Review Article

Vast gap in iodization from production to plate - Hurdles in achieving Universal Salt iodization in India

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Abstract

Iodine deficiency is the most prevalent micronutrient deficiency in India and is one of the most important causes of preventable brain damage. Iodine deficiency disorders affect an individual's ability to work efficiently, which directly impacts the overall development and economic productivity of any nation. Global experiences have shown that salt fortification is the most effective way to control and reduce the burden of IDD in the community. Thirty-six years have passed since the declaration of universal salt iodization (USI) implementation in India by the Central Council of Health in 1983. However, iodine deficiency still remains a public health problem in the whole country.

Keywords: Cooking, iodized salt, iodine storage

Introduction

Iodine is an essential micronutrient that was discovered in 1811 by French scientist Courtois.[1] It is necessary for the synthesis of thyroid hormones, and its principal sources are food or iodide supplements.[2] People with severe IDD are found to have an intelligence quotient (IQ) that is lower by approximately 13.5 points than those with no iodine deficiency.[3] Iodine status differs in men and women, and iodine deficiency has more severe consequences for women as it affects future generations.[4] Iodine deficiency during foetal and infant developmental stages may cause mental retardation, autism, developmental delays, cretinism, goitre, and hypothyroidism in the offspring.[2,5]

Globally, in the last 25 years, the prevalence of IDD has come down from 13.1% to 3.2%. South-Asian regions recorded a comparatively low reduction in the prevalence of IDD. In 2019, it was predicted that because of IDD, a total economic loss of USD12.5 billion would occur.[6] According to the World Bank, low- and middle-income countries should lay extra emphasis on salt iodization for achieving a successful and sustainable outcome.[7]

In an Indian survey conducted in 414 districts of Indian states by the Directorate General of Health Services (DGHS), 337 districts were found to be endemic with more than 5% prevalence of IDDs.[8] In the national family health survey-4 (NFHS) conducted in 2015–16, households consuming iodized salt were 96.5% in urban areas and 91.5% in rural areas.[9] According to a recent survey by Nutrition International in collaboration with AIIMS Delhi (India Iodine Survey 2018–19), only 76.3% of households were consuming adequately iodized salt, which falls short of the NIDDCP goal of 100% consumption of adequately iodized salt (15 ppm) at the household level.[10]

The National Iodine and Salt Intake (NISI) survey conducted in 2014–15 in the south zone of India (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, and Telangana) showed that the coverage of

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adequately iodized salt was only 62%,[11] which was much below the national average. A survey in Bihar by Kumar P *et al.*, found that the total goitre rate (TGR) is more than 5%, and only 79% of households were consuming adequately iodized salt.[12] In another recently done study in Raichur, Karnataka on school children aged 6–12 years, the overall total goitre prevalence was found to be 18.6%, which indicates mild severity of the problem.[13] The recommended level of iodine is not being maintained from the level of production to the level of consumption. This can be gauged from the fact that Rajasthan, although being the second-largest producer of iodized salt in India, is also among the states having the lowest household coverage of iodized salt (65.5%).[10,14] Hence, it is evident that even after all the efforts made by the Government of India in creating awareness among the community on iodine deficiency and its ill effects, we have still not been able to achieve the USI target of >95%. Thus, there is a need to formulate community-based interventions and strong public advocacy to ensure the consumption of adequately iodized salt.

There are various faulty practices at production, retailer, and consumer levels in handling iodized salt, which lead to inadequate iodization of salt in the household. These need to be addressed for creating good information, education, and communication (IEC) materials. Issues at the consumer level need special attention. The various faulty practices are discussed below.

At production level

In India, transportation of iodized salt from the production centres to consuming states is a priority second only to defence.[15] According to the Prevention of Food Adulteration Act (PFA), the iodine content of the salt at the production level should not be less than 30 ppm, while at the consumer level, it should not be less than 15 ppm on dry weight basis. In the year 2006, the Government of India mandated the iodization of salt for direct human and livestock consumption. All salt production in government and big private factories is done in accordance with government guidelines. However, many small and medium level producers manufacture salt but do not follow prescribed standard guidelines. Many of these do not even label the packets correctly.[16]

Studies have shown that many people prefer to buy cheaper and substandard salt[17-20] because of a lack of awareness and cost preferences. Thus, regular monitoring and surveillance of the quality of salt produced by different companies are needed to ensure correct labelling and packaging. The Food Safety and Standards Authority of India (FSSAI) has to ensure proper iodization of salt in India.[21] Low-density polythene (LDPE) bags are best for packaging as these provide a good moisture barrier, but woven high-density polythene (HDPE) bags are preferred for packaging large amounts of salt because of their strength. These are a few key issues at the production level that need to be addressed by the Government of India to achieve USI targets of adequately iodized salt coverage.

