Effect of coagulants in removing cyanotoxin - microcystin in drinking water treatment process

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INTRODUCTION

- A continuing worldwide problem for drinking water treatment industry is the presence of cyanotoxins in source water produced by several species of cyanobacteria.
- The cyanotoxins are included in the most recent Contaminant Candidate List published by Safe Drinking Water Act.
- The growing concern regarding the acute and chronic effects of MCs has resulted in the World Health Organization setting a guideline value of 1 μg/L for microcystin-LR (MCLR) in drinking water.
- Standard drinking water treatment process involves coagulation/flocculation process as primary treatment to remove cyanobacteria from source water.
- Chemical coagulation process has been proved to be effective in eliminating cyanobacterial cells and intracellular MCs from drinking water sources, however study is limited on effect of coagulants on intercellular MCs.

RESEARCH PROBLEM

- Chemical coagulation process has been proved to be effective in eliminating cyanobacterial cells and intracellular MCs from drinking water sources
- As the majority of MCs are retained inside the cells, removal of intact cyanobacteria is desired during coagulation/flocculation process to avoid the release of MCs in the drinking water.

OBJECTIVES

- To investigate the effect of different types and concentrations of coagulants to remove intact cells plus intercellular MCs through coagulation and flocculation process

MATERIALS & METHODS

- jar tests, comprising of six 2-Unicode beakers with a magnetic stirrer filled with 1 L of microcystin-LA (MCLA) spiked influent water sample from a local water treatment facility, was performed to simulate a coagulation/flocculation process in laboratory condition.
- Alum, ferric chloride, ferric sulfate, and chlorine were prepared in different ratio for the coagulation/flocculation process followed by a sedimentation process. A control was prepared without the coagulants.
- Liquid Chromatography Triple Quadrupole Mass Spectrometry (LC/MS) was used to detect MCLA

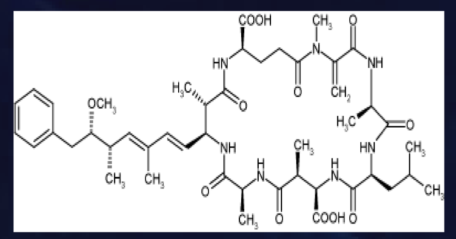
CONCLUSIONS

- Out study would evaluate different types and concentration of coagulants to establish effective methods to remove cyanotoxins at the primary drinking water treatment

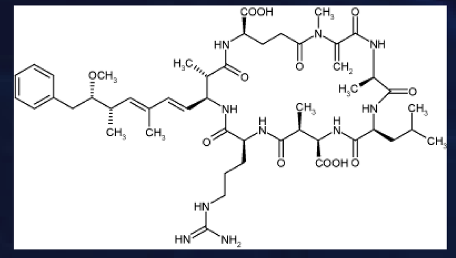
WHY THIS RESEARCH

- This study is important as it establishes a method that would eliminate harmful cyanotoxins before it enters into the secondary treatment process.

