(SD2022-133) Methods to monitor guanitoxin cyanobacterial blooms

Tech ID: 32825 / UC Case 2021-Z08-1

BACKGROUND

Freshwater is essential for drinking and agriculture, yet potable watersheds are increasingly impacted by the undesirable high-density growth of algae and/or cyanobacteria. Understanding, monitoring, and remediating harmful algal/cyanobacterial blooms (HABs/cyanoHABs) and their associated toxins are essential to reducing their societal impact. Recent scientific and technological advances continue to improve environmental cyanoHAB detection and prediction; however, the vast cyanotoxin structural chemodiversity creates challenges in their comprehensive detection and quantification using standard analytical chemistry assays. In contrast, quantitative molecular biological detection of biosynthetic genes via PCR provides a multiplexable and cost-effective monitoring strategy to identify the toxic potential of blooms independent of active toxin synthesis. The biosynthetic gene clusters (BGCs) for important freshwater cyanotoxins like microcystin, cylindrospermopsin, saxitoxin, and anatoxin-a have been defined and applied toward detection over the past decades. However, the biosynthetic pathway and genes for guanitoxin, the only known natural organophosphate neurotoxin, have yet to be described.

Previously known as anatoxin-a(s), guanitoxin is an irreversible inhibitor of acetylcholinesterase, sharing an identical mechanism of action with organophosphates like the synthetic chemical warfare agent sarin and the banned pesticide parathion. Guanitoxin induces acute neurological toxicity that can lead to rapid death, showing comparable lethality (LD50 = 20 µg/kg i.p.) to saxitoxin, the most potent known cyanotoxin. Sporadic detection in the Americas, Europe, and Middle East coupled with bloom-related animal deaths consistent with guanitoxin exposure suggests that this toxin could be an under-recognized threat in global watersheds.

TECHNOLOGY DESCRIPTION

Researchers from UC San Diego and Brazil have discovered and rigorously validated the genes encoding guanitoxin biosynthesis from cyanobacteria. This freshwater toxin is one of the most potent environmental neurotoxins.

It is a fast acting toxin that inhibits acetylcholinesterase and as a consequence leads to inhibition of acetylcholine recycling to result in the over stimulation of the muscles, leading to convulsions, muscle fatigue, and respiratory arrest.

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OTHER INFORMATION

CATEGORIZED AS

- Biotechnology
  - Other
- Environment
  - Other
- Veterinary
  - Other

RELATED CASES

2021-Z08-1

With genes and resulting recombinant proteins in hand, the researchers havededuced each and every biosynthetic reaction from arginine to guanitoxin – 9 in total. As a consequence, they now have methods in place for the first time to detect and measure the environmental chemical intermediates and encoding DNA/RNA associated with guanitoxin biosynthesis.

APPLICATIONS

These methods are useful to environmental monitors who query freshwater samples for toxin loads that may be harmful to humans, pets, livestock and other animals.

INTELLECTUAL PROPERTY INFO

UC is securing patent protection (https://patents.google.com/patent/WO2023154891A2). Presently, this technology has been excluisvely licensed.

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(54) **Title:** METHODS AND COMPOSITIONS FOR DETECTING GUANITOXIN PRODUCING BACTERIA

FIG. 2C

(57) **Abstract:** Provided herein, *inter alia*, are compositions and methods for detecting guanitoxin producing bacteria in an aqueous liquid. The methods provided herein include detecting one or more more guanitoxin biosynthetic genes in the aqueous liquid. Compositions provided herein include one or more nucleic acids at least partially complementary to a guanitoxin biosynthetic gene.

[Continued on next page]

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RELATED MATERIALS

- Biosynthesis of Guanitoxin Enables Global Environmental Detection in Freshwater Cyanobacteria Stella T. Lima, Timothy R. Fallon, Jennifer L. Cordoza, Jonathan R. Chekan, Endrews Delbaje, Austin R. Hopiavuori, Danillo O. Alvarenga, Steffaney M. Wood, Hanna Luhavaya, Jackson T. Baumgartner, Felipe A. Dörr, Augusto Etchegaray, Ernani Pinto, Shaun M. K. McKinnie, Marli F. Fiore, and Bradley S. Moore Journal of the American Chemical Society Article ASAP - 05/18/2022
- Deciphering the Biosynthetic Gene Cluster for Potent Freshwater Toxin: Scientific discovery enables future monitoring of harmful toxin. News Release UC San Diego - 05/18/2022

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