Research Article

Physico-chemical and bacteriological analysis of natural water resources of Mandi town of Himachal Pradesh

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Abstract

Physico-Chemical and Bacteriological analysis were performed on natural water resources of Mandi town of Himachal Pradesh to assess the quality of drinking water. A total of five samples from different natural water reservoirs were analysed. Various physical parameters including: temperature, pH, colour/odour and chemical parameters such as Alkalinity, Fluoride, Chloride, Calcium hardness, Phosphate, Iron and Arsenic were recorded using standard methods. Physico-Chemical analysis revealed that almost all the samples analysed were within the prescribed parameters recommended by Indian and WHO standards with exception of sample 1 that had increased level of fluoride (1.5 ppm), sample 2 had high level of phosphate (5.0 ppm) and samples 1, 2, 3 and 5 that showed alarming calcium levels of 90, 90, 140 and 80 ppm respectively. Similarly, bacteriological analysis of water samples were also conducted using Multiple tube method. The results were interpreted 48 hours of incubation of water samples in MacConkey broth medium in accordance with Mc Cardy probability table. Results showed that all the samples were contaminated with coliforms.

Keywords: Natural water resources, Physico-chemical analysis, Water bacteriology, Coliforms, Multiple tube technique

1. Introduction

During last few years, there has been increasing realization that water resources are limited and must be conserved, leading to the necessity for stringent quality control. Most communicable diseases of greatest impacts on mankind are waterborne, and a permanent reduction in morbidity and mortality can be achieved by providing safe drinking water (Gupta, 2016). Safe drinking water is essential to humans and other life forms but due to increased population, industrialization, indiscriminate use of pesticides and man-made activity, water is highly polluted with hazardous contaminants disrupting human health due to water borne diseases. Globally, nearly 4 billion clinical cases of diarrhoea and more than nearly

3 billion deaths occur due to water borne infections (Yasin et al., 2015). According to a report by World Health Organization and the United Nations Children's Fund (2000), it is estimated that approximately 1.1 billion drink unsafe water and nearly 88% of diarrheal diseases are attributed to unsafe water, sanitation and hygiene. It was reported that, in India 37.7 million people suffer due to waterborne diseases annually and nearly 1.5 million children die due to diarrhoea alone (Kumar, 2014). Therefore, it is necessary that the quality of water should be checked at regular intervals (Patil et al., 2012).

1.1 Study area: The study was conducted in Mandi town of Himachal Pradesh. Mandi is a major town of Mandi district and located in the heart of Himachal Pradesh. The town has mythological and historical significance. It is also referred as Chotti Kashi as there are many ancient temples in the town as well as on the banks of river Beas having unique architecture. The town has number of natural water reservoirs and water from these sources is used for daily household and drinking purposes. Moreover, natural water resources have utmost significance as water from these sources is used in all religious and marriage ceremonies. Therefore, present study was done to assess the physico-chemical and bacteriological quality of drinking water from natural resources.

2. Materials and Methods

The water samples were collected from five different natural water sources in the morning within the month of March 2020 (Table-1). Temperature, pH and odour were recorded at the time of collection by using thermometer and digital pH meter, whereas, the physico-chemical parameters such as: pH, Total Alkalinity, Fluoride, Chloride, Calcium hardness, Phosphate, Iron, Arsenic were recorded in the laboratory by using standard methods (APHA, 1985;Trivedi et al., 1985). Similarly, bacteriological tests i.e Test for growth of bacteria (Multiple tube method using MacConkey broth) was used for testing the quality of water. In multiple tube method, 10, 1 and 0.1 ml water from different water samples was inoculated into broth medium tubes. The tubes were incubated at 35° C for 48 hours and coliforms were identified by the production of gas (WHO, 1997) A statistical range of number of coliforms bacteria were determined by most probable number (MPN) for growth of bacteria in accordance with McCardy probability table.

Table-1: Location of water samples from Mandi Town of Himachal Pradesh.

Sample No.	Source	Location
1	Natural water reservoir	Khaliyar
2	Natural water reservoir	Shiva bawdy
3	Natural water reservoir	Near hospital
4	Natural water reservoir	Purani Mandi
5	Natural water reservoir	Jail road

3. Results and Discussion

The water samples collected from five different localities of Mandi town of Himachal Pradesh. All the water samples were analysed showing various parameters against Indian and WHO standards.

3.1 *Physical parameters:*

Temperature plays an important role in physico-chemical and bacteriological analysis of water samples. There is increase in the temperature in the area under study from the month of March. The temperature of natural water resources varies from 20^0C to 23.5^0C with maximum temperature was found in sample number 2 (Table-2).

pH ranges from 6.47 to 7.81which is within the prescribed parameters (WHO, 2004) and standard range of 6.5 to 8.5.

Table-2: Physical parameters of different water samples.

