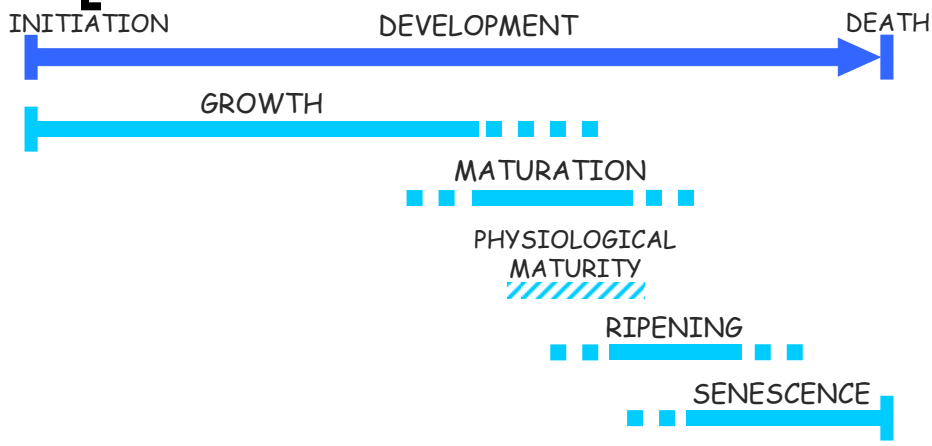
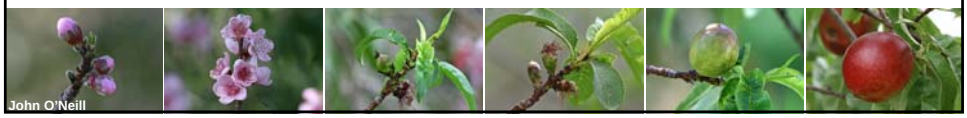
Fruit Ripening and Quality Relationships

UCDAVIS POSTHARVEST TECHNOLOGY

Florence Zakharov
Department of Plant Sciences
fnegre@ucdavis.edu

Stages of Fruit Development





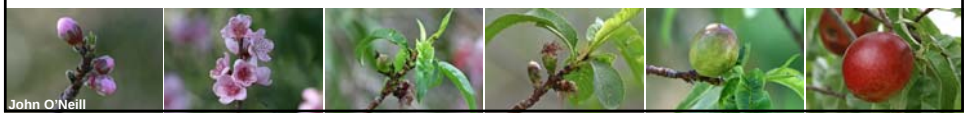
Stages of Fruit Development

Development

- The series of processes from the initiation of growth to death of a plant or plant part.

Growth

- The irreversible increase in physical attributes (characteristics) of a developing plant or plant part.



Stages of Fruit Development

Maturation

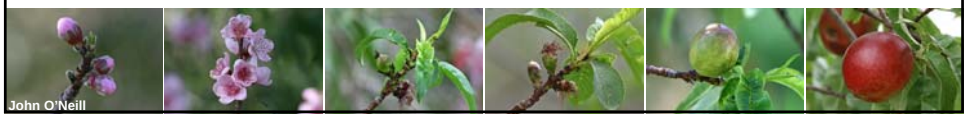
- The stage of development leading to the attainment of physiological or horticultural maturity

Physiological maturity

- The stage when a plant or plant part will continue developing even if detached

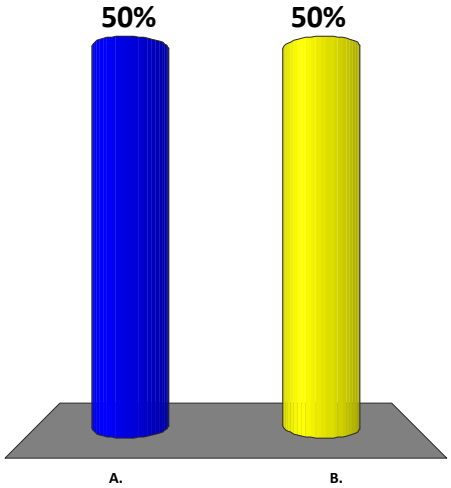
Horticultural maturity

- The stage of development when a plant or plant part possesses the prerequisites for utilization by consumers



At which maturity stage are most **fresh market tomatoes** harvested?

