New Discoveries Relating to Diferulates

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Introduction

A couple of years ago, we reported on the discovery of a whole class of dehydrodimers of ferulic acid in grasses (Ralph et al. 1994). Prior to that time, only one dehydrodimer (the 5–5-coupled dimer) was recognized and diferulates as a whole were under-quantitated by factors of up to 20. Since this time, collaborations with other labs have led to discoveries of diferulates in a wide variety of plant materials. Some of the recent findings are quite novel; others suggest enormous potential for utilization of ferulate dimerization in producing new food products. The importance of diferulates in cross-linking the plant cell wall is becoming recognized.

Implication of diferulates in hypocotyl growth-cessation. Researchers in Spain (Sánchez et al. 1996) have been studying the mechanism by which pine hypocotyl growth cessation occurs once the top of a germinating seedling encounters light. Such a light-response might be expected to be photochemical in nature but the plant halts extension of the cell walls (that would continue to occur in the dark) by infusing the cells with peroxidases and effecting ferulate dimerization. Cross-linking of the walls by diferulate bridges effectively prevents further expansion of these cells and allows the plant to move on to the next phase of its growth — producing shoots and leaves. What is intriguing in this case is that a range of diferulates was found (when pine cell wall development has not normally been considered to involve ferulates) and that none of the 5–5-coupled diferulates could be detected. Such an absence is more in line with the free-solution coupling of model ferulates which produces other dimers but not the 5–5-coupled isomer. Presumably this mechanism for growth-cessation could have been overlooked if researchers sought only the 5–5-coupled dimer as has been done for the past 20 years. The only other study of this type used rice coleoptiles. The 5–5-coupled dimer was observed to accompany growth cessation there. Recent studies in this lab show that the production of the full range of dimers (not just the 5–5) accompanies the growth cessation.

Diferulates in sugar beets. Sugar beets provide the food industry with many useful products in addition to the sugar that is produced in some countries. The beet pulp is a valuable source of pectins and has many uses in the food industry.

Collaborations with two groups in France (Micard et al. 1996) and Holland (Oosterveld et al. 1996) have revealed considerable amounts of all of the diferulates in sugar beet pulp. What is particularly important in this case is that the propensity for further ferulates in the pulp to dimerize (effecting polysaccharide cross-linking again) can be utilized to change the pulp properties. Thus a simple treatment of the pulp with peroxidase and hydrogen peroxide produces more dimers (more cross-linking) and consequently alters the pulp viscosity. Such a product then becomes amenable to further uses in the food industry, opening up further markets for its utilization.

Diferulates in Chinese water chestnuts, and a new method for determining diferulates. A lab in the UK (Waldron et al. 1996) has discovered that there are substantial levels of the range of diferulates in water chestnuts and is now attributing the crunchy texture, even after cooking, to these intriguing little molecules. Another collaboration (Parr et al. 1996) has resulted in an alternate HPLC method for quantitation of diferulates with compound identification via diode array spectroscopic detection; our established method utilizes GC for compound separation and quantitation, GC-MS for product identification. The availability of an alternate method opens up the analysis of these important wall components to more laboratories.

References

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