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Original Article

Microalgal Diversity of Middle Rift Valley Lakes (Arenguade and Killole) Oromia Region, Ethiopia

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ABSTRACT
Microalgae have been one of the richest and most promising sources of bioactive primary and secondary metabolites and their discovery has significantly expanded in the past decades. The aim of the study was to assess the diversity of microalgae in Lake Arenguade and Kilole. Lake Arenguade and Killole are an alkaline soda lakes located in Bishoftu, Ethiopia. Sampling of the two lakes and data were collected during February 2016. The preserved Microalgal samples and the fresh water samples grow on liquid media (BBM and BG-11) were examined using binocular microscope and their identification to genus or species level were made on the basis of various descriptors of Microalgae. The result indicated that *Arthrospira* is dominant species in Lake Arenguade and maximum diversity index showed in two lakes by phylum Chlorophyta and other Cyanobacteria genera were common in Lake Killole.

KEYWORDS: *Microalgae, diversity, Middle Rift Valley lakes, Arenguade, Killole.*

INTRODUCTION

Microalgae, either prokaryotes or eukaryotes, are oxygenic autotrophs that populate all aquatic ecosystems ranging from freshwater and brackish waters to oligotrophic marine waters. They comprise a vast group of photosynthetic, heterotrophic organisms which have an extraordinary potential for cultivation as energy crops (Guiry, M., 2012). They have been one of the richest and most promising sources of bioactive primary and secondary metabolites and their discovery has significantly expanded in the past decades (Sushanto *et al.*, 2015). The algae synthetize a variety of compounds such as carotenoids, terpenoids, xanthophylls, chlorophyll, vitamins, saturated and polyunsaturated fatty acids, amino acids, acetogenins, antioxidants such as polyphenols, alkaloids, halogenated compounds and polysaccharides such as agar, carrageenan, proteoglycans, alginate, laminaran, rhamnansulfate, galactosyl glycerol and fucoidan (Verdisson S. *et al.*, 2001).

They can be cultivated under difficult agro-climatic conditions and are able to produce a wide range of commercially interesting byproducts such as fats, oils, sugars and functional bioactive compounds. The Microalgal world represents rich biodiversity, characterized by different biological, ecological and functional traits (Barra *et al*., 2014). When cultivating algae, Essential factors must be considered, include water, carbon dioxide, minerals and light. Humans use algae as food, for production of useful compounds, as bio filters to remove nutrients and other pollutants from wastewaters, to assay water quality, as indicators of environmental change, in space technology, and as laboratory research systems. Microalgae are

commercially cultivated for Pharmaceuticals, Nutraceuticals, Cosmetics and Aquaculture purpose. Lake Arenguade and Kilole are an alkaline soda lakes located in Bishoftu, Ethiopia. These lakes are home to few lesser flamingos and birds. Melack, 1976 reported that the main diet for lesser flamingos is cyanobacteria, Arthrospira fusiformis and this cyanobacterium is now found in Lake Arenguade. Although numerous studies have been made on the dynamics (species composition biomass and photosynthetic production) of phytoplankton in various East African lakes (Talling and Lemoalle, 1998), relatively little has been done on this aspect in Ethiopian lakes. It is therefore important to investigate on Microalgal diversity in these two lakes. The aim of the present study was to assess the Microalgal diversity of middle rift valley lakes of Arenguade and Killole during February, 2016.

2. OBJECTIVES

2.1 General objective

The general objective of this study is to assess Microalgal diversity of Middle Rift Valley Lakes (Arenguade and Kilole).

2.2 Specific objectives

- To assess the microalgae diversity of Lake Killole and Arenguade.
- To compare diversity difference among the two lakes within the time of collection.
- To generate data on dominant Microalgae groups of the Lake.

3.MATERIALS AND METHODS

3.1. Study Area

Lake Arenguade and Kilole is member of string of volcanic explosion crater lakes that are found in Middle Rift Valley of Ethiopia. The two lakes are located at South East of Addis Ababa in Ada'a distinct of East Sheoa Zone near Bishoftu town Lake Arenguade is located at 7 km South west of Bishoftu town at Gerbicha kebele at latitude of 80 41' N, longitude 380 58' E and an altitude of 1900 meter above sea level and lake Killole is located 12 km distance from Bishoftu town. It situated at South East of Bishoftu in Hora 'kebele' at latitude 8^{o} 48' 350''N, longitude of 39^{o} 05' 152'' E and an altitude of 1880 meter above sea level.

