ANALYSIS OF POTASSIUM BROMATE IN BREAD SAMPLES OF JAIPUR CITY, INDIA

Rana, Rashmi Singh[1], **Mehtani**, Payal[1], **Sharma**, Charu[1], **Bhatnagar**, Pradeep[1]

[1]Department of Biotechnology, IIS(Deemed to be University), Gurukul Marg, SFS, Mansarovar, Jaipur, INDIA-302020
E-mail: payal.mehtani@iisuniv.ac.in

Abstract
Bread is one of the most popular food types consumed by all socio-economic groups. It is readily available in hotels, restaurants and homes and is prepared mainly from flour using various other components to improve its overall quality. One such component is potassium bromate, used as an oxidizing agent for maturation of flour. The use of potassium bromate in bread making industry has increased in past years because of its efficiency and cheap price. However, the chemical is carcinogenic and its consumption can lead to many adverse effects on health. In the present study, different types of bread samples belonging to various brands available in Jaipur city were analyzed for the presence of potassium bromate content via spectrophotometric method. The result of the study revealed that the bromate levels ranged from 10.72 ± 3.75 ppm in white bread sample to 39.73 ± 5.32 ppm in fruit bun bread which shows that the bakeries are not following the proper standards of bread preparation. The presence of potassium bromate was not detected in white and brown bread samples of only a few brands which indicates that their process of bread making was appropriate. The amount of potassium bromate content found could threaten peoples' life when consumed regularly and hence needs to be monitored strictly.

Keywords: Bakery, Bread, Carcinogen, Dough conditioner, Health

Received: 20.08.2019 Reviewed: 27.02.2020 Accepted: 02.03.2020

INTRODUCTION

Bread is the cheapest and one of the oldest processed instant food available for consumption. In India, bread is not consumed as staple food but it is a secondary food option as compared to *chapatti*, *puri* or rice, never the less its consumption has increased over the years. Bread is prepared from flour dough. There are several dough conditioners that mature flour, strengthen the gluten network in bread dough and enhance its elasticity. One such dough conditioner is potassium bromate that oxidizes the sulfhydryl or thiol (R-SH) groups of the gluten protein present in flour into disulphide bridges. This oxidation makes the dough more elastic to retain the carbon dioxide gas produced by the yeast (Emeje *et al*., 2010) there by increasing the volume and softness of the bread. Normally, during baking at high temperatures, potassium bromate ($KBrO_3$) (toxic) is converted to potassium bromide (KBr) (non-toxic). However, the residual amount of potassium bromate may be found, if the bread is baked for a shorter time period or if the process is not conducted at high enough temperature. The persistence of potassium bromate may also occur in the finished product if excess of the additive is used (Bushuk and Hlynka, 1960).

Consumption of potassium bromate can result in diarrhea, nausea, vomiting, abdominal pain, oligonuria, anuria, vertigo, hypotension, depression of the central nervous system, thrombocytopenia and cancer with other linked health problems (Atkins, 1993; Watson, 2000). It also degrades the vitamins and fatty acid present in flour thereby lowering the nutritional quality of bread (Emeje *et al*., 2010). Nephrotoxic and ototoxic effects of potassium bromate has been observed in experimental animals as well as in man. $KBrO_3$ is considered as a genotoxic carcinogen that has the ability to induce renal cell tumors, mesotheliomas, and thyroid follicular cell tumors in rats. It can both initiate as well as can promote the activities for the development of renal cell tumors (Kurokawa *et al*., 1990).

The use potassium bromate as a flour treatment agent has been banned in many countries across the world (Table 1). Joint FAO/WHO Expert Committee on Food Additives at its 44th meeting in 1995 assessed the detectable

Table 1. Regulatory status of $KBrO_3$ as a flour treatment agent

Country	Status
European Union	Banned (1990)
UK	Banned (1990)
Nigeria	Banned (1993)
Canada	Banned (1994)
Sri Lanka	Banned (2001)
Brazil	Banned (2001)
Peru	Banned (2002)
Columbia	Banned (2002)
China	Banned (2005)
Australia	Banned
New Zealand	Banned
United States	Not Banned

(Source: CSE Study, 2016)

residues of potassium bromate in the end product and evaluated the relation of potassium bromate with cancer. They concluded that use of this additive as a flour treatment agent is not acceptable (WHO, 1995). Moreover, in 1999, International Agency for Research on Cancer (IARC), associated with the WHO, classified potassium bromate as possible carcinogen for humans and placed it under Class 2B (IARC, 1986).

