West African Journal of Life Sciences. Available online at ***http://www.wajls.com*** *ISSN (Print):2992-5150. eISSN:3122-0916*
Volume 2; Issue 2: pages 1-8

Full Length Research

Growth Responses of *Chlorella Vulgaris* to Varying Concentrations of Omo and Klin Detergents in Nigeria

Omoruyi, O.A[1]* and Samson, F.T[2]

[1,2]Department of Plant Science and Biotechnology, Faculty of Life Sciences, Ambrose Alli University, Ekpom

***Corresponding Author's Email**: osasere.omoruyi@aauekpoma.edu.ng. Tel.: +234 805 565 6885

ABSTRACT

This study assessed the effects of two widely used powdered detergents in Nigeria Omo and Klin on the growth of *Chlorella vulgaris* over 14 days under laboratory conditions. Detergent concentrations ranging from 0 g/l, 3.33g/l, 6.67 g/l, 10.00g/l, 13.33 g/l and 16.67g were tested. Results revealed that Klin stimulated algal growth by up to 25% at optimal concentrations, while Omo reduced growth by as much as 45% across most treatments. The stimulation by Klin is likely due to its phosphate content, while Omo's inhibition is attributed to potentially toxic additives. These findings suggest *Chlorella vulgaris* has potential as an early-warning indicator of detergent contamination, though further studies involving more detergent types are necessary to confirm generalizability.

Keywords: Algae, Bioremediation, Detergent, Inhibition, *Chlorella vulgaris*, Pollution

Received April 25, 2025

Received in Revised form, Nov. 7, 2025

Accepted Nov. 9, 2025

Available Online Dec.30, 2025

W. Afr. J. Life Sci. 2 (2):1-8

INTRODUCTION

Detergents are chemical agents used extensively in households and industries for cleansing purposes. They typically contain surfactants and other additives, such as phosphates and enzymes, which help to emulsify and remove oily residues (Sarmiento, et al., 2015; Gurkok, 2019; Babajanzadeh et al., 2019). Once used, detergents and the pollutants they release often enter aquatic systems (Ekanem, et al., 2008), potentially impacting water quality and ecological balance.

Among the constituents of detergents, phosphorus, usually in the form of phosphate can promote eutrophication in freshwater systems by stimulating excessive algal growth. This, in turn, reduces light penetration, lowers oxygen levels, alters pH, and ultimately leads to algal death and disruptions in aquatic food chains.

In Nigeria, Omo and Klin are among the most widely used detergent brands. Due to their popularity, their potential to contribute to aquatic pollution through runoff and improper disposal is a growing concern. The active chemical compositions of these detergents may either stimulate or inhibit algal growth depending on their toxicity and nutrient profiles.

Algae such as Chlorella vulgaris are key primary producers and sensitive to changes in environmental conditions. Their growth responses to pollutants make them ideal bio-indicators for aquatic ecosystem health. This study aims to evaluate the growth responses of *Chlorella vulgaris* when exposed to different concentrations of Omo and Klin, providing insights into their ecological impacts and the potential for using algae in monitoring detergent contamination.

MATERIALS AND METHODS

Materials

Detergents (Omo and Klin): The Omo detergent contains surfactants, sodium sulfate, sodium carbonate, sodium silicate, sodium aluminosilicate, clay, enzymes, perfume, polycarbonates, optical brighteners, and polycarboxylates. Klin detergent includes linear alkylbenzene sulfonate (LABS), sodium tripolyphosphate (STPP), sodium carbonate, sodium sulfate, and enzymes.

Test Organism

A pure culture of *Chlorella vulgaris* (Division Chlorophyta) was obtained from the Phycology Laboratory, University of Benin, Nigeria.

Culture Medium

Chu's No. 10 medium was used for algal cultivation. Macronutrients included KH_2PO_4, $CaCl_2 \cdot 6H_2O$, $MgSO_4 \cdot 7H_2O$, $NaHCO_3$, $NaNO_3$, and $Na_2SiO_3 \cdot 9H_2O$. Micronutrients included $CoCl_2 \cdot 6H_2O$, $Na_2MoO_4 \cdot 2H_2O$, $ZnSO_4 \cdot 7H_2O$, H_3BO_3, $MnCl_2 \cdot 4H_2O$, and $CuSO_4 \cdot 5H_2O$. Iron stock was prepared using ferric citrate and citric acid. A vitamin stock (Supradyn) was also added.

