


Flavor and Aroma Biology



POSTHARVEST TECHNOLOGY
UC DAVIS

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Sensory Attributes of Foods

Taste
+
Aroma
=
FLAVOR

Flavor is the **combined sensation** perceived via the chemical senses (taste, smell, chemical irritation) from a food in the mouth.

Taste

Taste is the sensation perceived in the mouth, more specifically on the tongue.

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

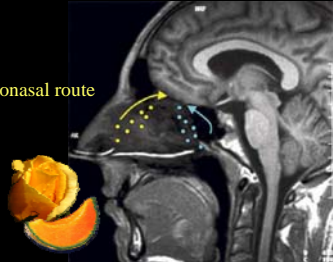
5 TASTES

Produce Composition and Taste Perception

Quality	Class of compound	Examples
Sweet	Sugars	Sucrose, fructose, glucose
	Some proteins	Thaumatococcus, monellin
Sour	Acids	Citric acid, tartaric acid, malic acid
Bitter	Alkaloids, phenylpropanoids, terpenoids	Isocoumarins, quinine, limonoids
Umami	Amino acids	Glutamate, aspartate
Salty	Ions	Sodium, calcium

Aroma

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



Orthonasal route

Retronasal route

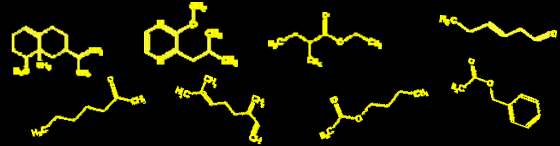
Taste and Aroma

- Taste and aroma are very closely **linked**.
- If you want to **only TASTE** something, you need to pinch your nose to avoid perceiving the volatiles in foods or drinks.



What is a volatile compound?

- A **small molecule** which has a high tendency to **evaporate**.
- Volatiles are **naturally** produced by **plants** (flowers, fruits, vegetables, herbs...) and **animals**. They can also be made **artificially** (by chemical reactions designed for their production).



What is a volatile compound?

- Scientists have identified **more than 2,000** different volatile compounds in nature (plants).



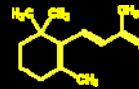
Roman Kaiser, Givaudan

How does a volatile smell like?

- Each single volatile compound has a **distinct smell**.



β -ionone



Floral, woody, sweet, fruity, berry, green



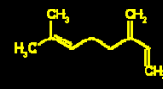
Dimethyl disulfide



Sulfurous, vegetable, cabbage, onion



Myrcene



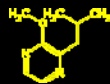
Peppery, spicy

Character-impact volatiles

Vanillin



2-isobutyl 3-methoxypyrazine



What is "aroma"?

- A natural aroma, smell or odor is typically made up of **tens** or sometimes **hundreds** of different volatile compounds.
- A mixture of volatile compounds is not perceived as "the sum of its parts": volatiles **interact** to create a unique, distinct, aroma.

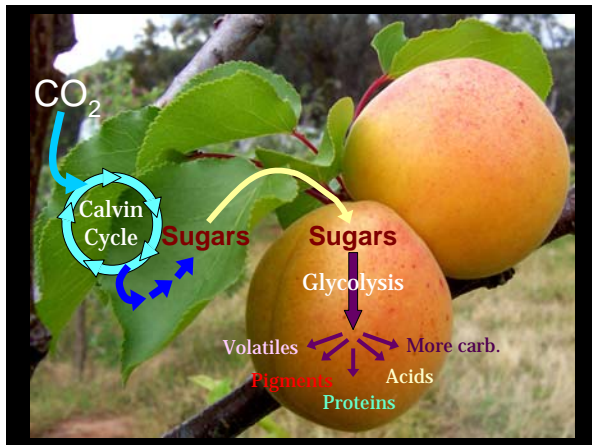
The Aroma of a Strawberry

Over 200 volatile compounds !!