3.2. Study design and Sample size

Stratified random sampling design will be conducted in Middle Rift Valley of Ethiopia in February, 2016 to assess Microalgae diversity. 120 samples (60 from each lake) in February were collected from (Arenguade and Killole) lakes. Six sampling stations will be selected for each lake. First: - from an area of high human and animal impact (near-shore station) and on its opposite area; second: - from the direction of wind blow and its opposite area; third: - from nutrient inflow (offshore) and its opposite at the surface of the lakes. Physical parameter data like pH and altitude are the most important steps in identifying the sampling locations for proper sampling.

3.4. Sampling Technique

Water samples were collected in sterile 35ml glass bottles and preserved in 4% of formaldehyde solution. And also fresh water samples were collected from each lake and put in a flask (100ml) containing BG/BBM media for survival of algal cells until they reach laboratory and kept in an aerator. Finally samples were transported using ice box to the laboratory for identification of important Microalgal species.

3.5. Laboratory work

The samples collected from different sites were mixed in equal proportions to produce composite samples based the sampling design method and GPS data result. The composite Microalgae samples were cultured on BBM liquid medium supplied with CO2 from

compressed gas cylinders (aerator). The culture in flask growth was observed after 15-21 days.

3.6. Cellular Microalgae Identification

The preserved Microalgal samples and the fresh water samples grow on liquid media were examined using binocular microscope and their identification to genus or species level were made on the basis of various descriptors of Microalgae (John *et al.*, 2002; Janse van Vuuren *et al.*, 2006; John D. Wehr and Robert G. Sheath, 2002 and Bellinger, E. G., and Sigee, D. C, 2010) and internet resources were also be used for identification.

3.7. Data analyses

Shannon's diversity (H') were analyzed statistically using Microsoft excel.

4. RESULT AND DISCUSSION

The present study in two lakes (water bodies) of Ethiopia showed a rich diversity belongs to various phyla in all sites of the lakes. Studies of water samples revealed the abundant growth of five groups of microalgae belongs to Chlorophyta, Bacillariophyta, Cyanophyta, Dinoflagellate and Euglenophyceae. In present investigation altogether 27 and 16 genera of microalgae were recorded in Lake Killole and Arenguade respectively. Most of the algal genera identified majorly belonged to the phylum Chlorophyta, Bacillariophyta and Cyanophyta. Observation revealed that Cyanophyta members were dominant followed by Chlorophyta and Bacillariophyta members. Among these *Arthrospira, Microsystis, Aphanozomenon, Melosira and Chrococcus* were found to be dominant in the preserved samples.

Some of the microalgae that were identified during the course of the study are discussed below.

Diversity of microalgae from lake **Kilole:** detailed microscopic examination of water samples revealed four families consisting of 27 genera of microalgae in the order: Chlorophyceae (14 genera), Cyanophyceae (9 genera), Bacillariophyceae (3 genera) and Dinoflagellated (1 genera)

Cyanophyta: - *Microsystis, Dolichospermum, Anabaena, Aphanocapsa, Aphanizomenon, Cylindrospermopsis, Nostoc, Merismopedia, Chroococcus*

Chlorophyta:- *Spirogyra, Scendesmus, Pediastrum, Chlamydomonas, Closterium, Selenastrum, Cosmarium, Treubaria, Gonium, Chlorella, Volvox, Tetrastrum, Golenikia, Haematococcus*

