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AN INVESTIGATION INTO THE HEALTH HAZARDS CAUSED BY CYANOBACTERIAL TOXINS ON HUMAN BEINGS

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ABSTRACT

As part of the subject matter under discussion an insight into cyanobacterial toxins is depicted in details. The definition of the term and the historical traces are also dealt in details. Along with the factors which contribute to the toxic production, the precise reasons for the toxin production are also explained in details. Along with it the diseases and hazards which are caused by the hazards are also studied and the mechanisms of toxin persistence and degration is very much part of the study. In the end after a detailed analysis , a conclusion is framed which focuses more on the prevention part rather than the eradication part..

Index Terms— Cyanobacterial toxins, toxins, health hazards.

I. INTRODUCTION

Cyanobacteria are aquatic as well as photosynthetic, that is they can live in water and manufacture their own food. As they are small and unicellular, they grow in colonies being large enough to be seen. They have the distinction of being the oldest fossils on the earth, and even though their visibility has decreased to a large extent in recent times, still they happen to the largest and oldest form of bacteria in the world of today (University of Berkeley, n.d.).

Another major contribution of cyanobacteria is in the origin of plants. The chloroplast which the plants tend to make for food and found to reside in the plant cells itself. They have an autotrophic form of nutrition and this is the precise reason for which they thrive in any environment like moist soils, salts, marshes. In fact they happen to be the earliest form of colonizers and the cells tend to be larger than the normal bacteria cells. From the distribution prespective, the organisms can grow rapidly favourable conditions such as fresh and marine waters or during the latest cool months in the summer months of the year. In fact blooms of the bacteria tend to occur in the same water, posing repeated exposure to human populations. In fact earliest report of toxic wastes was found in China close to 1000 years ago. Such has been the impact of the bacteria is that the masses who have been effected by it require intensive hospital care on all counts. The cyanobacterial toxins are found almost everyone in the world of today. If there is a natural poison on earth, cyanobacterial toxins derive the prominence in that regard as they are known to cause death by respiratory failure.

II. DEFINITION

The cyanobacteria belong to the kingdom Monera, division Eubacteria and class cynobacteria. They happen to be an ancient group of prokaryotic organisms that are found in diverse environments all over the world. Being prokaryotes, they share with others the lack of nucleus as well as a laminated extracellular wall. They tend to be ambiguous in waters with great range of salinity as well as temperature, where they are commonly found in the soils as well as the rocks. Because of this precise reason they are able to utilise the carbon dioxide as well as the bicarbonates ions as a source of inorganic carbon for the process of photosynthesis. While carbon is not natural for growth it may exert an influence on the relative proportion of the bacteria. Traditionally there were referred to as algae, but the modern view of it is limited and in recent times they are considered more of a bacteria.In fact they tend to thrive in waters which are neutral or slightly alkaline in nature. They derive the name blue algae as they were the first species to be recognized in this regard. Due to the presence of cosmopolitan range of pigments, their colour also tends to vary from olive green, grey green or purplish to red. In short they exist as solitary, free living cells.

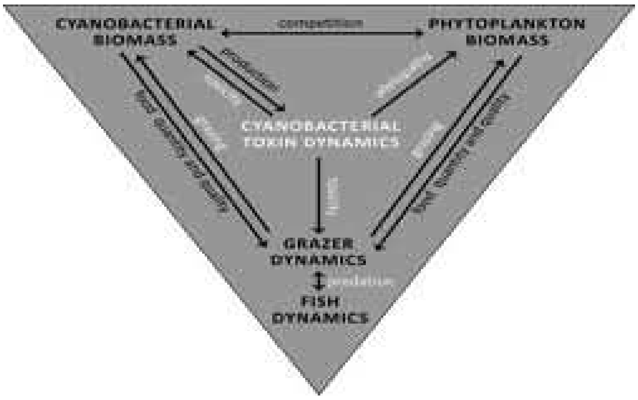

Figure 1: Cyanobacterial toxins dynamics

Reproduction of the cyanobacterial cells is primiarily by simple, asexual binary fission which occurs particulary in the unicellular forms. So it is quite clear that they depend on asexual methods of production. Fragmentation as well a binary fission are the most common methods. Since there are no sexual methods of formation there is no formation of gamete and there is absence of meiosis. [1]. Cyanobacteria also produce bioactive compounds which may be helpful for any sort of antiviral or antifungal activity.