SAMPLING & EXPERIMENTAL DESIGN

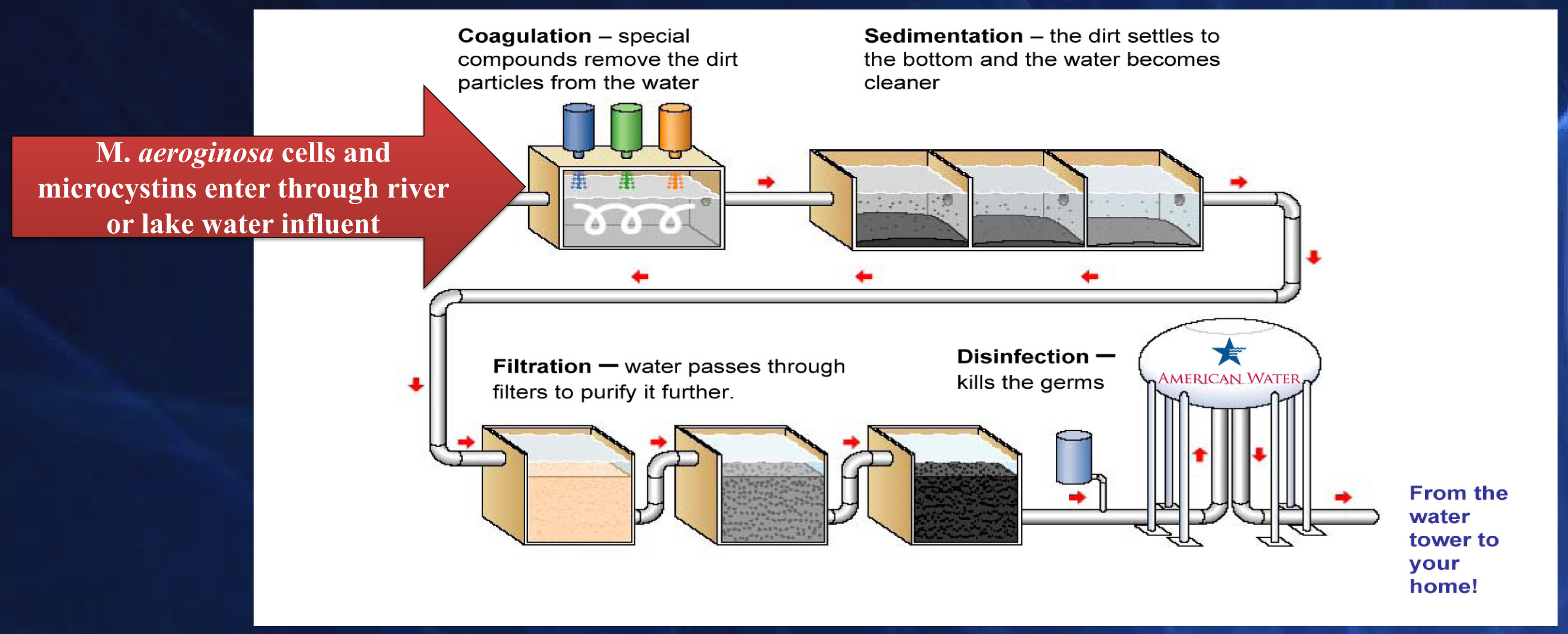


Microcystin- LA ($C_{46}H_{67}N_7O_{12}$)



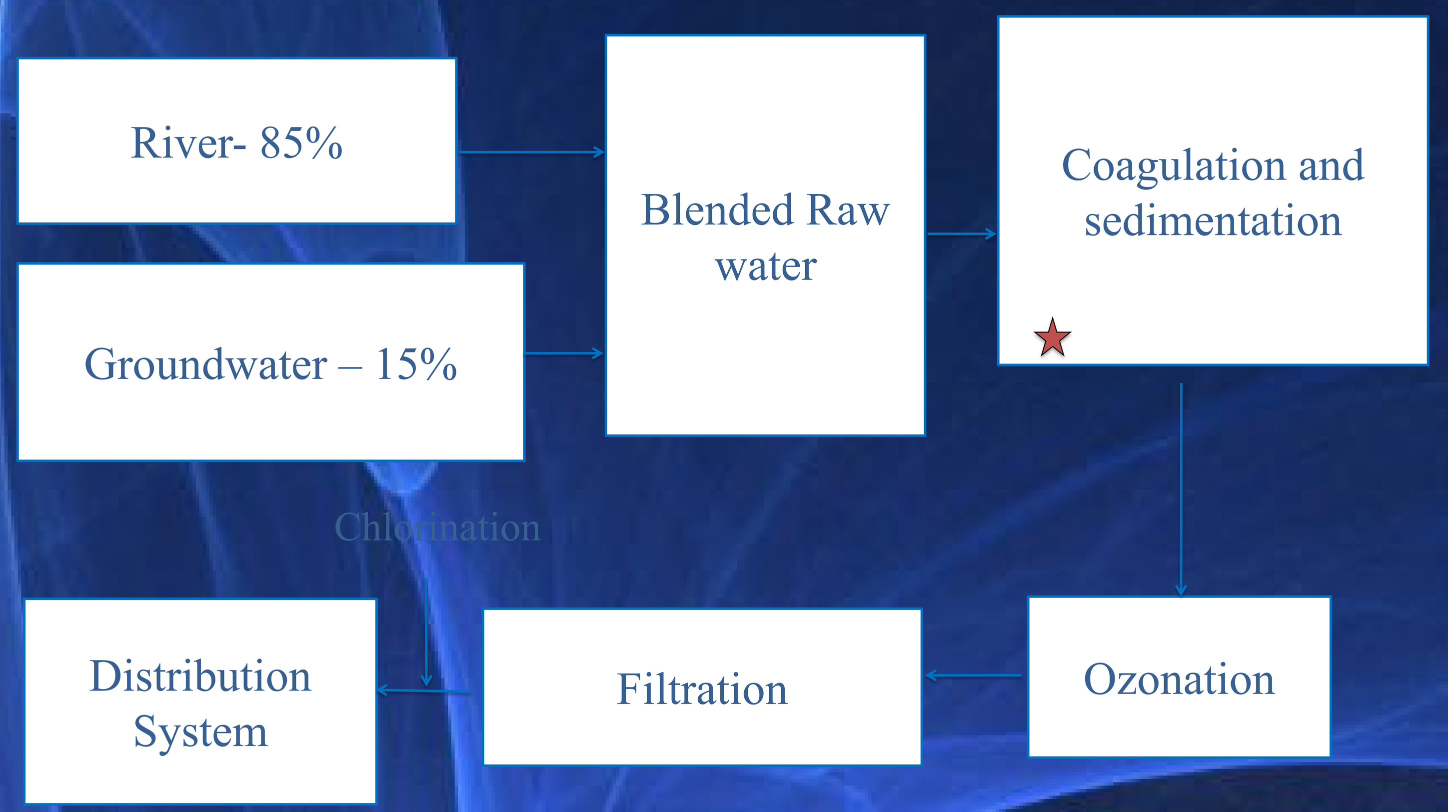
Microcystin- LR($C_{49}H_{74}N_{10}O_{12}$)

