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Water Quality Assessment of Schools in Solan District of Himachal Pradesh

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Abstract

Assessment of drinking water quality was done by selecting Nine Government senior secondary schools of three blocks in Solan district of Himachal Pradesh. The water quality parameters such as physical, chemical and biological parameters of water samples were analyzed. The water quality parameters such as temperature, pH, EC, TDS, temperature, BOD and COD ranged from 18.3 to 21.2°C, 6.95 to 7.13, 0.24 to 0.51 dS m^{-1}, 107.90 to 194.02 mg l^{-1}, 0.69 to 2.26 mg l^{-1} and 56.50 to 119.75 mg l^{-1}; trace elements (As, Cd, Zn, Pb, Cu, Mn and Ni) nil, 0.000 to 0.001 mg l^{-1}, 0.001 to 0.003 mg l^{-1}, 0.00 to 0.01 mg l^{-1}, 0.00 to 0.02 mg l^{-1}, 0.03 to 0.06 mg l^{-1} and 0.00 to 0.02 mg l^{-1} respectively and biological parameters like total coliform as 20.00 to 54.00 MPN ml^{-1}, which were within the permissible limits except Fe which ranged from 0.63 to 0.95 mg l^{-1} was above the permissible limits. The water quality index of drinking water for nine schoolswas in the rangeof 25.80 to 36.38,which categorized as excellent.

Introduction

Water is consideredas most essential and important natural resources for human beings, animals and plants. It is difficult to imagine an environment without water. Man can live only three or four days without water. The available total water quantity remains constant globally and is sufficient to meet demands of world living beings, its quality and improper management poses concerns of water crises. Although our planet has nearly 71 per cent of water, only 3 per cent of it is fresh.[1] Potable and drinking water plays an important role in the growth of the good health of a nation. Water should be suitable for drinking and food preparation[2] as itis a better solvent, absorb impurities quickly result in gchange in its sensory characteristics. Polluted water affects its normal functioning and properties.[3]

Water pollution is one of the major problems as a result of human activities such as domestic wastes,

agriculture wastes, industrial pollutants, particulate matter from construction activities, and waste from people littering. Polluted water is responsible forwater borne diseases. The trace elements in water also play harmful roles to health of living beings. The impurities present innatural water are, living impurities, organic impurities and water borne micro organism. These necessitate the need to manage and use water more efficiently.

However, poor water quality continues to pose a major warning to human health world wide. Globally, waterborne diseases cause thousands of deaths particularly children in developing countries.[4] Water pollution has the main effect on children and causes many diseases like cholera, diarrhea, typhoid and dysentery.

The study aimed to assess the water quality supplied to the educational institutes of Solan district by evaluating the physico-chemical characteristics and bacteriological quality parameters expressed as water quality Index (WQI) which is best technique to provide information to policy makersby combining complex data and giving a score toexpress WQI.[5]
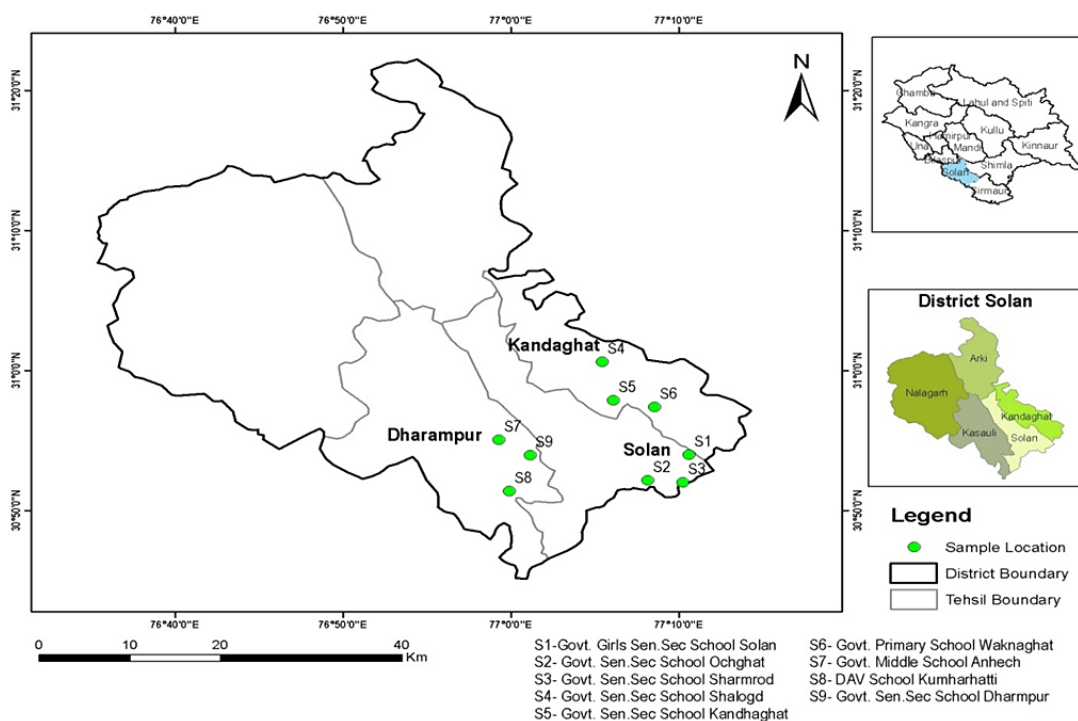

