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Potassium Bromate or Potassium Iodate in Bread

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1. POLLUTION MONITORING LABORATORY OF CSE

The Centre for Science and Environment (CSE), a non-governmental organization based in New Delhi, has set up the Pollution Monitoring Laboratory (PML) to monitor environmental pollution. PML is an ISO 9001:2008 accredited laboratory which conducts pollution monitoring and scientific studies on environmental samples. The lab has highly qualified and experienced staff that exercise Analytical Quality Control (AQC) and meticulously follow what is called Good Laboratory Practices (GLP). It is equipped with most sophisticated state-of-the-art equipments for monitoring and analysis of air, water, soil and food commodities, including Gas Chromatograph with Mass Detector (GC-MS), Gas Chromatograph (GC) with ECD, NPD, FID and other detectors, High Performance Liquid Chromatograph (HPLC), Atomic Absorption Spectrometer (AAS), UV-VIS Spectrophotometer, ELISA Reader, Particulate Matter Analyzer, Ozone Monitor, etc. and also a microbiology section with laminar air flow, bacteriological incubator, incubator shaker, microscope, etc. Its main aim is to undertake scientific studies to generate public awareness about food safety, water and air pollution. It provides scientific services at nominal cost to communities that cannot obtain scientific evidence against polluters in their area. The lab and its work are directed to use science to achieve environmentally sound and socially relevant public policy.

2. INTRODUCTION

Bread is the cheapest and basic instant food available for consumption. Though bread is not a staple food in India, its consumption has increased over the years. In comparison to chapatti, puri or rice bread is still a secondary staple food in India.[1] Bread is prepared from dough of flour and water, usually by baking. It has been popular around the world and is one of the oldest artificial foods, having been of importance since the dawn of agriculture. There are many combinations and proportions of types of flour and other ingredients, and also of different traditional recipes and modes of preparation of bread. As a result, there are wide varieties of types, shapes, sizes, and textures of breads in various regions.

Bread may be leavened by many different processes ranging from the use of naturally occurring microbes to high-pressure artificial aeration methods during preparation or baking. Commercial bread in particular, commonly contains additives, some of them non-nutritional, to improve flavor, texture, color, shelf life, or ease of manufacturing.

Different types of breads are available in India. Bureau of Indian Standards (BIS) has given the standards for following breads:

[1] http://www.aibma.com/industry%20profile.htm

- White Bread (IS 1483: 1988)
- Wheatmeal Bread (IS 1960: 1979)
- Protein Fortified Bread (IS 8665: 1977)
- Milk Bread (IS 11231: 1985)

Potassium bromate ($KBrO_3$, E number - E924) is a flour improver that acts as a maturing agent. It is a colourless, odourless and tasteless white crystal/powder. It acts to strengthen the dough and to allow higher rising. It acts principally in the late dough stage giving strength to the dough during the late proofing and early baking. It oxidizes the sulfhydryl or thiol (R-SH) groups of the gluten protein in flour into disulphide bridges and makes it less extensible and more elastic such that it can retain the carbon dioxide gas produced by the yeast.[2,3] The overall result is higher increase in volume and good texture of the finished product that is appealing to the consumer. This property of potassium bromate has been used profitably by bakers.

Potassium bromate is highly soluble in water. It has a melting point of 350^0C and it decomposes at 370^0C.[4,5] Potassium bromate is an oxidizing agent, and under the right conditions will be completely used up in the baking bread.[6] Potassium bromate converts into potassium bromide at high temperature during the baking process. However, if too much is added, or if the bread is not baked long enough or not at a high enough temperature, then a residual amount remains in the bread, which may be harmful if consumed.

Potassium bromate is a slow-acting oxidizer, contributing its functionality throughout the mixing, fermentation and proofing stages, with important residual action during the early stages of baking. Azodicarbonamide (ADA), potassium and calcium iodate, and calcium peroxide are rapid acting oxidizers, while ascorbic acid (vitamin C) works at intermediate rate.

[2] M.O. Emeje, S.I. Ofoefule, A.C. Nnaji, A.U. Ofoefule and S.A. Brown. Assessment of bread safety in Nigeria: Quantitative determination of potassium bromate and lead. *African Journal of Food Science* 2010 4(6): 394 - 397.
[3] M. Nakamura, T. Murakami, K. Himata, S. Hosoya and Y. Yamada. Effects of reducing agents and baking conditions on potassium bromate in bread. *Cereal Foods World* 2006 51: 69 - 75
[4] Stuti M. and D'souza D. Effects of potassium bromate on the kidney and haematological parameters of swiss albino mice. *The Bioscan* 2013 8(3): 1011 - 1014
[5] Toxicological Review of Bromate by USEPA, available at http://www.epa.gov/iris/toxreviews/1002tr.pdf, accessed on 15 Sep, 2015
[6] http://www.decodedscience.com/potassium-bromate-cancer/27263

Potassium bromate is a toxic substance. International Agency for Research on Cancer (IARC) has declared it as possibly human carcinogen.[7] Joint FAO/WHO Expert Committee on Food Additives evaluated the health risk of potassium bromate and concluded that its use as a flour treatment agent is not acceptable.[8]

3. REGULATIONS FOR POTASSIUM BROMATE/POTASSIUM IODATE

The European Union: Potassium bromate is not included in the list of permitted food additives for bread given in European Parliament and Council Directive No 95/2/EC of 20th February 1995 on food additives other than colors and sweeteners. Thus the European Union does not permit the use of potassium bromate.

Health Canada: Health Canada does not allow potassium bromate in bread as maturing or dough conditioning agent. But it allows the potassium iodate as maturing or dough conditioning agent in bread and unstandardized bakery products.

USA: US Food and Drug Administration allows the use of Potassium Bromate in specific standardized bakery products like bread, rolls, and buns. Code of Federal Regulations, 21 CFR136.110 allows the use of potassium bromate, calcium bromate, potassium iodate, calcium iodate, calcium peroxide, or any combination of two or more of these if the total quantity, including the potassium bromate in any bromated flour used, is not more than 0.0075 part for each 100 parts by weight of flour used.

India: Food Safety and Standards Authority of India (FSSAI) permits use of potassium bromate and/or potassium iodate in bread and bakery products. As per the Food Safety Standards (Food Product Standards and Additives) Regulations, 2011 the limit for maximum level of use of potassium bromate and/or potassium iodate is set at 50 mg/Kg in bread. In flour for bakery potassium bromate is permitted with the maximum level of use at 20 mg/Kg.

Among the bakery products use of potassium iodate as improver is permitted in bread.

Potassium bromate has been banned from use in food products in the EU, Canada, Nigeria, Brazil, South Korea, Peru and some other countries. It was banned in Sri Lanka in 2001 and in China in 2005.[9]

[7] http://monographs.iarc.fr/ENG/Monographs/vol73/mono73-22.pdf
[8] http://www.inchem.org/documents/jecfa/jeceval/jec_1969.htm
[9] http://www.aboutadditive.com/2009/02/common-illegal-additives-in-dairy.html

4. REVIEW OF LITERATURE

Abdulla. N. S. *et. al.* (2009) analyzed 15 bread samples from Hawler city of Iraq by spectrophotometric method and found potassium bromate in all the bread samples in the range of 11.09 – 67.45 ppm.[10]

Bread samples of five bakeries of wide coverage in Addis Ababa, Ethiopia were analyzed by Ergetie Z. *et. al.* (2012) by spectrophotometric method. Potassium bromate was found in all the samples ranging from 5.615 – 9.974 mg/Kg.[11]

Alli L. A. *et. al.* (2013) analyzed 20 bread samples consumed in the Gwagwalada area council of Abuja, Nigeria and found potassium bromate in all the 20 bread samples in the range of 3.6 – 9.2 µg/g.[12] Potassium bromate was determined by spectrophotometric method using promethazine hydrochloride.

