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Assessment of bacteriological quality of water from different sources in Himachal Pradesh -Hamirpur study

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Abstract
Introduction: Water quality has been linked to health outcome across the world. Availability and easy access to safe and quality water is a fundamental human right. Quality of water need to be assessed regularly for the good health of people. Present study was done to assess the bacteriological quality of drinking water in the year April 2022 to February 2023 from six blocks of Hamirpur district of Himachal Pradesh.
Methods: A total of 400 water samples were from different sources were collected and tested. The bacteriological analysis of water was done by multiple tube technique Results were interpreted after 48 hours incubation of water samples in MacConkey bile broth Medium in accordance with MacCardy probability table.
Results: of the 400 samples tested 289 (72.25%) were found to be satisfactory while 111 (22.75%) were unsatisfactory. Taunidevi block revealed the least contamination with 12/65 samples while Nadaun and Sujanpur followed by 22 samples each. Household taps showed the contamination of 35.1% (39/83), Natural resources and hand pumps were found to be contaminated 22 each E. coli was found to be the predominant contaminant.
Conclusion: Results of the study calls for public awareness, immediate attention and action by the concerned authorities. A comprehensive development program must include a practical and cost effective approach to provide potable water and a more aggressive approach to reduce the risk of water related transmission of diseases.

Keywords: Analysis of potable water, bacterial contamination, MPN method, coliforms, *E. coli*, water supply

Introduction
India is rich in water resources, being endowed with a network of rivers and blessed with snow cover in the Himalayan range that can meet a variety of water requirements of the country. The rivers India play an important role in the lives of the Indian people. Potable water is an essential ingredient for good health and the socio-economic development of man. Availability and easy access to safe and quality water is a fundamental human right.1 Availability of clean water and sanitation for all has been listed as one of the goals to be achieved by the year 2030 for sustainable development by the United Nations General Assembly (UNGA) 2. In developing countries, biological contamination of drinking water is a major concern for public health authorities. According to the World Health Organization, approximately 5% of all deaths in these countries are directly related to water diseases resulting from poor quality of drinking water and lack of hygiene and sanitation3. Water pollution is a global problem and one that does not respect national boundaries.4 AIIMS New Delhi found an alarming prevalence of various diseases causing microbes in drinking water and recreational water. 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 5. Water is an important component to sustain everyone's life. It is one of the basic human rights to have access to safe drinking water for maintaining optimal health. Currently, 2.2 billion people have limited access to safe drinking water, and by 2025, half of the world's population will be living in water-stressed areas 8, 9. The major health risk from drinking water is caused by the presence or introduction of coliforms in the drinking water supply

which may come from the non-treated sewage systems sited nearly the water source or distribution system as well as overflow from them. Water analysis mainly focuses on coliforms, thermo tolerant coliforms and E. coli is used as an indicator of faecal contamination of water. Faecal coliforms (or thermo tolerant coliforms) are coliforms which can ferment lactose at 44.5 °C, 10. The presence of faecal coliforms indicate recent contamination of water sources with human and animal wastes and this 'indicator organisms' indicate possible presence of other potential pathogens, The use of the coliform group as an indicator of faecal contamination is subject to strict governmental regulations. E. coli is the major coliform among the intestinal flora of warm blooded animals and its presence is associated with faecal contamination, therefore no *E. coli* is allowed in drinking water. Thus, detection of indicator organism is considered as the best method to detect the effectiveness of disinfection process and also recent and frequent faecal contamination of water 11. The most common waterborne disease, diarrhoea, had an estimated annual incidence of 4.6 billion episodes due to unsafe water supply and about 2.2 million deaths every year. The greatest risk to public health from microbes in water is due to the consumption of drinking water that is contaminated with human and animal excreta. Therefore, bacteriological water quality can be described in terms of the absence or presence of the indicator organism's i.e. faecal coliforms, Escherichia coli, and coliphages which were found to be more common in various unprotected water sources12,13. So, the presence of these organisms is considered an indication of water pollution and also leads to an increase in the risk of contracting a water-borne illness.