S1-Govt. Girls Sen.Sec School Solan
S2- Govt. Sen.Sec School Ochghat
S3- Govt. Sen.Sec School Sharmrod
S4- Govt. Sen.Sec School Shalogd
S5- Govt. Sen.Sec School Kandhaghat
S6- Govt. Primary School Waknaghat
S7- Govt. Middle School Anhech
S8- DAV School Kumharhatti
S9- Govt. Sen.Sec School Dharmpur

Fig. 1.1: Study area

(Note: S1 = Government Senior Secondary School (GSSS) Girls, Solan, S2 = GSSS, Oachghat, S3 = GSSS, Shamror, S4 = GSSS, Salogra, S5 = GSSS, Kandaghat, S6 = Government Primary School, Waknaghat, S7 = Government Middle School Anhech, S8 = DAV School Kumarhatti, S9 = GSSS, Dharampur).

Materials and Methods
Three blocks and nine sites namely Solan, Kandaghat and Dharampur of Solan district of Himachal Pradesh were considered for the present study. Solan district is located between 30°30" and 31°50" N Latitude and 76°42" to 77°20" E Longitude (Fig 1). Acid washed plastic bottles of 1 L capacity as per standard procedure were used to collect water samples[6] from selected schools during two seasons i.e., summer and winter with two replications. Drinking water samples were collected from running tap continuously for five minutes.[7] The physical parameters such as colour, odour, temperature (°C) were recorded using standard

procedures. The pH was measured by using pH meter (Model-1013 of EIA make), EC and TDS were determined by conductivity TDS meter (Model-1601 of EIA make) and expressed in dS m^{-1} and mg l^{-1} respectively. The BOD was determined by using 5 day BOD test based on 5210 B method.[8] The COD was determined by oxidizing water sample with hot H_2SO_4 solution of potassium chromate with silver sulphate as the catalyst. The water samples were digested at 148°C in the pre-heated thermo-reactor (TR 320) for 2 hrs. Chloride was masked with mercury sulphate, the concentration of Cr^{3+} ions was then determined photometrically by using Spectroquant Pharo 300 (Merk make) expressed in mg l^{-1}. The observed procedure wasrelated to EPA 410.4 US Standard method 5220 D, and ISO 15705.The trace elements such as As, Cd, Pb, Fe, Mn, Cu, Ni and Zn were estimated by using standard kits and Inductively Coupled Plasma of Atomic Emission Spectroscopy-6300 DUO (ICAP-6300 Duo) and expressed as mg l^{-1}.

The number of the coliform groups was estimated by preforming standard procedure, carried out by the multiple tube dilution tests (presumptive test, confirmed test, or completed test) and followed by[8] by the membrane filter technique.

Results and Discussion
Physical Parameters
The colour of tap water in selected educational institutes was colourless in all the selected locations. The odour of tap water in selected educational institutes was odourless in all the selected locations. The temperature of tap water ranged from 18.3 to 21.2°C in selected educational institutes (Table1). Among the seasons, the mean temperature was found higher (24.9°C) in summer and lower (13.2°C) in winter season. The temperature of drinking water in selected schools was within the prescribed limits of BIS. The results are conformity with the findings of Trivedi[3] and Rana[9] who observed maximum temperature in summer season.