The bacteria in water are able to move, even though they have no locomotor parts like the cilia or the flagellea. In addition to this many cyanobacterial possess the ability to regulate their buyoncy via the intracellular gas vacuoles. Along with it they tend to be the part of many eco systems in the world. In the midst of all this cyanobacterial blooms formation is not a new phenomenon. Historical evidence proves traces of it can be found as early as the 12th century [1-4] .

III. Factors which contribute to the toxic production

The diverse character of the blooms contributes to the unpredictability of the potential nature of the blooms which tends to be dangerous as well as harmful. The blooms can contain toxic as well as non -toxic strains along with a mixture of the various toxin species. In fact production of toxins within the blooms tend to arise every now and then[5]. The irony of the fact is that very few successful studies have been conducted whether a cyanobacterial bloom is toxic in nature or not. Most of the studies tend to be laboratory based and more attention should be paid to environmental factors as well genetic heterogeneity [6-10]. In fact little is known about the metabolic as well as the genetic process which regulate toxin production, as it has been observed that the toxin production tend to vary widely among different strains of the same species. On the other hand many cyanobacteria contain plasmids and it is suspected that many may contain the toxic genes as well. The development of toxicity may also be because of the relative proportions of toxigenic to non toxigenic cells in the bloom as well as the rate of toxigenic production are important parameters [10].

IV. The causes

Cyanobacteria commonly referred to as blue green algae, so named because these organisms tend to possess the characteristics of both algae as well as bacteria. Though there are commonly referred to as bacteria because the blue colour comes from their ability to photosynthesize like the plants. The Cyanobacterial toxins are classified on the basis of how they affect the human body. Some of the classifications are as follows

- Hepatotoxins- which effect the liver are produced by some strains of the cyanobacteria microcystis
- Neurotoxins- which affect the nervous system are produced by some stains of Aphanizomenon and Oscillatory. Normally are of three different types and the course of action varies accordingly and all of them tend to be fast acting molecules.

The chances of exposure of the masses to the cynobacterial toxins increase by drinking or bathing in contaminated water. In addition to this other sources of contamination many include the algae food tablets. It is observed that some species may form scum on the water, but higher amount of concentrations can be found throughout the water. Where surface scums occur there is a high chance of human hazard because of the higher levels of toxins present. The cyanobacteria present in the lakes, ponds as well as the dug outs in various parts of the earth are known to cause poisoning in animals as well as human beings (Lenntech, n.d.). In addition to this allergic response to cyanobacteria may also be demonstrated. Numerous incidence of animal poisoning may come to the fore and the causes of the death may be due to the dose of the cells digested as well as the toxins involved. In addition to this they have been linked to illness in various regions of the world. Humans are affected with a wide range of symptoms which include vomiting, stomach cramps as well as nausea.

Since cyanobacteria are autotrophs, they reach much higher concentrations than hetetrophic bacteria and can make drinking water poisonous as well as fatal for consumption. This in fact is a major problem with the various water reservoirs in the world. It has been observed that cyanobacteria thrive best and reach higher levels of concentration in entropic water bodies which are anoxic at depth (Wefer, Berger and Jansen, 2002).

V. THE DISEASES AND HOW IT AFFECTS PEOPLE

Diseases caused by cyanobacterial toxins tend to vary according to the type of toxins, the type of water as well as water related exposure. This could be in the forms of skin contact as well as drinking. The human beings are not left behind and are affected with a wide range of symptoms which include skin irritation, vomiting, diarrhoea, muscle, joint pain and blisters in the mouth as well as the liver [11-14]

The swimmers who swim in water affected with cyanobacterial toxins are prone to allergic reactions which could be asthma, eye irritation and blisters around the skin and the nose. The damage can also extend to birds, animals as well as fish that can be affected with a high level of cyanobacterial toxins**.**

The various scenarios of poisoning episodes, laboratory investigation into the toxicity of cyanobacterial toxins and the assessment on the human exposure fronts indicate on all counts that cyanobacterial toxins possess a major danger to human beings as well as animals whether present in drinking or recreational sources of water. They can cause acute effects like gastroteritis, allergic or irritation reactions. Pneumonia like symptoms, hepatoenteritis and long term chronic effects like liver damage or liver tumour promotion on prolonged exposure to toxins. Normally human health hazards can occur from three routes of exposure which are

- The intake of water taking cells by inhalation
- Accidental intake of water containing cells by swallowing
- Direct contact of the exposed parts of the body, including the eyes, ears, nose and the mouth.

