Eth. J. Indig. Know. Appl. Sci.
Vol. 3, No. 1, 2025, 21-25

Ethiopian Journal of Indigenous Knowledge and Applied Sciences

Determination of Nitrate Level in *Chacha* and *Beressa* River, Debre Berhan, Ethiopia

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Abstract

River nitrate (NO_3^-) pollution contributes to eutrophication, contaminated drinking water, and ecological degradation, making it a serious environmental and public health issue. To effectively manage water quality, nitrate sources and concentrations must be accurately determined. This review examines the reasons behind nitrate monitoring, earlier studies, and the importance of current research in this area. The amount of nitrate pollution in a selected river was measured using the spectrophotometric method, and the local population was informed about ways to reduce pollution. The Chacha River and Beressa provided samples for the investigation. The findings demonstrated that the nitrate concentrations in the samples from both rivers were higher than the Who is maximum allowable limit of 10 mg/l NO3--N. With nitrate concentrations of 15.38±0.52 and 14.25±0.53 mg/l NO3--N, respectively, the Beressa and Chacha rivers had the highest levels. To restore their quality and prevent further deterioration, both rivers need extra care.

Keywords: *Nitrate, methemoglobinemia, eutrophication, surface waters, nitrosoamines*

1. Introduction

Since all living things depend on water to survive, the growing human population is posing a growing threat to this precious resource. By 2030, universal and equitable access to clean and reasonably priced drinking water for all is one of the Sustainable Development Goals' objectives. According to recent figures, 51.7 million Ethiopians (57%) and 6.6 billion people (91%) globally had access to safe water [1].
Natural forms of nitrogen found in the environment, nitrates give plants and other living things the nutrients they need to flourish. As a result, they are found in the food and vegetables that people eat. Additionally, because inorganic nitrate ions are very soluble in water, they can seep into the soil and build up in groundwater and surface waters [2]. Nitrate pollution of water has grown to be a major environmental concern in the modern era. As a result, the nitrate ion is ubiquitous and is thought to be the most prevalent contaminant influencing groundwater quality globally [3].
A significant issue on Earth's surface is nitrate nitrogen (NO_3-N) pollution, particularly in dry and semi-arid areas. The conveyance of nutrients and terrestrial transformation depend on river networks. Excessive levels of nitrate, sulfate, chloride, and other contaminants are present in the majority of surface water contamination. Since the 1970s, nitrate has been a prevalent source of elevated N loading [4–7]. Most rivers in populous areas have nitrate nitrogen (NO_3-N) concentrations seven times higher than the World Health Organization's recommended healthy water quality level of 10 mg/L, according to the Global Environment Monitoring System database. Numerous ecological and environmental issues, including toxic algae blooms, lake and reservoir eutrophication, and extinction, can be brought on by high nitrate concentrations.of species in the river ecosystem [8-13]. Furthermore, prolonged exposure to drinking water containing high levels of nitrate may raise the risk of chronic poisoning in humans, which is associated with methemoglobinemia [12, 17–20]. Cancer can even be brought on by the presence of nitrite, another kind of nitrogen.
The British Geological Survey report states that there was evidence of nitrate and other contaminants polluting Ethiopia's groundwater (British Geological Survey, 1996). Due in major part to septic tank effluent leaks, groundwater from various metropolitan areas—particularly the Dire Dawa and Addis Ababa areas—has high nitrate concentrations. Urban regions

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Received: Dec 25/2024, Revised **Jan 15/20225**, **Accepted**: Jan 20/2025, **Published**: Feb 1/2025.

where the water tables are relatively close to the ground surface are likely to have the highest nitrate concentrations. Some of the saline groundwater that is impacted by evaporation may also have higher nitrate contents. The average nitrate concentration in all well water samples from Ethiopia's drinking water sources was higher than the WHO threshold value and the country's standard [27].

Consequently, nitrogen pollution is a serious environmental issue that needs to be taken very seriously [4–7].

