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ASSESSMENT OF DRINKING WATER QUALITY IN TRIBAL DOMINATED VILLAGES OF BARKAGAON, HAZARIBAG, JHARKHAND, INDIA

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Abstract

Water is most essential component for the survival of any kind of life on the planet Earth. Quality and quantity of water at any place play a vital role in health, wealth and prosperity of life. Geogenic contaminants including fluoride have affected ground water in more than 200 districts of 19 states of India. Fluoride is one of the most essential elements for calcification of bones and teeth where as excess intake (above 1.5 mg/lit.) may cause skeletal, non skeletal and dental fluorosis.

Drinking water samples from five tribal dominated villages of Barkagaon (23^0 52′ 5″ N latitude and 85^0 14′ 15″ E longitude), Hazaribag, Jharkhand, India were taken fortnightly from hand pump during rainy, winter and summer seasons (July 2011- June 2012) for fluoride analysis as per standard protocol of APHA (2005) and the results showed that all the samples contained higher concentration. The highest average concentration of fluoride was recorded in Bhurkundwa village (3.84±0.8 mg/lit.) where as it was lowest in Aswa village (1.89± 0.8 mg/lit). We have studied the impact of fluoride among 426 school children (06-16 yrs) with reference to Dean's Index for dental fluorosis which reveals that almost 87% were suffering from dental fluorosis. The results clearly indicate that the dental fluorosis among children is directly related to fluoride concentration in drinking water. Our opinion regarding the higher fluoride concentration in the study area is due to excess mineral exploration. Thus necessary steps must be taken to supply the quality drinking water to the locality for the maintenance of the health of tribal people.

Keywords: Drinking water, fluoride, dental fluorosis, tribal, barkagaon

Introduction

Water is one of the most essential natural resource for the entire living system on the earth. Due to rapid growth of population and modernization the pressure on water demand has increased manifold which is fulfilled by ground and surface waters. Water is a universal solvent, dissolves the minerals of rocks during its passage & storage and ultimately change the quality. In addition, various anthropogenic activities pollute and degrade drinking water resource. The suitable quality of drinking water is still a dream for most of the human population.

Average intake of water by an individual is 13.1% of the body weight (Kundu, 2013). The ground water resources have been rendered unsafe due to various reasons (Khayum *et al.*, 2011). More than 80% diseases of mankind are water borne (WHO, 1996). Geogenic contaminants including fluoride have affected ground water in more than 200 districts of 19 states of India (Kundu, 2013). Fluoride is one of the most essential elements for human health, plays an important role in the calcification of bones and teeth when it is taken within permissible limit i.e. 1.5 mg/ litre (BIS, 2003 & WHO, 1996), where as excess fluoride intake may result in skeletal, non skeletal and dental fluorosis (Susheela, 1999). The skeletal fluorosis causes pain in different parts of the body (WHO, 1996) where as non skeletal fluorosis may cause different ailments (Ozha and Mathur, 2001) and the dental fluorosis manifests variety of problems in the teeth (Murkute and Badhan, 2011). In Jharkhand, little study has been done on the occurrence of fluoride in potable water and its impacts on teeth particularly in tribal dominated areas. In view of the above, the present investigation is carried out to evaluate the extent of dental fluorosis among children (06-16yrs) due to above-normal fluoride content in drinking water in some of the tribal dominated villages of Barkagaon block, Hazaribag, Jharkhand, India.

The Study Area

As per census report 2001, more than 80% tribal population resides in villages of Potanga panchyat under Barkagaon block (23^0 52′ 5″ N latitude and 85^0 14′ 15″ E longitude) of Hazaribag district of Jharkhand in which five sampling villages namely Aswa, Bartola, Reskatola, Bhurkundawa and Gandhoniya have been selected for the study. An average rain fall of 1485 mm/year and altitude of above 600 mts. from mean sea level have been recorded. The district headquarter is about 65km away from study area which is connected by SH- 07 to NH- 33. Index map of the study area is shown in figure – 1. The area is rich in mineral deposits mainly the coal and is also surrounded by moderate to dense forest traversed by many natural streams. Topography of the area is undulating.