In India, as per the Food Safety and Standards (Food Product Standards and Additives) Regulations, 2011, the use of potassium bromate and potassium iodate was permitted to a maximum level of 50 ppm in breads and 20 ppm in bakery flour (CSE Study, 2016). But in May 2016, Centre for Science and Environment (CSE) submitted a study report that showed that 84.2% of bread samples in Delhi contained residues of potassium bromate/iodate and thus the use of such agents has been questioned. On the basis of this report, FSSAI (Food Safety and Standards Authority of India) has recommended to the health ministry of India to remove/ban the usage of potassium bromated (Times of India, 2016).

Despite the fact that many other non-toxic, flour enhancing alternatives are available, many bakers are still using potassium bromate for bread preparation thereby putting the life of the public at risk. Realizing the potential threat posed by such agents the present study was aimed at analyzing the potassium bromate residues in finished breads available in Jaipur city.

MATERIALS AND METHODS

Sampling

A total of 14 bread samples of different brands (I-V) were purchased from bakeries, retailers and fast food outlets located in Jaipur city, Rajasthan, India. Bread samples collected were of different types like white bread, brown bread, pav bread and fruit bun bread. These samples were named from A-N.

All the four breads are manufactured from wheat flour. In white bread, the flour is bleached to make it white, using chemicals like benzoyl peroxide, chlorine dioxide etc. Sometimes, added with starch and sugars, including high fructose corn syrup. Brown bread is similar to white bread in composition but contains caramel as an additional ingredient for the brown appearance (Times of India, 2018). Fruit bun and pav are small loaf of bread made from finely milled wheat flour without any bran, refined and bleached. Fruit bun contains additional cherries and fruits that add to its flavor and nutritional values.

Qualitative Analysis

The middle portion of the bread was taken, crushed and 2ml of 0.01M promethazine (98.8% purity, Sigma) was added followed by addition of 0.6ml of 12M hydrochloric acid (35 % purity, Thermo Fisher Scientific). The presence of potassium bromate was indicated by development of pink colour (Alli *et al.*, 2013).

Quantitative Analysis

Sample Preparation

The hard brown corners of the bread were removed and the central portion was used for analysis. In case of sweet bun and pav upper, lower and side hard portions were removed using clean and sharp knife and white central portion was used for analysis. The central portion was dried in oven for about 1 hour at 75°C. The dried crust was then powdered and used for quantitative estimation.

Preparation of Standard Calibration Curve

The spectrophotometric method described by El Harti *et al.* (2011) was used for the quantitative determination of potassium bromate in the samples of bread. Standard solution of $KBrO_3$ (1000 µg/ml) (99.8 % purity, Merck) prepared in water was used as stock solution from which intermediate stock standard solution (50 µg/ml) was prepared. Different aliquots from intermediate stock standard solution of $KBrO_3$ were placed in 10 ml volumetric flask, and diluted to 8 ml. Then 1.0 ml of 0.01M promethazine (PMZ) followed by 0.2 ml of 12M HCl were added in each flask and finally diluted to the mark. Mixtures were well shaken for 1 minute and the absorbance was measured at 515nm against a reagent blank. A standard curve was plotted and the regression equation was generated.

Spectrophotometric Analysis

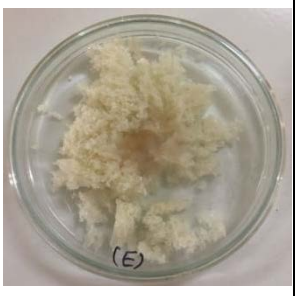
One gram of each powdered sample was weighed into a clean centrifuge tube and 20 ml of ultrapure deionized water was added. The mixture was vortexed for 2 minutes and then filtered. 8.0 ml of the filtrate solution was transferred into a 10 ml volumetric flask. 1.0 ml of 0.01M promethazine dye solution was added followed by 0.2 ml of 12M hydrochloric acid, the mixture was shaken for about one minute and absorbance of the colored solution obtained was measured by spectrophotometer (Thermo Fisher) at 515nm against a reagent blank. The concentration was calculated from the linear regression curve obtained from the standard solutions of potassium bromate as mentioned above. The results were reported in ppm.

