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# Physicochemical Analysis of Lake Chitu: The Origin of *Arthrospira Plantesis*

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## Abstract

Chitu is a unique poly-extreme soda lake with high alkalinity and salinity that supports Arthrospira plantesis inhabitation. In this study, the physical parameters, chemical analysis, and some heavy metal contents in Lake Chitu were determined using flam and hydride AAS. The physicochemical analysis showed higher variability in anion and cation concentration in the three transactional areas of the lake. The physical parameters of the lake showed no difference and the chemical analysis indicated that pH, carbonate, sulphate, and fluoride concentration were higher in the anthropogenic part of the lake. This shows that human/animal interference and thermal spring water play a role. Of the three transactional areas of the lake, samples from the flooded area of the lake showed the highest alkalinity and bicarbonate concentration, while samples from the protected area showed the lowest alkalinity. The mercury and arsenic contamination was highest in the protected and anthropogenic parts of the lake respectively. The present study strongly suggest that Lake Chitu, the unique habitat for arthrospira plantesis with possible use in diverse applications, which should be further investigated by seasonal sampling.

**Keywords:** *alkalinity, spirulina platensis, soda lake, anions and cations*

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## 1. Introduction

Water is the most precious natural resource, could not be replaced by any other known natural or man-made compound (Dar & Singh, 2020). It is an essential component for the survival of life on earth, which contains minerals, important for humans as well as for world and aquatic life (Raji *et al*., 2015). Lake is an indispensable element of the natural environment that defines both landscape and its ecological functioning, source of significant elements of the world's biological diversity (Pant *et al*., 2017) and has important social/economic benefits as a result of tourism/recreation and culturally/aesthetically important for the nearby communities (Dirican, 2015). Thus, water quality analysis is important to protect the natural ecosystem (Patil *et al*., 2012).

Natural water contains different types of impurities which are introduced into the aquatic system by different ways, such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities (mining, processing, and the use of metal-based materials) (Sharma *et al*., 2015). Water must be tested with different physicochemical parameters, before it is used for drinking, domestic, agricultural or industrial purposes, which helps to maintain a healthy ecosystem and biological diversity (Pant *et al*., 2017). It is difficult to understand the biological phenomenon fully because the chemistry of water reveals much about the metabolism of the ecosystem and explains the general hydro-biological relationship (Sharma *et al*., 2015). But the selection of physicochemical parameters depends on the purpose of using that water/objectives of the study and what extent we need its quality and purity which helps to get an exact idea about the quality of water (Dirican, 2015). Physical characteristics whereas chemical properties of the lake water highly govern the aquatic life and determine the trophic status of the water body. Abiotic factors are usually the governing forces of the environment and influence the wellbeing, distribution of organisms and functioning of the ecosystem (Pant *et al*., 2017).

In Ethiopia, Lake Chitu is a soda lake having extremely high primary productivity and algal biomass associated with the superabundance of *Arthrospira* and supporting the huge flocks of the Lesser Flamingos (Ogato *et al*., 2015). Basically, unlike terrestrial crops which grown on soil, *Spirulina* grows in water containing various minerals and free from substances inhibiting nutrient uptake (Sukumaran *et al*., 2014). Hence, water with proper nutrient supplementation enhances nutrient uptake, promoting microalgal growth and intracellular substance accumulation. *Spirulina* is capable of growing in high alkalinity with the presence of carbonate, bicarbonates and inorganic nitrogen (Devanathan *et al.*, 2019). *S. plantesis* is reported to grow over a wide range of salinity. Lake Chitu is a creator lake situated in the central refit valley, highly salty, surrounded by hot springs flow into the lake with high $CaCO_3$ containing types of soil. The high salinity and alkalinity with temperature makes Chitu Lake the preference habitats of *Spirulina plantesis* which is the main food source for huge flocks of the lesser flamingo (*Phoeniconias minor*) (Tadesse *et al*., 2014; Ogato *et al*., 2015). In view of the environmental preference in which natural populations of *S. plantesis* occur in line with the multi functionalities of the species, absence of research works on the physicochemical analysis of Chitu Lake, the need to study the physicochemical characteristics of Chitu Lake to determine the correlation with *S. platensis* growth as well as its component bicarbonate, sulphate, phosphate and heavy metals.

