TITLE OF PROJECT

AN EVALUTION OF THE POTENTIAL DANGERS OF POTASSIUM BROMATE IN BREAD UPON HEALTH

STUDENTS STUDY RESEARCH PROJECT
FOR THE ACADEMIC YEAR 2021 – 2022

Under the

JIGNASA

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SUBMITTED
To
COMMISSIONER OF COLLEGIATE EDUCATION
HYDERABAD. 500001, (T.S) INDIA.

AN EVALUATION OF THE POTENTIAL DANGERS OF POTASSIUM BROMATE IN BREAD UPON HEALTH

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Abstract:

Bread is one of the most extensively consumed foods by people from all walks of life. It is readily available in hotels, restaurants, and homes, and it is made mostly of flour with the addition of various extra components to improve its overall quality. One such component is potassium bromate, which is used as an oxidizing agent in the maturation of flour. Potassium bromate has witnessed a spike in use in the bread-making industry in recent decades due to its efficacy and inexpensive cost. The chemical, on the other hand, is carcinogenic, and its usage might result in a number of detrimental health effects. The presence of potassium bromate content in numerous types of bread samples from various brands available in Bhopal ally city was tested in the present study using a spectrophotometric technique. Bromate levels in white bread samples ranged from 08.84 3.0 ppm to 25.74 4.0 ppm in fruit bun bread samples, showing that bakeries are not following the essential requirements for bread manufacture. Because potassium bromate was not found in white or brown bread samples from just a few brands, it's safe to assume that their bread-making techniques were appropriate. As a consequence, when potassium bromate is consumed on a regular basis, the amount of potassium bromate found in the samples should be continuously monitored.

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

Introduction:

Potassium bromate is an oxidizing agent as well as one of the most effective and least priced dough improvers on the market. Because of its many advantages, it has a huge influence on the bread-making industry. Potassium bromate has a significant impact on the extent of gelatinization, viscosity, swelling characteristics, and gluten proteins in food biomolecules such as starch and protein; it removes the sulfhydryl group and causes the formation of disulfide linkages, which improves the texture and properties of bread. A huge number of research, on the other hand, show that it is hazardous to human health. It is a potential human carcinogen and a class 2B carcinogen, according to the International Agency for Research on Cancer (IARC). As a consequence, countries all around the world have either partially or completely prohibited the practice. Many

methods have been devised to determine the potassium bromate concentration in bread. A loaf of bread is the cheapest and one of the oldest processed fast meals available for human consumption. Bread is not a staple food in India; rather, it is seen as a secondary dietary option when compared to other staple meals such as chapatti, puri, and rice. Despite this, bread consumption has gradually increased throughout the years. Bread is formed from a flour dough. Dough conditioners are available that assist to mature flour, strengthen the gluten network in bread dough, and enhance dough elasticity. Potassium bromate, in particular, is a dough conditioner that may be used to enhance the texture and rise of dough by oxidizing the R-SH groups of the gluten protein found in wheat to generate disulphide bridges. This oxidation causes the dough to become more elastic, enabling it to retain the carbon dioxide gas produced by the yeast (Emeje *et al.,* 2010), resulting in enhanced volume and softness of the baked items. Most of the time, during high-temperature baking, the lethal potassium bromate ($KBrO_3$) is converted to the harmless potassium bromide (KBr) (non-toxic). A residual amount of potassium bromate, on the other hand, may be identified in bread baked for a shorter period of time or at a lower temperature than the manufacturer recommends. If an excessive quantity of the additive is used, potassium bromate may be detected in the finished product (Bushuk and Hlynka, 1960). Consumption of potassium bromate may cause diarrhoea, nausea, vomiting, stomach discomfort, oligonuria, anuria, vertigo, and hypotension, central nervous system depression, thrombocytopenia, and cancer, among other health concerns (Atkins, 1993; Watson, 2000). It also damages the vitamins and fatty acids included in flour, lowering the nutritional value of bread (Emeje *et al.,* 2010). In both experimental animals and people, potassium bromate has been demonstrated to cause nephrotoxic and ototoxic effects. Because it has the ability to generate kidney cell tumours, mesotheliomas, and thyroid follicular cell tumours in rats, among other malignant disorders, $KBrO_3$ is classified as a genotoxic carcinogen. It has the ability to initiate and accelerate the processes that contribute to the development of renal cell tumours (Kurokawa *et. al.,* 1990). Using potassium bromate as a flour treatment agent is unlawful in many countries across the world, including the United States (Table 1). The Joint FAO/WHO Expert Committee on Food Additives reviewed detectable levels of food additives during its 44th meeting in 1995.