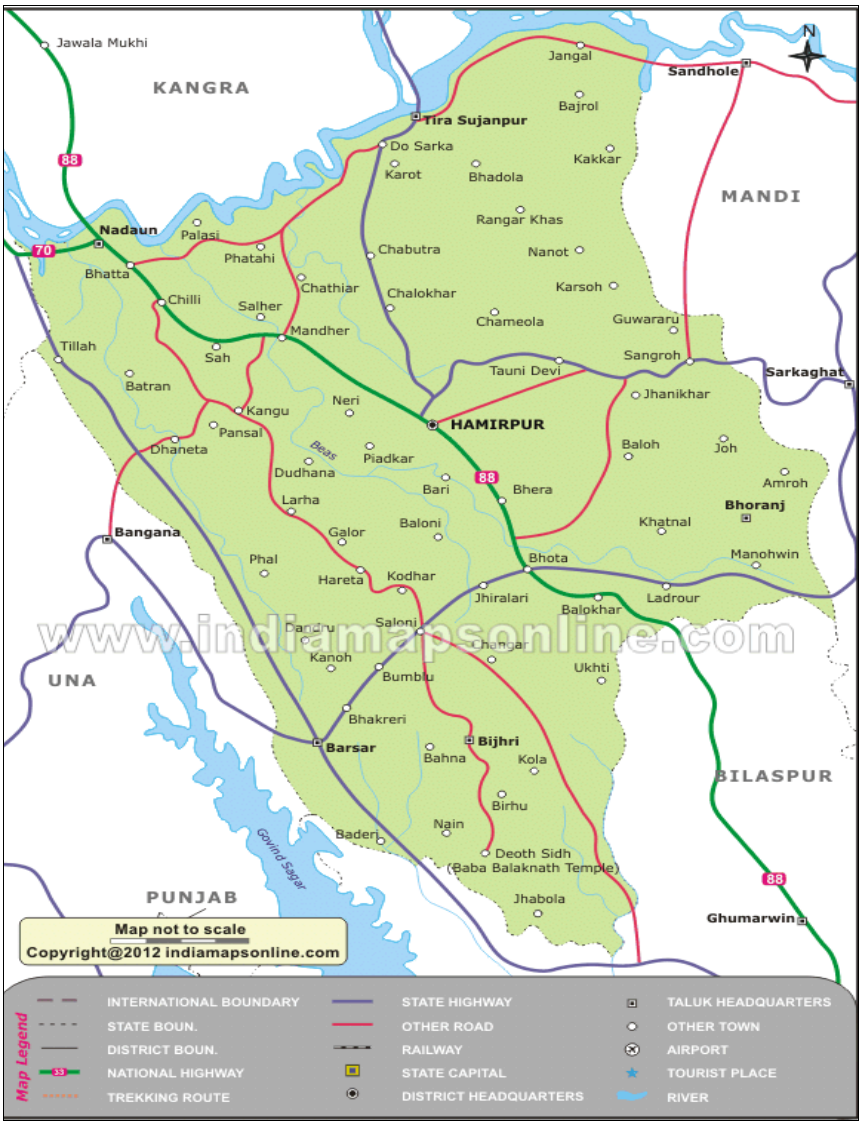
A few studies have been conducted in North India specially Himachal Pradesh Hence, the objective of this research was to provide information on the bacteriological quality of drinking water or its suitability for human consumption.

The present study was designed to analyse the microbiological quality of the available drinking water from various sources from Hamirpur District of Himachal Pradesh. Water quality has been linked to health outcome across the world. Availability and easy access to safe and quality water is a fundamental human right. Quality of water need to be assessed regularly for the good health of people. Present study was done to assess the bacteriological quality of drinking water in the year April 2022 to February 2023 from six blocks of Hamirpur district of Himachal Pradesh.