Material and Method

Potable water samples from each village of the study area were collected five times fortnightly from hand pumps in sampling bottles of 1 liter capacity during rainy, winter and summer seasons from July 2011 to June 2012 for fluoride analysis (APHA, 2005). The fluoride level in samples was evaluated within 24 hours of collection in the field laboratory. An ion specific F electrode (Orion 290^{+}) was used in the field laboratory with TISAB-II solution in 1:1 volume ratio with the samples. Fluoride level in five villages was determined and compared with the standard prescribed by BIS (10500-1991) and characteristic of teeth among school children (06-16 yrs) was also assessed by Dean's Index (Dean ,1934).

Result and Discussion

Drinking water samples of the study area were analyzed for the estimation of fluoride concentration as per standard protocol; data were (mean ± S.E.) recorded and shown in table – 1. It is observed that all the samples collected in rainy, winter and summer seasons showed higher concentrations of fluoride than permissible limit (1.5 mg/lit, WHO, 1996). The highest average concentration of fluoride throughout the year was recorded in Bhurkundwa where as it was lowest in Aswa. The relative average concentrations were evaluated as Bhurkundwa> Bartola> Reakatola> Gandhoniya> Aswa. The higher fluoride concentration in the study area (1.65± 0.5mg/lit to 4.9± mg/lit range) is due to excess mineral exploitation. Our opinion is also at par the report of Dev Burman *et al.*,1995.

Parallely the impact of fluoride among school children (06-16 yrs) of the study area has also been studied with reference to Dean's Index for dental fluorosis as shown in fig-2. Dean's Index is commonly used to diagnose the severity of dental fluorosis. The observation of teeth among 426 school children on the basis of Dean's Index reveals that almost 87% children were suffering from dental fluorosis where as the percentage occurrence of different categories of fluoride affected teeth in the study area were 12.91% - Normal, 15.02%- Questionable, 22.78%- Very mild, 23.70% - Mild, 16.44% - Moderate and 9.15%- Severe and shown in table -2. Tables 1 & 2 and figs. 2 & 3 seem to indicate that the dental fluorosis among children is directly related to fluoride concentration in drinking water. Same conclusion has also been given by Ray *et al.,* 1981; Brouwer *et al.,* 1988; Ruan *et al.,* 2004 and Kumar & Verma, 2007 in this regard .

The fluoride contamination in drinking water in the study area may be due to the following reasons:

1. Over exploitation of groundwater as surface water resources are limited.
2. Open cast coal mining along with excess explosion.

3. Lack of quality assessment and proper monitoring of drinking water quality.
4. Economic status of the population of the area falls below poverty line (BPL).
5. Lack of public awareness about health and hygiene.

Conclusion

Water is life but unfortunately, quality drinking water is not sufficiently available in the study area. Most of the sources of drinking water are unsafe to use without some sort of treatment including defluoridation otherwise people will face a lot of health hazards. Unit of oral health and hygiene should be established in the area for proper assessment, guideline and monitoring of drinking water quality with the help of State and Central Govt., Health Department. Since the area is tribal dominated, special care should be taken for their proper survival.

Table-1: Showing the seasonal variation of fluoride content in ground water

Season	Month	V I L L A G E S				
		*Mean+S.E. in mg.	*Mean+S.E. in mg.	*Mean+S.E. in mg.	*Mean+S.E. in mg.	*Mean+S.E. in mg.
		Aswa	**Bartola**	**Reskatola**	**Bhurkundwa**	**Gandhoniya**
Rainy	July11	2.10±0.7	2.35±0.8	2.40±0.7	2.50±0.7	2.15±0.7
	Aug 11	1.75±0.7	1.94±0.6	1.70±0.8	1.90±0.8	1.65±0.8
	Sept 11	1.80±0.6	1.73±0.7	1.96 ±0.6	2.15±0.7	1.95±0.5
	Oct 11	2.73±0.6	1.95±0.6	2.63 ±0.6	2.10±0.7	2.28±0.7
	AV:Values	**1.89±0.8**	**1.99±0.7**	**2.04±0.6**	**2.16±0.8**	**1.98±0.7**
Winter	Nov 11	2.02±0.7	2.85±0.8	2.34±0.7	2.96±0.8	2.41±0.7
	Dec 11	1.92±0.7	2.90±0.8	2.72±0.8	3.70±0.8	2.64±0.7
	Jan 12	2.16±0.7	3.17±0.9	2.87±0.8	3.92±0.9	2.90±0.8
	Feb 12	2.39±0.7	3.35±0.9	3.51±0.9	3.39±0.9	3.23±0.9
	AV:Values	**2.12±0.7**	**3.06±0.9**	**2.86±0.8**	**3.49±0.9**	**2.79±0.8**
Summer	March 12	2.52±0.7	3.46±0.9	3.32±0.8	3.61±0.9	3.54±0.9
	April 12	2.91±0.8	3.64±0.9	3.75±0.8	3.88±0.9	3.79±0.8
	May 12	3.00±0.7	3.25±0.8	2.70±0.7	3.10±0.7	2.77±0.7
	June 12	3.35±0.7	4.90±0.9	4.53±0.9	4.80±0.7	3.92± 0.7
	AV:Values	**2.94±0.7**	**3.81±0.8**	**3.57±0.8**	**3.84±0.8**	**3.50±0.8**

