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# Physicochemical and Microbial Quality of Drinking Water at Gorkha, Nepal.

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## Abstract

To assess the drinking water quality of Bhimsen Thapa Rural Municipality-6, situated in Gorkha district of Nepal, the physicochemical parameters like pH, electrical conductivity, total hardness, ammonia, and nitrate content were investigated using standard procedures. Likewise, for microbiological parameter coliform presence and absence was analyzed. A total of 37 samples were collected from four sampling stations ( the water source, water reservoir, point of collection, and household water storage) in the last week of November 2022 using simple random sampling for tap water and stratified random sampling for household water storage. When comparing the results with the National Drinking Water Quality Standards (NDWQS), 2005 and World Health Organization (WHO), 2004 guidelines, it was observed that most of the physiochemical parameters were within the standards. Based on the microbiological parameter, in most of the water samples during the study coliforms were detected indicating potential health hazards. Therefore, the findings suggest that water from these sources can be considered safe for drinking only after undergoing purification treatment. Urgent attention from relevant authorities is imperative to implement treatment measures for drinking water to ensure its safety before consumption.

**Keywords:** Drinking water quality, NDWQS, WHO, physicochemical parameters

## Introduction

Access to safe drinking water remains a critical global concern, particularly in developing countries, where 5.7% of the population, contributing to 80% of water-related diseases, lacks proper water and sanitation facilities (Yasin et al., 2015). Globally, 663 million people still lack access to safe drinking water (Chitonge et al., 2020). The scarcity of water is worsened by the rapid growth of the human population, leading to extensive depletion of groundwater, surface water contamination, and the far-reaching impacts of climate change (Poudel and Duex, 2017).

Despite having abundant water resources, Nepal still lacks access to safe drinking water. The rural economy, which sustains over 80 % of the population through agriculture, is severely affected by water scarcity (MOF, 2017). Clean water is not only essential for sustaining life but is also recognized as a basic human right by the United Nations (Hutton, 2013). The Sustainable Development Goal (SDG) target no.6 emphasizes "ensuring the availability and sustainable management of water and sanitation for all" by 2030 (WHO, 2017). In Nepal, rural areas that rely on untreated water from springs or streams face elevated risks of waterborne diseases due to microbial activities (DHS, 2016). The challenges of disinfection, a crucial step in water treatment, are particularly pronounced in developing countries, leading to contamination during collection, transportation, and storage (Bae et al., 2019).

Physicochemical parameters such as turbidity, pH, temperature, iron, ammonia, nitrates, and arsenic play a crucial role in determining water quality, while microbial quality verifies its suitability for consumption (CBS, 2011). Water scarcity, coupled with the effects of climate change and industrialization, poses significant health risks, underscoring the need for global attention to water crisis issues (Wu, 2020).

Despite Nepal's status as a country with abundant water resources, various regions face water shortages, pollution, and associated health risks due to inadequate technical solutions (Kurisu et al., 2016). Anthropogenic activities and climate changes contribute to the degradation of water quality, necessitating regular monitoring (WHO, 1993).In the Gorkha district, issues of microbial contamination and decreasing spring sources exacerbate water scarcity, requiring urgent treatment to mitigate health implications (Shah, 2013; Shrestha, 2020). Water scarcity in Gorkha, resulting from erratic rainfall and unplanned construction, underscores the need for pressurized water resources and measures to prevent microbial contamination (Khanal et al., 2019). Therefore, the objective of the present study was to evaluate the physicochemical and microbiological water quality parameters of drinking water of Bhimsen Thapa Rural Municipality-6.

## Materials and Methods

An evaluation of drinking water quality was conducted in Ashrang village, situated in Bhimsen Thapa Rural Municipality, Ward No. 6 of Gorkha district. The area is located at 28°57 '63.95 "N latitude and 84° 68' 97.51"E longitude, with an elevation of 1522 meters.The projected area comprises more than 407 houses with various domestic livestock. The spring source is approximately 3.4 km away from the water reservoir. There are two source reservoirs, with the lower one being functionless due to low water volume. Water is collected in the reservoir and then distributed to individual households.

