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Original Article

Iodine content in edible salt and drinking water in sub-Himalayan tarai region of Eastern Uttar Pradesh, India

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A R T I C L E I N F O

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A B S T R A C T

Aims & Objectives : To evaluate distribution of iodine through edible salts and bioavailability of iodine in sub-Himalayan Tarai region of Eastern Uttar Pradesh. Methods & Design: The study has been conducted in all 14 Community development (CD) Blocks in the studied region . To measure the iodine content of salt and water samples ,a total of 490 edible salt samples and 112 drinking water samples were collected from 14 study areas taking 35 Salt sample and 8 water samples from each CD Block respectively. Results: The present study shows that 79.2% of salt samples had iodine level below 15ppm and 2.2% had no iodine,11.8% had iodine level above 15ppm but below 30ppm, whereas the mean iodine content in drinking water samples of the studied sub-Himalayan tarai region of Eastern Uttar Pradesh was 8.99±2.97 µg/l. Conclusion : Only 18.5% of households of the sub-Himalayan tarai region consume salts with recommended iodine level (>15ppm) and the rest 81.5% households consume salt with inadequate iodine level (<15ppm).Thus intake of iodine through edible salt is insufficient. The result of iodine content in drinking water shows that the studied region is moderately iodine deficient.

1. Introduction

The daily requirement of iodine is 150 µg per person for adults [1]. The level of iodination of salt has to be sufficient to cover this requirement together with losses from the point of production to the point of consumption including the expected shelf life. It also has to take into account the per capita salt consumption in an area. The level of salt iodization should provide a physiological intake of 100-150 µg/day, which should bring the median urinary iodine excretion (UIE) level within a range of 100-200 µg/l [2]. Keeping in view of the mean daily intake of common salt of 10g by the population in different parts of the country, it is mandatory under National Iodine Deficiency Disorder Control Programme (NIDDCP) that a minimum of 15 ppm of iodine should be present in per gram of edible salt at the beneficiary level to ensure at least 150 µg of dietary intake of iodine per day through the salt. As there is considerable loss of iodine during transportation and storage, hence under NIDDCP it is mandatory that a minimum of 30 ppm should be present in edible salt at the manufacturers' level.

Iodine content in the plant foods/vegetables grown and consumed by the people of a particular geographical region is dependent on iodine content of the soil that can be assessed by measuring iodine content in drinking water [3]. Therefore the iodine content in water has been considered as bioavailability of iodine [4]. During post salt iodization phase reports on iodine content in edible salt and the bioavailability of iodine in goiter endemic sub-Himalayan Tarai region of Eastern Uttar Pradesh are not available. Therefore, in order to know the dietary intake and environmental source of iodine, iodine content in edible salt and drinking water was measured.

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2. Materials and Methods

Selection of study areas

The Siddharthnagar district of Eastern Uttar Pradesh comprises of 4 tahsils, namely Itwa, naugarh, Dumariyaganj and Bansi. There are 14 Community Development Blocks (CD Blocks) in the district of which 10 are rural and 4 are urban CD Blocks. The rural blocks are Mithwal, Khesraha, Uska, Jogia, Loton, Khuniyaon, Itwa, Birdpur, Bhanwapur, Domriaganj and the urban blocks are Barhni, Sourathgarh, Naugarh and Bansi respectively. The present study was conducted in 14 representative localities taking one from each of the CD Blocks covering the entire Siddharthnagar district by purposive sampling method [5].

Collection of salt samples

Iodine content of at least 35 salt samples collected at random from a locality represent valid estimate about the iodine content of the edible salt of the locality [6]. Therefore to measure iodine content of edible salt samples available in the in each selected study area of the respective block 35 marked airtight plastic containers were distributed at random to the school students and they were asked to bring about 20 g of salt from their households the next day. A total of 490 edible salt samples werecollected from 14 study areas and samples were kept at room temperature in the laboratory

Collection of water samples

There are 14 CD Blocks in the studied region. In each selected study area of the respective block 8 drinking water samples of about 100 ml each were collected at random from the available sources i.e. shallow tube wells (100-150ft depth).To cover the entire region, a total of 112 (14x8) drinking water samples were collected. Water samples were collected in sterile wide mouth screw capped plastic bottles. The samples were brought to the laboratory and kept at 4°C till analyzed.

Measurement of iodine in edible salt samples

The iodine content of each sample was measured within a week by iodometric titration method [7].

Measurement of iodine in water

The iodine content of drinking water was determined by the method of Karmarkar *et al.* [8].

Statistical methods

Mean, standard deviation and values have been used to describe the data as appropriate. Correlation coefficient (r) have been calculated to explain the interrelation between excretion pattern of urinary iodine and iodine content in water in different study areas of the region. Two-tail chi square test was applied to compare nature/texture of salt samples and its iodization. P-values of less than 0.05 were considered statistically significant.

