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Assessment of iodine content in the commercial edible salt of Bangladesh

Abstract

IDD (Iodine deficiency disorder) is regarded as a major global public health disease. Universal salt iodization will root out this problem. In Bangladesh, at least six core people suffer from iodine deficiency as producer's market table salt without adding iodine in compliance with government rules. As a result, such deficiency is causing hypothyroidism, resulting in thyroid enlargement, mental retardation, increased neonatal and infant mortality, retardation of growth and development of the central nervous system in children (cretinism), reproductive failure, and an increase in the fluid in the tissues. All of this is due to the lack of iodine in table salt. Iodine is a mineral present in certain foods. To produce thyroid hormones, the body needs iodine. Such hormones regulate the metabolism of the body, as well as many other essential functions. The body also needs thyroid hormones during pregnancy and infancy for proper development of the bone and brain. The research was demonstrated to determine the concentration of iodine obtained from different areas of Bangladesh in different labeled salt. All the samples were obtained by Noakhali and out of Noakhali City. The concentration of iodine in salt was determined by the iodometric titration process. $K_2Cr_2O_7$, standardized $Na_2S_2O_3$, KI, $NaHCO_3$, starch, concentrated HCl, H_2SO_4 were used as reagents. Most of the salts collected show an acceptable level of iodine. Result showing that only one out of ten brands showed poor iodine content. From the result, it can be decided that most of our country's people now use iodized salt.

Keywords: Iodine deficiency disorders, symptoms, treatment, iodine determination

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Introduction

Iodine is an important mineral for normal growth and development of human and animals. A healthy human body contains 15-20 mg of iodine, of which 70-80% is stored in the thyroid gland.[1] The thyroid gland uses iodine for synthesis of the hormones thyroxin and tri iodothyronine, which are essential for maintenance of the body's metabolic rate by controlling energy production and oxygen consumption in cells, regulate temperature, improve digestion, maintain a healthy weight and for neural and sexual development.[2] According to the WHO, the recommended iodine intake for pregnant women is 200 to 250µg per day and for the adults should be 150µg per day.[3,4] Usually iodine is assimilated through the diet where rich sources of dietary iodine include iodized salt, saltwater fish, seaweed, shellfish, soy sauce, yoghurt, grains and from some medications.[5] Iodine deficiency affects at every stage of humans life and leads to several severe disorders. It is the leading cause of brain damage, goiter, cretinism, reduced of intelligence, mental retardation, deafmutism and cause miscarriage in pregnant women, stillbirth and failure of fertilization as well in the world.[6] Different statistical report of a survey conducted that the iodine deficiency can be basically caused by consumption of iodine less salt or less iodine containing salt below the minimum requirement.[7,8] A comprehensive literature review concluded that the stability of iodine in salt is determined by many factors, such as, the moisture of the salt and humidity of the atmosphere, bad packaging, light, heat, impurities in the salt, alkalinity or acidity.[9]

Many methods were used to determine iodate in iodized salt; however, most methods do not explicitly define and distinguish the species of iodine. Universal Salt Iodization (USI) is the most effective way of preventing Iodine deficiency disorders.[10] Iodometric titration is often used in analysis of iodate in iodized salt; however this method is not quite precise for determination of potassium iodate in iodized salt.[11] A literature review conducted that loss of iodine in iodized salt and foodstuffs after cooking, caused by the differences in the methods of analysis.[12]In our present study, we focus on a number of companies of our country which produce edible salt necessary for human body. But at the earlier time, iodine was supplied in salt as KI but at the recent time iodine is supplied as KIO_3 due to the highly volatile nature of KI. However, we think that as most of the iodine compounds are volatile in nature as well as to ensure their presence in edible salt we have assessed the various edible salts to determine their iodine content and their presence after cooking as well.

Materials and methods

For this analysis, iodized salt samples were obtained from seven branded and three open market samples from Noakhali City's local market as well as from outside of Noakhali.

Preparation of a 100ml solution of 0.1N $K_2Cr_2O_7$

Approximately 0.49gm of K2Cr2O7 was accurately measured on an electronic balance and placed with the help of a funnel in a 100ml volumetric flask. Then a small amount of distilled water was added to the flask and shaken well until it dissolves completely. The flask was then filled with distilled water, up to the 100ml mark.

Preparation of 500ml of 0.1N $Na_2S_2O_3$

At an electronic balance, 12.5 gm of $Na_2S_2O_3$ was accurately measured and put in a 500 ml volumetric flask with the aid of a funnel. Subsequently, a small amount of distilled water was applied to the flask and then shaken until the solution dissolved. The flask was then filled to the 500ml mark with distilled water.

Preparation of 1% starch indicator solution

Weighed 1 g of soluble starch and placed in a conical flask or beaker of 100ml. The starch was then dissolved by heating and continuously stirring the solution at 79ºC for 5 minutes into 100ml of distilled water. The solution was then allowed to cool to room temperature after the reaction was completed.

Preparation of 10% potassium iodide

10 g of Potassium Iodide was weighed and dissolved in 100 ml of di-mineralized water in a volumetric flask in order to prepare 10% Potassium Iodide solution.

Preparation of sulfuric acid (2N)

In a 50ml volumetric flask, 2.8ml of sulfuric acid (conc.) was measured using a pipette and gradually applied to the distilled water. The solution was then filled up to the 50ml level with water.

