# MEASUREMENT OF IODINE AVAILABILITY AND STABILITY OF SOME IODIZED SALTS IN BANGLADESH

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## Abstract

*Iodine is a key regulator of the body's basic metabolic activity and insufficiency of this micronutrient can lead to goiter as well as physical and mental disorder in both adults and children. To meet iodine deficiency disorders, salt iodization program launched in Bangladesh at 1989. Different industries are parts to produce iodized salts in Bangladesh but their original iodine content and amount of available iodine at consumer level is in question. A total of 18 salt samples were analyzed in well setup laboratory to determine iodine availability of iodized salts commonly found in the market of Bangladesh. Results reveal that almost all of the salt samples given positive results of iodine availability at their indication level (p< 0.5). About 61% of iodized salt samples contain 20-50 ppm iodine whereas, 17% salts contain less than 20 ppm iodine and 22% salts contain more than 50 ppm iodine. Iodine stability was reduced at the average percentage of 8.7, 13.1, 15.6 and 17.6 in open boiling condition whereas in case of close boiling, the percentage was 4.7, 8.5, 10.5 and 12.9 for Confidence, Fresh, Ifad, Molla and Pubali Fine iodized salts respectively at different boiling temperatures (70ºC, 80°C, 90ºC and 100°C). It was also found that iodine was less stable during different storing time period. After keeping in open environment for 1, 2, 3 and 4 weeks iodine stability was reduced consequently and the average reduction percentage was 2.9, 10.9, 15.5 and 16.9 of Confidence, Fresh, Ifad, Molla and Pubali Fine iodized salts respectively.*

***Keywords:*** *Iodized salts, Micronutrient, Iodine availability, Goiter, Iodine stability.*

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## 1. INTRODUCTION

Iodine is a micronutrient and dietary mineral that is required for the biosynthesis of thyroxine ($T_4$) and triiodothyronine ($T_3$) hormones by the thyroid gland [1]. Adolescents and adults need iodine in amounts of 150 mg per day [2]. Iodine is a part of thyroid gland hormones that influence to normal growing and developing, regulate the speed of basic metabolism, create the energy and regulate the body temperature, synthesis of cholesterol, functioning of nerve and muscular tissue etc. [1]. Marine foods – sea fish and shellfish – are pre-eminent as sources of iodine and the oils of those fish are even richer in this element. The edible flesh of sea fish and shellfish may contain from 300-3000 µg 1/kg on the fresh basis, compared with 20-40 µg/kg for fresh water fish [3]. Iodized salt is table salt mixed with a minute amount of various salts of the element iodine. The ingestion of iodide prevents iodine deficiency. Worldwide, iodine deficiency affects about two billion people and is the leading preventable cause of mental retardation [4]. Cretinism is occurred by deficiency of iodine which is marked by mental retardation, goiter, dwarfism, and soft bones. Cretinism may also include spastic muscles, lack of coordination, and deaf-mutism [5]. Iodine deficiency disorders are a major health problem in Bangladesh. A survey by Khorasani SSMA (2005) showed that 41.7% of the population had symptoms of goiter, 0.5% had congenital hypothyroidism and 68.9% had biochemical iodine deficiency [6]. About 69% of Bangladeshi population had a biochemical iodine deficiency (urinary iodine excretion [UIE] < 10 µg/dl) (hilly areas, 84.4%; flood-prone, 67.1%; and plains, 60.4%). Women and children are more affected than men, in terms of broth goiter prevalence and UIE [7]. The Bangladesh Iodine Deficiency Disorder (IDD) survey conducted in 1993 reported that 47.1% of the population had either visible or palpable goiter (visible, 38.3% and palpable, 8.8%), and 0.5% of the children were cretins [8]. According to the report of UNICEF (State of the World's Children, 2001), only 55% of households were using iodized salt in Bangladesh [9]. The coverage of household iodized salt consumption has been increased from 44% (1995) to 84% (2006). Prevalence of biochemical iodine deficiency has been decreased from 70.2% (1993) to 38.6% (2006) [10]. Salt iodine concentration is used as a proxy indicator for iodine status of a population. Iodine is given in food to prevent the consequences of iodine deficiency. It is proved that table salt is, consumed in relatively constant amounts (about 10 g/day), the great carrier of iodine, so it proved to be the most reliable way to take in iodine [11]. World Health Organization (WHO) and ICCIDD recommend that the amount of added iodine should be 20-40 mg/kg of salt [12]. In Bangladesh, the optimum level of fortification is 45-50 ppm at the production level, 20 ppm at the retail shop level and a minimum of 15 ppm at the consumption level [13].

