Phytochemistry, Vol 23, No 11, pp 2513–2514, 1984
Printed in Great Britain

0031–9422/84 $3 00 + 0 00

TAXONOMIC SIGNIFICANCE OF CELLULOSIC CELL WALLS IN THE BANGIALES (RHODOPHYTA)

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(*Revised received* 12 *April* 1984)

Key Word Index—*Porphyra leucostricta*, *P umbilicalis*, Bangiaceae, cell walls, cellulose

Abstract—Cellulose has been characterized from isolated cell walls of the conchocelis phases of both *Porphyra umbilicalis* and *P leucostricta* Evidence for cellulose II (regenerated cellulose) in Schweitzer's reagent extracts was provided by X-ray powder analysis and paper chromatography of partial hydrolyzates The presence of cellulose in the conchocelis phase of species of *Porphyra* provides evidence for the continuity of cell wall composition within the Rhodophyta Adoption of a classification scheme incorporating consolidation of all red algal orders under the single class Rhodophyceae is proposed

INTRODUCTION

The red algal division Rhodophyta typically has been taxonomically divided into two classes, the Bangiophyceae and Florideophyceae [1] This separation was based primarily on morphological and reproductive characteristics that are now subject to question [2] Cell wall composition was also thought to differ among the two classes with members of the Florideophyceae having cellulose and those of the Bangiophyceae lacking this polymer [3] Gretz *et al* [4], however, reported a cellulosic cell wall for the conchocelis phase of the bangiophycean alga *Bangia atropurpurea* (= *B fuscopurpurea*), providing an exception to the previous generalization Mukai *et al* [5] subsequently reported the presence of cellulose in the conchocelis phase of *Porphyra tenera* We now describe the characterization of cellulose from the cell walls of the conchocelis phases of *P umbilicalis* and *P leucostricta* and discuss the taxonomic significance of this finding

RESULTS AND DISCUSSION

X-ray powder analysis of the cellulose fraction extracted from isolated cell walls of the conchocelis phases of *P umbilicalis* and *P leucostricta* yielded cellulose II (regenerated cellulose) diagrams (Table 1) The lattice spacings agree with those previously reported for cellulose II [6] Partial hydrolysis of this fraction and PC analysis gave only spots corresponding to glucose, cellobiose and cellotriose (Table 2) Plots of the negative logarithm of the chromatographic mobility relative to glucose as a function of the assumed degree of polymerization were linear, indicating a polymer homologous series in all cases [7] These analyses confirm the cellulosic nature of the cell walls of the conchocelis phase of *P umbilicalis* and *P leucostricta*

Cellulosic cell walls have been reported, or inferred, for a number of genera of the Florideophyceae based on X-ray analysis, cytochemical staining and solubility considerations [3, 8] The confirmation of cellulose in life cycle alternates of genera of bangiophycean algae provides evidence of the continuity in cell wall composition between the two classes of red algae

Based on the lack of a biochemical or morphological basis for continued use of the class designations Bangiophyceae and Florideophyceae (or subclasses Bangiophycidae and Florideophycidae), we support the systematic treatment of Taylor [9] and Lee [10] in which all red algal orders were consolidated under the single class Rhodophyceae without subclass designations

Table 1 Lattice plane spacings (nm) of cellulose II (regenerated cellulose) from *Porphyra* conchocelis phase cell walls compared with an Avicel* standard and reported values

P leucostricta	*P umbilicalis*	Avicel	Reported values†
0 735	0 735	0 735	0 735
0 443	0 443	0 443	0 442
0 407	0 407	0 407	0 403
0 312	0 312	0 312	0 314
0 258	0 258	0 258	0 258
0 221	0 221	0 221	0 221

*Commercially available microcrystalline cellulose
†Ref [6]

EXPERIMENTAL

Unialgal cultures of the conchocelis phases of *Porphyra umbilicalis* (L) J Ag and *P leucostricta* Thur were obtained from the Culture Collection of Algae, University of Texas, Austin, U S A (LB 1517 and LB 1415, respectively) Algae were fragmented and grown in sterile medium described by Gretz *et al* [11] maintained at 15° on an 18/6 LD cycle (approx 2500 lx) for

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Table 2 Chromatographic mobilities (R_{Glc}) of hydrolysis products of cellulose isolated from *Porphyra* conchocelis phase walls compared with an Avicel* standard

Hydrolysis product	R_{Glc} solvent A†		solvent B‡	
	standard	*P leucostricta*	standard	*P leucostricta*
D-glucose	1 00	1 00	1 00	1 00
Cellobiose	0 47	0 47	0 50	0 50
Cellotriose	0 10	0 10	0 11	0 12
	standard	*P umbilicalis*	standard	*P umbilicalis*
D-glucose	1 00	1 00	1 00	1 00
Cellobiose	0 48	0 47	0 50	0 50
Cellotriose	0 10	0 10	0 13	0 13

*Commercially available microcrystalline cellulose
†*n*-BuOH–EtOH–H_2O (13 8 4)
‡*n*-PrOH–EtOAc–H_2O (7 1 2)

60 days followed by incubation in the dark for 8 days Cell walls were obtained and a cellulose fraction isolated following the methods of Gretz *et al* [4] X-ray powder diagrams of regenerated cellulose were prepared and interplanar spacings (d) were calculated from Bragg's equation [4] Partial hydrolyzates (1 hr at 22° in fuming HCl) of cellulose were analyzed by PC as described by Bertke and Aronson [12]

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