Research Paper

Iodine content of potable water sources

NISHI AGARWAL **AND** P.A. VALI

ABSTRACT : Iodine deficiency disorders (IDD) is considered as a major public health problem all over the world including India. An inverse relationship between iodine content of drinking water and goitre prevalence has been noted and supported by several investigators. Iodine content of drinking water varies from region to region and also within a region. Several villages in Nagpur district have been categorized as endemic by Public Health Department. The variation in iodine content in drinking water from different sources (bore well (BW), tap water (TW) and dug well (DW) from the endemic pockets of Nagpur district covering fourteen villages under five talukas (Kalmeshwar, Ramtek, Kamptee, Kuhi and Parseoni) were analyzed. The drinking water sources differed in the villages and also showed varied levels of iodine. The mean iodine values noted in water from DW was found to be highest (32.9 ± 9.26). Water sources from BW and TW showed slightly lower mean iodine levels (28.89 ± 14.11 and 28.82 ± 12.02, respectively). Amongst the five talukas, the lowest mean iodine levels were seen in BW water (20.46 ± 12.66) and DW water (19.59 ± 2.17) in Ramtek taluka. The mean levels of iodine observed in water sources in other villages were found to range between a minimum of 24.06 ± 10.91 to a maximum of 47.91 except for the water sources of Kamptee taluka. The results showed that drinking water from different sources from the same geographical background of endemic regions of the five talukas of Nagpur district did not reflect significant variations in iodine concentration.

KEY WORDS : Iodine deficiency disorders, Endemic, Potable water

See end of the paper for authors' affiliations

Correspondence to :
NISHI AGARWAL
Department of Home Science and Extension Education, Nagpur University, NAGPUR (M.S.) INDIA

Iodine is an important micronutrient required for human nutrition. Lack of iodine in the diet leads to visible and invisible spectrum of health consequences collectively called iodine deficiency disorders (IDD). In India, a nation wide survey revealed that out of 283 studied districts of 29 states and four union territories, 235 have prevalence of endemic goitre (Chandra, 2006). Requirement of iodine is normally met from food and drinking water. Drinking water is one of the most important sources of iodine intake. The sources of drinking water reflect upon the iodine level based on the composition of rocks and soil of the region. It has been identified that there is considerable difference in the levels of iodine in water from different sources and places.

Natural factors like the erosion of soil in riverine areas which occur due to loss of vegetation which is again linked to forest clearing for agriculture, overgrazing, or the depletion of forests for domestic requirement of wood ensures a continued and increasing loss of iodine from the soil. Ground water and locally grown plants in these areas also lack iodine. Iodine deficiency in human beings is thus due to the ecological chain of consumption, who are dependant on these animals and plants for their dietary supply of iodine.

Differences in iodine nutriture and goitre in subjects have been attributed to significant differences in iodine content of water in Siwa Oases (Coble Yank *et al.*, 1968).

A good correlation between iodine content of drinking water and incidence of thyroid enlargement points to the inadequate intake of iodine as the most probable cause of goitre in Iran (Emami *et al.*, 1969).

Although, many factors such as iodine content, pH, and manurial treatment and nitrogen components of the soil determine the amount of iodine in food stuffs, composition of water with respect to iodine would be a primary determining factor. The concentration of iodine in water is therefore an index of their contents in foods either directly or indirectly derived from the soil through which the water flows (Tulpule, 1969).

Though a major part of the diet is made by foods and vegetables, the ground water as a source of iodine cannot be ruled out. Water sources which have iodine in the concentration of 25-30 ug/l can supply almost 50-100ug/l iodine with a daily water intake ranging between 2-4 litres by

adults.

Reports from Public Health Department Nagpur showed that out of 14,375 population of Nagpur district of 5 talukas, 2067 (14.37%) of the surveyed population was affected by goitre.

From this perspective, it was postulated to study the iodine content of drinking water sources from reported endemic pockets in Nagpur district.

■ RESEARCH METHODS

The study area covered five talukas-Ramtek, Kalmeshwar, Kamptee, Kuhi, and Parseoni from Nagpur district, Maharashtra, India. Based on the data of Public Health Department, 14 villages with higher percentage of endemic goitre were selected by purposive sampling. A survey was conducted in all the villages to assess the drinking water sources available to the population of each village. Table A outlines the water sources and the samples collected for analysis from each village under study.

