*International Research Journal of Environmental Sciences*_____ ISSN 2319–1414
Vol. **10(4),** 20-23, October **(2021)** *Int. Res. J. Environmental Sci.*

Review Paper

A review on contamination of drinking water due to pathogenic microbes and water-borne illness in Uttarakhand, India

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Available online at: www.isca.in, www.isca.me
Received 8th June 2021, revised 18th August 2021, accepted 19th September 2021

Abstract

Microbes are found in all places including drinking water and affect our life directly or indirectly. They include non-pathogenic as well as disease causing pathogenic species. Drinking water, a key resource of our food supply has been invaded by countless pathogenic microbes. The main cause of this problem lies in the transportation machinery of drinking water which is riddled with ineffective and obsolete components resulting in chemical as well as microbial contamination leading to water-borne afflictions. Hence, regular and systematic surveillance of drinking water and its distribution networks for harmful microbes is needed to determine the level of contamination. A precise review of literature on contamination of drinking water due to pathogenic microbes and disease outburst in Uttarakhand was conducted. The study concluded that total coliform and faecal coliform contamination in raw water such as rivers and lakes is more than water treatment plants. Although ground water was found to be satisfactory.

Keywords: Total coliform, Faecal coliform, MPN analysis, Disease outburst, Water-borne diseases.

Introduction

Water is an essential but limited natural resource and is considered a vital need of life universally. The usefulness of water in sustenance of human life is a well-known fact, however a closure inspection of our water resources today gives us a terrible jolt. Uttarakhand in particular boasts of a wide array of natural water bodies, however in recent years the quality of this precious resource has suffered. Water is being contaminated through industrial waste, sewage outflow and fecal discharge of human and animal origin, all of which has negatively affected it.

Water is necessary for sustenance of life on earth because it is an important component of the tissues of most living things comprising up to two-third of the human body[1]. However, drinking water quality in Uttarakhand has arisen as a major problem which is getting the attention of researchers and government. Distribution channels of drinking water are riddled with numerous defects thus causing chemical as well as harmful microbial contamination of the very elixir of life. Microbes are believed to be omnipresent thus precautions should be taken during the supply and distribution of drinking water. Water in its transportation route will be subjected to quality check for chemicals as well as microbes, as the microbes will always be present in drinking water to some extent[2].

Faeces can be a source of disease-causing pathogenic micro-organisms. Thus, the greatest health risks are associated with ingestion of faeces contaminated water[3]. Assessment of quality of drinking water is a vital need of present-day and requires ample manpower due to the importance of the task. Therefore, timely quality checks of drinking water are necessary before supply. People's access to safe drinking-water is a constituent of their basic human right as mentioned in the international health policy laid down by the World Health Organization. Improving access to safe drinking-water can result in perceptible benefits and a person's overall well-being.[3]

For the making of this review article, we collected and analysed data regarding microbial contamination of water from various published research articles. The aim of this review paper is to put forward a well-organized data spectrum regarding microbial contamination of water resources/drinking water in Uttarakhand. This article is, hence, framed to analyze current works in a systematic and precise manner to provide a reference for future studies regarding the subject. Further, the influence of water resources development on microbial contamination, future challenges, and recommendations are summarized.

Methodology

A precise review of works on pathogenic microbial contamination of water was conducted. Articles were downloaded from high profile journals and used for writing this review article. A search was conducted using these phrases: contamination of drinking water, contamination of water due to microbes in Uttarakhand, guidelines for improving drinking water quality. The search engines used to download the articles were Base-search.net, PubMed, Google Scholar, Microsoft Academic, Science Direct and Google chrome. Guidelines of

World Health Organization (WHO) were also taken into consideration. Data presented and analyzed in this review article was collected from research papers that included the studies on pathogenic microbial/ bacterial contamination of surface water/ drinking water and disease outburst due to contaminated drinking water in Uttarakhand state of India.

