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Benefits and Safety of Dietary Iodine Intake in India

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Magnitude of IDD in India: In India, Iodine Deficiency Disorders (IDD) are present throughout the country. Out of 275 districts surveyed by Government of India institutions, Indian Council of Medical Research and Central Goiter Survey Teams in different States and Union Territories, 235 have been found to be endemic for iodine deficiency disorders (Tiwari *et al*., 1998; I.C.M.R., 1989).

Deficiency of iodine, which is among the body's essential micro nutrients, is both easy and inexpensive to prevent. Iodine is an essential element for normal growth and development in animals and humans. It is required for synthesis of the thyroid hormones i.e., thyroxine (T_4) and tri-iodothyronine (T_3). Thyroid hormones bring about a wide variety of vital physiological processes such as early growth and development of the brain and body in man. Scientific studies in India and elsewhere have shown that nutritional iodine deficiency causes deficiency of thyroid hormones during foetal life and childhood. A normal healthy thyroid gland of an adult human contains 8-12 mg iodine. This can be reduced to as low as 1 mg or less in iodine endemic areas (Ranganathan and Reddy, 1995).

Iodine deficiency not only causes goiter; it can also result in impaired brain development in the fetus and infant and retarded physical and psychomotor development in the child. It also affects reproductive functions and impairs children's learning ability. The cumulative impact of nutritional iodine deficiency results in compromised socio-economic development in the affected communities. Iodine deficiency is the most common cause of preventable mental retardation in the world today (Kochupillai *et al*., 1986).

Use of Iodised Salt in Prevention of IDD: In the last 50 years, many countries in North America, Asia, Europe, and Oceania have successfully eliminated IDD, or made substantial progress in their control, largely as a result of salt iodization with potassium iodide or potassium iodate and through dietary diversification. For example, in Switzerland, where salt iodization began in 1922, cretinism has been eliminated and goiter has disappeared, while there has been negligible evidence of any adverse effects from iodine intake (Sooch *et al*., 1965; 1973; WHO/UNICEF/ICCIDD, 1996; WHO, 1994).

In India, keeping in view the magnitude of the problem and technical, administrative, financial, and operational feasibility on the recommendations of the Central Council of Health, Government of India in 1984, took a policy decision for USI i.e. all edible salt in the country would be fortified with iodine (Tiwari *et al*., 1998).

Substantial progress has been made in the country in the production of Iodised salt from 3 Lakh MT in 1983 to nearly 40 Lakh MT in 1997. Similarly, recent IDD surveys conducted by the various institutions have revealed that more than 70% of population is consuming Iodised salt (Sundaresan, 1998). Concurrently, the total goiter prevalence and incidence of neonatal hypothyroidism have also reduced (Kochupillai, 1992). Further, estimation of urinary iodine excretion levels amongst population in different states indicate adequate iodine intake (Kochupillai, 1992; Kapil, 1998; Sohal *et al*., 1998; Kapil and Sharma, 1997). All these findings have been further substantiated by reports on iodine content of salt samples analyzed and received from different states through Monitoring Information System (MIS) of Salt Department and increase in production and supply of Iodised Salt. These findings indicate successful implementation of USI programme in India (Sundaresan, 1998). Recently, the scientific journal "Nature Medicine" has commended the Indian salt iodization programme as one of the most successful preventive public health programme amongst the developing countries (Jayaraman, 1993).

Recommended Dietary Allowances of Iodine: Iodine requirements have been calculated based on (a) average daily loss of iodine in the urine, which is 100-200 mcg/day and (b) balance studies to attain a positive balance, which is 44-162 mcg/day (Ranganathan and Reddy, 1995). Based on scientific studies of iodine balance over a 24-hour period, a safe daily intake of iodine has been estimated to be between a minimum of 50 mcg and a maximum of 1000 mcg (FAO/WHO, 1996; WHO, 1994). A generally accepted desirable adult intake is 100-300 mcg/day. At all intake levels of iodine, a proportionate amount of iodine is excreted in the urine, which is the biochemical basis for assessing iodine status (Sundaresan, 1998; Kochupillai, 1992).

Iodine Toxicity: Iodine has relatively wide margin of safety. Acute and chronic toxicity studies with sodium iodate have been carried out. Results of these long-term experiments of administration to man and to animal of doses comparable to those, which are used in prophylaxis, have failed to produce toxic signs (Kapil, 1998). On the basis of toxicological studies, it has been confirmed that potassium iodate is very safe at the level used in salt iodization (Sohal *et al*., 1998). This has

been confirmed on the basis of worldwide experience of salt iodization programme.

Iodine Intake in USA and Canada: In the United States of America, potassium iodate is used as dough conditioner in bread making. Under Food and Drug Administration (FDA) Regulation No. 17, potassium iodate or potassium bromate, calcium iodate and/or calcium peroxide (Kapil, 1997) are used in bakery products at a maximal concentration of 0.0075%, that is, 75 parts per million by weight of flour alone. The FDA regulations (FDA : 121.101) also permit the addition of potassium iodide to table salt for fortification up to a maximum concentration of 0.01%. As both bakery products and table salt are meant for human consumption, and the maximum permissible limits are 75 parts per million of potassium iodate and 100 parts per million of potassium iodide, it can be concluded that within these specified limits of the FDA, the salts are safe for human consumption (Kapil, 1997).

