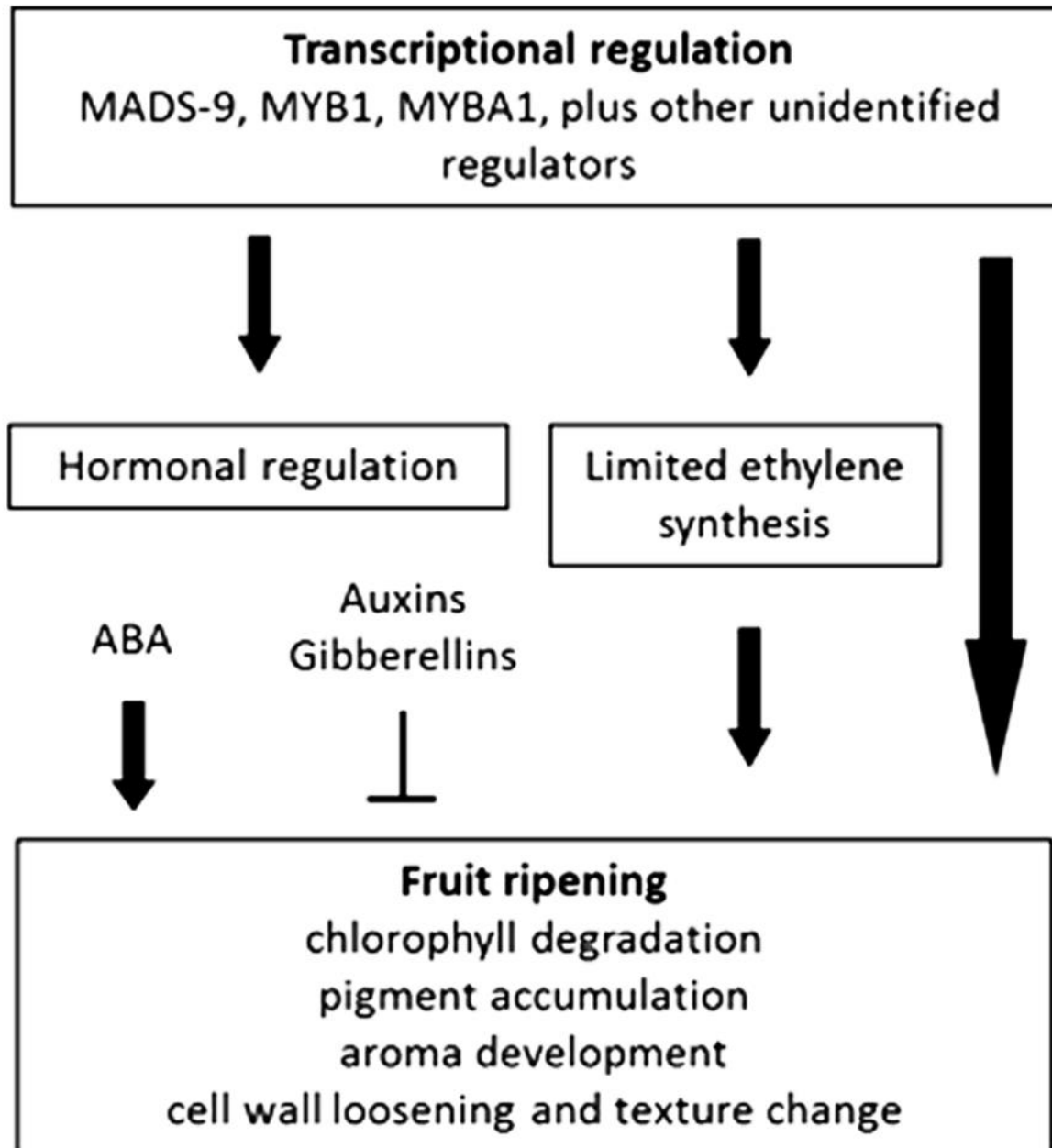


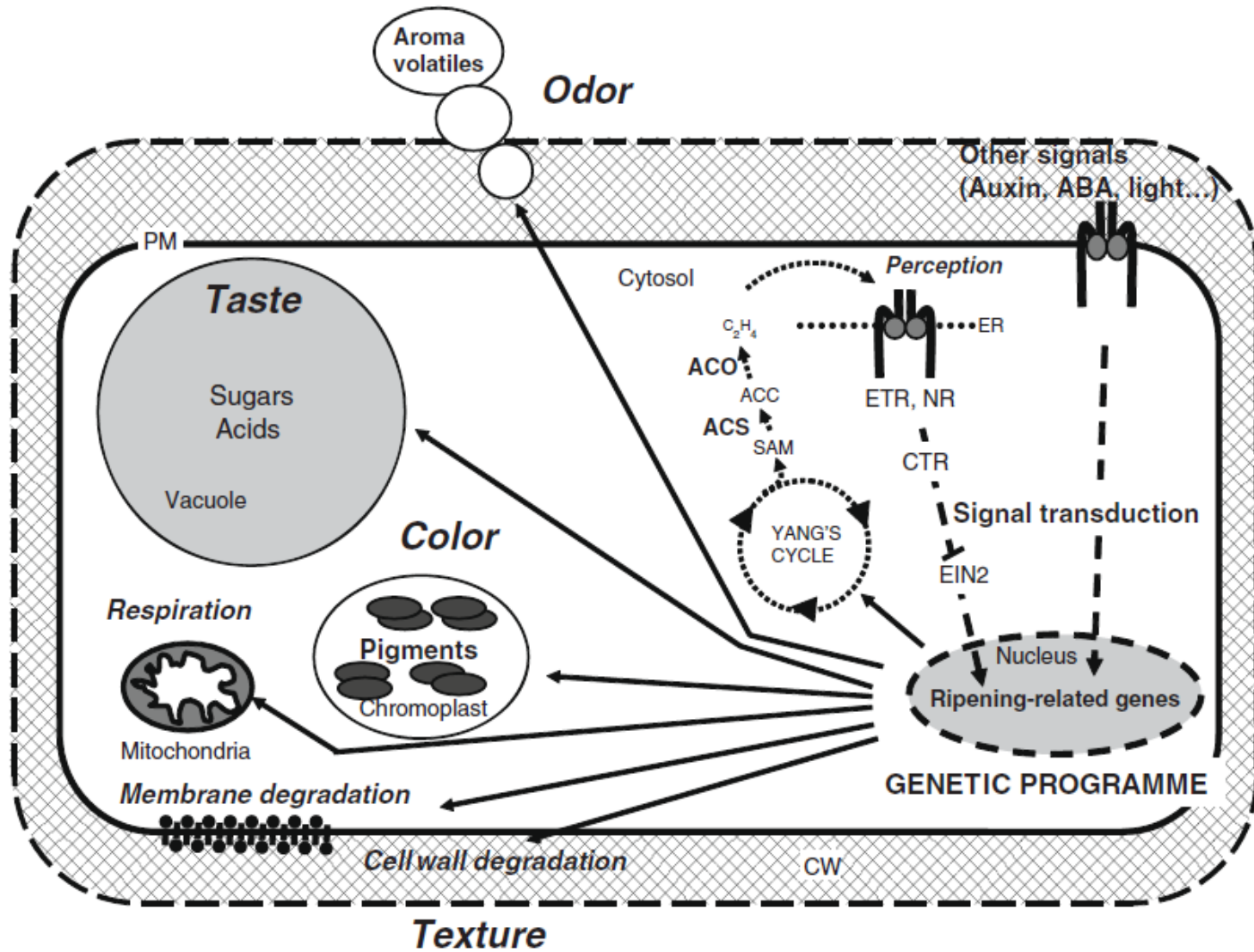
# 6<sup>th</sup> Lecture: Physiology

**Maturation processes are carried out under molecular control**

