CARUS WATER



Removal of Microcystin by Permanganate Treatment of HAB-Impacted Reservoir Water

BACKGROUND

Recently, a significant blue-green algae bloom occurred in Milford Reservoir (Kansas), a raw water source for many down-stream utilities on the Kansas River. A permanganate treatment study was conducted to show that permanganate lessens the adverse impact of the bloom, improving water quality. In particular, the test shows that permanganate controls the cyanotoxin microcystin.

Microcystin-LR was measured before and after permanganate addition, showing that permanganate removes extracellular cyanotoxin in natural waters and that typical water treatment permanganate dosages do not lyse algae cells.

SUMMARY

Milford Reservoir water had an average total microcystin concentration of 5.7 ppb and an average extracellular microcystin-LR concentration of 0.29 ppb.

At permanganate test dosages of 0.75 mg/L, 1.5 mg/L and 3.0 mg/L, extracellular microcystin is lowered by 30-92%.

Permanganate, at the 3.0 mg/L amount, drops the extracellular microcystin concentration to less than the detection limit.

At all permanganate dosages tested, there was no apparent algal cell lysis or leakage since there was no change in the intracellular microcystin concentrations.

PROCEDURES

In a series of jar tests, Milford Reservoir water was treated with permanganate using 0.75, 1.5, and 3.0 mg/L $KMnO_4$ dosages. Both extracellular and total microcystin were measured at 30, 60, and 120 minutes, post $KMnO_4$ addition. These conditions were chosen to reflect typical permanganate dosages and contact times for traditional surface water treatment plants.

An ELISA test method was used to determine the amount of microcystin in the samples. Intracellular microcystin was calculated by subtracting the extracellular amount from the total microcystin concentration. A "zero" minute sample was always collected before permanganate was added to the jar to determine the starting microcystin level for each permanganate dose.

TEST RESULTS AND ANALYSIS

The data presented in Graph 1 shows that intracellular microcystin concentrations remain unchanged during the 120 minute jar test. The variability of the test results reflects the expected precision of the ELISA test method.

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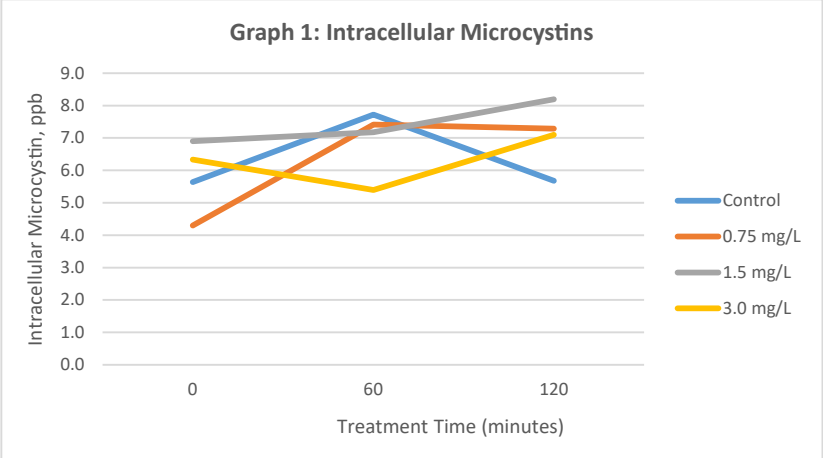
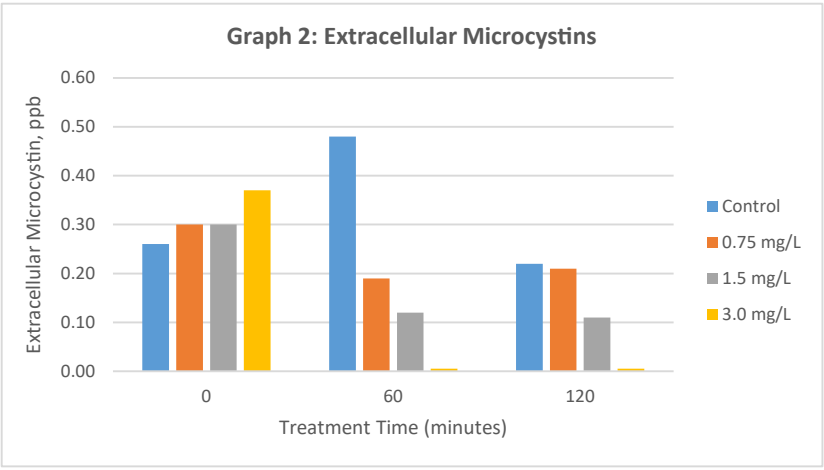
If cell destruction or leakage was occurring due to permanganate oxidation, the intracellular values would decline with time and increasing permanganate dosage.



Graph 2 shows the extracellular microcystin concentrations during the jar test. Extracellular microcystin concentrations decline with increasing permanganate dosage and increasing reaction time. A 3 mg/L $KMnO_4$ dose at 60 minutes has removed the microcystin to less than the detection limit. There is less toxin removal with the 0.75 mg/L $KMnO_4$ dosage, but this is expected because the water background demand consumed all of it in less than 60 minutes. This same effect can be seen for the 1.5 mg/L $KMnO_4$ dose beyond 60 minutes.



CONCLUSIONS

The results of this jar test study are similar to the findings of other water treatment field and laboratory research. Using typical dosages and contact times, permanganate pre-oxidation removes extracellular cyanotoxin without the loss of intracellular cyanotoxin. At all doses tested, there was no increase in extracellular toxin, even after the permanganate had fully reacted. This indicates that permanganate oxidation is effective and did not result in cell lysis.

Permanganate products are not registered as a pesticide under the Federal Insecticide, Fungicide and Rodenticide Act administered by U.S. EPA or similar state laws. Use as a pesticide is not government approved.

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