In a study carried out by Magomya *et. al.* (2013) bread samples of 15 different brands produced in Zaria metropolis of Northern Nigeria were analyzed for potassium bromate and some heavy metals. The study revealed the presence of potassium bromate in all the samples analyzed ranging from 2.46 - 13.60 mg/kg.[13]

Emeje O. M. *et. al.* (2015) analyzed 26 different brands of bread samples from the 6 area councils in the Abuja, Nigeria by spectrophotometric method. All the samples were found to contain potassium bromate in the range of 1.01 – 12.66 µg/g which is in violation of the standard set for potassium bromate by country's apex drug and food regulatory agency National Agency for Drug Administration and Control (NAFDAC).[14]

5. HEALTH EFFECTS OF POTASSIUM BROMATE AND POTASSIUM IODATE

Potassium bromate is toxic substance and has various health effects. Many countries across the world have banned the use of potassium bromate as a flour treatment agent. It can cause abdominal pain, diarrhoea, nausea, vomiting, kidney failure, oligonuria, anuria, deafness, vertigo, and hypotension,

[10] Abdulla N. S. and Hassan M. A. Spectrophotometric Determination of Bromate in Bread by the Oxidation of Dyes. *Journal of Kirkuk University –Scientific Studies* 2009 4(1): 31-39

[11] Ergetie Z. *et. al.* Determination of potassium bromate in bread samples from five bakeries in Addis Ababa, Ethiopia. *International Journal of Pharmacy and Research* 2012 2(4): 397 - 399

[12] Alli L. A. *et. al.* Determination of Potassium Bromate content in Selected Bread Samples in Gwagwalada, Abuja-Nigeria. *International Journal of Health & Nutrition* 2013 4(1): 15-20

[13] Magomya *et. al.* Potassium Bromate and Heavy Metal Content of Selected Bread Samples Produced in Zaria, Nigeria. *International Journal of Science and Technology* 2013 2(2): 232 - 237

[14] Emeje O. M. *et. al.* Assessment of Bread Safety in Nigeria: One Decade after the Ban on the Use of Potassium Bromate. *Journal of Food Processing and Technology* 2015 6(1)

depression of the central nervous system, thrombocytopenia with other related health problems.[15] It also affects the nutritional quality of bread by degrading the vitamins and essential fatty acid contents of flour.[16] It degrades vitamins A2, B1, B2, E and niacin which are the main vitamins available in bread.[17] Significant differences in essential fatty acid content of flour treated with bromate or in bread made from flour containing bromate have been reported in several studies.[18] International Agency for Research on Cancer (IARC) has found it as a possibly carcinogenic to humans (Class 2B).[19]

Potassium iodate is considered as good source of iodine. In 1965, the Joint FAO/WHO Expert Committee on Food Additives recommended that potassium iodate should not be used as a flour treatment agent due to the possibility of a higher intake of iodine. The committee considered that "the use of a food additive for the treatment of a staple, such as flour, of a substance having such physiological significance and potency as iodine is highly undesirable". Its use may result in a daily intake of iodine that is five or ten times than the usually recommended level of 100-200 µg.[20] Potassium iodate is not recommended to be used as a flour treatment agent in several parts of the world including UK[21], EU[22], Australia[23] and New Zealand[24].

6. OBJECTIVES OF THE STUDY

The main objective of this study was to analyze the breads available in Delhi for the presence of potassium bromate/iodate.

[15] Johnson O. R, Daniel K. D., Iyabo A. G. and Oloruntoba A. C. Analysis of Potassium Bromate and Hydrocyanic Acid Contents of Commonly Consumed Loaves of Bread and Wheat Flour Samples In Karu,Nasarawa State, Nigeria. *IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)* 2015 6(1): 42 - 46

[16] ibid

[17] Emeje M. O., Ofoefule S. I., Nnaji A. C., Ofoefule A. U. and Brown S. A. Assessment of bread safety in Nigeria: Quantitative determination of potassium bromate and lead; *African Journal of Food Science* 2010 4(6): 394 - 397

[18] ibid

[19] http://monographs.iarc.fr/ENG/Monographs/vol73/mono73-22.pdf

[20] 'Ninth Report of the Joint FAO/ WHO Expert Committee on Food Additives, Rome 13-20 December, 1965', Published by FAO and WHO, (http://apps.who.int/iris/bitstream/10665/39853/1/WHO_TRS_339.pdf, as viewed in May 2016).

[21] 'The Bread and Flour Regulations 1995', UK, http://www.legislation.gov.uk/uksi/1995/3202/schedule/3/made, as viewed in May 2016.

[22] Food Additive database, European Commission, https://webgate.ec.europa.eu/sanco_foods/main/?event=substances.search&substances.pagination=1 as viewed in May 2016.

[23] Food Additive list, http://www.foodstandards.gov.au/consumer/additives/additiveoverview/Documents/Additives%20-%20alpha%20%28July%202014%29.pdf as viewed in May 2016.

[24] Food Additive list, http://www.foodstandards.gov.au/consumer/additives/additiveoverview/Documents/Additives%20-%20alpha%20%28July%202014%29.pdf as viewed in May 2016.

7. MATERIALS AND METHODS

7.1 Sampling

A total of 38 samples of bread, ready to eat burger bread and ready to eat pizza bread were purchased from retail shops, bakeries and fast food outlets in Delhi. Samples analyzed included white bread, whole wheat/atta bread, brown bread, multigrain bread, sandwich bread, pav, bun, ready to eat burger bread and ready to eat pizza bread. The details of the samples analyzed are given in *Table 1*.

7.2 Equipments

The following equipments were used in the study:

- UV-Visible Spectrophotometer (Agilent, Carry 100)
- Vortex Mixer

7.3 Chemicals

The potassium bromate, potassium iodate and hydrochloric acid used were obtained from E. Merck and Promethazine hydrochloride was purchased from TCI, Japan. Water used for analysis was obtained from Elga USF Maxima Ultra Pure DI System.

7.4 Glassware

All the glassware was soaked overnight in 10% nitric acid and cleaned with detergent and rinsed thoroughly with distilled water before use.

7.5 Sample Preparation and Analysis

7.5.1 Preparation of Standard Calibration Curve

The spectrophotometric method described by El Harti *et. al.* (2011)[25] and Alli *et. al.* (2013)[26] was used for the quantitative determination of potassium bromate/iodate in the samples of bread.

Primary stock standard solution of $KBrO_3$ (1000 µg/mL) was prepared by dissolving $KBrO_3$ in water. Intermediate stock standard solution of $KBrO_3$ (50 µg/mL) was prepared from the stock solution. 0.01M Promethazine hydrochloride solution (PMZ) was prepared in ultra pure deionized water. Only freshly prepared PMZ solution was used for analysis.

