

Research Article

Monitoring and estimation of iodine content of edible salt in urban areas of Meerut district, after four decades of Universal Salt Iodization

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Abstract

Objective: It is estimated that 200 million people in India are exposed to the risk of iodine deficiency disorders (IDD). To protect future generations, Universal Salt Iodization (USI) is the mainstay of the intervention. So, we carried out the study to estimate salt iodine content at the house hold and retail level in urban areas of Meerut district of Uttar Pradesh.

Method: A total no of 64 (48 from house hold and 16 from retail) samples of salt were estimated by iodometric titration method for the iodine content. Legal requirement for iodine level in India ranges from 30 parts per million (ppm) at retail level and 15ppm at consumer level.

Results: We found that at retail level the range of concentrations of iodine in salt samples from Shiv Kunj, Krishna Vihar, Yadav colony, Ratan nagar. At retail level the range of concentration of iodine in salt sample was 26.5 to 33.6 ppm, 28.8 to 34.6 ppm, 31.3 to 36.8 ppm, 29.6 to 32.6 ppm respectively, while at house hold level were 12.7 to 34.6 ppm, 15.1 to 33.9 ppm, 15.8 to 38.4 ppm, 15.2 to 29.6 ppm respectively.

Conclusion: Our study reveals a positive new momentum that reflects changes in India's salt industry. These changes include better production, better refining and iodization practices, improvement in salt quality, improvement to packaging, effective monitoring to iodine levels from production to consumption and better consumer awareness in the urban areas.

Key words - Iodine Deficiency Disorder (IDD), Iodometric titration, Universal Salt, Iodization (USI), Urinary Iodine (UI)

1. Introduction

IODINE (atomic mass unit 126.9) is an essential component of the hormones produced by the thyroid gland¹. It is an essential micronutrient in human growth² and an essential component of thyroid hormones that is triiodothyronne (T3) and tetra iodothyronine (T4)³. The WHO recommendation for adequate daily iodine intake of 150 micro gram per day for man and non pregnant, non lactating women, 250 microgram per day for pregnant and lactating women and a daily intake of iodine of 90 micro gram for preschool children (0-59 months) and 120 micro grams for school children (6-12 yrs)⁴. When these physiological requirements are not met in a given population, a series of functional and developmental abnormalities occur. They are grouped under the general heading of "iodine deficiency disorders" or IDD⁵. The term IDD was coined and became widely recognized as a spectrum of related disorders potentially affecting 1.5 billion individuals. Programmes against IDD have clear political appeal because its human, economic and social consequences could be averted by a low-cost intervention, USI. Since 1990, elimination of IDD has been an integral part of many national nutrition strategies⁶.

Salt iodization remains the most cost effective way of delivering iodine and of improving cognition in iodine-deficient populations⁷. Worldwide the annual cost of salt iodization is estimated at US\$ 0.02-0.05 per child covered; the costs per child death averted are US\$ 1000 and per disability-adjusted life year (DALY) gained are US\$34-36⁸. Looked at in another way, before widespread salt iodization, the annual potential losses attributable to iodine deficiency in the developing world have been estimated to be US\$35.7 billion as compared with an estimated US\$0.5 billion annual cost for salt iodization, i.e. a 70:1 benefit cost ratio⁹.

Globally, since 1990 the number of households using iodized salt has risen from less than 20% to more than 70%, dramatically reducing iodine deficiency¹⁰. This effect has been spurred by a coalition of international organizations, including the ICCIDD, WHO, the Micronutrient Initiative and UNICEF, working closely with national IDD control committees and the salt industry; this informal partnership was established after the world summit for children in 1990. It has been funded by Kiwanis International, the Gates Foundation and country aid programs. Currently, WHO estimates that nearly 2 billion individuals have an insufficient iodine intake, including one third of all school age children¹¹. Almost one third of the population lives in areas of iodine deficiency¹².

In India, despite intensive efforts to promote iodized salt, only about half of the population is covered, and coverage is especially poor in low socioeconomic populations^{13, 14}.

It is estimated that 200 million people are at risk of IDD in India¹⁵ and more than 71 million suffer from goitre and other forms of IDD¹⁶. The main strategy for control of IDD –salt iodization – was adopted by the world health assembly in 1993 and established as a UN General Assembly’s Special Session on Children goal in 2002. Salt has been chosen as a vehicle because of its wide spread consumption and the extremely low cost of iodization¹⁷. The concept of adding iodine to salt began with the French chemist Boussingault, who in the beginning of the 19th century stated “Je ne doute nullement qu’en repandant l’usage des sels faiblement iodiferes, le goitre ne disparaisse complement...” (I have no doubt that addressing the use of low iodifères salt, goiter disappears completely)¹⁸.

