Plant & Cell Physiol. 24(3): 345–355 (1983)

Auxin-Induced Changes in the Cell Wall Xyloglucans: Effects of Auxin on the Two Different Subfractions of Xyloglucans in the Epicotyl Cell Wall of *Vigna angularis*[1]

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In order to study the IAA-induced modifications of the cell wall of azuki bean (*Vigna angularis* Ohwi et Ohashi cv. Takara) epicotyl segments, the xyloglucans were subfractionated into two components, i.e., 4K-U and 24K xyloglucans, which were obtained by extraction with 4% KOH solution containing 8 M urea and 24% KOH solution, respectively. The weight-average molecular weights of 4K-U and 24K xyloglucans were estimated to be 40×10^4 and 106×10^4, respectively. Complete acid hydrolysis of 4K-U and 24K xyloglucans gave glucose, xylose, galactose and fucose in mole % 48.3 : 33.5 : 13.8 : 4.4 and 45.3 : 30.9 : 19.6 : 4.3, respectively.

Treatment of epicotyl segments with IAA (0.1 mM) caused a decrease in the amount of 24K xyloglucans and an increase in 4K-U xyloglucans, whereas the total amount of the two xyloglucans remained constant. Furthermore, IAA treatment caused a decrease in the molecular weight of 24K xyloglucans from 106×10^4 to 78×10^4 without causing changes in their sugar compositions. With 4K-U xyloglucans, IAA caused an increase in the mole % of xylose and a decrease in the mole % of galactose and fucose.

Key words: Auxin — Azuki bean — Cell wall — Extension growth — Molecular weight — Xyloglucan.

Auxin causes cell wall loosening and thereby induces cell extension growth (Cleland 1971, Masuda 1978). To understand the biochemical basis underlying the auxin-induced cell wall loosening, attention has been focused on the effects of auxin on metabolic and structural changes in the hemicellulosic polysaccharides (Masuda 1978, Labavitch 1981), particularly in xyloglucans (Labavitch and Ray 1974a, b, Terry and Bonner 1980). In pea epicotyl segments, Labavitch and Ray (1974a, b) and Terry and Bonner (1980) showed that auxin promoted liberation of xyloglucans into the water-soluble fraction and suggested involvement of the xyloglucan metabolism in auxin-induced cell extension growth.

Our recent studies using gel permeation chromatography have demonstrated that auxin induces a decrease in the weight-average mol wt of cell wall xyloglucans, when it induces cell extension growth in azuki bean epicotyl segments. The auxin-induced change in the xyloglucans occurs even when cell extension growth is osmotically suppressed by 0.15 M mannitol solution (Nishitani and Masuda 1981). This line of evidence suggests that degradation or depolymerization of cell wall xyloglucans is involved in the process responsible for cell wall loosening and therefore cell extension growth. However, little is known about the process or mechanism by

[1] This paper is dedicated to the late Professor Joji Ashida.

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Abbreviation: T_0, minimum stress-relaxation time.

which the mol wt of xyloglucan decreases by the action of auxin. The present study was undertaken to obtain a more precise picture of what happens to the xyloglucans when auxin promotes cell wall loosening and thus cell extension growth.

Materials and Methods

Growth experiments—Azuki bean (*Vigna angularis* Ohwi et Ohashi vc. Takara) seeds were soaked overnight in running tap water at 30°C, then grown for 6 days in moistened vermiculite under fluorescent lamps (10 W m^{-2}) at 25°C (Nishitani and Masuda 1981). From the epicotyls (8–10 cm long), 10-mm segments were excised 5–15 mm below the first leaves and kept in pure water for 3 h at 25°C. These segments were incubated under white fluorescent lamps (10 W m^{-2}) at 25°C in a petri dish containing 10 mM K-phosphate buffer solution (pH 6.0) with or without 0.1 mM IAA.

