Could HLB-tolerant mandarins be used in Florida orange juice?

By Laura Reuss, Fred Gmitter and Yu Wang

Sweet orange and mandarin fruits are the most popular citrus crops worldwide. Although often mistakenly considered one and the same, oranges and mandarins are different species with specific distinctions. For instance, mandarins are smaller and easier to peel than oranges. Additionally, mandarins are primarily eaten as fresh fruit, whereas most sweet oranges produced in Florida are processed for their juice.

HLB AND FLAVOR

In the United States, prior to the ravages of huanglongbing (HLB), Florida was the largest producer of oranges, and it was Florida's signature crop. Unfortunately, HLB has drastically reduced orange yields and devastated the Florida citrus industry for over a decade. One of the many devastating effects of this disease is the change in the flavor of oranges. This has had a negative impact on the processed orange juice business.

Therefore, there is a need to adjust orange-processing procedures in an effort to alleviate the negative effects resulting from HLB, such as bitter tasting fruit and the decline in fruit availability. Both of these effects have led to a shortage of raw material required to meet consumer demand. While researching cultivars that appear HLB tolerant, scientists in the citrus breeding program at the University of Florida Institute of Food and Agricultural Sciences Citrus Research and Education Center (UF/IFAS CREC) in Lake Alfred have identified specific mandarin hybrid varieties that demonstrate a high level of HLB tolerance.

COMPARING FRUIT FLAVORS

Interestingly, some of these HLB-tolerant mandarin hybrids produce fruit with a distinctive orange-like flavor yet maintain the physical traits of mandarin fruit. Therefore, understanding the differences between orange and mandarin fruit flavor has generated tremendous interest within the citrus research community. Additionally, a better understanding of orange fruit flavor versus mandarin fruit flavor may support the use of HLB-tolerant mandarin hybrid juice to supplement orange juice products in order to meet consumer demand while sweet orange supplies are low. To investigate these flavor differences, we conducted sensory evaluations to determine consumer opinions of an HLB-tolerant mandarin with distinctive orange-like flavor.

Aromatic compounds have been used to compare orange varieties and to identify flavor components of satsuma mandarins and mandarin juice. Due to the numerous key aromatic compounds orange and mandarin fruits have in common, characterizing the differences responsible for their flavors is quite complex. Therefore, recently published studies in Yu Wang's lab at CREC have led to investigations into an unreleased mandarin hybrid known to produce fruit with orange-like flavor to validate the identification of characteristic volatiles of orange-like aroma.

TASTE TESTS

The sensory analysis component of this study was comprised of two tests: the nose-pinch and the pinch-free sensory test. Fifteen trained panelists were exposed to different varieties of fresh-squeezed orange and mandarin juices to become familiar with the flavors.

For the nose-pinch test, panelists blocked their own nasal passage using their thumb and forefinger to pinch their nostrils together while drinking each juice sample. For the pinch-free test, panelists simply drank each freshly squeezed sample (Figure 1) that was randomly presented to them.

Panelists were asked to consecutively taste each juice sample, and then choose the orange juice sample from the two presented. In the nose-pinch test, 40 percent of the panelists selected the correct sample, while 6 percent of the panelists picked the incorrect sample. Notably, the remaining 54 percent

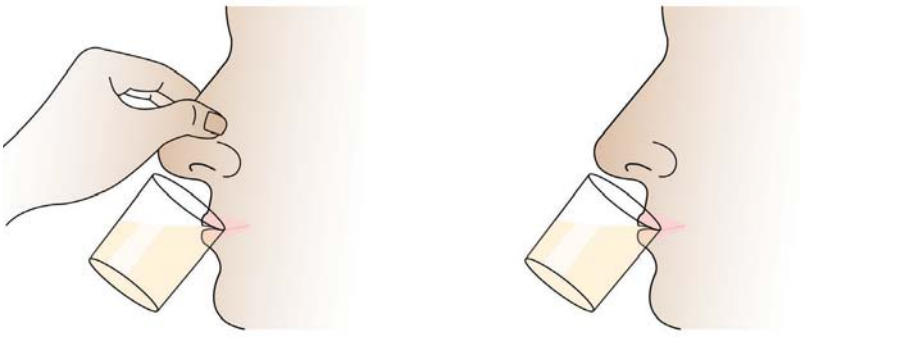

Figure 1. Allowing panelist input from two senses (taste and olfactory) provided a more accurate evaluation of juice samples as compared to excluding olfactory input (nose-pinch test).

