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A Review Article
The Role Of Blue-Green Algae In Water Toxicity

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Abstract:

Cyanobacteria, another name for blue-green algae, are photosynthetic microorganisms that grow in a variety of aquatic habitats. Certain types of cyanobacteria can create strong toxins, but they also produce oxygen and feed aquatic life, which is why they are essential to the environment. These pollutants may have detrimental effects on aquatic ecosystems, human health, and water quality. The mechanics of cyanobacterial toxicity, the kinds of toxins produced, their effects, and methods for tracking and controlling cyanobacterial blooms are all covered in this review.

Keywords: blooms, cyanobacter, toxins, water, environment .

مقال مراجعة الموضوع
دور الطحالب الخضراء المزرقة في سمية المياه

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مستخلص:

البكتيريا الزرقاء، وهو اسم آخر للطحالب الخضراء المزرقة، هي كائنات دقيقة تقوم بالتمثيل الضوئي وتنمو في مجموعة متنوعة من الموائل المائية. يمكن لأنواع معينة من البكتيريا الزرقاء أن تنتج سمومًا قوية، ولكنها أيضًا تنتج الأكسجين وتغذي الحياة المائية، ولهذا السبب فهي ضرورية للبيئة. قد يكون لهذه الملوثات آثار ضارة على النظم البيئية المائية، وصحة الإنسان، ونوعية المياه. يتم تناول آليات سمية البكتيريا الزرقاء، وأنواع السموم المنتجة، وآثارها، وطرق تتبع ومراقبة تكاثر البكتيريا الزرقاء في هذه المراجعة.

الكلمات المفتاحية: الأزهار، البكتيريا الزرقاء، السموم، الماء، البيئة .

1. Introduction

Water blooms caused by cyanobacteria are a global environmental health hazard (1). The most obvious indications of eutrophication of lakes, rivers, and coastal waters are a strong coloring of the water, aggregation at the surface in distinct scums, and occasionally a strong smell generated by algal blooms. The cyanobacteria-produced toxins in these blooms may be toxic to humans in addition to degrading the environment and interfering with quality targets and lake restoration (2,3). There is a lot of literature on dangerous cyanobacterial blooms because of the general interest in them. Some recent publications and reviews on the topic are The World Health Organization's (WHO) book Toxic Cyanobacteria: A Guide to their Public Health Consequences, Monitoring and Management discusses the hazards for people, particularly through the intake of drinking water(4). This paper examines the issues brought about by toxic cyanobacterial blooms specifically from the perspective of how humans may be exposed to these toxins by eating food (such as fish, crayfish, prawns, and mussels) that have been collected from waterbodies that are home to cyanobacterial blooms. However, we catch marine animals under the name of seafood without taking into account the accumulation of toxins in their bodies because they are in freshwater systems shared with blue-green algae

Toxins resulting from blue-green algae accumulate in some living organisms such as snails and oysters, causing consumers to become poisoned as a result of eating seafood (6). Therefore, there is an urgent need for studies and obtaining data to assess risks because there are mechanisms through which toxins accumulate and concentrate and reach harmful quantities. For humans, it has been indicated that shellfish are the main cause of the concentration of cyanotoxins in aquatic environments

Therefore, studies focused on the toxins accumulated in shellfish and cyanotoxins, which are accumulations of cyanobacterial cells that form in the form of surface foam, causing pollution of swimming areas and drinking water basins (8).

2. IDENTIFICATION OF BLUE-GREEN ALGAE

Scientifically referred to as Cyanobacteria, blue-green algae are microscopic, single-celled organisms that naturally grow in both fresh and saltwater. Under a microscope, they can be observed as individual cells, a collection of cells are called colonies, or fragments of cells are called trichomes. They belong to the prokaryotic bacterium class, not the eukaryotic algae, and are capable of synthesizing chlorophyll a. As a result, they function similarly to plants in that they use a process called photosynthesis to convert carbon dioxide and water into carbohydrates.

Because they have vesicles, or gas pockets, inside of vacuoles in their cells that they fill with gas, blue- green algae are able to adjust their buoyancy in reaction to changes in their surroundings. The blue-green algae have a competitive advantage in light and nutrients because of this buoyancy regulating system, and they migrate to areas with the highest concentrations of both nutrients and light(9).

