

cultivars are also explained in part by physical and chemical differences in the cell wall, linking tissue mechanics directly to wall composition (Matteo et al., 2022).

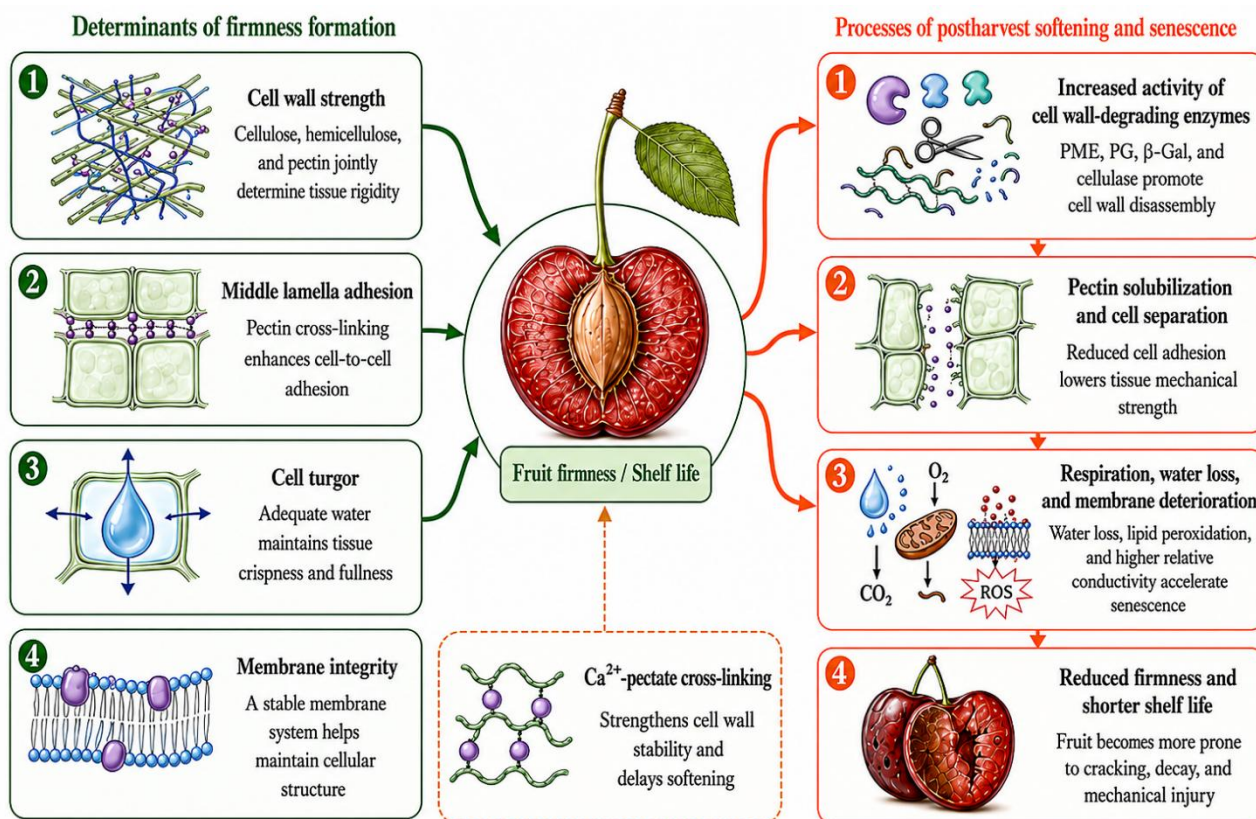


Figure 1 Physiological mechanisms underlying firmness formation and postharvest softening in sweet cherry fruit

Image caption: Fruit firmness is mainly determined by cell wall strength, middle lamella adhesion, cell turgor, and membrane integrity. During storage, cell wall-degrading enzymes promote pectin solubilization and polysaccharide disassembly, while respiration, water loss, and membrane deterioration accelerate firmness loss and senescence

At the structural level, the primary cell wall consists mainly of cellulose microfibrils embedded in a matrix of pectins and hemicelluloses, and this composite architecture underpins tissue rigidity (Hocking et al., 2016; Zhai et al., 2021). Pectin, cellulose, and hemicellulose are the major wall polysaccharides that change during ripening and softening (Guo et al., 2023; Wang et al., 2023). Pectin is especially important because it can account for a large fraction of fruit wall mass and contributes strongly to intercellular adhesion through the middle lamella (Matteo et al., 2022). Cellulose provides a comparatively stable structural scaffold, while hemicellulose helps connect the wall matrix; in cherry and related fruits, higher cellulose and hemicellulose contents are associated with firmer texture (Wang et al., 2023). Pectin solubilization and hemicellulose degradation appear to be especially important in determining firmness differences between hard- and soft-fleshed cherry types (Posé et al., 2019).

2.2 Postharvest softening and senescence

Postharvest softening is a major determinant of shelf life because it is an irreversible ripening outcome that reduces market quality after harvest (Zhai et al., 2021; Wang et al., 2025). The central mechanism is cell wall disassembly. During ripening and storage, pectins and matrix glycans are depolymerized and solubilized, neutral sugars are lost from pectin side chains, and intercellular adhesion weakens, which together increase cell separation and reduce firmness (Posé et al., 2019). In cherries, softening is associated with increased activities of pectin methylesterase, polygalacturonase, β -galactosidase, and related enzymes that damage cell wall components during storage (Correia et al., 2017). Xyloglucan endotransglucosylase/hydrolases, expansins, cellulases, and