Since then, salt iodization has become progressively the main approach to control iodine deficiency throughout the world, as it has been proven as effective measure through rigorous monitoring and evaluation.

Worldwide, salt iodization is an ongoing effort springing from the recognition in the 20th century that inexpensive spraying of commercial salt with iodide can reverse IDD¹⁹. USI was made compulsory in India in 1998, although it was revoked in 2000 and again reinstated in 2005²⁰. Iodization of salt is an effective and sustainable public health strategy to prevent and control iodine deficiency and has been ongoing in several countries for over 60 years. Iodization of salt is currently undertaken following the universal salt-iodization initiative²¹⁻²³. In India the salt should contain at least 15 ppm iodine to provide the normal requirements of 150 microgram per day to the population i.e. at consumer level. It is usually necessary to iodize the salt at higher levels (30 ppm or more) to compensate for the loss of iodine during storage and distribution i.e. at retailer and production level²⁴. So we conducted a study to find out the level of iodine in edible salt at consumer i.e. household level and at retailer level, as no such study has been done in this area since last 13 yrs.

2. Material and method

The present study was done in Meerut a district of Uttar Pradesh to assess the progress being made in IDD elimination through USI. The study was approved by the ethical committee of institution and was conducted by the department of biochemistry in collaboration with community medicine of Subharti Medical College, Meerut. Salt samples were collected from areas coming under the Urban Health and Training Centres (UHTC) of the institute i.e. Shiv Kunj, Krishna Vihar, Yadav Colony, Ratan Nagar of Meerut district. In each urban area 12 household were chosen systematically using the chief’s house as the centre point. A structured questionnaire was generated which gave information on type of salt whether coarse or fine, package available, brand name, whether it was labelled iodized or not, method of salt storage. Similarly four shops were chosen randomly from each of the urban area for estimation of iodine in salt. A structured questionnaire was also generated which gave information on brand name of salts, their prices, whether they were labelled iodized or not and also how long it was stored in the shop. Different companies have their salt packed in different quantities. Packets of different brand/companies (Tata, Captain Cook, i-shakti, Aashirvad, Annapurna) were collected and stored for analysis for retail content of iodine. In case of household level about 10 grams (2 teaspoonfuls) of salt from each house was collected and kept in a closed plastic bag in dark room till analysis was done.

An iodometric titration method²⁵ was used for analysing the iodine content of salt samples. This was done in laboratory of the department of biochemistry. A total of 10g of salt was dissolved in distilled water and made up to 50 ml solution. 1ml of 2N sulphuric acid and 5ml 10% potassium iodide was added. The liberated iodine was titrated with sodium thiosulfate solution using 1ml of 1% starch indicator near the end of titration. The level of thiosulfate in the burette was recorded and converted to ppm using a conversion table recommended by Mannar and Dunn²⁶. Preparations of 0.005 M sodium thiosulfate (Na₂SO₃), 2N sulphuric acid (H₂SO₄), 10% potassium iodide (KI) and soluble chemical starch were performed according to the methods of Mannar and Dunn²⁶.

2.1. Statistical method

Statistical analysis was done using Microsoft Excel 2007 and scientific calculator. The results were expressed as mean ± standard deviation (SD), median and standard error of mean (SEM).

3. Result

The Range of iodine content of various salt samples of UHTC (Urban Health & Training centre) Multan nagar is as follows. At retail level the range of concentration of iodine in salt samples was 26.5 to 33.6 ppm, for shiv kunj, 28.8 to 34.6 ppm for krishna vihar, 31.3 to 36.8 ppm for yadav colony and 29.6 to 32.6 ppm for ratan nagar respectively and at house hold level it was 12.7 to 34.6 ppm for shiv kunj, 15.1 to 33.9 ppm for krishna vihar, 15.8 to 38.4 ppm for yadav colony and 15.2 to 29.6 ppm for ratan nagar respectively (Table).