Aims and objectives of the study

1. To assess the Bacteriological, Physiological and heavy elements In water.
2. To spread awareness about safe potable water, avoiding pollution of water and saving of water through sensitizing talks, printed materials for community education using different modes to students of schools,

Study area: Hamirpur District of Himachal Pradesh



Description of study area

Hamirpur District lies in the South West part of the state and constitute the central micro region of Himachal Pradesh. Tract is hilly covered by Shivalik range situated between 76 0 18'to 76 0 44' East longitudes and 31 0 25' to 310 52' North latitude. Total population of Hamirpur is 454,768 according to the census of 2011.

It has three sub divisions and five tehsils. The main traditional sources for the drinking water in Hamirpur area are wells, boaries and khatries. Hamirpur district forms a part of Changer belt, which is an acute water scarcity area of Himachal Pradesh and experiences almost severe drought conditions. Khatries / traditional water harvesting structures are very common in the Northern part of the district in and around Sujanpur- Sachui- Patlender – Ahwadevi area. Traditional methods of water harvesting like roof top rainwater and collection of rain water in tanks called Talavs are still in practice.

Methodology

Study was planned after the approval from the institutional Ethics committee.

Type of study: Water testing, Community education

Study area: Hamirpur Di strict of Himachal Pradesh

Study population: Students of schools, Colleges and general public in Hamirpur Distt.

Four hundred (House hold taps n= 83, Hand pumps n=83, natural resources n=78, Filters n =78 and packed water n = 78. Water samples were collected aseptically for bacteriological testing by well-trained team of Laboratory Technicians supervised by a senior faculty of Microbiology Department of Dr. Radhakrishnan Government Medical College Hamirpur during April 2022 to February 2023. The method of water sample collection at each source was according to the World Health Organization (WHO) Guidelines for drinking water quality assessment and the Indian Council Medical Research (ICMR). The samples were stored at 2 °C-8 °C in a dark area to avoid changes in the bacterial count until analysis and transported strictly in accordance with the procedures and guidelines described in the WHO's guidelines for drinking water quality. Samples were collected from all the six blocks of District Hamirpur.

Water samples Testing method

Water sample testing

The total coliform count test was based on the multiple tube fermentation method to estimate the Most Probable Number (MPN) of the coliform organism in 100 mL of water for the diagnosis of bacteriological contamination. Double strength and single strength MacConkey broths in tubes containing Durham's tube for indication of gas production were used. The media contain neutral red as an indicator. Measured amounts of water samples were added by sterile graduated pipettes 10 mL of water each to five tubes of 10 mL double strength medium, and 1 mL of water each to five tubes of 5 mL single strength medium. 0.1ml of water was added into a set of five tubes with 5ml ingle strength macconkey broth. The inoculated tubes were incubated at 37o C for 48 hours. An estimate of coliform count per 100 mL was made from tubes showing acid and gas production using McCray's probability table.

The presumptive coliform count per 100 mL were interpreted as:

- 0: Excellent
- 1-3: Satisfactory
- 4-10: Suspicious

Unsatisfactory/ Highly unsatisfactory > 10

Tubes showing acid and gas were subculture to single strength MacConkey broth and incubated at 44 degree c for overnight and Eijkman test to test for Thermo tolerant E.coli and specific microorganisms were isolated and identified in unsatisfactory water samples. Microorganisms were identified by using standard microbiological methods/ biochemical tests.

Samples were processed by MPN Method for coliforms. The total coliform count was based on the multiple fermentation method to estimate the most probable number (contamination). Water samples tested positive for Coliforms were subject to Eijkman test incubating at 44 degree Celsius for overnight to check for thermotolerent E.coli, indole production. Catalase production for confirmation of Thermotolerent *E. coli.*

Awareness regarding saving, avoiding pollution and conservation of drinking water was done through Power point presentations talks in 23 schools, 6 colleges and staff of 6 block hospitals of the district. This was a direct approach reaching out to general public to students and staff of the institutions. Printed multicolored pamphlets were distributed among students, staff and people of villages. Distribution of pamphlets was an indirect approach to send the message to the family members of the staff and students.