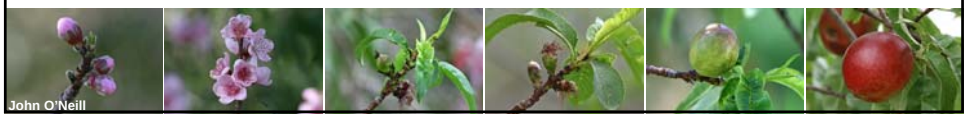
A. Physiological maturity
B. Horticultural maturity

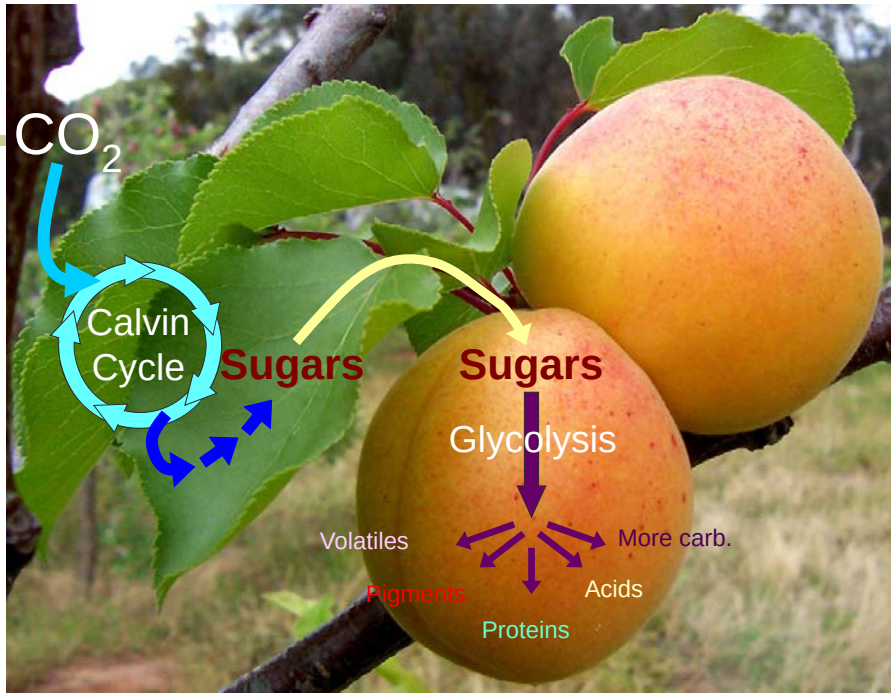


Stages of Fruit Development

Ripening

- The set of processes that occur from the later stages of growth through the early stages of senescence and that results in characteristic aesthetic and/or eating quality, as evidenced by changes in composition, color, texture, or other sensory attributes.





Stages of Fruit Development

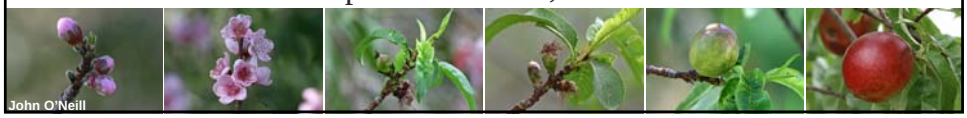
Senescence

- The last stage of development during which degradation of biological components occur.

Physiological Changes Accompanying Senescence of Horticultural Crops

Cellular:

- Loss of chlorophyll, disassembly of chloroplast structure
- Degradation of cell walls
- Altered membrane composition, loss of fluidity
- Loss of cellular compartmentation, release of vacuolar contents

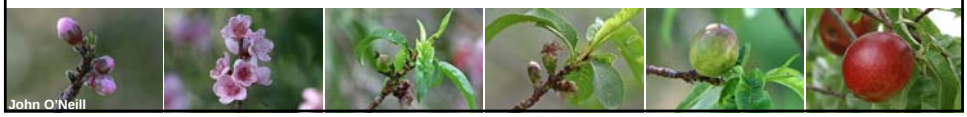


Stages of Fruit Development

Physiological Changes Accompanying Senescence of Horticultural Crops (cont.)

