Tissue distribution of the toxin beta-methylamino-L-alanine (BMAA) and its isomers in fishes of Lake Erie

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ABSTRACT:

Harmful algal blooms (HABs) release toxic compounds in water and are increasing in frequency worldwide due to eutrophication. HABs in Lake Erie are monitored extensively but some HAB toxins, the neurotoxic isomers of β-methylamino-L-alanine (BMAA), have only been investigated recently (A. Reside 2022 MSc Thesis, University of Guelph). In this early study, BMAA and its isomers AEG, DAB, and BAMA were found in Lake Erie organisms (zooplankton, mussels, forage fish, adult yellow perch, and adult walleye) captured near Point Pelee, Ontario, using liquid chromatography with tandem mass spectrometry in whole invertebrate samples and fish brain tissue. The present GLFC pilot project evaluated the body distribution of BMAA isomers using various tissue samples of yellow perch and walleye (brain, gill, liver, axial muscle, heart, kidney, scales, gonad). Two objectives were sought: 1) Identify if BMAA isomers are present in fish axial muscle and measure their concentrations to evaluate the risk of exposure through human consumption of Lake Erie yellow perch and walleye. 2) Evaluate tissue distribution of BMAA and its isomers in fish to possibly gain insight into the mechanism generating variability in brain isomer content across species. All four isomers were detected among samples, but BMAA was detected the least frequently. AEG was detected in all samples, except for some brains. DAB was most detected in the liver while BAMA was most detected in gonads and gills. Sum concentrations of BMAA isomers were greatest in yellow perch liver and gonads, while they were greatest in walleye kidney tissue. The isomers AEG and BAMA were often detected at higher concentrations in tissues, and divergent patterns of isomer concentrations were seen in the brain and kidney of yellow perch and walleye. Overall, BMAA isomers are present in organisms of Lake Erie and our investigation highlights important uncertainties related to the ecotoxicology of these compounds. First, considering that BMAA isomers also exhibit toxic effects, focus on BMAA at the expense of its other isomers may be misguided. In particular, the toxicity of AEG and BAMA to humans and wildlife will need to be evaluated. Second, variability in isomer abundance among organisms suggest species-specific metabolism or exposure to these compounds. Assessing the presence of BMAA isomers in Lake Erie water and conducting experimental exposures to these compounds are obvious next steps in this research project. The present findings have opened new research avenues on the effects of HABs in Lake Erie.