Twenty representative water samples from six blocks were tested at Soil and water testing Laboratory of Punjab Agricultural University Ludhiana for heavy elements like Arsenic, Boron, Calcium, Cadmium, Chromium, Copper, Iron, Potassium, Manganese, Sodium, Nickel, Phosphate, Lead, Sulphur and zinc. Elevated levels of these heavy elements can cause various health hazards such as Hypertension, liver disorders, damage of immune system, kidney, skin, blood, cardiovascular diseases, bronchitis, thyroid gland damage etc.

Results

A total of 400 water samples were collected from various sources from Hamirpur district during April 2022 to February 2023 in the department of Microbiology of Dr Radhakrishnan Govt. Medical College Hamirpur Himachal Pradesh. Table 1. Showing Distribution of water collected from different sources.

These samples were tested for physiochemical properties as well for the presence of coliform bacilli using presumptive coliform test. Table 1. Shows the distribution of water collected from different sources.

Table 1: Samples tested in Hamirpur District

S.no.	Name of block	Number of samples collected	Unsatisfactory samples
1	Taunidevi	65	12
2	Nadaun	65	22
3	Bhoranj	66	20
4	Galore	67	21
5	Barsar	67	14
6	Sujanpur Tihra	70	22
Total		400	111

Of the 400 samples tested 289 (72.25%) were of excellent quality, 11 (2.75%) satisfactory, 23 (5.75%) suspicious and 78 (19.5%) unsatisfactory according to MacCardy probability table. Table 2 depicts the presumptive coliform count of the samples tested.

Table 2: Presumptive coliform count of the samples tested.

Sr. No.	Grade of water samples	Presumptive coliform count / 100 ml.	Number (Percentage out of 400
1	Excellent	0	289 (72.25)
2	Satisfactory	1-3	11 (02.75)
3	Suspicious	4-9	22 (05.75)
4	Unsatisfactory	More than 10	78 (19.50)

Of the 111 unsatisfactory samples following contaminating organisms were detected on solid media subcultures.

Table 3: Contaminating organisms

Sr. No	Contaminant	Number	Percentage
1	*E. coli*	40	36.3
2	*Pseudomonas sp.*	18	16.21
3	*Proteus sp.*	17	15.3
4	*Citrobacter sp.*	10	09.0
5	*Enterococcus sp.*	07	06.3
6	*Staphylococcus sp.*	07	06.3
7	*Klebsiella sp.*	04	03.6
8	*Bacillus sp.*	04	03.6
9	*Enterobacter sp.*	03	02.7
10	*Acinetobacter sp.*	01	0.90
	Total	111	100

Since 27.25% of the samples were found to be nsatisfactory, source wise distribution was done

Table 4: Showing source wise distribution of unsatisfactory samples

Sr. No	Source	Total samples tested	Samples found unsatisfactory and percentage
1	Taps	83	39 (35.1)
2	Natural source	78	32 (28.8)
3	Hand pump	78	32 (28.8)
4	Filter	83	08 (7.2)
5	Bottled water Pouch	78	00 (00)
6	Total	400	111

Hamirpur District has six blocks (Taunidevi, Nadaun, Bhoranj, Galore, Barsar and Sujanpur Tira) Results of each block is shown below.

Table 5: Results of Samples tested in Taunidevi block

S. No.	Source of water collection	Number of samples collected	Unsatisfactory samples
1	Natural resources	13	02
2	House hold	13	03
3	Filtered WATER	13	02
4	Hand pumps	13	05
5	Bottled water	13	00
Total		65	12

Table 6: Results of Samples tested in Nadaun block

S. No.	Source of water collection	Number of samples collected	Unsatisfactory samples
1	Natural resources	13	09
2	House hold	13	05
3	Filtered water	13	01
4	Hand pumps	13	07
5	Bottled water	13	00
Total		65	22