Water treatment process

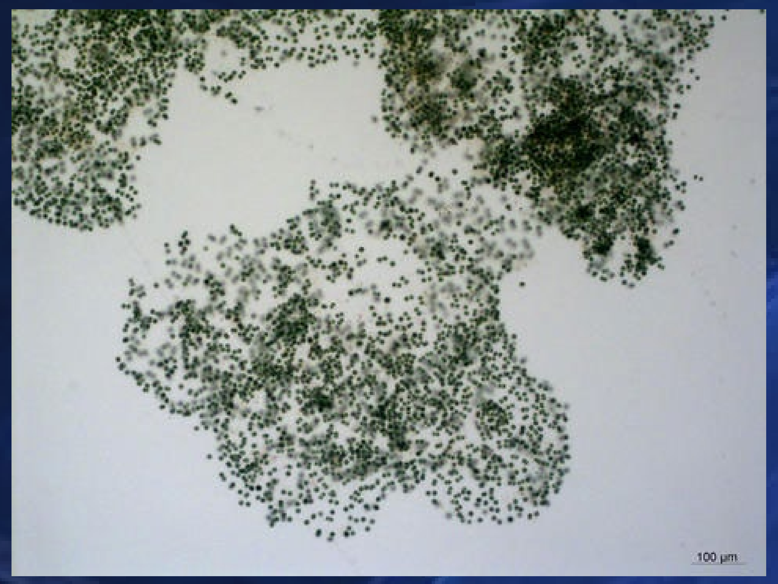


From the time source water from a lake, stream or reservoir enters one of our treatment plants, until it flows through your tap, it goes through five basic treatment steps:
Coagulation : Alum and other chemicals are added to water to form tiny, sticky particles called "floc," which attract dirt and other particles suspended in water. This allows cyanobacteria's cells to precipitate with flocs. Cyanotoxin may come out if cell breaks during 'mixing'
Sedimentation : The heavy floc particles with intact cells settle to the bottom of treatment tanks, allowing for their separation from the water.
Filtration : The water passes through filters of sand, gravel and charcoal to help remove even smaller particles.
Disinfection : Chlorine is added or other disinfection methods are used to kill bacteria or other microorganisms in the water.
Storage :Water is placed in a closed tank or reservoir to allow for disinfection. Water then flows through pipes to homes and businesses in the community.