Sample No.	Temperature	pH	Colour/ Odour
1	21^oC	7.02	Colourless/Tasteless
2	23.5^oC	6.47	Colourless/Tasteless
3	20^oC	6.70	Colourless/Tasteless
4	21.5^oC	7.81	Colourless/Tasteless
5	21^oC	6.97	Colourless/Tasteless

3.2 Chemical parameters:

The increase in alkalinity is due to increase in carbonates (CO_3^{2-}) and bicarbonates (HCO_3^-) in water. It is the quantitative capacity to react with a strong acid to a designated pH (Simpi et al., 2011). Alkalinity varies from 75 to 125 ppm in terms of $CaCO_3$ (Table-3). It is within the admissible range of Indian standard i.e. 200 ppm and WHO standard (125-350 ppm).

Fluoride ions show dual significance. High concentrations cause dental fluorosis, whereas, low concentrations cause dental caries (Gupta, 2016). The value of Fluoride ranges from 1.0 to 1.5 mg/l which is within the range with standard WHO recommendation. However, sample no. 1 shows increasing fluoride levels as compared with Indian standards.

Chloride is one of the major inorganic anion in water. Water becomes salty by chloride concentrations. Increase in the level of chloride causes eye and nose irritation, stomach discomfort and also increases corrosive character of water (Patil et al., 2012). The level of Chloride fluctuates from 30 to 70 ppm which is also within both and Indian and WHO Standard i.e. 250 ppm and 200 ppm respectively.

Calcium is the major constituent of various types of rocks and most common constituent of natural waters. Calcium is the cause for hardness in water and incrustations in boilers (WHO, 2004). Calcium hardness varies from 75 to 140 ppm in water samples which is within WHO (75-200 ppm) standards but alarming in sample no. 1, 2, 3 and 5 as indicated by Indian standard (75 ppm).

High level of Phosphate i.e. 5.0 ppm was found in sample no. 2 (Table-3). High phosphate levels stimulate microbial growth and increases rancidity of water due to bacterial action, resulting in unpleasant taste and odour in drinking water. Higher levels of phosphate was also reported in the water samples, which is either mainly due to rain, surface run off, agriculture run off and washer man activity could have contributed to inorganic phosphate content. Excess phosphorus in water can be harmful as it stimulates plant and algal growth and is the main cause of eutrophication, which may eventually deplete oxygen from the water (Simpi et al., 2011).

Iron ions show both benefits and disadvantages. Iron is an essential element for haemoglobin, myoglobin and a number of enzymes and its deficiency lead to anaemia and loss of well-being. However, its overload causes severe health problems in human beings such as liver cancer, diabetes, cirrhosis of liver, heart diseases and infertility etc. The presence of higher concentrations of iron changes colour, taste, odour of water, leaving stains on clothes and corrodes water pipe lines (Behera et al., 2012). But, iron ions were not found in any of the samples analysed from Mandi town.

Arsenic occurs in natural water forming compounds with sulphur and heavy metals. However, high concentrations are alarming because of toxic nature of Arsenic. It was reported that arsenic exerts its toxicity by inactivating up to 200 enzymes, especially those involved in cellular energy pathways and DNA synthesis and repair. Acute arsenic poisoning is associated initially with nausea, vomiting, abdominal pain, and severe diarrhoea. Chronic arsenic toxicity results in multisystem disease. Arsenic is a well documented human carcinogen affecting numerous organs (Ratnaike, 2003). But, arsenic was not found in any of the samples analysed.

Table-3: Chemical parameters of different water samples.

Parameters	Sample No.1	Sample No.2	Sample No.3	Sample No.4	Sample No.5	Indian Standard	WHO Standard
Alkalinity (ppm in terms of $CaCO_3$)	125	110	100	75	100	200	125-350
Fluoride (ppm)	1.5	0.0	1.0	1.0	1.0	0.6-1.2	1.5
Chloride (ppm)	60	50	70	40	30	250	200
Calcium hardness (ppm)	90	90	140	75	80	75	75-200
Phosphate (ppm)	0.0	5.0	0.0	0.0	0.0	0.3	-
Iron (ppm)	0.0	0.0	0.0	0.0	0.0	0.3	0.1
Arsenic (ppm)	0.0	0.0	0.0	0.0	0.0	0.05	0.05

3.3 *Bacteriological parameters:*

Bacteriological analysis showed that MPN (Most Probable Number) for growth of bacteria is maximum for sample 3, 4 and 5 (Table-4).

Table-4: Bacteriological parameters for different water samples.

Sample No.	No. of infected test tubes			MPN of growth of bacteria (per 100 ml)
	10 ml	1 ml	0.1 ml	
1	3	3	3	>1600
2	3	0	0	23
3	3	3	3	>1600
4	3	3	3	>1600
5	3	3	3	>1600

4. Conclusion

It is concluded that most of the water samples are within Indian and WHO standards. However, level of Fluoride in sample no. 1, phosphate level in sample no. 2 and calcium level in sample no. 1, 2, 3 and 5 are alarming. Results also indicated that all samples were found contaminated with coliforms. However, MPN is maximum for sample 3, 4 and 5.

Therefore, it is recommended that water used for drinking/domestic purpose should be either boiled or purified with purifying agents/ water filters should be installed.

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