Instruments

UV/Vis Spectrophotometer (Jenway 6715) for absorbance readings at 750 nm

Metler MT-301 electronic balance for weighing test substances

Methods

Various grams namely: 0g, 1g, 2g, 3g, 4g, 5 g of each detergent were weighed and dissolved in 300 mL (0.3L) of Chu's medium in separate culture containers make a concentration of 0 g/l, 3.33g/l, 6.67 g/l,/l 10.00g/l, 13.33 g/l and 16.67g respectively. A

4 mL inoculum of *Chlorella vulgaris* was added to each culture container. Control setups contained no detergent (0 g/l). All treatments were in triplicates and maintained under favorable light conditions. Absorbance was measured every two days for 14 days.

Growth rate calculation:

$$\mu = \frac{\ln N_2 - \ln N_1}{t_2 - t_1}$$

N_1 = initial cell density/No

N_2 = final (measured) cell density/No

t_2 = time at end of experiment

t_1 = time at start of experiment

Percentage (%) Inhibition = $\frac{100 - \text{Measured Biomass}}{\text{Theoretical Biomass}} \times 100$

RESULTS

The effects of varying concentrations of Omo and Klin detergents on the growth of *Chlorella vulgaris* were monitored over a 14-day period. The growth pattern, growth rate, and percentage inhibition were evaluated and are presented in Figures 1–6. In Omo-treated samples (Figure 1), *Chlorella vulgaris* exhibited an initial exponential growth phase from day 0 to day 8 across all concentrations. This was followed by a decline, then a slight increase in cell density up to day 12, and another decline by day 14. In contrast, the control group exhibited a lag phase up to day 8, after which exponential growth occurred until day 12, followed by a decrease in cell density on day 14.

Growth patterns in Klin-treated samples (Figure 2) demonstrated a brief lag phase from day 0 to day 2, followed by steady exponential growth until day 8. Thereafter, the cultures entered a stationary phase, with little to no further increase in algal biomass. Control groups showed similar trends.