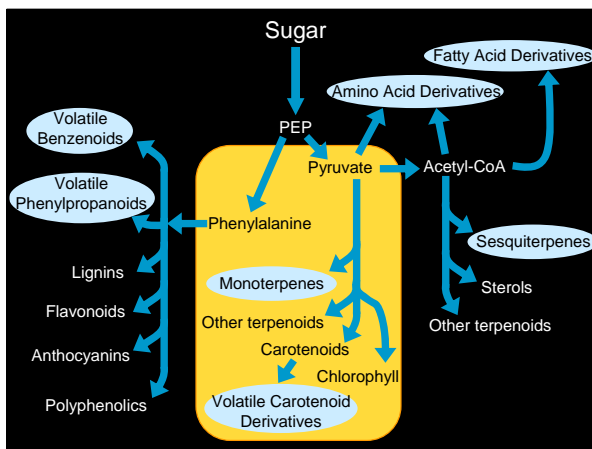
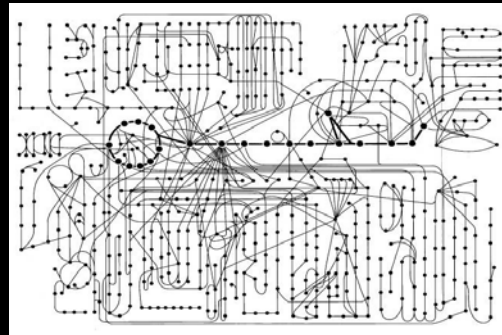


Aroma Biology

- How are aroma volatiles made in plants?
- How is aroma volatile production regulated in fruits/vegetables?
- What are the impacts of cultural practices and postharvest storage on aroma formation?



Metabolic Pathways: Diversity and Complexity



Aroma Biology

- How are aroma volatiles made in plants?
- There are more than 2,000 volatiles known to date in plants. About 900 different volatiles have been reported in fruits and vegetables.
- Scientists have identified genes involved in the synthesis of less than 10% of all volatiles known.

Carotenoid Cleavage Dioxygenase: a gene involved in tomato aroma formation

β -carotene $\xrightarrow{\text{CCD}}$ β -ionone

Lycopene $\xrightarrow{\text{CCD}}$ Geranylacetone

Simkin et al., 2004

Alcohol Acyl Transferase: a gene involved in strawberry aroma formation

$R_1-OH + R_2-S-CoA \xrightarrow{\text{VAAT, SAAT, CM-AATs, BanAAT, AAT}} R_1-O-CO-R_2 + HS-CoA$
 Alcohol + Acyl-CoA \rightarrow Volatile Ester + CoA

Aharoni et al., 2000

Aroma Biology

How is aroma volatile production regulated in fruits/vegetables?

- In climacteric fruits, **ethylene** plays an important role in triggering aroma formation during fruit ripening.

Regulation of Aroma Formation

Figure 4. Phenotype of wild-type (WT) and antisense ACC oxidase (AS) cantaloupe Charentais melons harvested 38 days after pollination and stored for 10 days at 25°C.

Ayub et al., 1996

Regulation of Aroma Formation

El-Sharkawy et al., 2005

Aroma Biology

What are the impacts of cultural practices and Postharvest storage on aroma formation?

- Pre-harvest factors**

Supply of carbon (sugars) to the fruit, water stress, light, temperature, plant diseases...

Aroma Biology

- Postharvest factors

Temperature

- Cold slows down metabolism (less volatiles made).
- Cold slows down evaporation of volatiles from fruit surface.

Ethylene

- In climacteric fruits, aroma cannot form without ethylene.

Modified or controlled atmosphere

- MA or CA alters plant metabolism – risk of anaerobic metabolism which can cause off-odors.

Is there hope?...



Quality-oriented practices

- Understand the physiology of commodity, select cultivars with optimum flavor quality.
- Harvest at maximum potential (riper) to attain (and retain) maximum flavor quality.

Research underway...

- Improving techniques to slow down metabolism when fruits already started to ripen.
- Understanding aroma formation in non-climacteric fruits (independent from ethylene?).

Questions?