For determining nitrate, a number of methods have been developed, each with advantages and disadvantages. These methods include potentiometry, spectrophotometry, spectrofluorometry, chemiluminescence, fluorimetry, polarography, coulometry, etc. Spectrophotometric techniques are the most often utilized for determining nitrate because of their high detection limits and simple protocols [5]. Therefore, the current study measures the amounts of nitrate ions in the Chacha and Beressa Rivers using a UV-visible spectrophotometer method.

1. METHODOLOGY

1.1. Materials and Methods

Graduated pipettes (2, 5, and 10 ml), Analytical balance, volumetric flask (25 to 1000 ml), Plastic funnel, Refrigerator, Beaker (100 ml to 250 ml), Desiccator, and Measuring cylinder spectrophotometer (uv-1800 reader).

1.2. Chemicals and Reagents

All chemicals used were analytical grade. Double distilled water, Hydrochloric acid (37%), Potassium nitrate (KNO_3).

1.3. Procedure for Water Sample Collection

Samples were collected in plastic bottles that had been thoroughly cleaned with detergent, rinsed with 1N hydrochloric acid, and then rinsed with distilled water for a long period of time. Once the bottles were dry and secured with lids that had been treated in some way, they were taken to the sampling location and rinsed with the surface water that was to be sampled. The research methodology will typically be experimental. Gently submerge the sampling bottle, fill it to the brim with the water sample, seal it tightly, label it, and wrap it in a black plastic bag to keep light from getting to the sample. The samples will then be taken to the chemical engineering laboratory at Debrebrehan University and kept in a refrigerator at 4 °C until they are needed.for analysis. In order to analyze the surface water quality, some of the samples were carefully transported to the Ethiopian Public Health Institute Research Center. The analysis was completed prior to the two-day or 48-hour maximum holding time.

1.4. Preparation of Nitrate Standard Solution (Spectrophotometric method)

To make a typical nitrate solution Potassium nitrate was dried for 24 hours at 1050 degrees Celsius in an oven. After that, it was kept in a desiccator. Dissolving 0.7218g of precisely weighed pre-dried potassium nitrate in 100ml of pure water in a beaker. The standard solution had a concentration of 100 mg/l, and 1 ml of this solution contained 0.1 mg of nitrate ion (as NO3--N). The solution was then transferred to a 1000 ml volumetric flask and diluted in 900 ml of distilled water to form precisely 1000 ml.Create NO3- calibration standards by diluting to 50 ml and ranging from 0 to 31.01 mg/lNO3--N. The quantities of the intermediate nitrate solution are as follows: 0, 4.43, 8.86, 13.29, 17.72, 22.15, 26.58,... 31.01 ml.

50 ml of nitrate sample solution was mixed well with 1 mL of Hcl at a concentration of 1M to avoid the interference of hydroxide and carbonate ions with nitrate ions.

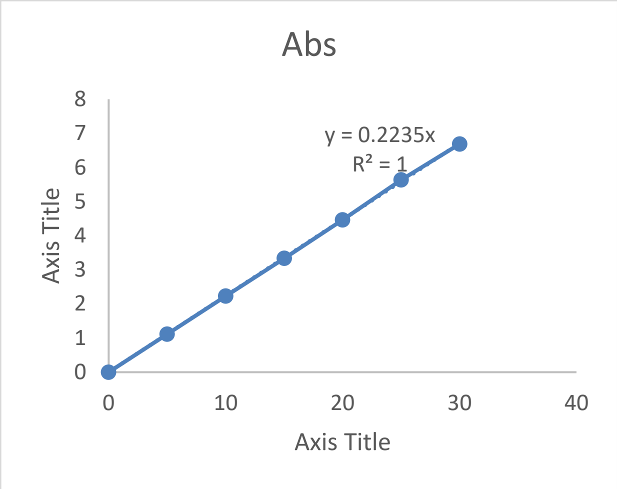
The UV spectrophotometric screening method was used to measure the nitrate concentration ([NO3--N mg/L]. The process outlined in the standard techniques for the evaluation of water and waste was precisely followed in this manner. Since NO3- is only absorbed at wavelengths, samples were examined using an Ultraviolet-Visible (UV-VIS) Spectrophotometer in the ultraviolet (UV) spectrum at a wavelength of 220 nm [28]. The unknown concentration of the sample was determined by measuring the absorbance of a calibration curve created using standards of known nitrate concentration made from a standard solution. The analyte concentration in the samples can be estimated using the regression statistics and the calibration equation (i.e., the gradient and the intercept) from the calibration curve analysis in Figure 1.