Table 7: Results of Samples tested in Bhoranj block

S. No.	Source of water collection	Number of samples collected	Unsatisfactory samples
1	Natural resources	13	05
2	House hold	13	08
3	Filtered water	13	02
4	Hand pumps	14	05
5	Bottled water	13	00
Total		66	20

Table 8: Samples tested in Galore block

S. No.	Source of water collection	Number of samples collected	Unsatisfactory samples
1	Natural resources	13	07
2	House hold	13	06
3	Filtered water	13	01
4	Hand pumps	15	07
5	Bottled water	13	00
Total		67	21

Table 9: Results of Samples tested in Barsar block

S. No.	Source of water collection	Number of samples collected	Unsatisfactory samples
1	Natural resources	13	02
2	House hold	13	06
3	Filtered water	13	01
4	Hand pumps	15	05
5	Bottled water	13	00
Total		67	14

Table 10: Results of Samples tested in Sujanpur Thira block

S. no.	Source of water collection	Number of samples collected	Unsatisfactory samples
1	Natural resources	13	07
2	House hold	18	11
3	Filtered water	13	01
4	Hand pumps	13	03
5	Bottled water	13	00
Total		70	22

Block Naudaun and Sujanpur showed 22 samples unsatisfactory each, Galore and Bhoranj tested 21 and 20 samples unsatisfactory each. Barsar revealed 14 and Taunidevi tested 12 samples unsatisfactory respectively.

Discussion

With the growing population and industrialization, the portability of drinking water has been decreased due to pollution and improper sanitization**.** Water quality has been linked to health across the world. Water is a precious natural resource and one of the most essential requirements for all kinds of life, as it could not be replaced by any kind other known natural or man-made compound. After air, potable water is second essential need for existing of human life in this planet earth.

Himachal Pradesh is located in north western Himalayas and is rich in water resources. In recent years these resources are drying and the amount of water flowing is reduced or they are dried completely. These resources are being contaminated by human activities. Studies by various researches have pointed out various quality issues in water supplied. The report quoting WHO said that more people would die of consuming contaminated drinking water and unsanitary conditions by the year 2020 than from AIDS. The quality of water is determined mainly by the coliform and bacteria count, apart from the degree of hardness. If coliform count is high, it is an indication of water pollution/ contamination with faeces.

The consumption of drinking water contaminated with pathogenic microbes of faecal origin is a significant risk to human health. As a standard procedure, water intended for human consumption is distributed to consumers after treatment. Nevertheless, the quality of treated water can deteriorate during distribution due to contamination and inadequate storage conditions. In developing world, especially in remote rural areas and industrial areas, over 3 million deaths per year are attributed to water-bone diarrheal diseases.

The provision of effective sanitation programs and access to safe drinking water have been a major problem for many developing countries. In the developing world, especially in remote rural areas and industrial areas, over three million deaths per year are attributed to waterborne diarrheal diseases, especially among infants and young children in poor communities [14] has been estimated that water, sanitation, and hygiene are responsible for 40% of all deaths and 5.7% of the total disease burden occurring worldwide. In the present study Taps were found to be the highest number 35.1% while Natural resources and Hand pumps were found to be 28.8% unsatisfactory each.

This could be due to the population growth, unplanned urbanization, poverty and others. This appears to be contamination with human and animal excreta. The possibility of open defecation is ruled out since Himachal has been declared open defecation free.

Our study also supports the WHO recommendation that E. coli is the most discriminating marker for faecal contamination and therefore a microbiological indicator of choice for drinking water portability and safety especially in developing countries with limited resources.