Preparation of cell walls—Cell wall material was prepared by the procedure described previously (Nishitani and Masuda 1981). Briefly, methanol-boiled segments were rehydrated and treated with 0.02% Pronase-P (Kaken Kagaku Co., Ltd.), homogenized in ice-cold water, washed successively with ice-cold water, acetone and a methanol-chloroform mixture (1 : 1, v/v), and finally air-dried at 40°C. The dried cell wall material was treated with 10 units of pancreatic α-amylase (Sigma Chemical Co., Ltd.) to remove starch. After the α-amylase treatment, the cell wall material was extracted four times with 20 mM ammonium oxalate-oxalic acid buffer solution (pH 4.0) at 70°C for 1 h each to remove pectic polysaccharides.

Extraction of hemicellulosic subfractions—For the extraction of total hemicellulose, the pectin-free cell wall was extracted three times with 24% KOH solution for 24 h at 25°C.

The hemicellulosic subfractions (4K, 4K-U and 24K) were fractionated according to the procedure described in Fig. 1. The pectin-free cell wall material was first extracted three times with 4% KOH solution to obtain the 4K subfraction. The residue was next extracted three times with 4% KOH solution containing 8 M urea to obtain the 4K-U subfraction. Finally, the residue was extracted three times with 24% KOH solution to obtain the 24K subfraction. The 4K subfraction is the same as hemicellulose-1 and the sum of the 4K-U and 24K subfractions corresponds to hemicellulose-2 in the method usually adopted (Kato and Matsuda 1976, Nishitani and Masuda 1982).

Each alkali extract was slightly acidified (pH 5.0) with acetic acid (1/3 and 1/18 volume of acetic acid for 24% and 4% KOH solutions, respectively). The acidification caused no precipitation of the hemicellulosic polysaccharides.

Determination of total polysaccharide and xyloglucan contents—The total polysaccharide contents in the hemicellulosic fractions were determined by the phenol sulfuric acid method (Dubois et al. 1956) and expressed as glucose equivalents. The xyloglucan contents in the fractions were determined by Kooiman's iodine staining method with a slight modification (Kooiman 1960, Nishitani and Masuda 1981). One milliliter of polysaccharide solution was mixed with 0.25 ml of an aqueous solution containing 0.5% I_2 and 1.0% KI and 2.0 ml of an aqueous solution of 15% sodium sulfate. After the reaction mixture had been kept for 1 h at 4°C in darkness, A_{640} was read. The absolute amount of xyloglucans in the polysaccharide solution was estimated from the calibration curve derived from pure xyloglucans which had been prepared from the azuki bean hemicellulose by gel permeation chromatography.

Gel permeation chromatography of hemicellulosic fractions—For the gel permeation chromatography, slightly acidified (pH 5.0) hemicellulosic fractions (4K-U and 24K) were dialyzed overnight against pure water using Cellophane-tubing Seamless (18/32 inch), then lyophilized. The lyophilized powder of the hemicellulosic subfractions (prepared from 100 segments) was dissolved in 0.1 M NaOH solution. The insoluble impurity in the solution was removed by centrifugation

at 1,000×*g* for 30 min. The supernatant was applied to a Sepharose CL-4B column (80× 1.5 cm) which had been equilibrated with 0.1 M NaOH solution, and eluted with the same solution at a flow rate of ca. 15 ml/h (hydrostatic pressure; 55–60 cm). Fractions of 2.1 ml each were collected (Nishitani and Masuda 1981).

The total sugar content in each fraction was determined by the phenol-sulfuric acid method (Dubois et al. 1956) and the xyloglucan content by the iodine-staining method. The neutral sugar composition in each fraction was determined by gas-liquid chromatography (Albersheim et al. 1967, Sakurai et al. 1977, Nishitani and Masuda 1980).

Calculation of weight-average mol wt of xyloglucans—Weight-average mol wt of xyloglucans was estimated from their gel permeation chromatograms on Sepharose CL-4B column using a calibration curve derived from authentic dextrans purchased from Pharmacia Fine Chemicals and Sigma Chemical Co., Ltd. The weight-average mol wt of the xyloglucan was estimated with the following formula: Weight-average mol wt $= \Sigma M_i w_i / \Sigma w_i$ where w_i is the xyloglucan content and M_i is the mol wt of the ith fraction estimated from the calibration curve derived from the authentic dextrans.