$Y = mx + b$ ----------------------- Equation 1

Consequently, the regression coefficient (R2) value was 0.9997 and the equation y = 0.2507*x +0.00 was derived from the calibration curve. There was a better correlation between the y and x values because the R2 value was closer to 1. The water's unknown content was determined using the calibration curve equation.

Table 1 The absorbance of standard solution for UV/Visible spectrophotometer

conc	Abs
0	0
5	1.112
10	2.228
15	3.34
20	4.457
25	5.631
30	6.685



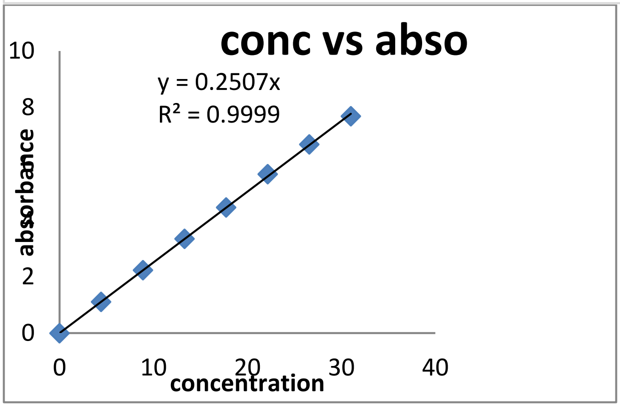


Figure 1 Calibration curve of the standard solution by UV/Visible spectrophotometer

1.5. Sample preparation

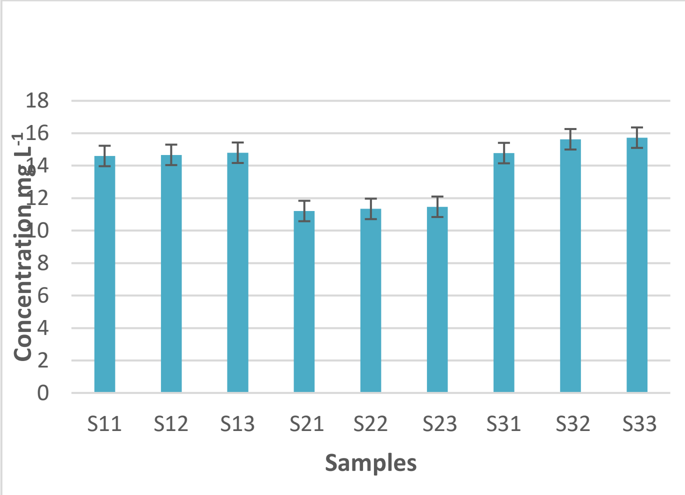
Using plastic bottles, river water samples were taken from Chacha and Beressa at various locations. Whatman No. 42 filter paper was used to filter the samples in order to prevent turbidity-induced interference. 50 ml of the filtrate should be thoroughly mixed with 1 ml of 1 M hydrochloric acid [29].

1.5.1. Determination of nitrate level in sample

Using plastic bottles, 1L of water samples were collected from the Beressa and Chacha rivers at various locations.To stop the hydroxide and carbonate ions from interfering with the nitrate ion, 1 milliliter of 1M Hcl was added to each sample solution and thoroughly mixed.In the lab, a UV-visible spectrophotometer was used to measure the concentration of surface water. Within a day, the material was transported to the laboratory of the Ethiopian Public Health Institute. Ten milliliters of each collected sample were taken and put into a UV-visible spectrophotometer's quartz cuvette.