Composition:

- Altered sugar content, and switch to alternative substrates for respiration
- Net loss of RNA
- Increased protease activity, net loss of protein
- Altered amino acid content



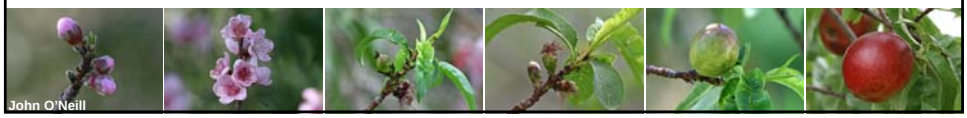
Stages of Fruit Development

Physical Changes Accompanying Senescence of Horticultural Crops

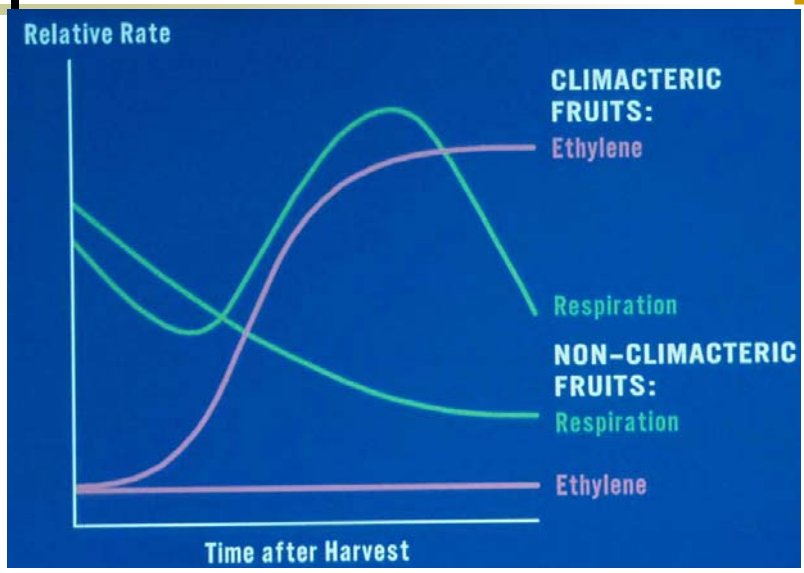
Color:
- Loss of green color
- Synthesis of new pigments (carotenoids, flavonoids)

Texture:
- Softening
- Wilting
- Drying

Loss of resistance to pathogens:
- Development of infections
- Lesions



Respiration and ethylene production rates of climacteric and non-climacteric fruits



Maturity and Ripening

Group 1:
Fruits that are **not** capable of continuing their ripening process once removed from the plant.

Blackberry	Loquat	Pomegranate
Cherry	Lychee	Prickly pear
Grape	Mandarin	Rambutan
Grapefruit	Muskmelons	Raspberry
Lemon	Orange	Strawberry
Lime	Pepper (bell)	Tamarillo
Longan	Pineapple	Watermelon

California Minimum Maturity Indices for Selected Non-Climacteric Fruits

Fruit	Minimum maturity indices
Pomegranate 	Red juice color and below 1.85% acid in juice
Grape 	14 to 17.5% SS (depending on cultivar and production area) or a SS/A ratio of 20 or higher
Strawberry 	>3/4 of fruit surface showing a pink or red color

SS=soluble solids, A=acidity

Maturity and Ripening

Group 2:
Fruits that **can be** harvested before fully ripe, and ripened off the plant

Apple	Mango	Persimmon
Apricot	Nectarine	Plum
Avocado	Papaya	Quince
Banana	Passion fruit	Sapodilla
Cherimoya	Peach	Sapote
Guava	Pear	Tomato
Kiwifruit	Pepper (chili)	

California Minimum Maturity Indices for Pome Fruits

Fruit	Minimum maturity indices
Apple 	Starch pattern, above 10.5 to 12.5% SS and below 18 to 23 lb-force firmness (depending on cultivar)
Pear (Bartlett) 	Yellowish-green color, and/or below 23 lb-force firmness, and/or above 13% SS
Persimmon 	Yellowish-green to orange color (depending on cultivar)

SS=soluble solids

Quality Attributes of Fruits

- Vary depending on protagonist in PH chain
- Consumer-centric "quality" ultimately drives marketability and sales
- Overall consumer acceptance strongly correlated with "Flavor acceptance"


Perception of Quality

- Our sensory systems are responsible for generating an internal representation of the outside world, including its **chemical** (**taste** and **olfaction**) and **physical** (**mechanical**, **sound**, **vision** and **temperature**) features.
- When evaluating the quality of the foods we eat, we use the complete array of our **sensory system** (chemical and physical senses) and integrate this information to formulate a judgment.