## 2. Material and Methods

### *2.1. Description of the Study Area*

Lake Chitu was selected based on the availability of *Spirulina*. Lake Chitu is a volcanic explosion crater lake which is located 287 km South of Addis Ababa in West Arsi zone which is situated at 25 km from Shashamane town with **latitude 07$^{0}$ 24' 26''N, longitude of 038$^{0}$ 25' 33''E** with an altitude of 1540 meters above sea level. The lake covers an area of 0.8 km$^2$ and a maximum depth of 21 meters.

### *2.2. Sample Collection*

The 99 water samples were collected in clean glass stoppered sampling bottles from three transactional areas of the lake represented as flooded area, anthropogenic and protected area (33 samples from each). The water sample was immediately brought to the laboratory to analyse the required parameters. pH, temperature, EC and TDS were taken from the lake at the time of sample collection.

### *2.3. Laboratory analysis*

***pH.*** pH is considered as an important factor for the growth of *spirulina*, it is the measurement of the acidity and alkalinity of the water and was measured by pH meter (HANNA instruments, Italy) at the time of sample collection.

***Electrical Conductivity (EC), Total dissolved solids (TDS) and Temperature.*** The EC, TDS and $T^0$ of Chitu Lake were measured at the time of sample collection by EC/TDS tester (Model AD31, Europe).

***Ammonia ($NH_3$-N)***. Ammonia was determined by nessler's method by the principles of the reaction free ammonia or ammonium ions with nessler's reagent to form a reddish-brown complex and the absorbance of the complex was measured at 420nm which is proportional to the ammonia nitrogen content (Wang *et al*., 2019).

***Alkalinity ($CaCO_3$) test***. The alkalinity of the water sample was measured due to the ability of the water sample to neutralize acids by titrating the water sample with sulphuric acid of known values of pH, volume and concentration. Based on stoichiometry of the reaction and the number of moles of sulphuric acid needed to reach the reaction point, the concentration of alkalinity in water was calculated by the equation below.

$$Alkalinity, {}^{Mg}/_{L}\, CaCO_3 = \frac{(V_a x\ N_a)E_{wt}}{V_s}$$

Where: $V_a$- Volume of acid used
$N_a$-normality of acid
$E_{wt}$-equivalent weight of CaCO3

***Carbonate ($CO_3^{2-}$) and Bicarbonate ($HCO_3^-$) estimation.*** The presence of carbonate ($CO_3^{2-}$) and bicarbonates ($HCO_3^-$) influences the hardness and alkalinity of water. The concentration was measured by titration with standardized hydrochloric acid using methyl orange as indicator to be turned yellow below pH 4.0 mentioned by Sharma *et al*., (2015). At this pH, the carbonic acid decomposes to give carbon dioxide and water.

***Nitrate ($NO_3$-N) and Nitrite ($NO_2$-N) Test***. $NO_3$-N was estimated by Cadmium reduction method in principles of reduction of nitrate to nitrite when the sample allowed to pass through a column containing amalgamated cadmium filings. Nitrate has been calculated from the standard curve by plotting absorbance of standards against $NO_3$-N concentration (Balance, 1996). Nitrite, that originally present plus that reduced from nitrate, was then determined.

***Nitrite ($NO_2$-N)*** concentration has been estimated in accordance with the principles reactions of nitrite with sulphanilamide in strong acid medium and the resulting diazo compound is coupled with N-(1-naphthyl)-ethylenediamine dihydrochloride to form an intensely red colored azo-compound (Balance, 1996). The absorbance of the dye at 540 nm is proportional to the concentration of nitrite present.

***Silica ($SiO_2$) test***. Silica concentration was estimated based on the formation of heteropoly acids when ammonium molybdate reacts with silica and phosphate approximately at a pH of 1.2 (Balance, 1996). Thus, addition of oxalic acid destroys any molybdophosphoric acid but not the molybdosilicic acid and the yellow molybdosilicic acid is reduced by amino-naphthol-sulphonic acid to heteropoly blue, finally, the concentration of Silica was measured at 815 nm. Silica was calculated as:

$$[Silica] = \frac{SiO_2\ from\ graph\ (mg)}{(L)\ of sample}$$

***Fluoride ($F^-$) estimation***: Estimation of fluoride concentrations was performed by modifying Reshetnyak *et al*. (2019) methods of direct potentiometry to determine fluoride ion activity using fluoride ion–selective electrode. A standard silver chloride electrode was used as a reference electrode. To determine fluoride concentration in water sample, the method of standard addition was applied and water samples were diluted in total ionic strength adjustment buffer (TISAB), which sets constant ionic strength during measurement and which also pre-complexes interfering ions.