3.The Presence and Proportion of Cyanobacteria

According to(10) cyanobacteria are oxygen-evolving, nitrogen-fixing prokaryotes that use sunshine as their only energy source. These are widely distributed in rice fields that are flooded with water in Bangladesh, India, China, Japan, Thailand, and the Phillipines. In India, Blue-Green Algae made up 33% of the 2213 samples on average, while some sources suggest that in some of the southern and eastern states, up to 50% of all algae were BGA . Compared to other farmed soils, paddy soil had the highest concentration of these. The most common genera that fix nitrogen are Anabaena, Nostoc, Aulosira, Calothrix, Tolypothrix, Aphanothece, and Gloeotrichia. Analyzing cyanobacteria’s biomass, N content, and nitrogen-fixing activity will reveal its nitrogen-fixing capability.

It is known that diets containing phosphorus cause the appearance of blue-green algae ten to fifteen days after transplantation. Adding single superphosphate at a rate of 5 kilograms per hectare stimulates nitrogen-fixing bacteria.

By adding phosphorus and nitrogen to the soil planted with rice, other amounts of phosphorus are added, and the environmental conditions of the dry season are considered suitable for the flourishing and reproduction of blue-green algae (11). The biovolume can be determined by calculating the amount of space occupied by the algae.

This serves as a quantitative indicator of the amount of algal cells in the sample. Cell sizes can vary within one species, and the amount of dry matter in the sample has a strong correlation with the concentration of the toxin compared to the number of cells

The use of biovolume is to identify different species and microalgae. The main source of information for assessing risks associated with recreational activities should be the number of cells. Biovolume is used to evaluate the risks associated with different species and microalgae. Through biovolume, it is determined whether the dominant species is a known source. To toxins like Aphanocapsa, Aphanothece, Cyanodictyon, Chroococcus, or Radiocystis(12)

4.The Presence of Hazardous Cyanobacteria

Around the world, both upland and coastal water habitats are home to toxic cyanobacteria. Vertebrates have been demonstrated to be poisonous by at least 46 species. Microcystis spp., Cylindrospermopsis raciborskii, Planktothrix (syn. Oscillatoria) rubescens, Synechococcus spp., Planktothrix (syn. Oscillatoria) agardhii, Gloeotrichia spp., Anabaena spp., and Synechococcus spp. Lyngbya spp., Aphanizomenon spp., Nostoc spp., some Oscillatoria spp. Schizothrix spp. and Synechocystis spp are the most frequent poisonous cyanobacteria in fresh water(13).

It is impossible to rule out toxicity for most species and generas. More poisonous species are probably to be discovered as research expands and encompasses more areas of the world. As a result, it is wise to assume that every cyanobacterial population has the potential to be harmful. Microcystins and neurotoxins are the most common cyanobacterial poisons.

Microcystis, the most prevalent organism that forms blooms, has nearly invariably lethal field populations(14) hazardous properties are typically not exclusive to any one species; rather, most species have hazardous and harmless varieties.

According to research ~~by~~, the toxicity of a strain of microcystis is determined by whether or not it possesses the gene necessary for producing microcystins. Field populations are made up of a mixture of genotypes with and without this gene

Experience with cyanobacterial cultures further demonstrates that, with the exception of minor environmental variations, a strain or genotype's ability to produce microcystin is a reasonably stable feature The variables that cause cyanobacterial growth are well understood several theories have been proposed on the physiological or biochemical role of toxins for cyanobacteria, but the factors that cause toxic strains to predominate over non-toxic ones are. Approximately 60% of cyanobacteria samples are under study globally to identify the types of toxins they produce

.A single bloom's toxicity can vary across time and distance. As long as the cells are evenly distributed, cyanobacterial population toxicity in a particular lake does not always indicate a risk to the environment or to humans. The risks are mass developments, particularly surface scums(15).

5. Cyanobacterial Toxicity Mechanisms

Those who produce toxins:

Several classes of cyanobacteria-generated toxins are produced by several species belonging to various genera .The freshwater literature has regularly documented the presence of harmful cyanobacteria, specifically Microcystis (which includes species such as M. aeruginosa, M. flos aquae, and M. viridis) and Planktothrix (P. agardhii and P. rubescens). The peptide hepatotoxins they mostly manufacture, microcystin (MCYST), are found in over 70 structural variations or congeners

There are three distinct poisonous kinds that blue-green algae can create, each with its own mode of action. The most prevalent type of blue-green toxins are hepatotoxins.

The liver and other internal organs are attacked by them. In addition, they could result in nausea, vomiting, vision abnormalities, diarrhea, and muscle weakness. Compared to neurotoxins, they act more slowly(16). Species including Anabaena, Cylindrospermopsis, Microcysfis, and Nodularia are capable of producing neurotoxins. Neurotoxins : function as inhibitors of neuromuscular junctions. They cause death by paralyzing the respiratory and peripheral skeletal muscles, which results in respiratory arrest. Species of Anabaena, Aphanizomenon, Nostoc, and Oscillafora generate neurotoxins.

