



## **Determination of Iodine Content of Commercially Available Table Salts at the Retailer Level in Selected Areas of Bangladesh**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors MRA and MKI had designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors MD, AZ and SM collected the samples and did laboratory analysis. Author SR helped with literature research and statistical analysis. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Aims:** Iodine deficiency is one of the most common micronutrient deficiencies in Bangladesh. To combat iodine deficiency disorders, universal salt iodization is mandatory in Bangladesh. The aim of our study was to determine the iodine content of both packaged and open edible table salts sold at the retailer level in different areas of Bangladesh.

**Study Design:** The study is an experimental cross-sectional study.

**Place and Duration of Study:** The present study was conducted in the food analysis laboratory of Department of Food Technology and Nutrition Science, Noakhali Science and Technology University from March 2019 to June 2019. A total of 90 salt samples were collected from ten

retailers selected based on convenience sampling from two districts: Dhaka and Noakhali. Among the samples, 45 were packaged salts from Fifteen different brands and the rest of the 45 samples were non brand open salt.

**Methodology:** The iodine content of iodized salt samples was determined by the iodometric titration method.

**Results:** The mean iodine content of both types of salts is  $17.801 \pm 1.973$  ppm. The mean iodine contents of packaged salts and open salts are  $30.691 \pm 2.679$  ppm and  $4.912 \pm 1.008$  ppm, respectively. Only 42% of the total salt samples are adequately iodized ( $>20$  ppm). 75% of packaged salt samples are adequately iodized and only 8% of open salt samples are adequately iodized.

**Conclusion:** As iodine content in open table salts doesn't meet the criteria set by the government, the sale of open salt for human consumption should be stopped.

*Keywords: Iodine content; table salt; titrimetric method; iodized salts; Bangladesh.*

## ABBREVIATIONS

*G* : Gram;  
*IDD* : Iodine Deficiency Disorders;  
*Ppm* : Parts per Million;  
*SD* : Standard Deviation;  
*SEM* : Standard Error of Mean.

## 1. INTRODUCTION

Iodine deficiency is one of the major causes of micronutrient deficiencies in the world. About two thousand million people are suffering from iodine deficiency disorders (IDD) [1]. Iodine deficiency causes dysfunction of thyroid hormones production, which are responsible for normal brain development. In pregnant women, iodine deficiency is associated with a range of defects such as miscarriages, stillbirths as well as congenital anomalies, neurological cretinism, myxedematous cretinism, mental disorders, dwarfism, hypothyroidism, psychomotor defects etc., in new-born and children. Goitre, iodine-induced hyperthyroidism, hypothyroidism, impaired mental function, increased susceptibility to nuclear radiation and so on, are associated with iodine deficiency in adults [2].

Universal salt iodization is an efficient and cost-effective approach to prevent and control iodine deficiency disorders. Universal salt iodization refers to the fortification with iodine of all food-grade salts, which are used in household and food processing [3]. Due to the universal salt iodization strategy, 86% of world population has access to iodized salt [4].

According to the first National iodine deficiency disorders survey in Bangladesh 1993, nearly 69% of population had biochemical iodine deficiency and total goitre rate was 47.1% [5].

Therefore, the Government of Bangladesh is one of the first countries to make legislation for mandatory universal salt iodization by enacting "Protection Law of Diseases Caused by Lack of Iodine 1989" to ensure iodization of all edible salts for human consumption. A set of regulations under "Diseases for Deficiency of Iodine Prevention Act 1994" were set and salt policy was embraced by the cabinet decision in 2011. According to the law, all salts for human consumption must be fortified with iodine and they must contain 45-50 parts per million (ppm) iodine at production stage, minimum 20 ppm iodine in retail stage in order to ensure at least 15 ppm iodine at household level [6]. After 10 years of obligatory universal salt iodization, in 2004, the prevalence of iodine deficiency was 33.8% in children and 38.6% in women of reproductive age and 51% of salts that were consumed in household level were not adequately iodized as per the regulation [7]. The number of households with adequately iodized salt was increased to 57% in 2011-12 [8]. In another study in 2015, around 70% of all packaged salts were found to be adequately iodized as well as very less than 2% of open salt samples were adequately iodized [9].

The aim of this study was to determine iodine content in both packaged and open edible table salts at the retailer level in selected areas of Bangladesh.

