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PEACH MARKET LIFE – SHOULD WE APPLY THIS CONCEPT?

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One of the most frequent complaints by consumers and wholesalers is lack of juiciness (flesh mealiness), flesh browning (FB), black pit cavity, flesh translucency, red pigment accumulation (bleeding), and loss of flavor in peaches (Fig. 1). These symptoms are caused by a genetic disorder, and are triggered when fruit is exposed to low temperatures; therefore the condition is known as chilling injury (CI). In the specific case of peach, the expression of chilling injury is also called internal breakdown (IB). Peach fruit are highly perishable and may deteriorate quickly at room temperature, thus, low temperature during storage and/or shipping is used to extend fruit market life. As these symptoms mainly develop during fruit ripening after cold storage, this problem is usually not noticed until fruit reaches consumers. Thus, the onset of these symptoms determines the potential postharvest market life because CI development reduces consumer acceptance and consumption. Market life has subjectively been defined as the number of weeks each cultivar lasted under continuous storage at 32°F and/or 41°F, without exceeding 20% flesh mealiness or 15% browning symptoms. It is important to point out that the onset and intensity of CI symptoms during postharvest handling varies according to cultivar, preharvest cultural

practices, growing season environmental conditions, and postharvest handling (temperature). Among these, the relationship between cultivar and temperature on market life has been investigated in detail by my group during the mid 1990s and early 2000s.

This genetic disorder is the main limitation to long-term storage and shipment to distant markets for CI-susceptible peach cultivars. It is well known that CI is induced when fruit are stored below 50°F for a prolonged period and CI symptoms developed more rapidly in fruit held at 36°F to 41°F than in fruit stored at 32°F. In CI susceptible peaches, the greatest development of CI symptoms occurs at storage temperatures between 34°F and 48°F so we named this the killing temperature range. Unfortunately, to slow down deterioration (respiration, water loss, decay development, softening), peaches are typically exposed to this temperature range during transport and warehouse handling operations.

I believe that information on peach cultivar market life is fundamental in developing prepackaging, storage, shipping and retail postharvest handling strategies to reduce CI, protect flavor, and extend peach market life. Evaluation of peach chilling injury has been a continuing part of our department's research programs. For a long-term solution, this information is valuable to geneticists/breeders to develop peach cultivars free of CI, to understand the genetic inheritance of CI, and to locate the genes responsible for these disorders and develop markers for an early mass selection. In addition, this new information is important for plant physiologists in order to design fundamental studies to improve the basic understanding of the CI problem.

The Genetic and Temperature Interaction Factor

Over the last 15 years (early 1990s through early 2000s), my research group has evaluated ~ 120 peach selections/cultivars. During this 15-year period, we concluded that lack of flavor, flesh mealiness, and flesh browning were the most frequently observed CI symptoms among most of the California peach cultivars tested. In these cultivars, flesh bleeding was observed only in a few cases and it did not affect fruit flavor. Thus, in many of these recently released cultivars, the formation of red color in the flesh (bleeding) was not related to CI symptoms. In previous evaluations (1980) using a different group of peach cultivars, flesh bleeding was considered part of the chilling injury symptoms.

From our work, we found that the type of symptoms and the storage time prior to the development of CI depended on the cultivar and storage temperature. A majority of peach cultivars developed lack of flavor, flesh mealiness and flesh browning. Some cultivars developed lack of flavor and flesh mealiness but not flesh browning, while a few cultivars had only lack of flavor and flesh browning but no flesh mealiness symptoms. Finally, some cultivars did not develop any flesh mealiness or flesh browning symptoms. We classified cultivars as type A, cultivars that did not develop any CI symptoms at either storage temperature (32°F and 41°F); type B, cultivars that did not develop any CI symptoms when stored at 32°F but they did develop when stored at 41°F; and type C, cultivars that develop CI symptoms when stored at either temperature. Market life at 41°F varied from less than 1 week to at least 5 weeks while market life at 32°F varied from 3 to at least 5 weeks.