## 2. MATERIALS AND METHODS

### 2.1 Sample Collection and Study Period

Non iodized salts (open salts) and iodized salts of different brands were collected from the local market throughout the country and the research was conducted between April to September, 2013 at the laboratory of the department of Food Technology and Nutritional Science of Mawlana Bhashani Science and Technology University.

### 2.2 Name of the Iodized Salts Collected as Sample

Iodized salt samples were collected from the following brands: Open salt, Shaudagor salt, Bodhua iodized salt, Ruchi iodized salt, Iodized pubali salt, Dolphin brand iodized salt, Muskan salt, Dolphin super salt, Iodized pubali fine salt, Number-1 premium salt, Mala iodized salt, Confidence iodized salt, Molla salt, Confidence iron+ salt, ACI pure salt, Ifad iodized salt, Fresh super premium salt, Molla super salt.

### 2.3 Measurement of Iodine Content

The iodine content of iodated salt samples was measured using an iodometric titration, as described by DeMaeyer EM et al, (1979) [14]. At first l0g of the salt sample was weighted into a 250ml Erlenmeyer flask with a stopper. Then approximately 30ml water was added and swirled to dissolve salt sample. Further additional water was added to make volume up to 50ml. 1ml 2N $H_2SO_4$ was added and after that 5mL 10% KI was added. All the salt samples solution turned yellow (except open salts) which indicated the presence of iodine in the salt samples. Next the salt sample was put in the dark (cupboard or drawer) for 10 minutes. Burette stand was prepared and rinsed and burette was filled with 0.005M $Na_2S_20_3$, and adjusted level to zero. After 10 minutes sample containing flask was removed from drawer, and $Na_2S_20_3$ from the titration burette was added until the solution turns pale yellow. Then approximately 2ml of starch indicator solution was added (the solution should turn dark purple) and continued titrating until the solution becomes pink and finally colorless. Finally the level of thiosulphate in the burette was recorded and converted into parts per million according to the conversion table [14].

### 2.4 Data Analysis

An elaborate and constructive analysis was made to each of the table that represents information about selected eighteen iodized salts. Possible cross table analysis between different variables have also been done by MS Word, MS Excel and SPSS16 programme.

## 3. RESULTS AND DISCUSSIONS

The main focus of the present study was measurement of iodine availability and stability of iodine in iodized salts. In total, 18 salt samples from the market were analyzed. The experiment was done with strict controlled environment in well setup laboratory. The study showed measurement of iodine availability and iodine stability of the iodized salts at different cooking and storing conditions.

### 3.1 Iodine Content of the Different Salt Samples

The figure-1 shows the iodine content of Open salt, Shaudagor salt, Bodhua iodized salt, Ruchi iodized salt, Iodized pubali salt, Dolphin brand iodized salt, Muskan salt, Dolphin super salt, Iodized pubali fine salt, Number-1 premium salt, Mala iodized salt, Confidence iodized salt, Molla salt, Confidence iron+ salt, ACI pure salt, Ifad iodized salt, Fresh super premium salt and Molla super salt was 0 ppm, 6.3 ppm, 15.9 ppm, 24.3 ppm, 25.4 ppm, 26.5 ppm, 26.5 ppm, 29.6 ppm, 33.9 ppm, 37.0 ppm, 37.0 ppm, 44.4 ppm, 46.6 ppm, 49.7 ppm, 51.9 ppm, 54.0 ppm, 54.0 ppm and55.0 ppm respectively. Diagram shows the iodine availability of the 18 salt samples these were analyzed and critically examined in well set-up laboratory. It is clear that majority of the salt samples showed required iodine availability compared with their indication level (20-50 ppm) ($p<o.5$). Open salt is not iodized. Shaudagor and Bodhua iodized salts contained less than 20 ppm iodine, although these two brands indicate 20-50 ppm iodine contents in their package. The table also shows that, 17% salt samples contain less than 20 ppm iodine, 61% salt samples contain 20-50 ppm iodine and 22% salt samples contain more than 50 ppm iodine.

