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Studies on the Fine Structure and Functional Role of Plant Cell-wall Polysaccharides

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This paper describes our studies on the fine structures and functions of the important hemicellulose, xyloglucan and glucuronoarabinoxylan, of the primary cell-walls of all higher plants. Xyloglucan: 1) A method for rapidly identifying six of the most commonly found xyloglucan oligosaccharide units, XXXG, XLXG, XXLG, XLLG, XXFG and XLFG was developed by high-performance anion exchange chromatography with pulsed amperometric detection before and after digestion with purified isoprimeverose-producing oligoxyloglucan hydrolase (IPase). The usability of this method was confirmed strongly by the studies of the compositional analysis of oligosaccharide units of xyloglucans isolated from the cell-walls of thirteen vegetables and eleven fruits. In our sequential experiments, most fucose-containing xyloglucans were shown to have essentially a small quantity of XLLG, XLXG and XXLG besides XXXG, XXFG and XLFG as major structural oligosaccharide units. 2) The structures of xyloglucans from *Solanaceae* (eggplant, sweet pepper, red pepper and tomato) and *Gramineae* (barley and bamboo shoot) were investigated using xyloglucan-specific enzymes (xyloglucanase, IPase, oligoxyloglucan reducing endo-specific cellobiohydrolase), β-D-glucosidase and β-D-galactosidase. The former was built from hexa-(XXGG), hepta-(XLGG, LXGG, and XSGG) and octa-saccharide units (LSGG), and the latter was built from tetra-(XX), penta-(XXG), hexa-(XXGG), hepta-(XXGGG and LXGG), octa-(XLGGG, LXGGG, XXGGGG, and GXXGGG) and nona-saccharide units (XLGGGG, LXGGGG, GXLGGG, GLXGGG, and XXGGGGG). 3) A comparative study of the structures of xyloglucans prepared from the cell-walls of apple fruit obtained at various development stages showed that the structural modifications of cell-wall xyloglucan occur during development of apple fruit. Glucuronoarabinoxylan: 1) Feruloylated glucuronoarabinoxylan liberated from *Zea* shoot cell-walls by treatment with a purified

endo-(1→4)-β-D-xylanase had a xylan backbone which contained (1→4)-β-D-xylopyranosyl residues, with 60 to 70% substitution at the C-2 or C-3 position with arabinose, glucuronic acid, and other substituents. Ferulic acid occurred at 3-*O*-arabinosyl branch-points of linear backbones of (1→4)-linked β-D-xylopyranosyl residues in the glucuronoarabinoxylan. 2) Feruloyl and diferuloyl esters between polysaccharides were found to be involved in the aggregation of cultured rice cells. 3) The rootlets from the kilned malt were hydrolyzed with acid followed by treatment with an enzyme to give carbohydrate fragments containing ferulic acid. Feruloylated mono- and tri-saccharide fractions were prepared from the mixture of fragments. These fractions were tested for effects on the growth of COLO 201 human tumor cells before and after treatment with esterase. The cell growth was reduced by feruloylated mono- and tri-saccharides, especially feruloylated tri-saccharide, and was not reduced by ferulic acid, monosaccharide or trisaccharide.

Key words: xyloglucan, feruloylated glucuronoarabinoxylan, ferulic acid, xyloglucanase