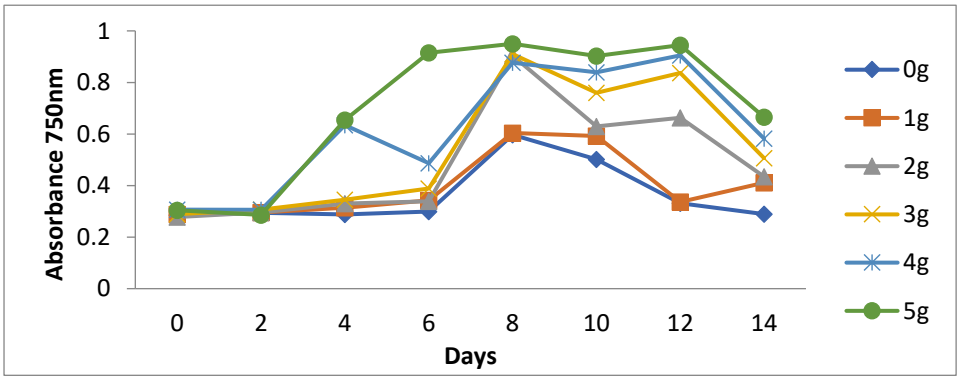

Figure 1: Growth curve of *Chlorella vulgaris* in Omo detergent

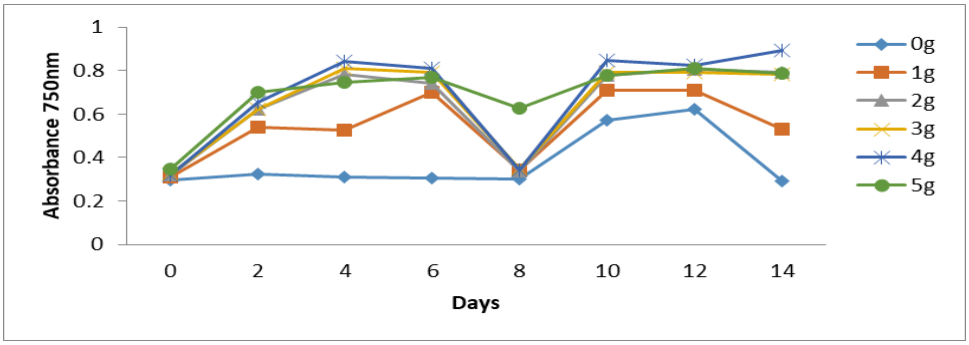

Figure 2: Growth curve of *Chlorella vulgaris* in Klin detergent

Figures 3 and 4 display the growth rate of *Chlorella vulgaris* exposed to Omo and Klin detergents, respectively. In Omo treatments (Figure 3), growth rates initially rose but showed considerable fluctuations and a general downward trend, From a growth rate of 0.045, 0.274, 0.332, 0.349, 0.34 and 0.347 on day 2 for 0g, 1g, 2g, 3g, 4g, 5 g respectively to a growth rate of -0.379, -0.145, -0.001, -0.007, 0.039, -0.013 on day 14 for 0g, 1g, 2g, 3g, 4g, 5 g respectively indicating inhibitory effects across all concentrations. Conversely, in Klin treatments (Figure 4), positive growth rates were observed across concentrations, with moderate fluctuations suggesting growth stimulation.

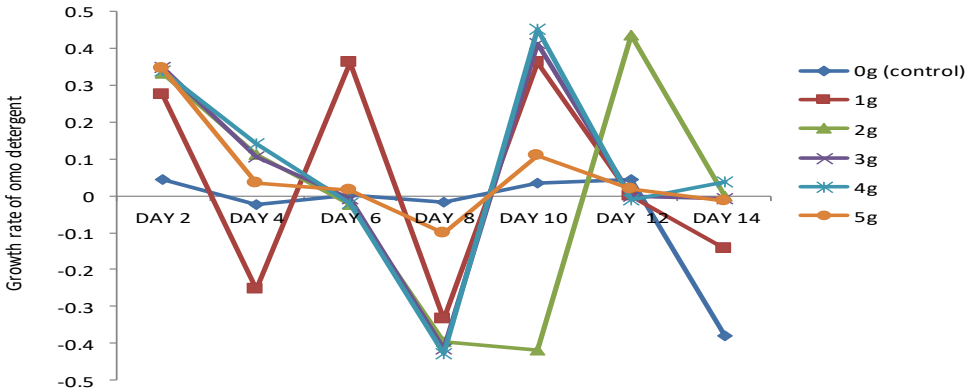

Figure 3: Growth rate of *Chlorella vulgaris* in Omo detergent

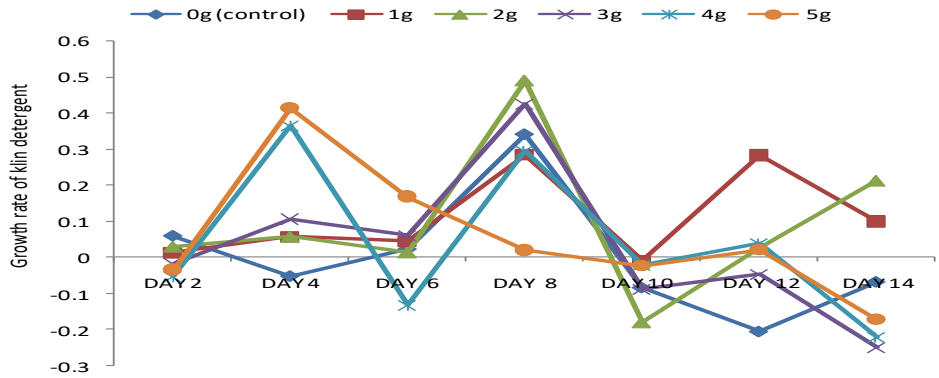

Figure 4: Growth rate of *Chlorella vulgaris* in Klin detergent

Percentage inhibition values (Figures 5 and 6) further confirmed the inhibitory effect of Omo and the stimulatory effect of Klin on *Chlorella vulgaris*. Omo treatment (Figure 5) resulted in notable growth inhibition at all concentrations, with the least inhibition at 2g (6.67 g/l). On the other hand, Klin exposure (Figure 6) led to negative percentage inhibition values, indicating enhanced algal growth at all tested concentrations. Omo exposure consistently inhibited *Chlorella vulgaris* growth, with reductions in biomass ranging from 20% to 45% depending on the concentration. Maximum inhibition was observed at 5g (16.6g/l). In contrast, Klin promoted algal growth, particularly at 2g (6.67g/l)–3g (10g/l), with biomass increases up to 25% above the control.