Water samples were collected from all the principal drinking sources such as DW, BW and TW. Samples of DW (shallow aquifer) water were collected in iodine free polyethylene containers. By up and down motion of the sampler, the DW water was sufficiently agitated to disperse particle matter floating on the surface of the well water and in the process, the sampler was thoroughly rinsed. BW water samples were obtained directly by the hand pump or electric pumps installed on such wells. All precautions taken for DW samples were also observed during collection of BW samples. Water from taps was collected after allowing water to run for at least ten seconds. All the water samples were carefully transferred to the laboratory and analyzed for iodine content (APHA).

Each sample was analyzed in duplicate and means and standard deviations were derived for iodine values according to source of water and the villages in each taluka. The data were tabulated taluka wise showing the overall mean iodine content with standard deviation. The results were subjected to‘t’ test of significance to assess the differences in the iodine content between the different sources of drinking water from each village.

■ RESEARCH FINDINGS AND DISCUSSION

Total 35 drinking water samples from different sources were collected from 14 villages under five talukas and analyzed for iodine content. The mean values of iodine with the statistical values are presented in Tables 1 to 5 representing the five different talukas. The overall mean iodine values of the endemic pockets of Nagpur district is represented in Fig. 1.

Table A : Drinking water sources in villages of Nagpur district

Sr. No.	Name of villages	Water sources	Number of samples
1.	Pipla (Kalmeshwar)	Bore well	01
2.	Dhapewada (Kalmeshwar)	Bore well	01
3.	kohli (Kalmeshwar)	Bore well	01
4.	Sindi (Kalmeshwar)	Tap	01
5.	Waroda (Kalmeshwar)	Tap, Dug Well	02
6.	Niloni (Kalmeshwar)	Dug Well	01
7.	Wadsawangi (Kalmeshwar)	Dug Well	01
8.	Salai(Ramtek)	Bore well, Dug Well	02
9.	Walghat (Ramtek)	Bore well, Tap	02
10.	Mansar (Ramtek)	Bore well, Tap	02
11.	Hiwara Bazar (Ramtek)	Bore well, Tap	02
12.	Pauni (Ramtek)	Bore well	01
13.	Kandri (Ramtek)	Tap	01
14.	Deolapar	Dug Well	01
15.	Ajani (Kamptee)	Bore well, Tap	02
16.	Kamptee (City)	Bore well, Tap	02
17.	Sonegaon (Kamptee)	Bore well, Tap, Dug Well	03
18.	Wadoda (Kamptee)	Tap	01
19.	Gumthala (Kamptee)	Dug Well	01
20.	Gada (Kamptee)	Tap	01
21.	Parseoni (City)	Bore well, Tap, Dug Well	03
22.	Kuhi	Bore well	01
23.	Akoli (Kuhi)	Bore well, Dug Well	02

Kalmeshwar is located towards the northern side of Nagpur at a distance of 30 Km. Available drinking water sources of seven villages from Kalmeshwar taluka are shown in Table 1.

Observations reveal that only two villages in Kalmeshwar taluka were using TW facility for drinking purposes, whereas 3 villages each showed either BW or DW in use for drinking water. Amongst the villages, the highest iodine content (52.27 ug/l) was observed in tap water from Sindi while the lowest (8.7 ug/l) was observed in Dhapewada village. The mean iodine value of TW obtained from 2 sources was slightly higher (37.02 ± 3.90) while that of the BW obtained from three sources was the lowest (24.06 ± 10.91). The iodine content of drinking water sources from DW from three villages showed a closer range (32.67 ug/l – 37.02 ug/l) with a mean of 36. 29 ± 2.70. Comparisons drawn between the water sources with respect to iodine concentration were found to be statistically insignificant.

