BIBECHANA
Vol. 20, No. 2, August 2023, 200–204

ISSN 2091-0762 (Print), 2382-5340 (Online)
Journal homepage: http://nepjol.info/index.php/BIBECHANA
Publisher:Dept. of Phys., Mahendra Morang A. M. Campus (Tribhuvan University)Biratnagar

Chemical and microbial evaluation of water of Rupa lake

Kamal Prasad Dhungana[1], Akkal Dev Mishra[2,*], Kalpana Gautam Adhikari[3]

[1]*Department of Chemistry, Prithvi Narayan Campus, Pokhara*
[2]*Central Department of Chemistry, Tribhuvan University, Kathmandu*
[3]*Department of Microbiology, Janapriya Campus, Pokhara*

[*]Corresponding author. Email: mishraad71@gmail.com

Abstract

Analysis of chemical and microbial features of Rupa lake water was carried out in summer season by adopting accepted analytical techniques. Water samples were collected at 28°C, and on-site observations were made for features like colour, odour, pH, transparency, dissolved oxygen, and free carbon dioxide. In the laboratory, the concentration of prominent mineral ions and microbial contamination were measured using accepted analytical techniques. Transparency of lake water was noted 91cm and electrical conductivity 41 µs/cm indicating the presence of suspended particulate at moderately higher concentration. This water is slightly alkaline with pH of 7.2 that is accounted by domination of alkali and alkaline metal ions. Presence of nitrogenous species mainly ammonium and nitrate in excess amount has detected to be major reason for rapid eutrophication in the lake. Analysis of Rupa lake water has shown the considerable presence of phosphate and sulphate which have added to the hardness 130 mg/L of the water as well. On the top of this fairly higher concentration of free carbon dioxide indicates presence of organic wastes in association with decaying matters. Domestic sewage discharge, the use of pesticides and fertilizers in agricultural areas, as well as other solid waste dumps has caused microbial contamination and the biggest dangers to the viability of Rupa lake. The risk of contamination and the eutrophication process needs to be managed by creating public awareness [1].The study shows that water quality of Rupa lake is contaminated for drinking but adequately suitable for all aquatic life and ecological balance.

Keywords
Chemical features, rock weathering, eutrophication, ecological balance, microbial contamination.

Article information
Manuscript received: June 22, 2023; Accepted: July 11, 2023
DOI https://doi.org/10.3126/bibechana.v20i2.56526

1 Introduction

Lakes have diverse physical and chemical characteristics, making them valuable ecosystems for drinking water, fisheries, recreational activities, and ecological studies. The lake ecosystems are considered as one of the valuable ecosystems in the world [2]. Water quality is vital for developing a healthy ecosystem, as both non-living and living factors depend on each other [3]. Rivers, lakes and oceans

greatly facilitated the world wide spread of the population and commerce, springs, waterfall, glaciers and snow fields. About 97% of the total available water on earth is contained in Ocean, and remaining 3% is available as fresh water. Among fresh water, 2% is contained in ice in accusable region and 0.7% as ground water. Out of the total fresh water available on Earth, only 0.25% exists in lakes and rivers at any given time, with the rest being stored in ice in inaccessible regions and groundwater [4]. The surface water is the form of oceans, rivers, lakes, ponds and streams on the earth's surface. There are about 5000 lakes in Nepal Out of them; ten are listed in the list of Ramsar site. The water from the lakes is the source of drinking and for various household uses for rural and urban people [5]. Water quality and suitability for use are determined by its taste, odour, colour, and Concentration of organic and inorganic matters. Contaminants in the water can affect the water quality and on the health of the people. Most of the lakes of Nepal are situated in the hilly region. Among hill districts, the Kaski district contains the largest number of lakes and all of them are located to the Pokhara Valley. Pokhara valleyis Known as the "city of lakes' '. Phewa lake, Begnas lake, Rupa lake, Maidi lake, khaste lake, Dipang lake, Nyureni lake, Gude lake are the most popular lakes of Pokhara valley [6].

