



## Iodine Content of Packaged Salt and Related Knowledge and Storage Practices at Household Level in Dhaka City, Bangladesh

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### *Authors' contributions*

*This work was carried out in collaboration between both authors. Author MSH designed the study, collected information and samples, did laboratory analysis, did literature search, wrote the protocol and first draft of the manuscript and conducted statistical analysis. Author MNIK supervised the study and helped in statistical analysis. Both authors read and approved the final manuscript.*

### *Article Information*

DOI: 10.9734/EJNFS/2020/v12i1130318

#### Editor(s):

(1) Dr. Hudson Nyambaka, Kenyatta University, Kenya.

#### Reviewers:

(1) Oarabile Mogobe, Okavango Research Institute, University of Botswana, Botswana.

(2) Tadesse Fikre Teferra, Hawassa University, Ethiopia.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/63597>

Original Research Article

**Received 28 September 2020**

**Accepted 02 December 2020**

**Published 12 December 2020**

### ABSTRACT

**Aims:** Iodine deficiency disorders are one of the major public health concerns in Bangladesh. Regular consumption of iodized salt can help combat these disorders. The aims of this study were to determine the content of iodine in edible packaged salt and to assess iodized salt related knowledge and storage practices in Dhaka City, Bangladesh.

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

**Place and Duration of Study:** The present study was conducted from June 2019 to July 2019 in Dhaka City, Bangladesh. A total of 120 households were selected for interview and packaged salt sample collection. The chemical analysis was done in the Food Analysis Laboratory of Institute of Nutrition and Food Science, University of Dhaka.

**Methodology:** A closed-ended questionnaire was used for collection of information. Iodometric titration method was used to determine the content of iodine in packaged salt samples.

**Results:** The mean ( $\pm$ SD) iodine content in the salt samples was 31.469 ( $\pm$ 10.196) ppm. More than 90% salt samples were adequately iodized. Twenty five percent of the respondents know that consumption of iodized salt helps prevent goiter. Only 10.8% of the respondents know that iodine

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content decreases if iodized salt is stored close to fire. About 87% of them store salt away from fire.

**Conclusion:** Along with consuming packaged iodized salt, householders should be educated about iodized salt related knowledge and storage practices to control iodine deficiency disorders.

*Keywords: Iodine content; packaged salt; household; knowledge & storage practices; Bangladesh.*

## ABBREVIATIONS

*g* : Gram  
*kg* : Kilogram  
*mg* : Milligram  
*mL* : Milliliter  
*N* : Normal  
*ppm* : Parts per Million

## 1. INTRODUCTION

Iodine ( $I_2$ ) is an essential mineral required at a trace amount in our daily diet (150 micrograms for both men and women) to maintain and promote a healthy life [1]. The only known metabolic fate of iodine in the body is to synthesize thyroid hormones in the thyroid gland which perform various crucial metabolic functions in almost every bodily cell to accelerate proper linear growth and intellectual development as well as to enhance immunity [2-5]. It is clearly evident that the chronic deficiency of iodine in the body results in serious physical and mental maladies through reduced synthesis of thyroid hormones. These are known as iodine deficiency disorders (IDDs) and include cretinism (characterized by deaf-mutism, dwarfism, spasticity), goiter (enlargement of the thyroid gland), abortion, miscarriage, stillbirth which afflict children, elderly people and pregnant women [6-8]. The primary cause of IDD is insufficient intake of dietary iodine and a secondary cause may be the reduced bioavailability of iodine resulting from interaction with goitrogens in thyroidal iodine uptake [9].

The long-term manifestation of IDD at the population level is the arrest of GDP growth of a country because of lowered intellectual potential and physical fitness of the citizens as well as excess cost to treat the disorders [10-11]. Realizing this severe impact, the UN organizations in collaboration with the global leaders have taken initiatives in the 1990s and discovered fortification of all kinds of dietary salt with iodine (known as universal salt iodization or USI) as the most cost-effective approach to prevent and control the disorders at the global level [12-13]. Due to the adoption of USI, 86% of the households from low- and middle-income

countries of the world are now having access to iodized salt [14].

