CARBOHYDRATE METABOLISM IN THE SHOOTS OF BAMBOO *LELEBA OLDHAMI*

IV. A Structural Study of Cell Wall Polysaccharides*

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Introduction

A preliminary work on the polysaccharides of the shoots of bamboo *Leleba oldhami* has revealed that there are absent in the plant starches and pectic substances, both soluble, at least in part, in boiling water. The lack of these polysaccharides, especially the intercellular pectic substances, may have some bearings on the remarkable cooking quality of the vegetable, i. e. no loss of firmness and crispness after prolonged boiling in water.

The very intimate association of hemicelluloses with cellulose in plant cell walls has been studied (Dennis and Preston, 1961), however, the nature of chemical forces holding the different polysaccharides together to form cell wall fibrils is still not known. It might be this relationship among polysaccharides that largely determines the texture of plant tissue. The hemicelluloses of plant cell walls have been extensively studied in wood, fibrous plants and grains (Aspinal, 1959), but to only a very limited extent in fruits and vegetables.

The rapidly growing shoot of *Leleba oldhami* is very active in hemicellulose synthesis (Su, unpublished), and may serve as a good system for the study of biosynthesis of complex hemicellulose polysaccharides. This investigation has been done to provide information useful in forwarding the biosynthetic work in the future.

Experimental Procedures and Results

I. *General Analysis:*

General analysis on the edible portion of the vegetable was made according to the methods described in the Methods of Analysis, AOAC (1960), and

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the results are given in Table I. From these results, it is seen that the plant is rich in soluble saccharides. As we have reported previously (Su, 1965; Su and Chou, 1965), the 70% ethanol soluble matter of bamboo shoots consists, in the greatest part, of soluble saccharides, and, in a less significant amount, of glyco- and phospholipids. If the amount of 70% ethanol soluble saccharide, which is obtained roughly by subtracting fat from total 70% ethanol soluble matter, is substracted from the nitrogen-free extract, one can obtain the approximate estimate of hemicellulose in the plant. When this is added to crude fiber, the percentage of total cell wall polysaccharides in the plant, on moisture free basis, is obtained.

Table I. *General Analysis of Edible Bamboo Shoot Tissue (Presented on dry matter basis except moisture)*

Moisture	Protein	Fat	Fiber	Ash
93.08%	26.0%	3.18%	11.4%	10.3%
N-free extract	70% ethanol solubles		Cell wall polysaccharide*	
49.1%	45.3%		18.4%	

* See text for explanation.

II. *A General Survey of Bamboo Shoot Cell Wall Polysaccharides:*

The chemical nature of the bamboo shoot cell wall materials is studied by a solvent fractionation method as described in the following.

Fresh bamboo shoots harvested at the suburb of Taipei were bought from the local market. After shelling, the edible portion was homogenized with equal weight of 95% ethanol in a Waring blendor. The insoluble part was obtained by centrifugation, and then extracted successively with 50% ethanol and acetone to remove simple sugars, amino acids, lipids, etc. The residue thus obtained was subjected to the following extraction treatment.

Hot water extraction: A weighed sample was extracted with hot water (90–95°) for 3 hours with constant stirring. The extract was first strained through two layers of cheese cloth and then clarified by filtering through filter paper. To the filtrate, 7 volumes of 95% ethanol was added to precipitate the extracted polysaccharide. The white precipitate was separated by decantation followed by centrifugation, and dehydrated by solvent exchange with 95% ethanol and ether and finally dried in a vacuum desiccator over conc. sulfuric acid.

Extraction with 0.5% ammonium oxalate: The residue obtained from hot water extraction was extracted with 0.5% ammonium oxalate in a water bath

(85–95°) for 2 hours. A white precipitate was obtained when 5 volumes of 95% ethanol was added to the extract.

Extraction with alkali: The residue obtained from ammonium oxalate extraction was extracted successively with 2%, 4%, 8% and 18% NaOH. The extracted polysaccharide was precipited by adding 7 volumes of 95% ethanol to the clarified extract. The pinkish precipitates were washed with 1 *N* HCl in 80% ethanol until neutrality and then dried in the usual manner.