Sensory Attributes of Foods

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

} Flavor

Sensory Attributes of Foods
Appearance

- First attributes perceived
- Shape
- Color
  - Strongly-set expectations
  - Emotional connotations

Sensory Attributes of Foods
Taste

- Our sense of **taste** is in charge of evaluating the nutritious content of food and preventing the ingestion of toxic substances.
- Taste is a sensation perceived **in the mouth**, more specifically **on the tongue**.

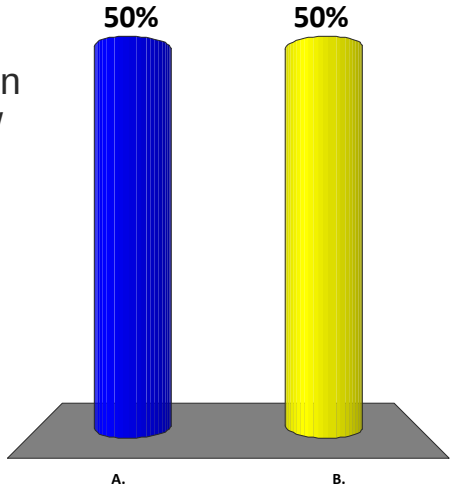
- Sweet
- Salty
- Bitter
- Sour (acidic)
- Umami (protein – savory)

5 TASTES

Are taste preferences *innate* or *learned*?

A. Innate (we are born preferring sweet/salty/umami tastes)

B. Learned (as we grow up, we learn to prefer sweet/salty/umami tastes)



Fruit Composition and Taste

Quality	Class of compound	Examples
Sweet	Sugars	Sucrose, fructose, glucose
Sour	Acids	Citric acid, malic acid, tartaric acid
Bitter	Alkaloids, Phenolics, Terpenoids, some proteins	Naringin, cucurbitacins, limonoids
Salty	Ions	Sodium, calcium
Umami	Amino acids	Glutamate, aspartate

Taste vs. Sugar/Acid Ratio

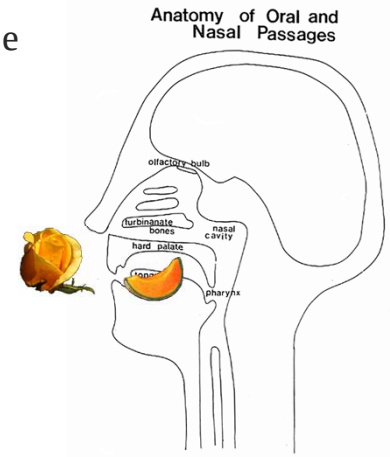
Acids	Sugars	
	Low	High
Low	Insipid, tasteless	Sweet
Moderate to High	Sour, tart	Best taste combination

Soluble solids measured by a refractometer = sugars, organic acids, soluble pectins, anthocyanins, phenolic compounds, ascorbic acid…

Need quick methods of measuring total sugars and titratable acidity

Sensory Attributes of Foods
Aroma

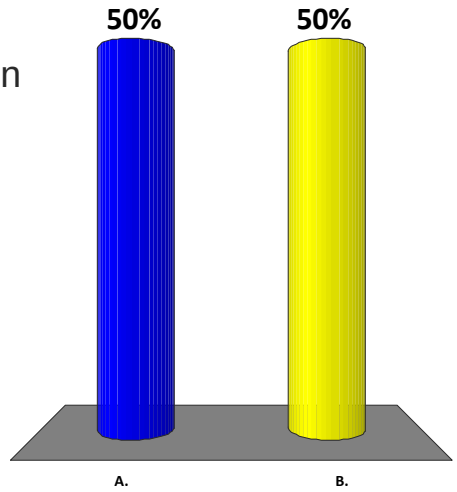
Aroma (or smell or odor) is the sensation perceived when **volatile compounds** are drawn into the **nose**.



Are smell/scent preferences *innate* or *learned*?