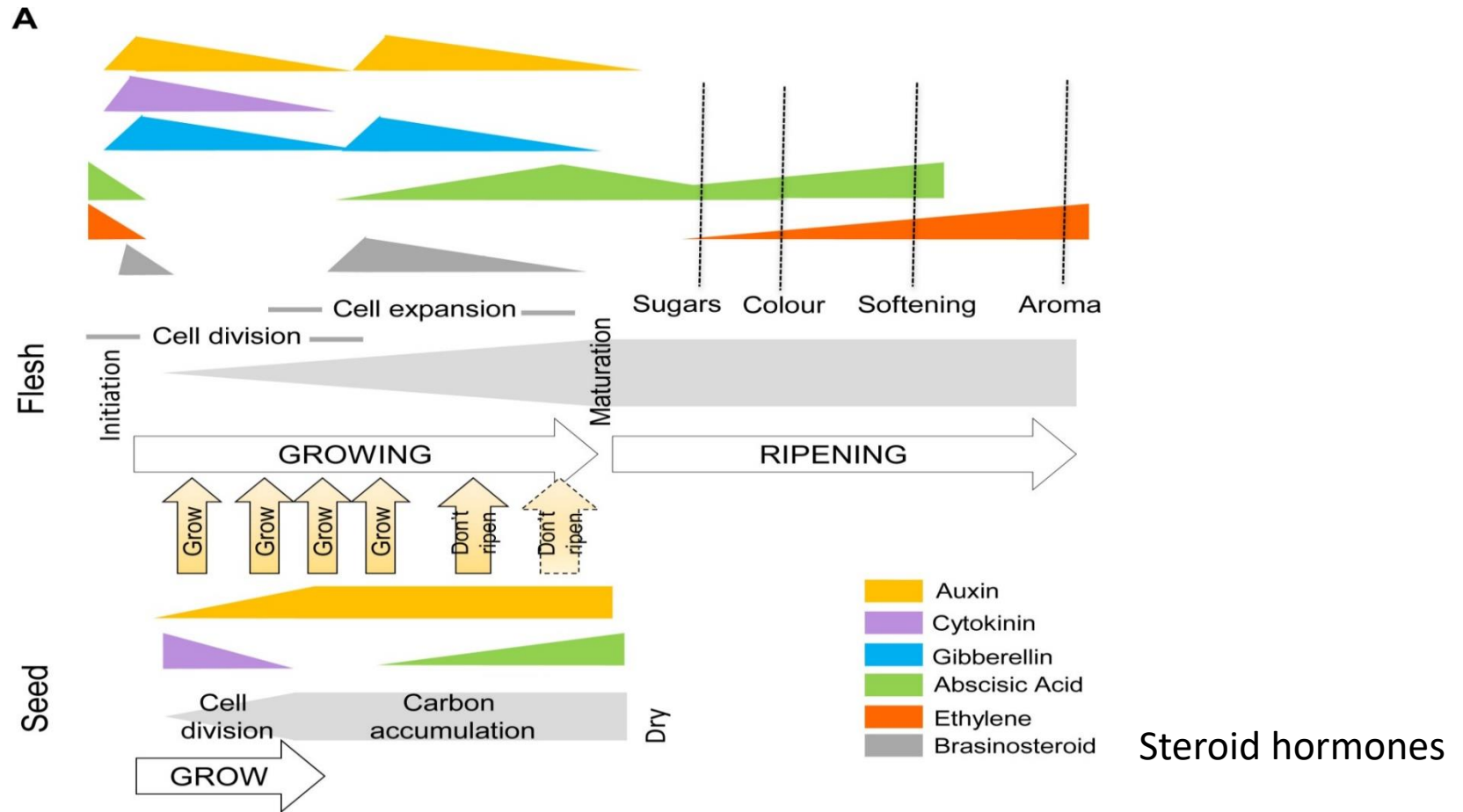
# Maturation processes are carried out under molecular control



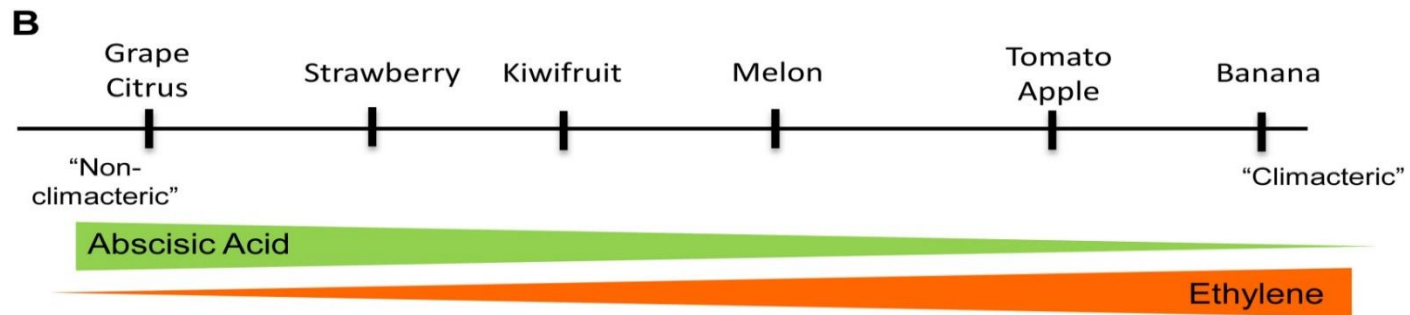
# And it's all under molecular control.