Endotoxins: Lipopolysaccharides are found in the outer walls of all blue-green algae. These are mostly contact irritants that, in persons who come into touch with the algae by swimming or showering, can result in severe dermatitis and conjunctivitis. They might also result in gastrointestinal headaches, fever, nausea, cramping, and if eaten, may also result in asthma attacks and respiratory difficulties. When blue-green algae lipopolysaccharides come into contact with humans or animals, they can cause allergic reactions and irritation. Adverse health effects for swimmers exposed to blue-green algal blooms have been documented. Asthma, conjunctivitis, hay fever-like symptoms, and irritating contact dermatitis are among the symptoms. Inadvertently consuming the water could cause gastroenteritis.

The symptoms caused by the various toxins generated by different cyanobacteria species are summarized(17).

6. Environmental bioaccumulation

Bioaccumulation is the process by which toxic compounds enter an accumulating individual organism. This procedure increased the concentration of toxic chemicals in the food web by moving them from one trophic level to the next. One of the biggest issues facing public health is the bioaccumulation of microcystin in the food chain. Phytoplankton, zooplankton, and gastropods all contain it(18) Fish as well as freshwater clams and mussels bioaccumulated the microcystins. Fish have a higher concentration of microcystin in their livers, while mussels have a higher concentration in their hepatopancreases. Consuming the bioaccumulated fish by humans could have serious health consequences.

Accordingly, the standard recommendation made by Duy et al. is to avoid eating the fish viscera, as the contaminants were primarily found there, resulting in serious health problems if consumed. Phytoplanktivorous fish are a type of fish that live in aquatic environments and eat phytoplankton, primarily algae blooms. Bighead and silver carp fish are the primary grazers of Microcystis aeruginosa bloom. Therefore, it is hypothesized that when those fish ingested the toxic cyanobacteria, the cyanotoxin contamination was counteracted. Waters that are tinted or impacted by cyanobacteria scums may worry aquatic field workers who are eager and/or obligated to collect samples. It has been reported that a “heavy bloom of Microcystis species” and a “scum of Oscillatoria” contributed to the two events in which British soldiers and sea cadets were engaged in canoe capsizing exercises in the seas. Although many recreational users would steer clear of waters that are obviously losing their visual appeal, avoidance behavior in these circumstances cannot be presumed. Microcystis aureus . Flu-like symptoms include fever, headache, lassitude, arthralgia, myalgia, sore throat, cough, diarrhea, and vomiting, according to many sources. One theory put out for this set of symptoms is a coordinated, cytokine-mediated innate immune response. The incidence of fever and malaise is controlled by endogenous mediators.

7. Effects of toxicity in lab animals

According to (19)microcystin-LR is an unusually acute toxin. Mice were repeatedly fed 31.3 µg microcystin LR/kg BW every day for seven days, which resulted in a 75% rise in liver weight For 28 days, groups of ten adult male rats were given 150 µg microcystin-LR/kg through their drinking water, which produced another microcystin LR effect. According to[20], it also causes an increase in liver weight. In the other experiment, three vervet monkeys were gavaged with microcystin LK three times a week for the duration of the study. The dosages were raised gradually from 20 to 80 µg/kg. However, as a result, neither clinical nor hematological parameters show any appreciable alterations .The five pigs were fed the M. aeruginosa extract as drinking water for forty-four days at doses ranging from 280 to 1312 µg of total microcystins. According to .the liver alterations were observed at the lowest dose level of 280 µg microcystin-LR eq/kg.

8.Blue-green Algae Has an Impact on People

Users of water who are exposed to blue-green algae contaminated water face the following health risks:

consuming Blue water

green algae may create toxins, which can have a variety of effects on water users. They have been linked to paralysis, pneumonia, muscle weakness, nausea, headaches, vomiting, stomach pain, diarrhea, and gastroenteritis.

There is a significant correlation between the type of toxin, its concentration in water, and the quantity of water ingested with the incidence and severity of symptoms. Toxins won't disappear when the water boils. Boiling will destroy the algae, but it will also discharge poisons into the water. In actuality, boiling the water makes some poisons more potent. Additionally, research conducted in labs using test animals suggests that blue-green algae could encourage malignancies of the skin, liver, and intestines. In order to determine whether they have comparable effects on people, more research is require.

