



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

What's Your Name? Who's Your Daddy?
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Part 1. Nomenclature for the Sweet Orange

TITLE 21--FOOD AND DRUGS
CHAPTER I--FOOD AND DRUG ADMINISTRATION
DEPARTMENT OF HEALTH AND HUMAN SERVICES

Subpart B - Requirements for Specific Standardized Canned
Fruit Juices and Beverages

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

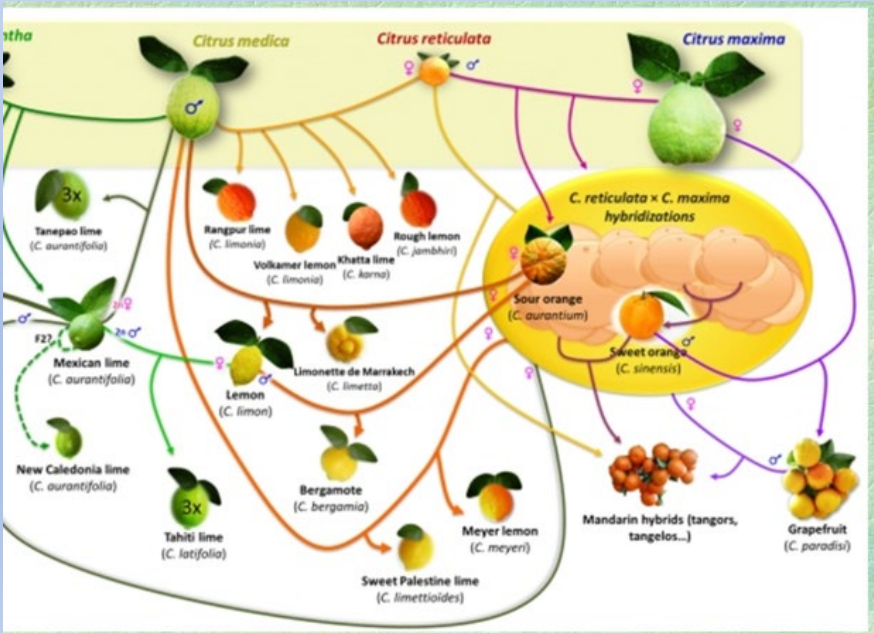
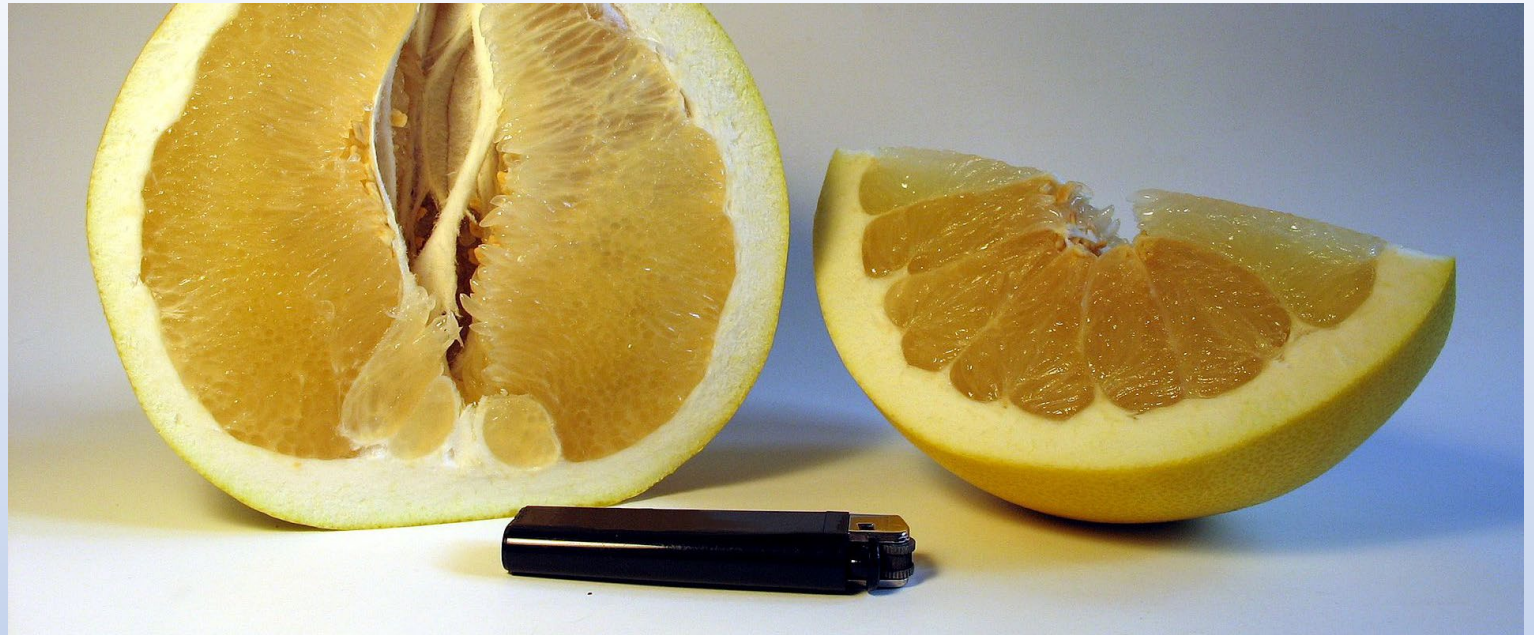
- Species= plants capable of exchanging genes for interbreeding. Taxonomic unit below Genus i.e. Citrus
- Variety = two plants crossed in nature
- Cultivar = 2 plants crossed by man
- Different cultivars can be in the same genus and species but can look very different
- Hybrids= two species crossed i.e. *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

