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Phytoplankton Composition and Saxitoxin Surveillance in Aquatic Species of Kedung Ombo Reservoir, Central Java, Indonesia

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ABSTRACT

The rapid growth of Indonesia's population and urban development has intensified water pollution, including eutrophication, which can trigger harmful algal blooms (HABs). In freshwater ecosystems, these events are referred to as cyanobacterial harmful algal blooms (CyanoHABs), some of which involve toxin-producing species capable of releasing saxitoxin (STX). This study aimed to investigate the phytoplankton community in the Kedung Ombo Reservoir, with a focus on Cyanobacteria that have the potential to form CyanoHABs, and to assess their relationship with water quality parameters and the possible presence of saxitoxin in aquatic organisms. Phytoplankton composition was analyzed microscopically, and the presence of saxitoxin was assessed using the Receptor Binding Assay (RBA) method. The phytoplankton community in the reservoir was found to consist of six phyla: Chlorophyta (40%), Cyanobacteria (35%), Bacillariophyta (16%), Euglenophyta (6%), Dinophyta (2%), and Charophyta (1%). Cyanobacterial genera with the potential to form CyanoHABs included *Aphanizomenon* spp., *Microcystis* spp., *Phormidium* spp., *Dolichospermum* spp., and *Oscillatoria princeps*. In addition, cyanobacterial cysts (akinetes) were detected in sediment samples at an average density of 53 cells/g dry sediment, suggesting a potential reservoir for future blooms under favorable environmental conditions. However, saxitoxin was not detected in any of the sampled aquatic organisms, which included snails (*Pila ampullacea*), carp (*Cyprinus carpio*), tilapia (*Oreochromis mossambicus*), and catfish (*Clarias gariepinus*). These results indicate no current risk of saxitoxin contamination in aquatic food resources from the reservoir, suggesting that food safety is not presently compromised. Nevertheless, the high nutrient levels and the presence of akinetes underscore the importance of proactive management strategies to safeguard aquatic resources and prevent the emergence of CyanoHABs in the future.

INTRODUCTION

The rapid expansion of Indonesia's population and urban areas has increased water pollution **(Triweko, 2021; Basuki *et al.*, 2024)**. A significant consequence of this pollution is the accumulation of excess nutrients in water bodies, a phenomenon known as eutrophication. This issue is particularly concerning due to its potential to trigger harmful algal blooms (HABs) in both marine and freshwater environments **(McKindles *et al.*, 2020; Abbas *et al.*, 2023)**. In freshwater systems, these blooms are referred to as CyanoHABs, which are predominantly composed of Cyanobacteria **(Pulido, 2016; Stauffer *et al.*, 2019; Pinto *et al.*, 2023)**. The development of CyanoHABs is influenced not only by nutrient levels but also by environmental factors, including climate change, which is expected to increase the frequency, intensity, and duration of such blooms **(Stauffer *et al.*, 2019; Karlson *et al.*, 2021; Pinto *et al.*, 2023)**.

CyanoHABs can have substantial impacts on ecosystems, economic activities, and human health **(Duermit-Moreau *et al.*, 2022; Bloch *et al.*, 2024; Boubacar *et al.*, 2024)**. These negative effects arise from the ability of certain Cyanobacteria to produce toxic substances known as cyanotoxins, which can be lethal to fish, wildlife, and other economically significant organisms **(Karlson *et al.*, 2021; Duermit-Moreau *et al.*, 2022)**. Among these, saxitoxin (STX) is a particularly potent neurotoxin, posing a significant risk to human health through multiple exposure pathways, including ingestion via the food chain, inhalation, and dermal contact **(McHau *et al.*, 2019; Christensen & Khan, 2020; Patel *et al.*, 2020; French *et al.*, 2023)**.

Several studies have been conducted to detect saxitoxin in Indonesia's coastal waters, particularly in shellfish. These investigations have reported various health effects on coastal communities along Java. A significant saxitoxin poisoning event occurred in Cirebon, West Java, affecting 115 individuals and resulting in two fatalities **(Pello, 2017; Nurlina, 2018; Januar *et al.*, 2019; Dwiyitno *et al.*, 2022)**. While marine environments have been extensively studied, research on saxitoxins in freshwater organisms remains limited—especially in Indonesia, a country abundant in freshwater resources such as rivers, lakes, and reservoirs. Given the documented saxitoxin cases along Java's coast and the limited research in freshwater systems, this study aimed to address that knowledge gap by investigating the Kedung Ombo Reservoir, a critical freshwater resource in Central Java.

