Sodium Carbonate Peroxyhydrate as a Potential Algicide

P. CHARLES QUIMBY, JR., STRATFORD H. KAY, AND JOHNNY D. OUZTS

INTRODUCTION

The use of phytotoxic chemicals for algal control is extremely restricted and only a few compounds are registered for use. Copper sulfate pentahydrate (CuSO₄·5H₂O) and simazine (6-chloro-N,N′-diethyl-1,3,5-triazine-2,4-diamine) are the most extensively used algicides, and both are registered by the Environmental Protection Agency for use in food fish cultue (3).

A need exists for the development of additional safe and effective compounds as algicides which will not restrict the use of the water. Recent research has shown that H₂O₂ may provide for environmentally acceptable chemical management of submerged aquatic macrophytes and algae. Hydrilla [Hydrilla verticillata (L.f.) Royle # HYLLL] and coontail (Ceratophyllum demersum L. # CEYDE) were sensitive to H₂O₂, but alligatorweed [Alternanthera philoxeroides (Mart.) Griseb. # ALRP] and waterhyacinth [Eichhornia crassipes (Mart.) Solms # EICCR] were not damaged at similar exposure levels (11). Guppies (Lebistes reticulatus) exposed to H₂O₂ in the presence of coontail were not killed at concentrations toxic to the plants. Combining H₂O₂ with low levels of copper enhanced both efficacy and the rate at which acceptable (>80%) control of coontail was attained (6, 8).

As early as 1969, H₂O₂ was recommended as a treatment for control of slimes and algae in cooling towers (13). Hydrogen peroxide was reported to have potential as an algicide for use with aluminum alloy water systems. Water quality and oxygen conditions were improved by H₂O₂ in a lake without creating long-term environmental disturbances (1). The H₂O₂ caused a sharp decrease in chlorophyll a and reduced the total volume of phytoplankton in the lake.

Kay, et al. (7) evaluated H₂O₂ as an algicide for potential use in commercial aquaculture. Concentrations of 0.5, 0.2, and 0.05 mM H₂O₂ reduced chlorophyll concentrations to ≤5 percent of those for the untreated controls for Anakistrodesmus sp. (Chlorophyta: chlorococcales), Raphidiaspis sp. (Cyanophyta: oscillariales), and Microcystis sp. (Cyanophyta: chroococcales), respectively, by 24 h after treatment in the laboratory. Barrion and Feuille (2) reported that H₂O₂ was more toxic to a cyanophyte (Oscillatoria rubescens DeCandolle) than to a chlorophyte (Pandorina morum Bory). Fowler and Barrett (4) have reported on H₂O₂ as an algicide for control of filamentous species.

Although dilute H₂O₂ has apparent potential as an algicide, concentrated H₂O₂ liquid can be hazardous to applicators. Sodium carbonate peroxycarbonate (SCP) has been formulated into granules which decompose upon contact with water into H₂O₂ and sodium carbonate. These granules may provide the safety and ease of application to make H₂O₂ practical for control of algae. The objective of this study was to compare granular and liquid forms of H₂O₂ as to efficacy in the laboratory against blue-green algae and their safety to fingerling catfish. This report follows an abstract published previously (12) and Ouizts et al. (10) have reported SCP to be an effective algicide for sewage lagoons.

MATERIALS AND METHODS

Suspensions (100-ml aliquots) of Anakistrodesmus sp. and Raphidiaspis sp. algae in a commercial medium were treated in 250-ml Erlenmeyer flasks, five flasks or replicates per treatment, with SCP or H₂O₂ at equivalent dosages of 10 mg/L of H₂O₂ and held in an environmental control chamber at 25 ± 2°C with a 12-h photoperiod at 450 μE·m⁻²·s⁻¹ photosynthetic photon flux density. According to Boyd (3), "chlorophyll a determination on the particular matter which may be removed from a water sample by filtration provides a good estimate of phytoplankton density." Therefore, chlorophyll a levels of treated and untreated (control) samples were determined spectrophotometrically at 665 nm 24 h after treatment to estimate relative algal densities. The chlorophyll was extracted...
with 90% methanol for 24 h at 4°C (9) and the suspensions were filtered through a 0.45 µm filter.7 The chlorophyll-bleaching efficacies of SCP and H₂O₂ were estimated by comparing the absorbance of the methanol extracts with a standard curve prepared from a commercial source of chlorophyll a dissolved in methanol. The experiment was repeated.