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

[26] Alli L.A. *et. al.* Determination of Potassium Bromate content in Selected Bread Samples in Gwagwalada, Abuja-Nigeria; *International Journal of Health & Nutrition* 2013 4(1): 15 - 20

Different aliquots from intermediate stock standard solution of $KBrO_3$ were placed in 10 mL volumetric flask, and diluted to nearly 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 reagent blank. The regression equation of calibration plot was calculated by the linear least squares method. The correlation coefficient (r^2) value of the curve was 0.9986. Standard curve for potassium iodate was also prepared in same way using the potassium iodate standards of same concentrations to check the linearity. The response was found to be linear with $r^2 = 0.998$.

7.5.2 Sample Preparation

A central portion of loaf of bread was taken by removing the hard brown portion of the bread and 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. In bread of ready to eat burger and pizza the stuffing and topping materials were removed carefully. Then upper, lower and side hard portions were removed using clean and sharp knife. The white central portion was used for analysis by drying in an oven for about an hour at 75^0C. The dried crust was pulverized and used for analysis.

7.5.3 Sample 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 using a double beam spectrophotometer at 515nm against reagent blank. The concentration was calculated from the linear regression curve obtained from the standard solutions of potassium bromate as mentioned above. The recovery for both potassium bromate and potassium iodate was checked and average recovery was found to be more than 90% in each case.

8. RESULTS AND DISCUSSION

A total of 38 samples of bread were tested for the presence of potassium bromate/iodate. Eight samples of brown bread, 5 samples of multigrain bread, 4 samples of each of white bread and whole wheat/atta bread, 3 samples each of sandwich bread, pav and bun, and 4 samples of each of ready to eat burger bread and ready to eat pizza bread were tested for the presence of potassium bromate/iodate. The results are given in *Table 2*.

Out of 38 samples tested 32 (84.2%) samples were found to contain potassium bromate/iodate in the range of 1.15 – 22.54 ppm. All the types of bread including breads used in ready to eat burger and pizza were found to contain the potassium bromate/iodate. The highest concentration of potassium bromate/iodate was found in sandwich bread (22.54 ppm) followed by pav (21.70 ppm), bun (20.58 ppm) and white bread (17.32 ppm).

Brown Bread: Out of 8 samples of brown bread 6 (75%) samples had potassium bromate/iodate in the range of 1.15 – 8.16 ppm. The highest concentration of potassium bromate/iodate was found in Perfect Premium Quality Brown Bread (8.16 ppm) followed by Harvest Gold's Hearty Brown- Stone Ground Wheat Brown Bread (8.03 ppm), Le Marché Brown Bread (5.75 ppm) and Britannia Daily Fresh Healthy Slice Brown Bread (5.48 ppm). Le Marché Jumbo Bread Slice (Brown Bread) and English Oven Brown Bread had 1.65 and 1.15 ppm respectively. Potassium bromate/iodate was not detected in two samples - Defence Bakery Jumbo Slices Brown and Defence Bakery Brown Bread.

Multigrain Bread: A total of 5 samples of multigrain bread were tested of which 4 (80%) samples had potassium bromate/iodate in the range of 1.66 – 4.20 ppm. The highest concentration of potassium bromate/iodate was found in Le Marché Multi Granex Loaf (4.20 ppm) followed by English Oven Multigrain Bread (2.37 ppm), Harvest Gold Multi Grain Gourmet Bread (1.99 ppm) and Britannia Multi Grain Bread (1.66 ppm). Defence Bakery Multigrain was found not to contain potassium bromate/iodate.

White Bread: All the 4 sample of white bread tested were found to contain potassium bromate/iodate in the range of 11.52 – 17.32 ppm. Amongst the white bread the highest concentration of potassium bromate/iodate was found in Harvest Gold White Bread-Premium Quality (17.32 ppm) and the lowest concentration in Le Marché Jumbo Bread Slice (White Bread) (11.52 ppm). Britannia Daily Fresh Healthy Slice Bread and Perfect Premium Quality White Bread-A Classic Bake had 17.12 ppm and 15.01 ppm respectively.

Whole Wheat/Atta Bread: Out of 4 samples of whole wheat/atta bread tested 3 (75%) samples had potassium bromate/iodate in the range of 1.52 – 4.67 ppm. The highest concentration of potassium bromate/iodate was found in Le Marché Whole Meal Bread (4.67 ppm) followed by Britannia 100% Whole Wheat Bread (2.58 ppm). English Oven Atta Bread had 1.52 ppm of potassium bromate/iodate. In Defence Bakery Whole Wheat Bread potassium bromate/iodate was not detected.

Sandwich Bread: A total of 3 samples of Sandwich bread were tested for the presence of potassium bromate/iodate. Two samples, Harvest Gold Sandwich Bread-Premium Large Size and Perfect Sandwich Bread-A Classic Bake were found to contain 22.54 ppm and 20.09 ppm of potassium bromate/iodate

respectively. Amongst all the 38 samples of different bread tested Harvest Gold Sandwich Bread-Premium Large Size had the highest concentration of potassium bromate/iodate.

Potassium bromate/iodate was not detected in English Oven Sandwich Bread.

Pav: All the three samples of Pav tested were found to contain potassium bromate/iodate. Amongst the Pav the highest concentration of potassium bromate/iodate was found in Perfect Premium Quality Pav-A Classic Bake (21.70 ppm) followed by Britannia Super Tasty Pav and Harvest Gold Bombay Pav-Premium Quality which had 15.01 ppm and 14.89 ppm respectively.

Bun: Three samples of bun were tested and all the three samples were found to contain potassium bromate/iodate. Harvest Gold Sweet Bun-Premium Quality had 20.58 ppm of potassium bromate/iodate while Perfect Premium Quality Fruit Buns-A Classic Bake and Britannia Fruit Fun Bun were found to contain 19.81 ppm and 16.74 ppm respectively.

Ready to Eat Burger Bread: A total of 4 samples of bread of famous ready to eat burger were tested for the presence of potassium bromate/iodate and 3 samples were found to contain potassium bromate/iodate. Amongst ready to eat burger breads the highest concentration of potassium bromate/iodate was found in the bread of KFC Aloo Burger which had 6.23 ppm. The bread of Subway Subz Burger had 1.36 ppm of potassium bromate/iodate while the bread of Mc Donald's Mc Aloo tikki Burger had 1.23 ppm of potassium bromate/iodate. In the bread of Nirula's Chatpata Aloo Burger potassium bromate/iodate was not detected.

Ready to Eat Pizza Bread: A total of 4 samples of bread of famous ready to eat pizza were tested for the presence of potassium bromate/iodate and all the 4 samples were found to contain potassium bromate/iodate in the range of 1.18 – 6.63 ppm. Bread of Nirula's cheese tomato onion pizza had 6.63 ppm of potassium bromate/iodate which is the highest in this category. Bread of Pizza Hut Margherita Pizza had 2.30 ppm of potassium bromate/iodate while bread of Slice of Italy Margherita Classic Pizza and Dominos Margherita Pizza had 1.23 ppm and 1.18 ppm of potassium bromate/iodate respectively.