Bacillarophyta: - *Melosira, Navicula, Nitzschia*

Dinoflagellated:- *Ceratium*

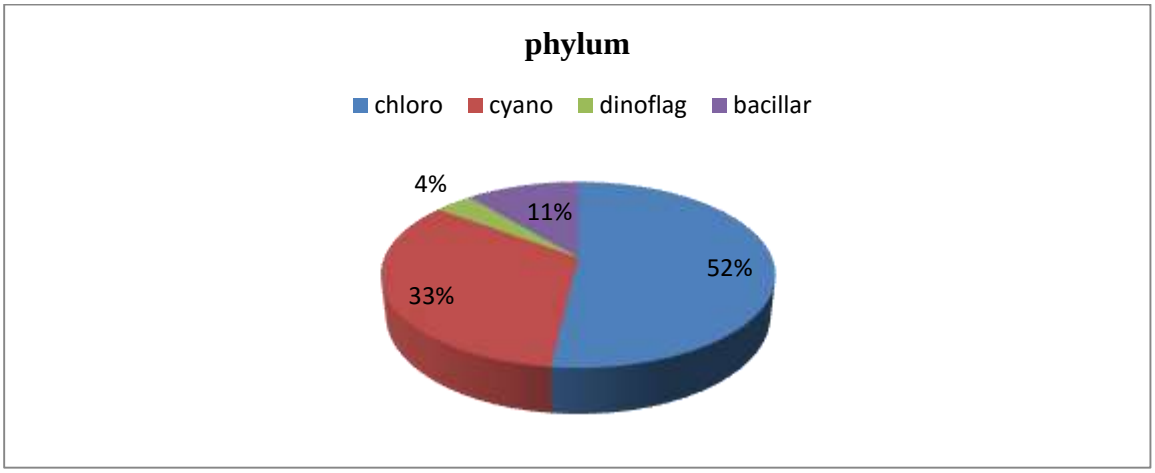

Fig 1. Graphical representation of micro- algal genera from Lake Killole

Table 1: Microalgae taxa from Lake Killole

MICROALGAE NAME	PRESERVED SAMPLES

CYANOPHYTA	
Microsystis	+++
Dolichospermum	-
Anabaena	++
Aphanocapsa	+
Aphanizomenon	+++
Cylindrospermopsis	-
Merismopedia	-
Nostoc	-
Chrococcus	+
CHLOROPHYTA	
Spirogyra	_
Scendesmus	+
Pediastrum	_
Chlamydomonas	+
Closterium	_
Selenastrum	-
Cosmarium	-
Treubaria	-
Gonium	-
Volvox	-
Chlorella	-
Tetrastrum	-
Haematococcus	-
Golenikia	-
BACILLARIOPHYTA	
Melosira	+++
Navicula	-
Nitzschia	+
DINOFLAGELLATED	
Ceratium	-

(++ dominant, + present, +++ very dominant, -rare/absent)

In Lake Killole *Microcystis, Melisora and Aphanizomenon* species are very dominate. The diversity index of the 4 phylum of microalgae was computed using Shannon-Weiner diversity index formula: Shannon index= H'

H'= −pi∑lnpi, where pi= the proportion of individuals of species i.

Pi= ni/N, where ni is the number of individuals in species i and N is the total number of individuals in the community.

Chlorophyta showed the diversity index of 2.34, Cyanophyta 1.32, Bacillariophyta 0.08 and Dinoflagellate 0. Maximum diversity was shown by Chlorophyta and minimum by Dinoflagellate. The presence of *Microcystis* blooms in fresh water ecosystems has been explained by a series of factors related to the cells capacity to regulate buoyancy, as well as a consequence of different environmental factors such as: the availability of light, nutrients, temperature and pH (Geoffrey *et al.*, 2014 and Lee *et al., 2015)*. The dominant algal genera in the lakes are cyanophytes, *Microcystis* and *Aphanozomenon*, which are more typical of eutrophic systems (Dokulil and Teubner, 2000).

Diversity of microalgae from lake **Arenguade:** detailed microscopic examination of water samples revealed four families consisting of 16 genera of microalgae in the order: Cyanophyceae (6 genera), Chlorophyceae (4 genera), Bacillariophyceae (4 genera), Euglinophyta (1 genera) and Glenodiniaceae (1genera). The present study shows that Cyanophyta taxon *(Anabaenopsis)* was absent and the lake was dominated by *Spirulina platensis (Arthospira fusiformis)* and *Chroococcus minutus*. The present study also stated that those in bold are reported for the first time. According to (Misgina B., 2010) reported that the two filamentous blue green algae-*Spirulina platensis* and *Anabaenopsis elenkinii* were the most dominant algal species in the study lake.