Among the cultivars evaluated for CI in the mid 1990s, 25% of the cultivars did not develop chilling injury symptoms at either storage temperature (Type A) (Table 1). Twelve and one-half percent of the cultivars developed CI only when stored at 41°F (Type B), and 62.5% developed CI when stored at either temperature (Type C). Among the early 2000s CI evaluations, 30% of the cultivars segregated into Type A, 28% into type B and 42% of the cultivars developed CI when stored at either temperature (Type C). It is important

to point out that recent releases from the California breeding programs are introducing peach genetic material that is less prone to chilling injury. For example, type C cultivars were reduced from 62.5% to 42%.

The Fruit Size Factor

In the mid 1990s, we studied the relationship between peach fruit size and market life for 'Elegant Lady' and 'O'Henry' peaches. For example, during the 1996 season, market life was affected by fruit size and storage conditions. By 14 days at 32ºF, only 21% of the 'Elegant Lady' large size air stored fruit were juicy, while medium and the small size fruit remained fully juicy. By 21 days storage in air at 32ºF, 60% of the medium size fruit were juicy and small size fruit remained fully juicy (Fig. 2). At 38ºF, 'Elegant Lady' fruit developed mealiness in all three sizes tested within the tested time period (Fig. 2). The first symptoms became visible after 7 days on both the large size (20% juicy) and for the medium size (80% juicy) air stored fruit at 38ºF (Fig. 2). By 14 days, most of the large size fruit were mealy. For medium size fruit, only 31% and 8% of the fruit remained juicy after 14 and 21 days storage, 38ºF, respectively.

After 14 days at 32ºF, 63% of large size 'O'Henry' fruit remained juicy and only 4% after 21 days while medium and small size fruit remained fully juicy. By 21 days at 41ºF, 45% of the medium size air stored fruit remained juicy. For small size 'O'Henry' fruit stored under air at 32ºF, mealiness reached critical levels (80% juicy) after 21 days (Fig. 2). All three sizes of 'O'Henry' peaches showed symptoms of CI when stored at 38ºF. After 7 days air storage at 38ºF, 62% of the large, 84% of the medium and 92% of the small size fruit were juicy. By 14 days at 38ºF, large size fruit had ~10% juicy fruit, medium size fruit ~20% juicy and small size fruit ~50% juicy (Fig. 2).

Based on this data, under 32ºF air storage conditions, predicted maximum market life of large, medium, and small size 'Elegant Lady' peaches was 9, 19 and 21+ days, respectively. The three similar sizes of 'O'Henry' fruit lasted 13, 16, and 21+ days in air storage at 32ºF, respectively. The predicted market life of 'Elegant Lady' in air at 38ºF (minimum market life) was 4, 8, and 21 days for large, medium, and small sizes, respectively. Large, medium, and small sizes of 'O'Henry' fruit stored in air at 36ºF had a minimum market life of 5, 6, and 12 days, respectively. Market life of 'Elegant Lady' and 'O'Henry' peaches stored at 32ºF or 38ºF in air was predicted using regression equations. Predicted market life was based on incidence of CI for both peach cultivars, but did not include the four days storage at 32ºF prior to the main storage treatment.

The Preconditioning Treatment

A commercial controlled delayed cooling or preconditioning treatment was developed to extend peach market life of the most popular California peach cultivars. A controlled 48-h cooling delay at 68ºF was the most effective treatment for extending market life of chilling injury susceptible peaches without causing fruit deterioration. This preconditioning treatment increased minimum market life (41ºF) by up to 2 weeks in the cultivars tested when properly executed (Table 2). Detailed monitoring of these fruit quality changes during the delayed cooling period and proper use of fungicides is highly recommended for success in this new fruit delivery system. Rapid cooling after preconditioning is important to stop further fruit deterioration such as flesh softening, senescence, decay and weight loss. Controlled delayed cooling can also be used to pre-ripen susceptible and nonsusceptible peaches in order to deliver a "ready to buy" product to the consumer.

