Algal physiology

Lab.: Aquatic algal toxins

Aquatic algal toxins are a diverse group of toxic compounds produced mainly by microalgae and cyanobacteria that pose a severe risk to human& animal health and aquatic ecosystems. The production of algal toxins was normally associated with algal bloom, or the rapid growth and exceptionally dense accumulation of algae. Cyanobacteria produce toxins termed as **(cyanotoxins)**at different rates depending on the growth phase of their populations, late Exponential phase is usually that where cyanotoxins production at maximum level. **Several hypotheses** have been launched to explain why cyanobacteria produce toxins (allelopathy, grazing deterrents, nutrients reserve especially for nitrogen and phosphate. In addition to regulating endogenous protein phosphatase)

Algal groups that most frequently associated with toxin production are:

1-**cyanophyta**: ex. *Microcystis, Oscillatoria, Cylindrospermopsis, Anabaena, Planktothrix, Aphanizomenon, Nodularia, and Lyngbya,*

2-**dinoflagellates** :ex. *Hematodinium, Gymnodinium breve*

3-**diatoms: ex.** *Chaetoceros , Pseudo-nitzschia*

Classification of Cyanotoxins

Cyanobacterial toxins are grouped according to:

A- the physiological systems, organs, tissues, or cells which are primarily affected. They include the following:

1-Neurotoxins: potent neuromuscular blocking agent, inhibit transmission of nervous impulses .

Ex.Anatoxins, saxitoxin, ß-methylamino alanine(BMAA)

2- Hepatotoxin: binds covalently and irreversibly to liver protein phosphatase, causing inhibit its function.
Ex.**Microcystin, Nodularin, cylindrospermopsin**

3- Dermal& gastrointestinal irritants: stimulate irritant and allergenic responses in human and animal tissues that come in contact with the compounds
Ex.aplysiatoxin and lyngbyatoxin.

B-based on their chemical composition, cyanotoxins can be grouped into:
1-Cyclic peptides
Ex.(Microcystin, Nodularin, BMAA)

2-Alkaloids
Ex.(**Anatoxins**, **saxitoxin, CYlindrospermopsin**)

3-Lipopolysaccharides
Ex.(aplysiatoxin, lyngbiatoxin)

Routes of exposure of cyanotoxins

1-Exposure to cyanotoxins from contaminated drinking water sources may occur by oral exposure (drinking water, cooking with water, and incidental ingesting through showering).

2-Dermal exposure (contact of exposed parts of the body during bathing or showering, washing dishes, or outside activities).

3- Exposure via inhalation (during bathing, showering or washing dishes)

4- Intravenous exposure (e.g. via dialysis).

Detection of cyanotoxins:

Detection of cyanotoxins can be performed by using different chemical and biological methods. Each test has advantages and disadvantages depending on the aim of the user and the analytical problem. These methods include:
1-Bioassays: (mouse bioassay, Protein phosphatase inhibition assay)

2-Biochemical assays: immunoassay(ELIZA), gene-based polymerase chain reaction.

3-Analytical methods: based on column chromatography ex.(**(HPLC)**

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Molecular detection of microcystin(mcy):

A majority of molecular methods employ PCR amplification of cyanobacterial genomic DNA to either detect presence/absence of various mcy genes in samples as in **conventional PCR**. This DNA-based detection method, that use **primers** specific to the genes involved in biosynthesis of cyanotoxins have been widely employed. Thus, the detection of potentially microcystin producing cyanobacteria can be accomplished by amplifying genetic marker.

This group of toxins is encoded by the **MCy synthetase (*mcy*) gene cluster**. The cluster of *mcy* gene contains **10 genes**, namely *mcy* A to *mcy* J, which have been fully sequenced and characterized in many cyanobacterial species. Mcy gene clusters have been considered a **molecular marker** for identification of MCs-producing cyanobacteria. The mcyE gene was chosen over all other genes in the mcy cluster because of the important role it plays in the synthesis and incorporation of the toxicity determining amino acids moieties into the MC structure.