Plant Classification

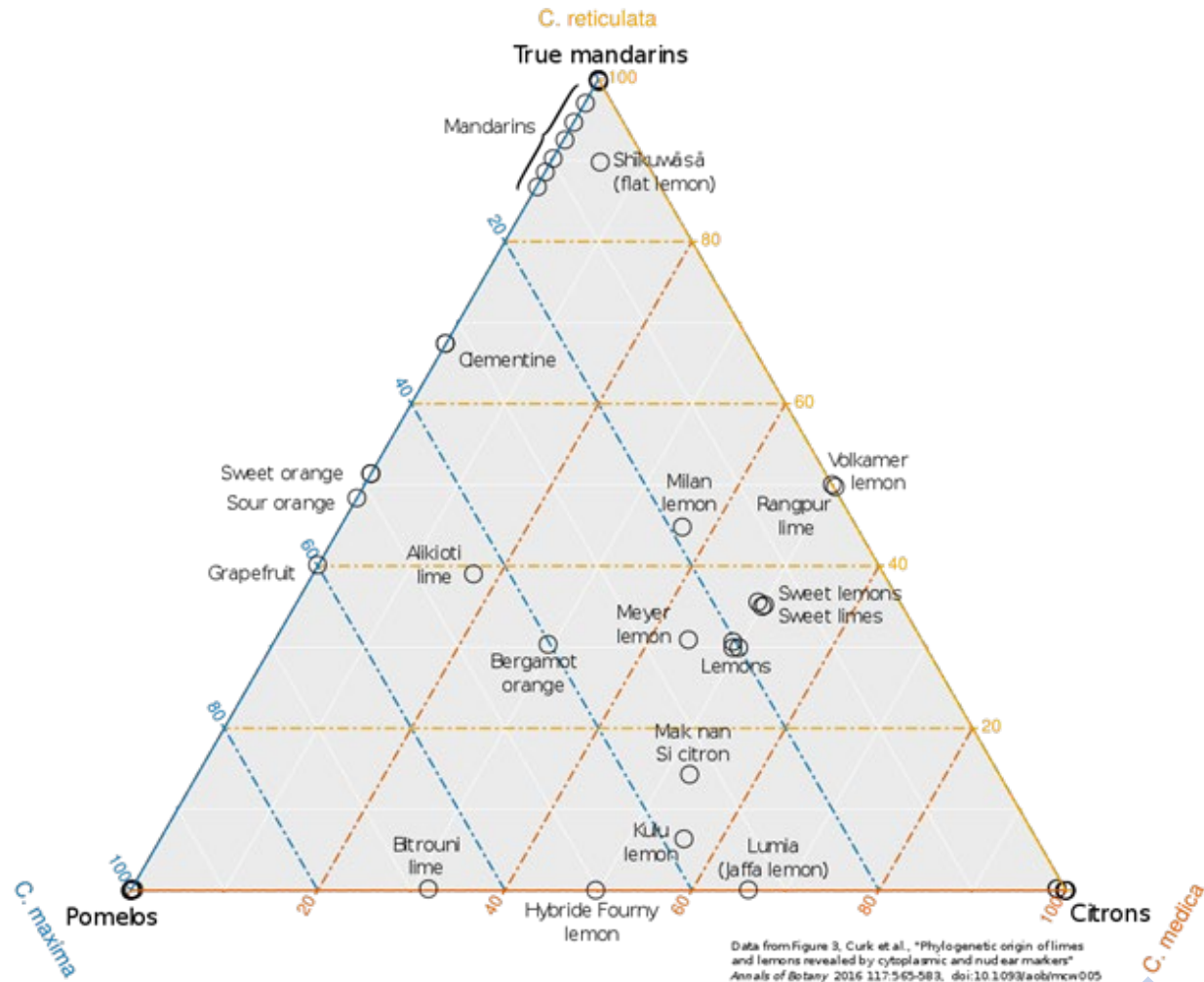
Grouping plants by their similar characteristics