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

Sl. No	Country	Status
1	European Union	Banned (1990)
2	UK	Banned (1990)
3	Nigeria	Banned (1993)
4	Canada	Banned (1994)
5	Sri Lanka	Banned (2001
8	Brazil	Banned (2001)
7	Peru	Banned (2002
8	Columbia)	Banned (2002
9	China	Banned (2005)

Investigations were performed on the existence of potassium bromate residues in the completed product, as well as the link between potassium bromate and cancer. They came to the conclusion that utilizing this chemical as a flour treatment agent in the food and beverage sector was not a suitable solution (WHO, 1995). The International Agency for Research on Cancer (IARC), which is linked with the World Health Organization, recognised potassium bromate as a possible carcinogen for people in 1999 and classified it as a Class 2B carcinogen, which means it is harmful to humans (IARC, 1986). According to the Food Safety and Standards (Food Product Standards and Additives) Regulations, 2011, the use of potassium bromate and potassium iodate in breads up to a maximum level of 50 parts per million (ppm) and bakery flour up to a maximum level of 20 parts per million (ppm) has been authorized; however, the use of potassium bromate and potassium iodate in bakery flour has been prohibited (CSE Study, 2016).

A study report published in May 2016 by the Centre for Science and Environment (CSE) indicated that 84.2 percent of bread samples in Delhi included residues of potassium bromate/iodate, raising concerns about the use of such preservatives in bread. A recommendation has been made to the Indian Ministry of Health based on the results of this investigation: potassium bromate should be phased out or prohibited totally from usage, according to the FSSAI (Food Safety and Standards Authority of India) (Times of India, 2016). While there are other non-toxic flour boosting choices available, many bakers continue to utilize potassium bromate for bread manufacture, putting the public's health and safety in jeopardy. The current experiment attempted to establish the existence of potassium bromate residues in finished loaves available in the city of

Bhoopalppally in the state of Telangana, in recognition of the potential hazard posed by such compounds.

Bakery Products

In 1964, the Food and Agricultural Organization of the United Nations (FAO) and the World Health Organization (WHO) collaborated on an investigation of the effects of potassium bromate on flour after it had been treated with the chemical. It was later discovered that, when taken within permissible levels, it had no negative effects on the body. In addition to being used in the production of bread, potassium bromate is also used in the production of beer to cure the barley. In Japan, it is used to improve the quality of fish paste used in a variety of foods.

However, subsequent studies by joint committees of the FAO and the WHO concluded that potassium bromate should not be included in food and, if it is, it should be present in minimal quantities. In any case, it should only be considered appropriate if it falls under the maximum permissible daily bromide consumption limit. Through testing, it has been shown that potassium bromate changes to bromide when bread is made from wheat using a bulk fermentation procedure. Bromide is completely safe and does not have any negative effects. When bromate was used in quantities less than 50mg per kilogramme of flour, no bromate residue was left behind; however, when bromate was used in quantities more than 50mg per kg of flour, potassium bromate was discovered in the bread. The higher the concentration of bromate utilized, the greater the amount of leftover bromate. Similar to this, when bromate is used to treat barley for beer production, the bromate becomes bromide. Fish paste that has been treated with bromate, on the other hand, has residues in the goods. There is no consensus on what amounts of bromate are regarded safe at this time, with the exception of those used in the treatment of bread. As a result, the FAO/WHO committee determined in 1992 that utilising potassium bromate as a flour treatment agent was "not acceptable.

The majority of the evidence for potassium bromate's potential carcinogenicity has come from animal research. Because there is insufficient data to conclude that potassium bromate causes cancer, it has been classified as Group2B, which indicates that it may cause cancer. According to the United States Environmental Protection Agency (EPA), bromate has the potential to cause cancer in humans; however, since no long-term studies have been undertaken on humans, there is no definitive method to establish the amount of bromate that will cause cancer. When it is employed in flour at a concentration of 15-30ppm, it is completely consumed during the baking

process and leaves no trace in the completed product. As a result, the FSSAI had suggested a restriction of 20ppm for the use of the addition in flour; however, after the publishing of the CSE report, the FSSAI has decided to prohibit the use of the additive in any bakery goods. A formal withdrawal of potassium bromate standards was made by the Codex Alimentarius in 2012 since it was unable to determine what level of potassium bromate was harmful.