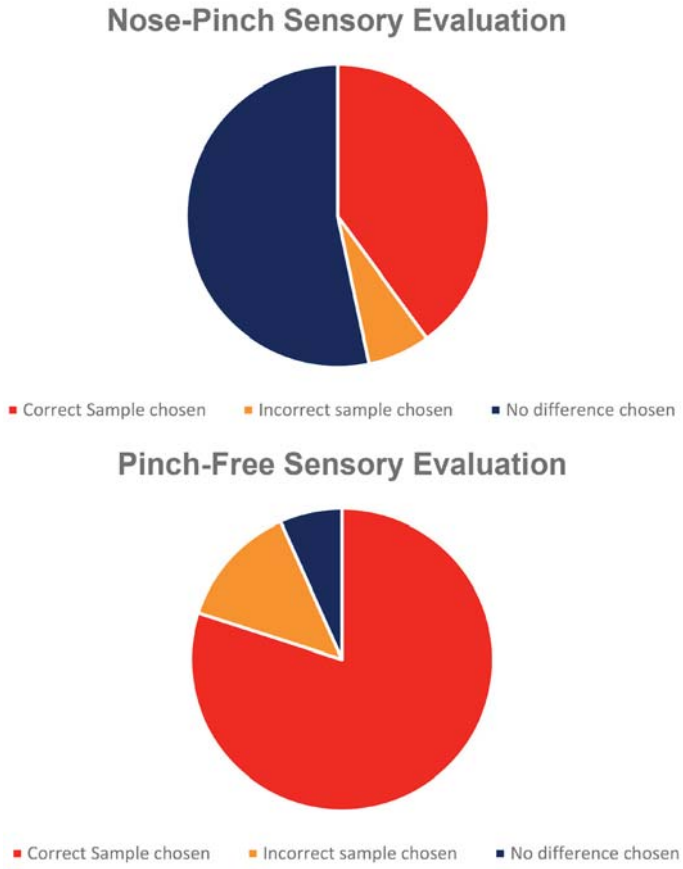

Figure 2. While pinching their noses, panelists were much less likely to differentiate between orange and mandarin juice samples.

of panelists were unable to tell the difference between the two samples.

Collected comments indicated that panelists who chose the correct sample based that decision on the idea that "orange juice always tastes sourer than mandarin juice" and "orange juice has a tart taste/aftertaste." In the pinch-free test, 80 percent of panelists selected the correct sample, 14 percent selected the incorrect sample, and 6 percent could not make a selection (Figure 2). Panelists failing to select the correct sample noted, "I cannot tell which one is orange juice."

FLAVOR PERCEPTION

Flavor perception involves most of our senses. The smell, taste, texture and color of food or drink all influence how we perceive flavor. This perception results as the receptors located along the nasal passageway and on the tongue are activated by the chemical compounds released as food or drink is ingested.

During the nose-pinch test, panelists were limited to solely taste perception as the sensory input to describe each juice sample. Chemically, orange juice is not necessarily sourer than mandarin, nor vice versa. Sourness and sweetness of orange and mandarin fruit flavor varies by cultivar, as well as from fruit to fruit. So panelists' interpretations of taste (sourness of the juice) inaccurately influenced their differentiation of orange and mandarin juice samples. The majority of panelists were unable to describe the juice samples using a single perception (taste), suggesting that taste alone cannot identify orange or mandarin fruit flavor characteristics.

Conversely, the combination of aroma perception with taste perception (pinch-free test) allowed panelists to respond with a more accurate interpretation of the flavor for both orange and mandarin juice samples. These results indicate that citrus fruit aroma largely contributes to differentiation of orange from mandarin. The flavor of orange or mandarin fruit is, therefore, the combined perception of both taste and aroma. The general understanding of taste and aroma is that they interact together. The combination of the two are thought to result in a sensation greater than the sum of the perceptions.

It has been demonstrated that the sensory input of taste and smell are linked by the central nervous system

over time. Additional studies into the taste-smell association, including evaluations of brain scans, indicate aroma alone may be able to elicit flavor perception. However, taste alone will not.

A follow-up sensory evaluation of juice from an unreleased mandarin hybrid was then conducted to validate the nose-pinch and pinch-free results. Evaluation of each juice sample was performed by 16 trained panelists who were asked to drink the juice and describe the sample as "orange juice," "mandarin juice" or "don't know," and to provide comments relating to their choice. Sixty-seven percent of the panelists stated the juice samples were "orange juice." Twenty-seven percent of the panelists chose "mandarin juice" based on the "thick texture" and 6 percent of the panelists selected "don't know" (Figure 3).

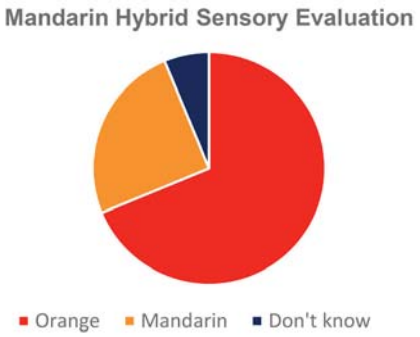

Figure 3. In the mandarin hybrid juice sensory evaluation, the majority of panelists stated the sample tasted like orange juice.

RESEARCH IMPLICATIONS

Resulting from a cross between sweet orange and mandarin, this unreleased mandarin hybrid developed by the CREC citrus breeding program exhibits substantial HLB-tolerance. Sensory evaluation of this mandarin juice flavor indicated an intense orange-like characteristic, whereas the juice texture could still be characterized as mandarin-like by some. Our results imply that this mandarin hybrid fruit not only has potential to confirm flavor differences between orange and mandarin fruit in further investigations, but notably, the characteristics of this orange-like mandarin fruit suggest future uses to supplement the orange juice industry.

Of course, changes to the U.S. Food and Drug Administration standards of identity regulations would be necessary to include more than the maximum allowable percentage of juice from fruit not harvested from *Citrus sinensis* into the product we call orange juice. Other juice and processing attributes of new HLB-tolerant cultivars such as this must be carefully studied to move forward beyond this first evidence of proof of concept.

Such a cultivar needs to be assessed for horticultural performance in order to ensure that it can meet the needs of processors and will be profitable for growers. Florida's citrus breeders have identified several candidates already and are making new crosses to select more candidates. Working together with food scientists, the breeders hope to provide new options for Florida's growers to succeed in the HLB era.

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