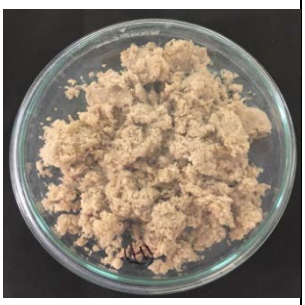
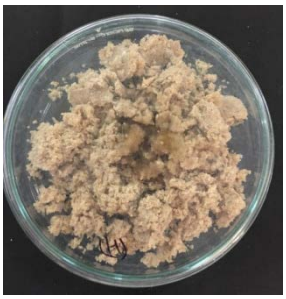
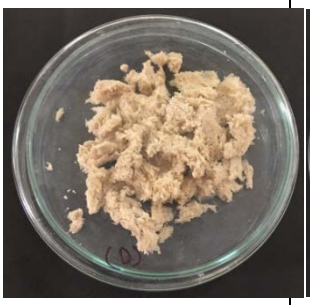
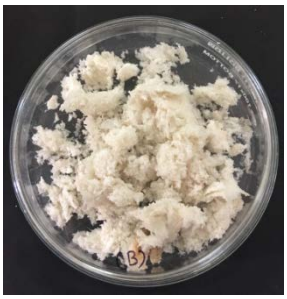
RESULTS AND DISCUSSION

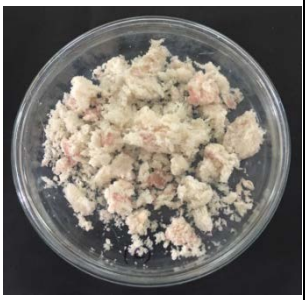
Qualitative analysis

Different type of bread samples like white bread, brown bread, pav and fruit bun breads that belonged to different brands were tested for the presence of potassium bromate. The oxidation of promethazine with bromate under acidic condition produced pink colour in 11 out of 14 samples (Table 2).

Table 2. Presence of $KBrO_3$ in different bread samples

Type of bread	Name of Brand/ Sample Designation	Before treatment	After treatment
White bread	Brand II/ N		
	Brand III/ E		

	Brand IV/ L		
	Brand V/ K		
Brown bread	Brand II/ H		
	Brand III/ D		
Pav bread	Brand I/ B		

	Brand III/ I		
	Brand V/ M		
Fruit bun	Brand I/ C		
	Brand III/ F		

Quantitative analysis of $KBrO_3$

Quantitative analysis was conducted spectrophotometrically for all the bread samples that showed positive result in preliminary analysis and the potassium bromate concentration was recorded in ppm (Table 3). The highest concentration was found in fruit bun (39.73 ± 5.32 ppm) of brand I and lowest in white bread of brand III (10.72 ± 3.75 ppm).

Inspite of the ban on use of potassium bromate in many countries, bakers are still using the same. Potassium bromate was banned in Nigeria in 2004. Despite the ban, a study conducted after a decade reported the presence of potassium bromate in 92% of the bread samples of Nigeria (Emeje *et al.*, 2010). The use of this chemical is not yet banned in India though its appearance in the finished product is not permissible. In a recent study, a wide range of different types of bread from simple

Table 3. Concentration of potassium bromate in various bread samples

Sample	Name	$KBrO_3$ (in ppm)
White Bread		
N	Brand II	13.84 ± 5.0
E	Brand III	10.72 ± 3.75
L	Brand IV	11.43 ± 2.98
K	Brand V	24.62 ± 3.75
Brown Bread		
H	Brand II	14.69 ± 6.02
D	Brand III	29.02± 5.45
Pav Bread		
B	Brand I	17.46 ± 1.71
I	Brand III	19.66± 2.96
M	Brand V	11.29 ± 5.01
Fruit Bun		
C	Brand I	39.73 ± 5.32
F	Brand III	29.02 ± 5.45

Values are expressed as mean ± standard deviation.

sandwich bread to ready to eat pizza/ burger bread of Delhi, India were studied in which 84.2% samples were found positive for potassium bromated (CSE Study, 2016). Similar results were found in the present study, 78.57% samples were found to contain potassium bromate in the range of 10.72 to 39.73 ppm. All the types of bread were found to contain the potassium bromate. The highest concentration of potassium bromate was found in fruit bun (39.73 ± 5.32 ppm) followed by brown bread (29.02 ± 5.45 ppm), white bread (24.62 ± 3.75 ppm) and pav bread (19.66 ± 2.96 ppm) (Figure 1). White bread samples of all brands except Brand I showed pink colour after addition of promethazine hydrochloride, hence were found to be positive for the presence of potassium bromate.

