International Journal of Engineering & Scientific Research
Vol.6 Issue 9, September 2018,
ISSN: 2347-6532 Impact Factor: 6.660
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

GENERAL REVIEW ON TOXIC ALGAE

[*1] Safiyanu, I., [2] Hassan, M.I., [3]Sale, A.I., [4]Sadiq, I.Z. and [5]Mardiyya, A.Y.

[*1,2,3,5] Department of Biology, Kano University of Science and Technology, Wudil, NIGERIA

[4]Department of Biochemistry and Molecular Biology, Federal University Dutsinma, Katsina, NIGERIA

Corresponding Author Email Id: idrisawa14@gmail.com

Article Received: 10th August, 2018 Article Revised: 18th August, 2018 Article Accepted: 28th August, 2018

Abstract

Algae are the green thallophytes, containing a green colouring matter called *Chlorophyll*, and in many algae the green colouring matter (*Chlorophyll*) may be masked by other colours, but in all of them, *Chlorophyll* is always present. They are autotrophic, meaning they manufacture their own food with the help of *chlorophyll* contained in them. They can affect water quality adversely by lowering the dissolved oxygen in the water. A number of algal species produce more potent toxins, if the water contains high concentrations of toxic algae or if their toxin is ingested. It presents a risk to human health, the algal toxins are usually released into the water when the cells of toxic algae rupture or die. The toxic algae have been grouped into two; freshwater species which are *cyanophyta* (blue-green algae) and marine species which are the *dinoflagellates (*diatoms). Algae have different types of toxicity which are not a phylogenetically conserved feature among the algae. Preventing sources of nutrients for not reaching the water is the best method against toxic algal blooms. Algal blooms are tested for their toxicity by using a mouse bioassay. Toxic algae can be removed by water treatment using best technology. And toxic algae blooms methods of controlling must be carefully because of risk problem.

Key Words: - Algae, Toxic Algae, *Cyanophytes, Dinoflagellates,* Algal toxins, Algal blooms, Prevention and Control Methods

Introduction

Algae are green thallophytes containing the green colouring matter called chlorophyll. In many algae, the green colour may be masked by other colours, but in all of them, chlorophyll is always present. Algae are also autotrophic, i.e. they manufacture their own food with the help of chlorophyll contained in them and the body of algae is composed of a true parenchymatous tissue (Dutta, 1964).

Algae are the simple rootless plants that grow in water in proportion to the amount of available nutrients. They can affect water quality adversely by lowering the dissolved oxygen in the water. They are food for fish and small aquatic animals. Algae are photosynthetic plants, almost exclusively aquatic, non-vascular plants that range in size from simple unicellular forms to giant kelps, several feet long. They have extremely varied life cycles and first appeared in the pre-Cambrian era (Mc Cracken, 2005).

Algae include some of the smallest and largest eukaryotes, although they live in a diversity of habitats, most algae live in water (Randy, 1995).

The great diversity of algae has led to many conflicting ideas about how they should be classified on different bases. For example, based on their habitat, type of chlorophyll present, based on their toxicity properties etc. (Carmichael, 1994).

Toxic algae that thrive on pollution kill fishes and animals and make people sick. While they have always presented, they become more prevalent, more frequent and more toxic around different parts of the world in the last 30 years. This is likely a warning of the declining health of ecologically vital and commercial valuable bays, estuaries of fresh water habitats. Algae also formed mutually beneficial partnership with other organisms. For example, algae live with fungi to form lichens plant-like or branching growth that forms on boulders cliffs and tree fruits. Algae called *Zooxanthellae* live inside the cells of reef-building coral. In both cases, the algae provide oxygen and complex nutrients (food) to their partners, and in return they received protection and shelter. This arrangement enables both partners to survive in conditions that they could not endure alone (Carmichael, 1994).

Increased development of coastal areas is sending more sewage effluent, farm runoff and factory waste flowing in bays and estuarine triggering or worsening poisonous marine algal blooms. Damning, diverting and polluting much of the world freshwater supplies have

eliminated natural flushing which causes increased nutrient levels and temperatures and triggers freshwater algal blooms. Scientists used the term harmful algal bloom (HAB) to refer to such high density of algal populations that contain toxins or that cause negative impacts. Most toxic marine blooms are caused by algal blooms. Almost all toxic freshwater blooms are caused by *cyanophytes,* and they also cause many toxic marine blooms. Researchers generally understand the biochemistry of these toxic ones, they are consumed or absorbed, but not as much about what causes the algae to produce them and how they can be prevented from flourishing (Carmichael, 1994).

Toxin of human health significance occurs primarily in three groups: *dinoflagellates, diatoms and cyanobacteria. Dinoflagellates* are responsible for the widest array. However, only a few dozen species of the several thousand species of *Dinoflagellates* are known to be toxic. Among the *Diatoms; Pseudonitzschia* is the best known species that produce a toxin, impacting human health (Hallegraef, 1993).