WHAT DO WE KNOW SO FAR?

- Peach market life is limited and it depends on the cultivar and postharvest temperature.
- Lack of flavor, development of mealiness and browning symptoms, thus, market life in the CI susceptible cultivars was delayed

when fruit were stored at 32°F rather than 41°F.

- CI symptoms developed more rapidly and with greater intensity at 41°F than 32°F and are one of most frequent consumer complaints.
- Fruit size influenced the onset and intensity of CI, and thus fruit market life potential. Large size fruit has a shorter market life than medium and small size fruit within a given marketing period.
- Peaches will often encounter 41°F temperatures during their postharvest handling in our current distribution system.

HOW CAN WE USE THIS INFORMATION TO REDUCE LOSSES?

- Peach market life information will provide guidance for growers, packers, shippers, handlers and retailers in designing their postharvest strategy. For example, special supervision, priority, and enforcement of proper postharvest temperature management should be carried out on Type B and C cultivars.
- Proper application of the preconditioning treatment will extend the market life under the worst postharvest handling conditions (41°F) by up to 2 weeks, protecting peach flavor within a limited time period.
- Shortcuts in the application of the preconditioning treatment will not extend market life, in fact these shortcuts can even jeopardize fruit integrity.
- Fast marketing will improve peach consumption.
- Identifying and developing genetic markers for the genes responsible for this disorder will help peach breeding programs.

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Table 1. Peach Market Life Evaluations

Cultivars (%)		Chilling injury		Type
1999	2004	0ºC	5ºC	
25	30	NO	NO	A
13	28	NO	YES	B
62	42	YES	YES	C

Source: Crisosto et al., 1999 and 2004b.

Table 2. Increase (↑) or decrease (↓) in market life of preconditioned peaches at 68ºF compared to untreated (no cooling delay) peaches based on development of chilling injury (CI) during storage at 32 or 41ºF.

Cultivar/ Delayed cooling treatment	Change in maximum market life at 32ºF (weeks)	Change in minimum market life at 41ºF (weeks)
'Flavorcrest' (1999) 48 h at 68ºF	0	↑ 1+
'Elegant Lady' (1999) 48 h at 68ºF	0	↑ 1+
'Summer Lady' (2000) 48 h at 68ºF	↑ 1+	↑ 2[1,2]
'O'Henry' (1999) 48 h at 68ºF	↑ 1+	↑ 1+
'Zee Lady' (2000) 48 h at 68ºF	0	↑ 1+
'Ryan Sun' (2000) 48 h at 68ºF	↑ 2+	↑ 2[2]

End of market life based on chilling injury (CI) determined when ≥25% of the fruit became mealy or leathery[1], or had flesh browning[2]. Superscript indicates limiting condition.

Source: Modified from Crisosto et al., 2004a.

