Title Developmentally dependent responses of cucumber (*Cucumis sativus* L.) fruit to exogenous ethylene

Author Brandon Hurr and Donald J. Huber

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Abstract

Studies with members of the *Cucurbitaceae* have demonstrated the ability of ethylene to induce fruit watersoaking. The present study explored the effect of mini-cucumber fruit developmental stage on the formation of watersoaking when treated with ethylene. Fruit were harvested at four levels of development: immature (4-8 days after anthesis, DAA), mature (10-14 DAA), breaker (16-20 DAA) and yellow (35-40 DAA). Fruit were stored at 15 °C in air or either 10 µl l^{-1} ethylene or 1300 µl l^{-1} propylene for 12 d. Immature fruit treated with ethylene for 9 d exhibited mesocarp watersoaking, epidermal sloughing and lower surface hue angle, mesocarp pH, and firmness. Mature fruit behaved similarly but exhibited reduced watersoaking. In contrast, breaker and yellow fruit after 9 d of ethylene exposure accumulated β-carotene and produced aromatic compounds, but did not exhibit watersoaking. Ethylene increased respiration in fruit of all stages of development; however, ethylene production was detectable only in decaying fruit. Decay incidence increased in ethylene-treated fruit and was inversely proportional to developmental stage at harvest; however, isolated decay organisms were found to be non-pathogenic in nature. Breaker and yellow fruit retained greater cellular viability in the presence of ethylene, compared to non-watersoaked tissue of immature and mature fruit; however, watersoaked tissue did not exhibit fluorochromasia, indicating that ethylene induced programmed cell death (PCD).

Immature mini-cucumber fruit treated with air or 10 µl l^{-1} ethylene were monitored for cellular and molecular hallmarks of PCD. Total nuclease activity in control fruit remained constant during storage in air; however, ethylene-treated fruit exhibited a 4-fold increase from 3 d to 7 d, concomitant with incipient watersoaking. Four nucleases of 37, 34.5, 32.5 and 31 kD were detected by SDS-PAGE followed by activity staining. The induction of 37 and 31 kD nucleases correlated with increased total nuclease activity and incipient DNA laddering. DNA ladder intensity increased through 7 d concomitant with increases in the activities of 37 and 31 kD nucleases.

The data strongly indicate that the response of mini-cucumber fruit to ethylene is developmentally dependent. Upon ethylene exposure, older fruit share ripening characteristics with the climacteric melon, whereas younger fruit exhibit symptoms of PCD prior to incipient watersoaking.