Present study is concurrent with other studies. However, a study from the sub-Himalayan region recorded that 12% of water samples were unfit for human consumption [17]. It might be due to the different study settings (hilly areas). This study has found 27.75.0% unsatisfactory samples which is lower as compared to other studies from Himachal Pradesh. Coliform count ranged between 2- 1600/ 100ml of water and *E. coli* count ranged from 1-26 / 100 ml of water. A study by Goel S and others in Kangra revealed much higher 81.3% in 2005 and 75% in 2006 unsatisfactory samples [18]. While Thakur SD and Panda AK 2012 showed that 91.7% piped water and 90% Natural resources were contaminated [19]. It has been seen that water leaving the treatment plant met bacteriological standards the detection of coliform bacteria in the distribution lines suggest that the water is contaminated in the distribution networks. This could be due to bacteria on biofilms or accidental point source contamination by broken pipes, installation and repair work [21]. Microbiological contamination of household water stored in containers could be due to unhygienic practices occurring between the collection and the point of use [22, 23].

Water lines are contaminated with sewage due to wrong practices adopted by citizens and water supply operators. Water supply lines work under pressure and sewage lines works on gravity flow. Both types of networks run parallel in the same street. But house service connections pass through across the pipe lines on both sides of houses. These connections start leaking due to various reasons while passing through drains, septic tanks and other structures. Sometimes the older connections are disconnected unscientifically.

Now most of the drinking water pipe lines works on intermittent supply. While these supplies water, these are pressurized positively but when the water supply is closed the negative pressure is created inside the pipeline so it starts sucking outside water inside it through leaks. Many times, the outside water may be sewage Water. This way sewage water reached into the drinking water pipe lines

Physiochemical parameters such as pH, odor, colour and TDS were determined using digital pH and TDS meter. Colour of samples visually. No odour was detected. pH ranged between 6.4 to 8.2 which is within the prescribed parameter (WHO 2004) and standard range of 6.5-8.5.

Twenty representative samples were tested at Soil laboratory PAU Ludhiana for heavy elements. Results of all the elements were within acceptable levels as per WHO standards. Elevated levels of heavy elements carry many health risks.

Data obtained from the survey was analyzed using

Microsoft excel and presented as descriptive statistic in the form of tables and graphs.

Conclusions

Since 27.25% of water saples were unsatisfactory for human consumption especially children and people who are immune compromised, since they are vulnerable to different types of waterborne diseases because their immune system in still developing it is important to determine the quality of water periodically on regular basis. Some disease causing microorganisms enter water from different sources and could cause diseases like Typhoid, Salmonellosis, Shigelloses, Hepatitis and Polio. Hence it is necessary to make regular sanitary checks on equipment, look for and correct structural faults, proper maintenance of water supply pumps and make arrangements of proper disinfection. We recommend a more consistent supply of treated municipal water in Hamirpur District and training of residents on hygienic practices of transportation and storage of drinking water from the source to point of use. There is a need of a comprehensive development program to include a practical and cost effective approach to provide potable water and a more aggressive approach to reduce the risk of water related transmission of diseases.

