Goodbye *Citrus sinensis* and Hello Biodiversity – Implications for FDA Orange Juice Standards

What’s Your Name? Who’s Your Daddy?

presented by Kristen Carlson

Executive Director
FLORIDA CITRUS PROCESSORS ASSOCIATION
ICBC, September 2022
Part 1. Nomenclature for the Sweet Orange
Sec. 146.135 Orange juice.
(a) Orange juice is the unfermented juice obtained from mature oranges of the species *Citrus sinensis* or of the citrus hybrid commonly called "Ambersweet" (1/2 *Citrus sinensis* X 3/8 *Citrus reticulata* X 1/8 *Citrus paradisi* (USDA Selection:1-100-29: 1972 Whitmore Foundation Farm)). Seeds (except embryonic seeds and small fragments of seeds that cannot be separated by current good manufacturing practice) and excess pulp are removed. The juice may be chilled, but it is not frozen.

(b) The name of the food is "orange juice". The name "orange juice" may be preceded on the label by the varietal name of the oranges used, and if the oranges grew in a single State, the name of such State may be included in the name, as for example, "California Valencia orange juice".
A few breeding fundamentals

- **Species** = plants capable of exchanging genes for interbreeding. Taxonomic unit below Genus i.e. Citrus
- **Variety** = two plants crossed in nature
- **Cultivar** = 2 plants crossed by man
- **Different cultivars** can be in the same genus and species but can look very different
- **Hybrids** = two species crossed i.e. *C. maxima* x *C. reticulata* that can happen naturally or controlled by plant breeders
- **“Interspecific”** = crossing two different species
- **Introgression** = transfer of genetic information from one species to another by repeated backcrossing of an interspecific hybrid with one or both parent species
Taxonomy is the practice of identifying plants, classifying them into categories and naming them. The tectonic plates are shifting in the classification of plants in the Genus Citrus.
DNA now reveals more about where a plant belongs taxonomically. Molecular markers and genome sequencing studies suggest that *Citrus sinensis* arose from a single individual ancestor derived solely from the introgression of C. maxima (Pummelo) and C. reticulata (Mandarin) – making it an inter-specific hybrid. Not a species.
Hybridization in citrus cultivars
Genetic mixing of three ancestral species
Code #1
International Code of Nomenclature (ICN) are rules that apply to all scientific names (nomenclature) of plants and classification (taxonomy)

• Under ICN, molecular data indicate that there are approximately 23 “true” species of genus *Citrus*

• *C. sinensis* is not one of the 23 because it is a domesticated hybrid— a cross between *C. maxima x C reticulata*
• The sweet orange has dropped a taxonomic rank below species

• When expressed as Genus, Species, variety, cultivar-- Now (if Valencia orange) could be called:
  • C. x aurantium var. sinensis ‘Valencia’; or
  • C. aurantium (Sweet Orange Group) ‘Valencia’
By operation of the International Code of Nomenclature for fungi, algae and plants—this has happened already!

Scientific names do not account for horticultural traits or utility.
Part 2. Monoculture and Biodiversity
Monoculture—practice of growing single species crop across vast land area

- By growing just one crop species at a time, monocultures enable farmers to use land, machinery, apply production practices etc. with efficiency
- Gives growers specialized knowledge, increased productivity
- Access to global markets
- Single crops have generally worked well

- Can mean larger amounts of pesticides, herbicides compared to diverse farming systems
- Can diminish nutrients, degrade soil, reduce life below the soil (fungi, bacteria)
- Can harm local environment and throw ecosystems out of balance
- Can reduce biodiversity and increase risk A narrow genetic base exposes agriculture to great risk when a susceptible crop, like sweet orange, is exposed to a new pathogen/disease, like HLB/CLas. The entire susceptible genotype can be taken down.
With the commercial dominance of the Sweet Orange, we’ve created a near **monoculture**

**United Nations’ Food and Agriculture Organization** – advocates trend reversal and bio-diversity of crops for sustainable farming

**Florida’s citrus production is 90% sweet orange. Brazil is 97% sweet orange.**

**Sweet Orange is among the most widely planted fruit trees in the world, and**

**Despite some phenotypic diversity in fruit traits such as maturity date, skin, shape, flavor etc. – sweet orange has a very narrow genetic base!**
The citrus industry is not alone

- New global awareness to promote crop biodiversity
- Best solutions to most epidemics are identification or development of plant material with genetic resistance or tolerance.

- The Cavendish banana is poised for extinction due to TR4 Panama Disease. Cavendish banana, like the sweet orange, lacks genetic diversity.
It is time to work our way out of our monoculture and establish a wider genetic base for fruit utilized in orange juice as we look for a tree that tolerates HLB.
Narrow genetic base vastly complicates breeders’ job—ties hands behind their backs

- Breeders have worked for years, but few HLB tolerant varieties yet. Evidence of HLB tolerance through field trials takes years to develop.