Only a few dozens of the many thousands of species of microscopic and macroscopic algae are repeatedly associated with toxic or harmful blooms. Some species, such as the *Dinoflagellates; Alexandrium tamarense* and the *Diatom; Pseudonitzschia australis* produce potential toxins which are liberated when the algae are eaten. Others like *Pflesteria pisicida* uses exotoxins to kill their prey. Other species kill their prey without using toxins such as *Chactoceros* which has spines with serrated edges in fish fill tissues, causing irritation, over production of mucous and eventual death. Various species of toxic algae that are release their toxins upon death: These toxins in water can irritate and cause severe distance or death to tank (pond) occupants that have no way to escape. If water containing high concentration of toxic algae or their toxin is ingested, it presents a risk to human health. Withing populations as a whole, children are one category, because they drink more water in proportion to their body weight than adult do. Individuals who already have injury to organs such as people with hepatitis, liver cirrhoses or kidney damage, are at higher risk. Kidney dialysis patients are especially vulnerable, because treatment exposes them intravenously to large volume of water. Therefore toxic algae are very dangerous to both aquatic and many terrestrial animals, as they cause various types of diseases to human directly by contact or indirectly by ingestion (Lawler, 1998).

Algae as Living Organisms

Algae are groups of eukaryotic organisms and they may be defined as chlorophyll containing organisms which have no true roots, stems and leaves. Such relatively undifferentiated body is called a *thallus.* Algae are often unicellular or colonial organisms. However, some like kelp (*Microcystis)* are very large; they have characteristic properties of life process such as sexual and asexual life cycle, which can be dominated by a haploid phase or diploid phase, they also have a similar or little in common method of reproduction and nutrition, some of them are motile while some are non-motive (motile ones use flagellum for locomotion) and equally they serve as a very important part of biotic components of the earth surface. The unifying feature of algae that has traditionally led botanists to classify them with plants is their ability to photosynthesize using chlorophyll "a" or chlorophyll "b" in certain groups (Randy, 1995).

Distribution of Algae

Although people often think of algae only as pond scum or sea weeds, but algae are nearly ubiquitous and occupy a wide variety of habitats. They live in marine and freshwater, either free living or attached to rocks, wood pilings, shall fish or to other algae (Randy, 1995).

Many species are terrestrial living on moist soil, rocks, stones, roofs and walls or tree bark. Some of them were unusual habitats which include clouds and air borne dust, and forcing endosymbionts inside the cells of protozoan, sponges, sea slogs, sea anemones and salt water fish. Green algae live symbiotically with fungi and cyanobacteria in lichens (Carmichael, 1994).

Morphology of Algae

The body of algae is a thallus, different members range from simple microscopic unicellular forms to large complex thalloids forms. Example of unicellular form members are *Volvox* and *Chlamydomonas,* while the complex form is kelp where they behave as unicellular. The whole body structure is move up of only cell controlling the living activities of the body, the cell can forms groups and give a colonies formation. Under the colonial algae there are the following morphologies:

- Cell aggregates e.g. *Ankistrodesmus*
- Coenobium e.g. *Volvox*
- Filamentous e.g. *Spirogyra*
- Parenchymatous e.g. higher plants
- Pseudo parenchyma e.g. higher plants
- Coenocytes e.g. higher plants

Algae are characterized by the presence of pigments; the pigments are used in food manufacturing and in identification. These pigments give different colours to the group of algae which are green, red, brown, yellow, golden, blue-green etc (Dutta, 1964).

Toxic Algae

Toxic algae are those species of algae that are responsible for the production of potent toxins. Some algal species particularly the diatoms and dinoflagellates have strains or varieties which are sometime lethally toxic. This usually occurs under heavy bloom condition when there are high nutrients, a lot of sunshine and warm temperature (Lawler, 1998).

The toxic algae have been group into two; freshwater toxic algae and marine toxic algae. Brackish and estuarine species are included under marine toxic algae (Gorham, 1988).

Freshwater Toxic Algae

Virtually all freshwater blooms are caused by *cyanophyta* (blue-green algae). Freshwater toxic algae rarely cause problems more than oxygen depletion problems due to their high density blooms. Algae blooms are most common in warm, calm shallow bodies of water ponds and so on, while they do not normally occur in flowing waters, like rivers, streams, springs, etc. (Gorham, 1988).

Example of Freshwater Toxic Algae

Species of *Anabaena*, *Microcystis* and *Gonyaulax etc*, are responsible for causing toxicity in freshwater habitats.

E.g. *Anabaena flosaquine*

Aphanizomenon flosaquine

Microcystis aeruginosa

*Anabaena cylindrical, Anabaena doliolum etc (*Kumar, 1979).