Table 1 : Iodine concentration in drinking water sources in Kalmeshwar taluka

Sr. No.	Name of Taluka	Name of village	Iodine content ug/l Water sources			Statistical interpretation ('t' test)		
			BW	TW	DW	BW vs TW	TW vs DW	BW vs DW
1.		Pipla	33	00	00			
2.		Dhapewada	8.7	00	00			
3.	Kalmeshwar	Kohli	30.49	00	00	0.24	0.01	0.33
4.		Sindi	00	52.27	00			
5.		Waroda	00	21.78	37.02			
6.		Niloni	00	00	32.67			
7.		Wadsawangi	00	00	39.19			
	Mean S.D.		24.06±10.91	37.02± 3.90	36.29 ± 2.70			

BW-Bore well, TW- Tap water, D W- Dug well, S.D. - Standard deviation.
Values without mark indicate insignificant difference at both 5% and1%levels (p>0.05)

Table 2: Iodine concentration in drinking water sources in Ramtek taluka

Sr. No.	Name of Taluka	Name of village	Iodine content ug/l Water sources			Statistical interpretation ('t' test)		
			BW	TW	DW	BW vs TW	TW vs DW	BW vs DW
1.		Salai	8.7	00	21.77			
2.		Walghat	10.89	38.19	00			
3.		Mansar	10.89	43.55	00			
4.	Ramtek	Hiwara Bazar	37.02	17.42	00	0.15	0.43	0.14
5.		Pauni	34.84	00	00			
6.		Kandri	00	37.02	00			
7.		Deolapar	00	00	17.42			
	Mean S.D.		20.46 ±12.66	34.04 ± 9.90	19.59± 2.17			

BW-Bore well, TW- Tap, DW-Dug well, S.D. - Standard deviation.
Values without mark indicate insignificant difference at both 5% and1%levels (p>0.05)

Table 3 : Iodine concentration of drinking water sources in Kamptee taluka

Sr. No.	Name of Taluka	Name of village	Iodine Content ug/l Source of water			Statistical interpretation ('t' test)		
			BW	TW	W	BW vs TW	TW vs DW	BW vs DW
1		Ajani	45.73	30.49	00			
2		Kamptee (City)	37.02	21.77	00			
3	Kamptee	Sonegaon	41.38	19.59	37.02	0.72	0.29	0.17
4		Wadoda	00	30.49	00			
5		Gumthala	00	00	28.31			
6		Gada	00	21.78	00			
	Mean S.D.		41.37± 3.55	24.82± 4.69	32.66± 4.35			

BW-Bore well, TW- Tap water, DW-Dug well, S.D. - Standard deviation.
Values without mark indicate insignificant difference at both 5% and1%levels (p>0.05)

Table 4 : Iodine concentration of drinking water sources in Kuhi taluka

Sr. No.	Name of Taluka	Name of village	Iodine Content ug/l Water sources			Statistical interpretation ('t' test)		
			BW	TW	DW	BW vs TW	TW vs DW	BW vs DW
1.		Kuhi	48.13	00	00			
2.	Kuhi	Akoli	20.69	00	47.91	--	--	0.21
	Mean S.D.		34.41± 13.71	00	47.91			

BW-Bore well, TW- Tap water, DW- Dug well, S. D. - Standard deviation.
Values without mark indicate insignificant difference at both 5% and1%levels (p>0.05)

Table 5 : Iodine concentration of drinking water sources in Parseoni taluka

Sr. No.	Name of Taluka	Name of village	Iodine content ug/l Source of water		
			BW	TW	DW
1.	Parseoni	Parseoni (City)	37.02	11.54	34.84

Ramtek is a taluka that is located towards the eastern side of Nagpur at a distance of 40 Km. The geology and parent material of Ramtek taluka shows metamorphic rocks. Iodine content of different water sources from seven villages in Ramtek taluka with statistical values is presented in Table 2. Observations showed that a major percentage of the villages had access to both BW and TW sources while only 2 villages had DW for drinking water purposes. A wide variations in the iodine content in the drinking water from BW sources was observed ranging between a minimum of 8.7 ug/l to a maximum of 37.2ug/l. The iodine content from TW source also showed a wide range with a minimum of 17.42 ug/l to a maximum of 43.55 ug/l. DW water sources in Ramtek showed a range of iodine content (17.42 ug/l to 21.77 ug/l).

Compiling the mean iodine values for each of the three different drinking water sources, TW showed the highest concentration (34.04 ± 9.90) while DW reflected the lowest (19.59 ± 2.17). The differences in iodine content between the three water sources were however found to be statistically insignificant.