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'***



Citrus

Aurantium

=C. Maxima x C. reticulata

By operation of the International Code of Nomenclature for fungi, algae and plants– this has happened already!
Names of Hybrids https://www.iapt-taxon.org/nomen/pages/main/art_h4.html

The screenshot shows a web browser window displaying the GRIN-Global website. The browser's address bar shows the URL: npgsweb.ars-grin.gov/gringlobal/taxon/taxonomydetail?id=10689. The website header includes the USDA logo, the text "United States Department of Agriculture Agricultural Research Service", a shopping cart icon with "0" items, and a "Welcome!" message. A green navigation bar contains "GRIN-Global" and "U.S. National Plant Germplasm System", along with "Log in" and "New User" buttons. Below this is a grey navigation bar with "Version: 2.3.0.4" and a menu of "Accessions", "Descriptors", "Reports", "GRIN Taxonomy", "GRIN", "Help", "Contact Us", and "Your Profile".

The main content area features a search box with the text "Taxon: *Citrus x aurantium* L. var. *sinensis* L." and a "New Species Search" button. Below the search box are four tabs: "Nomenclature" (selected), "Common Names", "Distribution", and "Economic Uses".

The "Summary" section contains the following information:

- Genus: *Citrus*
- Family: *Rutaceae*
- Subfamily: *Aurantioideae*
- Tribe: *Aurantieae*
- Subtribe: *Citrinae*
- Nomen number: 10689
- Place of publication: Sp. pl. 2:783. 1753
- Protologue link: <https://www.biodiversitylibrary.org/page/358804>
- Typification: [View in Linnean Typification Project](#)
- Verified: 03/06/2020 ARS Systematic Botanists.
- Accessions: 743 (320 active, 0 available) in National Plant Germplasm System. ([Map it](#))

The "Other conspecific taxa" section lists:

- Citrus x aurantium* L. (131 active accession[s])
- Citrus x aurantium* L. var. *aurantium* (5 active accession[s])
- Citrus x aurantium* L. var. *chrysocarpa* (Hassk.) ined. (84 active accession[s])
- Citrus x aurantium* L. var. *racemosa* (Risso) ined. (74 active accession[s])

At the bottom, there are two sections: "Autonyms (not in current use), synonyms and invalid designations" with a sub-section for "Homotypic Synonym(s)", and "No images".

The Windows taskbar at the bottom shows the search bar and several application icons.

An aerial photograph showing a vast, organized orange grove in the foreground. The trees are arranged in neat, parallel rows, with many bright orange fruits visible through the green leaves. In the background, a dense, dark green forest covers a hillside. A large, white, semi-circular structure, possibly a water feature or a large tent, is visible on the left side of the forest. The sky is a clear, pale blue.