Physical characteristics such as light, temperature, transparency, pressure, water current and conductivity whereas chemical properties like dissolved oxygen, carbon dioxide, pH, alkalinity, hardness, etc. of the lake water are some of the key factors to evaluate water quality [7]. Pollutants present like Pb, As, Hg, Cd, U, etc in the water may cause serious health hazards. Rupa Lake has become tourism attraction spot and provides enough spaceforboating and recreation.Farmers in the Kaski district have formed the Rupa Lake Rehabilitation and Fisheries Cooperatives limited to help protect the watershed [8]. The concentration of all minerals is related to two main factors are the abundance of chemical elements in the earth crust and the solubility of their compounds. The main anions contained in natural water are $C1^{-}$, $SO_4{}^{2-}$, HCO_3^{-} and CO_3^{2-} and the main cations are Ca^{2+}, Na^{+}, Mg^{2+}, K^{+} etc [9].

All natural water contains dissolved gases but they differs in their origins such as volcanic process and degassing of the earth's mantle supply oxides and dioxides of carbon, methane, ammonia, hydrogen sulfide, hydrogen chloride, sulfurous gas [10]. Some other gasesmayappearand dissolve in waterasresult ofultravioletradiation, thunderstorm discharge sulfurous gas, vapour of iodine, ammonia, carbonic acid, etc. Biogenic substance these include compound of silicon, nitrogen, phosphorus, iron, etc. Organic matters are composed of organic compound that have come from remains of organism such as plants and animals and their waste products in the environment [11].

Main objective of present study is to examine Rupa lake water for mineral ions and microbes which determine water quality for drinking, irrigation, animals and aquatic creatures as compared to WHO standards. This study will help in creating public awareness to safeguard lake water, conserve the lake area and maintain local ecosystem.

2 Methods and Materials

The study area, Rupa Lake, is a freshwater lake located in the border of Pokhara Metropolitan and Rupa Rural Municipality of Kaski District, Nepal. It is the third-largest lake in the Pokhara valley, covering an area of about 1.35 km2, with an average water depth of 3 m and a maximum depth of 6 m. The lake is elongated north to south and is fed by perennial streams. Its watershed area is 30 km^2 where the main inflow of water is from Talbesi stream, whereas Dhovan khola is the feeder stream with its outlet Tal khola at Sistani ghat. It supports a number of floral and faunal species. A total of 36 species of water birds have been recorded in the lake which represents about 19 percent of the total 193 wetland-dependent birds found in Nepal [12]. Rupa lake is the third largest lake in the cluster of Pokhara which is located at latitude of 28007'-28012'N and longitude of 84005'-84010' E. The lake is surrounded by dense forests over humus soils with hard rocks.

The physical and chemical parameters such as temperature, transparency, dissolved oxygen, carbon dioxide, pH, alkalinity, hardness, dissolved solids, chloride, calcium, and magnesium were evaluated using various methods. Some of other parameters such as Sulphate, Phosphate ($PO_4{}^{3-}$), Nitrate ($NO_3{}^{-}$), Ammonium ($NH_4{}^{+}$), Iron (Fe^{2+}/Fe^{3+}) were studied with the help of spectrophotometer. The concentration of Potassium (K^{+}) was estimated by Flame Photometer and electrical conductivity by conductivity meter [13]. All the solutions of the reagents to be used were prepared in 0.01M concentration in distilled water for titration and other reactions. Spectrophotometric absorption was observed at 396 mμ-512 mμ for the detection of Fe^{2+}/Fe^{3+} ions simultaneously. Similarly, K^{+} ions gave purple emission with 760 nm in flame photometry at about 1800^0C.

Table 1: Methods applied for evaluating the Physico-chemical features of water.

Parameters	**Methods employed**
Transparency (cm)	Secchi disc method
Temperature (^{0}C)	Standard mercury thermometer
Dissolved Oxygen (mg/L)	Winkler's iodometric titration Method
Hydrogen Ion Concentration	Microprocessor pH meter
Total Alkalinity (mg/L)	Titration Method
Total hardness (mg/L)	EDTA Titration Method
Total Solid (mg/L)	Evaporation Method
Total dissolved Solid (mg/L)	Filtration Method
Calcium (mg/L)	Titration Method
Magnesium (mg/L)	Titration Method
Chloride (mg/L)	Titration Method

In addition to this, the microbial contamination in the lake was analyzed by Most Probable Number (MPN) method [14]. Preliminary test was done by inserting Durham's tube containing lake water into MacConky broth in inverted form. The change in colour into yellow indicates the presence of coliform bacteria in water and formation of colony at 37 gives its confirmation. The number of positive tubes were counted and compared with standard chart to find MPN of 100 ml water sample.