Table 3 presents the iodine values in the different water sources from villages in Kamptee taluka. This taluka is also located towards the eastern side of Nagpur at a distance of 15 km. In contrast to the observations from Ramteke taluka, the BW drinking water showed the highest level of iodine concentration (41.37 ± 3.55). Almost 5 villages in this taluka had facility of TW, while only 2 villages had DW as drinking water source. Sonegaon village in this taluka was the only village in the study where in all three drinking water sources were available. The TW in this village showed a comparatively low iodine content (19.59 ug/l) as compared to DW (37.02 ug/l) and BW (41.38 ug/l). Between the water sources, the overall mean iodine content was found to be highest in drinking water from BW (41.37 ± 3.55) and lowest in TW (24.82 ± 4.69). No statistical difference was however observed between the mean iodine content of BW and TW, TW and DW water and between BW and DW water.

The iodine content of water sources obtained from two villages in Kuhi taluka. The statistical interpretation is presented in Table 4. This taluka is located towards the south eastern side of Nagpur at a distance of 35 km. The geology and the parent material of this taluka is quartzite. Both the villages under study did not have TW facility for drinking purposes. Kuhi had BW water source with comparatively

Table 6 : Iodine concentration of drinking water within talukas of Nagpur district, Maharashtra

Sr. No.	Name of the Taluka	Statistical Interpretation ('t' test)		
		Bore well water	Tap water	Dug well water
1.	Kalmeshwar and Ramtek	0.59	0.06	0.37
2.	Kalmeshwar and Kamptee	0.48	0.36	0.22
3.	Kalmeshwar and Kuhi	0.35	00	0.16
4.	Kalmeshwar and Parseoni	0.30	0.24	0.02
5.	Ramtek and Kamptee	0.86	0.53	0.23
6.	Ramtek and Kuhi	0.87	00	0.35
7.	Ramtek and Parseoni	0.80	0.56	0.28
8.	Kamptee and Kuhi	0.17	00	0.15
9.	Kamptee and Parseoni	0.07	0.90	0.02
10.	Kuhi and Parseoni	0.10	00	0.21

Values without mark indicate insignificant difference at both 5% and1%levels (p>0.05)

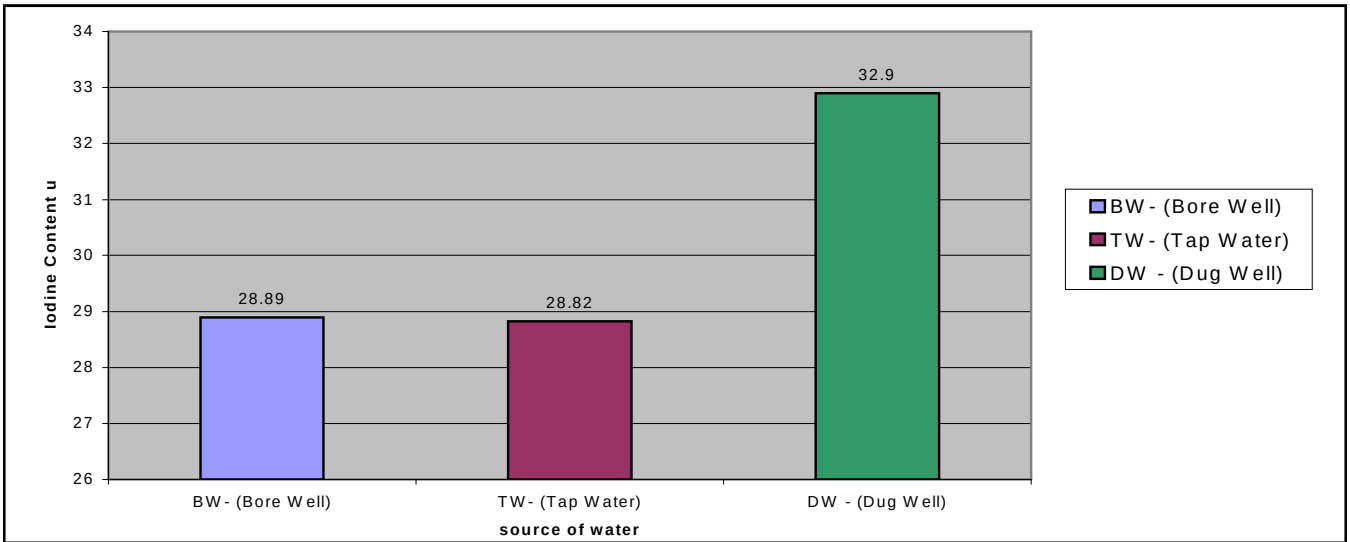

Fig. 1 : Mean iodine content of water sources from five Talukas of Nagpur district

higher iodine content (48.13 ug/l) as compared to Akoli village (20.69 ug/l). The mean iodine content of water from DW in Akoli was found to be higher (47.91 ug/l) as compared to BW source from the same village (20.69 ug/l). A difference in iodine content between BW and DW water sources was however found to be statistically insignificant.

