

Potential Citrus Hybrids Tolerant to HLB for Orange Juice

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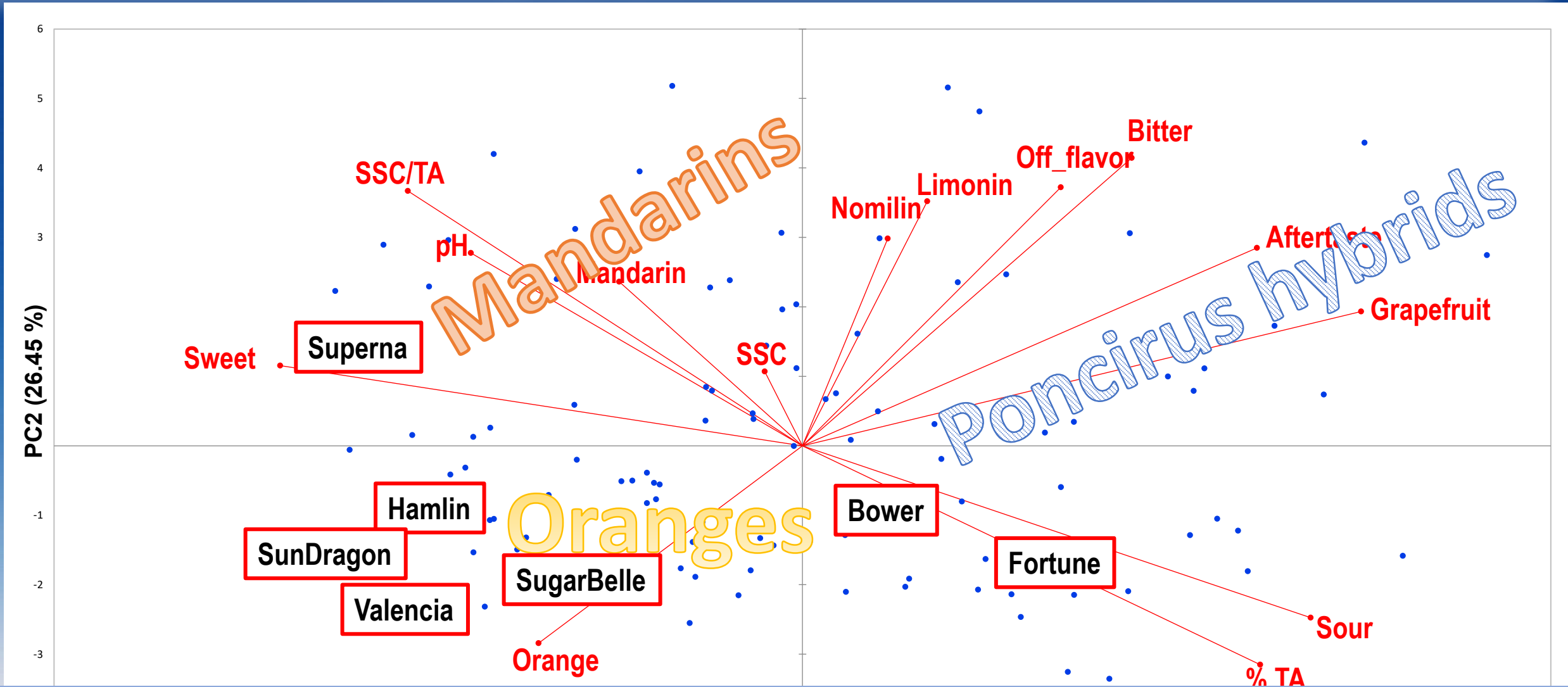
Agricultural Research Service
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Sensory & Chemical Analysis at USDA FP



 **60 hybrids and named varieties observed since 2016-17 (multiple harvests)**

Identify Citrus Flavor Groups



Which chemicals are responsible for the flavor of each group?