Many fast food rolls, buns, and pizza bases include brominated flour, which is present in certain restaurants and bakeries as well as in some fast food rolls, buns, and pizza bases. Potassium bromate is used in conjunction with flour by a variety of bread and baked goods makers because it enhances flexibility, speeds up baking, and imparts a lovely white colour to the bread. These goods may be totally safe if the quantity of bromate in them is under 'limits,' but there is no way for consumers to know how much bromate is still present in them, particularly when they are used in burger buns or pizza bases. As a result, the FSSAI, along with a number of other nations, has decided to prohibit the use of potassium bromate. Potassium bromate has been substituted by other dough-enhancing ingredients in several commercial products. Potassium bromate may be replaced with other ingredients by manufacturers; however, they must adhere to the food additive criteria set forth in Appendix A of the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011.

Back ground of the study:

In India, bread is considered a staple meal, and it is eaten in vast amounts. In houses, restaurants, and hotels, it is consumed in great amounts in a variety of forms. Bread is made from wheat, which has a low protein level, and it is baked. It often contains a variety of ingredients that work together to increase the overall quality of the bread. Some of the necessary components that have been identified, in addition to flour, are: table salt; sugars; flavours; and, at the absolute least, a flour improver such as potassium bromate (Vicki, 1997). It is a major challenge in both the flour milling business and the baking industry to get high baking quality flour, which is evaluated by the capacity of dough created from it to retain gas when baked at a high temperature. Various treatments and supplements (flour/bread improvers) are used to improve the strength of the dough when mixing, the flexibility of the dough for shaping, and the volume and texture of the loaf as a result of the wide range of variances in flour composition available. The use of many different improving substances has occurred throughout history, but research have shown that some of them are dangerous to one's health, forcing the removal of these products from stores and shelves.

As an oxidizing agent, flour millers and bakers all over the world have traditionally depended on potassium bromate since it is affordable and, in some cases, the most effective agent currently on the market. This oxidising agent is present in the dough at various stages of fermentation, proofing, and baking, and has an effect on the structure and rheological properties of the dough. As a result of this breakthrough, many bakeries now use potassium bromate as an additive to help in the rising process and to provide a texture in the finished product that is appealing to the general public as well. There is a detrimental influence on one's health caused by potassium bromate, and the repercussions of this impact may be classified into two categories. Those who fall into the first category are concerned about side effects that are not associated with malignancy. This includes the effect it has on the nutritional quality of the loaf of bread, which is another consideration.

It is capable to destroying the vitamins A2, B1, B2, E, and nicotinic acid, which are the key vitamins contained in bread and other baked foods, as well as other nutrients (IARC, 1999). According to a 1999 research undertaken by the International Agency for Research on Cancer (IARC), there were significant differences in the essential fatty acid content of wheat treated with bromate or in bread made with bromate.

It is possible that individuals may experience coughing and sore throats if they inhale potassium bromate (Atkins, 1993). Additional non-cancerous health risks associated with potassium bromate use include stomach pain, diarrhoea, nausea, and vomiting, to name a few examples. Kidney failure, hearing loss, bronchial and ophthalmic issues are all known to arise as a result of this condition (Atkins, 1993). A large number of studies have revealed that potassium bromate has a high potential to cause cancer in both experimental animals and humans, which falls into the second group (CSPI, 1999; Watson, 2000). Using bromate as a bread improver has been outlawed for quite some time (Ekop et al., 2008).

The usage of potassium bromate by certain bakeries and bread makers in India, on the other hand, has continued in their baked products. According to the early findings, several additional elements utilized in bread manufacturing (for example, water) and the environments in which these bakeries are located are polluted with heavy metals such as lead, which is a concern. Due to these factors, this experiment was conducted in the eastern section of India, where bread consumption is fairly high and where several bakeries are located in the center of slums and shanty towns, as shown by the results of the previous experiment. The issue is stated as follows:

Following the discovery of the hazardous impact potassium bromated had on consumers, the toxic ingredient was prohibited by the Federal Ministry of Health in 1993. A food additive, potassium bromate ($KBrO_3$), is an oxidising agent that has traditionally been employed in the bread-making process. According to research, potassium bromate is a carcinogen that may cause kidney cell tumours, peritoneal mesotheliomas, and thyroid follicular cell tumours in humans and animals. Experiments conducted to determine the mechanism of carcinogenic activity have showed that potassium bromate is a full carcinogen, exhibiting both starting and propagating actions for the development of rat kidney tumours.