Hydrolysis and chromatographic analysis: The polysaccharide sample was hydrolyzed by heating with 1 *N* HCl at 110° for 4 hours. The hydrolysate was decolorized with charcoal and evaporated to dryness in a vacuum desiccator over KOH pellets. Monosaccharides in the hydrolysate were analyzed by descending paper chromatography. Two solvent systems, n-butanol-acetic acid-water, 4:1:1, and n-butanol-pyridine-water, 6:4:3, were used, The identification of sugar spots was made by cochromatography with authentic sugars. Aniline hydrogenphthalate (Partridge, 1949) and *p*-anisidine phosphate (Feingold *et al*, 1958) were used as the color reagents.

The results are shown in Table II.

Table II. *Results of Paper Chromatographic Analysis of Polysaccharide Fractions*

Sugars	Polysaccharide Fractions						
	Hot water	0.5% Am. oxalate	2% NaOH	4% NaOH	8% NaOH	18% NaOH	Residue
D-ribose	++	−	−	−	−	−	−
D-xylose	++	+	++	+++	++	++	+
L-arabinose	+++	+	++	++	++	++	+
D-glucose	++	+	++	++	++	++	+
D-galactose	++	+	++	++	++	+	+

Note: (1) The number of + signs indicates the relative strength of spots.
(2) No hexuronic acid and hexosamine could be detected in all fractions.

D-Ribose found in the water extract was considered to be the hydrolysis product of nucleic acids which were present in the sample; the hot water soluble material, when dissolved in dilute salt solution, showed a sharp UV absorption maximum at 255 mμ.

III. *Structural Analysis of Cell Wall Polysaccharides:*

Preparation of samples: The edible portion of fresh bamboo shoots was homogenized with 2 volumes of 95% ethanol in a Waring blendor and the final alcohol concentration was adjusted to 70%. After heating in a boiling water bath for 30 minutes, the extract was strained through two layers of cheese cloth which was treated with 2 *N* KOH before use. The residue collected on the cheese cloth was washed several times with 70% ethanol and dried in the

air at room temperature. To the dried residue, 100 times its weight of a 1 *N* KOH solution was added. The mixture was stirred at 30° for 24 hours to extract hemicelluloses. The extract was filtered through a sintered glass and the residue collected on the filter was washed several times with small aliquots of 1 *N* KOH. This residue was then washed with water until the washings showed no alkalinity, dehydrated by solvent exchange with 95% ethanol and ethyl ether and finally dried in a vacuum desiccator over conc. sulfuric acid. Part of the white powder thus obtained was extracted with 4 *N* KOH according to the procedure of 1 *N* KOH extraction as described above. The alkali extracts were neutralized with glacial acetic acid and the polysaccharides were precipitated by adding two volumes of 95% ethanol to the neutralized extracts. After standing at room temperature overnight, the polysaccharides were collected by decantation and centrifugation. The precipitates were washed several times with 80% ethanol and worked up in the usual manner.

Pentosan determination: Pentosan contents of the ethanol insoluble residues and various fractions of cell wall polysaccharide were determined according to the phloroglucide method described in the Methods of Analysis, AOAC. The results of pentosan determinations and the yields of the polysaccharide fractions are given in Table III.

Table III. *Pentosan Contents and Recovery of Some Polysaccharide Fractions*

Polysacch. fractions	Pentosan (%)	Yield (% of 70% EtOH residue)
70% EtOH extd. residue	19.2	—
1 *N* KOH soluble	33.0	14.3
4 *N* KOH soluble	46.5	12.4
4 *N* KOH extd. residue	16.1	22.3

Compositions of alkali soluble polysaccharides: The monosaccharide compositions of the samples were analyzed by a quantitative paper chromatographic technique as described in the following. One-tenth gram of the polysaccharide sample was sealed with 10 ml of 1 *N* sulfuric acid in a glass tube. After heating the mixture at 100° for 4 hours, the acid was neutralized with $BaCO_3$ and the white precipitate removed by centrifugation. The supernatant liquid was concentrated and applied on a large sheet of filter paper as a streak with two guiding spots on both ends. After developing the chromatogram with a mixture of ethylacetate-pyridine-water, 8:2:1, by descending method, the separated sugars were located by the aid of the guiding spots. The paper strips containing the sugars were cut and eluted with water and the eluates made

up to a definite volume. Since arabinose and xylose could be very well separated in the solvent system used, they were analyzed directly by an orcinol method (Mejbaum, 1939). However, a mixture of galactose and glucose could not be competely resolved in the solvent system, so that they were separated as a single fraction and the total hexose content determined by an anthrone method (Su and Ho, 1955), using as the standard a mixture of glucose and galactose the ratio of which was determined by an enzymic method as described in the following.

