

Working toward better orange juice in the HLB world

By Jude Grosser, Fred Gmitter, Yu Wang and Bill Castle

It's no secret that huanglongbing (HLB) has challenged the industry to maintain the outstanding quality associated with Florida orange juice. Moreover, increased prices and competition from new juice products and blends have reduced Florida orange juice consumption. We believe that improving the quality, especially flavor and color, of juice products can help battle the declining juice consumption problem (Figure 1).

The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) citrus improvement team at the Citrus Research and Education Center (CREC) has been engaged in sweet orange improvement since the mid-1980s. The complex biology of sweet orange makes it difficult to directly breed new sweet oranges. Therefore, the program has exploited other reliable sources of genetic variation, in addition to conventional breeding, in efforts to improve numerous quality factors.

Last year, the citrus improvement team published an article in Citrus Industry magazine describing how HLB-tolerant mandarin hybrids that have been developed could be used to improve Florida orange juice (<http://citrusindustry.net/2018/09/17/could-hlb-tolerant-mandarins-be-used-in-florida-orange-juice/>). That article focused on research to gain a better understanding of the genetics that control fruit flavors as well as using sensory analyses (taste tests) to decipher flavor perception.

This article provides an overview of progress and strategies regarding the development of true processing sweet oranges with potential to enhance the Florida not-from-concentrate (NFC) portfolio. Also included in this article is the development of sweet orange-

like hybrids that could be used to enhance Florida juice quality or to produce new high-quality, stand-alone juice products.

SOMACLONAL VARIATION

The initial effort at processing sweet orange improvement exploited somaclonal variation, a tissue culture technique that produces trees that

sometimes exhibit useful variation from which improvements can be selected. It is a shot-gun approach, requiring large populations of trees to identify improved clones.

We created and evaluated more than 1,000 clones each of Hamlin and Valencia selections through this evaluation process. From these, several improved sweet oranges have been released for commercial production. Since the earlier work, additional somaclones of Orie Lee Late (OLL) have been developed and released that exhibit improved quality factors. The new cultivars include:

- Hamlin N13-32, selected for improved juice color
- EV-1 and EV-2, early-maturing Valencias that reach 15 ratio around Thanksgiving
- Valquarius, an earlier-maturing Valencia that can be harvested



Figure 1. Left: Juice from UF sweet orange OLL-8; right: commercial not-from-concentrate juice. Note the color difference.

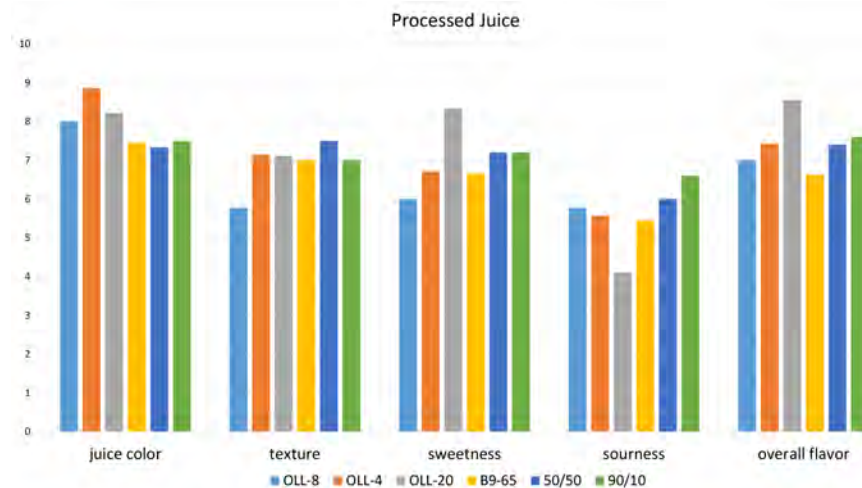


Figure 2. Results from the University of Florida/Institute of Food and Agricultural Sciences Feb. 19, 2019 Juice Display. Subjective mean scores from display attendees are on a scale of 0 to 10 with 10 being a perfect score. 50/50 is a 1:1 blend of pasteurized Valquarius and LB8-9 Sugar Belle® juice; 90/10 is a 9:1 blend of the same varieties.

from mid-January through February

- Valencia B9-65, a standard-maturity Valencia with superior yield and soluble solids production
- N7-3 (ValenFresh), a nearly seedless Valencia
- OLL-8 and OLL-4, very productive Oriee Lee Late selections that exceed Valencia for flavor and color (Figure 2, page 12).

