ples compared to those with added 3% glucose + fructose. In the combined data set, many aroma descriptors showed significant differences. Overall aroma was determined to be more intense in the control and samples with 3% glucose than in samples with added 2 and 3% fructose or 3% glucose/fructose mix. Tomato green aroma was rated highest in samples with added 3% sucrose compared to those with 2% sucrose or 3% glucose/fructose mix. Tomato ripe aroma was perceived to be highest in the control compared to all spiked samples. And finally, tomato sweet aroma was higher in samples with 2% fructose compared to those with 2% sucrose.

When both sugar levels are averaged, overall taste is rated higher in fructose- and sucrose-spiked samples than in glucose-spiked puree or controls ($P = 0.08$). Samples spiked with glucose + fructose were found to have more intense overall taste than controls as well. Sweetness was rated highest in fructose, glucose + fructose and sucrose-spiked samples than for those spiked with glucose, which, in turn, was rated sweeter than controls ($P = 0.001$). Sourness was rated higher in controls than glucose-spiked samples which were rated more sour than those with added fructose. For overall aftertaste, samples with added glucose were rated highest and were different from controls. For aroma, overall aroma was rated most intense in controls which were more intense than those spiked with sucrose, fructose, or the glucose + fructose mix. Tomato ripe aroma was also found to be most intense in controls, which were rated higher than fructose, the glucose + fructose mix, or sucrose.

For sugar levels, samples with added sugars (2 and 3% added sugar to the base level in the tomato puree, v/w) were rated higher in overall taste than controls (0% added sugar). Not surprisingly, sweetness intensity was found to be highest in samples with added sugars at 3%, followed by 2%, followed by controls. Conversely, sourness intensity was perceived to be greater in controls compared to samples with 2 and 3% added sugars. Overall aftertaste was rated higher for samples spiked with 2% sugar levels than for controls.

Generally, addition of sugars raised perception of sweetness and decreased perception of sourness, as expected. However, equal levels of fructose, sucrose, or the glucose + fructose mix were equally effective at both the 2 and 3% levels in this respect. Sucrose-spiked samples were rated higher in overall taste, however, than samples with added glucose + fructose mix at the 3 but not the 2% level. Nevertheless, there does not seem to be much advantage to increasing levels of sucrose in lieu of increasing the normal ratio of fructose and glucose or fructose alone in tomato breeding or genetic engineering programs. Also, addition of extra sugar appeared to result in reduced perception of aromas. This was especially true for the sweeter sugars, fructose and sucrose.

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INTERRELATIONSHIP OF SENSORY DESCRIPTORS AND CHEMICAL COMPOSITION AS AFFECTED BY HARVEST MATURITY AND SEASON ON FRESH TOMATO FLAVOR

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Abstract. **Tomatoes (*Lycopersicon esculentum*), harvested at breaker and red-ripe stages from two different locations and two different seasons, were evaluated for flavor characteristics. Tomato flavor was studied using a trained sensory panel and instrumental and chemical techniques to measure sugars, acids, and aroma volatiles. The tomatoes harvested at the red-ripe stage were rated higher for fruitiness and tomato-like descriptors and lower in pH than those harvested at the breaker stage. The correlations of sensory descriptors with volatile and non-volatile flavor measurements were different for the two crops. The fall crop (Bradenton, FL) had more significant correlations than the spring crop (Homestead, FL). Tomatoes,**

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assessed to be more flavorful by the breeder, were rated higher for sweetness, fruitiness and tomato-like intensities. These tomatoes also had higher solids and total sugars content and intermediate to high levels of the aromatic volatiles. Variables like season/location, growing conditions, and fruit-to-fruit variation suggest that genetic material is not the sole factor in determining fresh tomato flavor.

Characteristic tomato flavor is the result of complex interactions of taste and aromatic components. The taste is mainly due to the sugars and organic acids present in tomatoes. Glucose and fructose are the predominant sugars, and citric and malic acid the predominant organic acids present in ripe fruit. Sugars and total soluble solids increase as the fruit matures and reach a peak at the turning to red stages. Acid content increases during growth and ripening up to the breaker stage and then starts declining (Petro-Turza, 1987). Aromatic volatile compounds in tomatoes are formed in intact fruit during ripening or when the fruit tissue is disrupted (Buttery, 1993) as would be the case when the fruit is eaten.

