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Potential bioaccumulation of cyanobacterial toxins by macrophytes *Ludwigia Adscendens* and *Amaranthus Hybridus*: Application in bioremediation of surface waters

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ABSTRACT

The growth in human population and climate change have led to an increase in water temperatures and the load of nutrients reaching surface waters hence intensifying the proliferation of harmful cyanobacterial blooms. Cyanobacterial toxins (cyanotoxins) have thus become compounds of importance in the past decades. Among these toxins are microcystins (MCs) and cylindrospermopsin (CYN) which are considered to present the greatest risk to human health, since they have both acute and chronic effects, and occur most frequently in fresh water systems. Conventional water treatment technologies are known to be ineffective in removing cyanotoxins and thus carbon filtration and other forms of tertiary treatment are required to remove these toxins in solution. These options generally raise the cost of water treatment and might not be suitable for rural water supplies.

This work focused on assessing the bioaccumulation potential of two aquatic plant species namely *Ludwigia adscendens* and *Amaranthus hybridus* for the in-situ remediation of algal toxins in raw freshwater using locally relevant concentrations of MCs and CYN. Raw lake water samples were collected from Hartbeesport Dam in the North West Province of South Africa and physico-chemically characterised before use in the laboratory experiments. The two plant species were collected from the Luvuvhu River catchment and acclimatised to the laboratory conditions prior to the experiments. The experiments were conducted in two phases; first beaker static separate plant experiments then later a recirculating (pilot pond) system was run.

In the first phase, plant biomass ranging between 3.27 to 9.40 grams in a litre of sample water was exposed to contaminated water for a period of 14 days. In the second phase the removal efficiency of *L.adscendens* was assessed by exposing a plant biomass of 5.62g/L to 50 L of raw dam water for a period of 5 days. Controls (i.e. with no plant material) were run concurrently with the treatments, under the same laboratory conditions. Samples were collected at predetermined intervals during the course of the experiments and these were concentrated using HLB cartridges and the toxins were quantified using HPLC-PDA. An ELISA method was used to analyse for MCs in the plant material.

The plants were exposed to concentrations of 5.385-7.641 $\mu g\ mL^{-1}$ for MC-LR; 8.905 $\mu g\ mL^{-1}$ for MC-RR) and CYN was below the detectable limit in all the experiments. Except in beaker experiments where the plants were exposed to artificial water dosed with crude

cyanobacterial extracts from bloom material, the treatments and their respective controls did not show any significant difference in percentage removals for the toxins when tested with a one-way ANOVA at $p=0.05$, thus showing that the plants were unable to significantly remove the toxins from solution under those conditions. A further analysis into the plant tissue however indicated that the plants were taking up the cyanotoxins but probably at a much lower rate than could be detected in the surrounding medium.