LUPINE PUBLISHERS

Concepts of Dairy & Veterinary Sciences

DOI: 10.32474/CDVS.2020.03.000160

ISSN: 2637-4749

Opinion

Is the Water Really Safe to Drink? A Potential Threat of Cyanotoxin Poisoning of Livestock by Water Supplies to Facilities Cyanotoxin Poisoning of Livestock in Facilities

Jian Yuan[1,2]*

[1]*Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University, USA*

[2]*Veterinary Diagnostic Laboratory, Iowa State University, USA*

***Corresponding author:** Jian Yuan, Department of Veterinary Diagnostic and Production Animal Medicine, Iowa State University, USA

Received: January 14, 2020 **Published:** January 21, 2020

Abstract

Freshwater toxic cyanobacteria can produce potent cyanotoxins which are detrimental and lethal to animals. Water from farm ponds contaminated by cyanotoxins can carry the toxins to nearby livestock facilities, posing a threat of animal poisoning when toxins reach a dangerous level. Therefore, fast and precise means should be conducted to reveal the existence and levels of cyanotoxins and toxic cyanobacteria to find out such threats in a timely fashion.

Keywords: Toxic cyanobacteria; cyanotoxins; farm ponds; livestock; facilities

Abbreviations: HAB: Harmful Algal Bloom; ELISA: Enzyme Linked Immunosorbent Assay; HPLC: High Performance Liquid Chromatography; MS: Mass Spectrometry; PCR: Polymerase Chain Reaction

Introduction

Cyanobacteria, colloquially called blue-green algae, are a group of photoautotrophic prokaryotic microalgae which inhabit a variety of environments on earth. Their ubiquity in global freshwater bodies has made them important cosmopolitan organisms in freshwater habitats. Being able to proliferate explosively under appropriate ambient conditions, for example sufficient nitrogen and/or phosphorus nutrients, cyanobacteria can easily become dominant in inhabited ecosystems and form an ecological phenomenon/disaster named HAB. An HAB can bring about many deleterious impacts on local ecosystems such as hypoxia caused by over consumption of oxygen by bacteria for degrading dead cyanobacterial cells. What is even worse, some cyanobacteria can produce potent cyanotoxins toxic to animals and humans, and the toxins can be enriched to a dangerous level in an HAB, causing health and sanitation problems [1,2]. Cyanotoxins contain a tremendous number of species and are categorized by their toxicological effects into hepatotoxin, neurotoxins, cytotoxin, etc. Microcystin, anatoxin-a, and cylindrospermopsin are the most prevalent representative toxins that fall into the three categories, respectively. They can kill a poisoned animal in a very low dose (e.g, 3 ppb for a nursery pig) [1]. As a secondary metabolite, these toxins are mostly produced by cyanobacterial species in *Microcystis*, *Anabaena, and Cylindrospermopsis*, respectively, although their production is also found in other genera. The process of toxin production is well profiled and regulated under a synthetic mechanism by a group of enzymes that are translated from clustered toxin synthetase genes [3-5]. Direct detection of cyanotoxins can be conducted using ELISA, HPLC, and MS. These techniques are already characterized with satisfactory specificities and sensitivities. Moreover, detection of toxic cyanobacteria can be done as an alternative approach for identifying toxicity. Because a toxic species actually has toxic strains as well as non-toxic strains that share identical morphologies but lack the toxin synthetase genes, traditional microscopic examination cannot fulfill the purpose of accurate recognition of toxicity. As a result, molecular methods targeting the existence of toxin genes is an effective approach to find out the toxic cyanobacteria, of which PCR is the most popular. While, intuitively, existence of genes doesn't equate to production of toxins as there is likely a "switching on/off" mechanism of the genes (frankly, "toxigenic" is more accurate than "toxic" per se), findings of good correlations for their existence as

well as quantities suggest revelation of toxic cyanobacteria is an excellent indicator of toxicity [6].

Microcystis and *Anabaena* exist across extensive latitudes, and Cylindrospermopsis can be discovered in temperate zones despite it was found in tropical zones. They grow in some waterbodies which are also water sources for livestock. Although the water is sometimes treated to remove possible contaminants, it is directly transported to facilities for animals' consumption, increasing the likelihood of cyanotoxin poisoning. In my recent study in five farm ponds and five swine facilities served by these ponds as water sources in the Midwestern United States, it was found that the abundances of toxic *Microcystis spp.* and *Anabaena spp.*, and levels of microcystin and anatoxin-a had no significant differences ($p > 0.05$ by paired *t*-tests) in water between ponds and facilities with a few chlorinated samples in one facility for detoxification (Figure 1). Although all the quantities were far below the warning levels for an HAB or a toxicosis, chronical effects may occur on swine due to accumulation of toxic cyanobacteria and/or toxins. More crucially, swine can easily be poisoned once toxins are rapidly accumulated in an unpredictable HAB event. Furthermore, the failure of decontamination of cyanotoxins by chlorination suggests an option of effective detoxification.

