Title Recent findings in plant cell wall structure and metabolism: future challenges and potential implications for softening

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Abstract

Purpose of the review: One of the main problems limiting the postharvest life of horticultural products is excessive softening. The textural properties of produce are associated with modifications in cell wall metabolism that affect wall structure and composition. Recent findings have increased the breadth of our understanding of cell wall metabolism. This article discusses future challenges and potential implications of softening.

Main findings and directions for future research: Work in the last decade has changed the way we visualise the cell wall. In terms of cell wall structure, observations showing the existence of covalent interactions between the wall's pectic and hemicellulose-cellulose microfibril networks have challenged some features of earlier cell wall models. There is also clear evidence showing that the borate ester cross-linking of the pectic compound rhamnogalacturonan II (RG-II) may influence plant growth and cell wall physical properties. It would be useful to evaluate the potential role of RG-II metabolism in fruit growth and ripening-associated softening. Another striking observation relates to wall plasticity, the way the wall's polymer composition can be varied and still maintain homeostasis. Understanding the extent to which cell walls could be modified without negative phenotypic side effects would probably contribute to the generation of alternative strategies for genetic manipulation of softening. A great deal is known about ripening-related changes in wall-modifying enzyme activities, as well as the developmental changes in the expression of the genes that encode these proteins. However, the biochemical characterisation (eg, determination of *in vivo* substrates, specific steric considerations that influence enzyme-substrate interactions, etc.) is still incomplete. Furthermore, investigations to identify wall-modifying activities that are known influence wall polymer integrity during plant cell growth, interactions with pathogens, etc. (eg, pectin acetylesterases, rhamnogalacturonases, yieldins and lipid transfer proteins) have received little emphasis in studies of fruit growth and ripening. The genetic engineering of fruits to delay softening via down-regulation of individual genes encoding wall-modifying enzymes has given limited success in some cases. However, approaches yielding the modified expression of combinations of genes could be useful for altering

cell wall disassembly more dramatically or overcoming functional redundancy; eg, polygalacturonase and pectate lyase, enzymes that use different mechanisms for cleaving the same homogalacturonan pectin target. Finally, most of the strategies evaluated to date have focused on reducing or altering cell wall degradation. An alternative approach that could have value in modifying wall behaviour would be a focus on modifying cell wall synthesis in order to generate custom-designed cell walls that could have desired functional properties.