# Involvement in growth regulators in the development and ripening of the fruit

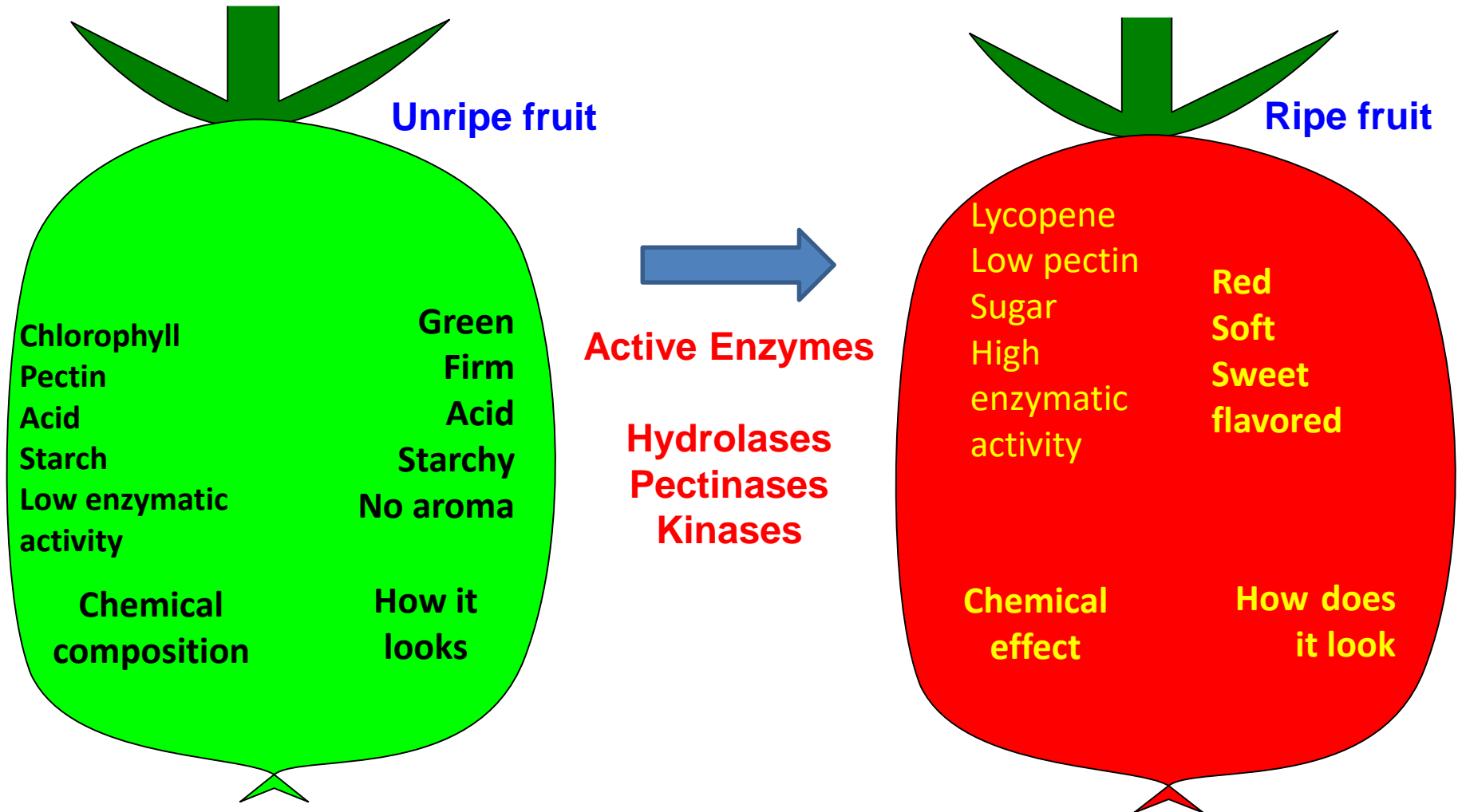


## Involvement in growth regulators in the ripening of the fruit



# Fruit ripening

- Increase in membrane permeability releasing enzymes into cell parts
- Increase in protein synthesis (enzymes)
- Changes in color, taste and aroma, texture that cause an increase in the sensory quality of the fruit



Development

Ripening

Postharvest



Slight XyG depolymerisation  
 Loosening of XyG-cellulose network  
**Major Pectin degradation:**  
 Demethylesterification  
 Solubilization  
 Depolymerisation  
 Loss of Gal and Ara

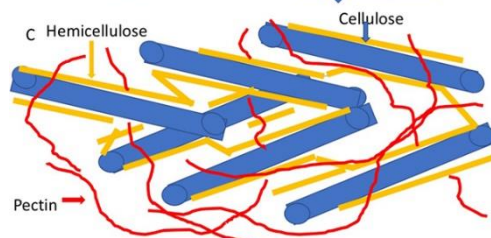
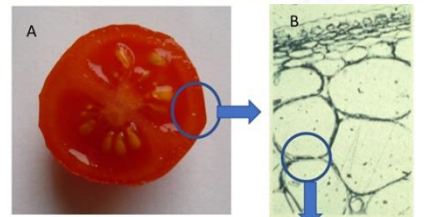
Weakening cell wall