***Phosphate ($PO_4^{3-}$-P) test***. Phosphate concentration was tested by Ascorbic acid/Molybdate blue method implemented by Habibah *et al*. (2018) based on the reaction between orthophosphate and ammonium molybdate in the aqueous acidic condition, followed by its reduction by ascorbic acid reducing agent. In the reaction result, molybdenum blue complex absorbance was measured at 800-900 nm range and the color intensity of the molybdenum blue complex were proportionally with the phosphate content in the water sample.

***Heavy Metal test***. The concentration of Chromium (Cr), Mercury (Hg) and Arsenic (As) were tested by Atomic Absorption Spectrophotometer (AAS) methods (novAA-400P, Germany). Chromium (Cr) was tested by Flame AAS, whereas Mercury (Hg) and Arsenic (As) were tested by Hydride AAS.

# 3. Result and Discussion

## *3.1. Physical Parameters*

Some physical tests were performed on the three-transactional area of Chitu Lake, stated on **Table 1**. The colors of the lake in protected area were slightly green due to the micro algae biomass dominated by *Spirulina.* Whereas, the anthropogenic and flooding areas were highly turbid and turbid brown respectively because of human and animal interferences and soil erosion in the mean order. The anthropogenic part of the lake was highly affected by human activities such as washing clothes with soaps/detergents, bathing and showering. More so, animal interference (drinking as well as disposing their feces and urine into the lake) which were disseminated into the other part of the lake via waves and concentration gradient after the anthropogenic part of the lake. Flocks of flamingos were staking in the lake has a great role in the lake's color and odor. There was no difference in the temperature and the electro-conductivity of the lake in the three transactional areas. But there was a high TDS concentration in the protected area as compared with the other area. This were due to

**Table 1**

*The physical parameters of Chitu Lake*

| Parameters | Anthropogenic area | Protected area | Flooding area |
|---|---|---|---|
| Color | Highly turbid | Turbid slightly green | Turbid brown |
| $T^0$ | 23 | 23 | 22.94±0.11 |
| EC | 399 | 399 | 399 |
| TDS | 200 | 228.75±0.46 | 221.63±13.35 |

## *3.2. Chemical analysis of Chitu Lake*

Chitu lake is an alkaline lake, "soda lakes" that has saline waters with carbonate species ($HCO^{3-}$ + $CO3^{2-}$) as the dominant ions and typically exceed a pH of 9. This is in consistence with the scientific report on the extreme physical and chemical conditions of "soda lakes" with combination of sodium and carbonates results in alkaline conditions (Boros & Kolpakova, 2018). The highest pH value was recorded on anthropogenic area as compared with the rest transactional areas were due to high animal and human interference. The animal feces, urine, and the dust on the animal legs may play a role in the pH value. In addition, the human wash their cloth, showing by using soaps and detergents and swimming activities leads to a high pH value in the area. But there was no significant pH difference in the protected and flooding area. pH is controlled in part by the concentration of $Ca^{+}$ and $CO3^{2-}$ (Bowman & Sachs, 2008), these ions were shown to be present in low concentrations in protected area as compared with the rest transactional part of the lake. Reports indicated that the well mixed and turbid part of the soda lake was highly alkaline which is similar to the result on Chitu Lake (Boros & Kolpakova, 2018). The Lake Chitu at the anthropogenic area was well mixed and turbid due to the human and animal interference, which plays a role in high alkalinity of the area. The same concept was reported by Bowman and Sachs (2008) to indicate the highly alkaline lakes containing a high concentration of carbonate.

**Table 2**

*The chemical parameters of Chitu Lake*

| Parameters | Anthropogenic area | Protected area | Flooding area | WHO allowable Conc. |
|---|---|---|---|---|
| pH (M±SD) | 9.99±0.06 | 9.86±0.05 | 9.87±0.13 | |
| Carbonate ($CO_3^{-2}$) (mg/L) | 32558.40 | 29376.00 | 31824.00 | ------- |
| Bicarbonate ($HCO_3^-$) (mg/L) | 2239.92 | Null | 5226.48 | ------- |
| Alkalinity ($CaCO_3$) (mg/L) | 56100.0 | 47736.0 | 57324.0 | ------- |
| Ammonia ($NH_{3-}N$) (mg/L) | 1.12 | 1.12 | 1.12 | ------- |
| Sulphate ($SO^{-2}{}_4$) (mg/L) | 67.03 | 60.72 | 60.24 | 400.0 |
| Nitrate ($NO_{3-}N$) (mg/L) | 9.9 | 10.1 | 7.8 | 10.0 |
| Nitrite ($NO_{2-}N$) (mg/L) | 0.8 | 0.79 | 0.83 | 3.0 |
| Fluoride ($F^-$) (mg/L) | 450 | 380.0 | 300.0 | 1.5 |
| Phosphate ($PO_4^{3-}$-P) (mg/L) | 0.1 | 0.1 | 0.1 | ------- |
| Silica ($SiO_2$) (mg/L) | ND | ND | ND | ------- |

