Chemical and structural similarities in wall polysaccharides of some *Penicillium*, *Eupenicillium* and *Aspergillus* species

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Received 30 September 1991
Revision received and accepted 18 October 1991

Key words: *Penicillium*; *Eupenicillium*; *Aspergillus*; Cell wall polysaccharides; β-(1-5)-Galactofuran; α-(1-3)-Glucan

1. SUMMARY

Various fractions were extracted from cell-wall material of *Eupenicillium crustaceum*, *Penicillium brevi-compactum*, *P. decumbens*, *Aspergillus flavipes* and *A. ochraceus*. The most characteristic fractions, which may have chemotaxonomic relevance, were FII, an α-(1-3)-glucan (alkali-soluble, water-insoluble), which amounted to 16.2–32.5% of the cell-wall material, and FIS (alkali and water-soluble) which represented 2.5–6.2% of the cell-wall material and was identified as a β-(1-5) galactan. ¹³C-NMR spectra of the FIS fractions showed the same pattern for all the fungal species, characteristic of β-(1-5) linked galactofuranose.

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2. INTRODUCTION

In *Penicillium*, at least two types of cell walls exist: Type A, where the 1 M NaOH-soluble material is an α-(1-3)-glucan; and Type B, where the material extracted with 1 M NaOH is a β-glucogalactan [1]. These types of cell wall have also been found in *Eupenicillium* [2] and *Talaromyces* species [3]. In another penicilloid fungus, *Gliocladium viride*, the FII fraction is a β-glucan while FIS is a gala-manno-glucan [4]. The cell wall of *Eupenicillium crustaceum* belongs to the A group, and the one of *Talaromyces flavus* to type B [5]. Although there is some information on the constituent sugars of the cell wall of *Aspergillus*, little is known about the composition and structure of the polymers of the wall. The α-glucans from *A. niger* have been investigated [6,7]. A chitin-associated α-glucan has also been characterized from the cell walls of *A. niger* [8]. In *A.*
nidalans the α-(1-3)-glucan and the β-(1-3)-glucan of the glucan-chitin complex have been studied [9,10]. A galacto-mannan, with side chains of (1-5)-linked-β-d-galactofuranose attached to the mannann, was extracted from hyphae of A. niger [11].

In this work we have isolated and characterized a β-(1-5)-galactofuran (fraction F1S) found in all the species investigated. This polysaccharide and the proportion and sugar content of the other fractions show a similar wall composition in the fungi.

3. MATERIALS AND METHODS

3.2. Wall material preparation and fractionation

The preparation of wall material was performed as previously described [4]. The fractionation procedure is summarized in Fig. 1.

3.3. Chemical analysis

Neutral sugars were released by hydrolysis with 2 M H₂SO₄ at 100°C for 5 h and then converted into their corresponding alditol acetates [12]. Identification and quantification were carried out by gas-liquid chromatography (GLC) using 3% SP-2340 on 100-120 Supelcoport as previously described [13].

3.4. ¹³C-NMR analysis

¹³C-NMR spectra from F1S fractions were obtained in D₂O solutions at 70°C in a Varian XL-300 spectrometer (¹³C, 75 MHz). FIS (20 mg) were dissolved in 2 ml of D₂O and centrifuged at 10000 × g for 15 min to remove insoluble material.

3.5. Infra-red spectra

Infra-red spectra were obtained by the KBr technique on a Perkin-Elmer 1420 infra-red spectrophotometer [14].

4. RESULTS AND DISCUSSION

The proportions of the fractions obtained from the cell-wall material of the different fungi were: F1S (2.5–6.2%); F11 (16.2–32.5%); F3 (1.0–4.3%) and F4 (43.1–59.8%).
The monosaccharide composition of FIS and FII fractions is presented in Table 1. In FIS the most abundant sugar was galactose, with lower proportions of mannose and glucose. In *P. brevicompactum* the amount of glucose reached 22%. Since in the $^{13}$C-NMR spectrum (Fig. 2c) only signals of $\beta$-(1-5) linked galactofuranose appeared, we assume that FIS from *P. brevicompactum* was contaminated with a water-insoluble glucan which was eliminated by centrifugation during sample preparation for NMR. The galactose was released when hydrolyzed with 0.05 M H$_2$SO$_4$ which indicated that the monomer was in the furanose form. The hydrolysis of the FII fractions gave glucose and only traces of mannose and galactose.

The F3 fraction was a glucoxylan, and the F4 fraction was a glucan-chitin complex. Both the F3 and F4 fractions have been described in other fungi [1,2]. The $^{13}$C-NMR spectra of the FIS fractions are shown in Fig. 2. The spectra are identical, and characteristic of a polymer of $\beta$-(1-5)-galactofuranose. The chemical shifts agree with those reported by Gorin and Mazurek [15] for a $\beta$-(1-5)-galactofuranose tetrasaccharide.

The IR spectra of the different fractions of *P. decumbens* are presented in Fig. 3. The spectra

![Fig. 2. $^{13}$C-NMR spectra of FIS fractions of (A) *E. crustaceum* (B) *P. decumbens* (C) *P. brevicompactum* (D) *A. ochraceus* and (E) *A. flavigipes* obtained in D$_2$O at 70°C.](image)

### Table 1

Percentage of the neutral sugars (as alditol acetates) detected by GLC of FIS and FII fractions of *E. crustaceum*, *P. brevicompactum*, *P. decumbens*, *A. flavigipes* and *A. ochraceus*, hydrolyzed with 2 M H$_2$SO$_4$

<table>
<thead>
<tr>
<th></th>
<th>FIS</th>
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<th>FII</th>
<th></th>
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<td>Galactose</td>
<td>Glucose</td>
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<td>22.0</td>
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<tr>
<td><em>Penicillium decumbens</em></td>
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<td>85.6</td>
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<tr>
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<td>7.7</td>
<td>41.7</td>
<td>6.4</td>
</tr>
<tr>
<td><em>Aspergillus ochraceus</em></td>
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<td>5.7</td>
<td>52.5</td>
<td>6.4</td>
</tr>
</tbody>
</table>

All values are averages of three determinations.
Fig. 3. Infrared spectra of the cell wall fractions of *P. decumbens.*

obtained from similar fractions of the other fungi were identical. The bands at 870 and 812 cm⁻¹ in the F1S fraction were characteristic of α-galactofuran; the spectrum of F1I showed bands at 850 and 930 cm⁻¹ typically attributed to α-glucans. Fraction F4 showed absorption bands at 1550 and 1650 cm⁻¹ characteristic of the -NH-CO- groups of chitin, and the 890 cm⁻¹ band from β-glucans [16].

The alkali-soluble material (F1) from certain species of *Penicillium* [1] and *Eupenicillium* [2,5] has been characterized as an α-(1-3) glucan containing low proportions of mannose and galactose. In other species of *Penicillium* [11,17] and in species of *Talaromyces* [5,18] this fraction contained β-glucogalactans with galactofuranose residues (1-2) and (1-5) linked.

β-(1-5)-Galactofuranose polysaccharides have not been described hitherto in fungal cell walls. From our results it seems that this polysaccharide is found in cell walls that also contain α-(1-3)-glucan. It may be concluded that there is a closer relationship among the species investigated than with other species of *Penicillium* [1] or *Eupenicillium* [2] which lack α-(1-3)-glucan and β-(1-5)-galactofuran.

ACKNOWLEDGEMENTS

This work was supported by Grant PB 87/0243 from Dirección General de Investigación Científica y Técnica.

REFERENCES