One hundred fifty 10- to 15-cm channel catfish fingerlings were divided and 15 fingerlings placed in each of ten 38-L aquaria each containing 30 L aged tap water which was continuously aerated; and either SCP or H₂O₂ was added at ten equivalent oxidant concentrations (as H₂O₂) varying from 0 to 50 mg oxidant/L. The water was changed and the oxidant renewed daily for 96 h; dead fish were removed as detected. The experiment was conducted twice. The 96-h LC50 and LC01 values were estimated by probit analysis (6).

RESULTS AND DISCUSSION

The SCP granules and liquid H₂O₂, at equivalent concentrations of 10 mg/L as H₂O₂, were similar in their bleaching action against each species of blue-green algae after 24 h (Table 1). The apparent differences in bleaching between the two algal species could not be determined statistically because initial cell densities may have differed. Nevertheless, the chlorophyll concentrations were similar; thus Raphidiopsis sp. appeared to be more sensitive to the oxidants than Anabaena sp. By 24 h after treatment with the oxidants, Raphidiopsis sp. had lost >2 times more chlorophyll than had Anabaena sp. The levels of chlorophyll in the untreated controls of both were similar at 1.6 and 1.7 mg/L, respectively. The results described here are similar to those found earlier for H₂O₂ against Raphidiopsis sp. (6).

The SCP granules and liquid H₂O₂ when applied at equivalent oxidizing strengths, were nearly equal in toxicity to catfish fingerlings 10 to 15 cm long. The 96-h LC50's (about 30 ± 3 mg/L) for H₂O₂ and SCP in this test were very similar to a previous trial (9) when the LC50 for H₂O₂was 36 mg/L for similar-sized channel catfish. The 96-h lower fiducial limits of the LC01s of the SCP granules and the liquid H₂O₂ were 10.5 and 15.6 mg/L, respectively. In the field, 3 mg H₂O₂/L will bleach algae satisfactorily (7). Therefore, at least a three-fold margin of safety (based upon the lower fiducial limit of the 96-h LC01) would exist for catfish if a 3 mg H₂O₂/L treatment were used for control of algae in a field pond.

The SCP granules are effective as an algicide against blue-green algae, and the granules compare favorably with equivalent oxidizing strengths of liquid H₂O₂ in safety to catfish fingerlings. Further toxicity tests would verify the safety of H₂O₂ to fish and field testing should be done to determine effects of H₂O₂ on other algal species.

### Table 1. Loss of Chlorophyll from Anabaena sp. and Raphidiopsis sp. 24 h after Treatment with Sodium Carbonate Peroxhydrate (SCP) or H₂O₂ (as 10 mg/L H₂O₂) in the Growth Chamber at 450 µE-m⁻²-s⁻¹.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Chlorophyll</th>
<th>Reduction</th>
<th>Chlorophyll</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mg/L)</td>
<td>(%)</td>
<td>(mg/L)</td>
<td>(%)</td>
</tr>
<tr>
<td>Control</td>
<td>1.69</td>
<td>—</td>
<td>1.57</td>
<td>—</td>
</tr>
<tr>
<td>SCP</td>
<td>1.17</td>
<td>31.0 a</td>
<td>0.43</td>
<td>72.6 a</td>
</tr>
<tr>
<td>H₂O₂</td>
<td>1.17</td>
<td>31.0 a</td>
<td>0.32</td>
<td>79.8 a</td>
</tr>
</tbody>
</table>

*Means within the column followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test. Each value is the mean of 3 replications with data from duplicate experiments combined.

ACKNOWLEDGMENTS

The authors thank Mrs. Kathy Bachman and Mr. Van Poindexter for excellent technical assistance. Mr. Emmett Findley provided the catfish fingerlings. Interox America provided the sodium carbonate peroxhydrate granules.

LITERATURE CITED


---