**Table 1: Seasonal variation of Physical Parameters of tap water in
selected Educational Institutes**

Schools	Colour	Odour	Temperature		
	Seasons		Seasons		
	W/S	W/S	Winter	Summer	Mean
S1	Colourless	Odourless	12.3	24.5	18.4
S2	Colourless	Odourless	12.6	25.5	19.0
S3	Colourless	Odourless	14.9	27.6	21.2
S4	Colourless	Odourless	12.3	24.3	18.3
S5	Colourless	Odourless	13.8	23.3	18.5
S6	Colourless	Odourless	12.6	25.6	19.1
S7	Colourless	Odourless	14.8	24.5	19.6
S8	Colourless	Odourless	12.6	24.9	18.7
S9	Colourless	Odourless	13.2	23.9	18.6

Chemical Parameters
The pH of water was in the rangeof 6.95 and 7.13 of tap water in all the selected locations. Among the seasons, the mean pH was found higher (7.07) in summer and lower (6.99) in winter season. ThepH of drinking water was within the prescribed limits of BIS. The higher pH during summer seasons due to more evaporation and less dilution in comparison with other seasons.[10] The EC of tap water was in the range of 0.24 and 0.51 dSm^{-1}in all the selected schools. Among the seasons, the mean EC was found higher (0.35dSm^{-1}) in summer and lower

(0.32 dSm^{-1}) was in winter season. The EC of tap water in the schools was within the limits of WHO and similar to the findings of Jadhav.[11]

The TDS of tap water was in the range of 107.90 and 194.02 mgl^{-1} in selected institutes. Among the seasons, the mean TDS was found higher (143.77 mgl^{-1}) in summer and lower (133.83 mgl^{-1}) in winter season. The TDS of tap water in selected schools was within the limits prescribed by BIS. The obtained trend is in confirmation with the findings of Sharma[12] and Rao.[13] The BOD of tap water was found to be between 0.69 and 2.26 mgl^{-1} in all the selected educational institutes. Among the seasons, the meanBOD was found higher (1.49 mgl^{-1}) in summer and lower (1.39 mgl^{-1}) in winter season. The BOD of tap water was within the limits prescribed by BIS. The results are similar to the findings of Trivedi[14] and Mathur[15] who have indicated enrichment of water sources with organic matter cause for high BOD. The COD of drinking water ranged between 56.50 and 119.75 mgl^{-1} in selected educational institutes. Among the seasons, the meanCOD was found higher (98.16 mgl^{-1}) in summer and lower (82.50 mgl^{-1}) in winter season. The COD of drinking water was within the limits as per of BIS. The results are similar to the findings of Joseph[16] and Chattopadhyay[17] who also reported similar results where they found maximum COD in summer season. The results are summarized in Table 2.

Heavy Metals
The concentration of As of tap water was found to be 0 mgl^{-1} in selected educational institutes and within the permissible limits as given by BIS. The concentration of Cd of tap water was in the range of 0.000 and 0.001 mgl^{-1} in selected educational institutes. Among the seasons, the mean Cd was found higher (0.001 mgl^{-1}) in summer and lower (0.000 mgl^{-1}) in winter season. The Cd of drinking water was within the prescribed limits of BIS. The results are similar to the findings of Lokeshwari[18] who reported Cd in the sampled water much below the permissible levels. The concentration of Zn of tap water ranged from 0.001 to 0.003 mgl^{-1} in selected educational institutes. Among the seasons, the mean Zn was found higher (0.002 mgl^{-1}) in summer and (0.001 mgl^{-1}) in winter season. The concentration of Zn indrinking water

in the schools was within the prescribed limits of BIS. The results are in confirmation of the findings of Shanbehzadeh[19] that the concentration of Zn was