Results

We have previously shown that when IAA induces extension growth of azuki bean epicotyl segments, IAA causes a decrease in the average mol wt of the total xyloglucans in the cell wall within 30 min after IAA application (Nishitani and Masuda 1981). To examine the effect of IAA on the amount of xyloglucans in the cell wall, we determined their amount in the total hemicellulosic fraction prepared from cell walls of epicotyl segments which had been incubated in the presence or absence of IAA. Table 1 shows that IAA had no effect on the amount of the total xyloglucans in the cell wall. This result indicates that the IAA-induced decrease in the mol wt of xyloglucans is not accompanied by changes in the total amount of xyloglucans in the cell wall.

We then fractionated the total hemicellulose fraction into three subfractions (4K, 4K-U and 24K subfractions) by the differential extraction procedure shown in Fig. 1. Contents of total polysaccharides and xyloglucans in these subfractions are shown in Table 2. While a very small amount of the xyloglucans was extracted with 4% KOH solution, about 40% of cell wall xyloglucans were extracted with 4% KOH solution containing 8 M urea (4K-U). The remaining xyloglucans (60%) was extracted by the subsequent extraction with 24% KOH solution (24K).

The two hemicellulosic subfractions (4K-U and 24K) were chromatographed on Sepharose CL-4B column to examine the mol wt distribution of xyloglucans in the subfractions. Fig. 2

Table 1 Effect of IAA on the total xyloglucan contents in the azuki bean cell wall

Treatment[a]	Xyloglucan content[b]	
	(μg/segment)	(%)
Initial	19.6±0.6	100
Control	19.1±0.1	98
IAA	19.7±0.8	101

[a] Lots of 30 epicotyl segments were incubated for 3 h in the presence or absence of 0.1 mM IAA. At the end of the incubation, the segments were killed in boiling methanol and subjected to the extraction of total xyloglucans in the cell wall.

[b] Xyloglucan contents were determined by the iodine-staining method. Mean values of three different experiments are given with standard errors.

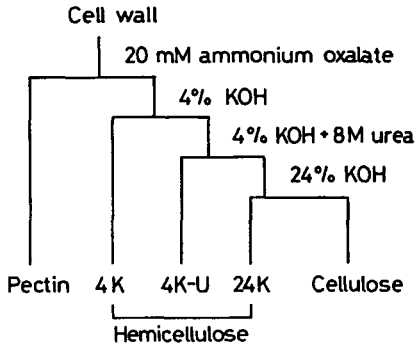

Fig. 1 *Flow chart for the extraction of hemicellulosic subfractions.*

shows chromatograms of total polysaccharides and xyloglucans in the two subfractions. Xyloglucans in the 4K-U subfraction were eluted in one peak. The 24K xyloglucans were separated into three polysaccharide peaks: most of the xyloglucans in the 24K subfraction eluted in the second peak of the chromatogram. Using the data shown in Fig. 2, the weight-average mol wt of 4K-U and 24K xyloglucans were calculated to be 40×10^4 and 106×10^4, respectively. The average mol wt of the 24K xyloglucans was more than twice as large as that of the 4K-U xyloglucans.

Fig. 3 shows the individual sugars in the eluate of the 4K-U and 24K subfractions chromatographed on Sepharose CL-4B column. For the 4K-U subfraction, fractions of eluates around the peak of the xyloglucans (cf. Fig. 2) contained glucose, xylose, galactose and fucose, which are known to be components of cell wall xyloglucans in several dicot plants (Bauer et al. 1973, Kato and Matsuda 1980). But the chromatograms of individual sugars did not coincide with that of the xyloglucans, presumably because of the presence of other polysaccharides containing xylose, galactose and glucose at both ends of the chromatogram. With 24K subfractions, the first and the second peaks of xyloglucans (cf. Fig. 2) coincided well with the chromatograms of glucose, xylose, galactose and fucose, whereas the third peak of the xyloglucans did not fit the peaks of xylose and fucose. The sugar composition of the polysaccharides in the third peak may have differed from that in the main peak of 24K xyloglucans.