Harvest maturity and ripening are two key factors in the development of fresh tomato flavor. Tomatoes are harvested either at the vine-ripe (breaker) or mature green stage. This is done to prolong the shelf life of the fruit and because the less mature fruit are generally firm enough to survive shipping and storage periods. The main problem inherited from this approach is the sacrificing of flavor and quality for shelf life. A number of studies have shown that fruits left to ripen fully on the vine (i.e., to pink or red stages) have more flavor and better overall quality than the breaker- or green-harvested tomatoes (Baldwin et al., 1991a; Hayase et al., 1984; Kader et al., 1977; Resurreccion and Shewfelt, 1985). The primary reason for this is that the total sugars, solids, and flavor volatiles reach peak concentrations in the later stages of maturity, namely turning to red stages.

The objective of this research was to study the flavor of tomatoes from two different locations and seasons and harvested at different maturity stages.

Materials and Methods

Fall 1999 fruit. Six tomato cultivars and breeding lines grown at the University of Florida Gulf Coast Research and Education Center in Bradenton, Florida, were selected, representing a wide array of flavors (Table 1). The tomatoes were set in beds of sandy organic soil in a randomized block (RCB) design with three plots and 8 plants per plot (Scott et al., 1997). Plants were grown with a stake culture and modified furrow (seepage) irrigation was followed. The tomatoes were harvested at two different maturity stages, red (R) and breaker (B) and were shipped the same day to the University of Georgia for sensory analysis. The B-harvested tomatoes were placed in storage at 15°C until ripe which was determined by color (Baldwin et al., 1998). The R-harvested fruit were immediately used for sensory analysis.

Spring 2000 fruit. Four tomato cultivars and breeding lines were grown at the University of Florida Tropical Research and Education Center in Homestead, Florida (Table 1). Plants were set in beds of Krome gravelly loam soil as described above except that there were 10 plants per plot and plants were grown with ground culture. The tomatoes were harvested at the red stage and shipped the same day to the University of Georgia for sensory analysis as described for fall fruit.

Table 1. Tomatoes selected from the A) fall 1999 (Bradenton, FL) and B) spring 2000 (Homestead, FL) crops.

Cultivar/breeding line	Pedigree	Breeder's assessment
A)		
201	(7060 × 7171)-Bk-74-SBK1-SBK	Bitter, sour, terrible
207	{7547 × [7479 × (7171 × E317)]}-BK-12-SBK-1	Sweet, moderate acid
212	{7547 × [7479 × (7171 × E317)]}-BK-57-3-SBK	Bland
215	'Solar Set'	Balanced
216	Fla. 7859 (Fla. 7692 × Fla. 7547)	Sweet, low acid
217	'Florida 47'	Industry standard
B)		
182	Fla. 7862	Balanced flavor
184	Solar Set	Balanced, not as sweet
190	(7060 × 7171)-BK-11- SBK-7	Vegetative
196	{7692F × [7599 × (7344 × 7402)}-BK-6-SBK-SBK	Sour, metallic, off-flavor

Sensory panel. The sensory panel was comprised of seven panelists, made up of students and staff of the Food Science Department at the University of Georgia. The seven judges, 4 male and 3 female, were in the age range of 21-50. These panelists had participated on previous descriptive analysis panels on tomato flavor.

Sensory method. The tomato cultivars were evaluated using a method modified from the Spectrum® technique for descriptive analysis (Meilgaard et al., 1991). This procedure calibrates panelists based on reference standards established for the Spectrum® method but rates samples using 150 mm unstructured line scales (Galvez and Resurreccion, 1990). Panelists were trained to evaluate the flavor of tomato samples, by the principal investigator, in 8 one-hour training sessions.

Eleven descriptors were developed for fresh tomato flavor. Reference standards and samples were provided to the panelists for each of the descriptors developed except overripe (Table 2). Tomatoes from local supermarkets were provided to the panelists during training and calibration. The panelist's performances were evaluated after each training session by calculating the mean and standard deviations. Panelists were judged to perform well when their ratings were within ±10 mm from the mean.

Sensory evaluations were conducted at the Food Products Research and Development Laboratory in two sessions per day, one in the morning and one in the afternoon. For sample preparation, one half of each tomato was used for sensory while the other half was used for chemical/instrumental analysis. The tomatoes were cut from the stem scar to the blossom end in the form of wedges and placed in 4-oz. plastic soufflé cups (representing several tomatoes), which were immediately capped. The samples were prepared 1 hour before evaluations and were coded with 3 digit random numbers. Panelists rated the samples individually in partitioned booths at room temperature, served in random order. Panelists were requested to rate the samples relative to intensity ratings of standards (served along with samples) established during training, using the scoresheets provided. Panelists were also provided with unsalted crackers and water to clear their palates in between samples.