3. Results

Iodine content in edible salt

Out of 490 collected edible salt samples 63% (309) was crystal and 37% (181) was powder salt. The household consumption pattern of edible salt by the population of the region has been shown in fig 1. All the salt samples were analyzed for iodine and it was found that 79.2% of salt samples had iodine level below 15ppm and 2.2% had no iodine,11.8% had iodine level above 15ppm but below 30ppm and only 6.7% salt samples had iodine level equal or more than 30ppm (Table 2.). Fig 2. shows the iodine content in two (crystal and powder) different category of salt . In 42.5% of the powdered salt and 4.5% of the crystal salt had the adequate (>15ppm) iodine level (Table1.). Iodine content in powdered salt was significantly higher than iodine in crystal salt ($P<0.001$).

Iodine content of drinking water

The mean iodine content in drinking water samples of the studied sub-Himalayan tarai region of Eastern Uttar Pradesh was 8.99±2.97 μg/l. Iodine content in drinking water was found highest in an urban area namely Sourathgarh (13.25μg/l) whereas in two rural area namely Itwa and Mithwal it was very low (3.42 μg/l and 3.57 μg/l respectively) (Table 3.). Area wise interrrelation in between mean urinary iodine and mean iodine content in water was depicted in Fig. 3. A significant positive correlation ($r=0.45$, $P<0.001$) found between mean urinary iodine concentration and mean iodine content in drinking water.

Table 1. Iodine content in different category of edible salts from Siddharthnagar in sub-Himalayan tarai region of Eastern Uttar Pradesh

Texture of salts	Iodine content in salt (ppm) <15	>15
Powder (n=181)	104(57.5)	77(42.5)
Crystal (n=309)	295(95.5)	14(4.5)
Total(n=490)	**399(81.5)**	**91(18.5)**

Chi square =109.05, d.f =1, P< 0.001,Figures in parentheses indicate percentages

4. Discussion

It has been recommended by WHO/UNICEF/ICCIDD that 90% of the household should get iodized salt at the recommended level of 15ppm [1]. However, only 18.5% of households of the sub-Himalayan tarai region consuming salts with recommended iodine level (>15ppm) and rest 81.5% household consuming salt with inadequate iodine level (<15ppm). The people of the region consume both crystal and powdered (refined) salt. In the crystalline salt, 95.5% of the samples had iodine level below 15ppm and in the powdered salt samples 57.5% had iodine below that recommended value though both type of salts are also iodized at the level of production. This observation revealed that, although salt was being iodized, either an inadequate quantity of iodine was added at the time of fortification in the point of production, or there were losses of iodine at the different point of distribution such as packaging (jute bags), transportation and storage condition (open air under sunlight), length of time in distribution (even a period of 9 months is required to reach household level) and climate (humid condition may reduce 30-98%). Even cultural practices such as washing salt may reduce the iodine content in many areas [6]. Earlier study on this region on iodine content in salt suggested that 64.7% of household were consuming salt below the recommended level of 15ppm [9] and our present study showed that 81.5% of the households are consuming salt with inadequate iodine (<15ppm). This report suggests that the Universal Salt Iodization is not successful in the region and iodine intake through edible salt was inadequate. Therefore, it has been suggested that there is an urgent need of strengthening the system of monitoring the quality of salt at the household as well as retailer level to ensure the availability of at least 15ppm of iodine at the consumption point or household level.

According to Zeltser et al. [10] iodine content in the drinking water indicates that the region is environmentally iodine deficient or soil is poor in iodine. Zeltser et al. [10] also have categorized the iodine deficient zone – as the severe deficient zone having iodine less than 4 µg/l of water; moderate deficient zone with iodine level 4-10 µg/l of water and the relative deficient zone having iodine level 20 µg/l of water. According to these criteria, , in two rural areas namely Itwa and Mithwal iodine deficiency was severe, in five study areas iodine deficiency was moderate and in rest seven areas iodine deficiency was relative . However, the entire studied region may be considered as moderate deficient zone as evidenced by mean iodine content (8.99±2.97 µg/l) in drinking water. A significant positive correlation ($p<0.001$) was found between mean urinary iodine level and mean iodine content in drinking water in the respective study areas. This positive correlation indicates that iodine content in drinking water plays an important role to meet the daily dietary requirement of iodine in the studied region. Lower level of iodine was also observed in drinking water samples from goiter-endemic belts of Manipur (mean value 2.3± 0.4 µg/l) [11], Assam (mean value 1.52 ± 0.48 µg/l) [12], in the sub-Himalayan zone of India.

Table 2. Iodine content of edible salt samples in different study areas of Siddharthnagar in sub-Himalayan tarai region of Eastern Uttar Pradesh

Study area (CDBlock)	No. of saltSamples	Iodine content in salt (ppm)			
		0	<15	15-29.9	≥30
Mithwal	35	0	31(88.6)	4(11.4)	0
Khesraha	35	0	15(42.8)	15(42.8)	5(14.3)
Uska	35	0	33(94.3)	1(2.8)	1(2.8)
Jogia	35	0	33(94.3)	0	2(5.7)
Loton	35	1(2.8)	30(85.7)	4(11.4)	0
Khuniyaon	35	0	15(42.8)	17(48.6)	3(8.6)
Itwa	35	0	34(97.2)	0	1(2.8)
Birdpur	35	4(11.4)	27(77.1)	1(2.8)	3(8.6)
Bhanwapur	35	0	30(85.7)	5(14.3)	0
Domriaganj	35	0	27(77.1)	3(8.6)	5(14.3)
Barhni	35	1(2.8)	31(88.6)	3(8.6)	0
Sourathgarh	35	3(8.6)	24(68.5)	3(8.6)	5(14.3)
Naugarh	35	2(5.7)	23(65.7)	2(5.7)	8(22.8)
Bansi	35	0	35(100.0)	0	0
	490	**11(2.2)**	**388(79.2)**	**58(11.8)**	**33(6.7)**