We collected fractions of the eluate (A for 4K-U and B for 24K as indicated in Fig. 2), which were apparently free of other polysaccharides and considered to be pure xyloglucans. Complete acid hydrolysis of these fractions of the eluates gave glucose, xylose, galactose and fucose in mole % 48.3 : 33.5 : 13.8 : 4.4 for 4K-U xyloglucans and 45.3 : 30.9 : 19.6 : 4.3 for 24K xyloglucans, respectively (Table 3). Note that galactose in mole % is less in 4K-U xylo-

Table 2 Polysaccharide compositions of hemicellulosic subfractions

	Subfraction[a]		
	4K	4K-U	24K
		(μg/segment)	
Total sugar[b]	19.6	16.4	13.5
Xyloglucan[b]	0.02	6.95	10.36

[a] Hemicellulosic subfractions (4K, 4K-U and 24K subfractions) were extracted from the epicotyl segments according to the procedure shown in Fig. 1.

[b] Amounts of total sugar and xyloglucans in each fraction were determined by the phenol-sulfuric acid method and iodine-staining method, respectively.

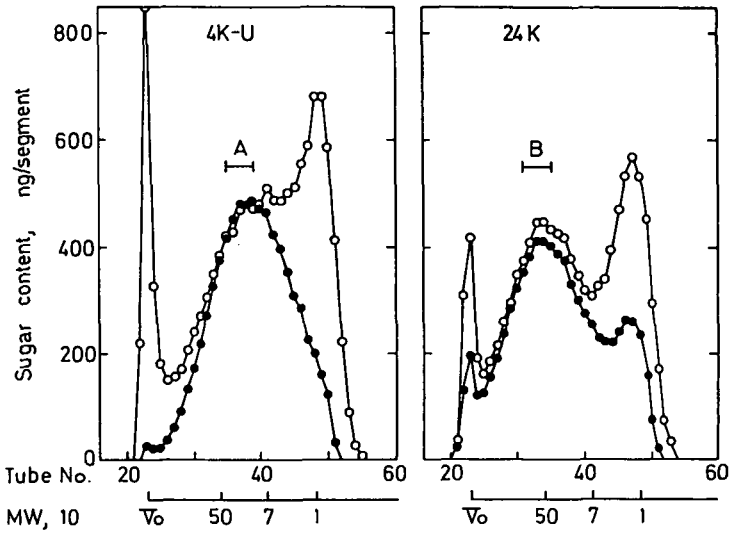

Fig. 2 Gel permeation chromatograms of 4K-U and 24K subfractions on Sepharose CL-4B column. From 100 epicotyl segments (10 mm long), 4K-U and 24K subfractions were extracted and chromatographed on a Sepharose CL-4B column. Contents of total polysaccharides (○) and xyloglucans (●) in the eluate were determined by the phenol-sulfuric acid method and the iodine-staining method, repsectively. The net amounts of polysaccharides in each fraction derived from one epicotyl segment are shown. MW, mol wt.

glucans than in the 24K subfraction. These results, as a whole, indicate that the two xyloglucan components (4K-U and 24K) differ both in their mol wt distributions and sugar compositions.

Next, we examined the effect of IAA on the contents of xyloglucans in the 4K-U and 24K subfractions. As shown in Fig. 4, IAA caused, within 2 h of incubation, an increase in the