Results and Discussion

Total coliform and Faecal coliform: Coliform bacteria are found in the gastrointestinal tracts of humans and other mammals, and are excreted through their faecal wastes and got their way into water. Coliform bacteria are negative for gram staining, rod shaped, facultative anaerobic and they do not form spores. On incubation at 35–37°C, they can ferment lactose resulting in the production of acid and gas.

Faecal coliforms are also the group of total coliform bacteria which exclusively present in the intestine and excreted with feces of animals and humans. *Escherichia coli* are the key species in the faecal coliform group. Other coliform bacteria are *Citrobacter, Enterobacter, Streptococcus and Klebsiella.* The faecal contamination of water is indicated by the presence of *E. coli, and* is also an indication of the incidence of other disease-causing micro-organisms too.

Most Probable Number Analysis: To test drinking water quality i.e., water is potable or not in terms of bacterial contamination, a popular method, Most Probable Number (MPN) analysis is applied. This method is commonly used in estimating bacterial contamination in water and soil. The statistical analysis based on the indiscriminate dispersion of microbes per volume in a given sample is done in this analytical method. The MPN count is considered a rather simple and reliable test for detection of coliform bacteria.

United States Environmental Protection Agency (EPA) has been established Maximum contaminant levels (MCLs) for drinking water quality[4]. MCL is the permissible limit on the sum total of a substance that is acceptable in municipal water systems under the Safe Drinking Water Act (SDWA). The limit is stated as a concentration in milligrams or micrograms per litre of water[5]. Zero is the MCL for coliform bacteria in drinking water[6].

The sum of most probable number (MPN) for the presumptive coliform bacteria of water samples from Dehradun city ranges from 2-240 MPN/100ml [7]. The presumptive coliform count of most probable number (MPN) for water samples from river Asan, Dehradun ranges from 387MPN/100ml to 519 MPN/100ml for total coliform and 265.5MPN/100ml to 408.5 MPN/100ml for faecal coliform[8]. Water of the river Gola has dangerously high MPN counts ranging upto 1,600/100ml[9].

Two sampling periods (first in December, 2017 and second in May, 2018) were surveyed for the measurement of MPN values in various Himalayan rivers by Bisht *et al*. in December, 2017. The MPN value of total coliform per 100ml was observed to be 28 for the river Mandakini; 28 for the river Alaknanda and 21 for the confluence at Rudrapryag. However, in May, 2018 it was recorded to be 210 for the river Mandakini; 1100 for the river Alaknanda and 1100 for the confluence[10].

MPN values for the total coliform bacteria during pre-monsoon season were recorded from 0 to160 colonies/100ml and in post-monsoon season the MPN values for these micro-organisms were recorded as 9 colonies/100ml for the river Alaknanda at Srinagar sampling site. While the MPN counts for fecal coliform during pre- monsoon season were recorded as 75 colonies/100ml, and on the other hand, the same sites during post-monsoon season, were found to be having no fecal contamination[11].

Disease outbreak: The water that we ingest in our system and our overall health are closely intertwined. Thus, afflictions arising from contaminated drinking water put a major burden on the proper functioning of our bodily systems. Systematic measures to improve drinking water quality reap significant paybacks to our wellbeing[3]. In rural as well as town isolated areas there is a discernible lack of filter and chlorination processes which results in consumption of water that is filled with harmful elements and causes disease. These conditions arise due to lack of cost-effective machinery involved in water purification due to which many of these places never receive proper treatment plants which triggers outbreaks of water-borne disease. Throughout chronicled history, waterborne illness outbursts due to numerous pathogenic microbes and inefficient drinking water transportation systems and their mismanagement have had adverse effects on public health all over the world[12].

In developing countries people experience pathogenic exposure chiefly from their drinking water. 1.7 million yearly deaths world-wide are attributed to infectious diarrhoea, a disease which is contacted due to poor quality of drinking water and improper sanitation of municipal water bodies and their surroundings. As the immune systems of children are quite sensitive to this disease, Nine out of ten deaths due to this disease are in children and almost all of the deaths are in developing countries[13]. In major faecal contamination events due to ineffective management, intestinal bacteria prove to be the riskiest contaminant[14].