Decrease intercellular contact

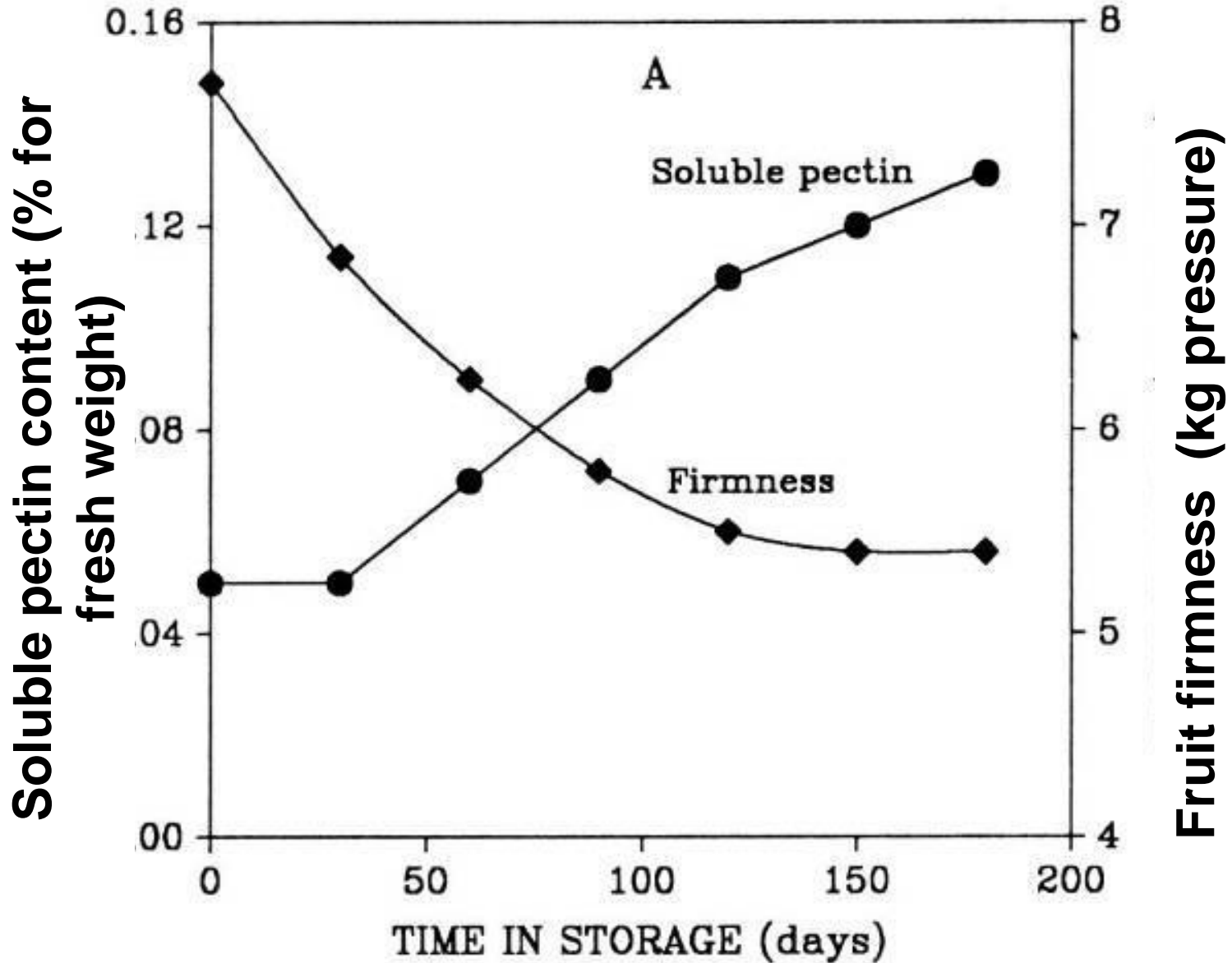
Turgor reduction

**Softening of the fruit**

**What are the general changes occurring in the fruit?**



# Changes in firmness in relation to the soluble pectin content in tomato fruits





# Physical and chemical changes that occur during the ripening of fresh produce

1. Seed development

2. Pigment changes

Carotenoid synthesis

Anthocyanidins synthesis

Chlorophyll catabolism

3. Softening

Changes in pectin structure