## 2. METHODOLOGY

The study was conducted as a cross sectional study. A total of ninety salt samples were collected from ten retailers selected based on convenience sampling from two districts of Bangladesh: Dhaka and Noakhali. Among the samples, forty-five samples were packaged salts

from Fifteen different brands and rest of the forty-five samples were non brand open salts. After collection, the packaging samples were removed, stored in similar vacuum container and coded in order to ensure allocation concealment. The iodine content of iodized salt samples was determined by the iodometric titration method using the following chemicals [10]:

1. **0.1 N Potassium Dichromate ( $K_2Cr_2O_7$ ):** 0.245 g of potassium dichromate (Merck) was dissolved in 50 ml distilled water.
2. **0.005 N Sodium Thiosulphate ( $Na_2S_2O_3$ ):** 1.24 g sodium thiosulphate (Merck) was dissolved in 500 ml distilled water. Sodium thiosulphate solution was standardized by titrating against 0.1 N potassium dichromate solution and was stored in dark and cool place.
3. **2 N Sulfuric Acid ( $H_2SO_4$ ):** 6 ml concentrated sulfuric acid (98%; Merck) was gently mixed with 100 ml distilled water.
4. **10% Potassium Iodide:** 100 g potassium iodide (Merck) was dissolved in 1000 ml water and stored in amber bottle in cold and dark place.
5. **1% Starch Indicator Solution:** 1 g of soluble starch (Chemspure) was weighed and dissolved into 100 ml doubly distilled water by heating and stirring the solution at 90 degree Celsius for five minutes.

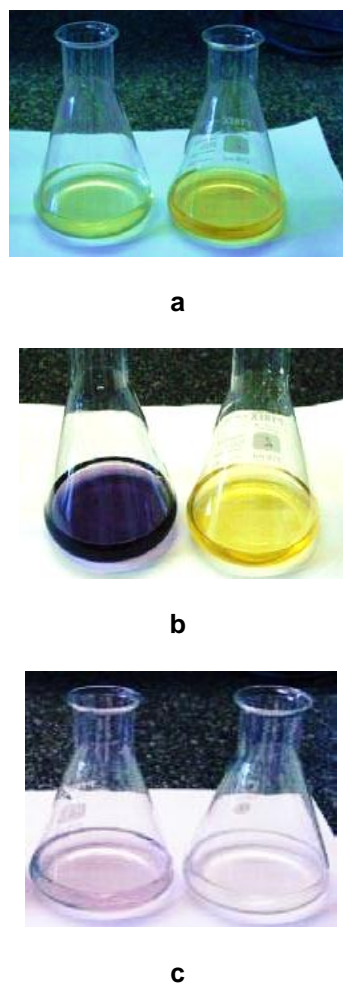
10 g of sample was weighed using an electronic balance and placed into a conical flask. To the flask, 50 ml distilled water, 5 ml potassium iodide and 1 ml of sulfuric acid were all added, one by one. The solution turned into a yellow/brown colour, as iodine was produced (Fig. 1a).

The solution was then titrated against the standardized sodium thiosulphate solution until the yellow/brown colour became very pale. Then, 2-3 drops of starch indicator solution were added, which produced a dark blue-black coloured complex with iodine (Fig. 1b). The titration was continued until the colour completely disappeared (Fig. 1c).

Finally, the iodine content in the sample was calculated by the following formula:

$$\text{Mg/kg (ppm) iodine} = \text{titration volume in ml} \times 21.15 \times N \text{ (Normality of sodium thiosulfate)} \times 1000 / \text{salt sample weight in g}$$

Statistical analysis to compute mean, standard deviation and variance of the iodine contents of the samples was carried out using IBM SPSS software (version 21.0) and graphs were generated by Origin Pro 2017 software.



**Fig. 1. Determination of iodine content in iodized salt by iodometric titration method; a. starting point of titration, b. during titration, and c. endpoint of titration**