The null bicarbonate ($HCO_3^-$) concentration in the protected area is expected to be due to grass coverage on the area, acacia coverage, macrophyts density which decreases the iterance of bicarbonate in to the lake and aggregates of *Spirulina* mass in the area may leads high bicarbonate consumption by the cyanobacteria as a carbon source. In addition, the sample was taken from the surface of the water, so the bicarbonate may be sediment under the water. This is corresponding with Keskinkan *et al*. (2012) report on the crucial role of cyanobacteria in carbonate precipitation within oceans, lakes, springs, caves, and soils. Farther more, the bicarbonate may be below the detection capacity of the machine.

Ammonia ($NH_{3-}N$) concentration was consistent in the three-transactional areas of the lake, this may be due to the absence of outflow. On the other hand, Chitu Lake may accumulate nutrients and organic matter in addition to salts, which maintain via internal cycling the active biological production. This idea is analogous with Clarisse *et al.* (2019) reports on the decomposition and associated ammonification of nutrient rich organic matter to be the principal source of $NH_3$ in soda lakes. In addition, the report includes the breakdown of plankton, droppings of flamingos and other water birds and miscellaneous organic material carried in animals or hot springs (plant residues, and waste of mammals and humans) (Clarisse *et al.*, 2019). All these factors were a critical feature of Lake Chitu which plays the same role as reported. In addition, via their feeding and excreting, Flamingos play an important role in nitrogen cycle of the Chitu Lake. *A. platensis* growth depends on nutrient availability, especially the nitrogen source, although nitrates and ammonium salts are commonly used. The cyanbacterium *Spirulina platensis* is capable of utilizing ammonia as a sole source of nitrogen even at pH 10 and above, since the entry of ammonia into *Spirulina* cells is primarily driven by the pH gradient (Belkin & Boussiba, 1991). Reports indicated that, the fed-batch addition of ammonia-based nitrogen sources was shown to prevent any inhibiting effect effectively on *A.plantesis* cultivation (Rodrigues *et al*., 2011).

Soda lakes are characterized by elevated pH and dominance of sodium and carbonate species in the cation and anion dissolved solutes, and key to the occurrence of conservative cations over conservative anions like $SO_4^{2-}$ (Deocampo & Renaut, 2016) and Sulphate ($SO^{-2}{}_4$) is the dominant anions (Sorokin *et al*., 2011). The Sulphate ($SO^{-2}{}_4$) concentration was higher in the anthropogenic part of the lake as compared with the other parts of the lake; there was no significant difference between the protected and flooded area of the lake. But the Sulphate ($SO^{-2}{}_4$) concentration of Chitu Lake was under the WHO recommendation level. The result corresponds with the report of Foti *et al.* (2007), on the sulfur cycle which is one of the most active element cycles in soda lakes. One of the explanations for sulfur cycle is the high-energy efficiency of dissimilatory conversions of inorganic sulfur compounds, both oxidative (driven by chemo-litho-autotrophic halo-alkaliphilic sulfur-oxidizing bacteria (SOB), unique for soda lakes) and reductive, sufficient to cope with costly life at double extreme conditions (Sorokin *et al*., 2011). Although, the relatively low sulphate ($SO^{-2}{}_4$) concentration in the lake expected to be the high-energy efficiency of microorganisms and *A. planthesis*. This idea is supported by the report on the importance of sulphate on the growth performance and biochemical status *Spirulina platensis*. In addition, the microscopic analysis of *Spirulina platensis* revealed that the number of whorls and filaments are influenced by sulphate salts concentration (Pierre *et al*., 2021). In this regard, the relatively higher concentration of sulphate ($SO^{-2}_4$) in the anthropogenic area could be due to the flow of spring water towards the lake and the low concentration in the remaining parts were expected to be due to *Spirulina platensis* mass observed at the time of sample collection.