The study is based on a combination of qualitative and quantitative techniques for data collection and analysis. Qualitative methods include simple household surveys, interviews with water operators, and field observations. Likewise, quantitative methods involve the analysis of physicochemical and microbial parameters of drinking water. Data collection took place during the field survey, where primary data were collected instantly using the Environment and Public Health Organization (ENPHO) water test kit and other structured questionnaires from the ENPHO lab. Structured questionnaires were also used for identifying the location of the drinking water supply source, reservoir, point of collection (tap), and household water storage in Ashrang village. A total of 37 water samples were collected, including 17 from the point of collection (tap), 1 from each water reservoir and point of source, along with 15 household water storage samples. Simple random sampling was used for water taps and stratified random sampling was employed for household water samples considering ownership, commercial/shops, and rental sectors as strata. Samples were collected haphazardly within these strata during the autumn season in the last week of November 2022. Water samples were collected in two separate bottles for field and laboratory testing. Physicochemical parameters like pH, EC, DO, nitrate, hardness, and ammonia were analyzed using the

ENPHO water test kit. Water samples for microbiological analysis were transported to the ENPHO Laboratory in Kathmandu within 24 hours and tested.

The collected data were entered into Microsoft Excel. R Statistics (version V4.2.1) (R Core Team. 2021) with RStudio (Version 2022.07+554) (RStudio Team. 2022) was used for further statistical analysis.

## Results and discussion

The physicochemical parameters of water are important as they have a profound impact on the quality of water. pH is a numerical expression that measures the degree of acidic or alkaline nature of the water . The pH values of the water samples range between 6.5 and 7.5. The majority of samples collected from the source have a pH of 7.1 which is almost neutral, while the tap water sample is slightly below neutral at 6.9 pH. The median pH values for the reservoir and household water storage are 6.8. All the water samples lie within the NDWQS, 2005. As such pH has no direct health impact but lower pH may be a factor to increase corrosion of water pipes (WHO, 2017) and higher pH results in taste complaints and negative impact on eyes and the skin (Rao & Rao, 2010).

Electrical conductivity (EC) is the ability of water to conduct an electric current and is a direct outcome of its total dissolved salts (Harilal et al., 2004). The overall conductivity ranges from 390 to 440 µS/cm , which are within the permissible limits. Source and storage water samples exhibit similar conductivity at 410 µS/cm. Similarly, the tap and household container samples have median conductivity values of 420 µS/cm. Higher EC in water may be as a result of dissolved salts and metallic ions ( Oyem et al., 2014) which may lead to scaling and corrosion of the boilers degrading the quality of the product (Ravikumar et al., 2013). Likewise, lower EC values are viewed as a sign of healthy water (Shah et al., 2008).

Dissolved oxygen (DO) is a measure of the concentration of oxygen present in water and offers a quick assessment of water quality (Rahman et al., 2021). DO in water samples average from 3.20 to 5.47 mg/L. The source has the highest recorded DO at 5.47 mg/L, followed by the reservoir at 5.24 mg/L, and the tap water sample with a median value of 3.854 mg/L. DO values show a decreasing trend from the source to the distribution canal as DO depends on temperature and atmospheric mixing. High DO value indicates that the quality of water is good.

Hardness of the water is generally caused due to calcium and magnesium cations present in it. Hardness in water samples during the autumn season ranges from 208 mg/L to 336 mg/L. The reservoir recorded the lowest hardness at 228 mg/L, while the household water storage sample observed the highest concentration at 336 mg/L. The hardness values did not exceed the WHO, 2004 and NDWQS, 2005 standard of 500 mg/L which is safe from a health viewpoint but higher value of hardness may cause a laxative effect ( APHA, 2005).