The iodine content of water sources obtained from Parseoni taluka is presented in Table 5. Parseoni taluka is located on the northern side of Nagpur at a distance of 40 Km. The geology and parent material of this taluka shows metamorphic rocks. Only one village reported to be endemic was taken up in the study from this taluka. Parseoni showed the availability of all three sources of drinking water. The iodine content was found to be lowest (11.5 ug/l) in TW source while it was highest in BW water source (37.02 ug/l). The DW water source showed higher iodine content (34.84 ug/l) as compared to the TW and BW water source.

The observations of the study revealed that the concentration of iodine varied both in the sources of drinking water, in the different villages. High iodine concentration was seen in TW in Kalmeshwar and Ramtek, in BW in Kamptee and Parseoni and in DW in Kuhi. Therefore mean iodine concentration of the three different water sources irrespective of the villages or talukas were derived to ascertain the water source of the highest contribution of iodine.

Fig. 1 represents the mean iodine concentration in drinking water sources from BW (14), TW (12) DW (9) collected from the known endemic pockets of 23 villages in five talukas of Nagpur district. It was observed that the overall mean values of iodine was slightly higher in the DW water source (32.9 ug/l) as compared to the BW (28.89 ug/l) and TW (28.82 ug/l) sources.

Table 6 shows the mean iodine content of water from different talukas of Nagpur district. The result of statistical interpretations showed that there was no significant difference at both the level (at 5% and 1%) in iodine content of water drawn from same geographical background.

Iodine content in drinking water samples were reported to be in the range of 22- 100 ug/l by Chandra *et al.* (2006) from their study in the endemic goitre Sundarban Delta of South 24 Parganas, West Bengal.

Tulpule (1969) reported that iodine content in water showed a wide variation in samples of drinking water (well, tank and river) collected from nine different states. The majority of values in non-goiterous regions ranged between 15-18 ug/l.

Iodine concentration in the range of 8-63 ug/l with an average value of 64 ug/l has been reported in ground waters of Jaiselmer, Nagor, and Pali districts of western Rajasthan. Sandstone foundation revealed, ground water of high iodide content than the other formation in the region (Gupta and Varshney, 1999)

Conclusion:

Samples of drinking water collected from different water sources (TW, BW, DW) from known endemic pockets of five different talukas of Nagpur district reflected a wide variation in the iodine concentration showing a minimum of 8.7 ug/l to a maximum of 52.27 ug/l. DW water showed the highest concentration of iodine as compared to other sources. Variations in iodine concentration were vividly observed in drinking water sources from the same village as well as in the villages under different talukas. However, statistically this variation in iodine content of water from different sources was found not to reflect significant differences. It is concluded from the present study that the

iodine concentration in drinking water sources is directly influenced by the geographical background.

Authors' affiliations:
S.A. VALI, Department of Home Science, Rashtrasant Tukadoji Maharaj, Nagpur University, NAGPUR (M.S.) INDIA

■ REFERENCES

American Public Health Association (2007), 20th Ed.

Chandra, K., Singh, Amar, Tripathy, Smritiratan, Ghosh, Deshari, Debnath, Arijit and Sanjukta, Mukhopadhyaya (2005). Iodine nutritional status and prevelance of goitre in Sunderban Delta of South 24-Parganas, West Bengal, *Indian J. Medical Res.*,**122** : 419-424.

Coble, Yank, Davis, James and Schulert, Arthur, (1968). Goitre and iodine deficiency in Egyptian Oases, *American J. Clinical Nutr.*, **21** (4) : 277-283

Emami, A., Shahbazi, H., Sabzevari, M. and Gawam, Z. (1969). Goitre in Iran, *American J. Clinical Nutr.*, **22** (12) : 1584-1588.

Gupta, S.C. and Varshney, C.P. (1999). Iodide concentration in ground waters of Western Rajasthan, *Indian J. Environ. Health*, **41** (1) : .59-64.

Tulpule, P.G. (1969). Iodine and fluorine content of drinking water. *J. Nutr. & Dietetics*, **6** : 229-233.

****