Recreational contact with Microcystis may cause blistering of the lips. In fact human consumption of Cyanobacteria Spirulina is widespread as it is often marketed as a health food. The other cyanobacteria which emerges from natural sources such as freshwater blooms are also marketed as food supplements. These tend to become potentially hazardous substances if they contain a slight level of toxic species as well as strains. One of the potential threats of cyanobacterial toxins on human health is tumour promotion after skin contact during bathing, or after prolonged exposure to sub acute levels of toxins in drinking water [15,16]. Mass occurrences of toxic cyanobacteria are common worldwide. In the temperature regions toxic blooms are seasonal, occurring in the seasons of late summer as well as autumn. In the warmer climates the blooms may persist round the year**.**

In the current world of today there are efficient methods for removing toxins and toxin cells during the water treatment procedures. They occur in lipid layers and one of the typical examples in this regard would be DDT [17].

In fact the highest level of hepatotoxin concentrations are found in the liver and this is the precise reason on why it is recommended that the livers and the intestines of fish and water fowl should not be used for consumption during the bloom period. The toxins have contributed to the numerous animal poisonings of domestic as well as wild animals. What is all the more alarming fact is that the recent surveys have shown that cyanobacterial toxins may be found in certain diary supplements as well.

VI. Toxin persistence and degradation

Evaluating the combined efforts of toxicants as well as toxicity, related factors like persistence , toxic degradation and toxic additivity as well as synergy are important. This is the case when toxic impurities in water are found and as soon as an effluent tends to mix with water the properties associated with it begin to change. The rate of change of that toxicity in that effluent is a measure of the toxicity resistance as well as degradation. Toxicity may present a more serious problem in lake receiving waters where the toxicity is not flushed away rapidly. On the other hand when multiple toxicants pave way to receiving water the emerging ambient toxicity tends to be appealing. The fact of the matter is that eace and the compostion of each and every element evolves around individual toxic waters and the mixture of the effluents in receiving water produces a mixture of individual elements [18-21].

The persistence of the toxins added tends to be a function primarily of the concentration added, the rate of consumption as well as deactivation, rate of degradation of the microorganisms and the rate of the abiotic activation. It is observed that the genes which are coded and engineered into the plants the toxins continue to be synthesized during the growth of the plants. If the production exceeds the consumption, the toxins would accumulate to concentrations that may enhance the control of target pests or constitute a hazard to the non target organisms such as soil micro biota [22-24]**.**

The soil type is very important for the toxic persistence. Toxins are bound to clays and humid acids within a few hours of entering the soil and then tend to make their presence felt there over long periods of time. Higher clay contents result in great persistence of the soil. So it is quite clear that close to 80 % of the micro organisms in the soil are absorbed into organic minerals as well as clay matter. In hindsight these active toxins may have a larger target base and affect the various components of the eco system with the consequences pointing to the functional dynamics [25].

VII. Conclusion

From the analysis done till now certain major facts emerge as part of the subject matter under consideration. Cyanobacterial blooms are part of the aquatic environment and evolve under conditions which generally is a combination of factors. But the difficult part in this regard is that no incidence of it has been available as well as no historical records could prove that aspect as well. Though not generally accepted , but an inevitable truth is the connections which has been established by the waterways and the incidence of cyanobacterial blooms, in all likehood the problem of bloom formation will continue until the problem of eutrophication is fully solved. One of the effective mechanisms is this regard would be to focus on land as well as water management practices. In hindsight preventive measures should be adopted to reduce the risk associated with cyanobacterial exposure and there is strong need for the relevant authorities to address this issue and take strong action to the degradation of water quality.

In fact control of cyanobacterial blooms on the mechanism of prevention rather than eradication. Prevent of bloom formation in the rivers may include the reduction of phosphate inflow into the rivers, lakes as well as water bodies, aeration and suppression of phosphate mobilization. Algicides as a method of control of cyanobacterial have been a favoured measure for a long time. Introducing a wet land/ swamp at the beginning of a reservoir can also reduce bloom formation. Copper sulphate is the favourite and effective algicide,but its use on toxic blooms can release toxins from cells and can enter finished water. Coagulation can also be an effective method for eliminating cyanobacterial cells from water. Cyanobacterial toxins are water soluable and the control measures involve the chemical procedures reducing toxicity or completely removing the toxins from drinking water.

So from the above analysis it is quiet clear that cyanobacterial toxins thrive in the water bodies and have lot of potential hazards from the human beings as well as animals. So proper steps should be taken in this regard for prevention of it.

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