Changes in structure of cell wall

Hydrolysis of reserve components

4. Changes in carbohydrate structure

Hydrolysis of starch

Changes in sugar components

5. Occurrence of aroma volatiles

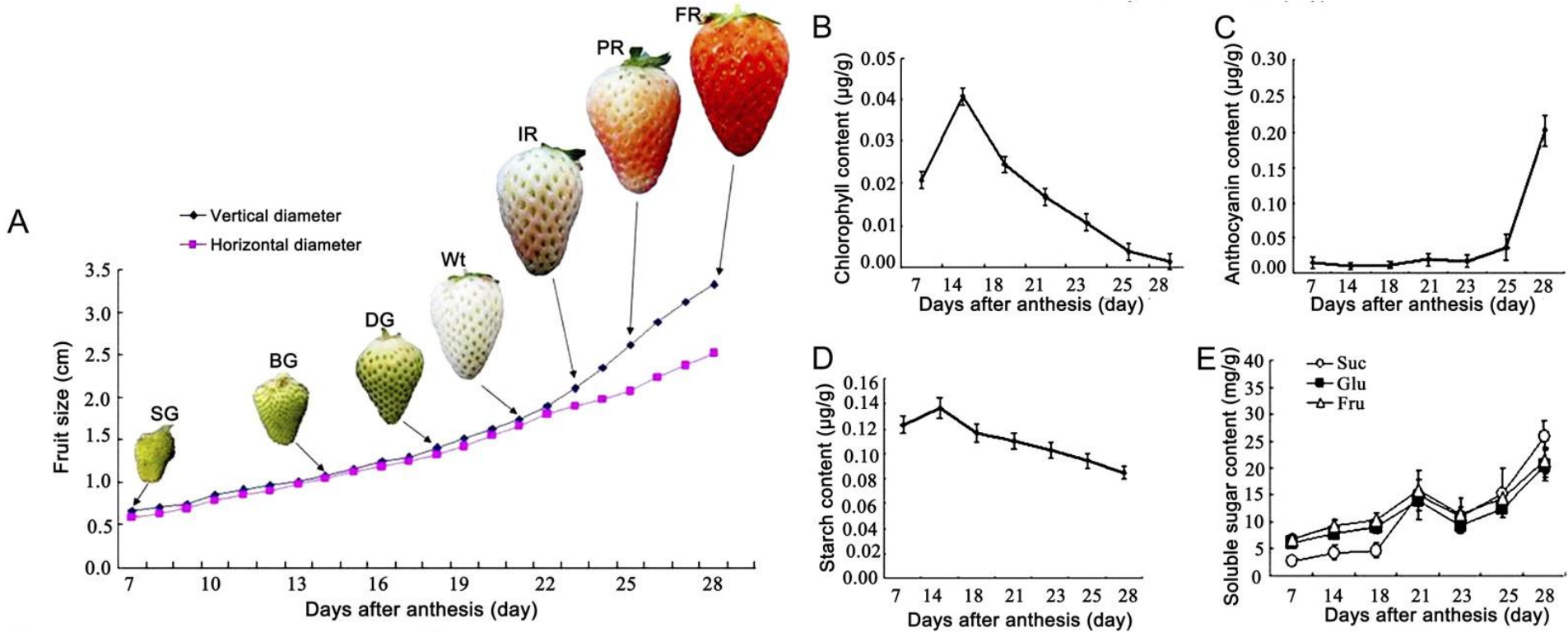
6. Changes in organic acids components

**Color**

**Texture**

**Taste and  
aroma**

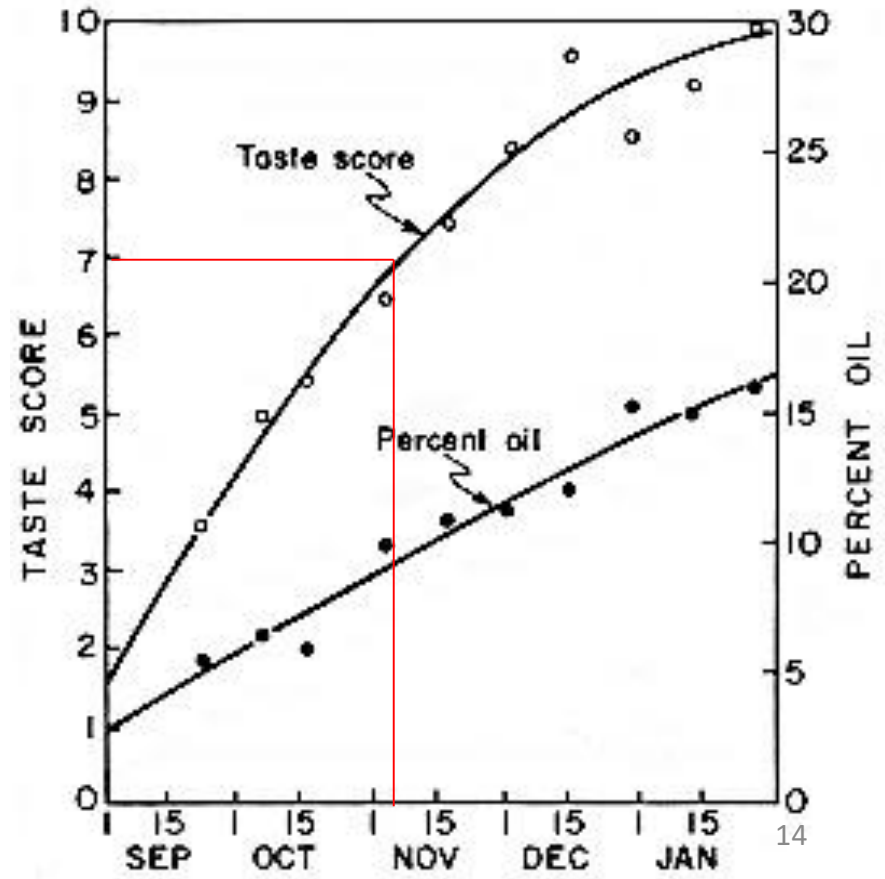
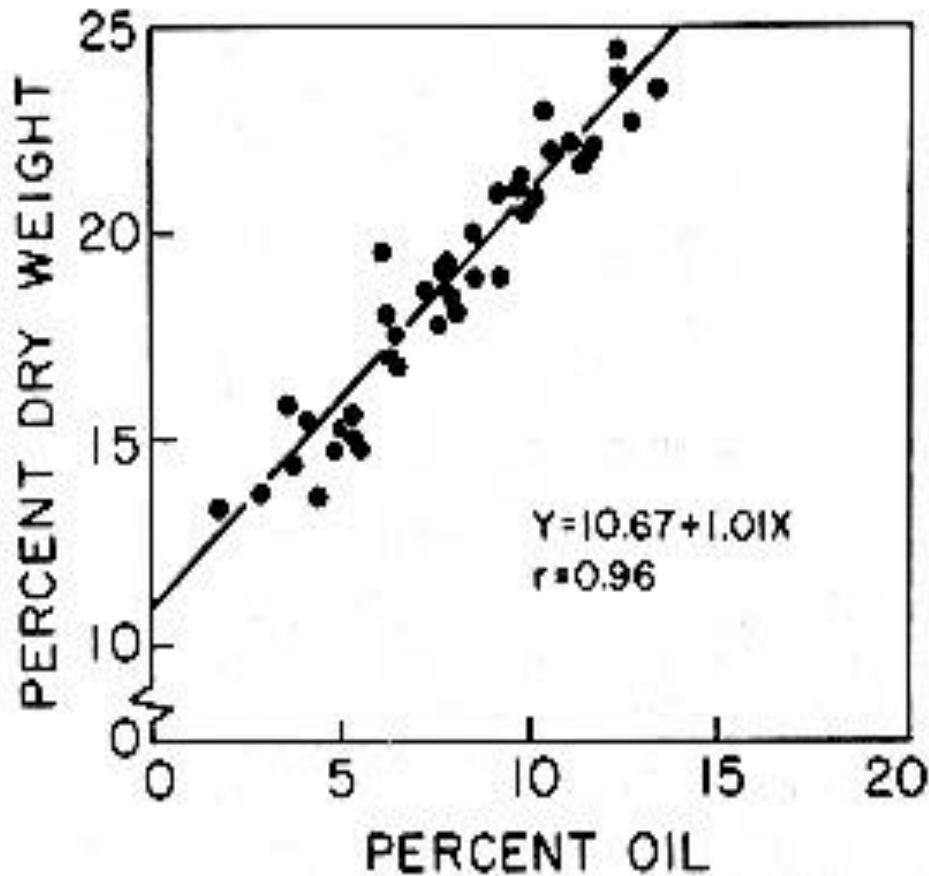
# Morphological and physiological changes during strawberry development