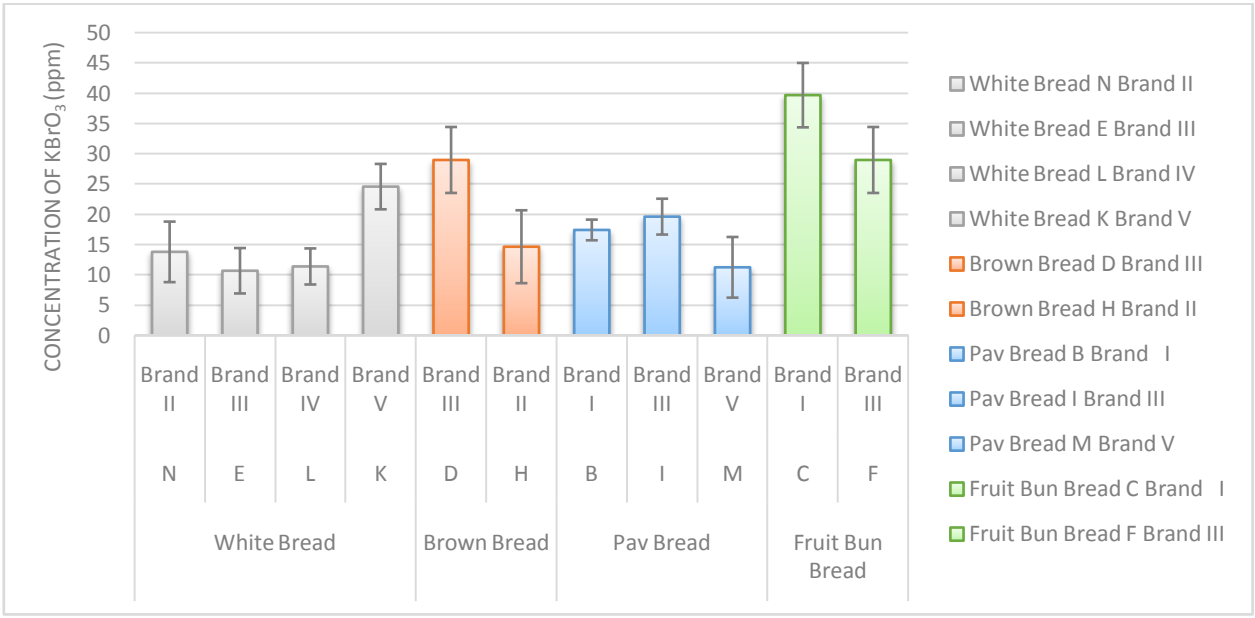


Figure 1. Presence of potassium bromate in various brands of different breads

The highest concentration was found in Brand V (24.62 ± 3.75 ppm) and least in Brand III (10.72 ± 3.75 ppm). In brown bread, 50% of the samples contained potassium bromate with highest concentration of potassium bromate was found in Brand III (29.02 ± 5.45 ppm) followed by Brand II (14.69 ± 6.02 ppm). Whereas, pav bread and fruit bun samples of all the brands tested were positive for the presence of potassium bromate. The quantitative analysis showed that the concentration of potassium bromate was much higher in fruit bun samples as compared to pav bread. White bread samples of Brand I and brown bread samples of Brand I and V were found to be fit for consumption as they showed negative results for potassium bromate.

The varying residual amounts of potassium bromate were found in the finished products, may be due to baking of bread for a shorter time period or the process is not being conducted at high enough temperature. The persistence of potassium bromate may also occur in the finished product because of the excess use of the additive (Bushuk and Hlynka, 1960).