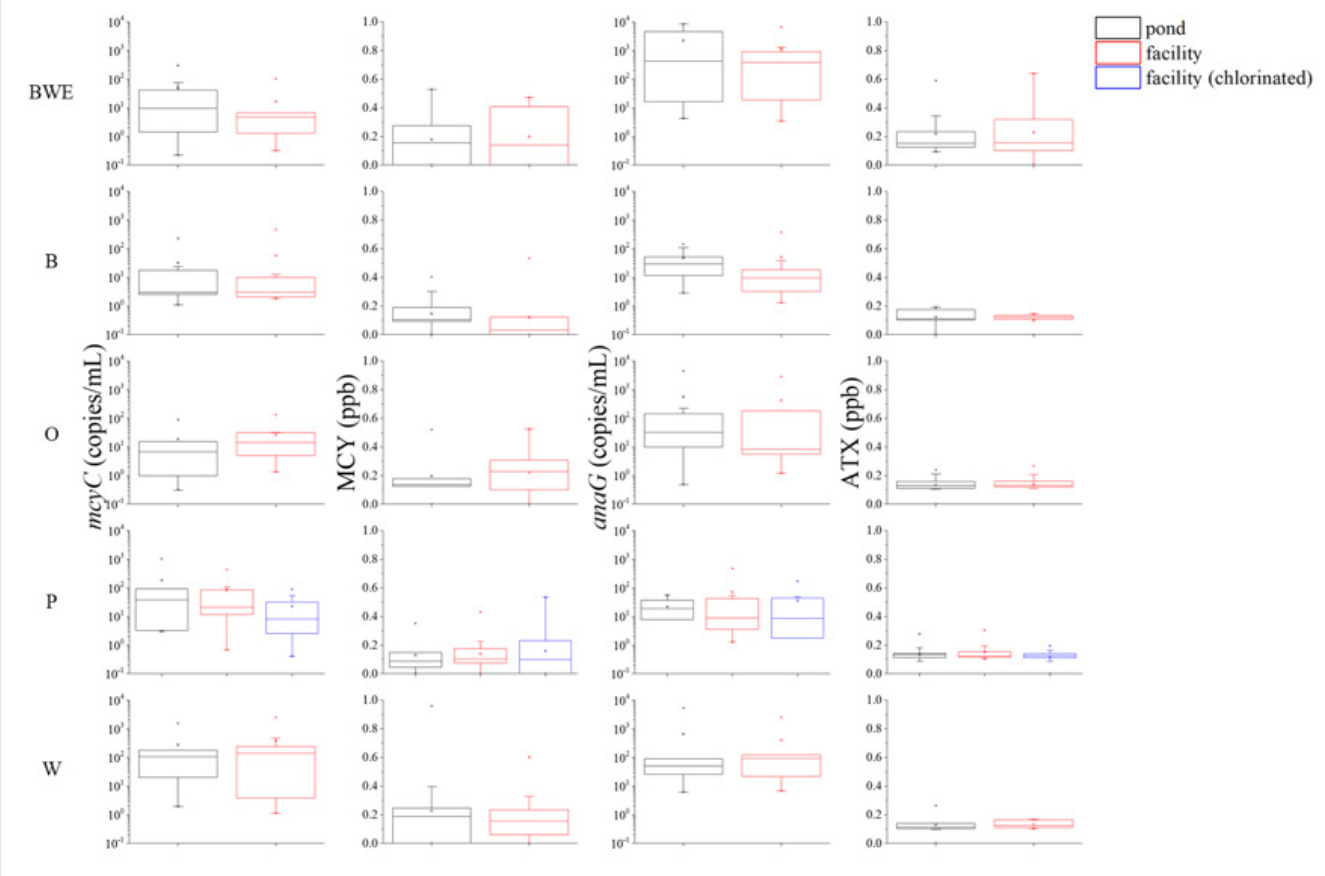

Figure 1: Abundances of toxic *Microcystis spp*. and *Anabaena spp*, and levels of microcystin and anatoxin-a in 105 water samples from five farm ponds and five swine facilities in the Midwestern United States. Toxic *Microcystis spp*. and *Anabaena spp*. are represented by one synthetase gene for microcystin and anatoxins-a (mcyC and anaG), respectively. MCY and ATX are abbreviations for microcystin and anatoxins-a, respectively. Ponds and facilities are indicated by BWE, B,O,P, and W. Black, red, and blue squares refer to pond water, facility unprocessed water, and chlorinated water, respectively.

Conclusion

In farm ponds as water resources to facilities lies a potential threat of livestock poisoning by cyanotoxins produced by toxic cyanobacteria. Therefore, accurate and prompt detection approaches for toxins and their producers are highly necessary. Nowadays, detection of toxic cyanobacteria and cyanotoxins is a component of routine water monitoring programs for large and important waterbodies like lakes and reservoirs. However, such a program doesn't exist for small farm ponds that are prone to eutrophication (over enrichment of nutrients) causing HABs. As they are vital for livestock health as water sources, it is strongly suggested monitoring of toxic cyanobacteria and cyanotoxins should be set up in these farm ponds as a diagnostic or prewarning tool for veterinarians, producers, and stakeholders.

References

1. Classen DM, Schwartz KJ, Madson D, Ensley SM (2017) Microcystin toxicosis in nursery pigs. Journal of Swine Health and Production 25(4): 198-205.
2. J Swine He Pouria S, de Andrade A, Barbosa J, Cavalcanti RL, Barreto VTS, et al. (1998) Fatal microcystin intoxication in haemodialysis unit in Caruaru, Brazil. Lancet 352(9121): 21-26.
3. Pacheco AB, Guedes IS, Azevedo SM (2016) Is qPCR a reliable indicator of cyanotoxin risk in freshwater? Toxins 8(6): 172.
4. Tillett D, Dittmann E, Erhard M, Dohren HV, Borner T, et al (2000) Structural organization of microcystin biosynthesis in Microcystis aeruginosa PCC7806: an integrated peptide-polyketide synthetase system. Chem Biol 7(10): 753-64.
5. Mejean A, Paci G, Gautier V, Ploux O (2014) Biosynthesis of anatoxin-a and analogues (anatoxins) in cyanobacteria. Toxicon 91: 15-22.
6. Mihali TK, Kellmann R, Muenchhoff J, Barrow KD, Neilan BA (2008) Characterization of the gene cluster responsible for cylindrospermopsin biosynthesis. Appl Environ Microbiol 74(3): 716-722.

DOI: 10.32474/CDVS.2020.03.000160