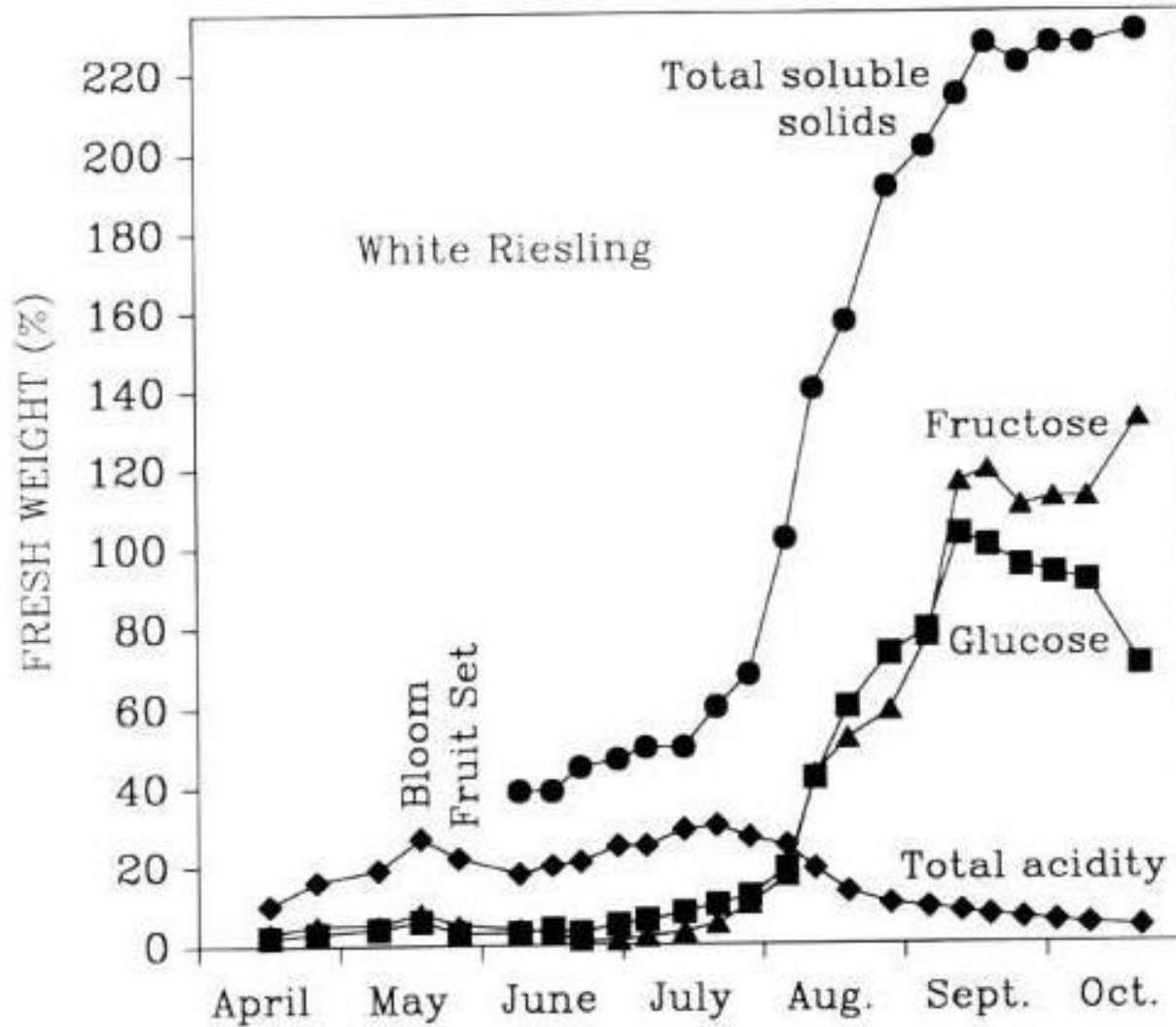
# Physical and chemical changes that occur during the ripening of fresh produce

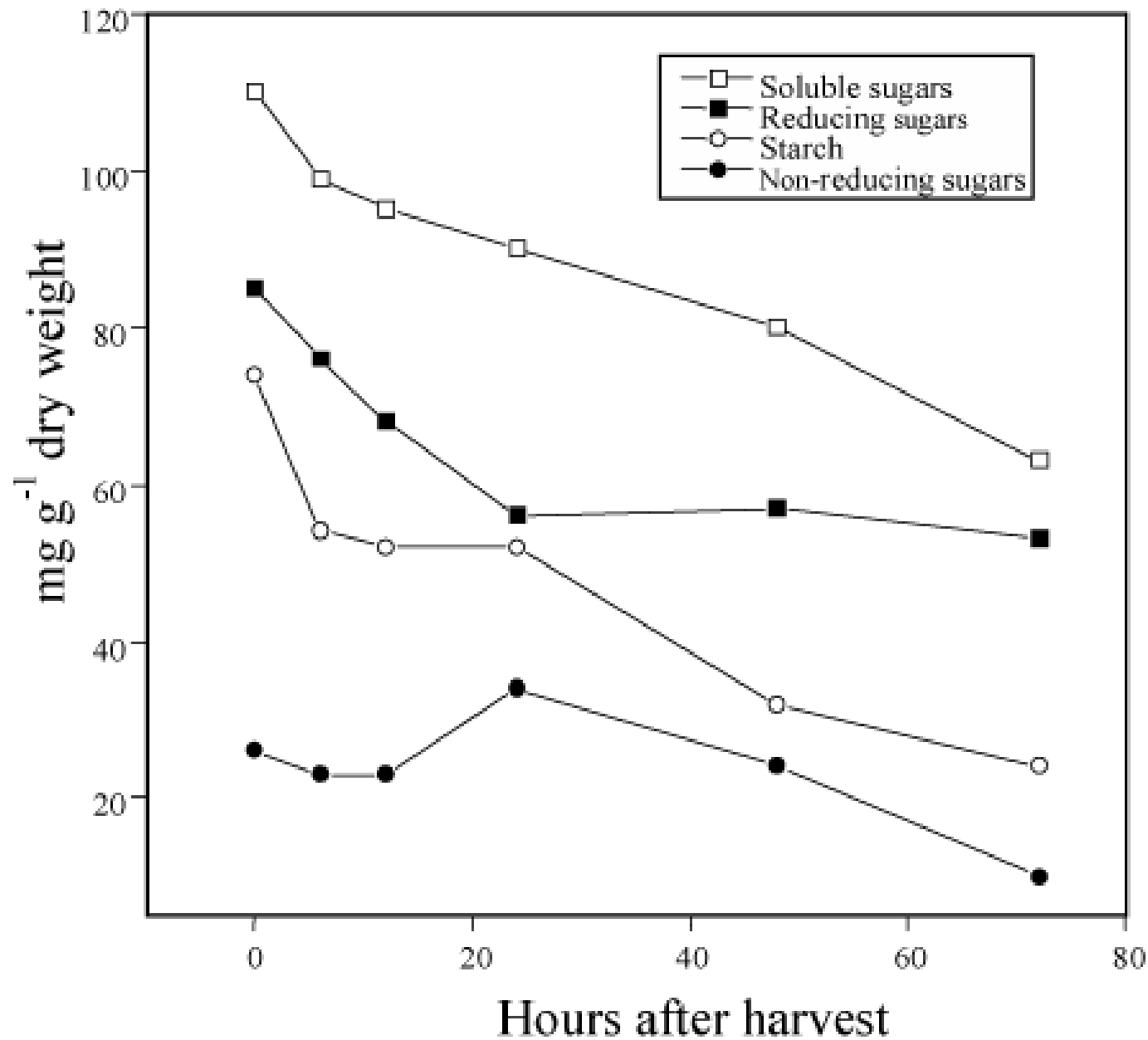
7. Changes in respiration
8. Changes in the rate of ethylene synthesis
9. Changes in tissue permeability
10. Changes in proteins (quantity and qualitative)
11. Wax accumulation on the fruit cuticle.