Marine Toxic Algae

Marine toxic algae produce toxins that are among the potent and fast acting known and there are no antidotes or treatment, other than support, after ingestion has occurred. Marine toxic algae affect commercial and recreational shellfish and fish harvesting recreational swimming and diving and the fish and wildlife food chain (Gorham, 1988).

About 75% of the known toxic marine algal species are dinoflagellates which are microscopic, single-celled with flagella that enable them to travel through the water. Some dinoflagellates species produce potent neurotoxins that are capable of producing poisoning in human consumers of contaminated sea food. Some species can grow rapidly, accumulating near the sea surface and discolouring the water in a phenomenon called a **red tide.** Some species produces toxic ad they redden the sea. Other algae species produces toxins but they do not discolour the sea at all (Hallegraef, 1993).

Examples of Marine Toxic Algae

The diatoms are prefaced with"#" and the dinoflagellates with "*"

**Alexandrium catenella*

**Alexandrium acatenella*

* *Alexandrium excuvatum*

**Alexandrium fundyense*

**Alexandrium minutum*

**Alexandrium monilata*

**Alexandrium tamarenses*

#Chactoceros convoatum

#Chactoceros concavicornis

The common classifications of human health problems caused by harmful marine toxic algae consist of the following syndromes:-

- Amnesic Shellfish Poisoning (ASP):

Causative organism: - e.g. *Pseudonitzschia pungens*

Toxin produced: Domaic acid.

- Ciguatera Fish Poisoning (CEP):
  Causative organism: - e.g. *Prorocentrum*
  Toxins produced: - Ciguatoxins, Maitotoxin etc.
- Diarhetic Shellfish Poisoning (DSP):
  Causative organism: - e.g. *Dinophysis*
  Toxin produced: - Okadaic acid
- Neurotoxin Shellfish Poisoning (NSP):
  Causative organism: - e.g. *Gymnodinium breve*
  Toxin produced: - Brevetoxins
- Paralytic Shellfish Poisoning (PSP):
  Causative organism: - e.g. *Alexandrium excuvatum*
  Toxin produced: - Sax toxins (Tibbets, 1996).

Types of Toxicity

Toxicity is the synthesizing, producing and secreting some compounds that are harmful or lethal to other living organism. Toxicity is a phylogenetically conserved feature among algae. Since in most instances species that are closely related to a toxigenic species based on morphological or molecular phylogeny may not be a toxic (Carmichael, 1994).

List of Toxicity

Based on the colour, odour and test of the algal blooms, list of toxicity can include the following: -

- **Anoxia: -** Blooms of unicellular planktonic algae have been associated with fish kills since biblical times. Algae blooms produce oxygen during the day but consume it at night, so the injected fish often die in the early hours of the morning. The decay process is associated with a dying bloom as well as depleting oxygen by bacterial respiration, which can produce ammonia, sulphides and other toxicants, which are harmful to fish (Carmichael, 1994).
- **Toxins: -** Some algae produce compounds that are lethal to fish and shellfish. Some secretes their toxins into the surrounding water and these toxins affect the cell

permeability, leading to unbalance osmosis (Carmichael, 1994).

- **Flavour:** - Some algae import off-flavour or bitter taints to shellfish, rendering them unpalatable and unmarketable (Carmichael, 1994).
- **Starvation:** - *Heterosigma carterae* is a poor food sources for mussels clams and oysters, and under bloom conditions, when it is the only food that is available, the shellfish do not get adequate nutrition even though the volume of food taken in many increase (Carmichael, 1994).
- **Sharp spines:** - Another way that algae can cause harm without toxins as exemplified by the diatom (*Chaetoceros concavicornis).* The algae have barbed spines, which break or irritate the gill of the fish and into the gills membranes of the fish and probably it may kill the fish (Carmichael, 1994).
- **Mucous:** - Certain species of algae can seriously be harmful to fish and shellfish by producing mucous which can clog the gills and suffocation, or mechanically obstruct and damage the gills. Example is found in diatoms, genus Thalassiosira (Carmichael, 1994).

Prevention of Algal Blooms

The following are the preventive measures against algae bloom development in both marine and freshwater bodies: -

- The best time to control or prevent a toxic algal bloom is before the bloom develops.
- Preventing fertilizers, animal waste and other sources of nutrient from reaching the water and this is the best method of prevention.
- Reducing nutrients and pollution run-off from land has generally been accepted as vitally important in greatly reducing the effects of algal blooms, though not eliminating the frequently, the toxicity and longevity of harmful algal blooms.
- High phosphorous is often precursor to an algal bloom, nutrients rich-bodies of water may support a rapid growth of algae. Under an ideal condition, a clear body of water can become very turbid with an algal bloom withing just a few days (Thomas, 1973).