Third Party Test Results:

To confirm the presence of bromated/iodate four samples of bread were sent to a reputed application lab (Third Party Lab) in September 2015. These samples were of same products but different batches, produced on different dates than those tested earlier by the PML. Third party lab tested the bread samples using Ion Chromatograph with Conductivity Detector. Detailed methodology and results of third party lab are given *Annexure I*. The same samples were also tested in PML for potassium bromate/iodate using UV-Visible Spectrophotometer. The name of the samples and results from both PML and third party labs are as below:

Sample Code	Sample Name	PML Result	Third Party Lab Result	
		Potassium Bromate/Iodate (ppm)	Bromate (ppm)	Equivalent Potassium Bromate (ppm)
Sample 1	Defence Bakery Brown Bread	ND	ND	ND
Sample 2	Harvest Gold Sandwich Bread-Premium Large Size	17.52	6.7	8.7
Sample 3	Britannia Daily Fresh Healthy Slice Bread	14.29	ND	ND
Sample 4	Perfect Premium Quality Pav-A Classic Bake	15.57	5.2	6.8

Third party lab did not find any bromate in brown bread of Defence Bakery. PML also did not find any potassium bromate/iodate in the same sample. In rest of the samples levels detected by third party lab are less than the levels detected by PML. Since UV-Visible spectrophotometer detects both potassium bromate and iodate. The difference in the results from two labs could be attributed to the presence of potassium iodate.

9. CONCLUSIONS

The results of the study showed that all types of bread analyzed contained potassium bromate/iodate in varying amount. 32 out of 38 (84.2%) samples tested were found to contain potassium bromate/iodate. The highest concentration of potassium bromate/iodate was found in Sandwich Bread. High concentration of potassium bromate/iodate was found in Sandwich Bread, Pav, Bun and White Bread. Few select samples were tested by third-party lab to confirm the presence of bromate and two samples were found to contain bromate. The results indicate that potassium bromate/iodate is being used in bread making which can be avoided by using the alternate dough conditioners.

10. RECOMMENDATIONS

1. Use of potassium bromate in bread and bakery products should be banned as is banned in many other countries.
2. Potassium iodate should not be allowed as flour treatment agent in bread and bakery products.
3. Alternative dough conditioner available should be used in bread and bakery products.

Table 1: Details of the Bread Samples

S. No.	Name of the bread	Use by date	Manufacturer	Lot Number
White Bread				
1.	Britannia Daily Fresh Healthy Slice Bread	16/05/2015	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	23 F2H96
2.	Harvest Gold White Bread- Premium Quality	14/05/2015	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil-Tijara, Distt.-Alwar, Rajasthan	ARR[ ]15
3.	Perfect Premium Quality White Bread- A Classic Bake	17/05/2015	L. R. Foods Pvt. Ltd., Indira Complex Industrial Area, Sector-86, Faridabad, Haryana-0121002	B2
4.	Le Marché Jumbo Bread Slice (White Bread)	01/06/2015	Sugar & Spice India Pvt. Ltd., 77B, IFFCO Road, Sector 18, Gurgaon	020001301
Whole wheat/Atta Bread				
1.	Britannia 100% Whole Wheat Bread	15/05/2015	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	21 E2R96
2.	English Oven Atta Bread	26/05/2015	Mrs. Bectors Food Specialities Ltd., Plot No.11-A, Udyog Vihar, Greater Noida-201306	ETP3
3.	Defence Bakery Whole Wheat Bread	26/05/2015	34, Defence Colony Market, New Delhi-110024 (India)	2100339050009
4.	Le Marché Whole Meal Bread	27/05/15	Sugar & Spice India Pvt. Ltd., 77B, IFFCO Road, Sector 18, Gurgaon	020010201
Brown Bread				
1.	Britannia Daily Fresh Healthy Slice Brown Bread	15/05/2015	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	17 E1S96
2.	Harvest Gold's Hearty Brown-Stone Ground Wheat Brown Bread	13/05/2015	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil - Tijara, Distt. - Alwar, Rajasrhan,	AHG[ ]16
3.	Perfect Premium Quality Brown Bread	17/05/2015	L. R. Foods Pvt. Ltd., Indira Complex Industrial Area, Sector-86, Faridabad, Haryana-121002	B2
4.	Defence Bakery Jumbo slices Brown	23/05/2015	34, Defence Colony Market, New Delhi-110024 (India)	2100185035007
5.	Defence Bakery Brown Bread	24/05/2015	34, Defence Colony Market, New Delhi-110024 (India)	2100041045003
6.	English Oven Brown Bread	22/05/2015	Mrs. Bectors Food Specialities Ltd., Plot No.11-A, Udyog Vihar, Greater Noida-201306. Distt. - Gautam Budh Nagar (U.P.) India	EQP1

7.	Le Marché Jumbo Bread Slice (Brown Bread)	27/05/15	Sugar & Spice India Pvt. Ltd., 77B, IFFCO Road, Sector 18,Gurgaon	020004801
8.	Le Marché Brown Bread	31/05/2015	Sugar & Spice India Pvt. Ltd., 77B, IFFCO Road, Sector 18, Gurgaon	020001301
Multigrain Bread				
1.	Britannia Multi Grain Bread	15/05/2015	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	13 E1S96
2.	Harvest Gold Multi Grain Gourmet Bread	15/05/2015	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil-Tijara, Distt.- Alwar, Rajasthan	AHG[ ]22
3.	Defence Bakery Multigrain	24/05/2015	34, Defence Colony Market, New Delhi-110024 (India)	2100225050007
4.	English Oven Multigrain bread	26/05/2015	Mrs. Bectors Food Specialities Ltd., Plot No.11-A, Udyog Vihar, Greater Noida-201306. Distt. - Gautam Budh Nagar (U.P.) India	EUA2
5.	Le Marché multi Granex Loaf	27/05/2015	Sugar & Spice India Pvt. Ltd., 77B, IFFCO Road, Sector 18, Gurgaon	020005601
Sandwich Bread				
1.	Perfect Sandwich Bread- A Classic Bake	17/05/2015	L. R. Foods Pvt. Ltd., Indira Complex Industrial Area, Sector-86, Faridabad, Haryana-121002	A1
2.	Harvest Gold Sandwich Bread-Premium Large Size	18/05/2015	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil-Tijara, Distt.- Alwar, Rajasthan	AHG[ ]09
3.	English Oven Sandwich Bread	23/05/2015	Mrs. Bectors Food Specialties Ltd., Plot No.11-A, Udyog Vihar, Greater Noida-201306. Distt.- Gautam Budh Nagar (U.P.) India	ERP 1
Pav				
1.	Harvest Gold Bombay Pav-Premium Quality	14/05/2015	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil-Tijara, Distt.- Alwar, Rajasthan	AHG[ ]16
2.	Perfect Premium Quality Pav- A Classic Bake	17/05/2015	Harpreet Foods Pvt. Ltd., Tigaon Road, Faridabad, (Haryana)	L10812003000006
3.	Britannia Super Tasty Pav	18/05/2015	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	10 B1B96
Bun				
1.	Perfect Premium Quality Fruit Buns-A Classic Bake	15/05/2015	Harpreet Foods Pvt. Ltd., Tigaon Road, Faridabad, (Haryana)	10812003000006
2.	Harvest Gold Sweet Bun- Premium Quality	17/05/2015	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil-Tijara, Distt. - Alwar, Rajasthan	C-7[3]15