2. RESULT AND DISCUSSION

Table 2 shows the average concentration of nitrate ion in water from the randomly selected points in river Beressa by UV-Vis spectrophotometric methods.



Results of Table 2 reveal that the maximum mean valve of 15.38±0.52around diverse home waste disposal area of Beressa River and 14.69±0.101around Jerusalem vegetable farm of Beressa River. Nitrate

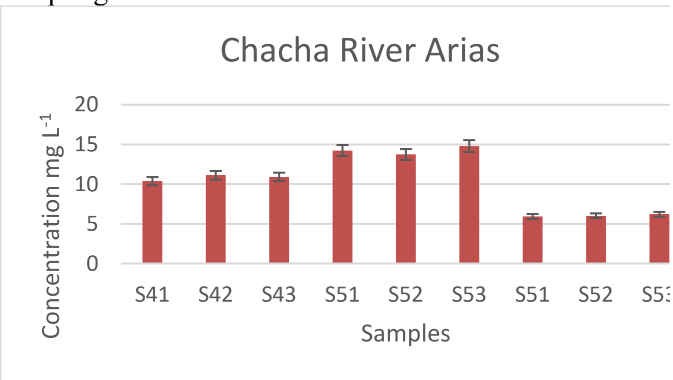
No.	Sample sites	Sample codes	Nitrate level NO_3^- N(mg/l) Mean ± SD n=5	Mean ± SD
1	From Jerusalem vegetable farm areas	S11	14.60±0.101	14.69±0.101
		S12	14.67±0.211	
		S13	14.80±0.111	
2	At DBU waste disposal areas	S21	11.21±0.031	11.34±0.13
		S22	11.34±0.301	
		S23	11.47±0.121	
3	At different house hold waste disposal areas	S31	14.78±0.0920	15.38±0.52
		S32	15.63±0.123	
		S33	15.73±0.34	

levels in river water can occasionally exceed the WHO acceptable guideline of 10 mg/l, especially in the various areas of the Beressa River where domestic garbage is disposed of. The usage of nitrate-rich fertilizers in irrigated farmlands and the ongoing release of untreated solid and liquid household waste into the river are two potential causes of the high nitrate concentrations in various Beressa River locations.

Table3 shows the average concentration of nitrate ion in water from the randomly selected points in Chacha River by UV-Vis spectrophotometric methods.

No.	Sample sites code	Trial	Nitrate level (mg/L)	Mean ± SD
1	Tulurecha	S41	10.36	10.79±0.39
		S42	11.12	
		S43	10.90	
2	At chacha town bridge	S51	14.23	14.25±0.53
		S52	13.74	
		S53	14.79	
3	jalissa irrigation	S51	5.93	6.05±0.14
		S52	6.01	
		S53	6.21	

According to Table 3's results, the mean nitrate values ranged from 6.05±0.14 to 14.25±0.53 mg/l; the highest value was 14.25±0.53 mg/Lin sample, which was taken from Chacha Town near the bridge. The discharge of human, animal, and other household waste that may contain nitrogenous organic compounds that bacteria may convert to nitrate is one probable explanation for the high nitrate levels at this sampling location.



2.1. Conclusion

This study's primary objective was to determine the level of nitrate ion pollution in the Beressa and Chacha rivers using a spectrophotometric method. It also provided information on the current state of the river water and the mitigation measures that have been implemented. According to the study's findings, the nitrate ion concentrations in the sample site's water were found to be higher than the WHO-established permissive limit of 10 mg/l NO3--N. This is brought on by excessive use of fertilizers containing nitrogen, septic tank leaks, and poor home sewage management. Adopting strict policies to lower the danger of fertilizer, manure, or sewage contamination, preventing septic tank leaks, and managing residential sewage properly are some of the mitigation techniques.

Conflicts of Interest

The authors declare no conflict of interest

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