The Kedung Ombo Reservoir (storage capacity: 723.106m³) spans three administrative districts in Central Java Province: Grobogan, Boyolali, and Sragen **(Ariyani & Fauzi, 2022; Ariyani & Fauzi, 2023)**. This reservoir supports a range of essential functions, including irrigation, raw water supply, power generation, fisheries, and tourism **(Legono *et al.*, 2022; Pambudi *et al.*, 2023; Primawati *et al.*, 2025)**. These varied activities have contributed to declining water quality in the reservoir, with eutrophication emerging as a key concern **(Irianto & Triweko, 2019)**, potentially encouraging phytoplankton proliferation. Since 2012, annual mass fish mortality events have been reported in the reservoir (communication with fish farmers).

In response to these concerns, this study aimed to analyze the phytoplankton community in the Kedung Ombo Reservoir—focusing on Cyanobacteria capable of forming CyanoHABs—and to assess their relationship with water quality and the presence of saxitoxin in aquatic organisms. Considering the reservoir's importance as a water resource, the study is expected to contribute to food security efforts and inform long-term water management strategies.

MATERIALS AND METHODS

1. Sample collection

This study was conducted in September and October 2024. A purposive sampling method was employed to select sites that were considered representative of the overall conditions and characteristics of the research area **(Sugiyono, 2018)**. Six sampling stations were identified: Station 1 (floating net fish cages), Station 2 (dock), Station 3 (hydropower plant area), Station 4 (tourist area), Station 5 (reservoir inlet), and Station 6 (reservoir outlet). These locations are illustrated in Fig. (1).