3.	Britannia Fruit Fun Bun	15/05/2015	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	08E1696
Ready to eat burger bread				
1.	KFC Aloo Burger		A-Block Connaught Place, New Delhi	
2.	Mc Donald's Mc Aloo tikki Burger		V3S East Center Mall, Laxmi Nagar New Delhi	
3.	Subway Subz Burger		V3S East Center Mall, Laxmi Nagar New Delhi	
4.	Nirula's Chatpata Aloo Burger		K-Block Connaught Place, New Delhi	
Ready to eat pizza bread				
1.	Dominos Margherita pizza		G-24 South Extension, Part-I New Delhi	
2.	Slice of Italy Margherita Classic pizza		147-Mehar Chand Market Lodhi Colony, New Delhi	
3.	Pizza Hut Margherita pizza		K-95 Lajpat Nagar-II, New Delhi	
4.	Nirula's cheese tomato onion pizza		K-Block Connaught Place, New Delhi	
Samples sent to third party lab				
1.	Britannia Daily Fresh Healthy Slice Bread	19/09/15	Shakun Consumer Products (Pvt.) Ltd., B-36 Lawrence Road, Industrial Area, Delhi 110035	19I1K96
2.	Defence Bakery Brown Bread	24/09/15	34, Defence Colony Market, New Delhi-110024 (India)	2100041045003
3.	Harvest Gold Sandwich Bread-Premium Large Size	20/09/15	Harvest Gold Industries Pvt. Ltd., Village Chhapar, Post-Jhiwana, Tehsil-Tijara, Distt.- Alwar, Rajasthan	A[ ]10
4.	Perfect Premium Quality Pav- A Classic Bake	20/09/15	Harpreet Foods Pvt. Ltd. Tigaon Road, Faridabad,(Haryana)	SL 10812003000006

Results of Potassium Bromate/Iodate in Bread

S. No.	Sample Type	Sample Name	Number of Samples	Concentration (ppm)
1	White bread	Harvest Gold White Bread-Premium Quality	4	17.32
		Britannia Daily Fresh Healthy Slice Bread		17.12
		Perfect Premium Quality White Bread-A Classic Bake		15.01
		Le Marché Jumbo Bread Slice (White Bread)		11.52
2	Whole wheat/Atta bread	Le Marché Whole Meal Bread	4	4.67
		Britannia 100% Whole Wheat Bread		2.58
		English Oven Atta Bread		1.52
		Defence Bakery Whole Wheat Bread		ND
3	Brown bread	Perfect Premium Quality Brown Bread	8	8.16
		Harvest Gold's Hearty Brown- Stone Ground Wheat Brown Bread		8.03
		Le Marché Brown Bread		5.75
		Britannia Daily Fresh Healthy Slice Brown Bread		5.48
		Le Marché Jumbo Bread Slice (Brown Bread)		1.65
		English Oven Brown Bread		1.15
		Defence Bakery Jumbo Slices Brown		ND
		Defence Bakery Brown Bread		ND
4	Multigrain bread	Le Marché Multi Granex Loaf	5	4.20
		English Oven Multigrain Bread		2.37
		Harvest Gold Multi Grain Gourmet Bread		1.99
		Britannia Multi Grain Bread		1.66
		Defence Bakery Multigrain		ND
5	Sandwich bread	Harvest Gold Sandwich Bread- Premium Large Size	3	22.54
		Perfect Sandwich Bread- A Classic Bake		20.09
		English Oven Sandwich Bread		ND
6	Pav	Perfect Premium Quality Pav- A Classic Bake	3	21.70
		Britannia Super Tasty Pav		15.01
		Harvest Gold Bombay Pav- Premium Quality		14.89
7	Bun	Harvest Gold Sweet Bun- Premium Quality	3	20.58
		Perfect Premium Quality Fruit Buns- A Classic Bake		19.81
		Britannia Fruit Fun Bun		16.74
8	Ready to eat burger bread	KFC Aloo Burger	4	6.23
		Subway Subz Burger		1.36
		Mc Donald's Mc Aloo tikki Burger		1.23
		Nirula's Chatpata Aloo Burger		ND
9	Ready to eat pizza bread	Nirula's cheese tomato onion pizza	4	6.63
		Pizza Hut Margherita pizza		2.30
		Slice of Italy Margherita Classic pizza		1.23
		Dominos Margherita pizza		1.18

Determination of bromate in bread

Branch

General Analytical Chemistry; Food, stimulants, beverages, flavors: 1, 7.

Keywords

Suppressed; MagIC Net 3.1; Metrosep A Supp 1 250/4.6; branch 1, 7.

Summary

This application work covers determination of bromate in bread samples using suppressed conductivity detection. Metrosep A Supp 1 250/4.6 column is used with sodium carbonate as eluent.

Samples

Sample 1
Sample 2
Sample 3
Sample 4

Reagents

- Sodium carbonate-Sigma Aldrich
- Acetonitrile, Merck HPLC grade
- Potassium bromate, Sigma Aldrich
- Sulfuric acid, Merck GR
- Ultrapure water, resistivity >18 MΩ·cm (25 ℃), type I grade (ASTM D1193)

Instruments

930 Compact IC plus ChS/PP	2.930.1300
IC Conductivity detector	2.850.9010
919 IC Autosampler plus	2.919.0020
Metrosep A Supp 1 250/4.6	6.1005.300
Metrosep A Supp 1 Guard/4.6	6.1005.340

Solutions

Eluent : 3.0 mmol/L sodium carbonate.

Diluent : Ultrapure water

Suppressor solution

Regeneration solution: 100 mmol/L Sulfuric acid

Rinsing solution : Ultra pure water

Standard solutions (mg/L):

1000 mg/L bromate standard prepared from potassium bromate salt,

All the lower level standards are prepared from the 1000 mg/L bromate standard by diluting with ultra pure water.

Standard	L 1	L 2	L 3	L 4	L 5
Bromate	0.1	0.25	0.5	1.0	10.0

Sample preparation:

Around 0.2 g of sample is weighed accurately, transferred into IC vial and 3 mL of ultrapure water is added. The sample solution ultra sonicated for 5 min., then made up to 10 mL using ultrapure water. Sample solution is centrifuged for 3 min. Then the supernatant solution is filtered through 0.22 µm filter and injected into the ion chromatograph.

Parameters

Eluent Flow	1.0 mL/min.
Column temperature	Ambient
Sample volume	20 µL
Sampling Device	919 IC Autosampler plus
Recording time	30 minutes
Mode of analysis	Suppressed
MSM II	Active
Polarity	+ ve
Temperature coefficient	2.3%/℃

Blank:

Ultrapure water

Calculation

Automatic integration with MagIC Net 3.1 software using peak area for bromate.

Results (mg/Kg):

Sample ID	Bromate
Sample 1	**ND**
Sample 2	**6.7**
Sample 3	**ND**
Sample 4	**5.2**

Comments:

- To check accuracy of the method, bread sample 3 & 4 are spiked with 0.1 mg/L & 0.25 mg/L bromate standard respectively. The recovery values are found to be in the range of 100 to 108%.