Martolia *et al* conducted a study in July 2005 on outbreak of hepatitis E in three villages of the district Nainital, Uttarakhand. The village which reported the highest incidence (23%) had its water supply from a spring which was vulnerable in the sense that it had virtually no water purifying systems apart from stone bed filtration[15].

From July 2012 to August 2013 numerous areas of Kumaon region, Uttarakhand, suffering from occurrences of water borne viral hepatitis were observed. The results pointed to sewerages as the locus source of contamination of water supply[16]. Reports

on Hepatitis E indicates that hepatitis E virus (HEV) accounts for 50% of severe hepatitis cases and in most of the cases faecal-oral spread of HEV because of sewage contamination of water is a major concern to this date[17].

In June 2013, flash floods caused a great loss of human life and infrastructure in the Sub-Himalayan region of Uttarakhand, India. An outbreak of scrub typhus caused by *Orientia tsutsugamushi* occurred in the district of Chamoli, Rudraprayag and Pauri Garhwal after the disaster[18].

Awasthi *et al* leda study on outbreak of the jaundice in Lalkuan, Nainital district, Uttarakhand in March 2013, Lalkuan area of Nainital district reported cases of acute hepatitis. Following that water samples were collected from the local water bodies to test residual chlorine. As per the lab reports HEV was proves to be the major causative agent in this outbreak, one that was spread due to contaminated drinking water. Investigation into the environmental factors confirmed the sewage contamination of drinking water in the supply network was also a prominent cause of the outbreak. The leakage of pipeline was found to the major mechanical and man-made fault because the rate of attack was much more (29.4%) among those people who were exposed to the leaking pipeline than the ones who were not[19].

Lack of treatment plants at grassroots level is a cause of major concern as there are many pockets of areas in the state which get an indirect supply of water which is subjected to an apathetic treatment without proper mechanization and sanitation. The current machinery in rural areas is hardly subjected to sanitation and checks which makes for a huge concern. Also, lack of adequate disposal of human, animal, and household wastes are conducive to waterborne diseases. The major microbial risks to humans are due to ingestion of feacal contaminated drinking water, as feaces are the key source of pathogenic microbes and protozoans[3].

Conclusion

During the course of this analytical review, a tangible difference between water qualities of various sites was observed. MPN analysis showed that river Gola in Haldwani, river Asan in Dehradun and Alaknanda in Rudrapryag are highly contaminated while river Mandakini in Rudraprayg and Alaknanda in Srinagar showed lesser contamination.

From an in-depth analysis, it was inferred that the drinking water quality of two major cities of Uttarakhand, Dehradun and Haldwani is not satisfactory. Most often the water is contaminated with raw sewage and transported through the water networks, the pertinacity of microbes in water supply routes is quite pertinent to how far downstream from the site of contamination such water can cause severe illness and even death[7].

To prevent contamination of drinking water and water resources appropriate infrastructure and management plans like sewage treatment plant and their maintenance, industrial waste water treatment is required. Before supply of water to the public, routine tests of drinking water for contaminants, including total coliform bacteria and other such pathogens should be performed. Although most coliform bacteria are not pathogenic, many of the ones present in faecal matter are.

It is a must that water in treatment plants be purified by treatment methods based on the addition of chlorine and chlorine-based compounds in order to get rid of microorganisms. Chlorine compounds thus play a crucial role in water purification processes there by certifying that clean water is supplied to the consumers' homes.