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



- The Cavendish banana is poised for extinction due to TR4 Panama Disease. Cavendish banana, like the sweet orange, lacks genetic diversity.

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



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

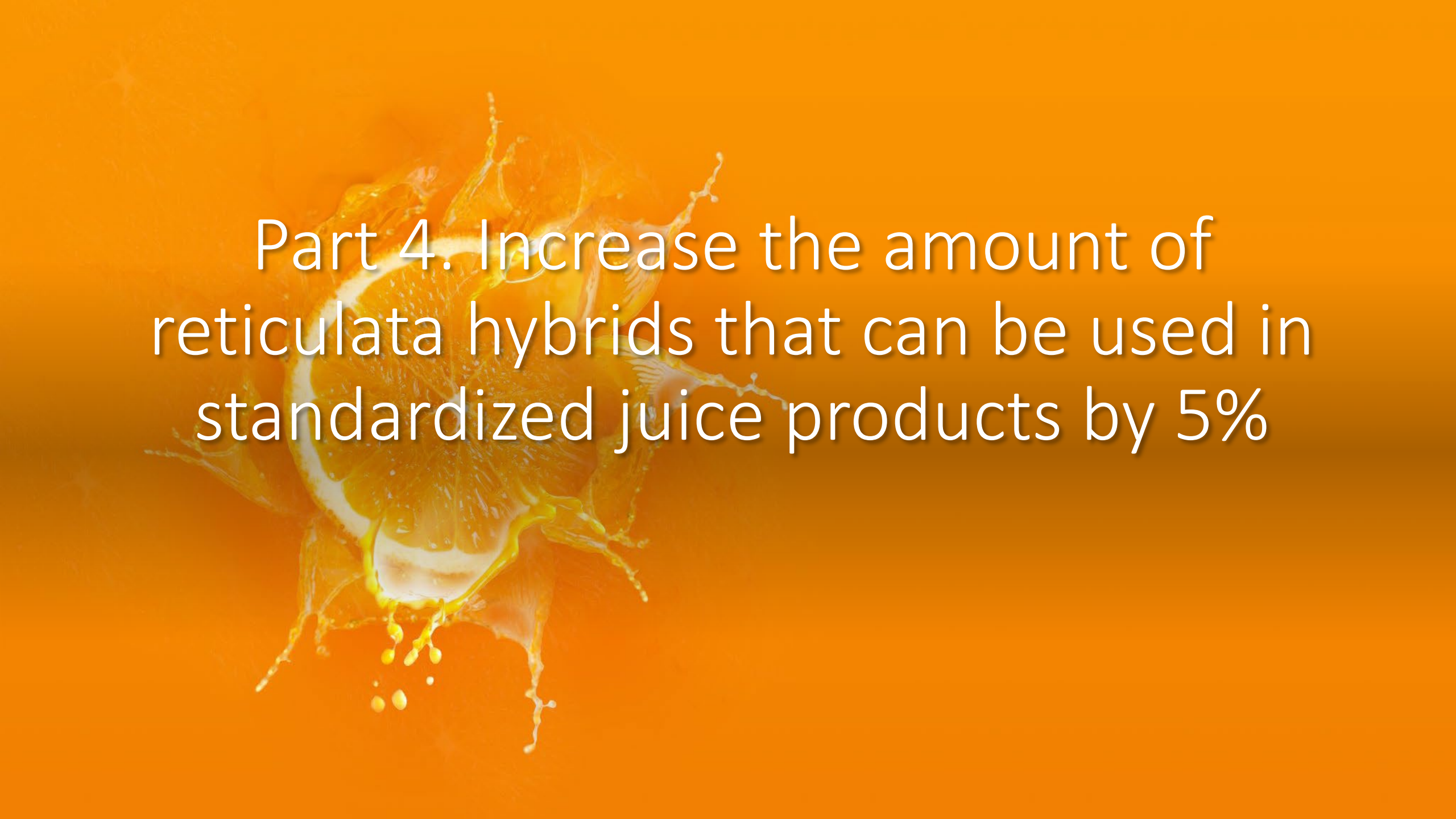
- International Cultivar Registration Authority Commission is responsible for the appt of all ICRA's. Scheme operates under ICNCP. Self policing of nomenclature.
- ICRA to be established for Juice Orange Group. An expert panel to develop a procedure that would supply sufficient evidence to prepare the 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



