

# Ethylene-induced Bitterness in Stored Parsnips

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Ethylene may induce off-flavor in stored carrot (*Daucus carota* var. *sativus*) roots and the formation of abnormal phenolic metabolites (3), including 3-methyl-6-methoxy-8-hydroxy-3, 4 dihydroisocoumarin (6-methoxymellein), which is associated with bitterness (4, 5). A similar response has been suggested (P.A. Ferretti, personal communication) to occur in parsnips (*Pastinaca sativa*). We report here preliminary work to verify this contention.

On 7 Oct. 'Harris Model' parsnips and 'Cellobunch' (Asgrow) carrots growing under standard cultural practices were harvested from commercial fields in the Holland-Bradford area in Ontario, Canada. Parsnip and carrot roots were placed in black polyethylene bags with holes and held for 68 days in two cold storage rooms at  $1^{\circ} \pm 1^{\circ}\text{C}$  and about 90% relative humidity. The air storage contained ethylene at either 0.03 (control) or  $4.90 \mu\text{l}\cdot\text{liter}^{-1}$  (levels averaged over the storage period). The latter level was from apples, a known ethylene emitting crop, which were held in the same room, the former was the result of outside contamination of a presumed ethylene-free environment.

Roots removed from storage were washed and hand scraped to remove a 1- to 3-mm portion of the peel, then cut into 10-mm-thick disks. Disk samples (300 g) were also boiled in 300 ml of water for 15 min. The flavor of parsnip peels, raw and cooked parsnips, and raw carrots were subjected to sensory evaluation by 14 untrained panelists using the triangle test (2). Samples (200 g) of raw and cooked parsnip tissue were homogenized, extracted with HPLC grade hexane and the hexane extract was scanned spectrophotometrically from 500 to 200 nm. The total phenol content in peel tissue of the parsnips was also estimated (3).

There were no visual external or internal abnormalities in the roots but the flavor of raw parsnip and carrot roots held in storage with apples was markedly poorer ( $P \leq 0.05$ )

than those from the control room. Many panelists commented that both parsnips and carrots possessed a bitter off-flavor, which lingered in the mouth well after the conclusion of the evaluation. Furthermore, the outer peel, which was removed before sensory evaluation, possessed a more pronounced bitter taste than the cortex (phloem), which in turn was more bitter than the core (xylem). The taste panel, as a whole, failed to detect a significant flavor difference ( $P \leq 0.05$ ) after parsnip disks were cooked in boiling water. Although a taste difference could not be conclusively established, it should be noted that the texture and overall flavor of the roots, which noticeably changed after boiling, might have influenced the evaluation.

Hexane extracts of the raw and boiled, peeled parsnips stored with apples contained UV absorbing compound(s) (Fig. 1) that were absent in control parsnips. The absorption curve for ethylene-treated roots had maxima at 286, 247, and 212 nm. It is possible that the UV spectrum profile might reflect the

accumulation of 8-methoxypsoralen (xanthotoxin); under certain conditions of stress this compound has been observed to increase in parsnip root tissues (1).

The total phenol concentration of the peel tissue of parsnip was substantially enhanced in roots exposed to ethylene during storage. The values were  $23.2 \pm 0.8$  and  $13.1 \pm 0.1 \text{ mg}/100 \text{ g}$  dry weight of tissue for ethylene-exposed and control roots, respectively.

Our results indicate that parsnip roots, like carrots, may increase in phenolic content and acquire a pronounced bitter flavor when exposed to ethylene. Presumably, there is a relationship between exposure duration and ethylene level that needs to be explored. Until this relationship is known and safe limits established, parsnips, like carrots, should not be exposed to ethylene in storage.

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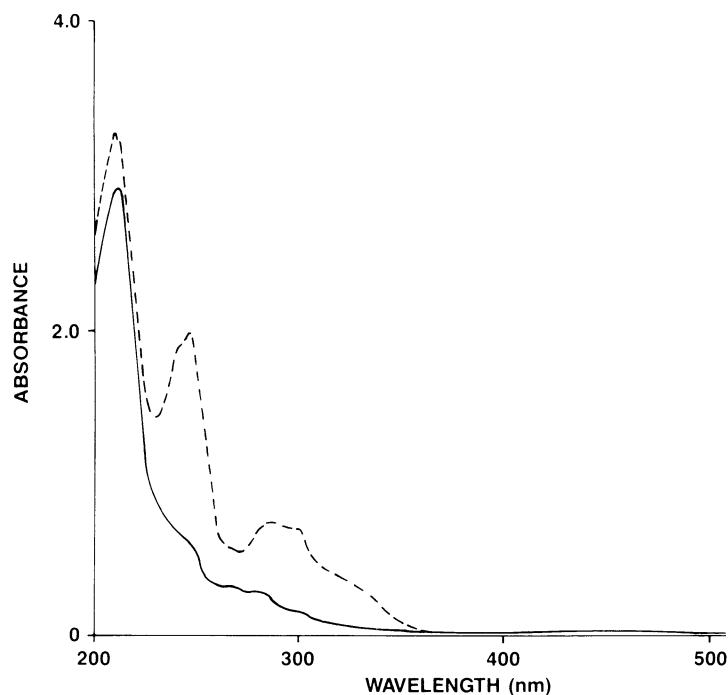


Fig. 1. Absorption profile of the hexane extracts of raw and boiled peeled parsnip root tissue after 68 days of storage at  $1^{\circ}\text{C}$  and 95% relative humidity. — = control; - - - = exposed to  $4.90 \mu\text{l}\cdot\text{liter}^{-1}$  ethylene during storage.

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