Date

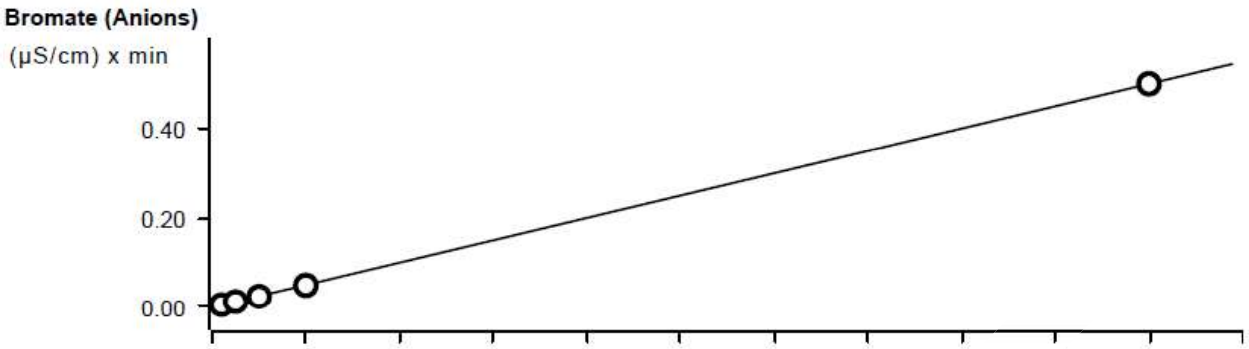
23.10.2015

Appendix

Instrumentation setup, calibration curves, chromatograms with results and tables.

Appendix

Calibration curves



Function: . . . . . *A = 2.49526E-3× Q*

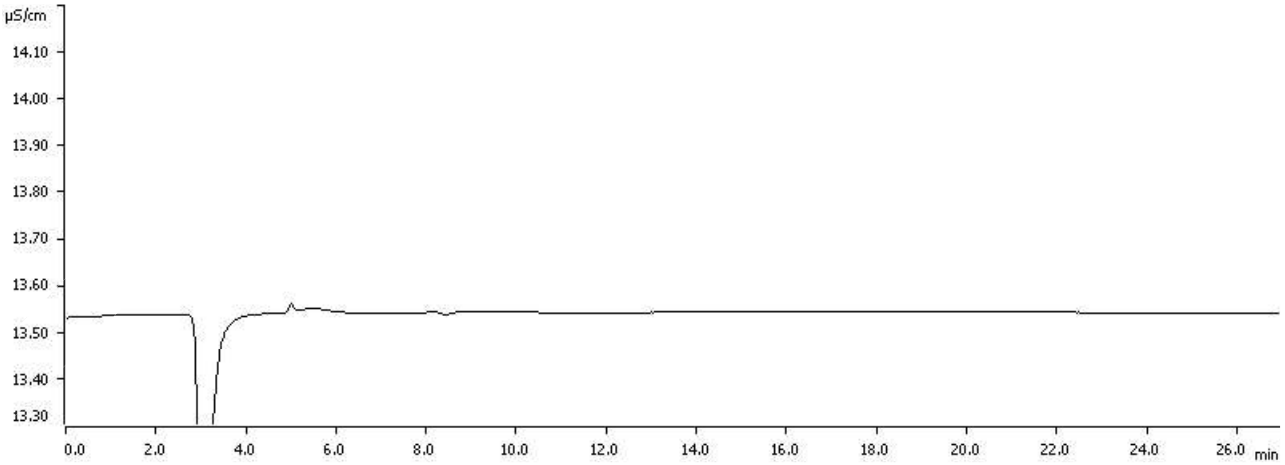
Relative standard deviation . . . . . *0.729332 %*

Correlation coefficient *0.999992*

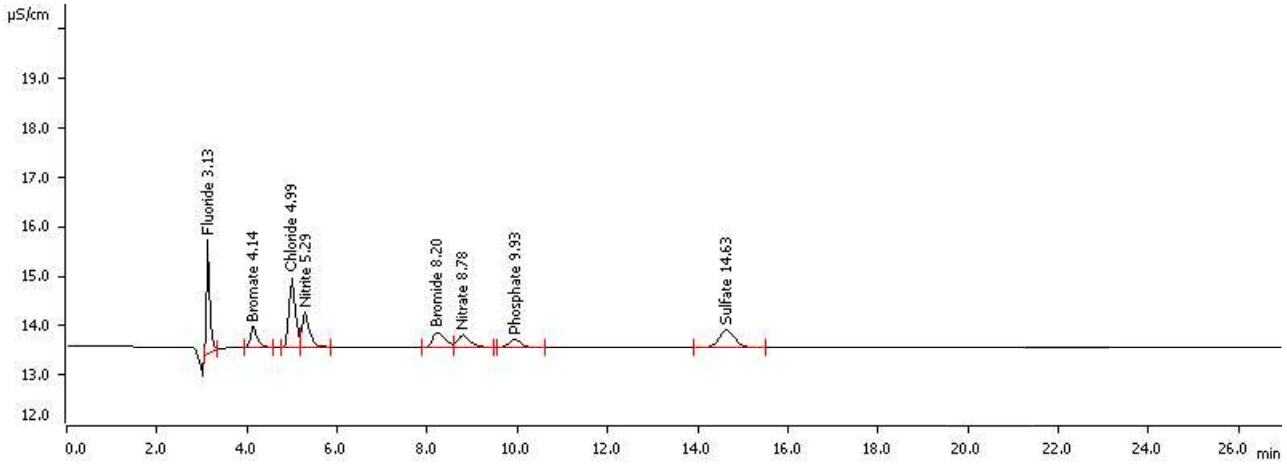
Sample type	Index	Conc.	Volume	Dilution	Sample amount	Area	Ident
Standard 1	1	0.100	20.0	1.0	1.0	0.005	0.1 mg/L bromate standard
Standard 2	1	0.250	20.0	1.0	1.0	0.012	0.25 mg/L bromate standard
Standard 3	1	0.500	20.0	1.0	1.0	0.024	0.5 mg/L bromate standard
Standard 4	1	1.000	20.0	1.0	1.0	0.049	1.0 mg/L bromate standard
Standard 5	1	10.000	20.0	1.0	1.0	0.499	10.0 mg/L bromate standard

Chromatograms:

Blank: Ultrapure water

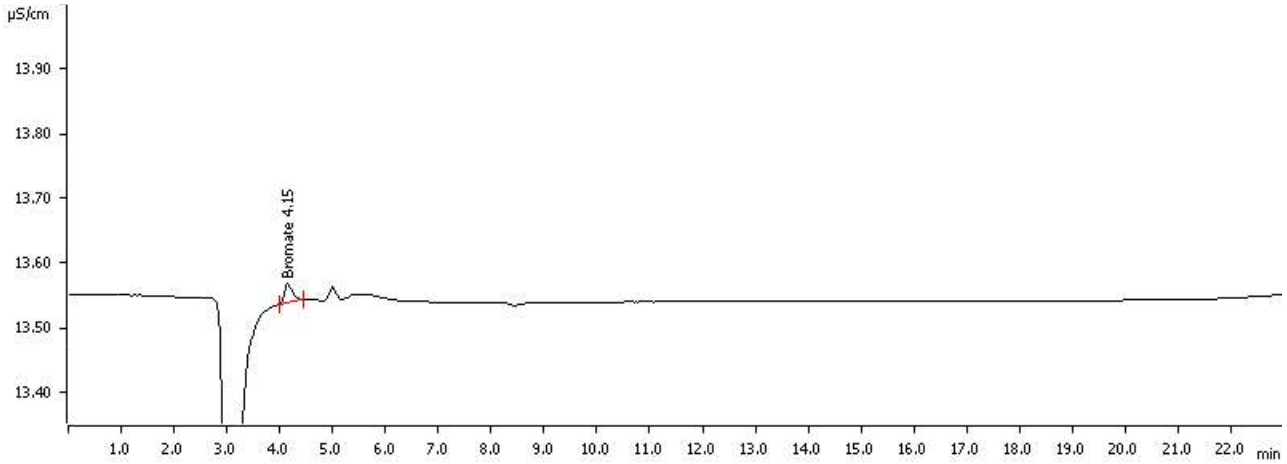


Selectivity: 1.0 mg/L mixed anions standard



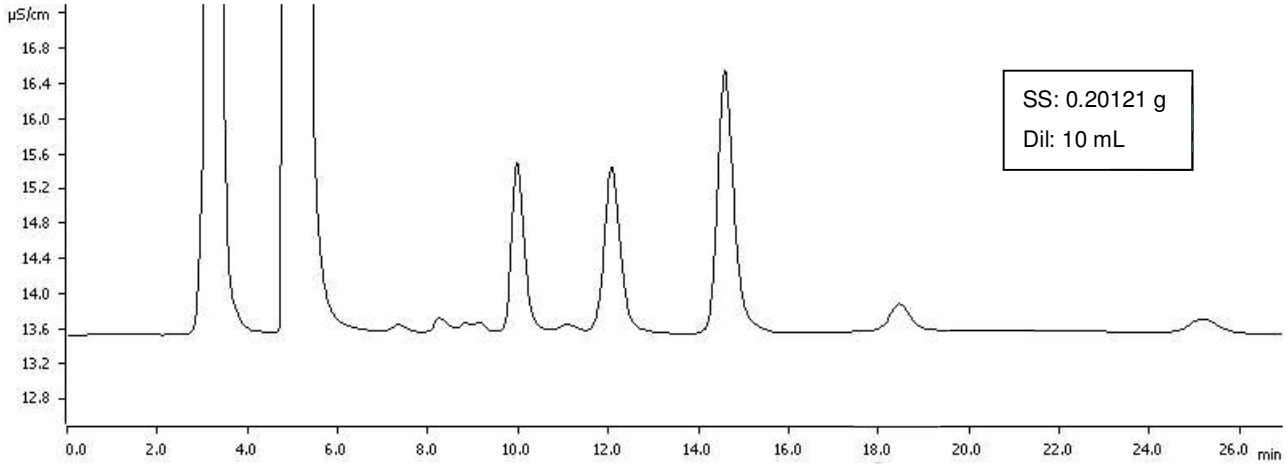
Component name	Retention time [min]	Concentration [mg/L]
Fluoride	3.13	1.000
Bromate	4.14	1.000
Chloride	4.99	1.000
Nitrite	5.29	1.000
Bromide	8.20	1.000
Nitrate	8.78	1.000
Phosphate	9.93	1.000
Sulfate	14.63	1.000

Standard: 0.1 mg/L bromate standard



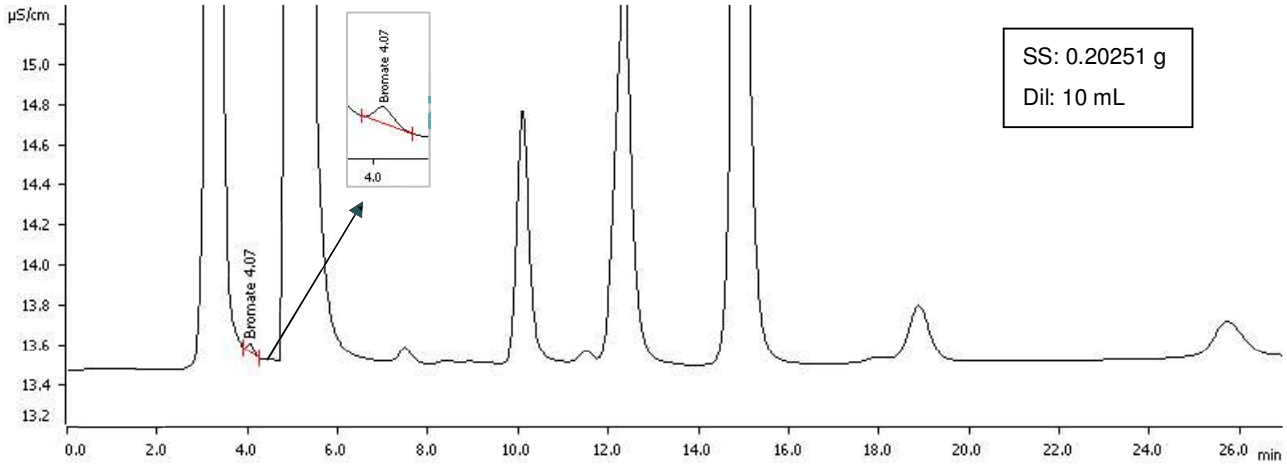
Component name	Retention time [min]	Height [µS/cm]	Area [(µS/cm) x min]	Concentration [mg/L]
Bromate	4.15	0.030	0.005	0.100