The UF/IFAS team is continuing to produce and evaluate sweet orange somaclones, and more releases are on the way. These include OLL-20, selected for its superior flavor profile (Figure 2, page 12), and a new mid-season Vernia selection that appears to be more tolerant to HLB.

SEEDLING INTRODUCTIONS

Florida Citrus Hall of Fame grower/researcher Oriee Lee and UF/IFAS' own Florida Citrus Hall of Fame team member Bill Castle have traveled the world to collect seed of sweet oranges that might have potential to improve the Florida Industry. They have collected and brought back many candidates which they have spent many years evaluating.

This pioneering work led to the commercial release of Vernia, now a mainstay mid-season clone in the industry because of its productivity and Valencia-like juice quality. Early Gold, Itaborai and Westin were also products of these efforts.

We continue to seek genetic variation found in sweet orange nucellar seedlings, with focus now on the OLL series. There may be a common genetic phenomenon that leads to a greater frequency of genetic variation occurring in the OLL oranges. The original OLL tree, produced from budwood irradiation more than 60 years ago, was unstable. This instability could be due to the movement of a transposon, also known as a "jumping gene," induced by the radiation process. Transposon movement in the genome can turn genes on or off, and such transposon-induced genetic variation can be exploited for variety improvement.

We previously planted a population of more than 200 OLL seedlings on their own roots in a commercial grove near Dade City, Florida, in an

area with very heavy HLB pressure. In fact, this grove has since been destroyed due to HLB. However, after four years, we identified 2 OLL seedling clones that were completely healthy. They exhibited no HLB symptoms and were PCR-negative for *Candidatus Liberibacter asiaticus* (CLAs), the causal agent of HLB. These two seedlings were recovered by grafting and will be evaluated on a large scale as part of a U.S. Department of Agriculture and Consumer Services Animal and Plant Health Inspection Service Multi-Agency Coordination

(MAC) project.

A second trial of OLL seedling trees is underway in Saint Cloud, Florida, with no formal psyllid control. (It receives only one standard oil spray per year.) This trial included 350 individual OLL seedlings. After five and a half years, we identified 17 individual seedling-derived trees that were PCR-negative (no HLB infection) and several more with very low CLAs titers. These OLL seedling clones are also showing significant variation in juice quality, maturity date and seed content. Continued evaluation could



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lead to the development of additional HLB-tolerant clones with improved juice quality.

BUDWOOD IRRADIATION

Exposing budwood to high doses of radiation to induce mutations has been used most commonly to develop seedless selections from high-quality but seedy selections. There have been several successes, including Tango mandarin (from seedy W. Murcott) and Star Ruby (from seedy Hudson).

We have used this approach with sweet oranges as well, leading to the release of the superior Midsweet 11-1-24, a nearly seedless selection with earlier maturity, greater yields and higher solids than other midseason selections. Two seedless Valencia clones from an irradiation experiment have shown notable tolerance to HLB and will be evaluated in the MAC project. We are evaluating irradiated budlines of Vernia and the OLL series. We have identified additional selections of Vernia with earlier maturity and excellent juice quality, and OLLs with improved color and flavor, along with

