

Characterization of Cyanobacterial Toxins in Lake Naivasha, Kenya

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Abstract

Microcystins are a class of cyanobacterial toxins largely found in water and are often responsible for poisoning animals as well as humans. A more recent scenario is the poisoning of domestic water supply system in Toledo (Ohio), USA. Consequently, water supply to the city had to be suspended for weeks in order for authorities to ascertain the commodity's safety before restoring supply. In Kenya, there have been very few studies on cyanotoxins and their adverse health effects in spite of the fact that cyanobacteria have been implicated in several poisoning episodes of humans and animals worldwide, occasioned by drinking microcystin contaminated water. This paper therefore, reports data on the first identification and characterization of hepatotoxic microcystins in water samples of Lake Naivasha. Samples from the lake were investigated over a modest period of three months. The phytoplankton community was mainly dominated by the cyanobacterium *Microcystis aeruginosa*. The colour of the water samples was found to be 520 ± 91 ptco, while the conductivity was 234 ± 0.8 $\mu\text{s}/\text{cm}$ and the total dissolved solids was 1035 ± 12 mg/L. Due to the high turbidity (59.0 ± 24 ntu), phytoplankton biomass was low, ranging between 1.5 and 8.2 mg L⁻¹. Using UV-Vis and HPLC techniques, the microcystin-LR, -RR and -YR were detected in all the water samples collected from the lake. HyperChem computational package was used to estimate the toxicity index of microcystin-RR based on the octanol-water partition coefficient and found to be 230 times more soluble in water than in octanol. Thus, microcystin-RR is highly soluble in polar biological tissues which may result in cell injury, oxidative stress, and ultimately cancer. To the best of our knowledge, this is the first evidence of microcystins in Lake Naivasha.

Introduction

Cyanobacterial toxins are the naturally produced poisons stored in the cells of certain species of cyanobacteria (Health Canada, 2014). Very few cyanobacterial toxins have actually been isolated and characterized to date. One group of toxins produced and released by cyanobacteria are called *microcystins* because they were isolated from a cyanobacterium called *Microcystis aeruginosa*. Microcystins are the most common of the cyanobacterial toxins found in water, as well as being the ones most often responsible for poisoning animals and humans who come into contact with toxic blooms (Health Canada, 2014). Microcystins are extremely stable in water because of their chemical structure, which means they can survive in both warm and cold water and can tolerate radical changes in water chemistry, including pH. So far, scientists have found about 50 different kinds of microcystins. One of them, microcystin-LR, appears to be one of the microcystins most commonly found in water supplies around the world. For this reason, most research in this area has focused on this particular toxin.

Microcystins have been described and detected in several cyanobacteria genera. These include *Anabaena* (Krishnamurthy *et al.*, 1986), *Microcystis* (Botes *et al.*, 1984), *Oscillatoria* (Brittain *et al.*, 2000) and *Planktothrix* (Meriluoto *et al.*, 1989). Worldwide, the nearly all cyanotoxin encountered in fresh and brackish waters are the cyclic peptides known as microcystin (McElhiney & Lawton, 2005).