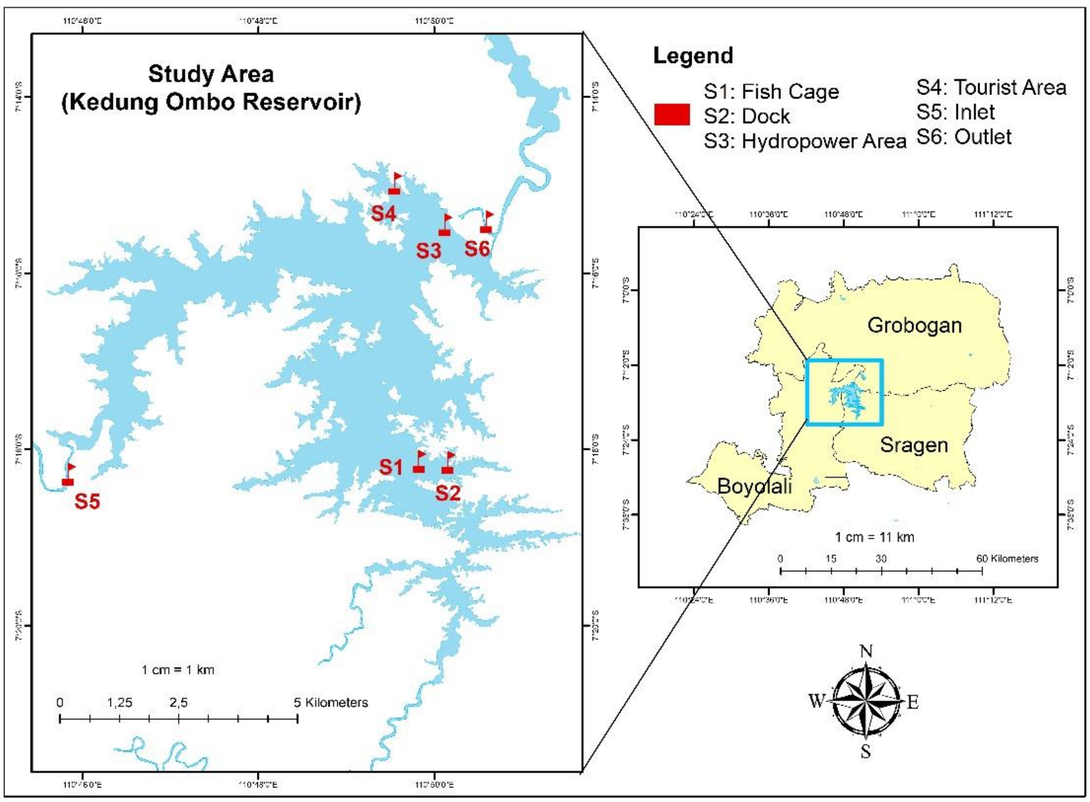

Fig. 1. Map of the study area

The collected samples included phytoplankton for community analysis, sediment for examining phytoplankton cyst presence, and various aquatic organisms for detecting saxitoxin. Phytoplankton were collected using a plankton net of 25 micrometer and preserved with a 4% Lugol solution **(APHA, 2017)**. Furthermore, several water quality parameters were also assessed. *In situ* measurements comprised temperature, pH, dissolved oxygen (DO), transparency, and turbidity. Laboratory analyses were conducted to determine the nitrate and phosphate concentrations.

The organisms used in this study included snails (*Pila ampullacea*), carp (*Cyprinus carpio*), tilapia (*Oreochromis mossambicus*), and catfish (*Clarias gariepinus*). In contrast to the other samples, the organism sampling methodology did not use purposive sampling; instead, samples were collected from fish farmers and collectors.

2. Nitrate and phosphate determination

Nitrate and phosphate concentrations were determined according to the procedures delineated in the Standard Methods for Examining Water and Wastewater, specifically methods 4500-NO_3-B and 4500-P D **(APHA, 2017)**.

3. Phytoplankton identification and quantification

Phytoplankton samples were placed in a Sedgwick-Rafter Counting Chamber and subsequently examined under a microscope at 10× magnification for their identification and quantification. Phytoplankton identification was conducted according to **Bellinger and Sigee (2010)** and **Komárek (2016)** to the lowest possible taxonomic level, and quantification was performed using the formula provided by **APHA (2017)**.

$$N = n \times \frac{1}{Vd} \times \frac{Vt}{Vs}$$

N: phytoplankton abundance (cells/L or individuals/L)
n: number of cells/individuals observed
Vd: volume of filtered water (L)
Vt: volume of filtered sample (mL)
Vs: volume of sample observed in Sedgwick Rafter (mL)

4. Sediment preparation for phytoplankton cyst identification

Certain phytoplankton species, including those with the potential to cause harmful algal blooms (HABs), can undergo a dormant benthic phase by forming cysts in response to unfavorable environmental conditions **(Fernández *et al*., 2015; Belmonte & Rubino, 2019)**. Therefore, the presence of phytoplankton cysts in the sediment was analyzed to support this study.

Sediment samples were processed according to the method described by **Narale *et al*. (2013)**. Wet sediment (3g) was treated with 10% HCl and 30% HF, then rinsed 3 – 4 times with distilled water to remove residual acid. Subsequently, the sample was filtered using two different mesh sizes, 120 and 20µm, to separate the coarse material. The 20mL filtrate that passed through the final filtration was stored in a bottle for further analysis.

The presence of phytoplankton cysts was identified using a microscope at 10× magnification, based on the identification guide by **Bellinger and David (2010)**, while the cyst concentration was calculated as the number of cysts or cells per gram of dry sediment (cysts/g dry sediment or cells/g dry sediment) using the following formula:

$$\frac{N}{W}(1-R)$$

N: number of cysts/cells

W: weight of wet sediment (g)
R: proportion of water in sediment
To estimate the proportion of water in the sediment, a wet sediment sample (1g) was dried at 70°C for 24 hours **(Matsuoka & Fukuyo 2000)**.

5. Saxitoxin concentration analysis

Saxitoxin concentrations in snails (*P. ampullacea*), carp (*C. carpio*), tilapia (*O. mossambicus*), and catfish (*C. gariepinus*) were analyzed using the Receptor Binding Assay (RBA) method, following the procedures of the **International Atomic Energy Agency (2013)**. The RBA method was selected because of its high sensitivity and specificity, allowing for the accurate assessment of potential neurotoxin threats in reservoir organisms. This method uses the ^{3}H-STX reagent to quantify the binding competition of saxitoxin with sodium channel receptors. The radioactivity of the unbound ^{3}H-STX was subsequently measured using a Liquid Scintillation Counter (LSC) to determine the saxitoxin concentrations in the organisms.