### 3. RESULTS

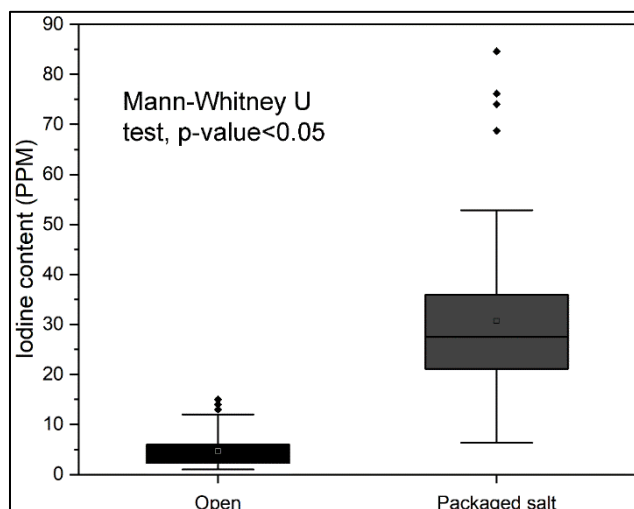
The mean iodine content of both types of salts is  $17.801 \pm 1.973$  ppm. The mean iodine content of packaged salts and open salts are  $30.691 \pm 2.679$  ppm and  $4.912 \pm 1.008$  ppm, respectively (Table 1).

According to Shapiro-Wilk test the data is not normally distributed ( $p$ -value $<0.05$ ). As a result, nonparametric Mann-Whitney U test to compare the means was done. There is a significant difference between the packaged and open samples ( $p$ -value $<0.05$ ) (Fig. 2).

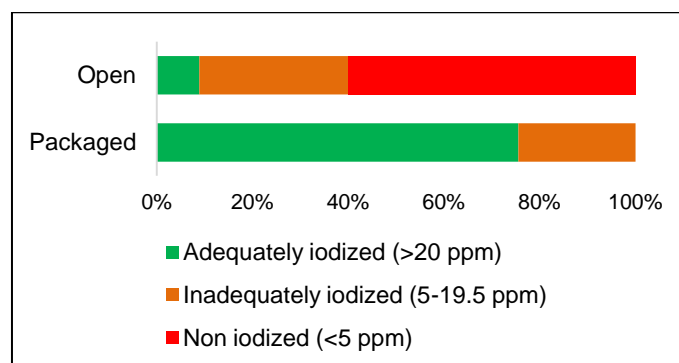
**Table 1. Descriptive statistics of iodine content (ppm) in samples**

	Mean	SEM	SD	Variance
<b>Packaged (n=45)</b>	30.691	2.679	17.969	322.86
<b>Open (n=45)</b>	4.912	1.008	6.764	45.757
<b>Total (n=90)</b>	17.801	1.973	18.714	350.25

SEM: Standard Error of Mean; SD: Standard Deviation



**Fig. 2. Box plot of iodine content (ppm) of package and open salt samples**  
ppm: parts per million



**Fig. 3. Comparison between iodine content of package and open salt samples**  
ppm: parts per million

Among the packaged salt samples, thirty-four samples are adequately iodized, and rest are inadequately iodized whereas only four samples are adequately iodized, fourteen samples are inadequately iodized, and twenty-seven samples are not iodized out of forty-five open salt samples (Fig. 3).

#### 4. DISCUSSION

According to our study, only 42% of the total salt samples are adequately iodized (>20 ppm). Here, 75% of packaged salt samples are adequately iodized and only 8% of open salt

samples are adequately iodized. Open salt is relatively cheaper than the packaged salt. The industries producing open salts try to minimize the price by adding no or insufficient amount of iodine in their salts. Furthermore, the packaging of open salt is not properly maintained so that iodine gets away through sublimation process. Moreover, the poorer segment of the society as well as food industries tend to use open salt due to the cost efficiency. Therefore, people face the risk of iodine deficiency disorder because of low intake of iodized salt. Although the iodine content is satisfactory among the packaged salts comparing with the previous data [5,7,9] it is not

up to the mark yet. Despite having a strict regulation for universal salt iodization, the goal has not been reached yet as a consequence of poor law enforcement as well as lack of nutritional knowledge regarding iodine deficiency disorders. The sale of open salts should be banned at retailer level. This study does not show the bigger picture since it shows only a snapshot of the iodine content at retailer level in relatively small sample size. It could describe the situation more efficiently if we could start the survey from production level and include the iodine content of household level as well as measure the absorption at individual level by urinary iodine excretion with appropriate sample size.

## 5. CONCLUSION

It is been evident that the iodine content in commercially available salt at retailer level in Bangladesh is below the standard. In order to eradicate iodine deficiency disorders both the behavior approaches such as nutritional knowledge dissemination on iodine deficiency along with environmental approaches such as law enforcing against the sale of non-iodized salt should be taken.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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