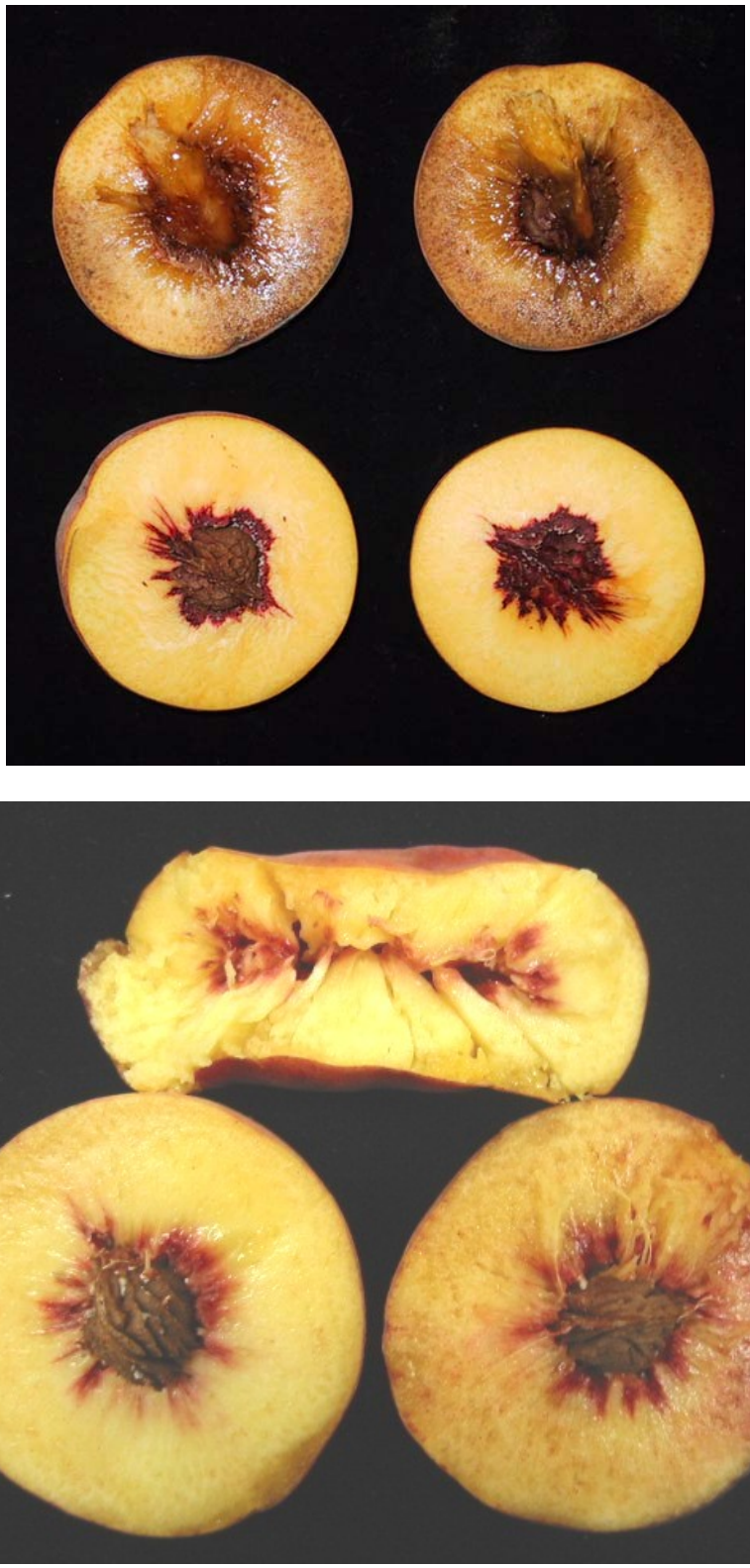

Fig. 1. Peach flesh browning (top photo, top row),) and mealy peach (bottom photo) are symptoms of chilling injury compared to a healthy peach (top photo, bottom row).