Table 2. The reference standards and their intensities for the various descriptors.

Descriptor	Reference standard[z]	Intensity value on 150-mm scale
Tastes		
Sweet	2% sucrose solution	20
	5% sucrose	50
	10% sucrose	100
	15% sucrose	150
Sour	0.05% citric acid	20
	0.08% citric acid	50
	0.15% citric acid	100
Salty	0.20% NaCl solution	25
	0.35% NaCl	50
Bitter	0.05% caffeine solution	20
	0.08% caffeine	50
Aromatics		
Earthy	Damp soil	100
Fruity	Libby's fruit punch	55
Tomato-like	Campbell's low sodium tomato juice	65
Green	Green beans	70
	Parsley leaves	110
Oral feeling factors		
Bite	Canada Dry ginger ale	40
Astringent	Welch's Grape juice	65

[z]Adapted from Meilgaard et al. (1991) and Civille and Lyon (1996).

Sample preparation for chemical analysis. Tomato halves from the same tomatoes sampled by the sensory panel were diced and blended for 30 s in an Oster blender (Oster Corporation, Milwaukee, WI). The blended homogenate was then held for a period of 3 min (Buttery et al., 1987). A 40 ml aliquot of the homogenate was removed and the remainder (at least 100 ml) was placed in plastic zippered bags and frozen for total sugar (TS), sucrose equivalents (SE), acid (pH), titratable acidity (TA), soluble solids (SS) and SS/TA, and SE/TA analyses. To the 40 ml homogenate, 10 ml of saturated calcium chloride was added and this mixture blended for 10 s (Baldwin et al., 1998). The saturated $CaCl_2$ solution deactivates any enzymes since the bivalent Ca^{2+} ions precipitate the proteins (Buttery et al., 1987). This stops enzymatic reactions in the broken tissue which, otherwise would continue to alter the volatile profile. After blending, the homogenate was poured into zippered bags and flash frozen in liquid nitrogen. These samples, to be used for GC-headspace analysis, were stored at a temperature of -90°C.

Chemical analyses. The frozen homogenate samples prepared earlier were used for sugar, TA, SS and pH analyses. A 40 ml aliquot of the homogenate was extracted in 80% ethyl alcohol according to Baldwin et al. (1998) and analyzed on a Perkin Elmer Series 410 HPLC system (Baldwin et al., 1991a; 1991b). Levels of percent glucose and fructose were converted to sucrose equivalents (SE), by multiplying by 0.74 and 1.73 respectively and combining them (Koehler and Kays, 1991). For total soluble solids (SS) content, a 40 ml sample was centrifuged @ 10000 rpm for 15 min using a Beckman J2-21 centrifuge (Palo Alto, CA) and the supernatant used to determine the SS as °Brix using an Atago digital refractometer (Japan). TA and pH were determined by the titration of 10 ml supernatant fluid using an Orion 950 pH meter and titrator (Orion Research, Inc., Boston, MA).

For volatile analysis, 2 ml homogenate were dispensed into 6 ml vials, which were immediately sealed using crimp-top caps with TFE/silicone septa seals. Volatile compounds were identified and later quantified using the headspace analysis procedure developed previously (Baldwin et al., 1991a; 1991b) using a Perkin Elmer 8500 gas chromatograph equipped with a model HS-6 headspace sampler, a FID detector, and a 0.53 mm × 30 m Stabilwax column of 1.0 µ film thickness (Resteck Corporation, Bellefonte, PA).

Statistics. Results were analyzed as a completely randomized design with cultivar as treatment using the General Linear Model (PROC GLM) procedure of the Statistical Analysis System (SAS Institute, Cary, NC, 1996). Significant differences in sensory attributes and instrumental/chemical measurements among the cultivars and stages of maturity were determined by Duncan's multiple range ($P = 0.05$). Correlation analysis using PROC CORR was used to determine correlations between sensory and instrumental and chemical analysis data.

