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Preharvest Fruit Drop and its Implications for Flavor of Oranges
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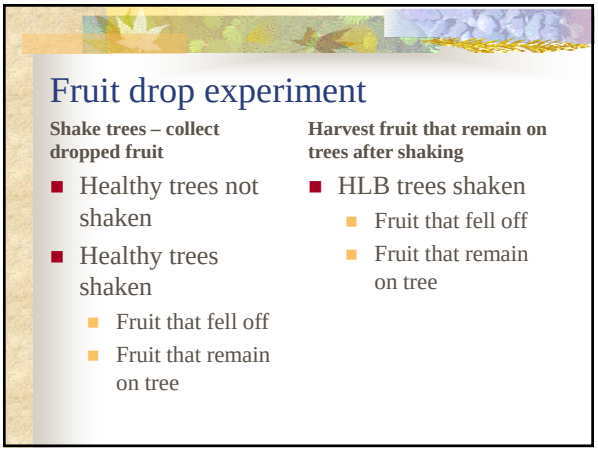
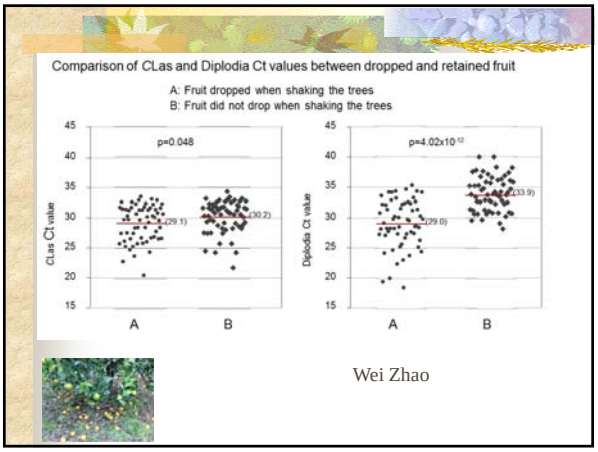
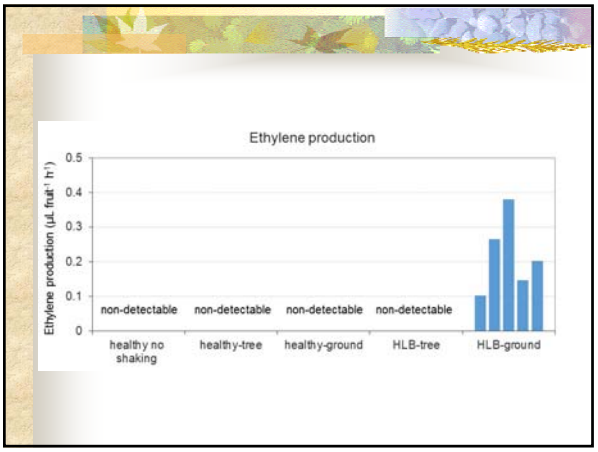
HLB Fruit Drop


Fruit drop experiment
Shake trees – collect dropped fruit
Healthy trees not shaken
Healthy trees shaken
Fruit that fell off
Fruit that remain on tree
Harvest fruit that remain on trees after shaking
HLB trees shaken
Fruit that fell off
Fruit that remain on tree


Difference in calyx abscission zone of HLB-affected fruit between the dropped and retained fruit when shaking the tree.
HLB-fruit retained when shaking the tree
HLB-fruit dropped when shaking the tree
HLB-fruit retained when shaking the tree
HLB-fruit dropped when shaking the tree
Wei Zhao


Comparison of CLas and Diplodia Ct values between dropped and retained fruit
A: Fruit dropped when shaking the trees
B: Fruit did not drop when shaking the trees
p=0.048
p=4.02x10-12
CLas Ct value
Diplodia Ct value
A
B
Wei Zhao


Ethylene production
Ethylene production (µL fruit-1 h-1)
non-detectable
healthy no shaking
healthy-tree
healthy-ground
HLB-tree
HLB-ground

Quality aspects for orange juice

Sensory/health characteristics
- Color
- Sweetness
- Sourness
- Bitterness
- Astringency
- Aroma
- Off-favor
- Mouthfeel
- Nutrition/health benefits

Chemical/physical/microbial characteristics
- Carotenoids
- Sugars
- Acids
- Limonoids/Flavonoids
- Phenolics
- Volatiles
- Microbial compounds
- Viscosity/pectin
- Vitamin C, folic acid,

Quality aspects for OJ juice affected by HLB

Sensory/health characteristics
- Color
- Sweetness
- Sourness
- Bitterness
- Astringency
- Aroma
- Off-favor
- Mouthfeel
- Nutrition/health benefits

Chemical/physical/microbial characteristics
- Carotenoids
- Sugars
- Acids
- Limonoids/Flavonoids
- Phenolics
- Volatiles
- Microbial compounds
- Viscosity/pectin
- Vitamin C, folic acid,

Tree/Ground or Cling/Drop Hamlin, December - DEC

Comments for Healthy trees qualified the Ground juice as slightly more bitter, more aftertaste, more bland and less sweet than juice from the tree harvested fruit.

