International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 29 العدد
April 2022 إبريل

Determination of Potassium Bromate Concentration on Bread Samples in Tobruk - Libya

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الملخص:

خلال القرن الماضي، تم استخدام برومات البوتاسيوم ($KBrO_3$) كعامل مؤكسد قوي على نطاق واسع في عمليات صناعة الخبز. هذه المواد لها العديد من الآثار الضارة على القيمة الغذائية للخبز. صُنفت أيضًا من قبل الوكالة الدولية لأبحاث السرطان (IARC) على أنها مادة مسرطنة للإنسان ومطفرة (تسبب تغيير في البيئة الجينية). لهذا السبب، تم حظر استخدام برومات البوتاسيوم في الخبز ومنتجات المخبوزات الأخرى في العديد من البلدان حول العالم. حيث حددت وكالة الغذاء والدواء الأمريكية (FDA) تركيز 0.02 ميكروغرام / غرام كحد أمن مسموح به لبرومات البوتاسيوم في الخبز. لذلك أصبح من الضروري تحديد محتوي مادة برومات البوتاسيوم في عينات الخبز المختارة في منطقة الدراسة (مدينة طبرق، ليبيا). في هذه الدراسة، تم فحص ستة وعشرين عينة من الخبز من مختلف المخابز في طبرق. أولاً تم اجراء التحليل النوعي والذي يعتمد على وجود لون مرئي ناتج عن تفاعل البرومات مع يوديد (محلول يوديد البوتاسيوم)، ومن ثم تم إجراء التحليل الكمي لقياس تركيز البرومات في جميع العينات باستخدام طريقة القياس الطيفي. خلُصت هذه الدراسة إلى أن جميع العينات التي تم تحليلها تحتوي على مستويات مختلفة من برومات البوتاسيوم. وتجدر الإشارة إلى أن أقل تركيز من برومات البوتاسيوم كان أعلى بمقدار 85 مرة من المستوى الآمن المسموح به، بينما كان أعلى تركيز والذي بدوره كان أعلى بمعدل 310مرةعن المستوى المسموح به، وهو ما يعتبر مهدد للحياة وغير آمن للاستهلاك البشري.

Abstract:
During the last century, potassium bromate $KBrO_3$ as a strong oxidizing agent have been used extensively in the process of bread-making. These additives have adverse effects on the nutritional value of bread. It has been also classified by the International Agency for Research on Cancer (IARC) as a human carcinogen and mutagen. For this reason, the use of potassium bromate in bread and other bakery products has been banned in many countries around the world. The US Food and Drug Agency (FDA) has set a concentration of 0.02 µg/gas permissible safe limit of potassium bromate in bread. Therefore, it became necessary to determine the content of $KBrO_3$ in some selected bread samples in the study area (Tobruk city, Libya). In this study, twenty-six samples of bread from different bakeries in Tobruk have been investigated. The qualitative method was based on the presence of a visible color resulted from the reaction of bromate with iodide (potassium iodide solution). The quantitative testto measure the concentration of $KBrO_3$ in all samples was performed using spectrophotometric method. It was found that all of the analyzed samples contained deferent levels of potassium bromate. It worth noted that the least concentration of potassium bromatewas 85 times higher than thepermissible safe level, while the highest concentration was 310 times higher which considers to belife- threatening and unsafe for human consumption.
Key words: Food additives, potassium bromate, bread, dough improver, spectrophotometer.

Introduction:
Food additives can be descried as any substance that affect the characteristics of food. The use of these additives may cause a health hazard even when used in appropriate amounts [1]. Potassium bromate is one of these additives that classified as a food improver. For a long time, $KBrO_3$ has been a common choice among bakers around the world, because of its cheap price as well as its effectiveness as an oxidizing agent [2, 3]. Oxidizing agents such as potassium bromate are mainly used as dough improver to enhance the bread quality and increasing the loaf volume, by forming disulfide bridges between gluten molecules [4, 5, 6]. On the other

hand, studies have shown that potassium bromate has effects on the nutritional value of bread as it decomposes the main vitamins found in bread, such as vitamin A2, B1, B2 and E [7, 8]. It has also serious effects on consumer's health [9, 10], where it has been classified as human carcinogen and mutagen by the International Agency for Research on Cancer (IARC) [11, 12]. Types of other chronic toxicity of potassium bromates includes hypotension, vertigo, deafness, oliguria, anuria, thrombocytopenia and depression of the nervous system have been also detected [13].

For this reason, the use of potassium bromate in bread and other bakery products has been prohibited in many countries around the world, but unfortunately it is still extensively used in most bakeries in Libya without caring about its health hazard, even with the presence of other enhancing alternatives such as ascorbate. In 2020, Alhanash et almeasured the bromate level on bread in Tajoura city, Libya, and found that its level was ranged from 6.00 to 23.67 µg/g [14]. The maximum amount of $KBrO_3$ which is approved as a safe level, allowed in bread by the US Food and Drug Agency (FDA) is 0.02µg/g [1, 8].

The aim of this study was the determination of potassium bromate residue in some bread samples collected from twenty-six bakeries in the city of Tobruk-Libya, the article also aimed to assess the safety of bakery products sold in the study area.