Results and Discussion

Fall 1999 fruit. For Cultivar differences, line 201, which was assessed as bitter/sour/terrible by the breeder, was rated low for sweet, and high for salty, and overripe flavor (Table 3). The other descriptors showed no significant differences between cultivars (bitter, tomato-like, earthy, green, fruity, bite, and astringent). This line had a high TA score and was low in SS, TS, SE, SS/TA and SE/TA (Table 4). Line 212, described as 'bland' or lacking flavor was rated low for sweetness and overripe flavor. This line had low TS and SS content and was intermediate for pH, TA and SE units (Table 4). Solar Set (# 215), which is described as a tomato with balanced flavor, had high scores for many descriptors, significant for sweetness and overripe, and was rated low for sour and salty. Solar Set also had the highest SS, TS, and SE units and was low in pH (Table 4). Breeding line 207 is described as sweet with moderate acid by the breeder. This line was rated the highest for sweetness and lowest for sour and had high TS, SE, SS/TA, SE/TA, and low TA.

Results for correlation analyses between sensory descriptors and chemical and instrumental measurements for R-harvested tomatoes are presented in Tables 5 (volatile measurements) and 6 (non-volatile measurements). The fall crop had more significant correlation coefficients between descriptors and aromatic volatiles or sugars and acids than

Table 3. Overall sensory panel scores for the six selections evaluated (Cul = cultivar).

	Descriptors			
Cul	Sweet	Sour	Salty	Overripe
201	22.7 b[z]	23.9 a	19.6 ab	48.1 a
207	30.9 a	15.6 b	15.9 b	38.0 bc
212	20.5 b	24.1 a	16.9 ab	30.2 d
215	28.0 a	19.8 ab	16.4 ab	42.5 ab
216	29.5 a	20.6 ab	17.8 ab	31.7 cd
217	22.6 b	27.1 a	21.0 a	31.9 cd

[z]Mean separation done by Duncan's procedure at $P < 0.05$. Means in a column with same letter are not significantly different.

Table 4. Non-volatile measurements on the six tomato selections (TA = titratable acidity; SS = soluble solids; TS = total sugars; and SE = sucrose equivalents).

	Sugar and acid measurements						
Cul	pH	TA	SS	TS	SE	SS/TA	SE/TA
201	4.35 a[z]	0.39 a	4.95 c	2.80 b	3.60 b	12.94 c	9.40 c
207	4.20 bc	0.25 c	5.38 bc	3.36 ab	4.28 b	21.50 a	17.20 a
212	4.24 b	0.33 ab	4.95 c	2.60 b	3.91 b	15.10 c	12.00 b
215	4.15 c	0.39 a	6.00 a	4.00 a	5.10 a	15.76 bc	13.30 b
216	4.21 bc	0.29 bc	5.38 bc	2.96 b	3.84 b	18.30 b	13.00 b
217	4.31 a	0.37 a	5.60 ab	3.33 ab	4.20 b	15.26 c	11.25 bc

[z]Mean separation done by Duncan's procedure at $P < 0.05$. Means in a column with same letter are not significantly different.

the spring 2000 crop. For taste factors, sweet correlated positively to ethanol and *cis*-3-hexenal, and negatively to hexanal and 2+3-methylbutanol (Table 5). Sour correlated negatively to acetaldehyde and positively to 2+3-methylbutanol and 6-methyl-5-hepten-2-one. Roth and Schrodter (1996) have previously reported that ethanol seems to enhance the perception of sweetness. Sweetness was positively correlated to SS and negatively to pH, whereas sourness was positively correlated to pH and negatively to SE, as one would expect (Table 6). This is in agreement with the results of Kader et al. (1977), Stevens et al. (1979) and Jones and Scott (1983). Astringent correlated positively to pH and negatively to TS and SE. Bite correlated positively to pH and negatively to SS, TS, and SE which was similar to results of Baldwin et al. (1998). SE was also negatively correlated with bitter and bite.

For aromatic descriptors, tomato-like correlated positively with *cis*-3-hexenal, while overripe negatively correlated with methanol and positively with *trans*-2-heptenal, *cis*-3-hexenol, and 2-isobutylthiazole. Earthy correlated positively to acetone and negatively to methanol, ethanol, hexanal, and *cis*-3-hexenal. Green correlated negatively to acetone. Kazeniac and Hall (1970) have described *cis*-3-hexanol as spoiled, vine-like, slightly horseradish type flavor, whereas Krumbein and Auerswald (1998) described 2-isobutylthiazole as having a musty/sharp odor. Tomato-like flavor had high correlation with soluble solids (Table 5).

