Phytochemistry, Vol. 22, No. 11, p. 2613, 1983.
Printed in Great Britain.

0031-9422/83 $3.00+0.00

ELEMENTAL SULPHUR, A POSSIBLE ALLELOPATHIC COMPOUND FROM *CERATOPHYLLUM DEMERSUM**

S. WIUM-ANDERSEN,† U. ANTHONI‡ and G. HOUEN‡

†Freshwater Biological Laboratory, University of Copenhagen, Helsingørgade 51, DK-3400, Hillerød, Denmark; ‡Chemical Laboratory II, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen, Denmark

Key Word Index—*Ceratophyllum demersum*; Ceratophyllaceae; horn-wort; sulphur; allelopathy.

Abstract—Elemental sulphur has been isolated from the freshwater macrophyte *Ceratophyllum demersum*. Release of sulphur could explain the very low amount of epiphytes associated with this species.

INTRODUCTION

Due to interest in the chemical ecology of freshwater macrophytes, our attention was drawn to *Ceratophyllum demersum* L., since field observations have revealed a general lack of periphyton associated with this species. Allelopathic interaction between *C. demersum* and some blue green algae has been described [1], as well as the possible influence of *C. demersum* on other macrophytes [2]. The inhibitory effect of elemental sulphur on both phytoplankton and epiphytes has been demonstrated [3]. We now report the isolation of elemental sulphur from *C. demersum* as a possible photosynthesis-inhibiting agent.

RESULTS AND DISCUSSION

Elemental sulphur has recently been implicated in allelopathic relationships, since it has been isolated from the red alga *Erythrophyllum delesseroides* [4] and from *Ceramium rubrum* [5] and shown to possess algicidal, fungicidal and bactericidal properties.

We now propose that sulphur could be released from *C. demersum* as an allelopathic agent, accounting for the very low epiphyte growth on this macrophyte. It is conceivable that *C. demersum* contains a labile sulphur compound that readily releases sulphur. Interestingly, the crude extract gives off sulphur on TLC silica gel plates, but not on TLC cellulose plates. So we have, therefore only indirect evidence for the existence of this compound. Although currently unverified, the above suggestion is compatible with the increased activity found upon storing a sample of the crude petroleum extract.

Gough and Gough [6] found that *C. demersum* harbors densities of epiphytes several orders of magnitude less than does *Utricularia purpurea*, the latter having an almost identical morphology. This difference may be the result of sulphur release from *C. demersum* suppressing the periphytic community.

EXPERIMENTAL

Ceratophyllum demersum was collected from a pond near Svanholm in Odsherred, Zealand, Denmark. The macrophyte flora was completely dominated by this species.

Petroleum extraction of lyophilized *C. demersum* (950 g dry wt) gave 855 mg of a yellow substance. A concn of 4 mg/l of freshly prepared crude extract reduced photosynthesis to *ca* 85% in a culture of *Nitzschia palea* [3]. However, after two weeks at room temp. the same extract reduced photosynthesis to *ca* 75%. No further increase in activity was observed when the extracts were stored for a longer period. The active agent could be obtained by CC on either silica gel or neutral aluminium oxide, using hexane as solvent. The compound was identified as sulphur by elemental analysis and mass spectroscopy. The characteristic test for sulphur on TLC with triphenyltetrazoliumchloride as developing agent, was positive. The petroleum extract contained *ca* 1% elemental sulphur.

REFERENCES

1. Kogan, S. I. and Chinnova, G. A. (1972) *Hydrobiol. J. (USSR)* Translocation Ser. **8**, 14.
2. Philips, G. L., Eminson, D. and Moss, B. (1978) *Aquat. Botany* **4**, 103.
3. Wium-Andersen, S., Anthoni, U., Christophersen, C. and Houen, G. (1982) *Oikos* **39**, 187.
4. Izac, R., Stierle, D. and Sims, J. (1982) *Phytochemistry* **21**, 229.
5. Iakawa, M., Thomas, V. M., Buckley, L. J. and Uebel, J. J. (1973) *J. Phycol.* **9**, 302.
6. Gough, S. B. and Gough, L. (1981) *Limnol. Oceanogr.* **26**, 987.

*Part 3 in the series "Aquatic Allelopathy". For Part 2, see ref. [3].