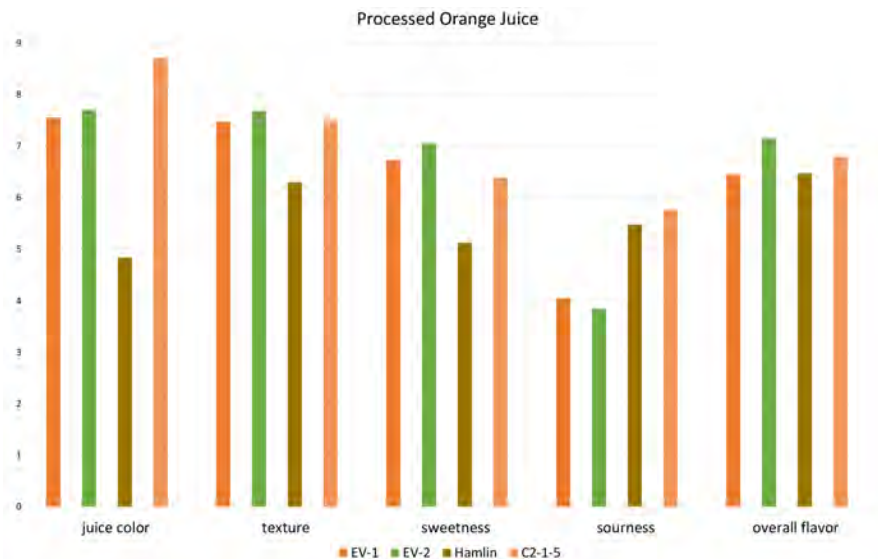



Figure 3. Data from the University of Florida/Institute of Food and Agricultural Sciences Oct. 30, 2018 Juice Display. Subjective mean scores from display attendees are on a scale of 0 to 10 with 10 being a perfect score. EV-1 and EV-2 are early-maturing Valencia clones, Hamlin is the standard early-season cultivar, and C2-1-5 is a seedless triploid orange-like hybrid that is only one-third sweet orange.

potentially improved HLB tolerance.


CONVENTIONAL BREEDING

Although conventional breeding of sweet orange is difficult, we have produced several HLB-tolerant, orange-like

hybrids. They could be classified as sweet oranges, with some minor changes to the “standard of identity” regulations currently used in the industry. Some of these are seedless triploid hybrids. In making such crosses, we




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focus on combining sweet orange genetics with increased HLB tolerance.

For example, we included juice from a new unreleased triploid hybrid of mandarin with orange, C2-5-1, in a UF/IFAS October 2018 Fruit Display. The results were very promising (Figure 3, page 14). Juice color of C2-5-1 was superior to that of even the Early Valencia clones, and flavor was like that of Hamlin and the EVs. This hybrid looks, smells and tastes like an orange. So, is it an orange? At minimum, it could be blended at 10 percent to increase the color and Brix of the early-season juice supply. What's more, the original C2-5-1 tree is showing very good HLB tolerance! Juice from a second such hybrid was included in the UF/IFAS January 2019 Fruit Display in Vero Beach. It also was highly regarded as a juice product, as well as an attractive fresh fruit selection.

BLENDING

Through blending, we have identified several mandarin hybrids with notable HLB tolerance and potential

for improving Florida NFC quality and flavor. Sugar Belle®, clearly the most HLB-tolerant commercial variety currently available, has led the way. It can be reliably used to improve the Brix, flavor and color of processed orange juice (Figure 2, page 12). Sugar Belle® also has potential as a stand-alone, high-quality juice product.

In a UF/IFAS December 2018 Fruit Display, we included a juice blend that was 80 percent hybrid C4-16-12 (a Hamlin-like, high-Brix triploid hybrid that is one-third sweet orange and one-eighth trifoliate orange) and 20 percent C4-10-42 (a highly colored, high-Brix and rich flavored triploid hybrid that is one-third Sugar Belle®). This blended juice, containing no true orange juice, was perceived as orange juice at the display, and was favored for flavor by nearly two to one over Hamlin and the Early Valencia selections. C4-10-42 produces richly flavored juice with up to 17 Brix and a 42 color score. It has tremendous blending potential.

Research to pursue blending opportunities is well underway at

the CREC. We have also produced and planted hundreds of additional hybrids of sweet orange with more HLB-tolerant mandarin parents that should be fruiting in the coming years to create even more opportunities. Hopefully, the major orange juice processors will team up with the UF/IFAS breeding/flavor chemistry team to fully exploit these opportunities. As the industry replants citrus for the future, we believe that at least 10 percent of the trees should be superior HLB-tolerant hybrids that will improve the flavor and quality of Florida juice products.

For more information on available UF/IFAS sweet oranges, visit the Florida Foundation Seed Producers website (<http://www.ffsp.net/varieties/citrus/>) and the New Varieties Development & Management Corporation website (<http://nvdmc.org/>). 🍊

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