Nitrate concentrations in water samples average from 5 to 10 mg/L during the sampling period. Source, reservoir, and tap water samples exhibit higher nitrate concentrations, with median values of 10 mg/L, while household water storage samples have a median of 5 mg/L. The nitrate concentration in the study area was within the permissible limit of NDWQS, 2005. Excessive nitrate concentration decreases the blood's capacity to hold oxygen, which causes methemoglobinemia (APHA, 2005).

Ammonia concentrations were recorded as 0.2 mg/L in 4 out of 17 tap samples. Similarly, household storage water also recorded 0.2 mg/L of ammonia in 4 samples out of 15. These concentrations comply with NDWQS, 2005, which has set the maximum concentration of ammonia at 1.5 mg/L.

Microbiological parameters are a useful indicator of water quality to detect the presence and absence of living organisms. A total of 37 water samples were analyzed for coliform presence using the coliform presence-absence kit. Out of these, 8 samples (21.62%) were found uncontaminated, while the remaining 29 samples showed coliform presence indicating that the water from these sources are unfit for drinking unless appropriate water purification methods are followed. According to WHO, 2004 and NDWQS, 2005 guidelines, no coliform should be present in water for drinking purposes.

## Conclusion

Among the 37 water samples analyzed, 78.378% (N=29) were found to contain total coliforms during the study, indicating a potential public health risk.. Other selected physicochemical parameters remained within permissible limits set by NDWQS, 2005 and WHO, 2004 guidelines. The majority of people in the study area rely on untreated tap water for drinking, while a few use treated water. Most of the tap and household container water samples and reservoir water are deemed risky for direct consumption. Implementing a proper management system, raising public awareness about sanitation, and employing water treatment methods like chlorination could minimize these risks in the future. Based on the available data, study findings, and the current condition of water sources, reservoirs, tap water supply, and household storage systems, the following recommendations are proposed:

Ensure that the surrounding water sources, reservoirs, taps, and household containers remain free from biological contamination.

Implement regular chlorination processes to disinfect water and maintain microbial quality..

Conduct effective public awareness programs in the Bhimsen Thapa Rural Municipality study area, focusing on sanitation conditions, cleanliness activities, methods of disinfecting drinking water, and preventive measures against water-related diseases.

## References

APHA (2005). Standard methods for the examination of water and wastewater, 21st ed., Washington, DC, American Public Health Association.

Bae, S., Lyons, C., & Onstad, N. (2019). A culture-dependent and metagenomic approach of household drinking water from the source to point of use in a developing country. *Water Research*, 100026. https://doi.org/10.1016/j.wroa.2019.100026

CBS (2011). Population Census 2011. Government of Nepal, National Planning Commission Secretariat, Central Bureau Statistics, Thapathali, Kathmandu, Nepal.

Chitonge, H., Mokoena, A., & Kongo, M. (2020). Water and sanitation inequality in Africa: challenges for SDG 6. *Africa and the sustainable development goals*, 207-218.

DHS (2016). Annual report of department of health services. Ministry of Health and Population, 23.

Harilal, C. C., Hashim, A., Arun, P. R., & Baji, S. (2004). Hydrogeochemistry of two rivers of kerala with special reference to drinking water quality. *Ecology Environment and Conservation*, *10*, 187-192.

Hutton, G. (2013). Global costs and benefits of reaching universal coverage of sanitation and drinking-water supply. *Journal of water and health*, *11*(1), 1-12.

Khanal, S., Thakuri, S., Dhakal, M., & Wagle, L. M., (2019). *Proceeding of Research Seminar on Climate Change* (Issue March). www.cen.org.np

Kurisu, F., Ramanathan, A. L., Kazmi, A. A., & Kumar, M., (2016). Trends in Asian water environmental science and technology. *Trends in Asian Water Environmental Science and Technology*, 1–250. https://doi.org/10.1007/978-3- 319-39259-2

Malla-Pradhan, R., Pradhan, B. L., Prasai Joshi, T., & Phoungthong, K. (2022). Water quality assessment through numerical indices in Phewa Lake, Nepal. *International Journal of Environmental Analytical Chemistry*, 1-15.