Figure 1: Overview of Rupa lake.

3 Results and Discussion

Transparency was measured at 28°C using a Secchi disk method. The transparency of Rupa Lake was found to be 91 cm, which suggests that the presence of organic and inorganic suspended particles, silts, sediments, and debris could affect the water quality. An increase in temperature might result in a drop in the quality of water as the organic matter composition decays more quickly due to the warmer water.

Rupa Lake has a slightly alkaline pH value of 7.2, indicating the presence of carbonates and bicarbonates of alkali and alkaline earth metals. The concentration of dissolved oxygen (DO) observed in this study is 4.2 mg/L, which is lower than the standard value of 5.0 mg/L, indicating poor suitability for aquatic life. Presence of carbonates, bicarbonates and hydroxides of alkali metals and alkaline earth metals like Na, K, Mg, Ca, accounts for total alkalinity water. The lake water's total alkalinity is 52 mg/L, making it slightly alkaline, and the total hardness is 130 mg/L, which is a bit high and might impact the biotic components of the lake. The electrical conductivity (EC) of the lake water is 41 µs/cm, suggesting higher dissolved ion concentrations or high total dissolved solids (TDS) values. The TDS measures the amount of chemical weathering in the watershed. Its amount in Rupa lake in present study is found to be 50 mg/L. The variety of natural and human induced pollutant causes in-

crease in TDS. The lake water's total solid matter is 136 mg/L, indicating a high level of solid materials, including dissolved and suspended solids, clay, plankton, organic waste, and inorganic precipitates.

The chloride concentration of Rupa lake is 14 mg/L. The primary sources of chlorine in lakes and ponds are domestic sewage and faecal deposits. It lies within the standard value prescribed by WHO. Calcium and magnesium concentration observed are 24 mg/L and 13mg/L respectively that exceed the normal acceptable level. However the concentration of phosphate is 0.04mg\L which lies above WHO guideline for drinking water. The observed concentrations of nitrates, ammonia, and sulfates in Rupa Lake are slightly higher, possibly due to domestic runoff, industrial discharge, agricultural runoff, and natural degradation of organic matter, as well as sewage contamination. These nitrogenous sources are responsible for eutrophication in water bodies. Nitrate is 0.61 mg/L, ammonia was 1.8 mg\L and sulphate is 2.6 mg\L in Rupa lake water respectively. The potassium concentration of lake water sample was 1.6 mg\L. The concentration of iron in the lake water is 0.5 mg/L, which exceeds the standard value of 0.3 mg/L. The higher iron concentration may be due to weathering of ferrous and ferric ions from surrounding rocks and minerals. Higher concentration of iron in lake water becomes rusty red or brown in colour that causes health hazards. It may be due to the weathering of ferrous and ferric irons from surrounding rocks and minerals. The observation of microbiological analysis performed by most probable number method revealed that the lake water contains coliform bacteria.

Table 2: Observations of various parameters of Rupa lake water.

Parameters	Rupa lake	WHO standards (2020)	Parameters	Rupa lake	WHO standards (2020)
Transparency (cm)	91	100.0	Calcium (mg\L)	24	10.0
Temperature (^{0}c)	28	12-25	Magnesium (mg\L)	13	5.0
Electrical conductance (µs/cm)	41	40.0	Phosphate(mg\L)	0.04	0.02
Total alkalinity (mg/L)	52	100.0	Nitrate (mg\L)	0.61	0.50
Total dissolved solids (mg/L)	50	45.0	Ammonia (mg\L)	1.8	1.5
Total solids (mg/L)	136	120.0	Iron (mg\L)	0.5	0.3
Dissolved oxygen (mg\L)	4.2	5.0	Sulphate (mg\L)	2.6	2.5
pH	7.2	6.5-8.5	Potassium (mg\L)	1.6	2.0
Chloride (mg\L)	14	20.0	Free CO2 (mg\L)	3.0	1.5
Total hardness (mg\L)	130	50.0			