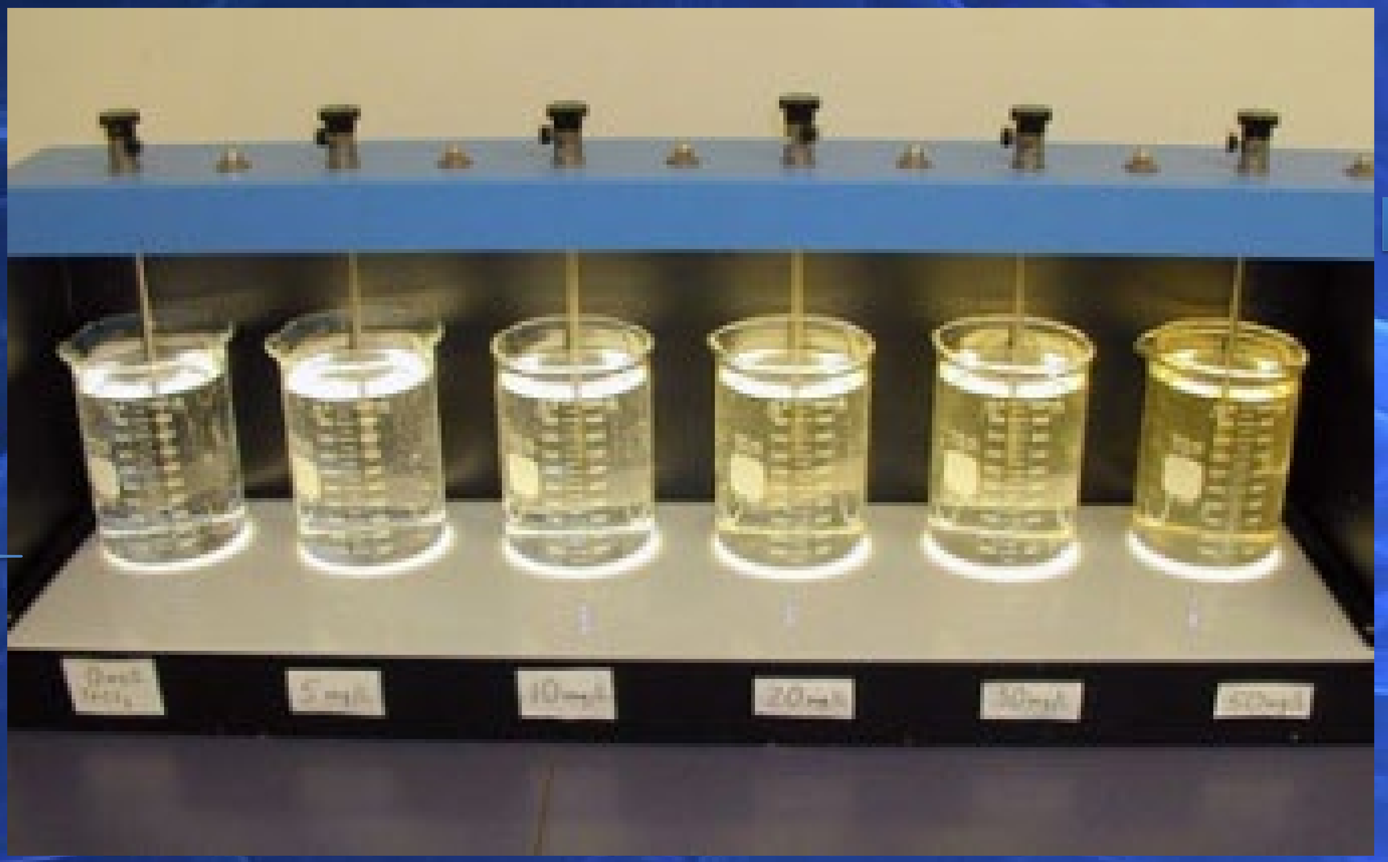
Moorhead Treatment Plant, MN



City of Moorhead Drinking Water System, Moorhead, MN simplified schematic diagram

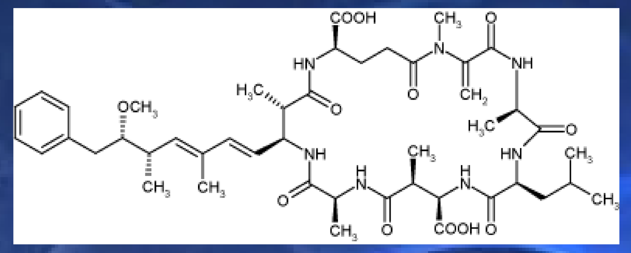


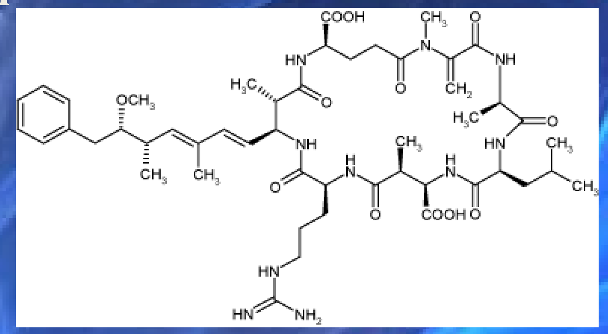
Microcystis culture



Parameter	Value
Rapid Mix Time (T_{mr})	10s
Rapid mix average velocity gradient	$600s^{-1}$
Flocculation time (T_{fl})	20 min
Flocculation Average velocity gradient (G_{fl})	$20s^{-1}$
Settling velocity (V_s)	1.5cm/min

Ongoing experiment: Same concentration of *Microcystis* cells or Microcystin LA (MCLA) ;different ratio(8mg/L, 12mg/L, 16mg/L, 20mg/L, 24mg/L, 50mg/L) of Coagulants (alum, ferric chloride, ferric sulfate, and chlorine) for coagulation/flocculation process followed by a sedimentation process.





Microcystins Extraction For LC/MS detection