In 1970, the Food and Nutrition Board of the National Academy of Sciences estimated that a daily intake of 1000 mcg of iodine is safe (Jayaraman, 1993). In 1980, American Medical Association noted that no adverse physiologic reactions were observed with iodine intake up to 1000 mcg per day in healthy adults (FAO/WHO, 1996).

Current estimates of daily iodine intakes in Canada and the USA are substantially above physiological need and are in the range of 460 mcg/day among 9-16 year old children, to greater than 1 mg/day among as many as 10-20% of adults (Barsona, 1981). With a level of iodization that provides these populations approximately 250 mcg/day of iodine from salt, it is thus apparent that much of the intake comes from non-salt sources (Ranganathan and Reddy, 1995).

Iodine Intake in Japan: Average daily intake of iodine in Japan has been reported to be 3000 micrograms, which is 20 times more than the RDA value of 150 mcg in India. Studies carried out in normal Japanese population have shown that they are biochemically and clinically eumetabolic in spite of the consumption of large amounts of iodine. The values for their thyroid hormone are not different from those in non-endemic areas of other countries indicating their adaptation to excess iodine intake (Barsona, 1981; Nagataki, 1984). Existence of this type of adaptation has also been confirmed by animal experiments. There is little indication that iodine in the amounts noted influences the prevalence of any of the thyroid diseases (FAO/WHO, 1996).

Normal Population and Iodised Salt: The average daily salt intake in India is 10 g per day. Consumption levels are within the 5-15 g/day range for children and adults. As per Government of India recommendations, the level of salt iodization (quantity of iodine added to salt) should provide a minimum of 150 mcg of iodine per day at the consumption level (Pandav *et al*., 1984). This recommendation accounts for the usual climatic factors like heat and humidity, which can affect retention of iodine in the salt. The use of potassium iodate has been preferred in India since it is more stable than potassium iodide under our tropical climatic conditions. Moreover because iodate, on ingestion, is very rapidly reduced to iodide and hence its use in Iodised salt is equivalent to use of potassium iodide.

From the average daily intake of 10 g iodine fortified salt, the estimated availability of iodine would be 150 mcg, of which about 30% is lost during cooking. The remaining 105 mcg is ingested and from this about 70% is absorbed by the body. This means approximately only 73.5 mcg is absorbed per day from iodine-fortified salt. This quantity when added to the iodine daily consumed through food will be broadly comparable to the daily physiological need of the body (Ranganathan and Reddy, 1995). Indeed urinary iodine excretion studies in the post iodization phase show that all over the country, the level achieved following salt iodization is not more than 300 mcg per day. Thus, the level of salt iodization is totally safe in our country.

Adverse Reactions to Iodised Salt Including Risk of Iodine Induced Hyperthyroidism: Since iodine, when ingested in large amounts, is easily excreted in the urine, iodine intake even at very high levels (milligram amounts) can be safe. It is documented scientifically that through adaptive mechanisms, normal people exposed to excess iodine remain euthyroid and free of goiter.

It is not correct to attribute skin reactions such as rashes and acne to iodized salt. Physiological levels of iodine intake do not cause “Iodism”. For example, among 20,000 children in the USA suffering from allergy during the period 1935-1974, not a single case was reported of allergic hypersensitivity to iodine in food. Following a publication, in Annals of Allergy, of a request for notification of allergy to iodine, not a single report was recorded between 1974 and 1980 (Matovinovic, 1980). However, high intakes of dietary iodine may induce hypothyroidism in autoimmune thyroid diseases and may inhibit the effects of thionamide drugs (WHO, 1996). Iodine-induced hyperthyroidism is an adverse effect, which may occur primarily in older people when severely iodine deficient populations increase their iodine intake, even when the total amount is within the usually accepted range of 100-200 mcg/day. Epidemiologically iodine-induced hyperthyroidism represents a transient increase in the incidence of hyperthyroidism, which disappears in due course with the correction of iodine deficiency (WHO/UNICEF/ICCIDD, 1996).

Iodine induced hyperthyroidism occurs in some people who have pre-existing autonomous nodular goiter. It appears likely that some patients with latent Graves’s disease are also at risk. The number of people at risk of iodine-induced hyperthyroidism is directly proportional to the number of subjects with nodular goiter. The occurrence of iodine-induced hyperthyroidism is probably related to the relative increase and rapidity of

increase of iodine intake, which occurs when Iodised salt is introduced in populations that have been severely iodine deficient. There is no level of iodine in salt that offers complete protection against some increase in the incidence of hyperthyroidism in a previously iodine-deficient population. From a public health point of view, the benefits of correcting iodine deficiency through USI greatly outweigh the risk of iodine-induced hyperthyroidism (WHO/UNICEF/ICCIDD, 1996). A comparative account of various levels of iodine intake to the functional status of the body as a dose response curve has documented that a daily intake in the range of 150-300 mcg is absolutely safe (Shivakumar *et al*., 1996).

Conclusion: Daily iodine intake of up to 1 mg i.e. 1000 mcg, appear to be entirely safe. Iodization of salt at a level that assures an intake of 150-300 mcg/day keeps iodine intakes well within daily physiological needs for all populations, irrespective of their iodine status. In India, daily consumption of 10 g of salt containing 15 parts per million of iodine would add a maximum of only 150 mcg of iodine. Thus, the likelihood of exceeding an iodine intake of 1 mg/day from iodized salt is remote.

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