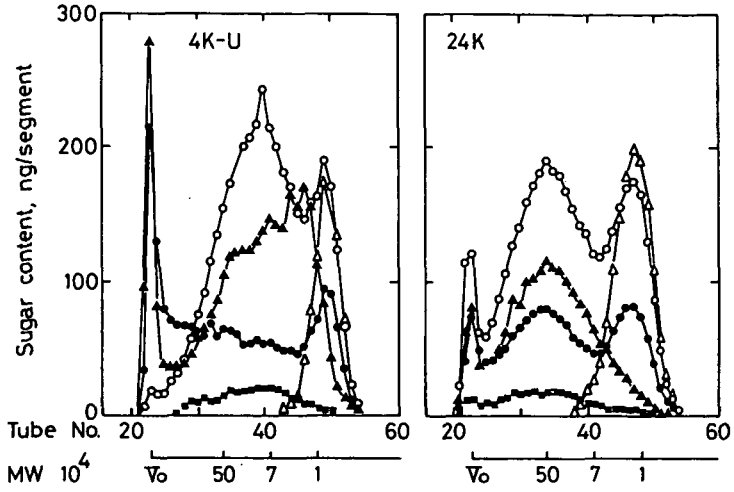

Fig. 3 Sugar compositions of the 4K-U and 24K subfractions chromatographed on Sepharose CL-4B column. 4K-U and 24K subfractions were extracted and chromatographed on Sepharose CL-4B column. Neutral sugar compositions in the eluate were determined by gas-liquid chromatography following acid hydrolysis of the polysaccharides. The net amounts of the individual sugar contents in each fraction derived from one epicotyl segment are shown. Symbols: (○) glucose; (▲) xylose; (●) galactose; (△) mannose; (■) fucose. MW, mol wt.

Table 3 Effect of IAA on sugar compositions of 4K-U and 24K xyloglucans

	Sugar[a]	Mole %		
		control	IAA	$\frac{\text{IAA}-\text{control}}{\text{control}} \times 100$
4K-U	glucose	48.3	47.3	−2.1
	xylose	33.5	36.4	8.7
	galactose	13.8	12.5	−9.4
	fucose	4.4	3.8	−13.6
24K	glucose	45.3	44.0	−2.9
	xylose	30.9	31.5	1.9
	galactose	19.6	20.2	3.1
	fucose	4.3	4.3	0.0

[a] Hemicellulosic subsfractions (4K-U and 24K) were extracted from epicotyl segments which had been incubated in the presence or absence of IAA and were chromatographed on a Sepharose CL-4B column as shown in Fig. 2. Portions of the eluate (A for 4K-U and B for 24K as indicated in Fig. 2) were collected and hydrolyzed. Sugar compositions in the hydrolysate were determined by gas-liquid chromatography.

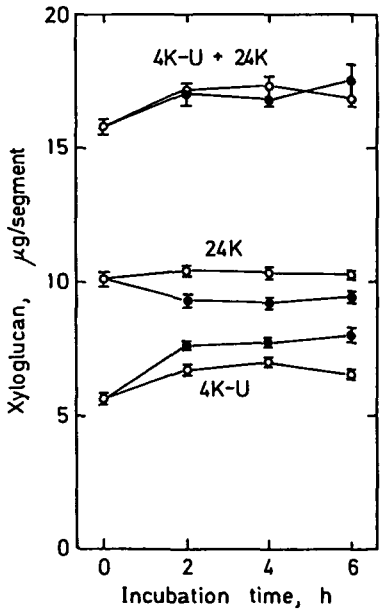

Fig. 4

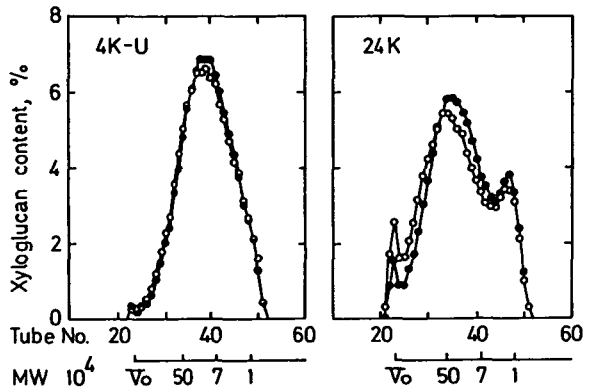

Fig. 5

Fig. 4 Time course of IAA-induced changes in amounts of xyloglucans in the 4K-U and 24K subfractions. Lots of 30 segments were incubated in the presence (●) or absence (○) of 0.1 mM IAA. At the end of the incubation, the segments were killed in boiling methanol and subjected to cell wall fractionation (see Fig. 1). Xyloglucan contents in the 4K-U and 24K subfractions were determined by iodine-staining method. Mean values of three different experiments are given with standard errors.