Modeling - Flavor & Instrument

Zhen Fan

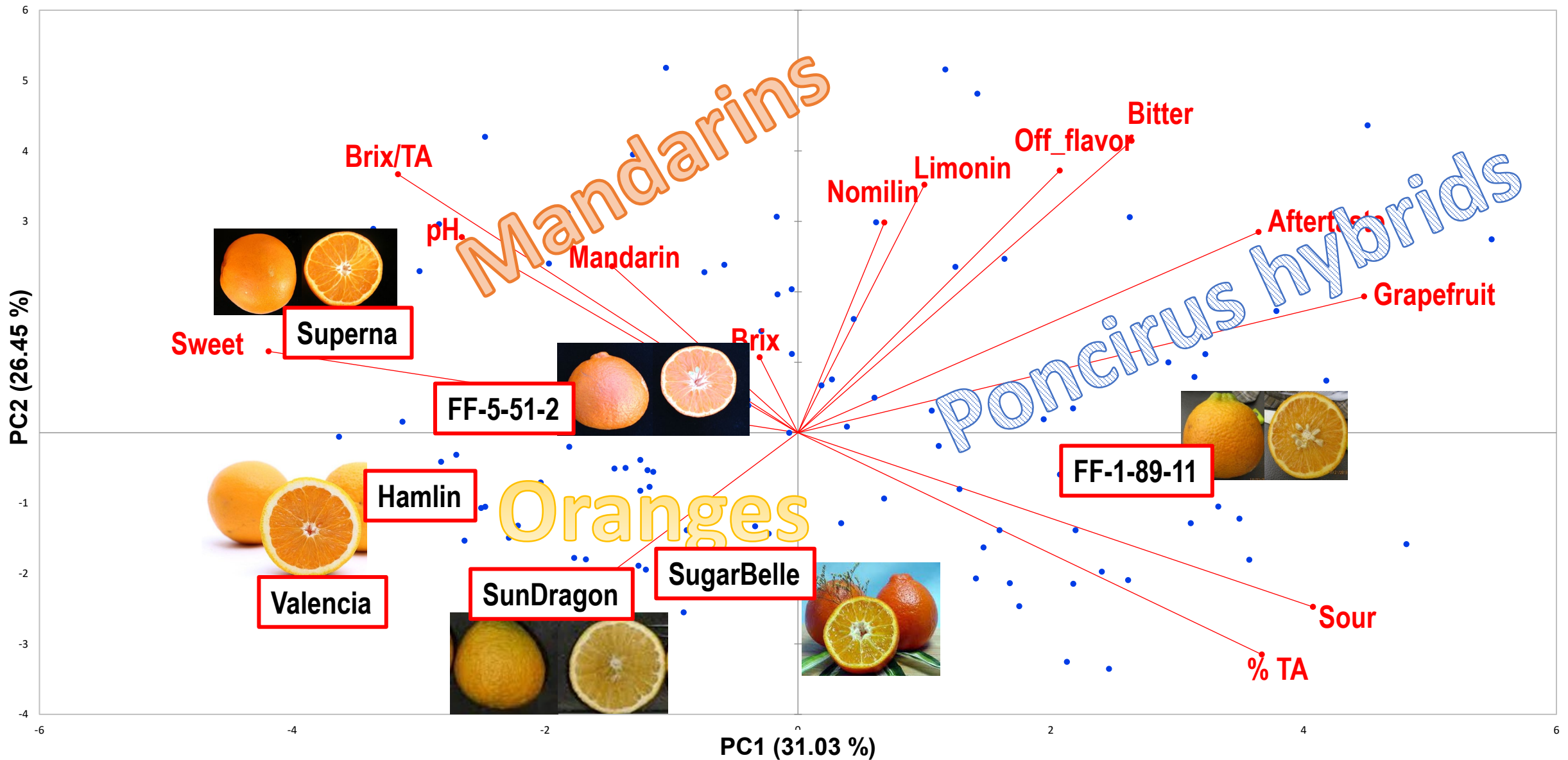
Tree-based prediction
using 179 data points
(2016-2022)

Positive VIP scores
Negative VIP scores
Highly significant

Chemical Group	Orange Flavor	Mandarin Flavor	Relative Orange (Orange – Mandarin)
Sugars	SSC/TA SSC Sucrose, Fructose	SSC/TA SSC Sucrose	SSC/TA Sucrose
Acids	Malic acid	TA	TA, Citric acid
Limonoids	Limonin Nomilin		Limonin Nomilin
Esters	Ethyl butanoate Ethyl propanoate Hexyl acetate Ethyl octanoate	Ethyl hexanoate Ethyl 3-hydroxyhexanoate	Methyl butanoate, Ethyl butanoate Ethyl 2-methylbutanoate Methyl hexanoate, Ethyl hexanoate Ethyl 3-hydroxyhexanoate Ethyl octanoate
Alcohols Aldehydes	Hexanol (E)-2-Hexenal	(E)-2-Pentenal	1-Pentanol (E)-2-Pentenal, (E)-2-Hexenal
Ketones	Carvone	Carvone	1-Octen-3-one

Esters are strong contributors to orange flavor

Selecting Hybrids for Blends (trained panel)



2021-22 - Valencia/Hamlin/SunDragon

Can SunDragon substitute Hamlin?

Single genotype sugars & acids

Genotypes	TA (%)	SSC (Brix)	SSC/TA
Valencia	0.82 a	10.6 b	13.0 c
Hamlin	0.54 b	9.7 c	18.1 a
SunDragon	0.83 a	13.8 a	16.7 b

Blends 2021-22 sugars & acids

Nb	Blends	TA (%)	SSC (Brix)	SSC/TA
1	60:40_Val:Ham	0.66 b	9.7 b	14.8 a
2	60:40_Val:SunD	0.81 a	11.9 a	14.7 a
3	60:30:10_Val:Ham:SunD	0.72 ab	10.5 b	14.6 a

Sensory quality: No perceived sensory differences overall. 60:40 Valencia:SunDragon slightly more sour

	Orange	Tangerine	Sweet	Sour	Bitter	Off-Flavor
60:40_Val:Ham	7.3 a	2.5 a	6.1 a	4.5 b	0.5 a	0.5 a
60:40_Val:SunD	8.4 a	3.0 a	6.5 a	5.8 a	0.7 a	0.7 a
60:30:10_Val:Ham:SunD	7.4 a	3.0 a	6.3 a	5.2 ab	0.5 a	0.6 a