RESULTS AND DISCUSSION

1. Phytoplankton community

The phytoplankton composition in Kedung Ombo Reservoir comprises Chlorophyta (10 species), Cyanobacteria (8 species), Bacillariophyta (6 species), Dinophyta (2 species), Euglenophyta (1 species), and Charophyta (1 species), as presented in Fig. (2) and Table (1). The number of phytoplankton species observed at each sampling station varied from 22 to 26 at stations 1, 2, 3, 4, and 6. In contrast, station 5 demonstrated the lowest species diversity, with 14 species identified (Table 1).

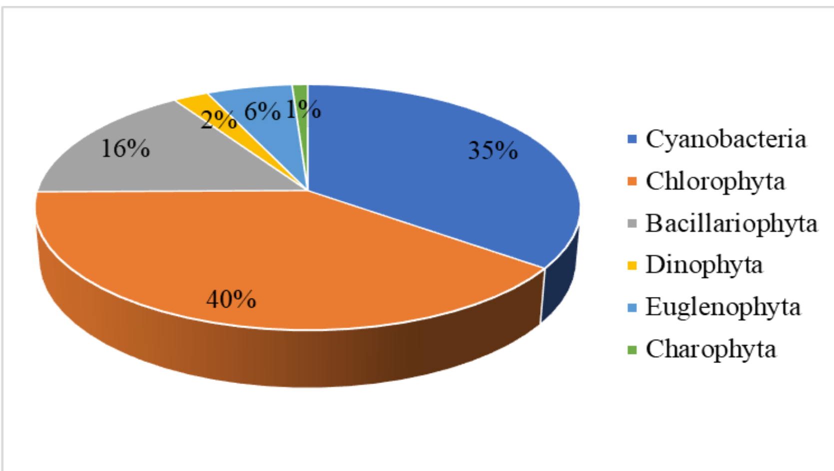

Fig. 2. Phytoplankton composition in Kedung Ombo Reservoir

The total phytoplankton abundance in the Kedung Ombo Reservoir reached 31514 ind/L, with Chlorophyta (12517 ind/L) and Cyanobacteria (11067 ind/L) as the predominant groups. Station 5 had the lowest phytoplankton abundance among the six observation stations, at 3639 ind/L (Table 1). This was due to variations in environmental factors, such as the lowest transparency (31cm) and the highest turbidity (20 NTU) at the station (Table 2). These conditions inhibit the penetration of sunlight into the water column, which can consequently affect the photosynthetic processes of phytoplankton **(Benayache *et al*., 2019; Akbarurrasyid *et al*., 2024)**.

Table 1. Phytoplankton composition and abundance in Kedung Ombo Reservoir (individuals/L)

No.	Phylum	Species	Station							
			1	2	3	4	5	6	Total (ind/L)	
1	Cyanobacteria	*Aphanizomenon* spp.	1143	578	403	470	289	605	3487	11067
2		*Microcystis* spp.	157	189	292	109	0	293	1040	
3		*Phormidium* spp.	19	0	46	0	0	96	161	
4		*Dolichospermum* spp.	0	14	0	48	0	171	234	
5		*Oscillatoria princeps*	0	0	0	0	193	160	353	
6		*Merismopedia tenuissima*	703	231	537	334	128	193	2126	
7		*Chroococcus* spp.	377	223	576	112	417	284	1677	
8		*Gleocapsa* spp.	196	82	308	642	128	321	1990	
9	Chlorophyta	*Scenedesmus acuminatus*	653	368	1263	257	257	241	3038	12517
10		*Monoraphidium minutum*	94	43	126	103	0	0	367	
11		*Crucigenia tetrapedia*	220	332	489	205	0	205	1452	
12		*Cosmarium* spp.	157	91	300	111	289	241	1189	
13		*Oocystis* spp.	188	173	347	151	539	193	1591	
14		*Pediastrum simplex*	19	220	134	117	0	138	627	
15		*Sphaerocystis* spp.	317	173	316	229	353	385	1773	
16		*Pandorina* spp.	239	144	355	64	0	342	1145	
17		*Dictyosphaerium* spp.	144	144	316	154	0	205	964	
18		*Ulotrix* spp.	0	0	217	154	0	0	371	
19	Bacillariophyta	*Navicula menisculus*	176	87	110	110	212	367	1062	5019
20		*Synedra ulna*	69	119	347	195	12	304	1047	
21		*Nitzschia navis-varingica*	100	274	505	462	135	321	1798	
22		*Aulacoseira granulata*	75	285	110	102	0	47	619	
23		*Cymbella* spp.	0	0	229	77	0	0	306	
24		*Gomphonema* spp.	0	0	141	0	0	47	188	
25	Dinophyta	*Peridinium cunningtoni*	65	39	144	16	225	229	718	756
26		*Ceratium lineatum*	0	14	23	0	0	0	37	
27	Euglenophyta	*Trachelomonas* spp.	220	173	371	305	462	292	1823	1823
28	Charophyta	*Staurastrum paradoxum*	19	29	182	103	0	0	332	332
Total (ind/L)			5350	4028	8187	4629	3639	5681		31514