Fig. 5 Effect of IAA on the mol wt distribution of xyloglucans in 4K-U and 24K subfractions. Epicotyl segments were incubated for 3 h in the presence (●) or absence (○) of 0.1 mM IAA. The 4K-U and 24K subfractions were extracted and chromatographed on a Sepharose CL-4B column. The xyloglucan content in the eluate was determined by the iodine-staining method and expressed in percent of the total xyloglucan content recovered in the whole eluate. MW, mol wt.

Table 4 Effect of IAA on the weight-average mol wt of xyloglucans

Treatment[a]	Weight-average mol wt, 10^4 [b]	
	4K-U	24K
Initial	40 [100][c]	106 [100]
Control	42 [105]	106 [100]
IAA	39 [98]	78 [74]

[a] Epicotyl segments were incubated in the presence or absence of 0.1 mM IAA. After the incubation, the segments were killed in boiling methanol and subjected to the fractionation of the cell wall according to the procedure shown in Fig. 1.
[b] 4K-U and 24K subfractions were chromatographed on Sepharose CL-4B column. Weight-average mol wt of respective xyloglucans were calculated using the chromatograms shown in Fig. 5.
[c] Percentages.

amount of 4K-U xyloglucans and a decrease in that of 24K xyloglucans, whereas the total amount of the xyloglucans (4K-U plus 24K) remained constant during IAA treatment (cf. Table 1). IAA treatment increased the ratio of 4K-U to 24K xyloglucans without causing any changes in the total amount of cell wall xyloglucans. In addition, Table 3 shows that IAA treatment caused an increase in the mole % of xylose and a decrease in the mole % of galactose and fucose in 4K-U xyloglucans. On the other hand, sugar compositions of 24K xyloglucans were little affected by IAA treatment.

Fig. 5 and Table 4 show the effect of IAA on the mol wt distribution of 4K-U and 24K

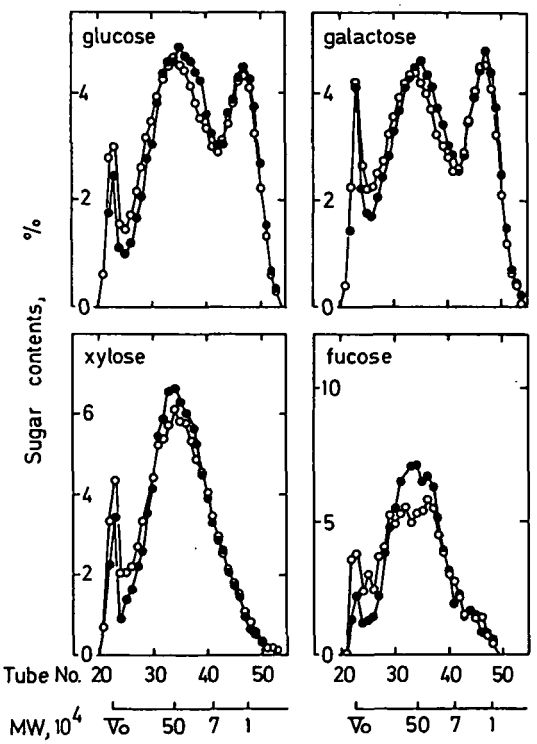

Fig. 6 Effects of IAA on individual sugars composing the 24K subfraction chromatographed on Sepharose CL-4B column. Epicotyl segments were incubated for 3 h in the presence (●) or absence (○) of 0.1 mM IAA. 24K subfractions were extracted and chromatographed on Sepharose CL-4B column. The sugar contents in each fraction of the eluate were determined by gas-liquid chromatography. Chromatograms for individual sugars were expressed in percent of the total amount of respective sugars recovered in the eluate. MW, mol wt.

xyloglucans. IAA treatment caused a shift of the mol wt distribution of 24K xyloglucans from higher to lower mol wt (from 106×10^4 to 78×10^4), whereas the mol wt distribution of 4K-U xyloglucans was little affected by IAA treatment (from 40×10^4 to 39×10^4).