To 0.2 ml of the hexose eluate, 0.1 ml of 0.1 *M* sodium acetate buffer, pH 5.6, and 2 mg of a glucoxidase preparation (Nutritional Biochemicals Corp., Cleveland, Ohio) were added. The mixture was incubated at room temperature for 5 hours. To stop the reaction, 0.1 ml of 12.5% $ZnSO_4 \cdot 6H_2O$ and 0.3 ml of 1 *N* NaOH were added to the reaction mixture. After dilution to a definite volume and centrifugation, the galactose content of the hexose mixture was determined by Nelson's arsenomolybdate method (Somogyi, 1952). Glucose content can be estimated by measuring the difference in reducing power before and after glucose oxidation.

From these data, the component sugar ratios of the polysaccharides can be estimated. The results are shown in Table IV.

Table IV. *Mole Ratios of Component Sugars in 1 N and 4 N KOH Soluble Polysaccharides*

Polysaccharides	xyl : ara : glc : gal	glc/gal	xyl/ara
1 *N* KOH soluble	3.60 : 1 : 3.10 : 4.18	0.74	3.60
4 *N* KOH soluble	2.20 : 1.52 : 1 : 1.62	0.62	1.47

Abbreviation used: glc = glucose, gal = galactose, xyl = xylose, ara = arabinose

The nature of arabinosyl residues in the polysaccharide: A sample of 1 *N* KOH soluble polysaccharide (0.2 g) was refluxed with 20 ml of 0.05 *N* sulfuric acid. At certain intervals, 1 ml aliquots of the hydrolysate were removed. After adding one mg of rhamnose to each aliquot, the hydrolysates were neutralized with $BaCO_3$ and centrifuged. The clear supernatant liquids were analyzed by quantitative paper chromatographic technique as described above. In this determination, eluted pentoses were estimated by the orcinol method and rhamnose by the anthrone reaction. The solvent system used for separation was n-butanol-acetic acid-water, 4:1:1. From the data obtained, arabinose/rhamnose and xylose/rhamnose ratios were calculated and the results presented in Figure 1.