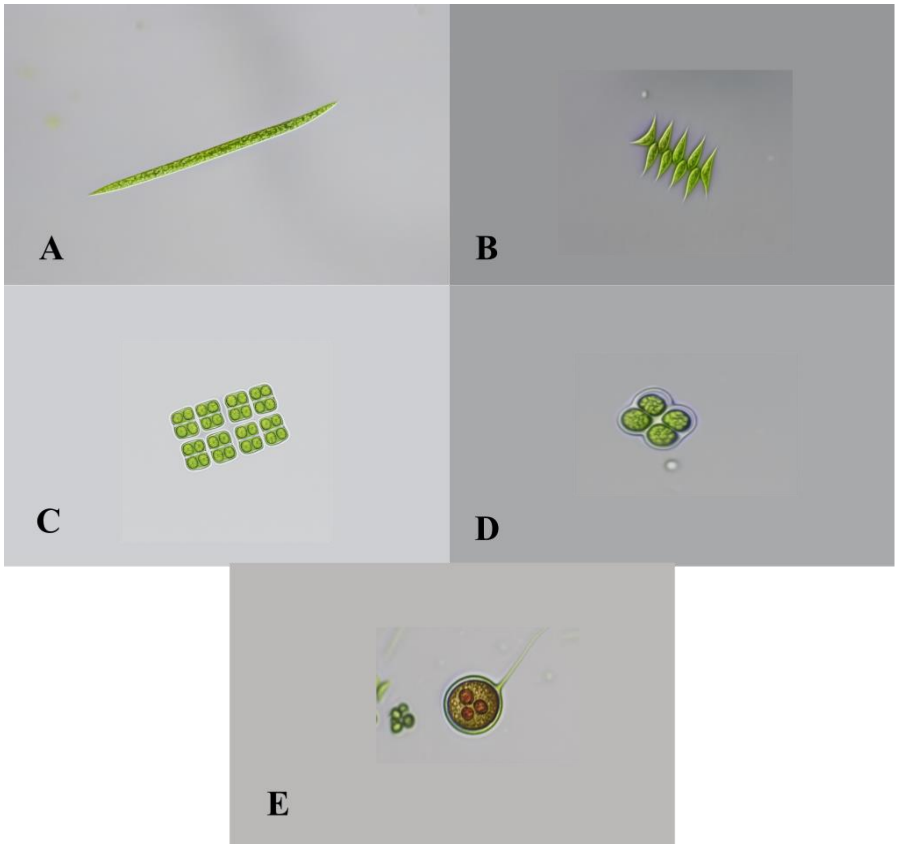

Fig. 3. Dominant phytoplankton species in Kedung Ombo Reservoir: **A)** *Aphanizomenon* sp.; **B)** *Scenedesmus acuminatus;* **C)** *Merismopedia tenuissima;* **D)** *Gloeocapsa* sp.; **E)** *Trachelomonas* sp.

Table 2. Water quality in Kedung Ombo Reservoir

Parameter	Station						Quality Standard*
	1	2	3	4	5	6	
Temperature (°C)	30.3	30.7	30.8	30.3	30.4	30.7	23–32
pH	7.82	7.9	8	8	7.91	7.88	6–9
DO (ppm)	6.8	6.4	6.5	4.9	5.3	4.46	≥4
Turbidity (NTU)	5.17	7.65	5.57	9.12	20	3.51	-
Depth (m)	16	10	15	3.5	<1	<1	-
Transparency (cm)	71	66	72.5	55.5	34	70	-
Nitrate (ppm)	0.562	0.526	0.485	2.580	0.476	0.436	<10
Phosphate (ppm)	0.014	0.014	0.013	0.015	0.013	0.013	≤0.2

*PP RI No. 22/2021 Class II (water designated for use in water recreation infrastructure/facilities, freshwater fish cultivation, animal husbandry, crop irrigation, and/or other purposes requiring equivalent water quality standards).