The effects of IAA on the chromatograms of individual sugars composing 24K subfraction were examined and shown in Fig. 6. IAA caused a shift of the first two peaks of glucose, xylose, galactose and fucose, from higher mol wt to lower mol wt. These data indicate that the mol wt change in xyloglucans, whose contents were determined by the iodine-staining method, agrees well with the mol wt changes in the individual sugars which constitute the xyloglucans (cf. Fig. 5).

Discussion

The present study has shown that xyloglucans in azuki bean epicotyl cell walls are comprised of two components, i.e., 4K-U and 24K xyloglucans, with weight-average mol wt of 40×10^4 and 106×10^4, respectively. The presence of two types of xyloglucans was reported by Hayashi et al. (1980) who separated the xyloglucans by chromatography on DEAE-Sephadex into two components with different mol wt, 6×10^4 and 18×10^4.

The present data have demonstrated that IAA causes a decrease in the 24K xyloglucans (larger-sized component) and an increase in the 4K-U xyloglucans (smaller-sized component) without causing any changes in the total amounts of xyloglucans (Fig. 4). Furthermore, IAA causes a decrease in the weight-average mol wt of 24K xyloglucans (Fig. 5 and Table 4). These IAA-induced changes in the two xyloglucan components led to a decrease in the weight-average mol wt of the total xyloglucans. Thus, the present data confirm our previous finding that IAA causes a decrease in the weight-average mol wt of total xyloglucans in azuki bean epicotyl cell walls (Nishitani and Masuda 1981). Previously we showed that the IAA-induced decrease in the weight-average mol wt of total xyloglucans became apparent within 30 min after IAA application. Thus, the IAA-induced changes in the two xyloglucan components also seem to have occurred within 30 min after IAA application.

The IAA-induced changes in the ratio of 4K-U and 24K xyloglucan reached a plateau within 2 h after IAA application. This time course effect of IAA on the xyloglucans is comparable to that of IAA on cell wall loosening, as represented by the decrease in the T_0 value of the cell wall, which was obtained by stress-relaxation analysis of the cell wall. In azuki bean epicotyl cell walls, the IAA-induced decrease in the T_0 value reached minimum within 2 h after IAA application and this value was maintained for more than 8 h during IAA treatment (Nishitani et al. 1979, Nishitani and Masuda 1981). These facts suggest that IAA-induced changes in the xyloglucans are related to the degree of cell wall loosening rather than the cell extension growth achieved.

One possible explanation for the mechanism of these changes is that portions of the 24K xyloglucans were transformed, through depolymerization or structural modification, into 4K-U xyloglucans. In pea epicotyl segments, Labavitch and Ray (1974a, b) and Terry and Bonner (1980) showed that IAA enhanced the release of water-soluble xyloglucans and suggested that IAA action involved the degradation of xyloglucans in the cell wall. Recently, Koyama et al. (1981) obtained a crude preparation of xyloglucan-degrading enzyme from soybean hypocotyls. These facts suggest that the decreases in the amount and mol wt of 24K xyloglucans are mediated by the action of some hydrolytic enzyme. However, it is not clear whether 24K xyloglucans were directly transformed into 4K-U xyloglucans or 24K xyloglucans were decomposed completely and 4K-U xyloglucans were newly synthesized. Our data also show that IAA treatment caused a decrease in the mole % of galactose and fucose and an increase in the mole % of xylose in 4K-U xyloglucans. This result suggests that IAA caused liberation of galactose and fucose

residues from the side chains of xyloglucan molecules. To obtain a detailed picture of the IAA-induced changes in the molecular structure of the xyloglucans requires further investigation.