References

1. Gaurav Naveen (2016). Detection of quality of water from different places of Dehradun, Uttarakhand state. *International Journal of Core Engineering and Management*, 2(10), 180-204.
2. Payment, P., Siemiatycki, J., Richardson, L., Renaud, G., Franco, E., & Prevost, M. (1997). A prospective epidemiological study of gastrointestinal health effects due to the consumption of drinking water. *International Journal of Environmental Health Research*, 7(1), 5-31.
3. Edition Fourth (2011). Guidelines for drinking-water quality. *WHO chronicle*, 38(4), 104-108.
4. Weinmeyer, Richard, Annalise Norling, Margaret Kawarski, and Estelle Higgins (2017). The Safe Drinking Water Act of 1974 and its role in providing access to safe drinking water in the United States. *AMA journal of ethics*, 10(2017), 1018-1026.
5. Ross, M David (2019). RE: National Primary Drinking Water Regulations: Perchlorate; Docket ID No. EPA–HQ–OW–2018–0780. (2019).
6. Acrylamide, O. C. (2009). National Primary Drinking Water Regulations. *Kidney*, 2(4), 1-7.
7. Rajendra, Sapkota, Dasgupta Rubin, and Malik Abhishek (2012). Microbiological quality of potable water in Dehradun city.
8. Khanna D. R., R. Bhutiani, Gagan Matta, Vikas Singh and Fouzia Ishaq (2012). Physico-chemical and microbiological status of River Asan in Dehradun Uttarakhand. *Environment Conservation Journal*, 13(1-2), 145-150.
9. Rawat, Vinita, Sanjay Kumar Jha, Arundhati Bag, Monil Singhai, and Chandra Mohan Singh Rawat (2012). The bacteriological quality of drinking water in Haldwani Block of Nainital District, Uttarakhand, India. *Journal of water and health*, 10(3), 465-470.

10. Bisht, Sarita, Ramesh C. Sharma, Swati Rawat, and Rahul Kumar. Physico–chemical attributes and bacterial diversity of river water at Rudraprayag, Garhwal Himalaya. *MOJ Eco Environ Sci*, 3(4), 277-282.

11. Tyagi, Shweta, Prashant Singh, Bhavtosh Sharma, and Rakesh Singh (2014). Assessment of water quality for drinking purpose in district Pauri of Uttarakhand, India. *Applied Ecology and Environmental Sciences*, 2(4), 94-99.

12. Ligon, Grant, and Jamie Bartram (2016). Literature review of associations among attributes of reported drinking water disease outbreaks. *International journal of environmental research and public health*, 13(6), 527.

13. Ashbolt Nicholas John (2004). Microbial contamination of drinking water and disease outcomes in developing regions. *Toxicology*, 198(1-3), 229-238.

14. Ashbolt, Nicholas John (2015). Microbial contamination of drinking water and human health from community water systems. *Current environmental health reports*, 2(1), 95-106.

15. Martolia, Harish Chandra Singh, Yvan Hutin, Vidya Ramachandran, Ponniah Manickam, Manoj Murhekar and Mohan Gupte (2009). An outbreak of hepatitis E tracked to a spring in the foothills of the Himalayas, India. *Indian Journal of gastroenterology*, 28(3), 99-101.

16. Rawat, Vinita, Ashok Kumar, Mukesh Kumar, Monil Singhai, C. M. S. Rawat and Sanjay Kumar Jha. Viral Hepatitis A and E Outbreaks in Kumaon Region of Uttarakhand. *National Academy Science Letters*, 39(1), 17-19.

17. Tripathy, Anuradha S., Meenal Sharma, Avinash R. Deoshatwar, Prasad Babar, Rakesh Bharadwaj and Omesh Kumar Bharti (2019). Study of a hepatitis E virus outbreak involving drinking water and sewage contamination in Shimla, India, 2015–2016. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, 113(12), 789-796.

18. Pal, Shekhar, Munesh Sharma, Swapna Kotian, Deepak Juyal, Amit Singh and Neelam Sharma (2016). Post-disaster outbreak of scrub typhus in Sub-Himalayan region of Uttarakhand. *Journal of The Academy of Clinical Microbiologists*, 18(2), 95.

19. Awsathi, Sadhana, Vinita Rawat, Chandra Mohan Singh Rawat, Vandana Semwal and Sunil Janki Bartwal (2014). Epidemiological investigation of the jaundice outbreak in Lalkuan, Nainital district, Uttarakhand. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*, 39(2), 94.