Correlation analyses for B-harvested tomatoes between sensory descriptors and volatile measurements revealed that sourness, bite and astringency correlated negatively with *cis*-3-hexenal (Table 5). Overripe correlated negatively with *cis*-3-hexenal, 6-methyl-5-hepten-2-one, 1-penten-2-one, and *trans*-2-heptenal. Earthy correlated positively with acetone, methanol, cis- 3-hexenol, and geranylacetone. For correlations to non-volatile measurements, salty correlated positively with pH and bite with TA (Table 6).

Spring 2000 fruit. Unlike Bradenton tomatoes, these tomatoes did not show many significant correlations with the aromatic volatiles or the sugars and acids. Sweet, bitter, fruity and astringent did not have any significant correlations with volatiles. Sour correlated negatively with acetaldehyde, tomato-like had very strong negative correlations with hexanal and β-ionone, overripe correlated with *cis*-3-hexenol, earthy correlated negatively with methanol (r = -0.95)and *trans*-2-heptenal, and green with acetaldehyde and positively with geranylacetone (Table 5). Among the non-volatile, overripe correlated negatively with glucose, earthy correlated positively with SS, green negatively with pH, and fruity positively with TA and negatively with SS/TA (Table 6). For tomatoes harvested at the breaker stage, green was highly correlated with TA while bite and astringency were negatively correlated with total sugars and SE (data not shown).

Conclusions

Correlation analysis data revealed that sourness was negatively correlated to acetaldehyde, overripe positively to *cis*-3-hexenol and earthy negatively to methanol for both the locations. There were no similarities in correlations between descriptors and sugars and acids for the two locations. Earthy aroma also correlated positively to acetone, and astringent negatively to *cis*-3-hexenal for both R and B spring 1999 tomatoes.

Some similarities do emerge from these studies conducted on tomatoes harvested in different seasons and locations, however. The sensory panel in general supported the initial flavor assessment of the tomatoes in the field, by the breeder. The tomatoes which were described as balanced or having better flavor, were rated high by the panelists for descriptors like sweet and were given low scores for sour and overripe. These tomatoes also seemed to have higher amounts of soluble solids and total sugars, which led to higher sucrose equivalents, lower pH, and intermediate SS/TA and SE/TA ratios. Tomatoes rated more flavorful by the breeder had intermediate to high concentrations of most of the important aromatic volatiles, including *cis*-3-hexenal, geranylacetone and ß-ionone (data not shown).

On the contrary, tomatoes initially assessed as bitter/terrible/bland, were rated high for descriptors like sour, and overripe. These tomatoes lacked the concentrations of volatile aromatic compounds as found in the more flavorful tomatoes (data not shown). Also, these tomatoes had higher pH values and lower TS, SS, and SE than the flavorful tomatoes. It appears that a flavorful tomato is one with high TS and SS, low pH, and intermediate to high TA as well as intermediate amounts of important aromatic volatiles. These results agree with Malundo et al. (1995), who stated that increasing sugar content in tomato samples increased the acceptability but acid levels reach a maximum, beyond which consumer acceptance decreased. Baldwin et al. (1998) also reached similar conclusions with their tomato flavor work. The descriptor green seems to be more related to the perception of acidity in tomatoes than pH and both bite and astringency are negatively related to the TS and SS in tomatoes. The results of correlation analysis were very different for the two locations. The only similar correlations for the two crops were acetaldehyde to sourness, methanol to earthy and *cis*-3-hexenol to overripe.

Table 5. Correlations between sensory descriptors and volatile flavor components of red-ripe (R) or breaker (B) tomatoes.