Objectives of the study.

- The main aim of this study is to investigate into the harmful effects of potassium bromated in bread. Specific objectives of the study are:
- To analyze the effect of potassium-bromate in bread.
- To examine the toxicity of potassium bromated in bread bakery.

This research will help in educating the general public, as well as bread customers, about the adverse consequences of potassium bromated. The findings of the research will educate readers on why they should participate in the battle against bakery operators that continue to use potassium bromated as an ingredient in the manufacture of bread**.**

Scope of the study

Based on bread samples from the Indian state of Telanagana, the research examines the impacts of potassium bromate and the damage it does to human health. Due to budgetary and time restrictions, the researcher was unable to explore a larger geographic region.

Materials and methods

A total of four bread samples (I-IV) from various brands were obtained from bakeries, shops, and fast food outlets in the city of Bhoopalpally in the state of Telanagana, India. The bread samples that were obtained included a variety of varieties, including white bread, brown bread, pav bread, and fruit bun bread. These samples were given letters ranging from A to N. Wheat flour is used in the production of all four loaves on the list. White bread is made by bleaching the flour using chemicals such as benzoyl peroxide, chlorine dioxide, and other substances to turn it white. A starch and sugar mixture, particularly high fructose corn syrup, is sometimes used in place of the starch. Brown bread has a similar composition to white bread, but it incorporates caramel as an extra ingredient to give it a brown look, as opposed to white bread (Times of India, 2018). Fruit

buns and pav are little loaves of bread produced from finely milled wheat flour that is devoid of bran, refined, and bleached, as well as other ingredients. Fruit buns are enriched with extra cherries and fruits, which enhance the taste and nutritional value of the product.

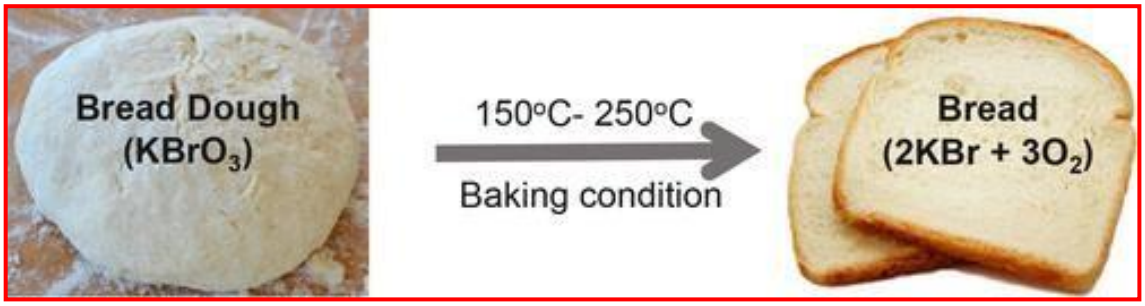
Fig-I a & b Students collected a variety of breads from a bakery in Bhopalpally. C&d Students have taken out bread covers from various types of branded bread and have begun an experiment at Department of Chemistry Bhoopalpally.

Qualitative Analysis:

To prepare the solution, the central piece of the bread was broken, and 2ml of 0.01M promethazine (98.8 percent purity, Sigma) was added, followed by the addition of 0.6ml of 12M hydrochloric acid to the mixture (35 percent purity, Thermo Fisher Scientific). In the presence of potassium bromate, the formation of a pink colour was indicative of its existence (Alli *et al.*, 2013).Quantitative Analysis

Sample Preparation: The hard brown edges of the bread were removed, and only the center section was utilized for the analytical process. Using a clean and sharp knife, the hard sections of

the sweet bun and pav were cut away from the top, lower, and side hard portions, and the white middle area was utilized for examination. The middle section was dried in the oven at 75°C for about 1 hour. The powdered crust was then utilized to make quantitative estimations from the dried crust.