# The ratio of oil content to flavor and dry weight in "Fuerte" avocado



# Changes in sugar in grapes during fruit development

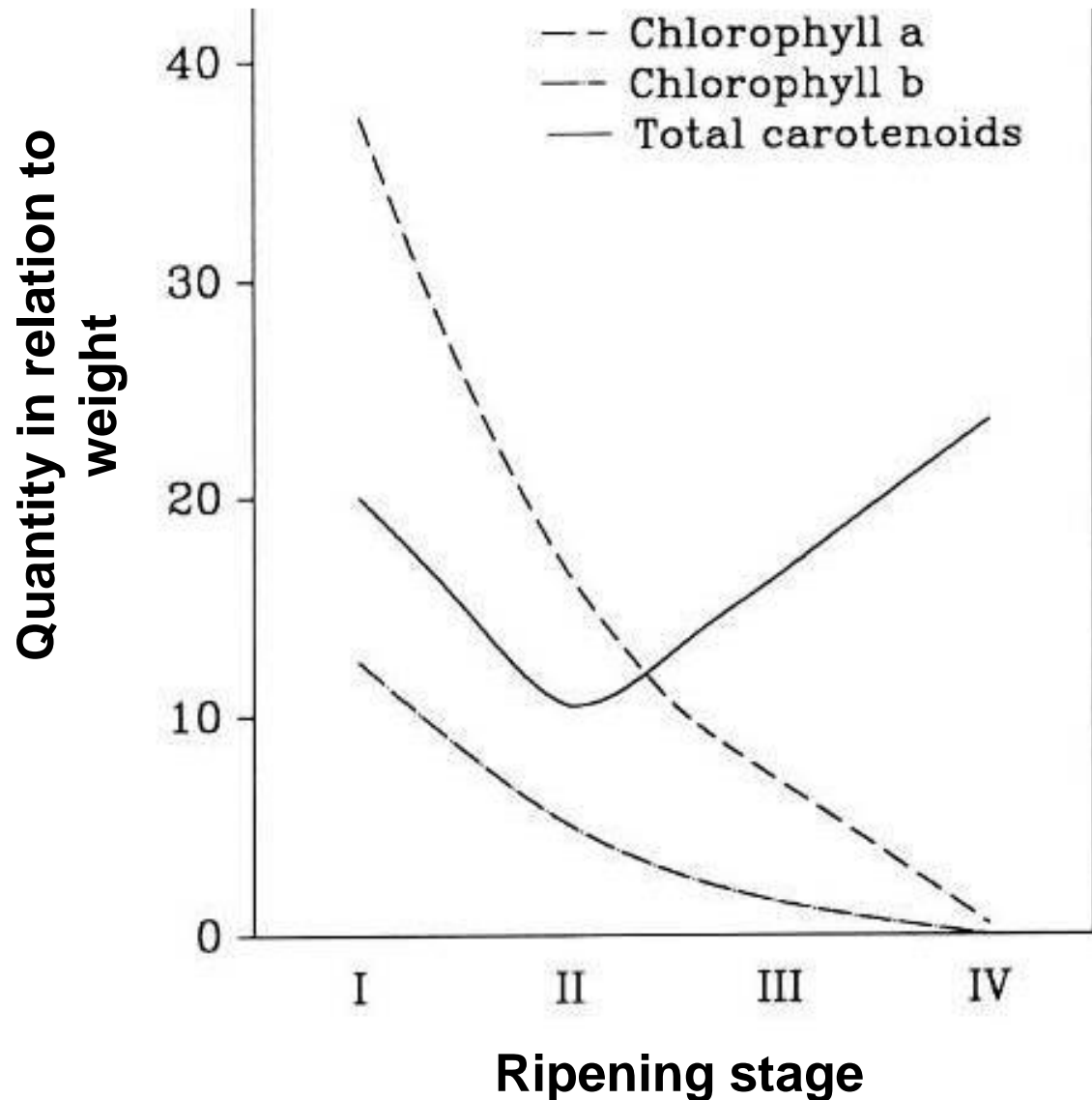




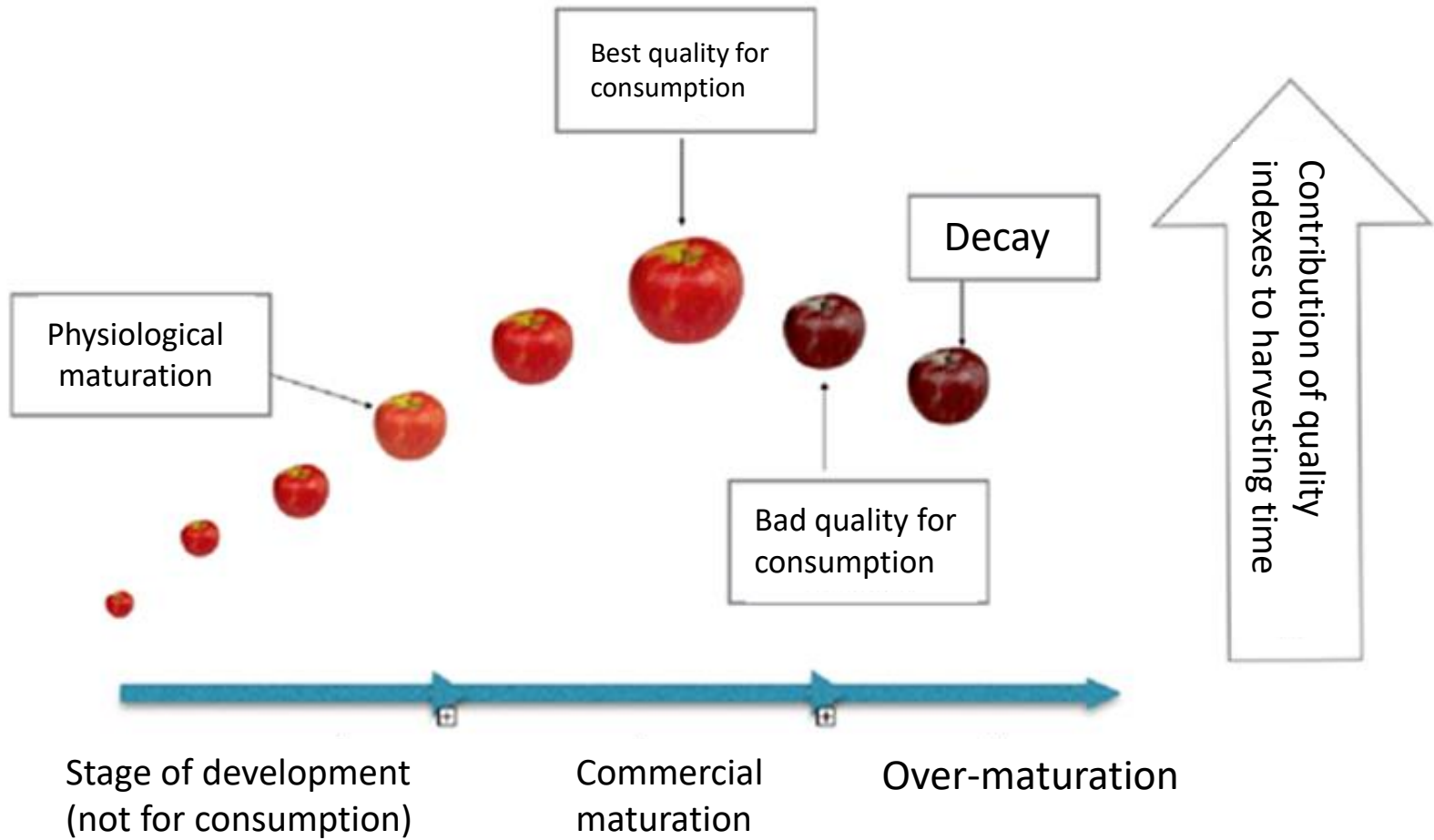
**Changes in starch, non reducing sugars, TSS during storage of Broccoli at 25 C at 96% RH for 3.5 days**

# Changes in chlorophyll and carotenoids during melon maturation

I- green  