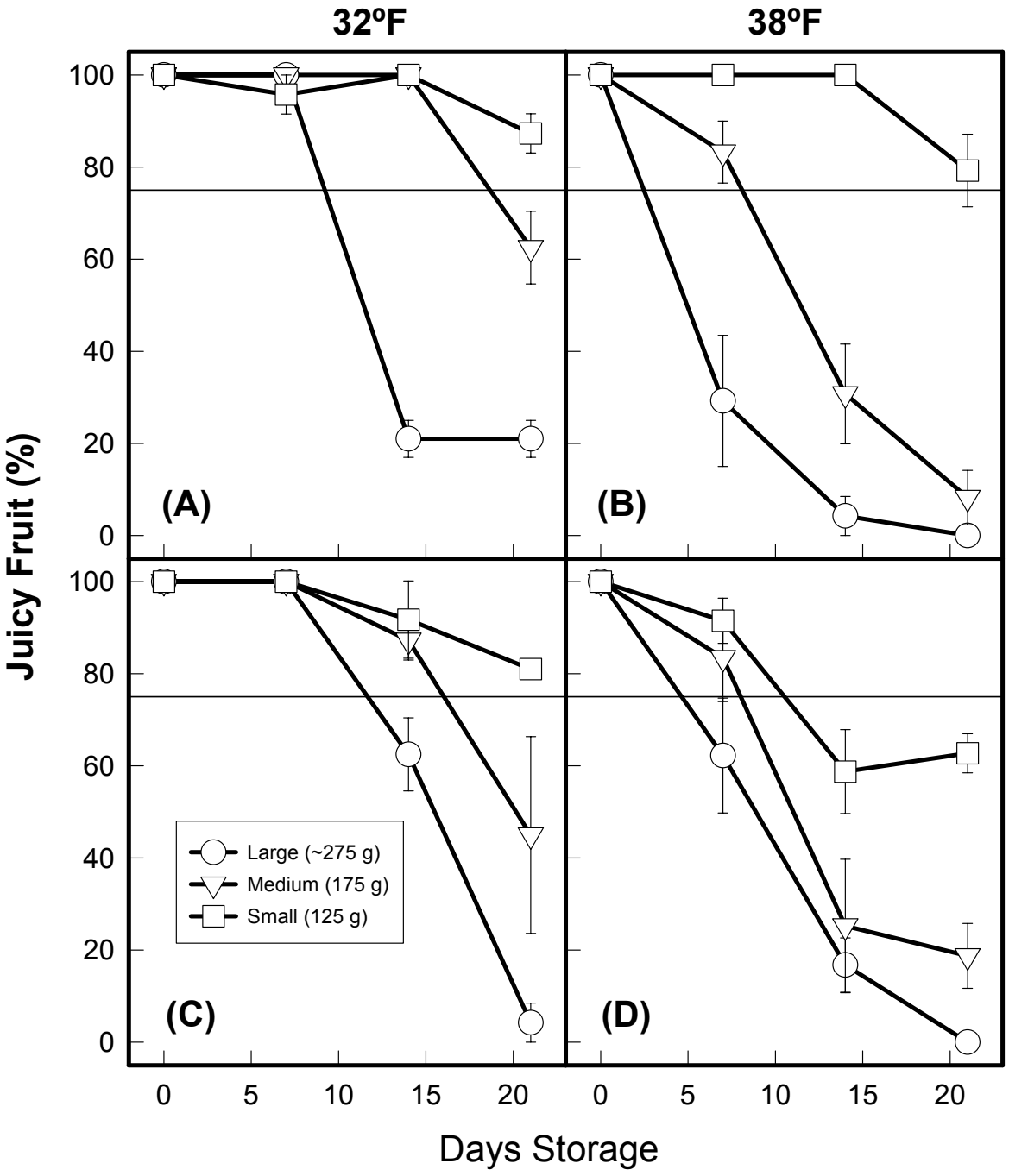

Fig. 2. Influence of fruit size and temperature on incidence of internal breakdown for 'Elegant Lady' peaches stored at (A) 32ºF and (B) 38ºF, and on 'O'Henry' peaches stored at (C) 32ºF and (D) 38ºF. Vertical bars represent ±SE; horizontal reference lines represent the marketability threshold.

Source: Crisosto et al., 1999.

FUTURE DATES

2006 Variety Displays and Research Update Seminars at the Kearney Agricultural Center, 9240 S. Riverbend Avenue, Parlier, CA. Sponsored by University of California Cooperative Extension and the Kearney Agricultural Center.

8:00 – 9:00 a.m.	Variety display by stone fruit nurseries, breeders and the USDA
9:00 – 10:00 a.m.	Research Update Topic and discussion in the field

Mark your calendars for these dates:

- Friday, June 9 — Mechanical Topping to Control Tree Height
- Friday, July 14 — Rootstock Options for Stone Fruit
- Friday, September 8 — Soil Fumigation Considerations

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Other upcoming events posted on the Postharvest Calendar at the ANR website can be found at: http://ucce.ucdavis.edu/calendar/calmain.cfm?calowner=5423&group=w5423&keyword=&ranger=3650&calcat=0&specific=&waste=yes

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