Titration for determination of iodine

The iodine content of iodine salts was calculated by iodometric titration using the following[13] method. At first, using electronic balance, 10 g of salt was weighed and put in a conical flask. The weighted salt sample was dissolved in 50 ml of distilled water and then applied 5 ml of 10% (m/v) KI solution, 1 ml of 1 M sulfuric acid and immediately closed. When iodine was made, the mixture was well shaken and turned into a yellow/brown color. Then the solution was titrated against the Standardized and Diluted $Na_2S_2O_3$ until the color yellow/brown became very pale. In the meantime, 2-3 drops of as prepared Starch indicator solution was added, resulting in an iodine-colored complex of dark blue-black. The titration continued until the end point was colorless. The process has been repeated two more times and an average value has been determined for the volume. After cooking, the dissolved salt heated at temperature between 60-80º C for 20 minutes to determine iodine. Then we followed the same iodine determination procedure as before.

Table 1 Iodine content for various brand of edible salt

Code no	Salt name	Before cooking		After cooking	
		Volume of (ml)	Iodine content (ppm)	Volume of (ml)	Iodine content (ppm)
1	CSI super salt	3.1	32.81	2.2	23.28
2	Bongo salt	2.56	27.1	2.23	23.6
3	ACI pure salt	2.67	28.26	1.9	20.1
4	Molla super salt	2.76	29.21	2.16	22.86
5	Fresh super premium salt	2.8	29.63	2.16	22.86
6	Health care salt	2.26	23.91	1.86	19.68
7	Popular salt	2.2	23.28	1.56	16.51
8	Pubali salt	2.33	24.67	2.1	22.22
9	Pubali fine salt	2.5	26.46	2.03	21.35
10	Badakopy	2.3	24.34	2.03	21.48

Result and discussion

Calculation of iodine content

The number of iodine (ppm) in the iodized salt samples was calculated using the following formula from the determined average volume of $Na_2S_2O_3$:

$$Iodine\ ppm = (R*100*1000*0.127*N)/6$$

Where, R=Average volume of $Na_2S_2O_3$

100 is to convert the reading for 1000g of salt

1000 is to convert gram of iodine to milligram of iodine

0.127 is the weight of iodine equivalent to 1ml of normal Thiosulphate solution

N is normality of Thiosulphate solution (which is 0.005N)

6 is to arrive at the value that corresponds to 1 atom of iodine liberated.

A total of 30 samples were obtained from 10 different brands of edible salt. The most frequently sampled brands were code 3 and 5. The samples were categorized into three groups based on their iodine content (ppm=mg iodine) according to guidelines of the International Iodine Standards National Committee; under standard limit (<20 ppm), acceptable standard limit (20–50 ppm), over standard limit (>50 ppm) standard limit. From table it is clearly observed that iodine content were ranged from 23.28 (Popular salt) to 32.81(CSI super salt) before cooking and 16.51 (Popular salt) to 23.60(Bongo salt) respectively. Before cooking, the tests showed that all products had an acceptable level of iodine. Upon frying, however, there was a significant change in the iodine content of salts. The major change was observed for CSI super salt, in which case the content of iodine was reduced by 29.04% and the minimum change was observed for Badakopy brand of 11.75%.

Discussions

Iodine deficiency disorders (IDD) are regarded as a major public health issue in the world. According to recent estimates, about 2.5 billion people have inadequate intake of iodine worldwide, with 313 million in South-East Asia, including Bangladesh.[14] Temperature and light can influence salt iodine quality, so we expected to find a

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difference between sample iodine content in warm months and cold months. However, the absence of such conditions indicates that the standard salt storage conditions are maintained by wholesale warehouses and grocery stores. Consequently, inadequacy of iodine content should be due either to under-standard production or lack of adequate attention to conditions of temperature, light and humidity during transport. Certain factors such as improper storage and salt maintenance in food shops, salt transport, high temperatures and humidity can also lead to the destruction of salt iodine. One of the limitations of this study was the lack of an evaluation of the iodine content of salts purchased and stored by households. The conditions under which salt is processed can have a significant impact on its iodine content and can potentially nullify any efforts made during production and distribution to maintain acceptable levels of iodine. Overall study showed that a decrease in the iodine content of edible salt during cooking is a vital factor for evaluation. It is therefore necessary to add extra iodine in edible salt so that the standard iodine limit is retained after cooking.

Conclusion

It has been claimed that for more than half a century goiter and cretinism, now included in the more general term iodine deficiency disorders (IDD), are known; but their complete eradication remains an elusive target. In addition, iodine deficiency causes a spectrum of growth and developmental effects, particularly in the fetus, neonate and child's brain development. Bangladesh has made significant progress in eliminating the country's iodine deficiency disorders. In the case of this demonic public health issue, the right decision and rapid response helped Bangladesh to achieve this success. Our present study was conducted in some widely used braded salt, which is too minute to conclude that the IDD rate in the nation is declining. The results in this case show that it is quite marked by almost all the salts that contain iodine above the minimum level. Nevertheless, as we have noticed a slight decrease in iodine content after cooking, it is therefore necessary to add extra iodine during packaging so that its minimum after cooking level stays within the normal limit.

Conflicts of interest

Authors declare that there is no conflict of interest.

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