Figures in parentheses indicate percentages

Table 3. Iodine content in drinking water of Siddharthnagar in sub-Himalayan tarairegion of Eastern Uttar Pradesh

Study area (CDBlock)	Iodine content in drinking water (μg/l) Mean±SD
Mithwal	3.575±0.576
Khesraha	6.250±0.763
Uska	10.725±0.221
Jogia	8.000±0.912
Loton	7.500±0.408
Khuniyaon	7.725±0.845
Itwa	3.425±0.741
Birdpur	10.725±1.726
Bhanwapur	12.250±1.611
Domriaganj	10.250±1.743
Barhni	9.525±0.347
Sourathgarh	13.250±1.128
Naugarh	10.500±0.503
Bansi	11.750±0.469
Total	**8.995±2.974**

Number of drinking water sample collected from each area = 8
Total number of drinking water sample = 112

Figure 1: Household consumption of edible salts

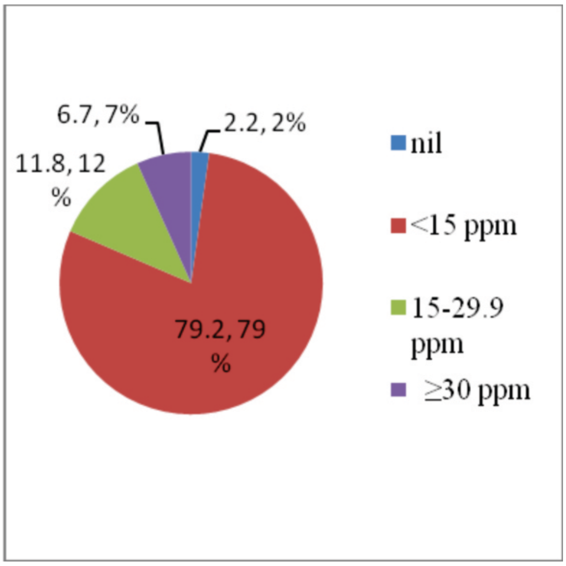


Figure 2: Iodine content in different category of edible salts

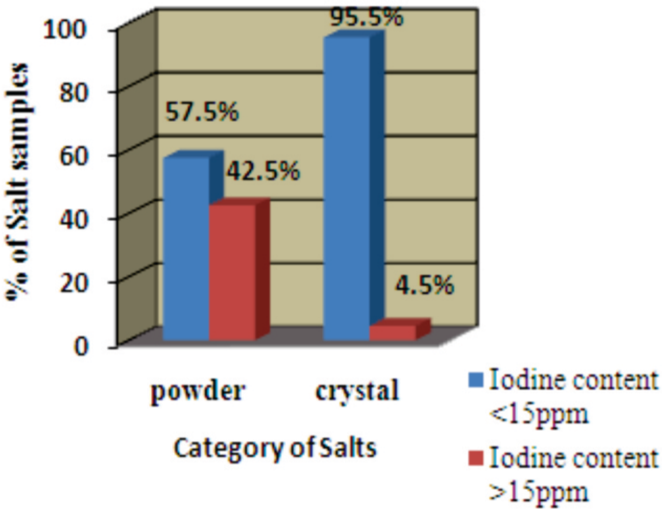
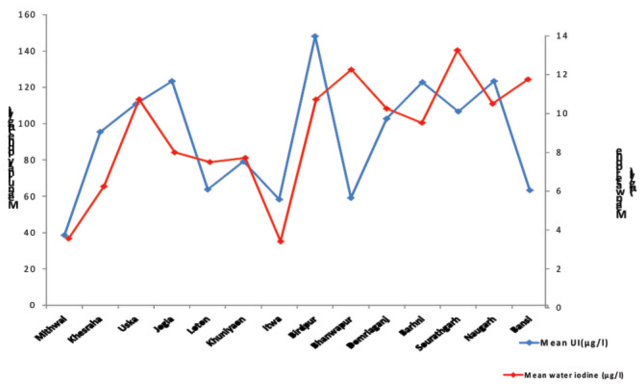


Figure 3: Area wise interrrelation between urinary iodine and iodine content in water



5. Conclusion

The people of the region consume both crystal and powdered (refine) salt. It was found that only 18.5% of households of the sub-Himalayan tarai region consume salts with recommended iodine level (>15ppm) and the rest 81.5% households consume salt with inadequate iodine level (<15ppm).Thus intake of iodine through edible salt is insufficient. The result of iodine content in drinking water shows that the studied region is moderately iodine deficient.

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