### 3.2 Iodine Stability of Iodized Salts at Different Boiling Temperature

Table-1 shows the reduction rate of iodine stability of iodized salts at different boiling temperatures. After open boiling in vessel at 70ºC, 80°C, 90ºC and 100°C for 20 minutes an average reduction percentage was 8.7, 13.1, 15.6 and 17.6 whereas in case of close vessel boiling the percentage was 4.7, 8.5, 10.5 and 12.9 for Confidence, Fresh, Ifad, Molla and Pubali Fine iodized salts respectively. In common practice, in most of the households all the cooking procedure is done in the open condition. By evidenced iodine is volatile and heat sensitive compound in nature. When heated at different boiling temperatures iodine stability was gradually reduced with high heat.

### 3.3 Iodine Stability of Iodized Salts at Different Time Period in Open Environment

Table-2 shows the reduction rate of iodine stability of iodized salts at different time period in open environment. It was found that iodine was less stable during different storing time period. After keeping in open environment for 1, 2, 3 and 4 weeks iodine stability was reduced and an average reduction percentage was 2.9, 10.9, 15.5 and 16.9 of Confidence, Fresh, Ifad, Molla and Pubali Fine iodized salts respectively. After keeping the salt samples in open environment for first and second weeks Pubali Fine salt showed greater iodine stability

and fresh iodized salt showed less stability. After third and fourth weeks Pubali Fine salt showed the greater iodine stability & confidence iodized salt showed less stability. In common practice of household table salts is generally kept in open jars or open environment for several weeks. By this way iodine was lost from salts because of its volatile nature. In particular, when salts was stored in open environment it will contact directly with air, moisture, sunlight and other vehicles and moisture absorbed by hygroscopic impurities contributes to the rapid loss of iodine.

## CONCLUSIONS

Almost all of the 18 salt samples collected from the market were given positive results of the iodine availability as their indication level. 2 samples out of 18 showed an iodine content less than the permitted level but they are demanding their brand as iodized. Iodine stability was reduced during cooking at different condition and it is greater in open vessel condition than closed vessel condition. Iodine stability is gradually reduced when it was kept in open environment during different time period. The concerned authority should establish approaches to ensure appropriate iodine fortification and regular market monitoring. Mass awareness and social consciousness are the most effective way to avoid iodine reduction during different cooking and storage condition. It is not solely the responsibility of the government but media, public representatives and societies must also be responsive to avoid consuming non-iodized open salt. Finally, it is recommended that emergency initiatives should be taken by the government and its related organizations or authority to develop specific awareness on iodine availability and stability of iodized salts.

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## BIOGRAPHIES:

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## LIST OF FIGURE AND TABLES