* 10 samples

Table-2: Showing the percentage occurrence of fluoride - affected teeth of children as per Dean's Index

Sl. No.	Villages	Number of cases (06-16 yrs)	Dean's Index					
			Normal	**Questionable**	**Very mild**	**Mild**	**Moderate**	**Severe**
01.	Aswa	114	21.05%	18.42%	16.67%	19.30%	11.40%	13.16%
02.	Bartola	84	8.34%	11.90%	28.58%	25%	19.04%	7.14%
03.	Reskatola	88	10.22%	12.50%	30.69%	25%	14.78%	6.81%
04.	Bhurkundwa	77	7.79%	19.48%	18.18%	23.38%	20.78%	10.39%
05.	Gandhoniya	63	14.28%	11.11%	20.64%	28.58%	19.08%	6.35%
Total Percentage of F– affected teeth			12.91%	15.02%	22.78%	23.70%	16.44 %	9.15 %

Fig-1: Showing the location of the Study Area
(Not to scale)

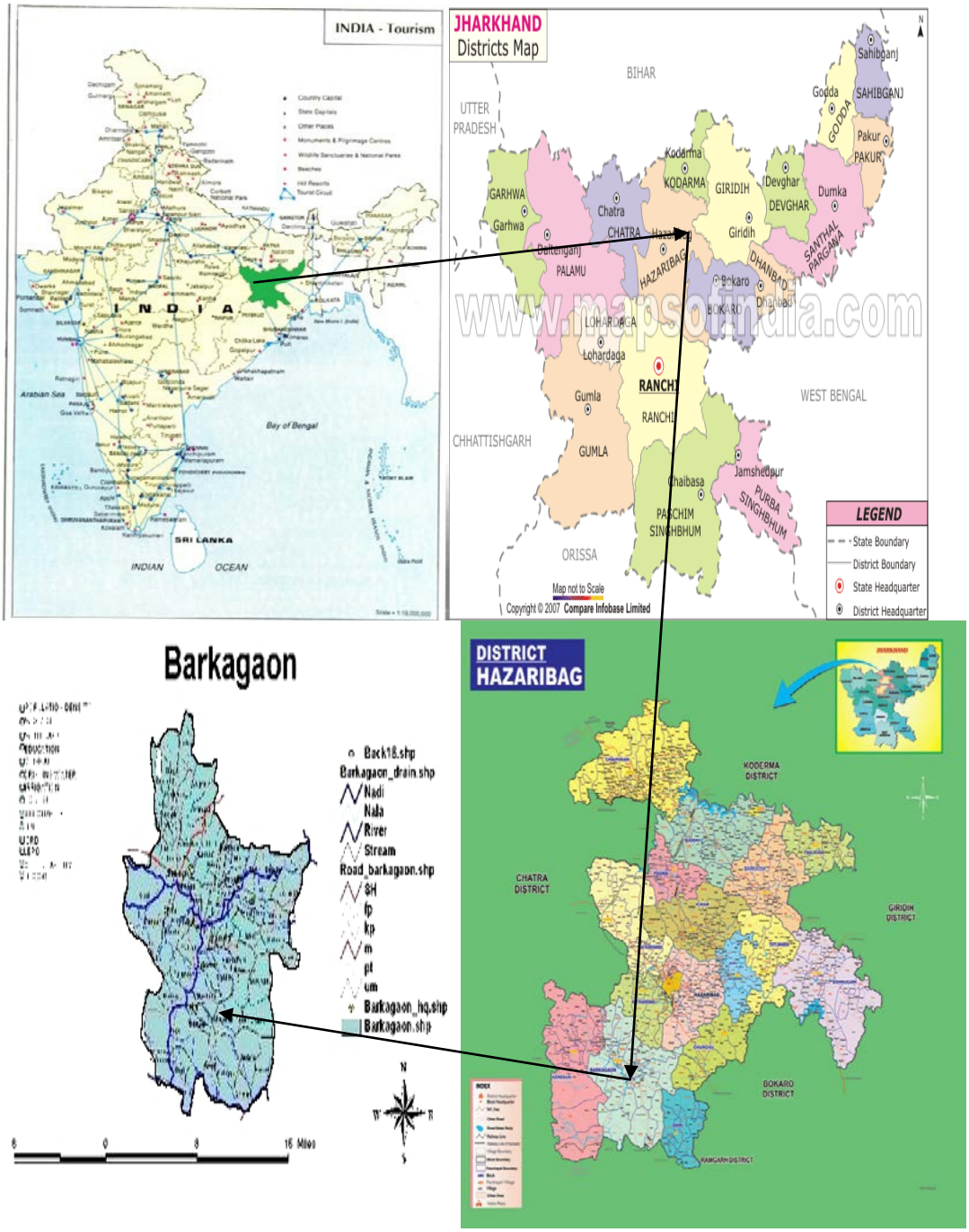
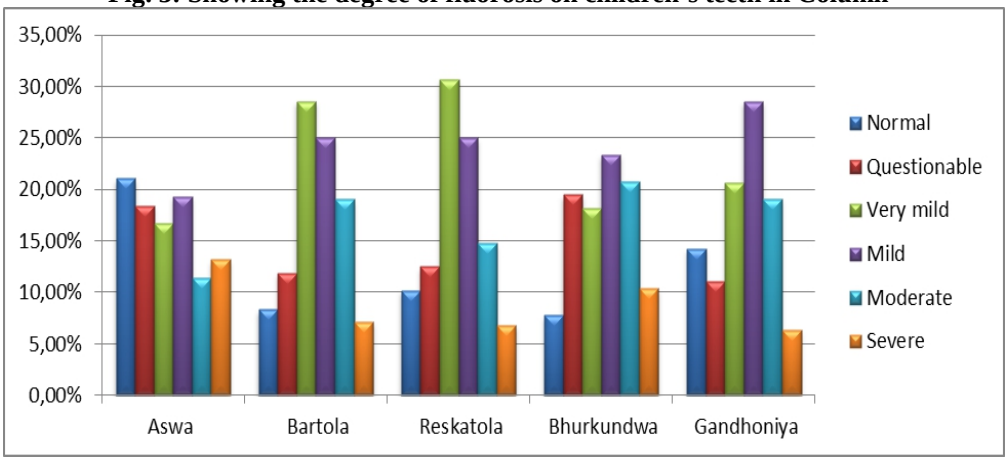


Fig. 2: Showing the comparison of teeth of children of the study area with Dean's Index to identify the degree of fluorosis

Sl. No.	Category of Dean's Index	Characters	Dean's Index Teeth	Observation of the teeth
01	Normal	Enamel is smooth and uniform in color		
02	Questionable	Enamel may exhibit some white flecks or small white spots. These are cases where there is not definitive fluorosis, but teeth do not qualify as "normal" either.		
03	Very mild	Less than 25% of the tooth surfaces display irregular white areas. Often these include cases where there are 1-2 mm of the tooth surface just at the cusp tips are affected.		
04	Mild	More than 25% of the tooth surface but less than 50% is affected.		
05	Moderate	Generalized areas of hypo calcification on all surfaces of the tooth, may exhibit attrition on susceptible tooth surfaces and brown spots may be present.		
06	Severe	Generalized pitting of the enamel on all surfaces, generalized brown discolorations, tooth shape may be affected as well.		

Fig. 3: Showing the degree of fluorosis on children's teeth in Column



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