CONCLUSIONS

Potassium bromate was found in approx. 80% of the finished bakery products of Jaipur City. The maximum limit of use of potassium bromate permissible in India is lower than 50 ppm and leaching of this chemical in finished product is not permissible. While in the current study, potassium bromate was found in the finished breads in varying concentrations. The present investigation ascertained that the bakeries in Jaipur, India are not following the proper norms of using potassium bromate. In view of the present study, some suggestions are recommended that can help to regulate the use of potassium bromate by bakery industries such as regular inspections of bakeries by FSSAI. Many non-toxic alternatives are available that equally enhances the quality of bread and can be used in place of $KBrO_3$ such as ascorbic acid. Corrales *et al.* (1993) demonstrated that it is technically feasible to replace potassium bromate with ascorbic acid, without affecting the bread acceptability. Also enzymes such as hemicellulases (volume enhancing), glutathione oxidase (protein strengthening) and exo-peptidase (improves colour and flavour) can equally be used. Glucose oxidase is another alternative known to perform similar functions and was approved by the FSSAI in November 2015. There are several other improvers and flour treatment agents approved by law such as ammonium persulphate, ammonium chloride and amylases. The differential amount of potassium bromate is being used by different manufacturers for different bakery products thus practically it becomes difficult to ascertain the quantity of added chemical. Moreover, looking at the availability of so many non-toxic alternatives to potassium bromate it would be more appropriate to completely prohibit its use in India like other countries.

ACKNOWLEDGEMENT

Authors gratefully acknowledge the financial assistance provided by IIS (Deemed to be University), Jaipur for the present work.

REFERENCES

[1] Alli, L.A., Nwegbu, M.M., Inyang, B.I., Nwachukwu, K.C., Ogedengbe, J.O., Onaadepo, O., Jamda, M.A., Akintan, G.A., Ibrahim, S.O., and Onifade, E.A. (2013). Determination of potassium bromate content in selected bread samples in Gwagwalada, Abuja-Nigeria. *International Journal of Health & Nutrition*,4(1): 15-20.

[2] Atkins, D.P. (1993). Potassium bromate in bread. *Index to MAFF-UK Food surveillance Information sheet. No. 2.*

[3] Bushuk, W., and Hlynka, I. (1960). Disappearance of bromate during baking of bread. *Cereal Chemistry*, 37: 573-576.

[4] Corrales, X., Guerra, M., Granito, M., and Ferris, J. (1993). Substitution of ascorbic acid for potassium bromide in the making of French bread. *Archivos Latinoamericanos de Nutrición*, 43(3): 234-240.

[5] CSE Study. 2016. Potassium bromate or potassium iodate in bread, Centre for Science and Environment, New Delhi (PML/P-49/2015)

[6] El Harti, J., Rahali, Y, Benmoussa, A., Ansar, M., Benziane, H., Lamsaouri, J., Idrissi, M.O.B., Draoui, M., Zahidi, A.,and Taoufik, J. (2011). A simple and rapid method for spectrophotometric determination of bromate in bread. *Journal of Materials and Environmental Science*,2(1): 71-76.

[7] Emeje, M.O., Ofoefule, S.I., Nnaji, A.C., Ofoefule, A.U., and Brown, S.A. (2010). Quantitative

determination of potassium bromate and lead. *African Journal of Food Science*,4(6): 394-397.

[8] India bans use of cancer-causing additive, potassium bromate, in bread, other food, Times of India. (June 20, 2016). https://timesofindia.indiatimes.com/india/India-bans-use-of-cancer-causing-additive-potassium-bromate-in-bread-other-food/articleshow/52836892.cms Accessed on 20-2-2019

[9] International Agency for Research on Cancer (IARC) (1986). Vol. 73 p. 481-496 https://monographs.iarc.fr/wp-content/uploads/2018/06/mono73-22.pdfAccessed on 20-2-2019

[10] Kurokawa, Y., Maekawa, A., Takahashi, M., and Hayashit, Y. (1990). Toxicity and carcinogenicity of potassium bromate- A new renal carcinogen. *Environmental Health Perspectives*, 87: 309-335.

[11] Watson Y. (2000). Material safety data sheet: potassium bromate (Mallinckrodt baker Inc. New Jersey).

[12] White bread vs brown bread: Here is the winner, Times of India (Oct 18, 2018) https://timesofindia.indiatimes.com/life-style/health-fitness/diet/white-bread-vs-brown-bread-here-is-the-winner/articleshow/66272088.cms. Accessed on 25-2-2020

[13] WHO Report. (1995). Evaluations of the Joint FAO/WHO Expert Committee on Food Additives (JECFA)http://apps.who.int/food-additives-contaminants-jecfa-database/chemical.aspx?chemID=4265 Accessed on 20-2-2019