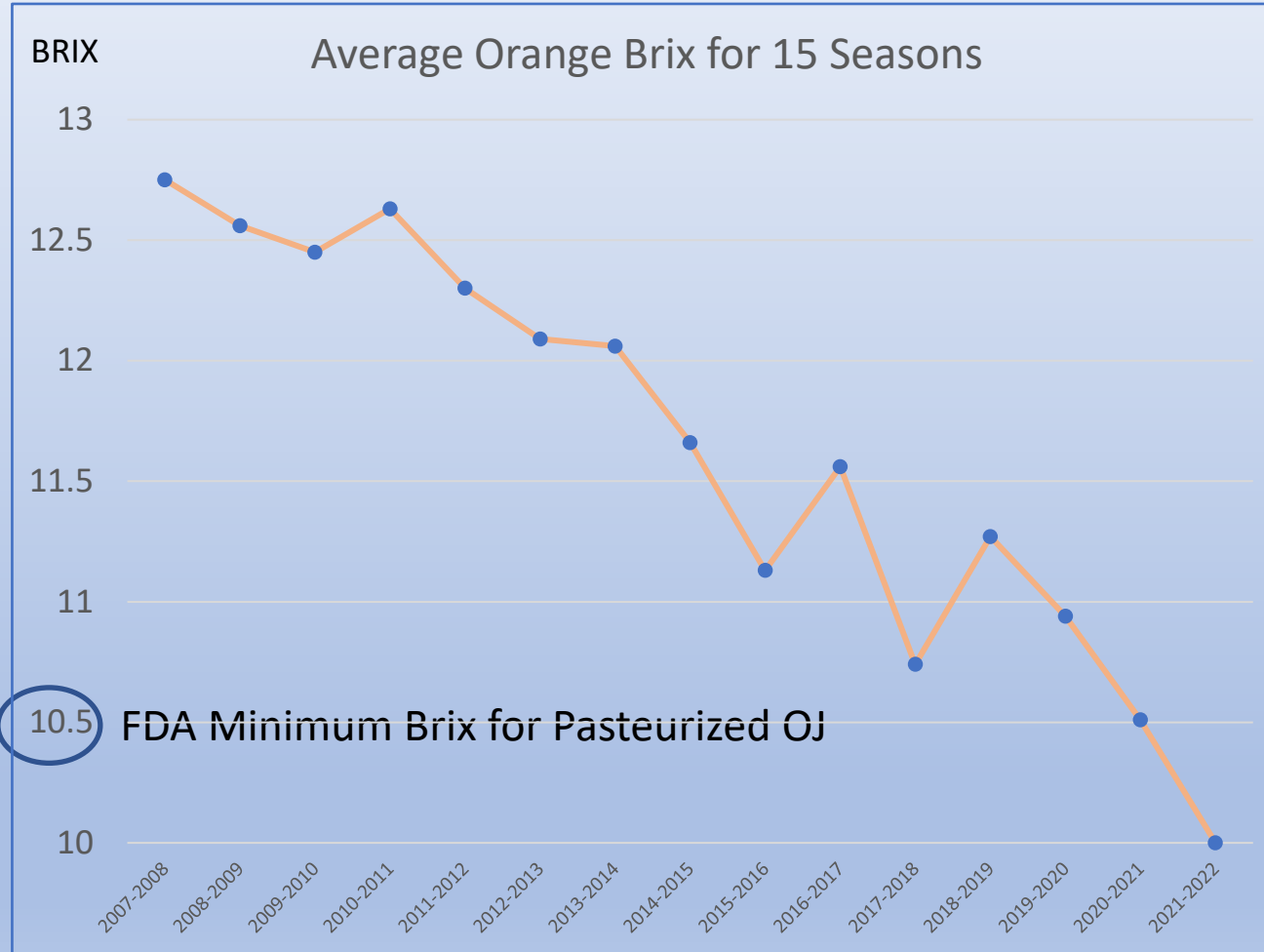
- Citrus flavor has been intensively studied, however, the characteristic *flavor* difference between sweet orange and mandarin has not been well defined by scientists yet. A recent study suggests that the role of *aroma* is more critical in differentiating orange flavor from mandarin flavor.
- USDA 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!