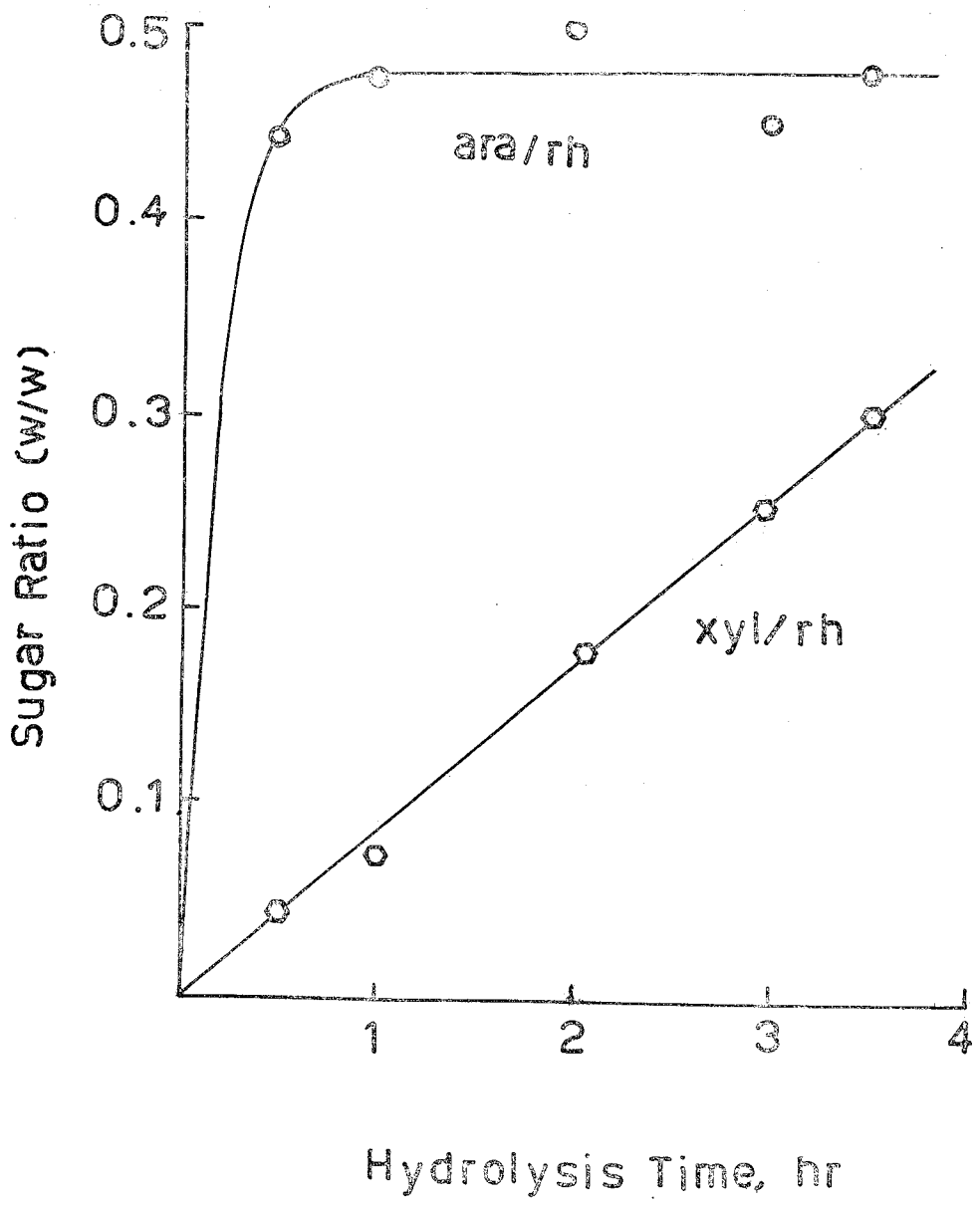

Fig. 1. Hydrolysis Kinetics of Xylosyl and Arabinosyl Residues*

Partial hydrolysis of 1 N KOH soluble polysaccharide: Ten mg of the polysaccharide was heated in a sealed tube with 3 ml of 0.05 *N*, 0.1 *N*, 0.3 *N*, 0.5 *N* or 1 *N* sulfuric acid at 100° for 1 hour. The reducing power of the hydrolysate was determined by Somogyi's method (1952). The empirical formulae $P = \frac{2}{i+1}$

* Rhamnose was added as the internal standard. The sugar ratios (pentose/rhamnose) thus represented the relative amount of pentose liberated.

was used to determine the condition under which the highest yield of disaccharide could be expected. In the formulae, P is the fraction of maximum reducing power and i is the degree of polymerization. The hydrolysis curve was presented in Figure 2. It is seen that, under the heating conditions, 0.2 N acid gave 60–70% of the maximum reducing power and the highest yield of disaccharides could be expected.