A. Innate (we are born preferring/rejecting certain smells)

B. Learned (as we grow up, we learn to prefer/reject certain smells)



The Aroma of a Strawberry

Over 200 volatile compounds !!

Guinard, 2005

Sensory Attributes of Foods
Texture / Mouthfeel

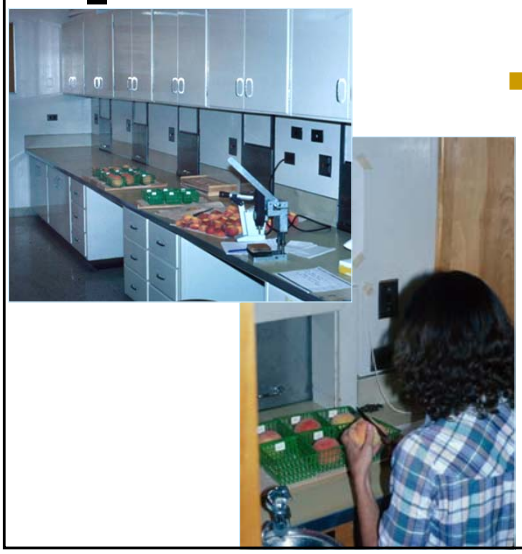
- Astringency (tannins, calcium oxalate)
- Sense of touch (mechanoreceptors)

Sensory Attributes and Fruit Composition

• All fruit components (sugars, acids, volatiles, etc...) **combine** to generate a **unique sensory experience** for the consumer.

• Physical methods can give accurate measurements of **fruit composition** but it is difficult to relate these measurements to **fruit quality** without information about **sensory perception**.

Sensory Methodology



- **Analytical tests**
  - Difference? What is it? How strong is it?
  - Descriptive analysis
  - Trained judges

Sensory Methodology

- **Consumer tests**
  - Preference, liking, purchase intent
  - Attitudes, beliefs
  - Ethnography
  - Untrained consumers

Objective measurements and Quality prediction

Development on the plant

- Developmental program
- Physiological processes (metabolism)
- Changes in composition
- Genetic/environmental/ cultivation factors

→ Harvesting at maximum potential

Easily measurable Quality Indices

Postharvest Life (?)

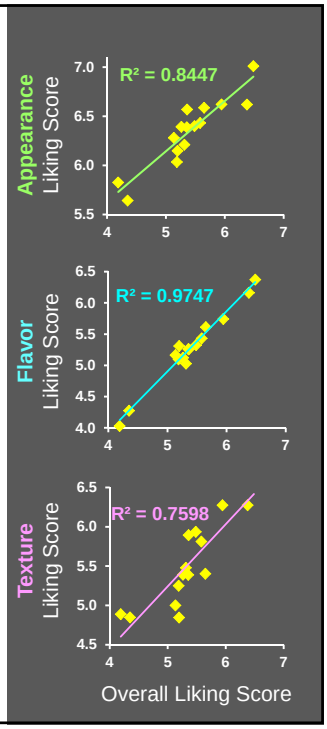
- Altered physiological processes (metabolism)
- Changes in composition
- Genetic/environmental/ handling factors

→ Attaining and retaining maximum quality

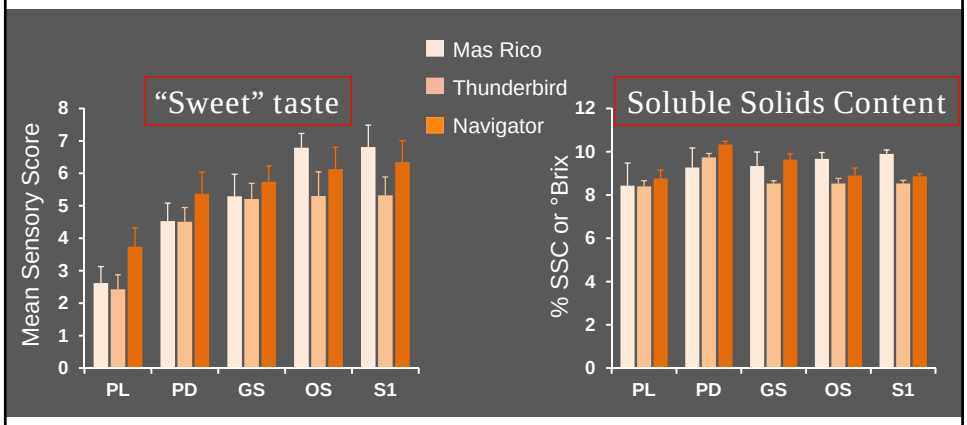
Case study:

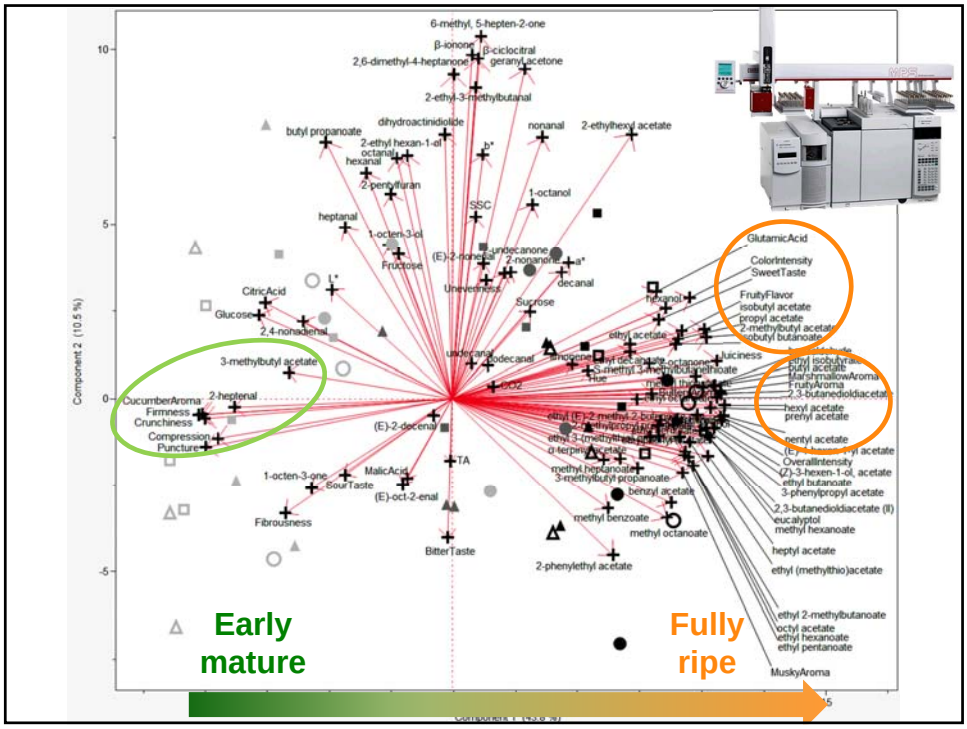
Perception of melon quality

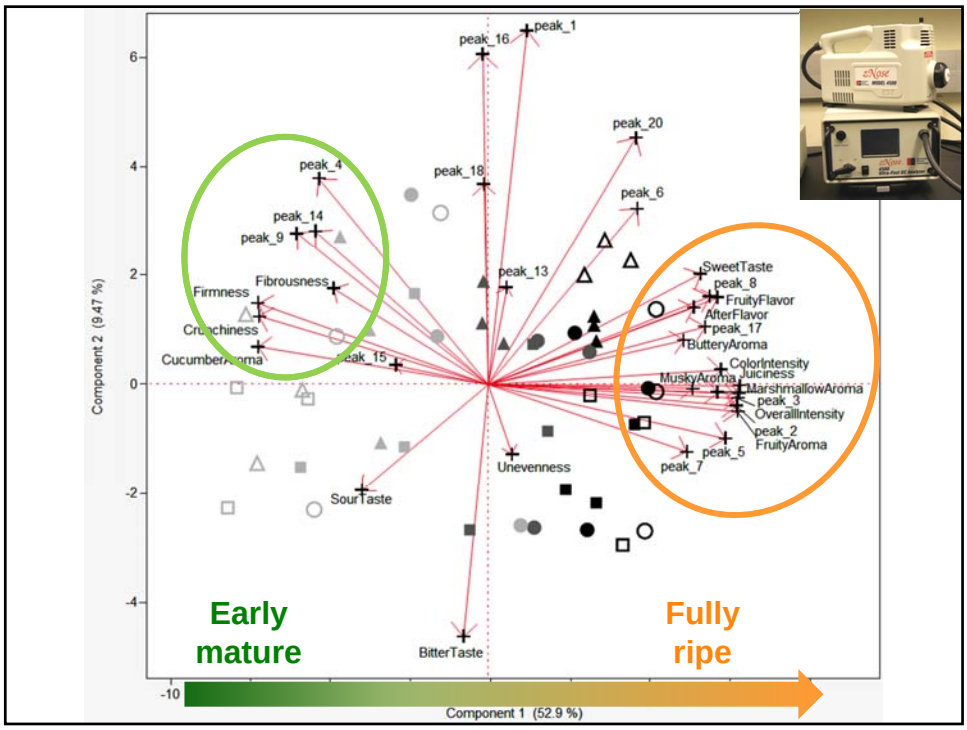
➢ Overall consumer acceptance (and repeat buy) strongly correlated with "Flavor acceptance"