***Nitrate and Nitrite***. The nitrogen fixing and denitrification activities of *Spirulina spp*. and some *Halomonas spp* respectively, have already been noted. Nitrate ($NO_{3-}N$) concentration is higher in protected area as compared with the anthropogenic areas as shown in **table 2**. Organic nitrogen sources from feather degradation may also be important in Lake Chitu as keratin-degrading microbes and their effective degradation of keratin from the feathers of flamingos was reported for the same lake (Sitotaw, 2014). It has been reported that, in productive lakes such as Lake Chitu, over 90% of the total nitrogen is in the algal biomass and this is regenerated during decomposition of the organic materials (Ogato *et al*., 2015). But the lowest nitrate concentration was recorded in flooding area of the lake. The high rates of denitrification by the abundant populations of some bacteria (e.g., *Halomonas spp*.) in soda lakes together with the favorably high tropical temperature are believed to contribute considerably to the low nitrogen levels in such lakes (Ogato *et al*., 2015). A relatively low nitrite concentration was observed in the protected area of the lake, this is an indication with nitrite reductase active within a very broad salinity range (Shapovalova *et al*., 2008). The lowest nitrate and a relatively highest accumulation of nitrite were observed in the flooded area of the lake. This suggested that, the presence of active populations of denitrifying and nitrate-utilizing bacteria, including heterotrophic haloalkaliphilic *Halomonas spp*. and chemolithoautotrophic (Yu & Gijs, 2005). In addition, high level of nitrite accumulation during anaerobic growth with nitrate at high salt suggested that the nitrite reduction step was a bottleneck in the denitrification process (Shapovalova *et al*., 2008).

The Rift Valley is one of few active rifts on the Earth's land area Fluoride is naturally found in volcanic rocks (Tekle-Haimanot *et al*., 2006). An abundance of thermal springs indicates the ongoing volcanic activity in the area and often high in elements such as florid (Reimann *et al*., 2003). It is obvious that the Rift Valley is the region in Ethiopia that is most affected by the fluoride problem. Thus, the present study is supported by the evidence due to high concentration of florid ($F^-$) (450 mg/L) (**table. 2**) in the anthropogenic area of lake Chitu as compared with the other transactional areas of the lake due to the abundance of thermal springs in the anthropogenic area. In addition, there was high hot spring in flow towards the lake in the protected area, as a result, increased florid concentration were recorded in the protected area of the lake. There was no thermal spring water in the flooded area of the lake, as a result of a relatively decreased concentration of florid (300 mg/L) were reported (**table 2**). In general, the florid concentration of Chitu lake were higher than the WHO recommendation, as a result the communities facing dental fluorosis. This report is supported by Reimann *et al*. (2003) on the use of drinking water from drilled wells in the Rift Valley, Ethiopia, dental and skeletal fluorosis has become a serious medical problem (Reimann *et al*., 2003).

***Phosphate ($PO_4^{3-}$—P).*** Phosphate is central to the origin of life because it is a key component of nucleotides, phospholipids, and metabolites such as adenosine triphosphate used in cellular replication, compartmentalization, and energy transfer, respectively (Tonera & Catling, 2019). But the phosphate level in Lake Chitu was consistent within the three transactional areas of the lake (0.1 mg/L), which was relatively lower as shown in table 2. Such concentration of phosphate may be mainly from the predominant phosphatic mineral-rich rocks and released to anoxic water column (Ogato *et al*., 2015). Lower phosphate concentration may be due to high-rate consumption of phosphate by *Artherospira*, other micro algae and macrophyta. The present result was supported by Sofiyah and Suryawan (2021) reports on the convenience of phosphate compounds for microalgae cell growth, energy transformation, photosynthesis, and for the formation of chlorophyll. On the other hand, phosphate used as a buffer to catalyze acid/base and nucleophilic reactions and acts as a pH and chemical buffer, which may lead to a low phosphate concentration in the lake (Powner *et al.*, 2009). Furthermore, a major issue for prebiotic chemistry is that phosphate combines with $Ca^{2+}$ down to micromolar levels to form apatite-group minerals [e.g., $Ca_5(PO_4)_3(OH,F,Cl)$] or with $Fe^{3+}$ and $Al^{3+}$ in acidic solutions to form Fe/Al phosphates which may cause low phosphate concentration (Tonera & Catling, 2019).

***Silica ($SiO_2$)***: The Silica ($SiO_2$) in Chitu Lake was not detected, this is probably due to the occurrence of some processes within the lake causing low $SiO_2$ concentrations. The present observations are in consistence with the result of Ogato *et al.* (2015) studies made on the same lake and other soda lakes of the Ethiopian rift valley. Several studies made on tropical African lakes (e.g., Gebre-Mariam, 2002) reported the association of $SiO_2$ depletion with the abundance of diatoms. Organic matter accumulation in the sediment, which inhibits dissolution rates of silicic acid from diatom frustules, may have contributed to the low $SiO_2$ in this lake.