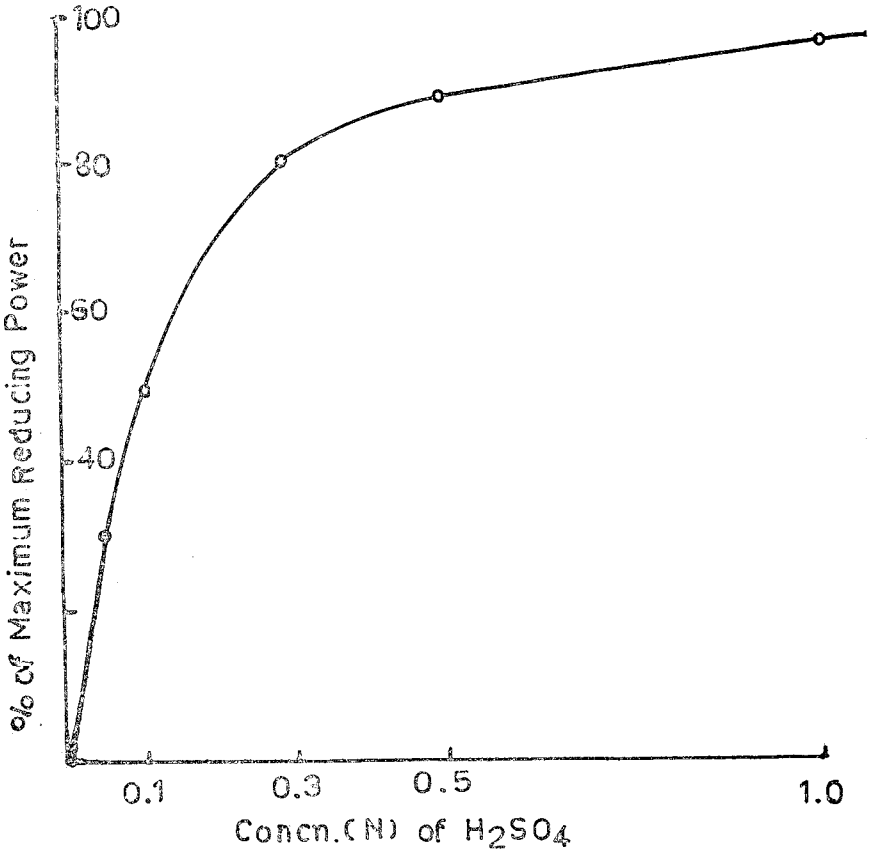

Fig. 2. Hydrolysis of the 1 N alkali soluble Polysaccharide with Acid. Heating Condition: 100°, one hour.

A sample of the polysaccharide (5 g) was partially hydrolyzed with 1,500 ml of 0.2 N sulfuric acid at 100° for one hour. After neutralization with solid $BaCO_3$ and centrifugation, the clear supernatant solution was concentrated under reduced pressure to a thin sirup. The hydrolysate was then fractionated on a charcoal-Celite column (Whistler and Durso, 1950) using ethanol-water system as the eluting solvent. The elution sequences were water, 5% ethanol, 15% ethanol and 50% ethanol. The elution pattern was traced by the phenol-sulfuric acid method (Dubois *et al*, 1956). The fractions eluted with 5% and 15% ethanol were further fractionated by repeated chromatography on paper

in the solvent systems n-butanol-acetic acid-water, 4:1:1, n-butanol-pyridine-water, 6:4:3 and ethylacetate-pyridine-water, 8:2:1. Although more than a dozen oligosaccharides could be isolated, only nine of them gave yields large enough to permit further analysis.

The separated oligosaccharides were characterized by the following techniques:

1. Component sugars were analyzed by paper chromatography after hydrolyzing the sample with 1 *N* HCl at 100° for 8 hours.

2. The reducing end of the oligosaccharide was determined in the following way. One mg of the sugar was dissolved in 2 ml of 0.05 *M* sodium acetate buffer, pH 4.7 and 50 mg of sodium borohydride was added. The mixture was stood at room temperature for 24 hours. At the end of the reaction, a little amount of Dowex-50 (H^+-form) was added to decompose the unreacted borohydride and also to remove sodium ions. After separation of the resin, the solution was evaporated to dryness. A small amount of methanol was added to the white residue and the methanolic solution was evaporated to dryness. The addition and evaporation of methanol was repeated until all the boric acid in the residue was removed as the volatile methyl borate. The reduced oligosaccharide was hydrolyzed by heating with 1 *N* HCl at 100° for 8 hours. Reducing sugars in the hydrolysate were analyzed by paper chromatography and the polyhydric alcohols by paper electrophoresis in 0.05 *M* sodium tetraborate (field strength, 40 v/cm). A benzidine-periodate dipping reagent was used to reveal polyhydric alcohol spots on the electrophoretogram (Gordon *et al*, 1956).