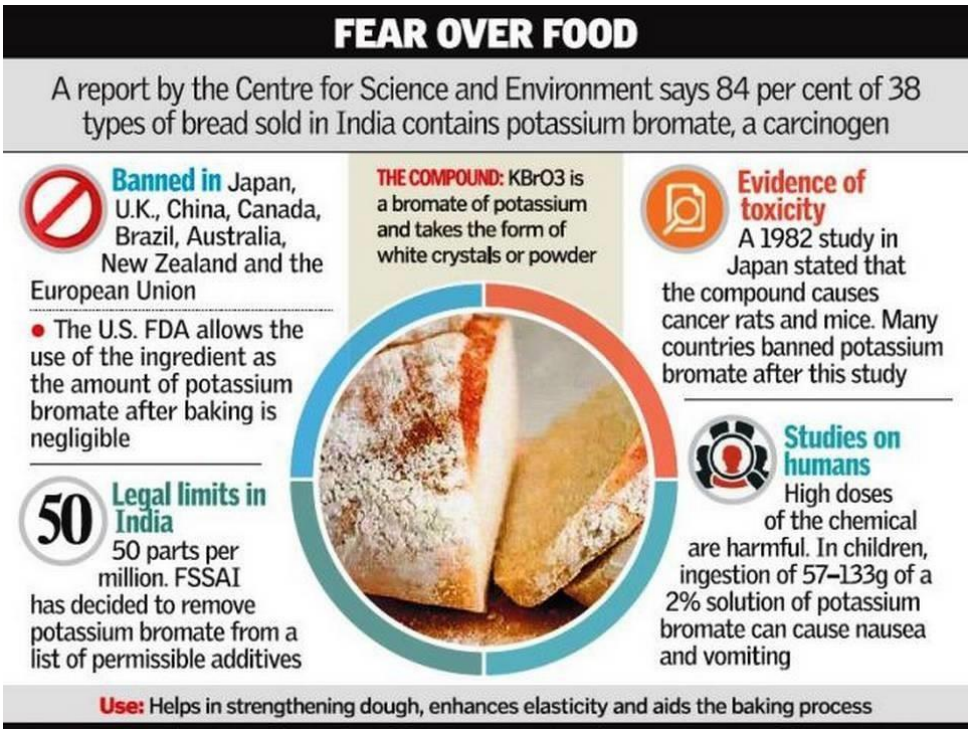


Fig-II Students are conducting experiments under the supervision of B. Sandhya Rani. At the Department of Chemistry Bhoopalpally

Preparation of Standard Calibration Curve:

The quantitative analysis of potassium bromate in the samples of bread was carried out using the spectrophotometric technique published by El Harti *et al.* (2011). The stock solution of KBrO3 (1000 g/ml) (99.8 percent purity, Merck) produced in water was used to create the intermediate stock standard solution (50 g/ml). The intermediate stock standard solution was generated from the stock solution. Various aliquots of the intermediate stock standard solution of KBrO3 were put in a 10 ml volumetric flask and diluted to 8 ml with distilled water to get the final concentration. Then, in each flask, 1.0 ml of 0.01M promethazine (PMZ) was added, followed by 0.2 ml of 12M HCl, which was then diluted to the desired concentration. The absorbance at 515nm was measured against a reagent blank after the mixtures had been well agitated for 1 minute. There was a standard curve drawn, and then a regression equation was calculated.

Spectrophotometric Analysis:

Each powdered sample was weighed into a clean centrifuge tube, which was then filled with 20 ml of ultrapure deionized water. After 2 minutes of vortexing, the mixture was filtered. A 10 ml volumetric flask was filled with 8.0 ml of the filtrate solution. A spectrophotometer (Thermo Fisher) was used to measure the absorbance of the coloured solution obtained after adding 1.0 ml of 0.01M promethazine dye solution and 0.2 ml of 12M hydrochloric acid. The mixture was shaken for about one minute and the absorbance of the colored solution obtained was measured at 515nm against a reagent blank. The concentration was determined using the linear regression curve derived from the potassium bromate standard solutions previously reported. The findings were given in parts per million (ppm).