Testing of Algal Blooms

Algal blooms are tested for their toxicity by using a Mouse bioassay, and when the toxins have been characterized chemically they can be tested individually, and this involve or are time – consuming and expensive processes. The mutual administrative procedure is to close the whole blocks of coastline to harvesting of a bloom has occurred on the assumption that the shellfish are toxic, until they can be proven safe. There are no validated rapid methods that are suitable for shipboard dockside or commercial testing of water or catches, or fish or shellfish for any of these toxins (algal blooms) (Falconer, 1996).

Water treatment against Toxic Algae

Water treatment techniques can be highly effective for removal of toxic algae with combination of the appropriate technology. Reducing nutrients concentrations particularly phosphorous compounds, in run – off to rivers, may reduce the toxic algae blooms or reduced their severity. Using a range of oxidants, including oxone and chlorine are readily oxidized cells and certain algal blooms. Researchers at Florida International University in Miami are experimenting by using 640 kilohertz ultrasound waves that create micro pressure zones as hot as $3{,}700^0$C. This breaks some water molecules into reactive fragments that can serve to kill the algae found in that water body. (Falconer, 1996).

Control Measures Against Toxic Algae

Methods of controlling toxic algae most are done carefully, because there is a problem in that when more toxins are released when the toxic algae are burst or their cells die, killing the toxic algae will increase the toxin level in the water. Therefore, one most either use two (2) fitters containing enough activated charcoal to filter out the toxins, or charcoal into Diatomaceous Earth (DE) filter along with the DE powder. One may have to clean and recharge the charcoal filter several times in order to remove all the toxins from the water. Then, the discard the DE powder and charcoal when done, and thoroughly wash all filters used (Carmichael, 1994).

Biological Control Method

A better method for algal control consists of introducing a suitable crustaceans or fish fingerling into the water body. These animals feed on algae either directly or indirectly and they may be harvested for food at maturity (Kumar, 1979).

Chemical Control Method

By the appropriate applications of algaecides, copper sulphate, selectively kills the algae withing a dose range of 0.25 – 9.5ppm in reservoirs and lakes freshwater bodies (Kumar, 1979).

Also, Metropolitan Water Board London has found that, the artificial circulation of water reservoirs is an effective method in reducing the growth of planktonic algae (Tibbets, 1996).

Conclusion

Algae are the green thallophytes, containing a green colouring matter called *Chlorophyll,* and in many algae the green colouring matter (*Chlorophyll*) may be masked by other colours, but in all of them, *Chlorophyll* is always present. They are autotrophic, meaning they manufacture their own food with the help of *chlorophyll* contained in them. They can affect water quality adversely by lowering the dissolved oxygen in the water. A number of algal species produce more potent toxins, if the water contains high concentrations of toxic algae or if their toxin is ingested. It presents a risk to human health, the algal toxins are usually released into the water when the cells of toxic algae rupture or die. The toxic algae have been grouped into two; freshwater species which are *cyanophyta* (blue-green algae) and marine species which are the *dinoflagellates (*diatoms). Preventing sources of nutrients for not reaching the water is the best method against toxic algal blooms. Algal blooms are tested for their toxicity by using a mouse bioassay. Toxic algae can be removed by water treatment using best technology. And toxic algae blooms methods of controlling must be carefully because of risk problem.

References

Carmichael, W. (1994). **The Toxins of Cyanobacteria**. *African Journal of Biotechnology,* **Vol. 3(3),** Pp: 159-168. Scientific American Press.

Dutta, A.C. (1994). **Botany for Degree Students**. 4th Edition, Oxford University Press, UK. Pp: 341-395.

Falconer, I.R. (1988).**Tumour Promotion by Cyanobacteria**. Academic Press, London. Pp: 74-79.

Gorham, P.R. (1988). **Hazards of Freshwater Blue - Green Algae**. Cambridge University Press, UK. Pp: 155-164.

Hallengreaf, G.M. (1993). **A Review of Harmful Algal blooms and Their Apparent Global Increase,** Phylogical Press, UK. Pp: 79-99.

Kabiru, M. (2003). **Lecture note of Algae**. College of Art and Science (C.A.S) Studies, Kano State, Nigeria. Pp: 25-28.

Kumar, H.D. (1979). **A Text Book on Algae**. Macmillan Press, 2nd Edition. Pp: 178-183.

Lawler, A. (1998). "**Toxic Algae**". Aquarticles Press.

Mc Cracken, M. (2005). **Definition of Algae**. Copyright, All Reserved.

Randy, M. (1995). **Text Book on Botany**. W.C.B. University of Akron. Pp: 622-650.

Tibbets, J. (1996). **Ocean Commotion Environmental Health Perspective**. Cambridge University Press, UK. Pp: 380-385.

Thomas, M. (1973). ***Plant Physiology***. Longman G.R.P Ltd, London. 5th Edition. Pp: 262-386.