Table - Iodine content of edible salt (Mean ± SD) samples of UHTC (Urban Health& Training centre)

UHTC	Category	No of Samples	Mean ±SD	Iodine content range (ppm)	Median	*SEM
Shiv Kunj	Household	12	21.5±8.2	12.7-34.6	19.2	2.3
	Retail	4	30.4±3.3	26.5-33.6	30.8	1.6
Krishna Vihar	Household	12	20.8±6.1	15.1-33.9	18.5	1.7
	Retail	4	31.3±2.6	28.8-34.6	31.0	1.3
Yadav Colony	Household	12	20.7±6.8	15.8-38.4	18.4	1.9
	Retail	4	34.5±2.5	31.3-36.8	35.0	1.2
Ratan Nagar	Household	12	19.5±4.3	15.2-29.6	18.4	1.2
	Retail	4	31.2±1.5	29.6-32.6	31.3	0.7

*SEM (standard error of mean)

SD (Standard Deviation)

4. Discussion

In 1999, it was estimated that of the 130 countries in the world having had a past iodine deficiency problem of public health significance, 68% of households had access to iodized salt as compared to five to ten per cent in 1990^{27,28}. A study reported that iodine deficiencies are major public health problems in India; only 51% of Indian households are using adequately iodized salt²⁹. A study in Rajasthan reveals that salt iodine content was ≥ 15mg/kg in 41.9% of the households and 23% used non iodized salt³⁰. Other reports stated that the consumption of iodized salt varied in respect of socioeconomic condition³¹. Kapil et al³² in their study found that 53% of the school going children of Meerut were consuming salt with an iodine content of less than 15 ppm. Also a recent study in Orissa reported the use of 45% and 47.7% of adequately-iodized salts at the households and retail outlets respectively³³. In our study of edible salt analysis in the urban areas of Meerut district of U.P. salt samples that are collected from UHTC Multannagar and the adjoining colonies coming under the health centre i.e Shiv Kunj, Krishna Vihar, Yadav Colony, Ratan Nagar, we have found that around 4% of the household samples from the urban area were having iodine content less than 15 ppm below the recommended level for the consumers by WHO/UNICEF/ICCIDD.

5. Conclusion

Iodine deficiency is a serious problem. The need to eliminate iodine deficiency is very clear based on the widespread damaging effects and the large number of people affected. Salt iodization is by far the most important population based intervention for IDD control. Efforts toward establishing and sustaining national salt iodization programmes have accelerated over recent years. Effective partnerships have been forged between relevant UN agencies, national and international NGOs, and the salt industry, increased awareness amongst consumer regarding iodization of salt and its demand. Salt iodization is not an end in itself but only a means to achieve optimal iodine nutrition. It is why besides monitoring iodized salt quality, iodine status also needs to be monitored. Our study reveals a positive new momentum that reflects changes in India's salt industry. These changes include better production, effective monitoring to iodine levels from production to consumption and better consumer awareness in the urban areas. As UI is a good marker of the recent dietary iodine intake, it is, therefore, the index of choice for evaluating correction of iodine deficiency so we further like to elaborate our study to UI status of the studying population.

