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WATER POLLUTION AND ALGAE

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ABSTRACT

The term "pollution" refers to a phenomenon that induces adverse effects on living species, including humans, animals, and marine organisms. The management of pollution involves a wide range of elements. It is interesting to note that algae plays a role in the regulation of pollution. Algae are mostly found in marine environments and are aquatic in nature. They are categorised according to their pigmentation, which includes green algae, brown algae, yellow-green algae, euglenophyta, golden brown, red algae, and fire algae. Green algae is the most common type of algae. In addition to being utilised in dietary supplements, it plays a significant part in maintaining a steady level of carbon dioxide. Both their manner of sustenance, which is autotrophic, and their capacity to conduct photosynthesis complement one another. The presence of dietary fibre, carotenoids, proteins, auxins, and cytokinins are only some of the bioactive chemicals that may be found in algae. The term "algal bloom" refers to the growth of colonies of algae that are not under control. Certain blooms have the ability to have toxic effects on marine animals and fish. To a limited extent, certain types of algae, such as aphanizomenon and microcystis, might be considered water pollutants.

keywords : *Water, pollution, algae*

INTRODUCTION

In the 1950s, Oswald put out the concept of treating wastewater using microalgae. Subsequently, this concept was expanded to include the use of this framework for the generation of energy through the harvesting and utilisation of algal biomass. The development of marine biotechnology has left its own stamp on the production of maritime items that are naturally occurring. Within the realm of bioactivity, pharmacological and biochemical investigations are included. Nitrogenous chemicals are produced by the metabolism of cyanobacteria, which consists of a wide variety of characteristics. Both of them are conical and unicellular in form, and they differ from one another morphologically. By providing a more environmentally sound method of addressing the issue of eutrophication, the cultivation of algae in waste water may significantly contribute to the management of freshwater biological systems. This is because it involves the cultivation of algae in large quantities. The incorporation of algal frameworks into the routine treatment of wastewater has the potential to enhance the water quality of the effluent by reducing the amount of nutrient and metal loads that are introduced into freshwater biological systems. Metals are introduced into the biological systems because of weathering of soil and shakes, from volcanic emissions and from an assortment of human workouts including mining, processing and utilisation of metals and also substances containing metal pollutants . The discharge of trash from industrial processes has resulted in elevated metal concentrations on the planet. These metal concentrations are approximately

100–1000 times greater than those found in the outer layer of the planet. When it comes to the local environment, live organisms can be exposed to significantly higher levels. Mercury is a component that has always been present in the earth. However, the movement of humans around the globe has led to a significant increase in the amount of mercury that is released into the atmosphere, the ocean, and the land. It is possible to use microalgae to generate oxygen, which is required by acclimatised microscopic organisms in order to biodegrade harmful poisons such as polycyclic sweet-smelling hydrocarbons, phenolics, and natural solvents. This is a possibility that has been indicated by ongoing research that appropriate techniques for algal determination and development are being utilised. Microalgae have been shown to be effective in removing harmful metals, phosphorus, and nitrogen from a broad variety of wastewaters. This has been proved through research. In the process of treating wastewater with algae, the slop that is left behind contains a significant amount of algal biomass, which may be further processed to produce biofuel or other essential products. Therefore, the treatment of wastewater and the production of biofuel would be able to be beneficial to the environment under these circumstances. The growth of algae in modern wastewaters and agricultural practices has been the subject of research. The most fatal and non-harmful blooms were those of the anabaena variety, and it was present in every neurotoxic sample. The hepatotoxicity and incidence of *Microcystis aeruginosa*, *M. wesenbergii*, *Anabaena spiroides*, *M. viridis*, and *Anabaena flos-aquae* were revealed to have measurable associations with one another. Utilisation of seaweeds will be supported by the growth of the human population, pollution, over exploitation of land, and the lack of freshwater resources. The power that algae generates is a renewable resource.

1.**Algae and water pollution**

Algae are the primary producers in all types of water bodies, and they are implicated in water pollution in a variety of major ways. Algae are the primary producers. To begin, the enrichment of the algal nutrients in water through the use of organic effluents may selectively boost the development of algae species, which therefore results in the production of huge surface growths or "blooms." This, in turn, lowers the quality of the water and has an impact on how it is used. On the other hand, certain types of algae that thrive in water that has been contaminated with organic wastes play a significant role in the process of "self-purification of water bodies." There is a possibility that certain types of pollution algae are poisonous to fish, as well as to humans and animals that consume contaminated water. In point of fact, algae may play a large role in the food chain of aquatic life; hence, any change in the quantity and types of algae has a considerable impact on all creatures in the chain, including fish. It is also recognised that algae are the source of tastes and odours that are present in water. In point of fact, a big number of different types of algae are the ones that are connected with different tastes and smells. Certain diatoms, blue-green algae, and coloured flagellates (especially Chrysophyta and Euglenophyta) are the most well-known types of algae that are known to cause such issues in water sources; however, green algae may also be implicated. The perfume that certain types of algae create is reminiscent of the aroma that certain types of flowers or vegetables emit. Moreover, odour algae are capable of producing a variety of odours, including a fishy odour, a grassy odour, and a spicy odour.