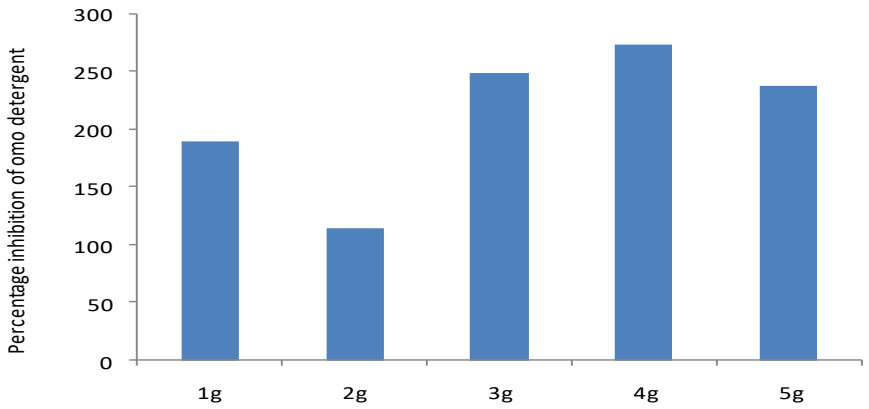

Figure 5: Percentage Growth inhibition of *Chorella vulgaris* in Omo detergent

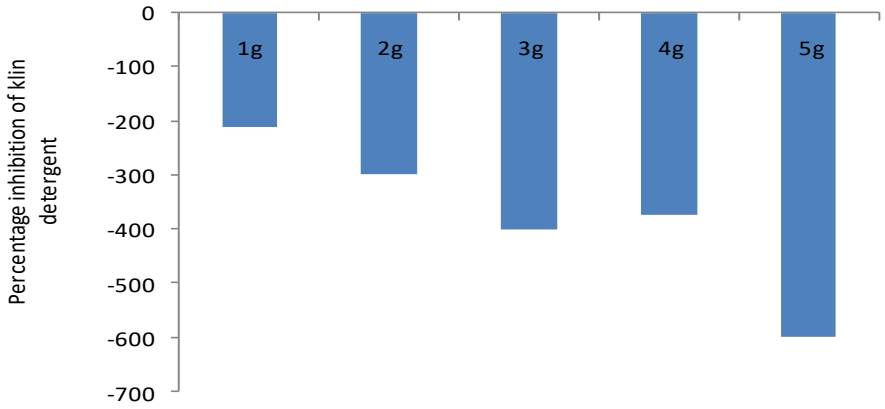

Figure 6: Percentage Growth stimulation of *Chorella vulgaris* in Klin detergent

DISCUSSION

This study revealed significant differences in the growth responses of *Chlorella vulgaris* when exposed to two commonly used detergents, Omo and Klin. Omo consistently inhibited algal growth at all concentrations, while Klin promoted growth, suggesting contrasting ecological impacts. The inhibitory effect observed in Omo treatments aligns with previous reports indicating that certain detergent components, such as sodium aluminosilicate and sodium silicate, can disrupt algal cell membranes and metabolic functions (Aizdaicher and Markina, 2006; Pathusamy et al., 2013 Kibuye et al., 2021; Binh et al., 2022; Sudibyo et al., 2023). Surfactants and additives in Omo may also reduce nutrient uptake or cause direct toxicity, leading to reduced biomass accumulation (Banks, et al., 2015; Ryu and Spuller, 2021; Munoza et al., 2022; Silva et al., 2024). In contrast, the growth stimulation observed in Klin treatments may be attributed to the presence of sodium tripolyphosphate (STPP), a known phosphorus source. Phosphorus is an essential macronutrient for algal growth, and its presence in detergents has been implicated in enhanced primary productivity and eutrophication (Agbazue et al., 2015; Barrante, 2015; Tahiluddin, 2023; Badamasi et al., 2019; Wurtsbaugh et al., 2019; Bossa et al., 2024; Ogwu, et al., 2025). The stimulatory effect of Klin observed in this study is consistent with previous findings that

low concentrations of phosphate-containing detergents can significantly boost algal biomass (Mustaffa et al., 2019; Mohsenpour et al., 2021; Olayemi 2021; Aulia et al., 2025; Li et al., 2025; Pavlíková et al., 2025).

