.[18]

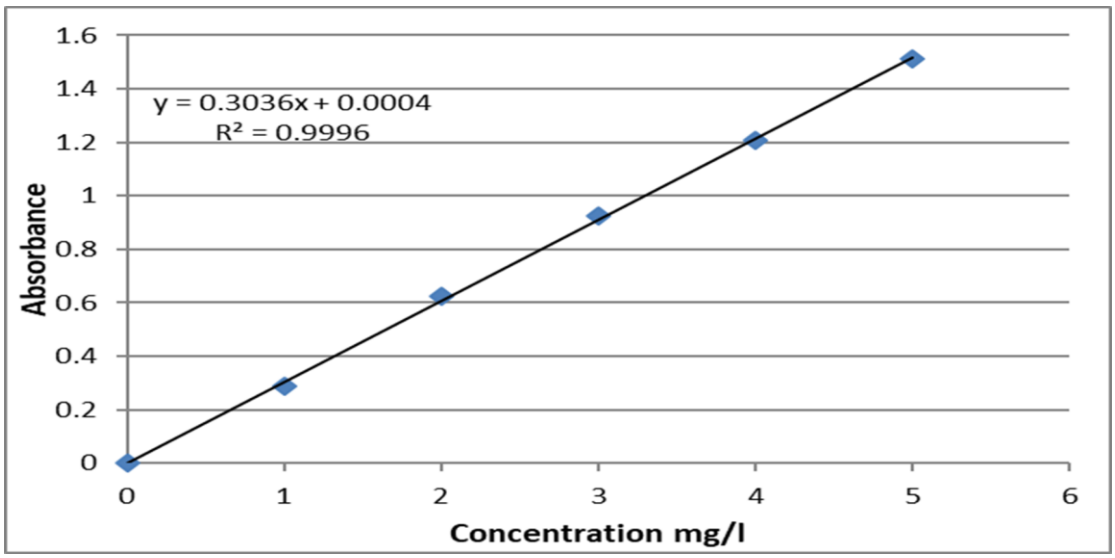

Figure 1. Calibration curve for potassium bromate.

Bromate is harmful to consumers, it may cause poisonous in two ways either by ingestion when present in food such as bakery products or by inhaling. S. Kumar et al. reported an accidental case of potassium bromate poisoning in nine bakery workers. All workers ingested potassium bromate considering it to be milk powder.

[19] Serious poisoning in adults are caused when 0.2-0.5g of potassium bromate per kilogram are infested.[20] Potassium bromate is therefore not safe for bread consumers and workers in bakeries or factories[21].

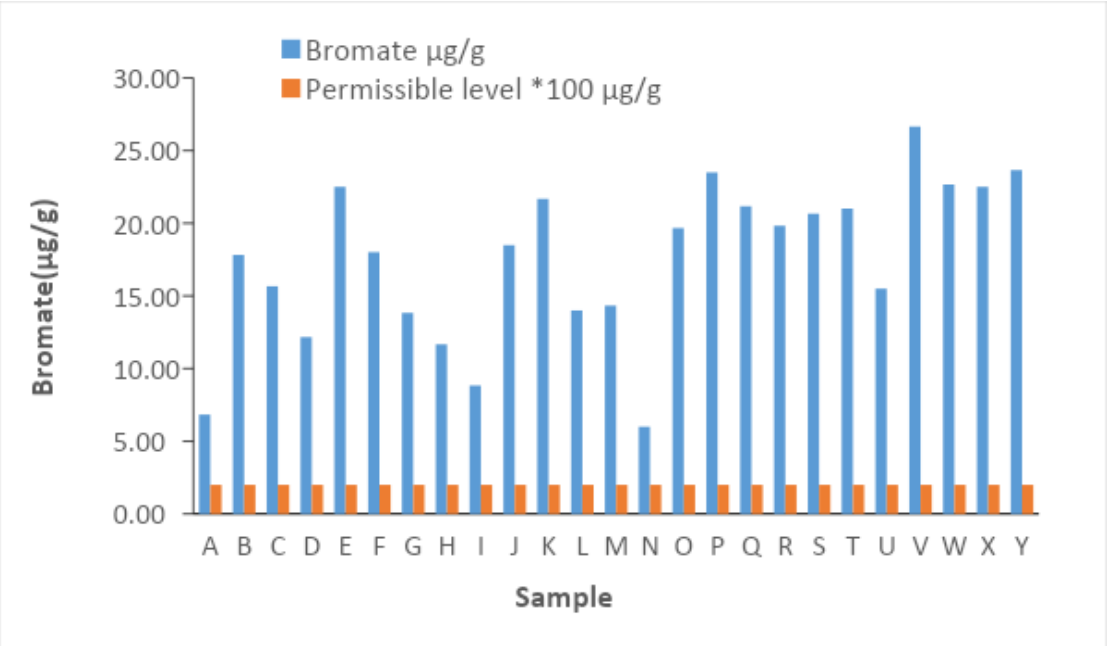

Figure 3. Histogram of bromate in bread samples.

Conclusion

In this study 100% of the tested samples contained high levels of residual potassium bromate above the permissible level. This confirms that potassium bromate is still used in Bakeries in Tajoura city and indeed in Libya, despite its ban since 2005. Bread consumers and bakers in Tajoura city are at threat of exposure to potassium bromate with health implications. This announces for strict action to be taken by relevant authorities to reaffirm the proposed ban. Routine checks should be implemented in order to ensure that bakeries always comply with the safety guidelines. Bread makers should use alternative flour improvers that are more safe to humans.

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