- HLB tolerance is important, but trees need to produce fruit useable in OJ.

- In the development of HLB tolerant Trees, a new orange-like inter-specific hybrid will not likely qualify as a “sweet orange” taxonomically.
New HLB resistant tree will likely NOT be *Citrus sinensis*.

- The juice of some mandarin hybrids is nearly indistinguishable from the juice of the sweet orange.
- Sugar Belle ® grove shows tolerance and expressed juice is like sweet orange.
International OJ standards all reference *C. sinensis*

- Since we need to update standards with new nomenclature anyway; good opportunity to create and reference a new OJ cultivar registry instead.

**Codex Standard 2005**
- *C. sinensis & up to 10% C. Reticulata*

**EU fruit juice Directive 2021**
- *C. sinensis only*

**FDA US 21 CFR 146.135**
- *C. sinensis*, Ambersweet,
- up to 10% *C. Reticulata in other forms such as POJ - building block for other juice forms*
• It is critical to prepare the standards to allow “sweet orange-like” fruit in orange juice.

• There is a push-pull dynamic where breeders and nurserymen will not invest, and growers will not plant new trees if juice manufacturers will not buy the fruit because they cannot use it in standardized orange juice product.
Part 3. Develop and employ a new Juice Orange Group via a cultivar registry

Widen the genetic base for breeders
Not limited to the sweet orange
Cultivar Registry Idea

- International Cultivar Registration Authority Commission is responsible for the appointment of all ICRA. Scheme operates under ICNCP. Self policing of nomenclature.

- ICRA to be established for Juice Orange Group. An expert panel to develop a procedure that would supply sufficient evidence to prepare the list of suitable cultivars that could make up the “Orange Juice Group” that would meet with regulatory approval. This procedure, once established, could be used to assess any new varieties that are developed in the future.

- The relevant data could be collected and evaluated, by a group of experts, to prepare the list of suitable hybrids that could be considered as part of the “Juice Orange Group.”

- Determine who should “hold” the list of suitable cultivars—the International Cultivar Registration Authority (ICRA), IFU or other (example: The American Rose Society serves as the cultivar registration authority for roses)

- Juice Standards will be amended to incorporate the Registry list by reference after the registry is set up.
Because the Codex juice standard is implicated and IFU is the fruit juice NGO for Codex – IFU is best suited to establish the home for an international registry and procedures for inclusion of selections into the registry’s juice orange group.

- Ancestry and taxonomic designation will not control selection into the Group
- Data have been and will continue to be generated on new selections
- Critical that the fruit juice have similar aroma/flavor to sweet orange
- Panel of experts to make selections and governments adopt Juice Orange Group ICRA into the standard
Part 4. Increase the amount of reticulata hybrids that can be used in standardized juice products by 5%
Current standards limit the percentage of reticulata to 10% max. and aurantium to 5% max.

- Past season, CA produced 21M boxes and FL 750,00 boxes
- Another supply source for domestic orange juice
- Consumers can benefit and processors have more blending options
- Increased % could accommodate new HLB tolerant hybrids that are not included in the Group with sweet orange-like traits
• Citrus flavor has been intensively studied, however, the characteristic *flavor* difference between sweet orange and mandarin has not been well defined by scientists yet. A recent study suggests that the role of *aroma* is more critical in differentiating orange flavor from mandarin flavor.

• USDA has conducted flavor panels with trained panelists and there was no statistical difference in the sensory descriptors among juice blends made of Valencia, Hamlin and Sun Dragon (with up to 50% Sun Dragon in the mix, the latter being a hybrid derived from *C. reticulata* and *C. trifoliata*).

• University of Florida/IFAS researchers on the reticulata cultivar Sugar Belle® with 78 sensory panelists found that the OJ and Sugar Belle® blends at 50-50% levels performed better in sensory evaluation than pure OJ. Willing to pay .$50 more

Flavor research to date generally supports argument that increasing the option for processors to add reticulata and aurantium hybrids up to 15% should not negatively impact juice quality, particularly with processing techniques are used.
We can’t forget about Brix!
Florida Oranges Brix for the Past 15 Seasons

Average Orange Brix for 15 Seasons

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td>October</td>
<td>10.09</td>
</tr>
<tr>
<td>November</td>
<td>9.47</td>
</tr>
<tr>
<td>December</td>
<td>9.69</td>
</tr>
<tr>
<td>January</td>
<td>10.21</td>
</tr>
<tr>
<td>February</td>
<td>9.86</td>
</tr>
<tr>
<td>March</td>
<td>9.90</td>
</tr>
<tr>
<td>April</td>
<td>10.12</td>
</tr>
<tr>
<td>May</td>
<td>10.41</td>
</tr>
<tr>
<td>Season Average</td>
<td>10.00</td>
</tr>
</tbody>
</table>

Source: Florida Department of Agricultural and Consumer Services.
Prepared: August 15, 2022
Path forward?
We consulted authorities about next steps
In U.S.- Two FDA Citizen Petitions by FCPA and FCM to Amend 1963 U.S. standards of identity for Orange juice – three- ten year process

Petition #1 (filed 7/22/22)
FDA docket number FDA-2022-P-1668.