Comments for HLB trees qualified juice from Ground harvest as very bitter and more sour than juice from Tree-harvested trees.

Number of correct and incorrect responses in two simple-difference tests, Healthy and HLB, replicated 3 times. Calculated chi-square and probability associated with the test are mentioned for each replication.

	Response	Presented Tree/Tree or Ground/Ground	Presented Tree/Ground or Ground/Tree
Healthy Rep 1	Correct	15	16
	Incorrect	12	12
	Calculated Chi-Square = 0.887		
	P value = 0.363 (not significant)		
Healthy Rep 2	Correct	18	13
	Incorrect	9	15
	Calculated Chi-Square = 0.982		
	P value =0.322 (not significant)		
Healthy Rep 3	Correct	17	12
	Incorrect	10	16
	Calculated Chi-Square = 0.194		
	P value =0.660 (not significant)		
HLB Rep 1	Correct	15	21
	Incorrect	13	6
	Calculated Chi-Square = 5.723		
	P value = 0.0167 (significant at the 5% level)		
HLB Rep 2	Correct	19	16
	Incorrect	9	11
	Calculated Chi-Square = 4.076		
	P value =0.0435 (significant at the 5% level)		
HLB Rep 3	Correct	17	25
	Incorrect	11	2
	Calculated Chi-Square = 17.274		
	P value = 0.000 (significant at the 1% level)		

Tree/Ground or Cling/Drop Hamlin, January - DEC

For juice from HLB trees, "HLB-Ground" samples were qualified as more bitter than "HLB-Tree" samples, but not consistently. Some "HLB-Tree" samples were perceived as having more aftertaste than the "HLB-Ground" juice. The lack of consistency in identifying the differences between "Tree" and "Ground" harvests in HLB trees is reflected in the lack of repeatability in the simple-difference test (Table 2).

Number of correct and incorrect responses in two simple-difference tests, Healthy and HLB, replicated 3 times. Calculated chi-square and probability associated with the test are mentioned for each replication.

	Response	Presented Tree/Tree or Ground/Ground	Presented Tree/Ground or Ground/Tree
Healthy Rep 1	Correct	16	15
	Incorrect	11	13
	Calculated Chi-Square = 0.908		
	P value = 0.341 (not significant)		
Healthy Rep 2	Correct	21	6
	Incorrect	6	22
	Calculated Chi-Square = 0.005		
	P value = 0.943 (not significant)		
Healthy Rep 3	Correct	17	13
	Incorrect	10	15
	Calculated Chi-Square = 0.498		
	P value = 0.480 (not significant)		
HLB Rep 1	Correct	16	10
	Incorrect	12	17
	Calculated Chi-Square = 0.194		
	P value = 0.666 (not significant)		
HLB Rep 2	Correct	16	23
	Incorrect	12	4
	Calculated Chi-Square = 10.642		
	P value = 0.001 (significant at the 1% level)		
HLB Rep 3	Correct	19	15
	Incorrect	9	12
	Calculated Chi-Square = 3.063		
	P value = 0.080 (significant at the 10% level)		

Trained descriptive panel (Anne Plotto)

- Rated flavor descriptors: orange, grapefruit, fruity-non-citrus, orange peel, green, stale, oxidized oil and typical HLB off-flavor
- Rated taste descriptors: sweetness, sourness, umami, bitterness and metalic
- Rated mouthfeel descriptors: body, tingling, astringent, and burning
- Rated after-taste descriptors: after-bitter, after-astringent and after-burning

Tree/Ground or Cling/Drop Hamlin, December – Trained panel

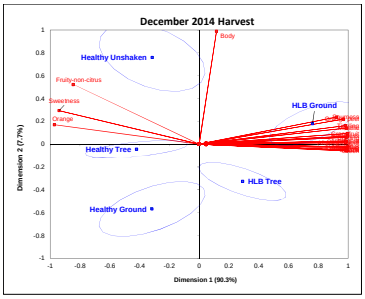
Sensory ratings by a 12-member trained panel for Hamlin harvested on December 2, 2014.