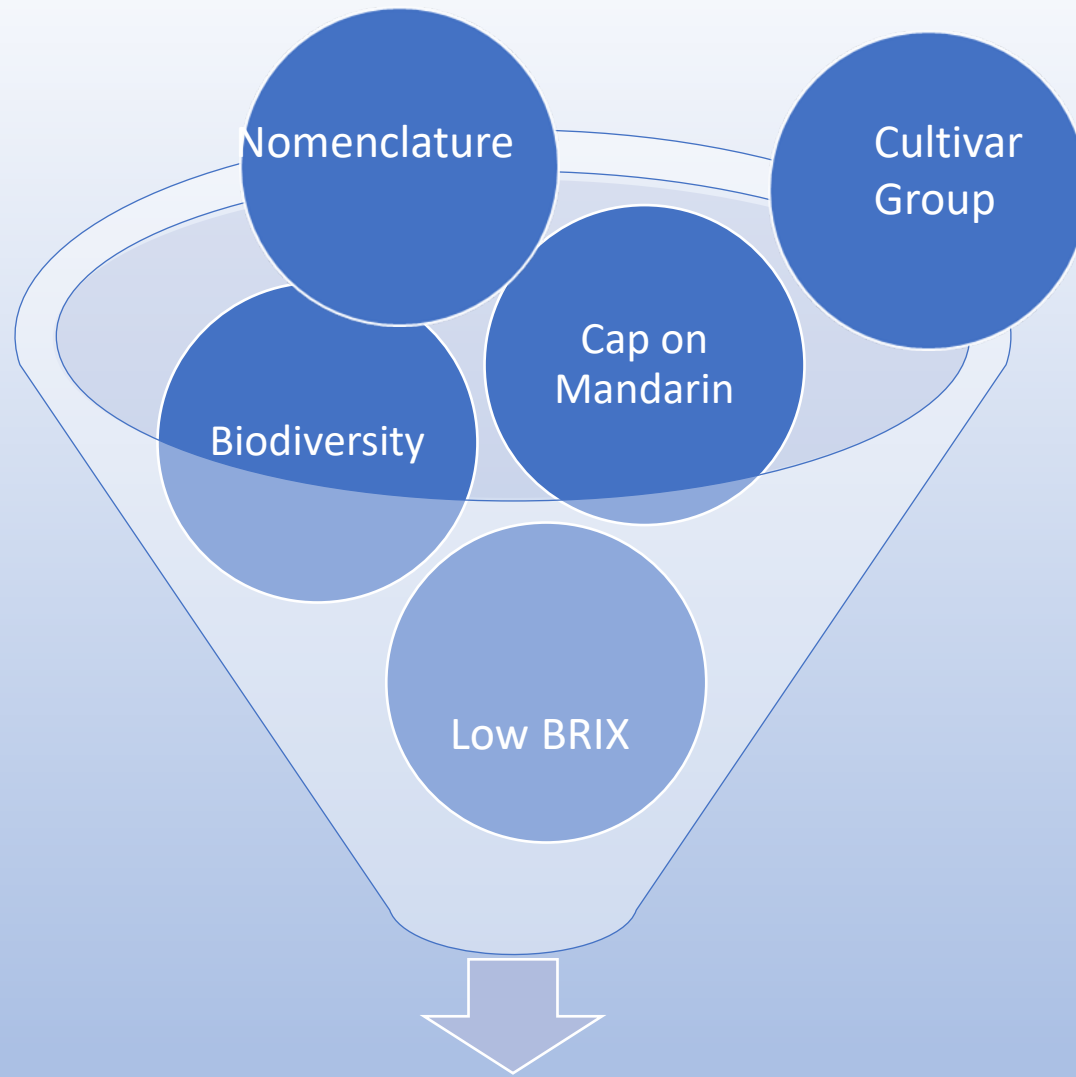
Florida Oranges Brix for the Past 15 Seasons



