Factors influencing mandarin fruit quality

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Mary Lu Arpaia, UCR

What drives the eating experience in mandarins?

- Exterior appearance is important for the initial purchase and can have some impact on the perception of taste
- Flavor quality is even more critical. Consumer acceptance......and whether they will buy again....is strongly linked with flavor quality
Outline of talk

- Impact of sugar and acid balance
- Influence of aroma compounds
- Off-flavor formation during storage

Sensory properties of food related to flavor

Flavor

- Taste
- Odor/smell/aroma
- Texture/mouthfeel
- Temperature
- Irritation/pain
Taste

Taste is a sensation that is perceived in the mouth by the tongue

• Sweet
• Salty
• Bitter
• Sour (acidic)
• Umami (protein – savory)

In navel oranges sweetness and acidity are described by the California standard

\[
\text{CA Standard} = (\text{SSC} - (\text{TA} \times 4)) \times 16.5
\]
Data from Australia suggests that if a California standard for mandarins is developed the value may need to be higher than that currently set for navels.

Analysis: Mark Loeffen
Delytics Ltd, New Zealand

The scatter in the individual points (fruit) below indicates that sugar and acid does not entirely determine flavor.
Flavor is not just Sugar: Acid.... aroma compounds are very important

- 80-90% of taste is aroma
- 2% of the human genome is involved in olfactory perception

Elizabeth Baldwin
USDA/ARS

Aroma compounds (Volatile)

Aroma (or smell or odor) is the sensation perceived when volatile compounds are drawn into the nose.

These compounds are also perceived by the brain when they travel up the back of the throat.

Florence Negre-Zakharov, UC Davis
GCMS for aroma volatile analysis
Robotic solid phase microextraction system

Aroma Analysis and Product Quality

• Odor descriptors
  - 2-Ethyl hexanol
    citrus, fresh, floral, oily, sweet
  - 2-Methyl butyl acetate
    banana, candy, citrus
  - Hexyl acetate
    apple, cherry, floral, pear, wine

• Odor thresholds (minimum concentration of a substance at which a majority of test subjects can detect and identify the substance characteristic odor)

Florence Negre-Zakharov, UC Davis
Many aroma volatiles are present in mandarins and help determine flavor. These below were found to change as a result of storage.

<table>
<thead>
<tr>
<th>Component</th>
<th>Gold Nugget (low)</th>
<th>Gold Nugget (high)</th>
<th>Pixie (low)</th>
<th>Pixie (high)</th>
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<tbody>
<tr>
<td><strong>Alcohols</strong></td>
<td></td>
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</tr>
<tr>
<td>Ethanol</td>
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<td>164*</td>
<td>300</td>
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<td>34*</td>
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<td>4-Terpinol</td>
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<td>24*</td>
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<td>26*</td>
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<td><strong>Esters</strong></td>
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<td>600</td>
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<td>9*</td>
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<tr>
<td>2-Nonenal</td>
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<td>Decanal</td>
<td>529</td>
<td>38*</td>
<td>223</td>
<td>54*</td>
</tr>
</tbody>
</table>

Malty, woody, earthy
Sweet, fruity
Spearmint, caraway
Fatty, grassy, green

Mandarins often develop off-flavor during storage

Not fresh
Over ripe
Spoiled
Strange aftertaste
Really old
Some factors influencing off-flavor in mandarins

Warm temps enhance time in cold storage influences response

Some varieties more problematic than others
Warm temperature response of other mandarin types

Harvest date can affect the negative impact of storage on mandarin flavor

Early in the season there was less of a flavor difference

When the flavor loss occurred it was mainly due to off-flavor

Data from Owari satsumas
Coatings provide a formidable barrier to gas exchange

We assayed for ethanol as an attempt to screen for off-flavor susceptibility:

- Ethanol easy to measure
- Substrate for volatile synthesis
- Major product of low oxygen and fermentation

Is there variability out there?
Large varietal differences exist in the amount of ethanol accumulated after waxing and storage.

Response of a high ethanol producer (Pixie) vs. a low ethanol producer (Gold Nugget) to waxing.

After waxing Gold Nugget maintains a higher internal oxygen level and produces less ethanol than does Pixie.
Passage of gases through the peel occurs more slowly in Pixie than Gold Nugget.

Lowering internal oxygen in the fruit with nitrogen gas leads to a very similar ethanol response for Pixie and Gold Nugget.

Ethanol production similar for both varieties in nitrogen gas and suggests an important role for the peel.
Conclusions

- The sugar:acid balance is a very important component of mandarin taste
- Aroma compounds also play a critical role in determining mandarin flavor
- Loss in flavor quality as a result of storage is common
  - Waxing
  - Temperatures following waxing
  - Time of season
  - Variety

Our research has been funded by the California Citrus Research Board and the US-IS BARD Program.
Questions?