3. The constituent saccharides were estimated by orcinol (for pentoses) and anthrone (for hexoses) methods. When both pentose and hexose were present in the sample, the estimation of hexose was made by calibrating against a blank in which a known amount of pentose was included.

4. The reducing end was estimated by Nelson's arsenomolybdate method (Somogyi, 1952) using the reducing end saccharide as the standard. From these data, the degree of polymerization (DP) of the oligosaccharide was calculated.

5. The oligosaccharide with a DP of three or higher was partially hydrolyzed by heating with 0.2 *N* HCl at 100° for 30 minutes. The hydrolysate was fractionated on paper and the separated oligosaccharides further hydrolyzed to determine the component sugars.

6. Periodate consumption was measured by the method of Dixon and Lipkin (1954) with the modification that the concentrations of metaperiodate and the sugars used were 2,000 times higher and the spectrophotometric readings were taken after proper dilution of the reaction mixture.

The paper chromatographic mobilities of the oligosaccharides are summarized in Table V. The results of component sugar analysis are presented in Table VI. The partial hydrolysis data of oligosaccharides VI–IX are shown in Table VII. Since the composition and DP of the oligosaccharides are known,

Table V. *Paper Chromatographic Mobilities of Oligosaccharides Expressed in R_{xylose}*

Oligosaccharide	BuOH-Pyr-H_2O 6:4:3	BuOH-AcOH-H_2O 4:1:1	EtOAc-Pyr-H_2O 8:2:1
I	0.565	0.290	0.225
II	0.293	0.105	0.089
III	0.678	0.433	0.428
IV	0.691	0.416	0.429
V	0.368	0.154	0.145
VI	0.358	0.149	0.154
VII	0.375	0.150	0.152
VIII	0.387	0.136	0.142

Table VI. *Component Saccharides of Isolated Oligosaccharides*

Oligosaccharide	Component Saccharide	Reducing End	Pentose/Hexose (mole/mole)	DP
I	glc	—	—	1.95
II	gal	—	—	1.85
III	xyl	—	—	2.08
IV	gal, ara	ara	1.0	2.0
V	xyl	—	—	3.07
VI	glc, xyl	xyl	1.80	2.77
VII	glc, xyl	xyl	2.01	2.75
VIII	glc, xyl	glc	0.55	3.11
IX	glc, xyl	xyl	3.56	4.18

Table VII. *Results of Partial Hydrolysis of Tri- and Tetrasaccharides*

Oligosaccharide	No. of Oligosacch. Produced	Composition of Oligosacch.	Possible Sequence
VI	2	xyl_2, glc→xyl	glc→xyl→xyl or xyl→xyl ↑ glc
VII	2	xyl_2, glc→xyl	ditto
VIII	2	glc_2, xyl→glc	xyl→glc→glc or glc→glc ↑ xyl
IX	3	xyl_2, xyl_3, glc→xyl	$(xyl)_{3-4}$ (glc)*

* This glucosyl residue can be attached to any one of the xylose unit.

the periodate consumption data can be calculated in mole periodate consumed per mole oligosaccharide. These results are presented in Table VIII. The yields of oligosaccharides IV and IX were not large enough to permit carrying out periodate oxidation experiment.

Table VIII. *Periodate Consumption Data*

Oligosacch.	Mole periodate/mole oligosacch.
I	3.16
II	4.86
III	3.96
V	4.88
VI	3.93
VII	5.14
VIII	3.05

From these results, the structure of the oligosaccharides are deduced as following.

O-β-D-glucopyranosyl-(1→3)-D-glucopyranose (or laminaribiose): Oligosaccharide I has two possible structures, O-D-glucopyranosyl-(1→3)-D-glucopyranose and O-D-glucopyranosyl-(1→2)-D-glucopyranose. However, since this oligosaccharide reduced triphenyltetrazolium chloride at the same rate as cellobiose does, the two glucose units are more likely linked together by 1→3 linkage. A β-D-glucosidase (Nutritional Biochemicals Corp.) could completely hydrolyze the disaccharide, thus the compound was established as laminaribiose.

O-D-galactopyranosyl-(1→6)-D-galactopyranose: Oligosaccharide II consumes nearly 5 moles periodate per mole, thus the only possible linkage between the two galactose units is 1→6. The stereoconfiguration of the galactosyl bond has not been established.