Flavor descriptor	Volatile	*r* Fall (R)	*r* Fall (B)	*r* Spring (R)
Tastes				
Sweet	Ethanol	0.77*[y]	ns	ns[z]
	Hexanal	-0.73*	ns	ns
	cis-3-Hexenal	0.75*	ns	ns
	2+3-Methylbutanol	-0.75*	ns	ns
Sour	Acetaldehyde	-0.76*	ns	-0.91**
	2+3-Methylbutanol	0.77*	ns	ns
	6-Methyl-5-hepten-2-one	0.73*	ns	ns
	cis-3-Hexenal	ns	-0.75	ns
Bite	*cis*-3-Hexenal	ns	-0.88	ns
Astringent	*cis*-3-Hexenal	ns	-0.80	ns
Aromatics				
Tomato-like	*cis*-3-Hexenal	0.73*	ns	ns
	Hexanal	ns	ns	-0.96**[x]
	ß-ionone	ns	ns	-0.91**
Overripe	Methanol	-0.91**	ns	ns
	trans-2-Heptenal	0.81**	ns	ns
	cis-3-Hexenol	0.90**	ns	0.95**
	cis-3-Hexanal	ns	-0.91	ns
	2-Isobutylthiazole	0.80*	ns	ns
	6-Methyl-5-hepten-2-one	ns	-0.82	ns
	1-Penten-2-one	ns	-0.87	ns
	trans-2-Heptenal	ns	-0.82	ns
Earthy	Acetone	0.84**	0.79	ns
	Methanol	-0.81**	0.82	-0.95**
	Ethanol	-0.81**	ns	ns
	Hexanal	-0.90**	ns	ns
	cis-3-Hexenal	-0.75*	ns	ns
	cis-3-Hexenol	ns	0.85	ns
	trans-2-Heptenal	ns	ns	-0.91**
	Geranylacetone	ns	0.83	ns
Green	Acetone	-0.92**	ns	ns
	Acetaldehyde	ns	ns	-0.98**
	Geranylacetone	ns	ns	0.93**
Fruity	Ethanol	0.90**	ns	ns
	Hexanal	-0.94**	ns	ns
	2+3-Methylbutanol	-0.94**	ns	ns
	6-Methyl-5-hepten-2-one	-0.87**	ns	ns
Chemical feeling				
Astringent	*cis*-3-Hexenal	-0.80**	-0.80	ns
	2+3-Methylbutanol	0.84**	ns	ns
Bite	ß-ionone	-0.80**	ns	ns
	Methanol	ns	ns	-0.91**
	1-Penten-3-one	ns	ns	-0.98**
	Methylbutanol	ns	ns	-0.98**
	cis-3-Hexenal	ns	-0.88 ns	
	trans-2-Heptenal	ns	ns*	-0.94*

[z]ns = not significant.
[y]* = significant at $P < 0.10$.
[x]** = significant at $P < 0.05$.

External factors like season, location, and harvest maturity affected the constituents in the tomatoes in this study that contribute to the flavor perception such that genetic differences and/or similarities were masked. There was wide variability present in the tomato fruits for sugar, acid, and volatile levels as well as for descriptor intensity even within selections. Galliard et al. (1977) also mentioned that work on tomatoes is difficult since they are in a constant state of metabolic change and flavor changes are occurring from day-to-day as ripening proceeds. Brauss et al. (1998) also encountered variation between fruits from the same cultivars. They further stated that this was important from a quality standpoint as quality tests were based on mean quality obtained from a representative sample, but consumers judge quality on individual fruits. Thus, even if the mean quality of a tomato crop was high, there might be a significant proportion of tomatoes below the acceptable standard of the consumers. In our work, we tried to minimize fruit-to-fruit variation by taking color measurements on the tomatoes and selecting those within a narrow range. Internally however, the tomatoes still were different from each other with respect to their volatile and nonvolatile composition.

Table 6. Correlations between sensory descriptors and non-volatile flavor components for tomatoes harvested red-ripe (R) or breaker (B) (SS = *soluble solids, SE = sucrose* equivalents, TA - titratable acidity).

Flavor descriptor	Non-volatile measurement	*r* Fall (R)	*r* Fall (B)	*r* Spring
Tastes				
Sweet	PH	-0.78*[y]	ns	ns[z]
	SS	0.78*	ns	ns
	Glucose	0.76*	ns	ns
Sour	PH	0.77*	ns	ns
	SE	-0.74*	ns	ns
Bitter	PH	0.93**[x]	ns	ns
	TS	-0.76*	ns	ns
	SE	-0.72*	ns	ns
Salty	PH	ns	0.78	ns
Aromatics				
Tomato-like	SS	0.84**	ns	ns
Overripe	Glucose	ns	ns	-0.91**
Earthy	SS	ns	ns	0.95**
Green	pH	ns	ns	-0.92**
Fruity	TA	ns	ns	0.97**
	SS/TA	ns	ns	-0.91**
Chemical feeling				
Astringent	pH	0.95**	ns	ns
	TS	-0.77*	ns	ns
	SE	-0.74*	ns	ns
Bite	pH	0.91**	ns	ns
	SS	-0.80*	ns	ns
	TS	-0.84**	ns	ns
	SE	-0.81**	ns	ns
	TA	ns	0.77	ns

[z]ns = not significant.
[y]* = significant at $P < 0.10$.
[x]** = significant at $P < 0.05$.

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