9.Humans may have either short-term or long-term consequences.

A. Short-term consequences

Human birth defect rates were higher in a neighborhood where residents drank water from a reservoir tainted by cyanobacterial blooms due to cyanobacterial toxins (20) Six settlements in Australia had relied on the Murray River as their water supply. Allergies and gastroenteritis were prevalent among residents of six communities Brazil is the site of the two most deadly poisonings linked to cyanobacteria in drinking water. Itaparica Dam's enormous anabaena and microcystis bloom was the cause of 2000 gastroenteritis cases and 88 fatalities, the majority of which were children.

After receiving standard hemodialysis therapy from February 13–20, 1996, 116 out of 131 patients at a hemodialysis center in Caruaru had acute liver failure, which manifested as nausea, vomiting, and visual problems. of the 100 individuals who eventually developed acute liver failure passed away. Comparing the symptoms and pathology of the victims with animal studies of the two suspected cyanotoxins, microcystins and cylindrospermopsin, revealed that intravenous exposure to microcystins—more especially, microcystin-YR, -LR, and -AR—was a significant contributing factor in the dialysis patients' deaths. The water used for dialysis treatment was predicted to have 19.5 LG microcystin/L based on exposure volumes and liver concentrations (21)Long-term consequences

Research on the potential role of cyanobacterial toxins as risk factors for the onset of human hepatocellular carcinoma (HCC) was conducted in China.

Geographically, this human hepatocellular carcinoma is distributed differently. The two known risk factors that cause the consumption of aflatoxin B1 are maize and the hepatitis B virus.

The source of water consumption was the third component of association.On a village level, water from deep wells had lower cancer death rates than water from ponds and ditches, which had significantly higher rates.

In southeast China, where human hepatocellular carcinoma is most com mon, cyanobacteria are prevalent in surface waters(22).

10.Contact of blue-green algae with the skin

Through water-based activities, people can come into contact with toxic and non-toxic types of blue-green algae, which can lead to a variety of health issues including skin rashes, swollen lips, eye irritation and redness, ear pain and itching, sore throat, asthma symptoms, hay fever, and possibly even the growth of skin tumors. As contact duration grows, the likelihood of issues will probably increase(23)

Depending on how likely it is that an action may result in a person coming into touch with the algae, the risk from different activities might range from zero, where there is no contact, to high.

Because the trapped algae inside the wet suit may come into prolonged close contact with the skin, wearing a wet suit may increase your chance of developing skin irritation(24).

11.Consuming fish from waters contaminated by algae

The discovery of "Paralytic Shellfish Poisoning" (PSP) toxins in one blue-green algae species has raised questions over the potential bioaccumulation of neurotoxins in edible mussels and other shellfish. Consumption of PSP-contaminated shellfish in maritime environments has resulted in numerous fatalities for humans. The edible flesh of crayfish has been found to have cyanospermopsin, another blue-green algal toxin that is frequently found in freshwater environments in Queensland. Consequently, it is not recommended to eat mussels, yabbies, or other shellfish collected in waters contaminated with algae(25).

It is not advisable to eat the liver or digestive tract of fish that have been caught in seas contaminated with algae, as they are probably toxic.

12.irrigating using water impacted by algae

The absorption and build-up of poisons in different plants is the subject of ongoing research. Microcystin is one of the toxins that can harm both plants and animals. According to what is now known, if there is a different source of water, it should not be utilized to irrigate food plants from a contaminated source(26).

Avoid spraying edible plants with water contaminated with blue-green algae. This includes plants such as lettuce, tomatoes, strawberries, and cabbage. Fruits and vegetables should be cleaned with non-toxic water before using them. According to research, the danger of blue algae lies in the fact that it remains toxic when dried for several months.

Stock issues may arise from irrigated pastures due to the possibility of chronic poisoning that can last for months or even years. Certain toxins may be lessened by sunshine, but some toxins can linger and continue to be active for several months. Allergies may arise by coming into contact with the outer layer of blue-green algae cells. Blue-green algae and other algae in water can clog sprinkler heads, meters, filters, and valves(28).

Conclusion

Cyanobacteria contain a higher number of poisonous species that are detrimental to both human and animal health. Cyanobacteria plays a significant part in the biogeochemical cycle. Drinking water bodies and other habitats should be adequately managed to prevent negative effects. .The primary consequence, eutrophication, is brought on by waste products and excess nutrients getting into water bodies. Therefore, before being released into the environment, wastewater and excess run off should be adequately monitored.

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