	Healthy Unshaken	Healthy Tree	Healthy Ground	HLB Tree	HLB Ground
Orange	4.4 a	4.5 a	3.8 b	3.1 c	2.1 d
Grapefruit	2.9 c	2.5 c	2.5 c	4.4 b	5.9 a
Fruity-non-citrus	1.8 a	1.7 ab	1.4 bc	1.1 c	1.1 c
Orange peel	2.3 b	2.1 b	2.0 b	2.5 ab	2.9 a
Green	2.4 b	2.4 b	2.4 b	2.8 ab	3.1 a
Stale	2.4 b	2.6 b	2.6 b	3.3 ab	4.1 a
Oxidized oil	1.6 b	1.6 b	1.5 b	2.2 ab	2.7 a
Typical HLB	4.1 c	4.0 c	4.3 c	7.6 b	10.2 a
Sweetness	5.5 a	5.1 ab	4.6 b	4.1 c	3.2 d
Sourness	5.0 ab	4.6 b	4.8 b	5.2 ab	5.6 a
Umami	2.3 b	2.2 b	2.4 b	2.8 ab	3.4 a
Bitterness	4.1 c	3.1 c	3.4 c	7.1 b	9.3 a
Metallic	2.4 c	2.0 c	2.1 c	3.1 b	4.3 a
Body	4.9 a	4.5 ab	4.3 b	4.4 ab	4.7 ab
Tingling	1.8 bc	1.6 c	1.5 c	2.3 ab	2.7 a
Astringent	2.3 b	1.8 b	2.1 b	3.4 a	3.9 a
Burning	1.4 b	1.2 b	1.2 b	2.1 a	2.5 a
AfterBitter	2.0 c	1.6 c	2.0 c	4.5 b	6.0 a
AfterAstringent	1.3 b	1.3 b	1.1 b	2.6 a	3.1 a
AfterBurning	0.8 bc	0.6 c	0.8 bc	1.3 ab	1.7 a

Means followed with a different letter indicate significant difference using the LSD test. Level of significance is indicated by the P-value.

Anne Plotto

The PCA plot clearly shows separation between healthy and HLB samples along the first dimension (90.3%), with orange flavor, sweetness and fruity-non-citrus flavor describing healthy samples.



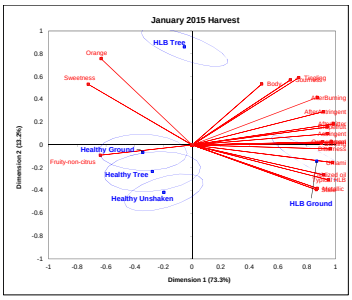
Tree/Ground or Cling/Drop Hamlin, January – Trained panel

Sensory ratings by a 12-member trained panel for Hamlin harvested on January 5, 2015.

	Healthy Unshaken		Healthy Tree		Healthy Ground		HLB Tree		HLB Ground	
Orange	5.1	bc	5.3	abc	5.5	ab	5.7	a	4.9	c
Grapefruit	1.7	b	1.4	b	1.7	b	1.9	b	2.6	a
Fruity-non-citrus	2.2	a	1.9	ab	1.9	ab	2.0	ab	1.7	b
Orange peel	2.2	ab	1.9	b	1.8	b	2.2	ab	2.6	a
Green	1.6	b	1.7	b	1.6	b	1.8	b	2.2	a
Stale	2.1	ab	1.8	b	1.8	b	1.8	b	2.4	a
Oxidized oil	1.6	b	1.3	b	1.4	b	1.4	b	2.1	a
Typical HLB	2.9	b	2.9	b	2.7	b	2.6	b	4.4	a
Sweetness	6.3	a	6.4	a	6.2	ab	6.5	a	5.9	b
Sourness	4.6	b	4.9	ab	4.9	ab	5.1	ab	5.2	a
Umami	1.9	b	1.9	b	1.7	b	1.9	b	2.5	a
Bitterness	2.8	b	2.4	b	2.4	b	2.8	b	3.6	a
Metallic	1.8	b	1.8	b	1.4	b	1.5	b	2.4	a
Body	5.2	a	4.9	a	5.0	a	5.3	a	5.2	a
Tingling	1.5	ab	1.3	b	1.4	b	2.0	a	2.0	a
Astringent	2.0	b	2.2	b	2.2	b	2.3	b	2.9	a
Burning	1.3	b	1.6	ab	1.2	b	1.5	b	2.1	a
AfterBitter	1.3	b	1.2	b	1.2	b	1.7	b	2.4	a
AfterAstringent	1.5	b	1.6	b	1.7	b	1.9	b	2.3	a
AfterBurning	1.0	ab	1.1	ab	0.9	b	1.3	ab	1.5	a

Means followed with a different letter indicate significant difference using the LSD test. Level of significance is indicated by the P-value.

The PCA plot shows grouping of all juice made with fruit from Healthy trees, regardless of Tree or Ground harvest, with descriptors of orange flavor, fruity-non-citrus flavor and sweetness. On the opposite side of dimension 1 (73.3%) was the samples from HLB trees harvested on the Ground. Juice made with fruit from HLB trees harvested on the tree were intermediate between all Healthy and HLB-Ground samples.



