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BROMATE PROBLEM IN WATERS

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ABSTRACT

Inroduction
Water which is essential for the existance and sustainability of life, should be healthy, safe and not have risk for human health. As a public health measure, treatment, disinfection etc processes are applied to the water presented to the human consumption in order to make it safe. Chlorine, Chlorine dioxide, Chloramine and Ozone are the most well-known disinfectants used for the disinfection of water. Each of the commonly used disinfectants has its advantages and disadvantages. In the use of ozone for disinfection, compounds such as bromate, bromoform and brominated acetic acids can be formed as by-products. Bromate causes some adverse effects on lungs, kidneys, central nervous system, and also Bromate has carcinogenicity risk.

Aim of the study
In this review the contamination of waters with bromate, its detection in waters and effects on health were examined.

Material and Method
The monitoring of Bromate for water intended for human consumption, natural spring and natural mineral waters are performed in Public Health Institution of Turkey within the framework of the By-law on water intended for human consumption and By-law on natural mineral waters.

Conclusion
The compliance of Bromate level to the determined limit values have a great importance from public health point of view both in drinking-using waters, spring and natural mineral waters.
The identification of Bromate in natural spring and natural mineral waters especially where ozone enriched air is not used, is the greatest evidence showing that the production company is not behaving properly according to the legislation provisions.

Key words: contamination, disinfection, ozone, water, bromate, public health

INRODUCTION

There is a required minimum liquid level to be taken for a healthy life. This liquid is mostly provided as water within the daily life (1). It is required that water which is essential for the existance and sustainability of life, should be healthy, safe and not have risk for human health.
Abundant clean water is essential for good public health. Humans can not survive without water, infact our bodies are 67% water (2)
Approximately 20 % of today's world population is deprived of water. Each year waterborne diseases such as diarrhea, malaria, dysentery effect millions of people and cause deaths especially in developing countries (3,4). As a public health measure, treatment, disinfection etc processes are applied to the water presented to the human consumption in order to make it safe. With good treatment the bacterial load of the water can be reduced 99,5 % but still there is a need for the disinfection of water (5).
Disinfection of drinking water is essential to protect the public from outbreaks of waterborne infectious and parasitic diseases (6).
However many of the chemicals used as disinfectants if overdosed or used inappropriately as part of a water treatment process, can result in the formation of disinfection by-products. Disinfection by-products are formed when disinfection chemicals react with organic or inorganic compounds. Human exposure to these by-products may have adverse health effects (7).
Chlorine, Chlorine dioxide, Chloramine and Ozone are the most well-known disinfectants used for the disinfection of water. Each of the commonly used disinfectants has its advantages and disadvantages in terms of cost, efficacy, stability, ease of application and formation of by-products (6).
Trihalomethanes which are formed with the use of chlorine and chlorine compounds in the disinfection of water, are the predominant by-products. On the other hand in the use of ozone for disinfection, compounds such as bromate, bromoform and brominated acetic acids can be formed . Besides being the most efficient disinfectant , ozone leads to the formation of some brominated compounds in the presence of bromide which are asserted to be carcinogenic.The bromide salts arising from the co-existance of bromide with chlorine, can turn into bromate under proper medium. Especially at high pH values, more bromate ions are formed while at low pH values brominated organic by-products are formed.According to this, application of ozon to the spring water depends on the bromide ion concentration in its content (4,8,9).

Table 1. Comparison of the basic properties of the substances used for disinfection purposes (10)

Disinfectant	Disinfection efficacy	Residual protection	Formation of disinfection by-products	Deocolorant properties	Deodorant properties
Chlorine	good	good	Normal amount	good	good
Chloramines	medium-good	excellent	Small amount	absent	Very good
Chlorine Dioxide	Very good	absent	Normal amount	good	good
Ozone	Very good	absent	Small amount	excellent	excellent
UltraViolet	good	absent	absent	absent	absent

Although the presence of Bromide ion in waters are mostly originated from the enterance of sea water, in some waters its presence can be originated from the geological formations in nature. During ozonation Bromide ion leads to the formation of Bromate (BrO3-) compound by reacting