References

- Zimmermann. Iodine Deficiency. *Endocrine Reviews*. 2009; 30(4):376–408
- Mary G, Karachalacherevu SN, Natesan B. Spectro-photometric Determination of Iodine Species in Table Salt, Pharmaceutical Preparations and Sea Water. *Eurasian J Anal Chem*.2011; 6(2): 129-139
- Ahmad N, Panthari M, Gupta A, Chandra P. Estimation of iodine content of edible salt in rural areas of Meerut district, Uttar Pradesh. *Int J Health Sci Res*.2012;2(9):25-29.
- World Health Organization. Assessment of iodine deficiency disorders and monitoring their elimination. 3rd ed. Geneva: WHO Press; 2007.
- Hetzel BS. Iodine deficiency disorders (IDD) and their eradication. *Lancet*.1983;2:1126-1129.
- Zimmermann MB, Jooste PL, Pandav CS. The iodine deficiency disorders. *Lancet*. 2008; 372:1251–1262.
- Engle PL, Black MM et al. International Child Development Steering Group. Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet*. 2007; 369: 229–242.
- Caulfield LE, Richard SA, Rivera JA, Musgrove P, Black RE. Stunting, wasting, and micronutrient deficiency disorders. In: Dean T, Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P. Disease control priorities in developing countries. 2nd ed. New York: Oxford University Press; 2006. Pp551–568.
- Horton S. The economics of food fortification. *J Nutr*. 2006; 136:1068–1071.
- Delange F, Burgi H, Chen ZP, Dunn JT. World status of monitoring iodine deficiency disorders control programs. *Thyroid*. 2002; 12:915–924.
- de Benoist B, McLean E, Andersson M, Rogers L. Iodine deficiency in 2007: global progress since 2003. *Food Nutr Bull*. 2008; 29:195–202.
- Jha S, Ahmad N. Prevalence of thyroid dysfunction in the patients visiting tertiary health care hospital, Faridabad; Haryana. *Int Journal of Scientific Research*.2013;2(10):1-2
- Ministry of Health and Family Welfare, Government of India. India. National Family Health Survey (NFHS-3) 2005–06. Mumbai: International Institute for Population Sciences;2007
- Sankar R, Pandav CS. Ban on sale of non-iodized salt for human consumption: A step in the right direction. *Natl Med J India*. 2005;18:169–171.
- Ahmad N, Panthari M, Gupta A, Chandra P, Nafees S. Prevalence of hypothyroidism among patients of Meerut, Uttar Pradesh: A hospital based study. *Int J Med Sci Public Health* 2013; 2:539-542.
- Mathew J, Kaushik S, Suvarabrat D. Reaching the rural poor in India with iodized salt: the Micronutrient Initiative's Iodized Salt Coverage Study 2010. *IDD NEWSLETTER*. 2011; 39: 6.
- Maria A, DeBenoist B, Darnton-Hill I. Iodine Deficiency in Europe: A continuing public health problem. Geneva: Unicef-World Health Organization; 2007. pp vii
- Boussingault JB. Recherche sur la cause qui produit le goître dans la cordillère de la Nouvelle Grenade [Research on the cause of goitre in the cordillera of Nueva Granada]. *Annales de Chimie et de Physique*. 1831; 48:41–69.
- Christina Y, Elizabeth NP. Iodine and Pregnancy. *J Thyroid Res*. 2011 doi 10.4601/2011/934104.
- Ministry of Health and Family Welfare, Government of India. Withdrawal of restriction on sale of common salt for direct human consumption. New Delhi: Press Information Bureau, 2000.
- Mannar MG. Control of iodine deficiency disorders by iodization of salt: strategy for developing countries. In: Hetzel BS, Dunn JT, Stanbury JB. The prevention and control of iodine deficiency disorders. *Amsterdam: Elsevier*; 1987: 111–25.
- Zhao J, van der Haar F. Progress in salt iodization and improved iodine nutrition in China, 1995–99. *Food Nutr Bull*. 2004; 25:337–43.
- Lamberg BA. Effectiveness of iodized salt in various part of the world. In: Hall R, Kobberling J. Thyroid disorders associated with iodine deficiency and excess. New York, NY: Raven Press; 1985.Vol. 22. pp. 81–94.
- Umesh K, Dwivedi SN et al. Validation of spot testing kit in the assessment of iodine content of salt: A Multi-Centric Study. *Indian Pediatrics* 2000; 37:182-18.
- William S. Official methods for analysis-association of official analytical chemists.;15th edi. Virginia: AOAC; 1984.pp23-25.
- Mannar MG, Dunn JT. Salt iodization for the elimination of iodine deficiency disorders. The Netherlands: International Council for Control of Iodine Deficiency Disorders; 1995. pp126.
- WHO, UNICEF, ICCIDD. Progress towards the elimination of iodine deficiency disorders (IDD). Geneva, World Health Organization, 1999 (WHO/NHD/99.4)
- Delange F et al. Iodine deficiency in the world: Where do we stand at the turn of the century? *Thyroid*. 2001; 11:437–447.
- Maria A, Thankachan P, Muthayya S. Dual fortification of salt with iodine and iron: a randomized, doubleblind, controlled trial of micronized ferric pyrophosphate and encapsulated ferrous fumarate in southern India. *Am J Clin Nutr*. 2008;88:1378–87
- Ategbo EA, Sankar R, Schultink W, van der Haar F, Pandav CS. An assessment of progress toward universal salt iodization in Rajasthan, India, using iodine nutrition indicators in school-aged children and pregnant women from the same households. *Asia Pac J Clin Nutr*. 2008;17(1):56-62
- Jooste PL, Marks AS, Van Erkom SC. Factors influencing the availability of iodised salts in South Africa. *S Afr J Food Sci Nutr*. 1995;7:49-52
- Kapil U, Tandon M. et al. Assesment of iodine deficiency disorders in Meerut district, Uttar Pradesh. *Asia Pacific Journal of Clinical Nutrition*. 2000; 9(2):99-101
- Moorthy D, Patro BK, Das BC, Sankar R, Karmakar MG, Pandav CS. Tracking progress towards sustainable elimination of iodine deficiency disorders in Orissa. *Indian J Public Health*. 2007; 51:211-5.