- Update taxonomic nomenclature for the sweet orange.
- Increase allowance for reticulata and aurantium hybrids to 15% in OJ products
- Begin process to establish a “Juice Orange Group” and cultivar registry for “sweet-orange-like” fruit for use in OJ w/o limit.
  - Develop objective criteria as to what constitutes “sweet orange like” is being established by independent international expert panel under IFU.

<table>
<thead>
<tr>
<th>Reduce minimum Brix in FDA standard for Pasteurized OJ from 10.5 to 10.0° to reflect decade of reduced Brix values.</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCT 10.09</td>
</tr>
<tr>
<td>NOV 9.47</td>
</tr>
<tr>
<td>DEC 9.69</td>
</tr>
<tr>
<td>JAN 10.21</td>
</tr>
<tr>
<td>FEB 9.86</td>
</tr>
<tr>
<td>MAR 9.9</td>
</tr>
<tr>
<td>APR 10.12</td>
</tr>
<tr>
<td>MAY 10.41</td>
</tr>
<tr>
<td>2021-2022 Season Average Brix = 10.0°</td>
</tr>
</tbody>
</table>
The exact amendments requested are as follows:

**Amendment to 21 CRF §146.135 Orange Juice**

(a) Orange juice is the unfermented juice obtained from mature oranges of the species *citrus sinensis* or of the citrus hybrid commonly called "Ambersweet" (1/2 *Citrus sinensis* x 3/8 *Citrus reticulata* x 1/8 *citrus paradisi* (USDA selection 1-100-29:1972 Whitmore Foundation Farm)).

Orange juice is the unfermented juice obtained from mature fruit of the species *Citrus x aurantium* var. *L. sinensis* L. [or conforming to a Group published in a cultivar registry recognized by the Food and Drug Administration and the International Society of Horticultural Science’s Commission on Cultivar Registration, with citrus fruit having traits characteristic of sweet orange, hereinafter referred to as "oranges."] Seeds (except embryonic seeds and small fragments of seeds that cannot be separated by current good manufacturing practice) and excess pulp are removed. The juice may be chilled, but not frozen.

The name of the food is “orange juice.” The name “orange juice” may be preceded on the label by the varietal name of the oranges used, and if the oranges grew in a single State, The establishment of a cultivar registry and Group for sweet orange-like citrus fruit is in progress and at such time as the registry is formed, Petitioners will amend the petition to properly reference the registry and Group. The industry will pursue conforming amendments.
Amendment to 21 C.F.R. § 146.146 Frozen concentrated orange juice.

Frozen concentrated orange juice is the food prepared by removing water from the juice of mature oranges as provided in § 146.135, to which may be added unfermented juice obtained from mature oranges of the species *Citrus reticulata*, other *Citrus reticulata* hybrids, or of *Citrus aurantium*, or both. However, in the unconcentrated blend, the volume of juice from *Citrus reticulata* or *Citrus reticulata* hybrids shall not exceed 15 percent (except that this limitation shall not apply to the hybrid species described in § 146.135) and from *Citrus aurantium* shall not exceed 5 percent. The concentrate so obtained is frozen. In its preparation, seeds (except embryonic seeds and small fragments of seeds that cannot be separated by good manufacturing practice) and excess pulp are removed, and a properly prepared water extract of the excess pulp so removed may be added.…….

Amendment to 21 C.F.R. § 146.140 - Pasteurized orange juice.

Pasteurized orange juice is the food prepared from unfermented juice obtained from mature oranges as specified in § 146.135, to which may be added not more than 15 percent by volume of the unfermented juice obtained from mature oranges of the species *Citrus reticulata* or *Citrus reticulata* hybrids (except that this limitation shall not apply to the hybrid species described in § 146.135). ..............The finished pasteurized orange juice contains not less than 10 percent by weight of orange juice soluble solids, exclusive of the solids of any added optional sweetening ingredients,..............
Surprise! SB 4394 Rubio, Scott, Warnock filed bill as well as Bi-partisan FL delegation filed a companion bill in House HR 8054

Legislation would lower Brix in POJ to 10.0

- For three years industry worked with FDA seeking enforcement discretion to no avail
- Law would preempt FDA regulations and skip through agency’s slow administrative process to amend standards.
- Blocked from unanimous consent calendar by (D) Senator Patty Murray
Juice standards are a team sport. Dr. David Hammond will tell you about how they are handling this in EU and plans for Codex.
Thank you!

www.fcplanet.org

Join us! Regular and allied members. Email me at: kec@macfar.com