Materials and Methods:

Samples Collection:

Samples used for this study were collected from twenty-six bakeries in the city of Tobruk/Libya. Qualitative and quantitative tests were performed immediately after buying the bread using 5 ml of potassium iodide solution.

Reagents:

2M hydrochloric acid, 1% potassium iodide, potassium bromate.

Equipments:

Measuring cylinder (100ml), beakers, test tubes, wattman's filter paper, funnel, balance (electrical digital), ceramic mortar and pestle,

petri dish, conical flask(100ml), oven and spectrophotometer (6405UV).

Preparation and analysis of bread samples:

A quantity of 10 g from the centre of each baking sample was taken and dried in an oven at 60 °C for 1 hour. The crust was then ground to a fine powder.5 g of each powdered sample was then weighed and transferred into a pre-cleaned petri dish. Distilled water (10 ml) was then added and the mixture was heated to 28 °C for 20 minutes. Equal quantity of 2 M HCl (1 ml) and 1% KI (5 ml) was measured and distributed over the samples inside the petri dish until all particles were wet. The presence of a color ranged from light to dark purple indicates the presence of potassium bromate.

The concentration of $KBrO_3$ in the samples was measured using spectrophotometric method. Firstly, in a conical flask, 50 ml of distilled water was added to 5g of each powdered sample and left to stand for 45 minutes. Then, 5 ml of each sample wasmeasured and transferred into a well labelled test tube. A freshly prepared 1% KI in 2M HCl (5 ml) was added to each test tube. The change in color of each sample from light to dark purple indicates the presence of $KBrO_3$. Each sample was then diluted by adding distilled water (50 ml), and transferred to cuvette and analyzed at 620 nm using spectrophotometer. The content of potassium bromate in all samples was measured from the calibration curve using standard pure sample of previously constructed potassium bromate. The accuracy and the precision of the results were checked by performing the measurements in three replicate determinations.

Results and Discussion:

Results of determining the presence of $KBrO_3$ in all samples under investigation is shown below (Table 1 and 2). It was found that all of the twenty-six samples used in this project contain deferent levels of potassium bromate, in which a visible color was appeared in each sample. The concentration of potassium bromate ranged from1.3 to 6.2 µg/g.

These results indicate that the amount of potassium bromate in each of the twenty-six bread samples analyzed was higher than thepermissible safe level, allowed to be in bread, by the US Food

and Drug Agency (FDA), which is 0.02 µg/g. Therefore, the bread samples that collected from different bakeries in Tobruk city are unsafe for human consumption, as it contains high levels of potassium bromate. The least concentration of potassium bromate (1.3 µg/g in sample **Z**) was found to be 85 times higher thepermissible safe level, while the highest concentration was 6.2 µg/g (Samples **L** and **S**) which is 310 times higher. Samples **E**, **G**, **J**, **L** and **S** showed the highest content of $KBrO_3$ and this correlates with a characteristic darker purple color.

Table-1: Qualitative determination of potassium bromate in some bread samples sold in Tobruk city, Libya.

Bread samples	Color change
A	Light purple
B	Light purple
C	Light purple
D	Light purple
E	Purple
F	Light purple
G	Purple
H	Light purple
I	Light purple
J	Purple
K	Light purple
L	Purple
M	Light purple
N	Light purple
O	Light purple
P	Light purple
Q	Light purple
R	Light purple
S	Purple
T	Light purple
U	Light purple
V	Light purple
W	Light purple
X	Purple
Y	Light purple
Z	Light purple

Letters A to Z represent the code for different bread samples analyzed.

Table 2: Quantitative determination of potassium bromate in some brands of bread sold in Tobruk city.

Bread samples	$KBrO_3$ content (µg/g)	Color change
A	**3.1± 0.10**	Light purple
B	**2.1 ±0.14**	Light purple
C	**4.5 ± 0.06**	Light purple
D	**2.3 ± 0.06**	Light purple
E	**5.6 ± 0.10**	purple
F	**4.2 ± 0.05**	Light purple
G	**5.7± 0.06**	purple
H	**3.4± 0.06**	Light purple
I	**2.8± 0.10**	Light purple
J	**5.2± 0.15**	purple
K	**3.1 ± 0.12**	Light purple
L	**6.2± 0.06**	purple
M	**4.7 ± 0.06**	Light purple
N	**3.7 ± 0.12**	Light purple
O	**1.7 ± 0.06**	Light purple
P	**4.1 ± 0.10**	Light purple
Q	**3.6 ± 0.06**	Light purple
R	**1.4 ± 0.06**	Light purple
S	**6.2 ± 0.15**	purple
T	**4.5 ± 0.06**	Light purple
U	**2.3 ± 0.15**	Light purple
V	**3.1 ± 0.06**	Light purple
W	**4.1 ± 0.59**	Light purple
X	**5.5 ± 0.15**	purple
Y	**2.7 ± 0.12**	Light purple
Z	**1.3 ± 0.15**	Light purple

Concentration reported in mean ± standard deviation.

Conclusion:

The results of the study show that all of the twenty-six bread samples in the study area contained different concentrations of potassium bromate at a harmful level on human health.These values ranged from1.3 to 6.2 µg/g, which were higher than thepermissible safe level (0.02 µg/g).Therefore, the authority in Libya must strictly ban the use of potassium bromate in bakery products, and work to provide other enhancing alternatives that are much safer.

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