4 Conclusion

The study of chemical and microbial features of Rupa lake revealed that the water is slightly alkaline with higher concentration of suspended and dissolved minerals as compared to WHO water quality standards. On the top of this, the water is contaminated with coliform bacteria. The water is not suitable for drinking purposes however it is acceptable for aquaculture and irrigation. Rapid eutrophication may be caused by household and industrial discharge along with decomposition of organic matters is posing severe danger to the sustainability of Rupa lake. This study has indicated another challenge to the sustainability of this lake like encroachment accompanied with deforestation and sedimentation due to weathering of soils and rocks from catchment areas. Right now it has become essential to conserve the lake by strict monitoring and safeguarding aquatic environment and watershed areas by creating public awareness towards local ecosystem and health hazards.

Acknowldgement

Authors would like to express sincere thanks to the Department of Chemistry, Prithvi Narayan Campus, Tribhuvan University, for providing the laboratory facility to conduct this research work. The University grants commission of Nepal deserves thanks for financial support to carry out this research work.

References

[1] B. Gautam and B. Bhattarai. Seasonal changes in water quality parameters and sediment nutrients in jagadishpur reservoir, a ramsar site in nepal. *Nepal Journal of Science and Technology*, 9:149–156, 2008.

[2] R. B. Raya. Impact of land use on water quality of phewa-lake pokhara, nepal. In *Urban waters: Resource or Risk?*, page 190, 2008.

[3] P. K. Neupane, M. Khadka, R. Adhikari, and D. R. Bhuju. Lake water quality and surrounding vegetation in dry churiya hills, far-western nepal. *Nepal Journal of Science and Technology*, 11:181–188, 2010.

[4] M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. Van Der Linden, and C. E. Hanson. *IPCC, 2007: climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change*. Cambridge University Press, 2007.

[5] P. Lamsal, K. P. Pant, L. Kumar, and K. Atreya. Sustainable livelihoods through conservation of wetland resources: a case of economic benefits from ghodaghodi lake, western nepal. *Ecology and Society*, 20(1), 2015.

[6] N. Paudel, S. Adhikari, and G. Paudel. Ramsar lakes in the foothills of himalaya, pokharalekhnath, nepal: An overview. *Janapriya Journal of Interdisciplinary Studies*, 6:134–147, 2017.

[7] K. Bishwakarma, R. R. Pant, K. B. Pal, A. Ghimire, L. B. Thapa, P. Saud, and K. P. Panthi. Water quality and land use/cover changes in the phewa watershed, gandaki province, nepal. *Nepal Journal of Environmental Science*, 7:31–39, 2019.

[8] P. Chaudhary, N. B. Chhetri, B. Dorman, T. Gegg, R. B. Rana, M. Shrestha, and S. Thapa. Turning conflict into collaboration in managing commons: A case of rupa lake watershed, nepal. *International Journal of the Commons*, 9(2), 2015.

[9] G. Kafle, M. Cotton, J. R. Chaudhary, H. Pariyar, H. Adhikari, S. B. Bohora, and B. Regmi. Status of and threats to waterbirds of rupa lake, pokhara, nepal. *Journal of Wetlands Ecology*, pages 9–12, 2008.

[10] D. Rupakheti, L. Tripathee, S. Kang, C. M. Sharma, R. Paudyal, and M. Sillanpää. Assessment of water quality and health risks for toxic trace elements in urban phewa and remote gosainkunda lakes, nepal. *Human and ecological risk assessment: an international journal*, 23(5):959–973, 2017.

[11] U. R. Khadka and A. L. Ramanathan. Major ion composition and seasonal variation in the lesser himalayan lake: case of begnas lake of the pokhara valley, nepal. *Arabian Journal of Geosciences*, 6:4191–4206, 2013.

[12] N. Pradhan, I. Providoli, B. Regmi, and G. Kafle. Valuing water and its ecological services in rural landscapes: a case study from nepal. *Mountain Forum Bulletin*, pages 32–34, 2010.

[13] N. M. Khadka, S. D. Gautam, and P. N. Yadav. *A Core Experimental Chemistry*. Third edition, 2010.

[14] E. W. Rice, L. Bridgewater, and American Public Health Association, editors. *Standard methods for the examination of water and wastewater*, volume 10. American public health association, Washington, DC, 2012.