Fungi Isolated After Harvest From Decayed California Avocado Fruit

New Project; Year 1 of 2

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Benefit to the Industry

Fungi that infect avocado fruit and cause stem or side rot significantly limit the market life of these fruit. Extending the market life of avocado fruit would greatly benefit this industry. Dr. Arpaia and coworkers showed that the incidence of stem-end rot is lower after snap- than clip-harvest. We will identify which pathogens are controlled by this practice. By producing a quantitative description of what fungi cause stem-end rot and estimate the importance of each under current California conditions; practices to manage this postharvest decay problems, such as field sanitation, pre- or postharvest treatments, or temperature management regimes, can be more effectively implemented to minimize postharvest decay losses.

Objectives

In cooperation with Dr. Arpaia in her ongoing research, we will isolate from avocados that develop stem end or side rot at the firm-ripe stage from her studies of the quality of snap- and clip-harvested avocados. The isolates will be identified. Frequently isolated pathogens will be assayed for virulence. Our work will produce a quantitative description of what fungi cause stem-end rot and estimate the importance of each; this knowledge is needed before other practices, such as field sanitation, pre- or postharvest treatments, or temperature management, can be successfully implemented. By identifying and enumerating pathogens associated with avocado decay, we will provide plant pathology support for Dr. Arpaia in her market surveys and experiments evaluating the impact of harvest methods and postharvest handling on fruit quality. We will also provide additional labor for Dr. Arpaia to conduct some of her tests.

Discussion and Summary

From December 1998 to August 2000, we isolated fungi from 929 avocados that rotted after harvest. They originated from many diverse locations throughout California. The most

commonly encountered fungi were *Dothiorella* (34.3%), *Alternaria* (17.2%), *Colletotrichum* (12.1%), *Phomopsis* (7.2%), and *Botrytis* (3.3%), followed by a large number of fungi of lower incidence. Postharvest pathogens of avocado have been reported in older work, most surveys were done in growing areas other than California. The most important postharvest diseases reported are anthracnose, *Dothiorella* rot, and *Phomopsis* rot (Snowdon, 1990). In our survey, we not only isolated the fungi that caused these diseases but also other fungi associated with decayed avocados that have not been called pathogens. A significant original finding in our survey was the common occurrence of *Alternaria* spp., a weak pathogen previously rarely reported on avocado (Snowdon, 1990; Zauberman et al, 1975), but we found it repeatedly associated with objectionable darkened vascular bundles in colonized fruit. The results of this survey are important because it shows which fungi must be controlled to reduce postharvest decay losses.

In 1998, Arpaia and Hofshi reported that among avocados from San Diego County, California, the incidence of stem-end rot (SER) after storage and ripening among 'snap' harvested avocados was 15.0% while that among 'clip' harvested avocados was 38.3%. Other workers reported SER incidence was reduced when avocados were 'snap' harvested (Johnson and Kotze, 1994).

From December 1998 to August 2000, we isolated fungi from 323 avocados with SER, primarily 'Hass' cultivar, from ripe avocados that had been harvested by the 'snap' or 'clip' methods from eight groves in southern California in collaboration with M. L. Arpaia and J. R. Sievert. SER lesion size in avocados was classified as 1 (minor), 2 (moderate), or 3 (severe). SER lesions were slightly larger on 'clip' harvested avocados, which had a rating of 1.3, than those of 'snap' harvested fruit, which had a rating of 1.1. Fungi responsible for SER differed between 'clip' and 'snap' harvested fruit. *Phomopsis*, *Dothiorella*, and *Alternaria* spp. were isolated from 23, 25, and 8%, respectively, of the 'clip' harvested avocados (n=152) with SER. *Phomopsis*, *Dothiorella*, and *Alternaria* spp. were isolated from 6, 6, and 35%, respectively, of the 'snap' harvested avocados (n=171). Aggressive pathogens, capable of penetrating the fruit skin and rapidly making large SER lesions, were isolated from 48% of the 'clip' harvested fruit with SER, while they were isolated from only 12% of the 'snap' harvested fruit. Most SER lesions on 'snap' harvested fruit contained weakly parasitic fungi and saprophytes that do not make large SER lesions.

We propose that the reason the distribution of fungi isolated and SER severity differs between 'clip' and 'snap' harvest is that a large proportion of the aggressive pathogens, such as *Dothiorella* and *Phomopsis*, were eliminated from the fruit that were snapped from the tree during harvest. These fungi are associated with colonization of woody twigs where they can occur as endophytes in stem tissue (Johnson and Kotze, 1994), that are spread by splashing water and not as air-borne spores. They remained associated with the stem left attached to the tree when the avocados are 'snap' harvested, while they remained with the fruit when the avocados were 'clip' harvested. Although the inoculum of the aggressive pathogens is greatly reduced by 'snap' harvest, the relatively unprotected avocado flesh (mesocarp) exposed when fruit are harvested in this fashion is vulnerable to colonization by air-borne spores of weakly parasitic and saprophytic fungi. The limited colonization of the flesh of the stem-end by these fungi causes minor, but still objectionable, SER symptoms. We noted particularly *Alternaria* spp., although only capable of

colonizing 2 to 3 mm into soft, ripe avocado flesh, caused vascular bundles throughout the fruit to darken objectionably.

This preliminary work supports the use of 'snap' harvest to manage postharvest SER, as was similarly reported SER by other workers (Johnson and Kotze, 1994). However, a negative consequence of 'snap' harvest they reported was that it delayed ripening, and the delayed ripening was associated with increased postharvest side rot losses by *Colletotrichum*. Working in South Africa with Fuerte avocados, Darvas et al (1990) reported removal of the pedicel at harvest reduced a stem end rot severity rating from 0.54 to 0.18, although this benefit was accompanied by a delay in ripening, from 4.7 to 6.0 days, which resulted in an increase in anthracnose side rot severity from 0.09 to 0.47. They found delayed ripening in general increased postharvest rot of Fuerte avocados. Conversely, Tingwa and Young (1975) reported removal of the button did not delay ripening of Hass avocados in California. Similarly, 'snap' harvested Hass fruit ripened at the same rate as 'clip' harvested fruit in the work of Arpaia and Hofshi (1998); presumably, side rot incidence in California would not be influenced by harvest method. Darvas et al. evaluated the impact of sealing the cut pedicel with wax, alone or with fungicides. They found wax sealing reduced stem-end rot significantly, with no impact on ripening time or side rot incidence. Waxing the entire fruit, however, delayed ripening, and the benefits of adding fungicides (prochloraz, benomyl, or thiabendazole) to the wax were small. Many new fungicides have been introduced in recent years, many in the USEPA "reduced-risk" class which facilitates registration, and their use to control postharvest rot deserves evaluation in California.

This work also shows which type of fungi are associated with SER under these two harvest methods; this information impacts the disease control methods employed to reduce SER. For example, for 'clip' harvested fruit, fungicides or other techniques employed for preharvest or postharvest management of SER should focus on *Phomopsis* and *Dothiorella* control, while on 'snap' harvested fruit, control of other fungi, such as *Alternaria*, becomes important. Methods to protect fruit from air-borne spores are presumably very important for 'snap' harvested fruit, because the fruit flesh is exposed and vulnerable to attack by air-borne spores of even weak pathogens and saprophytes. The woody stem of 'clip' harvested fruit resists postharvest infections from air-borne spores and may not require rigorous protection from contamination, although the stem itself often harbors quiescent SER infections of the very aggressive *Phomopsis* and *Dothiorella* fungi.

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