At retailer level

Due to lack of awareness, some retailers buy salt in huge stocks and keep selling it in the community over a period of time. It has also been observed that many retailers re-package old salt in new packets with wrong labelling and sell it. In a national survey by Nutrition International in India, results have shown that the two factors that affect salt purchasing are brand (40.9%) and price (41.0%).[10,17,22]

At consumer level

Food and water are the main natural sources of iodine, but soil erosion caused by deforestation, industrialization, landslides in hilly areas, and overgrazing by animals has resulted in decreased iodine content of soil, which has further led to the reduction in the iodine content of plants and animals.[23] In addition to this, the faulty practices at the consumer level unintentionally lead to a further reduction in the iodine content of food. For example, milk is a rich source of iodine; iodine in cow's milk ranges from 20 to 70 μg/litre,[24] but the last few decades has seen a rise in the use of packaged organic and ultra-high temperature (UHT)-treated milk, which has 44% and 27% lower iodine content, respectively, as compared to conventional milk. This increase in the use of lower-iodine-content milk is further exaggerated during the summer season.[25] It has been seen that iodine-related awareness is less among poor people and among those residing in rural areas.[26] Thus, the consumer level iodine losses can be identified at three levels: a) losses due to incorrect purchasing of salt, b) losses due to poor storage of salt, and c) losses due to wrong cooking practices.

Losses due to incorrect purchasing of salt

Salt purchased within 1 month from the date of manufacturing has almost similar iodine content.[27] Iodized salt older than 6 months from the date of packaging has a higher iodine loss.[28] Thus, buying salt in bulk should be avoided. Any salt packet that is more than 6 months past its date of manufacture should not be purchased and after buying, it should be consumed within 1 month.

Losses due to poor storage of salt

As iodine in salt is volatile, proper storage of salt becomes very crucial. Various study findings have suggested that the iodine content of salt can be ensured for longer times by taking small steps at the household level. In a study by Jayshree *et al.*, iodized salt was stored in five types of jars, that is, glass jar, plastic jar, earthen pot, unopened salt pack, and cut open salt pack, and the iodine content was measured at the end of first and third months.[28] It was found that maximum iodine loss occurred in salt stored in glass jar while the least iodine loss occurred in salt stored in cut open pack when seen after 3 months.[27] [Table 1] In another study by Karim *et al.*, the iodine loss was measured at fifth and sixth weeks from the date of storage.[29] It was seen that maximum loss of iodine occurred in salt stored in transparent mayonnaise glass bottle, which was 14.3% and 15.8% at fifth and sixth weeks, respectively. The least iodine loss occurred in the salt stored in yellow plastic cup container, where the loss was 10.2% and 10.4% at fifth and sixth weeks, respectively.[29] Singh *et al*.[30] confirmed in his study that maximum loss of iodine from salt occurred from Masaldan (22.87%), followed by polybag (17.6%), glass jar (10.88%), and plastic jar (9.76%). From this, it can be concluded that salt should be stored-

i) In its original packaging, if possible
ii) In a non-transparent glass jar as it is more effective in conserving iodine.

Another critical factor helpful in preserving iodine content during storage is its distance from the cooking area. A study by Rana *et al*., showed that the distance of salt storage from the cooking area was related to the iodine loss in salt when measured after 60 days from the day of storage.[31] They observed that as distance increases, the iodine retention in the salt becomes better. At a distance of 1–2 feet, the loss of iodine was 19.40%; the loss was 15.94% at 5–6 feet.[31] Thus, salt should be stored as far away from cooking areas as possible. Another study that reiterates this finding was conducted by Mukherjee *et al*.,[32] this study showed that the risk of inadequate iodization of salt was 6.17 (95%, CI: 2.68–14.26) times more where the salt was placed near the oven as compared to where it was placed away from the oven [Table 2].

Losses due to wrong cooking practices

Wrong practices while cooking food further widens this gap of meeting an individual's iodine requirement. Rana *et al*.[31] found that iodine losses during boiling, roasting, deep frying, and microwave cooking of food were 40.23%, 10.57%, 10.40%, and 27.13%, respectively. It is also seen in a study by Patel *et al*.[33] that closed cooking saves the iodine content of the salt. In closed pan cooking, the total amount of Iodine was 42.67 and 36.33 ppm at the beginning and end of a 30-mins cooking period, respectively, while for open pan cooking, the values were 42.67 and 32.07 mm at the beginning and end of a 30-min cooking period, respectively.