within the standard range for drinking water. The Pb concentration of drinking water was in the range of 0.00 and 0.01 mgl^{-1} in selected educational institutes. Among the seasons, the mean Pb was found higher (0.01 mgl^{-1}) in summer and lower (0.00mg l^{-1}) in winter season. The Pb of drinking water was within the prescribed limits of BIS. The results are within the findings of Wogu[20] where Pb had the least mean content of 0.01 mg l^{-1}. The concentration of Cu of tap water was in the range of 0.00 to 0.02 mgl^{-1} in selected educational institutes. Among the seasons, the mean Cu was found higher (0.01 mgl^{-1}) in summer and lower (0.00 mgl^{-1}) in winter season. The Cu of drinking water was within the prescribed limits of BIS. The results are similar to the findings of Shanbehzadeh[19] who reported that the mean concentration of Cu was within the standard range for drinking water. The Fe concentration of tap water was in the range of 0.63 and 0.95 mgl^{-1} in selected educational institutes. Among the seasons, the mean Fe was found higher (0.88 mgl^{-1}) in summer and lower (0.75 mgl^{-1}) Fe in winter. The Fe of drinking water was above the prescribed limits of BIS because soil in Himachal Pradesh is considered to be rich in iron. The results are in conformity of the findings of Puri[21] who found increase in Fe concentration during summer. The Mn concentration of tap water was in the range of 0.03 and 0.06 mg^{-1}in selected educational institutes. Among the seasons, the mean Mn was found higher (0.05 mgl^{-1}) in summer and lower (0.04 mgl^{-1}) Mn in winter season. The Mn of drinking water was within the prescribed limits of BIS. The results are in conformity of the findings of dwivedi[22] who found that the manganese content in water samples was below the prescribed limit. The Ni content of tap water was in the range of 0.00 and 0.02 mgl^{-1} in selected educational institutes. Among the seasons, the meanNi was found higher (0.02 mgl^{-1}) in summer and lower (0.00 mgl^{-1}) Ni in winter season. The Ni content of tap water was within the prescribed limits of BIS. The results are similar to the findings of Lokeshwari[18] where it was found that all the samples from various sources contain Ni much below the limits prescribed. The concentration of heavy metals has been presented in Table 3.

Biological Parameters
The total coliform of tap water ranged from 20.00 to 54.00 MPNml^{-1} in selected educational institutes

(Table 4). Among the seasons, the mean total coliform was found higher (41.53 MPN ml^{-1}) in summer and lower (34.11 MPN ml^{-1}) total coliform in winter season. The total coliform of water was within the prescribed limits of BIS. The results are within the findings of Shaikh[23] who observed maximum concentration of total coliform in summer and minimum in winter.

Table 4: Seasonal variation of Biological Parameters of tap water in selected Educational Institutes

Schools	Total Coliform		
	Seasons		
	Winter	Summer	Mean
S1	25.00	33.00	29.00
S2	39.00	58.00	48.50
S3	52.00	34.00	43.00
S4	34.00	36.00	35.25
S5	19.00	21.00	20.00
S6	35.00	57.00	46.00
S7	21.00	26.00	23.50
S8	34.00	52.00	43.25
S9	52.00	56.00	54.00

Correlation among Water Quality Parameters
The water quality parameters were correlated with each other significantly during winter. The pH was correlated negatively with chemical oxygen demand (r = -0.86, p<0.01) copper (r = -0.68, p<0.05). Akotoet[24] have reported similar results and total coliform (r = -0.69, p<0.05). The temperature has highly significant +ve correlation with nickel (r=0.87, p<0.01). The biological oxygen demand has significant -ve correlation with manganese (r=0-0.71,p<0.05).The Arsenic has highly significant and +ve correlation with copper (r = 0.66, p<0.05). Zinc has highly significant and +ve correlation with copper (r = 0.70, p<0.05) and iron (r = 0.70, p<0.05). Kar[25] have also reported similar results (Table 5).

The water quality parameters were correlated with each other significantly during summer. The pH showed significant positive correlation with electrical conductivity (r = 0.725, p<0.05) and chemical

oxygen demand (r = 0.686, p<0.05). Tripathi[26] have reported similar findings. The biological oxygen demand showed significant and -ve correlation with manganese (r= -0.672, p<0.05). The chemical oxygen demand showed highly significant -ve correlation with nickel (r = -0.83, p<0.01). The arsenic showed significant and -ve correlation with iron (r = -0.79, p<0.05) and +ve with cadmium (r = 0.060) and lead (r = 0.350). Similar finding has been reported by Akotoet.[24] The cadmium showed significant and +ve correlation with manganese (r=0.77, p<0.05) presented in Table 6.

Table 7:Water quality index in selected Educational Institutes

	Schools	WQI
1	S1	25.80
2	S2	28.16
3	S3	31.38
4	S4	35.75
5	S5	32.03
6	S6	32.72
7	S7	36.38
8	S8	33.31
9	S9	30.91

Water Quality Index (WQI)
The WQI ranged from 25.80 to 36.38 in selected educational institutes (Table7). The WQI for all the selected educational institutes in Solan district categorized as excellent.

Conclusions
The study revealed that various water quality parameters of drinking water in selected educational institutes were found to be within the prescribed limits of BIS and WHO except iron (0.63 to 0.95 mgl^{-1}), which was above the limit. The(WQI) in selected schools was found to be excellent.

Conflict of Interest

The authors do not have any conflict of interest.

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