Conflict of Interest

Not available

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References

1. World Health organization (WHO) and United Nations Children Fund (2000) Global water and sanitation assessment 2000 report. Available shtt://www.wHO.int/water_sanitation_health/monitoring/globalasssessment/Acessed 5 July, 2014.
2. Kumar G. Necessity of bottled water industry in India: some facts. Chem.Sci Rev Lett. 2014;3:99-806.
3. Martone RS, Martins BE, Paternella SF, Razzolini M, Tereza P. Assessment of the Bacteriological Quality of Drinking water Consumed in a Condominium of students. Sch. Acad. J. Biosci. 2014;2(9):564-569.
4. Ronging Guo. Cross-border environmental pollution and human health. Cross – Border Resource management Fourth Edition; c2021. p. 291-337.
5. Yasin M, Ketema T, Bacha K. Physio-chemical and Bacteriological quality of drinking water of different sources. MBCRes Notes. 2015;8:541.
6. Mberekpe P, Eze N. Effect of preservation on the quality of sachet water consumed Education Journal. 2014;6(7):25-30.
7. Pathania Singh Dhirendra, Bhardwaj Payal, Pathania Singh Mamta. Microbial Study of Water Samples Collected from Different Districts of Himachal Pradesh International Journal of Progressive Research in Science and Engineering. 2021Aug, 2(8).
8. Miner CA, Dakhin AP, Zoakah AI, Zaman M, Bimba J. Physical and microbiological quality of drinking water sources in Gwafan Community, Plateau State, Nigeria. Pyrex J Res Environ Stud. 2016;3(1):01-06.
9. World Water Day 2022: Groundwater, invisible but vital to health. https://www. who.int/news-room/feature-stories/detail/world-water-day-2022-groundwaterinvisible-but-vital-to-health. (Accessed on 5th May, 2022).
10. World Health Organization. Progress on household drinking water, sanitation and hygiene 2000-2017: special focus on inequalities. World Health Organization; c2019.
11. Payment P, Waite M, Dufour A. Introducing Parameters for the Assessment of Drinking Water Quality. In: Dufour AP. (Ed.) Assessing Microbial Safety of Drinking Water. London: Iwa Publishing; c2003.
12. Rodríguez DC, Pino N, Peñuela G. Microbiological Quality Indicators In Waters Of Dairy Farms: Detection Of Pathogens By Pcr In Real Time. Science of the Total Environment; c2012. p. 427–428, 314-318.
13. Zamxaka M, Pironcheva G, Muyima N. Microbiological and physico-chemical assessment of the quality of domestic water sources in selected rural communities of the Eastern Cape Province, South Africa. Water SA. 2004;30(3):333-40.
14. Kolawole OM, Afolayan O. Assessment of groundwater quality in Ilorin, North Central Nigeria. Arid Zone Journal of Engineering, Technology and Environments. 2017;13(1):111-26
15. Kumar D, Malik S, Madan M, Pandey A. Bacteriological analysis of drinking water by MPN method in a tertiary care hospital and adjoining area Western UP, India. J Environ Sci. 2013;4:17- 22.
16. Pruss A, Kay D, Fewtrell L, Bartrem J. Estimating the burden of disease due to water, sanitation and hygiene at global level. Environ Health Perspect. 2002;110:537-542.
17. Sidhu S, Malhotra S, Devi P, Gupta A. Bacteriological analysis of the drinking water from different schools in Northern India: A concern in developing countries. International Journal of Medical Research and Review. 2016;4(4):26.
18. Bhagra S, Singh D, Sood A, Kanga A. Bacteriological profile of water samples in and around Shimla hills: A study from the sub Himalayan region. Int. J Community Med Public Health. 2017;4:1966-71.
19. Goel S, Sood R, Mazta S, Bansal P, Gupta A. Bacteriological quality of water samples of a Tertiary Care Medical Centre Campus in North Western Himalayan region of India. The Internet journal of Third world Medicine. 2006, 5(1).
20. Thakur SD, Panda AK, Laboratory investigation of drinking water sources of Kangra Himachal Pradesh. The journal of communicable Diseases. 2012;44(2):103-108.
21. WHO, Guidelines for Drinking water quality. Recommendations (3rd ed). Geneva Switzerland. 2004, 1.
22. Karikari AY, Ampofo JA. Chlorine treatment effectiveness and physico-chemical and bacteriological characteristics of treated water supplies in distribution networks of Accra-Tema Metropolis, Ghana. Appl. Water Sci. 2013;3:535-543. doi: 10.1007/s13201-013-0101-6. [CrossRef] [Google Scholar]
23. Thompson T, Sobsey M, Bartram J. Providing clean

water, keeping water clean: An integrated approach. Int. J. Environ. Health Res. 2003;13:S89-S94. doi: 10.1080/0960312031000102840. [PubMed] [CrossRef] [Google Scholar]

24. Cronin AA, Breslin N, Gibson J, Pedley S. Monitoring source and domestic water quality in parallel with sanitary risk identification in Northern Mozambique to prioritise protection interventions. J Water Health. 2006;4:333-345. Doi: 10.2166/wh.2006.029. [PubMed] [CrossRef] [Google Scholar]

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