A progressive comparison of cyanobacterial populations with raw and finished water microcystin levels in Falls Lake Reservoir

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Introduction

Cyanobacteria and algal toxins have been placed on USEPA's drinking water Contaminant Candidate List (CCL2). Microcystin (MCYST), being the most frequently detected cyanobacterial toxin in water, is of high importance for study in potable water supply reservoirs. Processed water samples from numerous surface water supplies in the USA have been found positive for MCYST. MCYST has been detected in raw and finished water from Falls Lake, Raleigh, NC. Conventional drinking water treatment processes are only partially effective in removing cyanotoxins. To assess the risk of cyanotoxins in surface water supplies, USEPA is evaluating the use of cyanobacterial genera identification and enumeration. This study evaluated a known testing protocol and investigated the occurrence of MCYST in raw and finished water from Falls Lake Reservoir, as well as the relationship of toxin concentration to cyanobacterial populations.

Hypotheses

1) Applying standard sample extraction and concentration procedures increases the sensitivity of the Competitive-Binding ELISA assay.
2) Source water MCYST concentrations are directly related to cyanobacterial cell densities.
3) Water treatment processes used to treat Falls Lake raw water (pre-oxidation > coagulation/flocculation/PAC > sedimentation > filtration > chloramination) effectively remove MCYST from raw water.

Methods

From May 28-July 8, 2003, we collected raw and finished water samples from Falls Lake and Johnson WTP to assess the levels of microcystins. We applied standard sample preparation procedures, including: freeze-thaw/sonication; concentration via lyophilization; methanol-water extraction; and solid phase extraction. We then analyzed the concentrated samples using a commercially-available Competitive-Binding ELISA assay kit. Other aliquots of the water samples were preserved and analyzed by standard taxonomic and direct cell counting techniques.

Results

1) MCYSTs were detected above the assay limit of quantitation (LOQ)(0.160 ppb) in raw water concentrates.
2) MCYSTs in finished water concentrates were significantly lower, at or below the LOQ.
3) MCYSTs and the grouped densities of *Anabaena* and *Aphanizomenon* were weakly correlated ($R^2 = 0.11$).

Conclusions

1) For raw water samples, the sensitivity of the ELISA can be increased by using either an alternate low level protocol (LOQ 0.05 ppb) or pre-concentration techniques.
2) The low level protocol should be employed for finished water samples.
3) Conventional treatment processes removed 60-100% of MCYST.
4) *Anabaena* and *Aphanizomenon* densities may be useful predictors of MCYST levels.