2.Algae as bioindicators

Identifying and evaluating the impact that contaminants have on the environment may be accomplished through the use of bioindicator species. Bioindicators are able to provide information on the cumulative impacts of various pollutants in the ecosystem as well as the potential length of time that an issue may continue to exist. Indicator organisms can be any biological species that specifies a quality or characteristics of the environment; however, algae are recognised to be strong markers of pollution of many different sorts for the reasons that are listed below.

- Algae have wide temporal and spatial distribution.
- Many algal species are avaliable all the year.
- Response quickly to the charges in the environment due to pollution.
- Algae are diverse group of organisms found in large quantities.
- Easier to detect and sample.
- The presence of some algae are well correlated with particular type of pollution
- particularly to organic pollution

Many different types of algae are excellent indicators of the quality of the water, and many lakes are classified according to the phytoplankton groups that predominate in their waters. It is known that oligotrophic waterways contain a large number of desmids, but eutrophic bodies of water are home to a small number of species that are regularly seen there. In the same vein, a great number of blue-green algae can be found in waters that are deficient in nutrients, while others thrive in waterways that are organically contaminated.

An additional component of the ecosystem method to evaluating water quality is the incorporation of diatom species and associations, which serve as markers of organic contamination. For the purpose of determining the level of pollution in rivers in England, five different kinds of algae were chosen as markers. *Stigeoclonium tenue* is found at the downstream margin of the heavily polluted section of a river. On the other hand, *Nitzschia palea* and *Gomphonema parvulum* always appear to be dominant in the mild pollution zone. On the other hand *Cocconeis* and *Chamaesiphon* are reported to be found in the unpolluted sections of the stream or in the re-purified zone. It is emphasised that *Navicula accomoda* is an excellent indicator of sewage and organic pollution since the species is able to easily exist in the most extensively contaminated zones, which are areas in which other species are unable to exist to the same extent. In the same way, the same can be said about the species and varieties of *Gomphonem*a, which are frequently discovered in water that is heavily contaminated with organic matter. Additionally, *Amphora ovalis* and *Gyrosigma attenuatum* are presented as examples of diatoms that are considered to be impacted by the presence of a high organic content in water. Based on the findings of a significant number of writers, a list of more than 850 different taxonomic classifications of algae was published. This list indicates that a great number of algae genera have species that are able to thrive in water that contains a significant amount of organic waste byproducts. There is particular emphasis placed on blue-green algae *Oscillatoria* and *Phormidium*, as well as green algae *Chlamydomonas*, *Euglena*, diatoms, *Navicula*, and *Synedra*. These algae are able to endure organic pollutants. At the species level, it has been found that the presence of *Phormidium uncinatum* (Cyanophyta), *Euglena viridis* (Euglenophyta), *Nitzschia palea* (Bacillariophyta), *Oscillatoria limosa*, *O.tenuis*, and *O.princeps* is greater than that of any other species in organically contaminated waters. As a result of the fact that many species of algae are found in the clean water zone of streams, algae are also useful markers of the presence of clean water. However, it is more satisfactory to emphasise the presence or absence of numerous species of clean water algae rather than focusing on just one species in order to identify the clean water zone. There have been around 46 taxa that have been identified as being characteristic of the clean water algae. These taxa include a large number of diatoms, various flagellates, and specific green and blue-green algae. Nevertheless, it is emphasized that minute flagellates are better indicators of clean water than many bigger algae. This is because they are smaller. On the other hand, the majority of the algae that live in clean water are benthic, meaning that they are linked to the substrata that are located at the bottom or sides of the rushing waters. There have been a great number of research conducted by a variety of authors that highlight the connections between algae and clean water. It has been said that the section of the stream that has reverted to its normal state after being purified from a polluted condition has a community that is made up of the diatom *Cocconeis* and the blue-green alga *Chamaesiphon*. Among the organisms that were found in oligosaprobic and/or unpolluted zones, Kolkwitz identified 61 diatoms, 42 green algae, 41 pigmented flagellates, 23 blue-green algae, and 5 red algae. Lackey discovered 77 species of planktonic algae in the clean water portion of a small stream, forty of which were not present in the polluted area. Other species that have been identified as belonging to the oligosaprobic zone include the flagellates *Chromulina rosanoffi*, *Mallomonas caudata*, the green algae *Ulothrix zonata*, and *Microspora amoena*. *Cryptophyta* and *Chrysophyta* are two kinds of algae that are considered to be markers of clean and/or unpolluted water. This is due to the fact that members of both algal groups tend to be abundant and, on the other hand, respond negatively to pollution. Another factor that was considered to be a sign of clean water was the lack of blue-green algae.