with ozone. Due to this reason it is not recommended to use ozone in the pre-oxidation stage for waters having high bromide levels (11).
Bromate is non-volatile and can only be adsorbed on light soil or residues. Increase in pH and temperature can lead to increase in bromate formation. In one of the study conducted in Canada on bottled waters, the amount of bromate was found in the range of 4.3-37.3 µg/L. It was stated that the level of Bromate in waters depend on ozone dosage, alkalinity, temperature and amount of dissolvedorganic carbon (12,13). Many studies are done on the effectsof Bromate on human health.
Bromate can be discarded from the human body by urine. Although the conducted studies indicated that the amount of Bromate is reducing by converting into glutathione or sulfhydryl containing compounds in the body tissues, the other studies showed that Bromate is stable and is reducing in small amounts (12).
It is available in the literatures that as a result of taking into body Bromate causes some adverse effects on lungs, kidneys, central nervous system, and also Bromate has carcinogenicity risk. In the studies concerning Potassium Bromate, it was stated that this compound caused serious poisoning in children and for a kid having 20kg weight the daily intake of 46-92 mg Bromate per body weight caused serious poisoning. It is estimated that the lethal dose for Bromate (Potassium Bromate) is 150-385 mg/kg body weight (4,13).
The International Agency for Research on Cancer (IARC) has classified Bromate in B-2 group (possible human health carcinogen) and the maximum limit for drinking and using water has been determined as 10 µg/l. In our country it is determined that this maximum limit for drinking and using water is also 10 µg/ L while for spring and natural mineral waters it is 3 µg/l (8,13,14).
In accordance with the By-law on water intended for human consumption and By-law on Natural Mineral Waters, disinfection with ozone can be done for drinking and using waters but disinfection of any kind including ozonation is forbidden for spring waters and natural mineral waters. However permission is given to use ozone enriched air for removing iron, manganese, sulphur and arsenicfrom these waters. (8,14).Overuse of ozone in waters, has no effect on the ironi on while causing redissolving of the manganese ion (9).In coastal regions the high Bromide concentrations of ground waters are due to the leakages from the ocean waters. Innon-coastal Waters the basic sources of Bromide are natural resources and human-induced activities such as bicarbonate of soda production, potassium and charcoal mines, pesticides (15,16).
In this review the contamination of waters with bromate, its detection in waters and effects on health were examined.

MATERIALS AND METHODS

The Bromate analysis for water intended for human consumption, natural spring and natural mineral waters are performed in the Public Health Laboratories of the Public Health Institution of Turkey (17). Within this scope, sampling is done both by the central and local Provincial organisation of the Institution, the samples are analyzed in the Public Health Laboratories and the analysis results are evaluated within the framework of the By-law on water intended for human consumption and By-law on natural mineral waters (8,14).
In accordance with the By-law on water intended for human consumption (8) and By-law on Natural Mineral Waters (14), if ozonation is applied to the drinking water, natural spring and natural mineral waters, the analysis are done by adding the ozone (field analysis), bromate and bromoforme parameters to the check monitoring.
It is essential that samples are taken from all kinds of bottled water entered into the market for every 3 months and analysed for check monitoring parameters and arsenic, flouride, bromate and bromoforme parameters.The production companies have rights to object within 7 days to the analysis results of the non-conforming samples in terms of bromoforme and bromate and depending on the objection replicate sample is send to the laboratory for re-analysis.
There is no objection right for the non-conforming samples in terms of microbiological parameters (8,14,18).

DISCUSSION

The drinking and using waters are contaminated with the organic and inorganic substances usedtill they are presented to the consumption. Because of this reason the water intended for human consumption should be effectively and frequently controlled. The cleaning of these waters (disinfection) is an obligation (9,13). Ozonation shouldn't be used for the purpose of disinfection in spring waters and natural mineral waters but for the removal of substances such as iron, manganese and arsenic ozone enriched air can be used (8,14).
Meanwhile the dosage of ozone used for water play an important role in bromate formation. The pH andtemperature of the water are also effecting the bromate level (12,13). In a study done by Dönderici et al. (2010) on spring waters, bromate non-conformity was determined in the 3 of the 61 water samples (4,9%) (19).
Bromate which is not found in water under normal conditions, is a compound formed in bromide containing waters with the use of ozone.It was determinedin the study done by Taşkın etal. (2012)that as a result of ozonation in the waters,the percent reduction of free bromide was between the range of 11-100%whilepercent reduction of total bromide was between the range of 7-85% .It was indicated that this reduction was due to the formation of bromate(4).

CONCLUSION

As a result, with the use of ozone in waters, the bromate compound which is threatening the human health can be formed in the bromide containing waters. Although its usage for the purpose of disinfection in drinking and using water is not so extensive, it can be used in small scale for certain conditions. In our country according to the legislation the use of ozone for the purpose of disinfection in spring waters and natural mineral waters is not permitted. In drinking and using waters when the network systems and economical conditions are taken into consideration the use of ozone for the purpose of disinfection is not recommended.
In the bottled waters, in case when it is proven that the values of the substances such as iron, manganese, sulphur and arsenic are higher than their normal values, permission is given fort he use of ozone enriched air. In that case attention should be paid to the possible bromate level (8,14).

The compliance of Bromate level to the determined limit values have a great importance from public health point of view both in drinking-using waters, spring and natural mineral waters.
The identification of Bromate in natural spring and natural mineral waters especially where ozone enriched air is not used, is the greatest evidence showing that the production company is not behaving properly according to the legislation provisions.

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