However, while Klin may enhance algal growth, its continued use and discharge into freshwater systems could contribute to nutrient loading, potentially triggering harmful algal blooms and oxygen depletion. Therefore, while *Chlorella vulgaris* demonstrated resilience and stimulatory responses in Klin-contaminated media, such growth must be monitored closely in natural settings to avoid ecological imbalance. The differential responses of Chlorella *vulgaris* to Omo and Klin highlight the importance of detergent composition in determining aquatic ecological outcomes. The study also underscores the potential of *Chlorella vulgaris* as a bio-indicator species and its possible utility in bioremediation strategies, particularly in environments impacted by phosphate-based pollutants.

CONCLUSION

Chlorella vulgaris displayed variable growth responses when exposed to Omo and Klin detergents. Omo consistently inhibited algal growth, while Klin stimulated it, likely due to phosphate content. These findings underscore the importance of detergent composition in aquatic toxicity and support the use of algae in pollution monitoring.

Further studies are needed to evaluate other detergent brands, incorporate field studies, and assess long-term ecological consequences of detergent discharge in Nigerian water bodies.

AUTHORS' CONTRIBUTIONS

Both authors, Omoruyi, O.A and Samson, F.T initiated the idea, conducted the experiment, visualized the results, wrote the draft, and revised the manuscript.

REFERENCES

Agbazue, V. E., Ekere, N. R., & Shaibu, Y. (2015). Assessment of the levels of phosphate in detergent samples. *International Journal of Chemical Sciences*, 13(2), 771–785.

Aizdaicher, N. A., & Markina, Z. V. (2006). Toxic effects of detergents on the alga Plagioselmis prolonga (Cryptophyta). *Russian Journal of Marine Biology*, 32(1), 45–49.

Aulia, N., Fahruddin, & Samawi, M. F. (2025). Potential of microalgal growth in laundry effluents for phosphate phytoremediation. *Nature Environment and Pollution Technology*, 24(3), D1735. https://doi.org/10.46488/NEPT.2025.v24i03.D1735

Babajanzadeh, B., Sherizadeh, S., & Ranji, H. (2019). Detergents and surfactants: A brief review. *Open Access Journal of Science*, 3(3), 94–99.
https://doi.org/10.15406/oajs.2019.03.00138

Badamasi, H., Yaro, M. N., Ibrahim, A., & Bashir, I. A. (2019). Impacts of phosphates on water quality and aquatic life. *Chemistry Research Journal*, 4(3), 124–133.

Banks, M.-L. L., Kremer, R. J., Eivazi, F., Motavalli, P. P., & Nelson, K. A. (2015). Effects of selected surfactants on nutrient uptake in corn (Zea mays L.). *Journal of Plant Nutrition*, 38(7), 1036–1049. https://doi.org/10.1080/01904167.2014.881878

Barrante, L. J. (2015). The effects of dish detergent on algae. Central Catholic High School, 17p.

Binh, M. N., Thuy, N. T. T., & Serrano, A. E., Jr. (2022). Effect of sodium nitrate, sodium phosphate, and sodium silicate on growth and accumulation of nutritional compounds of microalgae Nannochloropsis oculata. *AACL Bioflux*, 15(1), 395–406.

Bossa, R., Di Colandrea, M., Salbitani, G., & Carfagna, S. (2024). Phosphorous utilization in microalgae: Physiological aspects and applied implications. *Plants*, 13, 2127. https://doi.org/10.3390/plants13152127

Coumar, M. V., Saha, J. K., Meena, V., Somasundaram, J., & Lenka, S. P. (2019). Phosphorus: Nutrient element for crop production and environmental quality. *Harit Dhara*, 2(2), 26–29.

Ekanem, A. P., & Ekpo, I. A. (2008). Effects of commercial detergent on the juveniles of Heterobranchus longifilis. *African Journal of Environmental Pollution and Health*, 6(1), 18–23.

Ekpan, F. M., Ori, M. O., & Samuel, H. S. (2025). Effects of environmental factors and nutrient availability on the biochemical composition of algae for biofuel production. *Discover Applied Sciences*, 7, 1209. https://doi.org/10.1007/s42452-025-07363-w

Gürkök, S. (2019). Microbial enzymes in detergents: A review. *International Journal of Scientific & Engineering Research*, 10(9), 75–81.