Cyanophyta: - *Arthrospira, - Microcystis, Aphanizomenon, Chrococcus minutus, Aphanocapsa and Chrococcus*

Chlorophyta: *Chlamydomonas, -Chlorella, Oocystis and Haematococcus*

Bacilarophyta:-*Syndera, Navicula, Cyclotella and Nitzschia*

Dinoflagellate: *Glenodinium*

Euglenophyta: *Euglena*

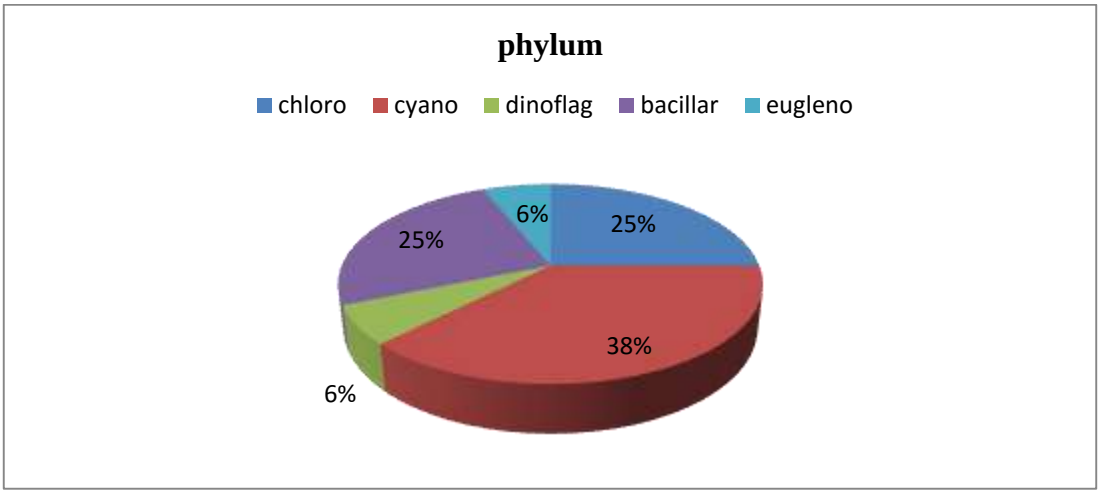

Fig 2. Graphical representation of micro- algal genera from Lake Arenguade

Table 2: Microalgae taxa from Lake Arenguade (Hora- Hado)

MICROALGAE NAME	PRESERVED
CYANOPHYTA	
Arthrospira	+++
Microcystis	++
Aphanizomenon	++
Chrococcus minutus,	+++
Aphanocapsa	+
Chrococcus	+
CHLOROPHYTA	

Chlamydomonas	++
Chlorella	-
Oocystis	-
Haematococcus	+
BACILLARIOPHYTA	
Syndera	+
Navicula	-
Cyclotella	-
Nitzschia	-
DINOFLAGELLATED	
Glenodinium	+
EUGLENOPHYTA	
Euglena	+

(++ dominant, + present, +++ very dominant, -rare/absent)

In Lake Arenguade *Arthrospira* and *Chrococcus* species are much dominated. The diversity index of the 5 phylum of microalgae was computed using Shannon- Weiner diversity index formula: Shannon index= H'

H'= −pi∑lnpi, where pi= the proportion of individuals of species i.

Pi= ni/N, where ni is the number of individuals in species i and N is the total number of individuals in the community.

Chlorophyta showed the diversity index of 0.93, Cyanophyta 0.60, Bacillariophyta 0.47, Dinoflagellate 0 and Euglinophyta 0. Maximum diversity was shown by Chlorophyta and minimum by Dinoflagellate and Euglinophyta. In the present study *Arthrospira (Spirulina)* grows abundantly forming an almost uni-algal community in alkaline Lake Arenguade. The blue-green alga *Spirulina,* which was recommended as a suitable protein source to combat malnutrition and protein deficiency in developing countries (Fox, 1996; Henrikson, 1989).

5. CONCLUSION AND RECOMMENDATION

Lake Arenguade was one of the few natural environments that sustained a nearly pure culture of *Spirulina platensis*. The current situation of the lake shows abundance of *Arthrospira fusiform* (*Spirulina platensis)*. The finding of this study provides necessary data support for the further diversity studies are still needed on the species composition, quantity characteristics, and distribution characteristics of the microalgae in Lake Killole and for the conservation of biodiversity. Based on the result of this study, the following recommendations are given: Further analysis is very important for studying molecular characteristics of the identified Microalgal species.

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