3.Use of algae in saprobien system

Kolkwitz and Marsson were the ones who initially presented the traditional method for interpreting the ecological state of streams, which is based on the biota. They recommended the use of aquatic species as markers of varying levels of pollution and/or recovery zones of rivers that were polluted with organic waste such as sewage. They created five zones based on the degree of pollution and proposed the use of aquatic organisms. Werner, on the other hand, presented nine distinct zones within the saprobic system of a stream that was biologically contaminated more recently. The results of the survey of the saprobic zones and the communities that correspond to them are shown in Table 1. In the saprobient system, the pollution zones that were proposed were essentially referred to as "Coprozoic," "Polysaprobic," "Mesosaprobic," "Oligosaprobic," and "Katharobic." The chemical and physical features of each zone were distinct from one another, and each zone included organisms that were unique to it. He named the species that serve as indicators of these zones, with the exception of the final one, which is actually clean water. The polysaprobic zone was distinguished by the nearly total lack of algae, with the exception of the blue-green algae Arthrospira (Spirulina) jenneri and the green algae Euglena viridis. Bacteria and protozoa were the two groups that were found in this zone the most often. The alfa-mesosaprobic zone was characterised by the preponderance of blue-green algae (Cyanophyta), whereas the beta-mesosaprobic zone was characterised by the preponderance of diatoms (Bacillariophyta) and green algae (Chlorophyta). Peridiniales, which belong to the Dinophyta, and Charales, which belong to the Charophyta, were only found in the oligosaprobic zone in any quantity. Although the quantity of bacteria was low in the same zone, there was a wide diversity of plants and animals, including fish, that were present in significant quantities.

4.Use of algae in wastewater treatment

Algae have recently emerged as important organisms for the biological filtration of wastewater. This is due to the fact that algae are able to collect plant nutrients, heavy metals, pesticides, organic and inorganic hazardous chemicals, and radioactive debris within their cells and bodies. In the past half-century, biological wastewater treatment systems that utilise micro algae have gained a significant amount of relevance. It is now generally acknowledged that algal wastewater treatment systems are just as effective as conventional treatment systems. As a result of these special characteristics, algal wastewater treatment systems have emerged as a significant low-cost alternative to sophisticated and expensive treatment systems, notably for the purification of municipal wastewaters. In addition, algae that has been harvested from treatment ponds is utilised extensively in the agriculture sector as a source of nitrogen and phophorus supplementation. Furthermore, it can be fermented in order to generate energy from metane. It is also possible for algae to amass highly poisonous compounds in their cells and/or bodies, such as selenium, zinc, and arsenic. This allows algae to eliminate these poisons from aquatic environments.

There are certain water sources that naturally contain radioactive elements, and there are other water sources that become radioactive as a result of contamination. Radiation is another significant form of pollution. Even when the quantities of radioactive minerals in the water are higher, several types of algae are able to absorb and store a large number of these materials within their cells. It was emphasised by MacKenthun that Spirogyra has the ability to acquire radio-phosphorus at a rate that is 850.000 times higher than that of water. In light of the fact that algae possess the capacity to cleanse contaminated waters of a wide variety of kinds, it is important to highlight the fact that the utilisation of algae technology in wastewater treatment systems is anticipated to become even more widespread in decades to come. Wastewater treatment, which is done to enhance or upgrade the quality of wastewater, involves physical, chemical, and biological processes in primary, secondary, or tertiary stages. The goal of wastewater treatment is to improve in quality. The items that are able to float or easily settle out due to gravity are removed during the first treatment process. The physical processes of screening, comminution, grit removal, and sedimentation are all factors that are included in this process. Secondary treatment, on the other hand, is often carried out by biological processes and is responsible for removing the soluble organic matter and suspended solids that were left over from initial treatment operations. When nitrates and phosphates, in addition to tiny particles, are eliminated during the tertiary or advanced treatment step, the purification process is said to have progressed. Nevertheless, the original cost as well as the operational cost of a wastewater treatment facility that includes primary, secondary, or advanced stages is quite high.