Conclusion and Recommendations

Sustaining effort is needed to achieve USI and NIDDCP targets. This can be achieved through upscaling behaviour change communication (BCC) campaign; the role of frontline workers such as ASHA and ANM is vital in this regard. There is a need for health education intervention that is culture-sensitive and especially addresses the knowledge gaps at the consumer level. In India, most of the currently available IEC material on IDD focuses mainly on imparting information on iodine deficiency disorders viz. What are the various IDDs, their consequences, types of iodine-rich foods available, and the importance of consuming iodized salt in food. To date, there is no IEC material regarding the precautions to be taken while buying and storing iodized salt and the appropriate cooking methods to minimize iodine losses. Thus, it is strongly recommended that suitable changes be incorporated in the already-existing IEC material to educate the community on these pertinent issues to bring about the desired changes in the attitude, behaviour, and practice among the community.

ANM and ASHA can be trained and educated regarding the various practices to prevent iodine content of salt, such as checking the manufacturing date of salt at the time of purchasing, discouraging the use of UHT treated milk, and various correct cooking and storage practices to minimize iodine loss.

Table 1: Different methods of salt storage and their effect on iodine content

Study	Materials used for storage of salt	Findings	Conclusion
Jayashree *et al*.[28]	Cut open salt packet, Glass jar, Earthen Pot, and Plastic jar	Iodine content (retained iodine) measured at end of 1st and 3rd month, respectively. Following results obtained: Glass jar- 94.33%. and 69.41% Plastic Jar- 87.06% and 59.64% Earthen pot- 91.15% and 64.30% Salt pack as it is- 98.82% and 91.69% Salt cut open pack- 92.73% and 74.61%	The iodine content in all storage methods decreased over a period of time irrespective of the brand of salt. Highest retention of iodine is in the intact salt package (99.19%) Storing salt in its packet is one of the good options for storing salt at household
Karim *et al*.[29]	Transparent bottle, Yellow plastic cup, Transparent plastic Bag, Tin	Iodine loss of salt measured 5th and 6th week Transparent bottle- 14.3% and 15.8% Yellow plastic cup- 10.2% and 10.4% Transparent plastic cup - 14.5% and 16.3% Tin -14.3% on 5th week, 6th week corroded and discarded	Loss of iodine was seemed to be maximum from transparent bottle and least from yellow plastic cup container
Singh *et al*.[30]	Glass Jar, Plastic jar, Polybag, *Masaldan*	After 3 months duration, iodine loss measured - Glass Jar-10.88% Plastic Jar-9.76% Polybag-17.6% *Masaldan*-22.87%IDD	Minimum iodine loss occurred from plastic jar and glass jar and maximum loss occurred from *Masaldan*

Table 2: Storage distance of salt from cooking area

Study	Distance from cooking area	Loss of iodine after 60 days	Result
Singh *et al*.[30]	1-2 feet 5-6 feet	19.40% 15.94%	Further salt kept away from cooking; lesser iodine loss seen in this study
Mukherjee *et al*.[32]	Near the oven Away from the oven		AOR 6.17 (95% CI: 2.68-14.26)

Further, these trained frontline workers can sensitize the community, especially vulnerable groups such as pregnant and lactating women and adolescents, through Anganwadis, Village Health Sanitation and Nutrition days (VHSNDs), or during their house-to-house survey.

Iodine deficiency and resultant adverse impact on the paediatric population is still a relevant public health concern in many parts of the country. There is a visible disconnect between the iodine salt distribution and the health system, which only focusses on diagnosing and treating the diseases without giving adequate emphasis on iodine preservation in food plate. Thus, physicians at all levels (primary, secondary, and tertiary) can make the most vulnerable groups, such as pregnant women and children, aware of the ill effects of iodine deficiency and the precautions to be taken to prevent it, such as discouraging pregnant and lactating mothers from using UHT milk and advising not to consume salt with the date of manufacture more than 3 months.

Strict implementation of iodine-related legislation by health personnel in their areas and periodic testing of salt at all levels, that is, at the production sites, at the retail outlets, and in the household, from time to time can ensure proper quality and availability of adequate Iodine to the community. Thus, based on the above discussion, the following points can be concluded:

- There is a need for new IEC material on IDD with all new updated information
- Role of physicians, staff nurses, and frontline workers in sensitizing the community will be pivotal at all levels
- Role of legislation always plays a major role in the success of any program.

As IDD causes permanent brain effect, implementing this tailor-made health education and communication strategy will play a decisive role in improving the iodine content of food on the plate and it will also contribute to it.

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Conflicts of interest

There are no conflicts of interest.

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