Average Brix 2021-22

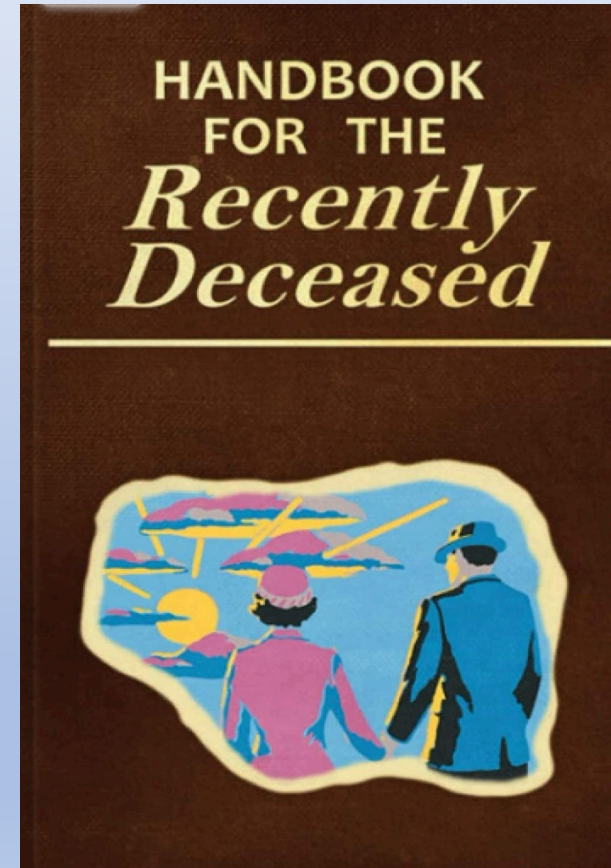
Month	Average Brix
October	10.09
November	9.47
December	9.69
January	10.21
February	9.86
March	9.90
April	10.12
May	10.41
Season Average	10.00

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.

Reduce *minimum* Brix in FDA standard for Pasteurized OJ from 10.5 to 10.0° to reflect decade of reduced Brix values.

OCT	10.09
NOV	9.47
DEC	9.69
JAN	10.21
FEB	9.86
MAR	9.9
APR	10.12
MAY	10.41

2021-2022 Season Average Brix = 10.0°

Petition #2 (file this fall)



- 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.

The exact amendments requested are as follows:

Amendment to 21 CFR §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~~ **10** 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 ~~10~~ **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 ~~10.5~~ **10.0** 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

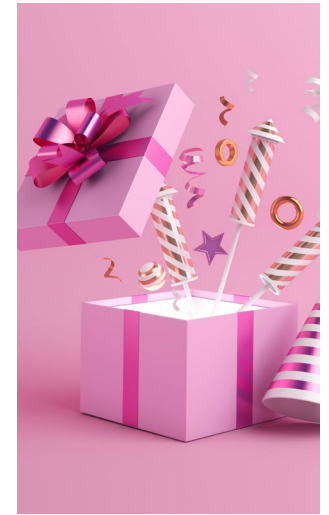
Legislation would lower Brix in POJ to 10.0

- 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

introduce **Defending Domestic Orange Juice Production Act**

JUN 16 2022

Washington, D.C. — U.S. Senators Marco Rubio (R-FL) and Rick Scott (R-FL) introduced the *Defending Domestic Orange Juice Production Act*. The legislation would direct the U.S. Food and Drug Administration (FDA) to lower the required




ICYMI: in Florida Playbook: Democrats Block Rubio Orange Juice Bill

AUG 05 2022

Gary Fineout
August 5, 2022
[Florida Playbook-
POLITICO](#)

**'WE MIGHT NOT
HAVE A CITRUS
INDUSTRY'** — Senate Democrats this week blocked an effort by



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