It is well knowledge that algae play a significant part in the process of self-purification from organic contamination that occurs in natural waterways. Furthermore, several studies have demonstrated that algae are able to remove viruses, minerals, heavy metals, pesticides, organic and inorganic pollutants, and nutrients from the water around them by collecting and/or utilising these substances inside their own cells. This is especially true for nitrogen and phosphorus. In addition, recent research has demonstrated that algae have the potential to be utilised effectively for the treatment of wastewater due to their capacity for bioaccumulation.

5.Algal-bacterial ponds

An algal-bacterial pond is a body of water that is formed with the purpose of storing and enhancing wastewater over a certain period of time. Ponds are used to treat wastewater by a variety of processes, including physical, chemical, and biological activities, as well as mechanical processes such as aeration. However, there are also ponds that are entirely dependent on the processes that occur under natural settings. The term "oxidation ponds" refers to ponds that are characterised by the presence of entirely aerobic conditions throughout the process of stabilising dissolved chemicals and suspended particles. The ponds that are referred to as "waste stabilisation ponds" are those that undergo stabilisation under facultative or anaerobic conditions. A variety of pond systems, including facultative, anaerobic, aeration, and maturation ponds, are evaluated for their ability to stabilise water bodies. Among the several types of ponds that make use of algae, facultative stabilisation ponds are the most common. The design of facultative ponds is intended to serve a variety of functions, including the reduction of waste retention time, the achievement of effective treatment, and the cultivation of algae. The most important mechanism of algal-bacterial ponds is the relationship between algal photosynthesis and bacterial breakdown. The ponds' activities, which include oxidation, settling, sedimentation, adsorption, and disinfection, are the consequence of a symbiotic relationship between the populations of bacteria and algae.

6.Advanced integrated wastewater ponds

A modification of waste stabilisation ponds systems, advanced integrated wastewater pond systems are built on a sequence of four advanced ponds, which are as follows: A maturation pond, a high rate algal pond, an algal settling pond, and lastly a facultative pond for sun disinfection and pathogen abatement are the four types of ponds that are included in this system. The first pond in the series is a facultative pond that has a depth of between four and five metres and has a digester pit. This pit behaves very similarly to an anaerobic pond, while the surface zone continues to exist in an aerobic environment. Following the removal of dissolved organic matter and nutrients from the effluent of the facultative pond, the effluent is directed to the high-rate algal pond, where it is then transferred to the settling pond, where it remains for a period of one or two days in order to sediment the algae and suspended particles. The last unit is called maturation ponds, and it is a place where treated water is exposed to the sun and wind, which results in natural oxygenation and solar disinfection, which ultimately means that pathogens are rendered inactive. In the early 1960s, the United States Department of Energy constructed the Wastewater Treatment and Reclamation Plant in St. Helena, California, using formed earth rather than reinforced concrete. Ponds should still only cost one-third to one-half as much to build as conventional plants, despite the fact that the total pond area required is far more than what is required for a conventional plant. The fact that the plant only created a little amount of sludge is yet another significant advantage of the facility.

CONCLUSION

The water that flows from lands into aquatic settings brings with it a significant quantity of organic matter and plant nutrients, which contribute to the development of eutrophication and pollution in the aquatic systems. As the number of people living in metropolitan areas expanded, the demand for sewage treatment plants (STP) became increasingly significant. Wastewater treatment, which is done to enhance or upgrade the quality of wastewater, involves physical, chemical, and biological processes in primary, secondary, or tertiary stages. The goal of wastewater treatment is to improve in quality. The removal of solids is the primary procedure followed by a secondary phase that may involve activated sludge or trickling filters in order to lower the Biological Oxygen Demand (BOD). More sewage treatment facilities are being developed to accomplish this two-step process. The removal of the nutrients that are left over after secondary treatment can be accomplished through a number of different processes. One of these processes involves the cultivation and harvesting of algae from the effluents. Other processes include ion exchange electrochemical, electrodialysis, reserve osmosis, distillation, and chemical precipitation as tertiary processes. Nevertheless, the original cost as well as the operational cost of a wastewater treatment facility that includes primary, secondary, or advanced stages is quite high. As a result of their bioaccumulation capabilities, algae have recently emerged as important organisms for the biological purification of wastewater. This is due to the fact that algae are able to absorb plant nutrients, heavy metals, pesticides, organic and inorganic hazardous compounds, and radioactive substances within their cells and bodies. In particular, biological wastewater treatment systems that utilise micro algae have become more significant over the past half-century. It is now generally acknowledged that algal wastewater treatment systems are just as successful as conventional treatment systems. When it comes to extremely high rate algal ponds, removal rates are practically identical to those of traditional treatment methods; nevertheless, this method is more effective and has a shorter retention duration. As a result of these special characteristics, algal wastewater treatment systems have the potential to be recognised as a substantial low-cost alternative to sophisticated and expensive treatment systems, notably for the purification of municipal wastewaters.

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