O-β-D-xylopyranosyl-(1→4)-D-xylopyranose (or xylobiose): Oligosaccharide III was obtained in a yield good enough to permit taking a reading of optical rotation. The obtained value was $[\alpha]_D = -22.5°$, very close to the value ($-25°$) given by Howard (1957) for xylobiose. All other data also indicate that the compound is xylobiose.

D-galactosyl-L-arabinose: Although no detailed study could be made on oligosaccharide IV, the isolation of this disaccharide proved the presence of linkages among the galactosyl and arabinosyl units in the polysaccharide.

Xylotriose: Oligosaccharide V must be O-β-D-xylopyranosyl-(1→4)-β-D-xylopyranosyl-(1→4)-D-xylopyranose (or xylotriose) although no optical rotation data could be obtained.

Glucosylxylobiose A: Oligosaccharide VI is a heterotrisaccharide. The available data showed that it could be either O-D-glucopyranosyl-(1→3)-O-D-xylopyranosyl-(1→4)-D-xylopyranose or O-D-xylopyranosyl-(1→4)-O-[D-glucopyranosyl-(1→2)]-D-xylopyranose. The two xylose units in this trisaccharide are believed to assume the configuration of xylobiose.

Glucosylxylobiose B: Oligosaccharide VII is also considered to be a glucosylxylobiose. The point of attachment of the glucosyl unit can be either 2 or 4 position of the nonreducing xylose unit, or the 3 position of the reducing xylose unit.

Xylosyllaminaribiose: The only possible structure for oligosaccharide VIII is O-D-xylopyranosyl-(1 → 3)-O-D-glucopyranosyl-(1 → 3)-D-glucopyranose. The two glucose units are considered to assume the configuration of laminaribiose.

Oligosaccharide IX: From the available data, it cannot be decided whether this oligosaccharide is a tetrasaccharide or a pentasaccharide. However, it can be proposed tentatively that it consists of a xylotriose or a xylotetraose chain and a glucosyl unit attached to one of the xylose units at either 2 or 3 position.

Discussion

From the results of general analysis, it is seen that bamboo shoot is not fiber rich; analytical results obtained with a one year old bamboo specimen (J. C. Su, unpublished data) showed, however, that the cell wall polysaccharides increase in one year from about 18% to 80%. It is conceivable, therefore, that bamboo shoot is very active in the synthesis of cell wall polysaccharides.

From Table II, it is apparent that the arabinose containing polysaccharide is more soluble in water while the xylose containing one is more easily extracted with 1 *N* alkali. Our recent work on the fractionation of bamboo shoot hemicelluloses has revealed the presence of a polysaaccharide fraction which is soluble in cold water and containd glucose, galactose and arabinose as the constituent sugars (J. C. Su, unpublished data). Whether these sugars are linked together in a polysaccharide molecule or they are derived from the mixture of a glucosan and an arabinogalactan is still not known.

It is very interesting to note at this point that, although an arabinose containing polysaccharide is more easily extracted with water than the xylose containing one, however the 1 *N* KOH soluble hemicellulose showed higher xylose/arabinose ratio than the 4 *N* KOH soluble fraction (Table IV). This implies that, there should be present in bamboo shoots at least two types of arabinose containing polysaccharides, one easily soluble in water and the other extractable only in strong alkali.

The results presented in Figure 1 show that the arabinosyl residues in the 1 *N* alkali soluble fraction have strikingly higher acid lability than the xylosyl residues. This implies that the arabinosyl residues are probably present in the furanosyl form.

The results of pentosan determination made on the different polysaccharide fractions (Table III) and the qualitative data presented in Table II indicate that the bamboo shoot fibers contain alkali resistant, non-cellulosic polysaccarides in them. The alkali resistance of these non-cellulosic polysaccharides cannot be due to the presence of lignins in the fiber; when histochemical staining technique was employed to detect lignins in the slices of fresh bamboo shoot tissue, only very weak phloroglucinol staining was observed, and when the alkali extracted residues was tested in the similar manner, no trace of lignin could be detected (Kalb, 1932). The mode of association of these polysaccharides with cellulose awaits future exploration.