2021-22 - Valencia/Hamlin or SunDragon with Mandarin hybrids at 10%

Single genotype sugars & acids

Genotypes	TA (%)	SSC (Brix)	SSC/TA
Valencia	0.82 b	10.6 d	13.0 cd
Hamlin	0.54 c	9.7 e	18.1 b
SunDragon	0.83 a	13.8 b	16.7 c
Superna	0.35 d	10.2 de	29.2 a
FF-5-51-2	0.53 c	11.6 c	21.8 b
FF-1-89-11	1.54 a	15.9 a	10.4 e

Blends 2021-22 sugars & acids

Nb	Blends	TA (%)	SSC (B)	SSC/TA
1	60:40_Val:Ham	0.66 c	9.7 c	14.8 a
6	60:30:10_Val:Ham:Superna	0.69 bc	10.4 bc	15.1 a
9	60:30:10_Val:SunD:Superna	0.77 b	11.6 ab	15.0 a
4	60:30:10_Val:Ham:5512	0.70 bc	10.5 bc	15.0 a
7	60:30:10_Val:SunD:5512	0.73 bc	10.8 bc	14.8 a
8	60:30:10_Val:Ham:18911	0.89 a	12.07 a	13.5 b
5	60:30:10_Val:SunD:18911	0.76 b	10.4 c	13.7 b

2021-22 - Valencia/Hamlin or SunDragon with Mandarin hybrids at 10%

Sensory quality: No perceived sensory differences overall.

	Orange	Tangerine	Sweet	Sour	Bitter	Off-Flavor
60:40_Val:Ham	7.3 a	2.5 b	6.1 bc	4.8 cd	0.5 a	0.5 a
60:30:10_Val:Ham:Superna	7.3 a	3.1 ab	5.9 c	4.5 d	0.5 a	0.6 a
60:30:10_Val:Sun:Superna	7.8 a	3.1 ab	6.4 abc	5.6 ab	0.5 a	0.6 a
60:30:10_Val:Ham:5512	7.1 a	3.9 a	6.1 bc	5.0 bcd	0.6 a	0.6 a
60:30:10_Val:Sun:5512	7.6 a	4.0 a	6.7 a	5.6 ab	0.5 a	0.5 a
60:30:10_Val:Ham:18911	7.8 a	3.1 ab	6.6 ab	5.2 bc	0.5 a	0.4 a
60:30:10_Val:Sun:18911	7.7 a	4.0 a	6.7 a	6.2 a	0.5 a	0.4 a

Mandarin is slightly perceived by a trained panel; Sweetness can be increased by mandarin juice

2021-22 Valencia/Hamlin with Mandarins at 20%

Single genotype sugars & acids

Genotypes	TA (%)	SSC (Brix)	SSC/TA
Valencia	0.82 a	10.6 bc	13.0 d
Hamlin	0.54 b	9.7 c	18.1 c
FF-5-51-2	0.53 b	11.6 b	21.8 b
SugarBelle	0.86 a	13.4 a	15.5 d
Superna	0.35 c	10.2 c	29.2 a

Blends 2021-22 sugars & acids

Nb	Blends	TA (%)	SSC (Brix)	SSC/TA
1	60:40_Val:Ham	0.66 b	9.7 b	14.8 c
10	60:20:20_Val:Ham:5512	0.69 b	10.6 ab	15.2 b
11	60:20:20_Val:Ham:SugarBelle	0.79 a	11.3 a	14.3 d
12	60:20:20_Val:Ham:Superna	0.66 b	10.3 ab	15.7 a

Sensory quality: 20% mandarin increases tangerine flavor.

	Orange	Tangerine	Sweet	Sour	Bitter	Off-Flavor
60:40_Val:Ham	7.3 a	2.5 b	6.1 b	4.8 b	0.5 a	0.5 b
60:20:20_Val:Ham:5512	6.5 a	4.6 a	6.2 b	5.7 a	0.7 a	1.0 ab
60:20:20_Val:Ham:Sugarbelle	7.3 a	4.3 a	6.8 a	5.5 a	0.6 a	0.7 b
60:20:20_Val:Ham:Superna	6.9 a	4.0 a	6.3 ab	5.0 ab	0.8 a	1.3 a

Summary

- 60+ hybrids and named cultivars evaluated for 6 years allowed to show that esters were a necessary contributor for “orange” flavor
- We selected SunDragon, Superna, SugarBelle, FF-5-51-2 and FF-1-89-11 for blends
- Blends with hand-made and non-pasteurized juice in 2020-21 and 2021-22.
- Mandarin can increase sweetness if added at 10% in the juice, but still perceived as mandarin flavor by trained panelists if added at 20% in the juice (15% not tested).
- Adding esters (flavor pack) to an orange:mandarin blend to get orange flavor?

Thank You!

<https://programs.ifas.ufl.edu/scion-guide/>



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