Xyloglucans have been shown to react with iodine to form an iodine-xyloglucan complex which appears green (Kooiman 1960). The reaction has been proved to be specific for xyloglucans and applicable to quantitative assays of xyloglucans. Thus, the iodine-staining method is convenient for determining the xyloglucan contents in solution containing other polysaccharides, although it is not suitable for the assay of xyloglucans which are insoluble in water solution (Kato and Matsuda 1976, 1977). Since the cell wall xyloglucans extracted from azuki bean epicotyls were soluble in water, we adopted this method for the quantitative assay of the xyloglucans (Nishitani and Masuda 1981). The data in Fig. 2 and 3 show that the peak of 4K-U xyloglucans and the first two peaks of 24K xyloglucans were chiefly composed of glucose, xylose, galactose and fucose, and indicate that the chromatograms as detected by the iodine-staining method actually represent the elution pattern of xyloglucans. However, the third peak of 24K xyloglucans as assayed by the iodine-staining method, had no peak of xylose which is one of the main constituents of xyloglucans. Probably, the iodine stain observed in the third peak of the 24K subfraction may be attributable to polysaccharides other than xyloglucans. Characterization of these polysaccharides needs further investigation.

Albersheim (1976) and his colleagues (Keegstra et al. 1973, McNeil et al. 1978) proposed a structural model of the primary cell wall and claimed that xyloglucan molecules were hydrogen bonded to cellulose microfibrils. However, direct evidence concerning the interaction between the xyloglucans and cellulose microfibrils has not yet been presented. If xyloglucans are attached to cellulose microfibrils only by hydrogen bonds, they should be extracted with boiling water or a concentrated solution of urea, which is known to break hydrogen bonds. To examine this, we tried to extract xyloglucans with hot water and a hot solution of 8 M urea from the pectin-free cell walls of azuki bean epicotyls, and found that no xyloglucan was extracted with these solutions. This result does not support the above possibility and suggests the participation of some other linkages stronger than hydrogen bonds. Furthermore, our data showed that about 40% of the cell wall xyloglucans (4K-U) were extracted by a solution containing 4% KOH and 8 M urea, and the remaining xyloglucans (24K) were extracted with 24% KOH solution. These data suggest that 24K xyloglucans are attached tightly to microfibrils by some alkali-labile linkages which are resistant to 4% KOH–8 M urea solution, whereas 4K-U xyloglucans are associated with cellulose microfibrils partly through hydrogen bonds and partly through dilute alkali-labile linkages.

For the cell wall to extend, cellulose microfibrils must be rearranged by sliding along their length or becoming separated. Rearrangement of the cellulose microfibrils should require either splitting of xyloglucan molecules or dissociation of linkages between xyloglucans and cellulose microfibrils. Thus, the degradation of 24K xyloglucans, which we showed in the present study, may reflect the splitting of xyloglucan molecules which are tightly associated with cellulose microfibrils. Therefore, degradation of 24K xyloglucans in the cell wall is likely to be one of the critical processes responsible for cell wall loosening caused by auxin.

In coleoptile segments of oat and barley, which are monocotyledonous plants, IAA caused degradation of β-1,3 1,4-linked glucans in the cell wall (Sakurai et al. 1977, 1979, Sakurai and Masuda 1978, Yamamoto et al. 1980). The β-glucan degradation was regarded as the biochemical basis for auxin-induced cell wall loosening in monocotyledonous plants (Sakurai et al. 1979). However, β-1,3 1,4-linked glucans are not found in dicotyledonous plants. Thus the IAA-induced degradation of the β-glucans seems to be a special reaction found in monocotyledonous plants. On the other hand, xyloglucans are known to occur widely in the primary cell walls of monocotyledonous (Labavitch and Ray 1978, Wada and Ray 1978, Yamamoto et al.

1980) and dicotyledonous plants (Bauer et al. 1973, Kato and Matsuda 1976, Kato et al. 1977, Nishitani and Masuda 1981). This suggests that the IAA-induced degradation of xyloglucans, which we found in azuki bean epicotyl segments, is a widely occurring reaction both in monocotyledonous and dicotyledonous plants. The roles of xyloglucans in other plants are under investigation.

We thank Dr. Seiichiro Kamisaka and Dr. Ryoichi Yamamoto of our laboratory for their invaluable discussions and criticism. This work was partly supported by a Grant-in-Aid for Science Research (No. 511616) to Y.M. from the Ministry of Education, Science and Culture, Japan.

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(Received November 26, 1982; Accepted February 7, 1983)