According to World Health Organization (WHO), household level dietary salt is categorized based on iodization as: adequately iodized:  $\geq 15$  ppm  $I_2$  ( $\geq 15$  mg  $I_2$ /kg salt), inadequately iodized: 5-< 15 ppm  $I_2$  (5-< 15 mg  $I_2$ /kg salt) and non-iodized: < 5 ppm  $I_2$  (< 5 mg  $I_2$  /kg salt) [12]. The government of Bangladesh as one of the early starters of USI strategy passed a law in 1989 to combat IDD making it obligatory to fortify all edible packaged salts with iodine (in the form of potassium iodate, a stable form of iodine) at a sufficient level to ensure a minimum of 15 ppm iodine at the household level [15]. From 1996 to 2015, five national level surveys conducted in Bangladesh to reveal the iodine nutrition and salt iodization status found that the coverage of usage of adequately iodized salt at the household level was in between 50 and 57% which is far away from achieving the threshold level (> 90%) to be recognized nationally as iodine sufficient and there was notable difference between urban and rural households in terms of coverage of utilization of adequately iodized salt [12,16-20].

Besides the content of iodine in the packaged salt, as per National Micronutrients Status Survey, iodized salt related knowledge and salt storage practices of those household members involved in cooking and food preparation are also important as these may potentially affect iodine content of dietary salt [19]. To the authors' knowledge, no other study was conducted to identify knowledge and storage practices in addition to estimation of salt iodine content. Hence, the current study was carried out to determine the iodine content of packaged dietary salt at household level and to assess relevant knowledge and storage practices of the householders in a selected area in Dhaka City, Bangladesh.

## 2. METHODOLOGY

### 2.1 Survey

A community-based cross-sectional study was conducted from June 2019 to July 2019. A total

of 120 households were chosen by random sampling method from a selected area in Dhaka City, Bangladesh. Women of the selected households aged between 20 and 50 years who were in charge of cooking and meal preparation were interviewed. Information on iodized salt related knowledge and storage practices was collected using a closed-ended questionnaire and cross-checked.

## 2.2 Determination of Iodine Content

More than 30-gram edible packaged salt sample was collected carefully in a vacuum zip-lock polythene bag from each selected household using kitchen weighing-scale. The salt samples were sent to the Food Analysis Laboratory of Institute of Nutrition and Food Science, University of Dhaka for determination of iodine content.

Iodometric titration was used in this study as it is the most widely used method and recommended by WHO to determine salt iodine content due to its high sensitivity and specificity [12]. The following reagents were prepared with double-distilled water for chemical determination of iodine:

- 0.005 N sodium thiosulfate solution
- 0.005 N potassium iodate solution
- 2 N sulfuric acid solution
- 10% potassium iodide solution
- 1% starch solution

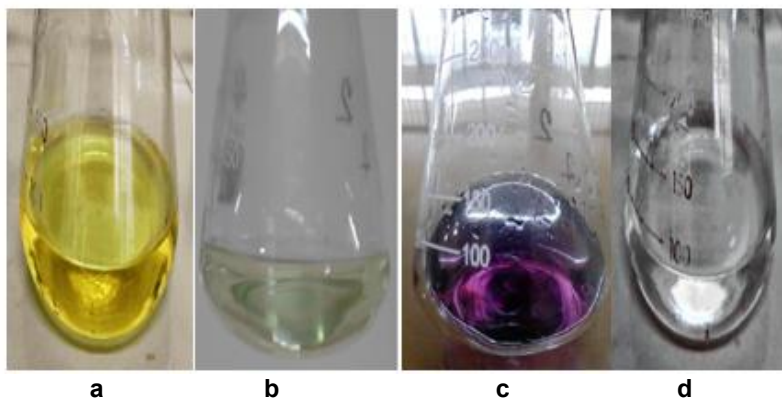
Ten gram of salt sample was weighed by electronic balance and poured in a conical flask. In the flask, 50 mL distilled water was poured and the flask was shaken well to dissolve the salt. Then, 2 mL of sulfuric acid and 5 mL of

potassium iodide solutions were added. The solution instantly became bright yellow in color if iodine was present in the salt sample (Fig. 1a). The flask was then closed with a stopper and kept in a dark closed chamber for 10 minutes. Then the solution was titrated against standard sodium thiosulfate solution (standard potassium iodate was used to standardize thiosulfate solution) until the solution turned into very pale yellow in color (Fig. 1b). Then, 1 mL of starch solution was added and shaken; the solution turned into deep purple (Fig. 1c). Thiosulfate solution was then again added drop by drop until the purple color completely disappeared (Fig. 1d). The whole procedure was repeated two more times for sample collected from each household and the required volume of thiosulfate was noted.