The dominance of Chlorophyta and Cyanobacteria in the Kedung Ombo Reservoir appears to be closely linked to the reservoir's water quality parameters, particularly pH, temperature, dissolved oxygen (DO), and nutrient availability. The recorded temperature (30.3–30.8°C; Table 2) falls well within the optimal ranges reported for both Chlorophyta (20–35°C) and Cyanobacteria (27.2–35°C) **(Lürling *et al*., 2013; Russo *et al*., 2021; Alhusainy & Kttafah, 2025)**. Similarly, the pH values observed (7.82–8.0) support the growth of these groups, aligning with previously reported ranges for Chlorophyta (pH 7.0–8.0) and Cyanobacteria (pH 7.5–11.0) **(Bano & Siddiqui, 2004; Touloupakis *et al*., 2016)**. DO concentrations between 4.46 and 6.8ppm (Table 2) meet the minimum requirement for phytoplankton viability, as stipulated by **PP RI No. 22/2021 for Class II** waters. Nutrient levels, particularly nitrate (0.436– 2.58ppm) and phosphate (0.013–0.015ppm), also play a role. Chlorophyta are often found in waters rich in nitrate with modest phosphate demands **(Ganguly *et al*., 2013; Wei *et al*., 2023)**. Although phosphate levels in the reservoir were low, Cyanobacteria may still flourish due to their ability to uptake and store phosphate efficiently, a trait observed in several species **(Tonetta *et al*., 2015; Caille *et al*., 2023; Tiwari, 2023)**.

The results of this study support the findings of **Larasati *et al*. (2024)**, who also reported a dominance of Chlorophyta in the same region. Interestingly, we observed an increase in the number of identified Cyanobacterial species, from four in the previous study to eight in the current one. This change may be related to the higher nitrate concentrations recorded in this study (0.436– 2.58ppm), which were notably greater than those reported by **Larasati *et al*. (2024)**, ranging from 0.30 to 0.43ppm.

Cyanobacterial abundance in the Kedung Ombo Reservoir (11067 ind/L) remained below the **World Health Organization**'s **(2023)** guideline of 2×10^6 cells/L, suggesting minimal health risk at the time of sampling. However, the increase in both cyanobacterial counts and nitrate levels observed in this study highlights the need for improved environmental monitoring and management to prevent potential blooms that could pose ecological and public health concerns **(Ibelings *et al*., 2014; WHO, 2023)**.

2. Phytoplankton species with potential to contribute to CyanoHABs

A total of 28 phytoplankton species were identified in this study, representing six phyla: Cyanobacteria, Chlorophyta, Bacillariophyta, Dinophyta, Euglenophyta, and Charophyta. These species were further classified into three groups based on their potential to cause blooms: Harmful Algal Blooms (HABs), Cyanobacterial Harmful Algal Blooms (CyanoHABs), and non-bloom-forming taxa (non-HABs), as summarized in Table (3).

Table 3. Identified phytoplankton species and their potential for algal bloom formation

No	Phylum	Species	Type of bloom	References
1	Cyanobacteria	*Aphanizomenon* spp.	CyanoHABs	**Hallegraeff *et al*. (2004); Sanseverino *et al*. (2017)**
2		*Microcystis* spp.	CyanoHABs	**Hallegraeff *et al*. (2004); Sanseverino *et al*. (2017)**