Kibuye, F. A., Zamyadi, A., & Wert, E. C. (2021). A critical review on operation and performance of source water control strategies for cyanobacterial blooms: Part I – Chemical control methods. *Harmful Algae*, 109, 102099. https://doi.org/10.1016/j.hal.2021.102099

Li, H., Kong, L., Ai, W., & Zhang, Y. (2025). Algal systems reimagined: Exploring the potential for sustainable solutions to diverse wastewater challenges. *Blue Biotechnology*. https://doi.org/10.1186/s44315-025-00033-x

Mohsenpour, S. F., Hennige, S., Willoughby, N., Adeloye, A., & Gutierrez, T. (2021). Integrating micro-algae into wastewater treatment: A review. *Science of the Total Environment*, 752, 142168. https://doi.org/10.1016/j.scitotenv.2020.142168

Munoza, S., Balbino, T. R., Alba, E. M., Barbosa, F. G., de Piera, F. T., de Almeida, A. L. M., Zilla, A. H. B., Antunes, F. A. F., Hilares, R. T., Balagurusamy, N., dos Santos, J. C., & da Silva, S. S. (2022). Surfactants in biorefineries: Role, challenges and perspectives. *Bioresource Technology*, 345, 126477. https://doi.org/10.1016/j.biortech.2021.126477

Mustaffa, A. R., Hamid, K. H. K., Musa, M., Idris, J., & Ramli, R. (2019). High nitrate and phosphate ions reduction in modified low-salinity freshwater through microalgae cultivation. *Processes*, 7, 129. https://doi.org/10.3390/pr7030129

Nagtode, V. S., Cardoza, C., Yasin, H. K. A., Mali, S. N., Tambe, S. M., Roy, P., Singh, K., Goel, A., Amin, P. D., Thorat, B. R., Cruz, J. N., & Pratap, A. P. (2023). Green surfactants (biosurfactants): A petroleum-free substitute for sustainability—Comparison, applications, market, and future prospects. *ACS Omega*, 8, 11674–11699.

Ogwu, M. C., Patterson, M. E., & Senchak, P. A. (2025). Phosphorus mining and bioavailability for plant acquisition: Environmental sustainability perspectives. *Environmental Monitoring and Assessment*, 197, 572. https://doi.org/10.1007/s10661-025-14012-7

Olayemi, T. E. (2021). Study on the balance of phosphate and nitrate concentrations in the Lagos Lagoon's water system. *African Journal of Environment and Natural Science Research*, 4(1), 14–44.

Pathusamy, V., Nandini, N., & Bheemappa, K. (2013). Detergent and sewage phosphates entering into lake ecosystem and its impact. *International Journal of Advanced Research*, 1(3), 129–133.

Pavlíková, M., Odehnalová, K., Zezulka, Š., Maršálková, E., Lamaczová, A., & Maršálek, B. (2025). Nature-based approaches for managing bioavailable phosphorus in aquatic ecosystems. *Hydrology*, 12, 236.

https://doi.org/10.3390/hydrology12090236

Ryu, S., & Spuller, K. (2021). Detergent pollutants decrease nutrient availability in soil. *Journal of Emerging Investigators*, 4, 1–6.

Sarmiento, F., Peralta, R., & Blamey, J. M. (2015). Cold and hot extremozymes: Industrial relevance and current trends. Frontiers in Bioengineering and Biotechnology, 3, 148. https://doi.org/10.3389/fbioe.2015.00148

Silva, M. D. G. C., Medeiros, A. O., Converti, A., Almeida, F. C. G., & Sarubbo, L. A. (2024). Biosurfactants: Promising biomolecules for agricultural applications. *Sustainability*, 16, 449. https://doi.org/10.3390/su16010449

Sudibyo, Agustin, N., Karo Karo, P. K., Suprihatin, Rohman, F. S., & Bashah, N. A. A. (2023). Influence of sodium silicate, sodium aluminate, and Filicium decipiens charcoal on the conductivity of artificial zeolite. Esteem Academic Journal, 19, 43–53.

Tahiluddin, A. B. (2023). Effects of phosphorus availability on macroalgae: A review. Journal of Biometry Studies, 3(1), 22–26. https://doi.org/10.29329/JofBS.2023.501.05

Wurtsbaugh, W. A., Paerl, H. W., & Dodds, W. K. (2019). Nutrients, eutrophication and harmful algal blooms along thefreshwater to marine continuum. Wires Water, 6, e1373. https://doi.org/10.1002/wat2.1373