MOF., (2017). Economic Survey: Fiscal Year 2016/17. Government of Nepal, Ministry of Finance, Singh Durbar, Kathmandu, Nepal.

MPPW (2005).National Drinking Water Quality Standard Implementation directives for national drinking water quality standard, Ministry of physical planning and works, Government of Nepal, Kathmandu.

Oyem, H. H., Oyem, I. M., & Ezeweali, D. (2014). Temperature, pH, electrical conductivity, total dissolved solids and chemical oxygen demand of groundwater in Boji-BojiAgbor/ Owa area and immediate suburbs. *Research Journal of Environmental Sciences*, *8*(8).

Pradhan, B. L. (2018). *Statistical Methods*, Samjhana Publication, Kathmandu, Nepal.

Poudel, D. D., & Duex, T. W. (2017). Vanishing springs in Nepalese mountains: Assessment of water sources, farmers' perceptions, and climate change adaptation. *Mountain Research and Development*, *37*(1), 35-46.

R Core Team (2021) R: a language and environment for statistical computing. R foundation for statistical computing, Vienna, Austria, Vienna, Austria. http://www.R-project.org/

Ravikumar, P., Aneesul Mehmood, M., & Somashekar, R. K. (2013). Water quality index to determine the surface water quality of Sankey tank and Mallathahalli lake, Bangalore urban district, Karnataka, India. *Applied water science*, *3*, 247-261.

Rao, G. S., & Rao, G.N., (2010). Study of groundwater quality in Greater Visakhapatnam City, Andhra Pradesh (India). *Journal of environmental science & engineering*, *52*(2), 137-146.

RStudio Team (2022) RStudio: integrated development environment for R. RStudio, PBC, Boston, MA, Boston, MA. http://www.rstudio.com/

Safiur Rahman, M., Shafiuddin Ahmed, A. S., Rahman, M. M., Omar Faruque Babu, S. M., Sultana, S., Sarker, S. I., ... & Rahman, M. (2021). Temporal assessment of heavy metal concentration and surface water quality representing the public health evaluation from the Meghna River estuary, Bangladesh. *Applied Water Science*, *11*(7), 121.

Shah, S. K., (2013). Water quality assessment of mardi river by using water quality index. *Bibechana*, *10*, 100–107. https://doi.org/10.3126/bibechana.v10i0.7106

Shah, M. C., Shilpkar, P. G., & Acharya, P. B. (2008). Ground water quality of Gandhinagar taluka, Gujarat, India. *E-Journal of Chemistry*, *5*(3), 435-446.

Shrestha, K. K., (2020). Water Quality in Pokhara: A Study with Microbiological Aspects. *Technical Journal*, *2*(1), 149–161. https://doi.org/10.3126/tj.v2i1.32852

WHO (2017). Safely managed drinking water-thematic report on drinking water. *World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF)*.

WHO (1993). *Guidelines for drinking-water quality*. World Health Organization, Geneva, Switzerland.

WHO. (2004). *Guidelines for drinking-water quality*, 3rd ed., World Health Organization, Geneva, Switzerland.

Wu, H., Yang, W., Yao, R., Zhao, Y., Zhao, Y., Zhang, Y., ... & Lin, A. (2020). Evaluating surface water quality using water quality index in Beiyun River, China. *Environmental science and pollution research*, *27*, 35449-35458.

Yasin, M., Ketema, T., & Bacha, K. (2015). Physico-chemical and bacteriological quality of drinking water of different sources, Jimma zone, Southwest Ethiopia. *BMC Research Notes*, *8*(1), 1–13. https://doi.org/10.1186/s13104-015-1376-5