The partial hyhrolysis study made on the 1 *N* KOH soluble polysaccharides revealed four important points. (1) Isolation of xylobiose and glucosyl-xylobiose indicated that a β-1,4-linked xylan chain, the chief structural feature of all known hemicelluloses, is also a component of bamboo shoot cell wall polysaccharides. (2) Identification of laminaribiose and a xylosyl-laminaribiose confirmed the presence of callose chains. (3) The presence of a xylosyllaminaribiose and two glucosylxylobioses suggested the interchain linkages of xylan and callose chains. (4) The isolation of a galactosylarabinose confirmed the presence of an arabinogalactan. Presence of a D-galactosyl-(1→6)-D-galactose and the labile nature of the arabinosyl residues in the polysaccharide suggested that the polysaccharide is probably consisted of a 1→6-linked galactan main chain branched with arabinofuranosyl side chains.

The confirmation of the presence of callose chains in the bamboo shoot hemicelluloses is in accord with the finding that the particulate enzyme of the plant is able to synthesize callose using UDP-D-glucose as the precursor (Su *et al*, 1967). It was further found, however, that UDP-D-xylose strongly inhibited the callose synthesizing reaction. It is highly probable, therefore, that the synthesis of callose is checked by the presence of UDP-D-xylose in the plant tissue and the interchain links of callose and xylan chains are accomplished by a transglycosylation reaction using the preformed callose and xylan chains as the glycosyl donor, as in the case of amylopectin synthesis. The possibility of simultaneous addition of glucosyl residues from UDP-D-glucose and xylosyl residues from an unidentified xylosyl donor in the formation of the heteropolysaccharide cannot be overlooked, however.

Although the partial hydrolysis study has revealed much of the chemical nature of the hemicelluloses of the bamboo shoot, the data obtained also

implied that the hemicelluloses of the plant consisted of a series of polysaccharides with various degrees of affinity toward the basic skeletal polysaccharide of cell wall, cellulose, and a thorough understanding of the structure of the cell wall of the plant can be achieved only when the problem is attacked not only by chemical methods but also by physical means.

Summary

Cell wall polysaccharides of the shoots of bamboo *Leleba oldhami* are made up of four monosaccharides, i. e. glucose, galactose, xylose and arabinose. Of the hemicelluloses, there seemed to be present two types of arabinose containing polysaccharides, one easily soluble in water and the other extractable only in strong alkali (4 *N*). When the 1 *N* alkali soluble hemicelluloses were studied by the partial hydrolysis technique, two types of polysaccharides were shown to be present: (1) an arabinogalactan consisting of 1→6 linked galactosyl chains which are branched with arabinofuranosyl side chains, and (2) a glucoxylan consisting of interlinked callose (β-1→3-linked glucan) and xylan (β-1→4-linked) chains. The types of linkages between the two glycosyl chains are xylopyranosyl-(1→3)-glucopyranose (linear) and glucopyranosyl-(1→3)-xylopyranose or glucopyranosyl-(1→2)-xylopyranose (branched).

綠竹筍之醣類代謝

IV. 細胞壁多醣類結構之化學研究

蘇仲卿 鄒東森 戴信雄

綠竹筍細胞壁多醣類由木糖，阿剌伯糖，葡萄糖及半乳糖等四種單醣所構成。含有阿剌伯糖之半纖維多醣類似有水溶性及强鹼可溶性兩種存在。以部份水解技術研究一規定鹼液可溶性半纖維多醣類之結構，發現有兩種類型存在：(1) Arabinogalactan，是半乳糖以(1→6)方式連結構成主鏈，而以呋喃型阿剌伯糖基構成分枝者。(2) Glucoxylan 是木糖以 β-(1→4) 方式連結而成之直鏈與葡萄糖以 β-(1→3) 方式連結之直鏈互相結合而成之多醣類；兩種醣鏈之互結方式有 xylopyranosyl-(1→3)-glucopyranose (直鏈型) 及 glucopyranosyl-(1→3)-xylopyranose 或 glucopyranosyl-(1→2)-xylopyranose (分枝型)。

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