### *3.3. Heavy metal contents of Chitu Lake*

Chromium ($Cr^{+6}$) concentration in Chitu lake was not determined as shown in **table 3**. This may be due to the absence of anthropogenic contamination of the lake with potential Chromium source industrial wastes. On the other hand, the $Cr^{+6}$ concentration may be below the detection levels of our laboratory equipment. Furthermore, bio-reduction of $Cr^{6+}$ to $Cr^{3+}$ by $Cr^{6+}$ by bioremediation process, since it is an effective way of combating $Cr^{6+}$ (Ibrahim *et al*., 2011).

**Table 3**

*Selected Heavy Metal content of Chitu Lake*

| Parameters | Anthropogenic area | Protected area | Flooding area | WHO allowable Conc. |
|---|---|---|---|---|
| $Cr^{+6}$ (mg/L) | ND | ND | ND | 0.05 |
| Hg (µg/L) | 0.2 | 0.32 | 0.23 | 0.006 |
| As (µg/L) | 11.47 | 11.25 | 11.09 | 0.01 |

Inorganic arsenic is the most abundant arsenic species in nature and is commonly found in different environments (Valdés *et al*., 2014). The anthropogenic area of the lake was the highly affected in Arsenic concentration, this is mainly caused by various anthropogenic activities such as excessive use of arsenic in pesticides, herbicides, wood preservatives and medicinal products, which is consistent with Dey *et al*. (2016) report. There was no significance difference in Arsenic concentration both in the protected and flooded part of the lake. These might be due to some microorganisms which can cope with arsenic toxicity by using different ways such as taken into the cell by aqua-glycero-porins play an important role in the arsenic geocycle (Omeroglu *et al*., 2022).

As shown in **table 3**, the concentration of Mercury was highest in protected area of the lake, and lowest in anthropogenic area. This is because the mercury might be released to ecosystems by both natural and anthropogenic processes, which is consistence with report of Windisch *et al*. (2022). Anthropogenic processes with the highest contribution to global Hg release include disposal of batteries and energy-efficient lamps (Xu *et al*., 2015), mining and mine wastes, fossil fuel combustion (mainly coal) (Zhu *et al*., 2018), leather tannery (Tasca *et al*., 2019) and other industrial activities, including the manufacturing of chlor-alkali and caustic soda using Hg-cell. But in the case of Chitu Lake, some of these reasons are not the main cause of increased mercury concentration, rather disposal of batteries and energy-efficient lamps might be the reason. Moreover, due to the Hg cycle through the air, water, and soil, re-emissions of Hg from Hg-contaminated areas, including natural and anthropogenic sources of the past, are also significant drivers of the total Hg releases, especially to the atmosphere (Windisch *et al*., 2022). Local factors such as the presence of hot springs around lakes are also thought to account for high Hg concentrations in the waters of Ethiopian Rift Valley soda lakes (Ermias Deribe *et al*., 2014).

The lowest Hg concentration in the anthropogenic part of the lake was expected to be due to the relatively high pH, alkalinity and sulphate concentration. This is consistent with Windisch *et al*. (2022) reports on the potential factors on Hg bioavailability. Water bodies in close proximity to one another can experience major differences of Hg content in biota depending on their physicochemical properties (salinity, alkalinity, pH, sulfur species and chloride concentrations) and biological activities have been identified to influence Hg cycling significantly by directly influencing availability of Hg– even if they receive similar atmospheric loads of the metal (Windisch *et al*., 2022).

## 4. Conclusion

This study showed that the water physicochemical nature of lake Chitu in line with the availability of micro-nutrients (carbonate, bicarbonate, nitrate, sulphate and phosphate) were the highly effective and supportive habitat for *Arthrospira plantesis*. The presence of high concentration of florid is visualized by the decayed tooth in the community, which suggested that stalk holders should take measures to access clean water for the societies. This study also demonstrated that the presence of heavy metals such as Mercury and Arsenic. The result indicated that Arsenic concentration in the anthropogenic area was the big concern, since the community and the animal were highly situated on the area. Additionally, the study was conducted by taking a water sample at a time, seasonal and explicit studies are needed to successfully exploit the full properties of the Chitu Lake including Silicate and heavy metal contamination in the lake.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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