Results and Discussion:

Qualitative research the presence of potassium bromate was examined in a variety of bread samples from various brands, including white bread, brown bread, pav and fruit bun breads. In 11 of 14 samples, oxidation of promethazine with bromate in an acidic environment resulted in a pink colour (Table 2).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 (25.74 ± 4.0 ppm) of brand I and lowest in white bread of brand III (08.84 ±3.0 ppm). In spite 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 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 08.84 to 25.74 ppm. All the types of bread were found to contain the potassium bromate. The highest concentration of potassium bromate was found in fruit bun (25.74 ±4.0 ppm) followed by brown bread (24.03 ±3.0 ppm), white bread (18.24±3.0 ppm) and pav bread (14.84 ±2.0 ppm). 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.

Table 2. Presence of KBrO3 in different bread samples

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

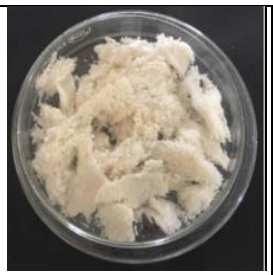
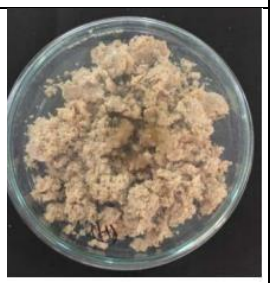
	Brand V/		
Brown bread	**Brand II**		
	Brand III		
Pav bread	**Brand II**		
	Brand III		
	Brand II		
Fruit bun	**Brand I**		
	Brand III		

Table 3. Concentration of potassium bromate in various bread samples.

Sample	Name	$KBrO_3$ (in ppm)
	White Bread	
A	**Brand II**	**11.84 ±2.0**
B	**Brand III**	**08.84 ±3.0**
C	**Brand IV**	**11.84 ±2.0**
D	**Brand V**	**18.24±3.0**
Brown Bread		
E	**Brand II**	**12.23 ±2.0**
F	**Brand III**	**24.04 ±3.0**
Pav Bread		
G	**Brand II**	**08.84 ±3.0**
H	**Brand III**	**14.84 ±2.0**
I	**Brand II**	**12.23 ±3.0**
Fruit Bread		
J	**Brand I**	**25.74 ±4.0**
K	**Brand III**	**24.03 ±3.0**

Acceptability of bread Enzymes including hemicellulases (which increase volume), glutathione oxidase (which strengthens proteins), and exo-peptidase (which enhances colour and flavour) may also be employed. Another option, glucose oxidase, was certified by the FSSAI in November 2015 and is recognized to fulfil comparable activities. Ammonium persulphate, ammonium chloride, and amylases are among the various flour improvers and treatment agents that have been authorized by the FDA. Varying producers employ different amounts of potassium bromate for different bread items, making it impossible to determine the amount of added chemical

in practice. Furthermore, given the abundance of non-toxic alternatives to potassium bromate, it would be more acceptable to outright restrict its usage in India, as it is in other nations. Brand V had the greatest concentration (18.243.0 ppm) and Brand III had the lowest value (08.84 3.0 ppm). Potassium bromate was identified in 50 percent of brown bread samples, with the greatest quantity recorded in Brand III (24.03 3.0 ppm), followed by Brand II (12.23 2.0 ppm). The presence of potassium bromate was found in pav bread and fruit bun samples from all of the brands examined. The quantity of potassium bromate in fruit bun samples was substantially greater than in pav bread samples, according to quantitative analysis. Brand I white bread samples and Brand I and V brown bread samples were judged to be suitable for ingestion.

Conclusions

About 80% of the completed bread items in Bhoopalpally included potassium bromate. In India, the maximum amount of potassium bromate that may be used is less than 50 ppm, and leaching of this chemical into final products is not allowed. Potassium bromate was identified in various quantities in the completed loaves in the present investigation. The current analysis discovered that bakers in Jaipur, India, are not following the potassium bromate use guidelines. Following the findings of this research, various recommendations are made to assist control the usage of potassium bromate in the baking industry, such as FSSAI inspections of bakeries on a regular basis. There are several non-toxic alternatives to $KBrO_3$ that improve bread quality and may be used in lieu of it, such as ascorbic acid. Corrales *et al.* (1993) proved that replacing potassium bromate with ascorbic acid is technically achievable without impacting negative potassium bromate outcomes. The presence of different residual levels of potassium bromate in the completed goods might be attributed to the bread being baked for a shorter length of time or the procedure not being carried out at a high enough temperature. Because of the excessive usage of the ingredient, potassium bromate may remain in the completed product (Bushuk and Hlynka, 1960).

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