CHAPTER 3

Efficacy of Potassium Permanganate to Reduce *Prymnesium parvum* Ichthyotoxicity

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Abstract

Highly toxic water containing *Prymnesium parvum* and associated ichthyotoxin was subjected to potassium permanganate treatments to determine the minimum effective concentration required to detoxify the toxin and allow fish survival. Potassium permanganate concentrations of 0-6 mg/L were tested at 2-mg/L intervals. Bioassays using fathead minnows were performed shortly after the toxic water was treated and test fish were observed for mortality at 15-minute intervals for 2 hours. All fish died in the control (0 mg/L $KMnO_4$) and 2-mg/L $KMnO_4$ treatments within 30 min and 90 min, respectively, while no fish died in the 4- or 6-mg/L potassium permanganate treatments. Because the potassium permanganate demand of the toxic water was 2 mg/L, it was concluded that potassium permanganate mitigated the ichthyotoxin at a minimum residual concentration of 2 mg/L (i.e., concentration above the potassium permanganate demand). Further research involving better resolution of potassium permanganate treatment concentrations would be needed to define the true minimum effective concentration of potassium permanganate that would detoxify the ichthyotoxin.

Introduction

The presence of *Prymnesium parvum* and the production of toxins (collectively called prymnesins) by this alga in fish rearing ponds at the Dundee State Fish Hatchery (DSFH) have resulted in significant fish mortalities. Effective control strategies must be implemented to make fish production possible. Control methods may target the alga or the toxin (Shilo and Shilo 1953) although preventing toxin accumulation by controlling *P. parvum* blooms appears to be the most popular strategy. This study targeted the ichthyotoxin to determine if and at what concentration potassium permanganate could neutralize the ichthyotoxin and consequently prevent fish mortality. Potassium permanganate has the potential to detoxify the ichthyotoxin due to its oxidative properties which are reported to detoxify fish toxins such as rotenone and antimycin (Lawrence 1956; Marking and Bills 1975).

Potassium permanganate is a widely used chemical. It oxidizes organic matter, reduces inorganic substances, and has been used as an antimicrobial to treat several fish diseases. However, potassium permanganate is toxic to phytoplankton, fish, and bacteria at relatively low concentrations (Boyd 1990). The amount of permanganate that quickly is reduced to manganese dioxide in water is called the potassium permanganate demand of the water (Boyd 1990) making the effectiveness of treatments strongly influenced by water quality characteristics and efficient use of potassium permanganate requires determination of

the potassium permanganate demand. The specific objective of this study was to determine the minimum effective concentration of potassium permanganate above the ambient demand required to detoxify *P. parvum* ichthyotoxin and allow fish survival for at least 2 h.

Materials and Methods

In order to calculate effective treatment rates, potassium permanganate demand was determined according to Boyd (1979). Dose titration for ichthyotoxin detoxification was then conducted using 12 1.9-L glass jars. Each jar was filled with 1 L of water obtained from a pond known to contain *P. parvum* density of 86,000 cells/mL and be highly toxic to fish (i.e., a bioassay resulted in complete mortality of all test fish in whole pond water without the co-factor, Appendix B). Appropriate volumes of a 1000-mg/L potassium permanganate stock solution were added to the test containers to achieve 0, 2, 4, or 6 mg/L concentrations. These concentrations were selected based partly on the potassium permanganate demand of the water and the recommendation of Tucker (1989) and each treatment concentration was in triplicate. Four or five test fish were placed into each container shortly after the treatments were applied to the test water. The fish were observed every 15 minutes for 2 hours and the total number of dead in each container was recorded. The water temperature was 27.8^{o}C and both the temperature and duration of the test were based on the toxicity bioassay protocol in Appendix B

Results and Discussion

The potassium permanganate demand of the water was determined to be 2 mg/L. In the detoxification test, fish mortality was 100% for the 2-mg/L potassium permanganate treatment and 0% for the 4-mg/L or 6-mg/L potassium permanganate treatment (Table 1). Because the potassium permanganate demand of the test water was 2 mg/L, the minimum residual concentration of potassium permanganate that detoxified the water and allowed test fish survival was 2 mg/L. These results suggest that a minimum potassium permanganate concentration of 2 mg/L above the permanganate demand may be used for at least a short-term relief of ichthyotoxicity to allow culturists time to implement measures that eradicate *P. parvum* and thus prevent further production of ichthyotoxin. Future research should address the long-term effects of potassium permanganate on the ichthyotoxin and *P. parvum* populations. In this study, a residual concentration of 2 mg/L of potassium permanganate was the lowest concentration tested. Residual concentrations < 2 mg/L should be tested to define the true minimum effective concentration required to detoxify the ichthyotoxin.

TABLE 1.—Bioassay results for toxic pond water treated with various concentrations of potassium permanganate or not treated (control) to neutralize the toxin produced by *Prymnesium parvum*.

Treatment	Replicate	Fish per jar	Percent mortality	Comments
Control (0 mg/L)	1	4	100	All dead within 30 minutes
	2	4	100	All dead within 30 minutes
	3	4	100	All dead within 30 minutes
2 mg/L	1	4	100	All dead within 90 minutes
	2	4	100	All dead within 90 minutes
	3	4	100	All dead within 90 minutes
4 mg/L	1	4	0	
	2	4	0	
	3	4	0	
6 mg/L	1	4	0	
	2	4	0	
	3	4	0	