3		*Phormidium* spp.	CyanoHABs	**Hallegraeff *et al*. (2004); Sanseverino *et al*. (2017)**
4		*Dolichospermum* spp.	CyanoHABs	**Hallegraeff *et al*. (2004); Sanseverino *et al*. (2017)**
5		*Oscillatoria princeps*	CyanoHABs	**Hallegraeff *et al*. (2004); Sanseverino *et al*. (2017)**
6		*Merismopedia tenuissima*	non-HABs	**Keliri *et al*. (2021)**
7		*Chroococcus* spp.	non-HABs	**Nwankwegu *et al*. (2023)**
8		*Gloeocapsa* spp.	non-HABs	**Hall & McCourt (2015)**
9	Chlorophyta	*Scenedesmus acuminatus*	non-HABs	**Ma *et al*. (2018)**
10		*Monoraphidium minutum*	non-HABs	**Petrova (2008)**
11		*Crucigenia tetrapedia*	non-HABs	**Gani *et al*. (2017)**
12		*Cosmarium* spp.	non-HABs	**Hall & McCourt (2015)**
13		*Oocystis* spp.	non-HABs	**Korponai *et al*. (2019)**
14		*Pediastrum simplex*	non-HABs	**Li *et al*. (2024)**
15		*Sphaerocystis* spp.	non-HABs	**Pratiwi *et al*. (2019)**
16		*Pandorina* spp.	non-HABs	**de la Cruz *et al*. (2017)**
17		*Dictyosphaerium* spp.	non-HABs	**Affe *et al*. (2021)**
18		*Ulotrix* spp.	non-HABs	**Natyaganova *et al*. (2022)**
19	Bacillariophyta	*Navicula menisculus*	non-HABs	**Chaghtai & Saifullah (1992)**
20		*Synedra ulna*	non-HABs	**Frenken *et al*. (2016)**
21		*Nitzschia navis-varingica*	non-HABs	**Hallegraeff *et al*. (2004)**
22		*Aulacoseira granulata*	non-HABs	**Kumar *et al*. (2022)**
23		*Cymbella* spp.	non-HABs	**Suzawa *et al*. (2011)**
24		*Gomphonema* spp.	non-HABs	**Gani *et al*. (2017)**
25	Dinophyta	*Peridinium cunningtoni*	HABs	**Rodríguez-Gómez *et al*. (2019)**
26		*Ceratium lineatum*	HABs	**Nwankwegu *et al*. (2023)**
27	Euglenophyta	*Trachelomonas* spp.	non-HABs - change in water color (brown)	**Hall & McCourt (2015)**
28	Charophyta	*Staurastrum paradoxum*	non-HABs	**Ahmed *et al*. (2021)**

Several cyanobacterial species known to be associated with CyanoHABs were detected in the Kedung Ombo Reservoir, including *Aphanizomenon* spp., *Microcystis* spp, *Phormidium* spp, *Dolichospermum* spp., and *Oscillatoria princeps.* Collectively, these species reached a total abundance of 5275 ind/L. Many of these taxa are capable of producing toxins that pose risks to both human health and aquatic ecosystems **(Hallegraeff *et al*., 2004; Sanseverino *et al*., 2017)**. In addition to cyanobacteria, two dinoflagellate species (*Peridinium cunningtoni* and *Ceratium lineatum*) were also identified as potential bloom-formers. However, their abundance was relatively low, with only 756 ind/L recorded. The limited presence of Dinophyta in this freshwater system may reflect their ecological preference for brackish or marine environments, where conditions are more favorable for their proliferation **(Akbar *et al*., 2018; Jeong *et al*., 2021)**.

The remaining 21 phytoplankton species identified in this study were categorized as non-HABs (Table 3). While these species are not known to produce toxins, their blooms may still disrupt aquatic ecosystems. Excessive growth of non-toxic phytoplankton can lead to oxygen depletion, unpleasant odors, and discoloration of the water **(Hall & McCourt, 2015; Karlson *et al*., 2021)**.

3. Presence of phytoplankton cysts

Cyanobacterial cysts, also known as akinetes, were observed in the sediments of the Kedung Ombo Reservoir, with a mean concentration of 53 cells/g dry sediment (Fig. 4).

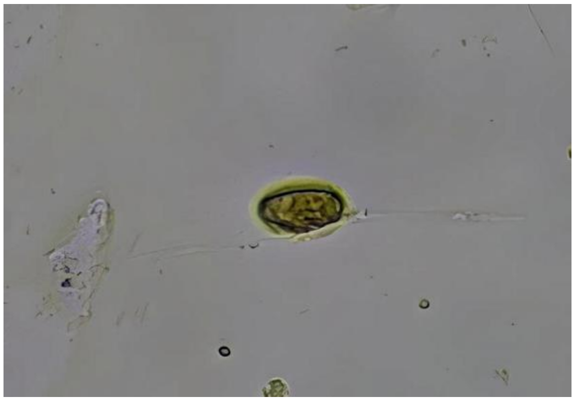

Fig. 4. Cyanobacterial cysts (akinete) observed in the sediment of Kedung Ombo Reservoir