The content of iodine in the salt sample was calculated by the following formula and the data of iodine content (ppm) in each sample was presented as the average value of the three estimates :

$$\text{Iodine (ppm or mg/kg)} = \frac{\text{Titration volume of sodium thiosulfate (mL)} \times 100 \times 1000 \times 0.127 \times \text{Normality of sodium thiosulfate}}{6}$$

Where, 100 = to convert thiosulfate reading for 1000 g of salt  
 1000 = to convert grams of iodine to milligram  
 0.127 = weight of iodine equivalent to 1 mL of normal thiosulfate solution  
 6 = to arrive the value of 1 atom of iodine liberated from potassium iodate present in salt



**Fig. 1. Determination of iodine content in iodized salt by iodometric titration method;**  
**a. after addition of potassium iodide, b. after addition of thiosulfate, c. after addition of starch,**  
**d. disappearance of color indicating end of titration**

### 2.3 Statistical Analysis

Statistical analysis including descriptive statistics and *chi square* test were performed using IBM SPSS software (version 22.0). Graphical illustration was done using Microsoft Excel 2016.

### 3. RESULTS

The mean ( $\pm$ standard deviation) iodine content of the household salt samples was 31.469 ( $\pm$ 10.196) ppm. The minimum and the maximum iodine content were 0.0 and 63.50 ppm, respectively (Table 1). The iodine content data of 120 salt samples are presented in Fig. 2.

In terms of level of iodization of the analyzed salt samples, 9 in 10 were found to be adequately iodized, 1 in 20 was inadequately iodized and 1 in 40 was identified as non-iodized (Fig. 3).

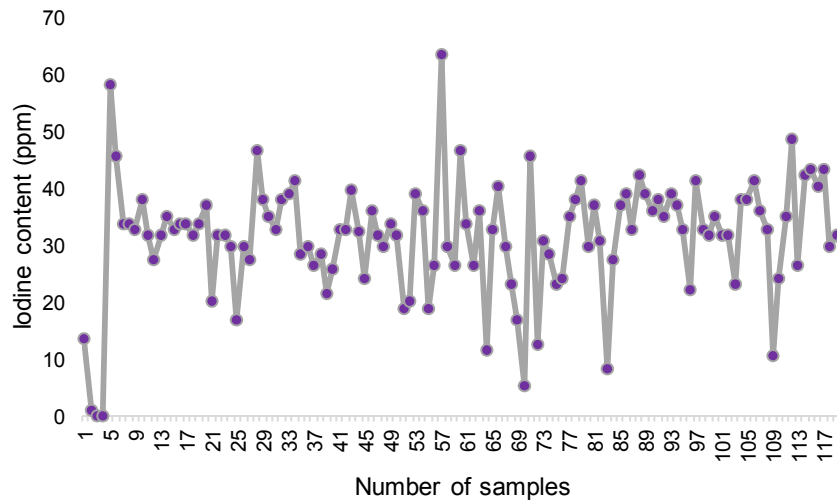
According to this study, 25.0% of the respondents know that consumption of iodized salt can protect us from developing goiter, 30.0% know that lemon juice can be used as an indicator to test the presence of iodine in table salt and only 10.8% respondents know that iodine content decreases when iodized salt is stored close to fire. Almost all households in this study use salt within 1 month of purchase. More than four-fifths of them store salt away from fire (Table 2).

A 2x2 *chi square* test was conducted to assess the relationship between iodized salt related knowledge (change in iodine content if iodized salt is stored close to fire) and storage practices (away from fire vs close to fire) of the respondents. No statistically significant association was found between them at  $P = .29$  (Table 3).