**Fig-1:** Iodine content of the different salt samples

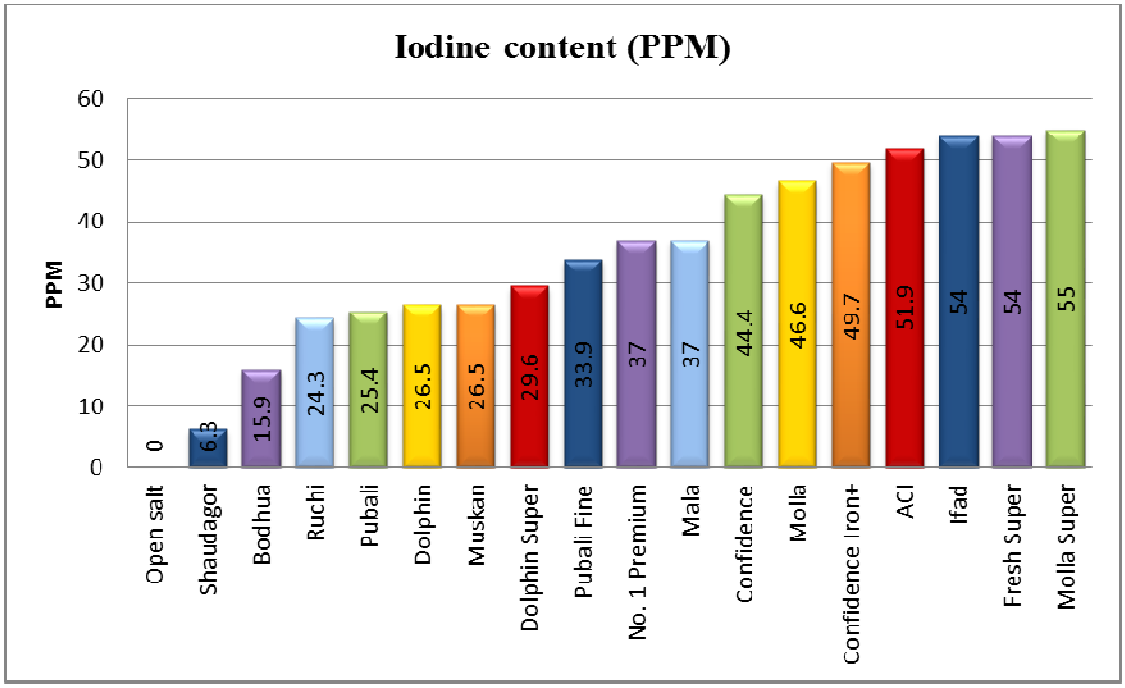


**Table-1:** Comparison table for the reduction rate of iodine stability of iodized salts at different boiling temperature

| Name of the iodized salts | Percentage of iodine stability reduction during different boiling temperature in open vessel & closed vessel | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 70ºC | | 80ºC | | 90ºC | | 100ºC | |
| | Open% | Closed% | Open% | Closed% | Open% | Closed% | Open% | Closed% |
| **Confidence** | 9.5 | 4.7 | 16.7 | 4.7 | 23.7 | 14.2 | 23.7 | 16.7 |
| **Fresh** | 11.9 | 5.9 | 17.7 | 11.9 | 21.7 | 11.9 | 21.7 | 13.7 |
| **Ifad** | 7.9 | 5.9 | 11.9 | 13.7 | 13.7 | 11.9 | 15.7 | 13.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Molla** | 7.6 | 3.8 | 9.6 | 5.6 | 9.6 | 7.7 | 11.5 | 7.6 |
| **Pubali Fine** | 6.5 | 3.2 | 9.4 | 6.5 | 9.4 | 6.6 | 15.6 | 12.9 |
| **Average** | **8.7** | **4.7** | **13.1** | **8.5** | **15.6** | **10.5** | **17.6** | **12.9** |

**Table-2:** Comparison table for the reduction rate of iodine stability of iodized salts at different time period in open environment

| **Name of the iodized salt** | **Percentage of iodine stability reduction during different time interval in open environment** | | | |
|---|---|---|---|---|
| | Week-1% | Week-2% | Week-3% | Week-4% |
| **Confidence** | 2.7 | 16.7 | 23.7 | 23.7% |
| **Fresh** | 6.0 | 17.8 | 21.7 | 21.7% |
| **Ifad** | 4.0 | 15.9 | 15.9 | 17.9% |
| **Molla** | 2.0 | 3.9 | 9.8 | 11.9% |
| **Pubali Fine** | 0.0 | 0.0 | 6.5 | 9.4% |
| **Average** | **2.9** | **10.9** | **15.5** | **16.9** |