Akinetes play a crucial role in the cyanobacterial life cycle, particularly in asexual reproduction. These specialized cells form when vegetative cells differentiate in response to adverse environmental conditions **(Sukenik *et al*., 2018; Ho *et al*., 2024)**. As a survival mechanism, akinetes descend to the benthic zone of the water body and enter dormancy. Under these conditions, they can persist in sediment for extended periods, potentially up to 120 years or more **(Ellegaard & Ribeiro, 2018; Wood *et al*., 2021)**. Upon the return of favorable conditions, akinetes germinate, forming new vegetative cells that proliferate and increase the abundance of Cyanobacteria **(Wood *et al*., 2021; Ho *et al*., 2024)**.

The presence of cysts in sediments has significant implications for long-term reservoir management. This condition necessitates a more comprehensive approach, as studies have demonstrated that conventional water quality monitoring alone is inadequate for predicting and managing blooms **(Paerl, 2014; Thawabteh, 2023)**. The capacity of cysts to persist in sediments for up to hundreds of years creates a long-term reserve of bloom-forming species that can respond to environmental changes such as climate change **(Karlson *et al*., 2021; Nowicka-Krawczyk *et al*., 2022; Pinto *et al*., 2023)**. Therefore, understanding the presence and dynamics of these cyanobacterial cysts should form the foundation for more proactive water resource management and long-term adaptation strategies to address the impacts of climate change.

4. Saxitoxin concentrations in aquatic organisms

In this study, saxitoxin was not detected in any of the examined aquatic organisms, including snails (*P. ampullaceal*), carp (*C. carpio*), tilapia (*O. mossambicus*), and catfish (*C. gariepinus*).

However, this study identified the presence of cyanobacterial genera, which have species capable of producing saxitoxins, such as *Aphanizomenon*, *Phormidium*, and *Dolichospermum* **(Hallegraeff *et al*., 2004; Sanseverino *et al*., 2017)**. It is noteworthy that not all species within these genera possess this capability; some can produce saxitoxin, while others cannot **(Cirés & Ballot, 2016; Österholm *et al*., 2020; Podduturi *et al*., 2021)**. Therefore, the presence of *Aphanizomenon, Dolichospermum*, and *Phormidium* in the Kedung Ombo Reservoir does not indicate that saxitoxin will be produced or detected in aquatic organisms.

CONCLUSION

This study identified phytoplankton communities in the Kedung Ombo Reservoir, comprising six phyla: Chlorophyta (40%), Cyanobacteria (35%), Bacillariophyta (16%), Euglenophyta (6%), Dinophyta (2%), and Charophyta (1%). Several Cyanobacterial species with the potential to form CyanoHABs have been identified, including *Aphanizomenon* spp., *Microcystis* spp., *Phormidium* spp, *Dolichospermum* spp., and *Oscillatoria princeps*. Furthermore, cyanobacterial cysts (akinete) were observed in the sediment at an average concentration of 53 cells/g dry sediment, potentially serving as a source of new populations in favorable environmental conditions. Despite the presence of Cyanobacteria capable of causing CyanoHABs, not all species within these taxa produce saxitoxins. The analysis revealed that saxitoxin was not detected in the examined organisms, including snails (*P. ampullacea*), carp (*C. carpio*), tilapia (*O. mossambicus*), and catfish (*C. gariepinus*) from the reservoir.

These findings indicate that, at present, there is no risk of saxitoxin accumulation in organisms within the Kedung Ombo Reservoir, suggesting no immediate threat to food safety. Nevertheless, the observed increase in nutrient concentrations and the presence of Cyanobacterial cysts in the sediment underscore the necessity of sustainably managing aquatic resources. This approach is crucial for mitigating future cyanobacterial blooms, particularly if environmental conditions become more favorable for their proliferation.

FUTURE WORK

While this study has successfully identified the presence of saxitoxin using the receptor binding assay, future research should aim to explore the genetic basis of toxin production. Specifically, examining the presence of key genes within the saxitoxin biosynthetic gene cluster (e.g., *sxtA*, *sxtG*, and *sxtB*) would offer molecular-level confirmation of toxin-producing Cyanobacteria. Incorporating such genetic screening would not only support the current findings but also strengthen ecological risk evaluations and contribute to more robust monitoring frameworks for freshwater ecosystems like Kedung Ombo Reservoir.

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