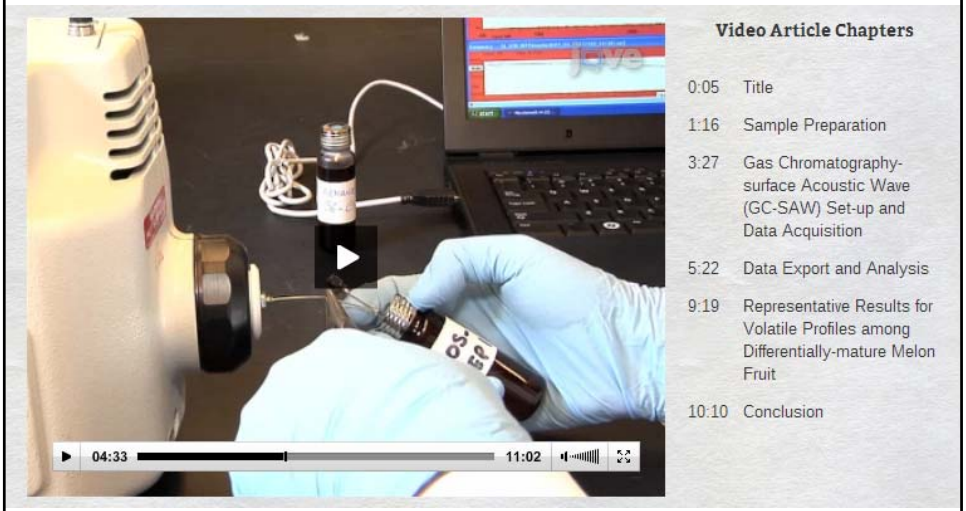
Effect of Maturity and Ripeness on Selected Sensory Attributes




Component 2 (10.5 %)
Early mature
Fully ripe
GlutamicAcid
ColorIntensity
SweetTaste
FruityFlavor
CitricAcid
Glucose
3-methylbutyl acetate
CucumberAroma
Firmness
Crunchiness
Compression
Puncture
2-heptenal
Fibrousness
BitterTaste
SourTaste
MuskyAroma
Juiciness
MarshmallowAroma
FruityAroma
OverallIntensity
Unevenness
Sucrose
SSC
TA
MalicAcid


Component 2 (9.47 %)
Component 1 (52.9 %)
Early mature
Fully ripe
peak_1
peak_16
peak_20
peak_18
peak_6
peak_4
peak_14
peak_9
peak_13
peak_15
Firmness
Fibrousness
Crunchiness
CucumberAroma
SweetTaste
peak_8
FruityFlavor
AfterFlavor
peak_17
ButteryAroma
ColorIntensity
MuskyAroma
Juiciness
MarshmallowAroma
peak_3
OverallIntensity
peak_2
FruityAroma
peak_5
peak_7
Unevenness
SourTaste
BitterTaste

Fruit Volatile Analysis Using an Electronic Nose



http://www.jove.com/video/3821/fruit-volatile-analysis-using-an-electronic-nose

Nondestructive Quality Sensing Needs

- Degree of freshness (time since harvest)
- Prior exposure to ethylene (concentration x duration x temperature)
- Prior exposure of chilling-sensitive commodities to chilling conditions (temperature x duration)
- Internal translucency / browning
- Mealiness (lack of juiciness)
- Acidity / nutritional value
- Aroma (volatiles)

Questions?

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