**Table 1. Descriptive statistics of iodine content in the salt samples**

	Mean	SEM	SD	Minimum	Maximum
iodine content (ppm)	31.469	0.931	10.196	0.0	63.50

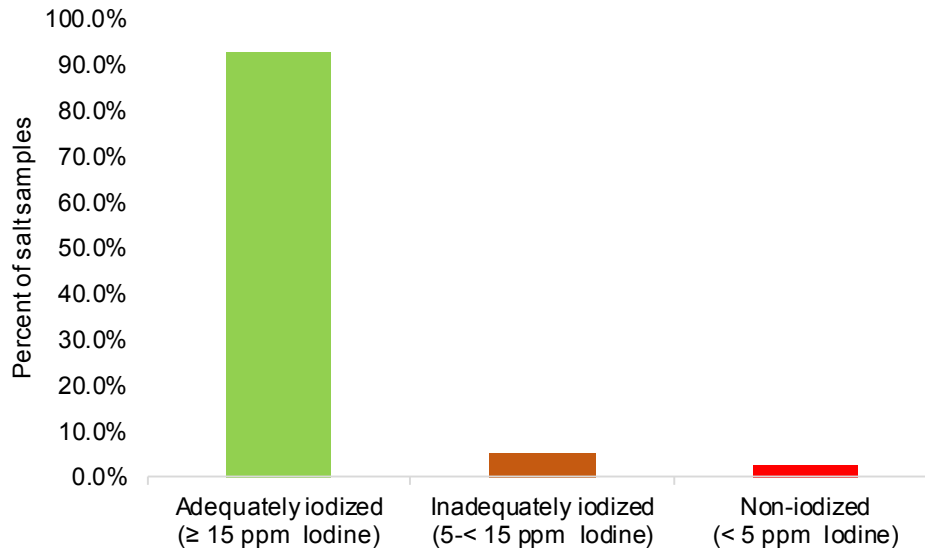
SEM: Standard Error of Mean; SD: Standard Deviation



**Fig. 2. Iodine content (ppm) in 120 salt samples**

**Table 2. Iodized salt related knowledge and storage practices**

Knowledge on iodized salt	% of respondents
Consumption of iodized salt helps prevent goiter	25.0
Presence of iodine in table salt can be tested using lemon juice	30.0
Iodine content decreases if iodized salt is stored close to fire	10.8
Salt using and storage practices	% of households
Use salt within 1 month of purchase	96.7
Store salt away from fire	86.7



**Fig. 3. Level of iodization of salt samples**

**Table 3. Relationship between iodized salt related knowledge and storage practices of the respondents**

Iodized salt storage area	knowledge of respondents about change in iodine content if iodized salt is stored close to fire		P value
	Iodine content decreases	Don't know	
Away from fire	13 (10.8%)	91 (75.8%)	.29
Close to fire	0 (0.0%)	16 (13.3%)	

*P < .05 was considered as statistically significant*

#### 4. DISCUSSION

The present study found that the average iodine content of the household salt samples (31.47 ppm) was more than twice the minimum recommended level (15 ppm) for adequately iodized salt [12]. More than 90% of the households were found to use adequately iodized salt which is considerably higher than the household coverage of usage of adequately iodized salt in the city areas (68.9%) as per National Salt Iodization Survey [20]. One important reason for this difference may be that only packaged salt samples were used in this study which can hold the added iodine for a lingering period. Many of the respondents of this study do not have proper knowledge about iodized salt (e.g. health effect, testing and change in iodine content in different storage conditions), but interestingly majority of the respondents (86.7%) have good salt storage practices. A few samples contained no iodine

(Fig. 2) but other samples of the same brands were found to contain a certain level of iodine which implies that improper storage of the salt samples by the householders may be a root cause of iodine escape from those samples. However, the findings of this study cannot be generalized to make a conclusion about the salt iodization status of the country as only household salt samples were used and the sample size was relatively small. To get a better picture, combined surveys starting from salt factories to retail shops to households need to be carried out at the national level. Moreover, it is noteworthy that there may be a significant loss of iodine from added iodized salt during cooking and eating of hot foods due to exposure of iodine to elevated temperature. Hence, national level nutrition education programs may be conducted to encourage people to consume sufficient amounts of iodized salt while eating foods and snacks (if addition of salt is required or preferred) in order to ensure optimal daily iodine intake.

## 5. CONCLUSION

According to the present study, majority of the household packaged salt samples were revealed to be adequately iodized. A great proportion of the respondents was not identified to have the right knowledge about the health benefits of consuming iodized salt and change in iodine content in different salt storage conditions. Nevertheless, most of the respondents were found to have good salt storage practices.

## CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

## ACKNOWLEDGEMENT

We gratefully acknowledge The Ministry of Science and Technology, Bangladesh for granting National Science and Technology (NST) Fellowship to meet the overall financial needs. We would also like to thank the Food Analysis Laboratory of Institute of Nutrition and Food Science, University of Dhaka, Dhaka-1000, Bangladesh for providing laboratory logistics support. We also express our gratitude to the respondents who spontaneously participated in the study.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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