Sample ID: Sample 1



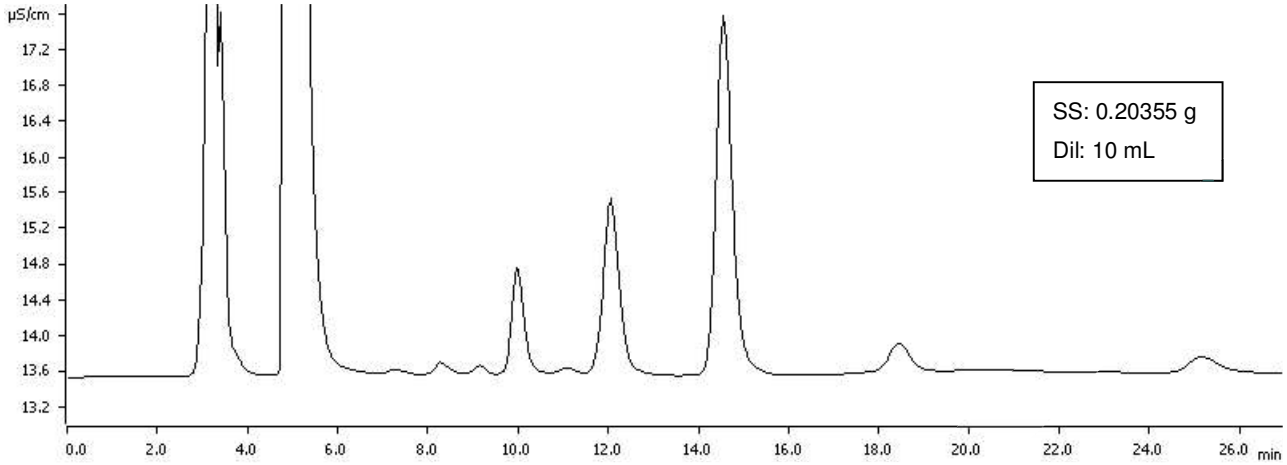
Not detected

Sample ID: Sample 2



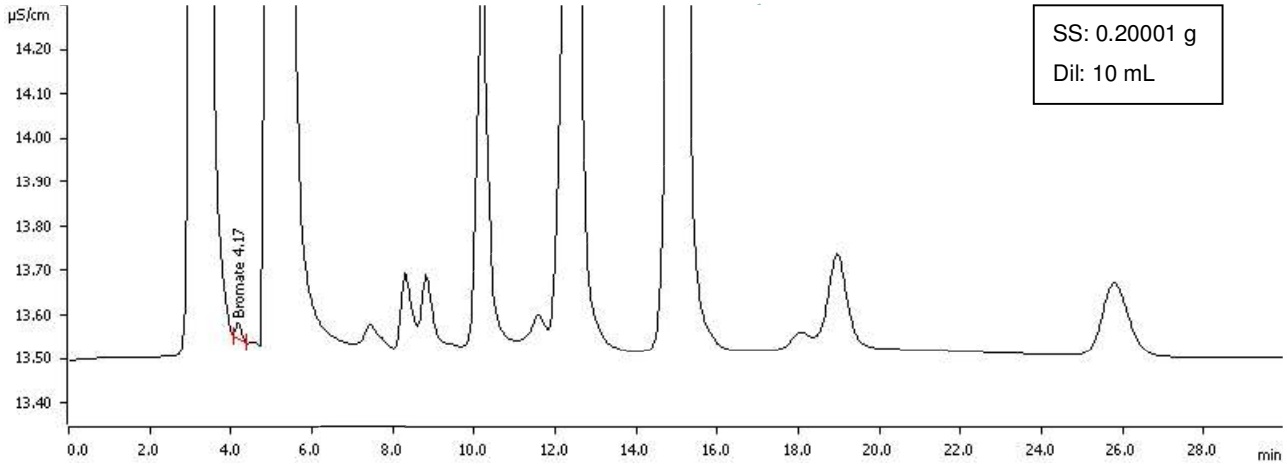
Component name	Retention time [min]	Height [µS/cm]	Area [(µS/cm) x min]	Concentration [mg/kg]
Bromate	4.07	0.047	0.007	6.764

Sample ID: Sample 3



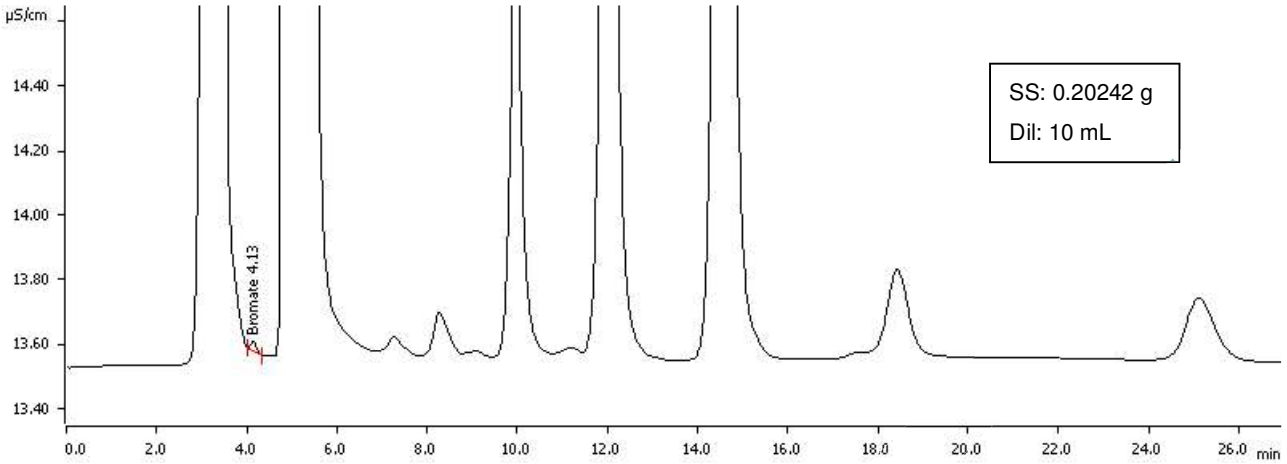
Not detected

Sample ID: Sample 4



Component name	Retention time [min]	Height [µS/cm]	Area [(µS/cm) x min]	Concentration [mg/kg]
Bromate	4.17	0.036	0.005	5.225

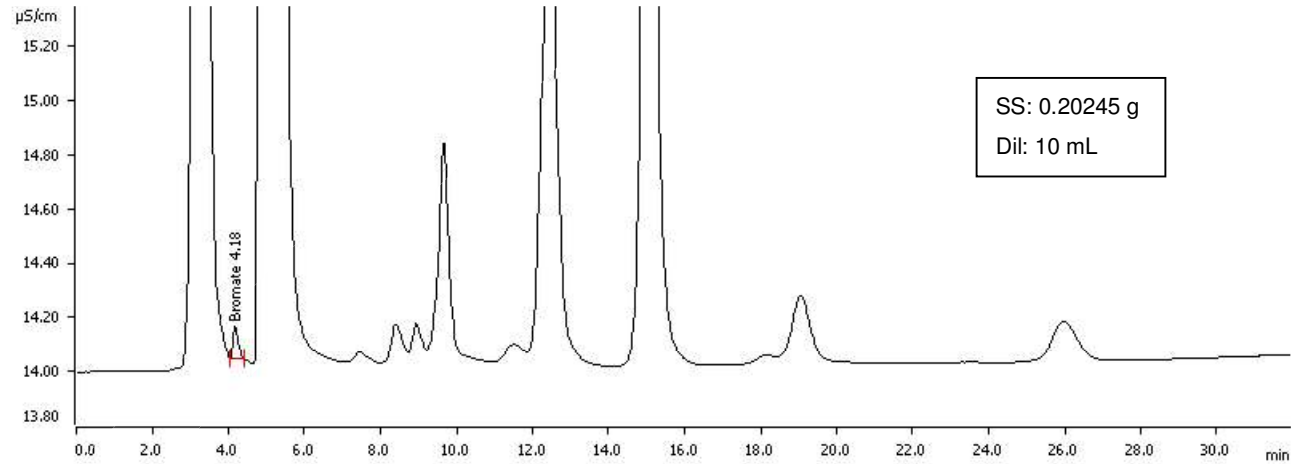
***Sample ID: Sample 3 +* 0.1 mg/L bromate standard spiked**



Component name	Retention time [min]	Height [µS/cm]	Area [(µS/cm) x min]
Bromate	4.13	0.033	0.005

Recovery: 100%

***Sample ID: Sample 4 +* 0.25 mg/L bromate standard spiked**



Component name	Retention time [min]	Height [µS/cm]	Area [(µS/cm) x min]
Bromate	4.18	0.120	0.018

Recovery: 108%