Measure chemical, biochemical and physical characteristics

- Sugars and acids, Refractometer and HPLC
- Limonoids and flavonoids, HPLC-MS
- Aroma volatiles, GC-MS
- Microbial populations, qPCR
- Measure pathogen DNA, qPCR

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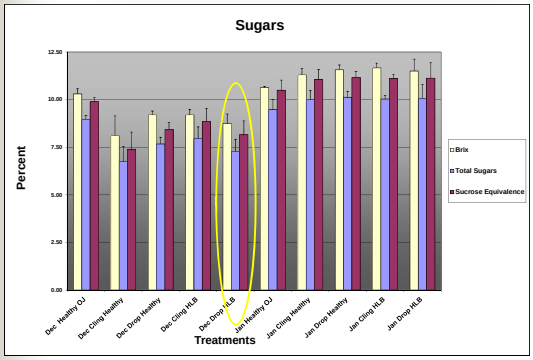

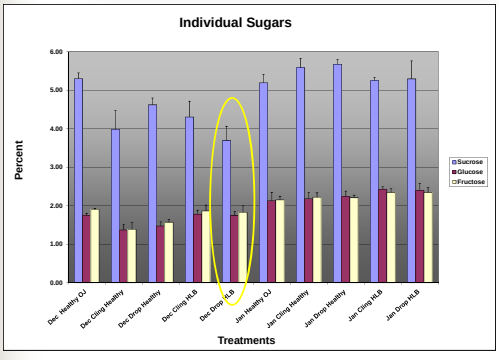

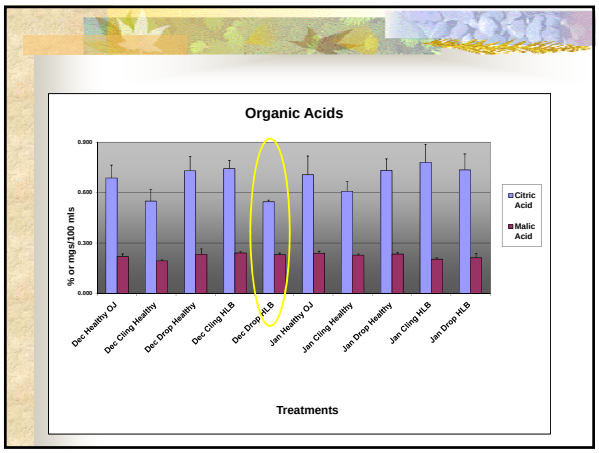

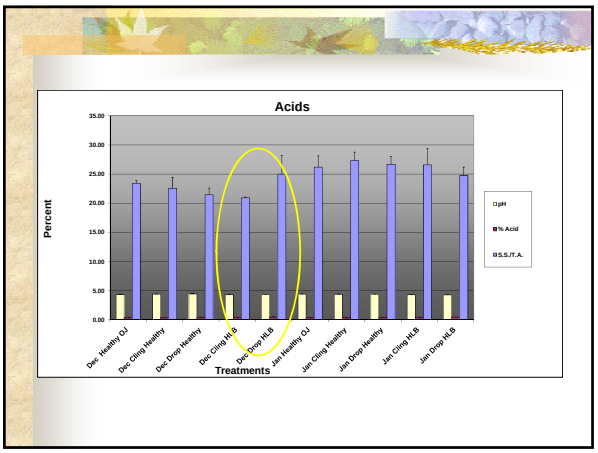

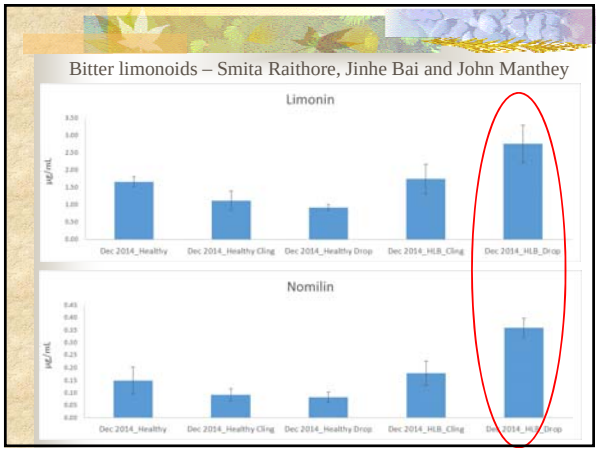

Conclusions

- Juice from HLB fruit were perceived to have lower flavor quality
- Juice from dropped HLB fruit had the lowest quality
- There was not much difference in sugars and acids
- HLB juice had higher levels of bitter limonids
- Dropped fruit had higher HLB and Diplodia titers