II- green/yellow  
III- yellow/green  
IV- yellow

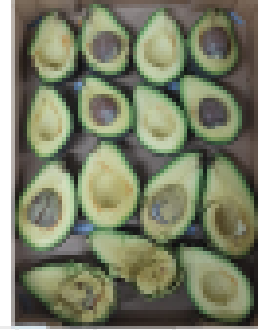


# Changes in apple quality during maturation





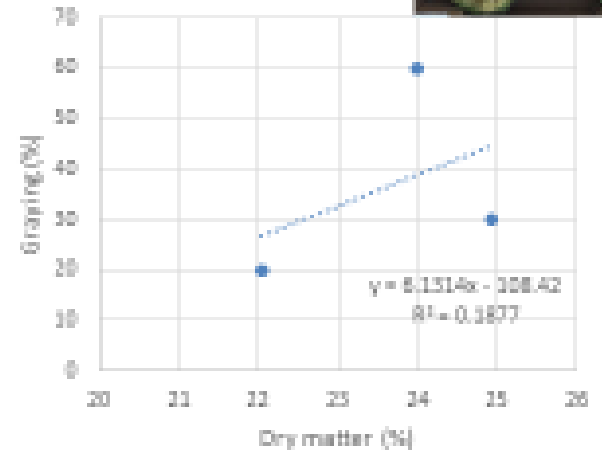
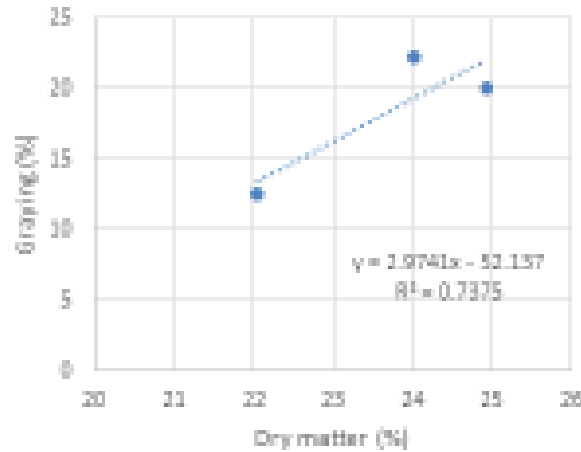
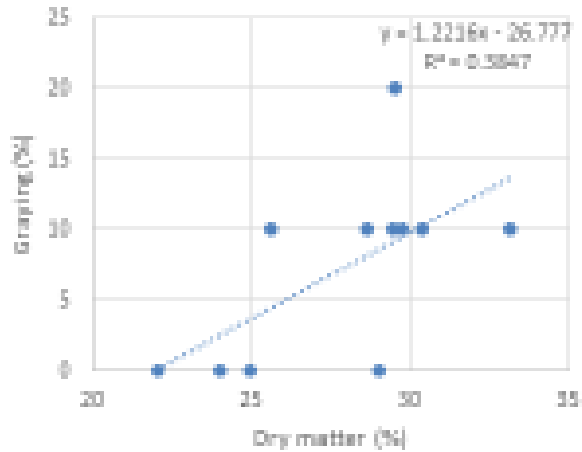
# Effect of the percent of dry matter weight on internal grey color of avocado



Sitria

Cfar- Glicson

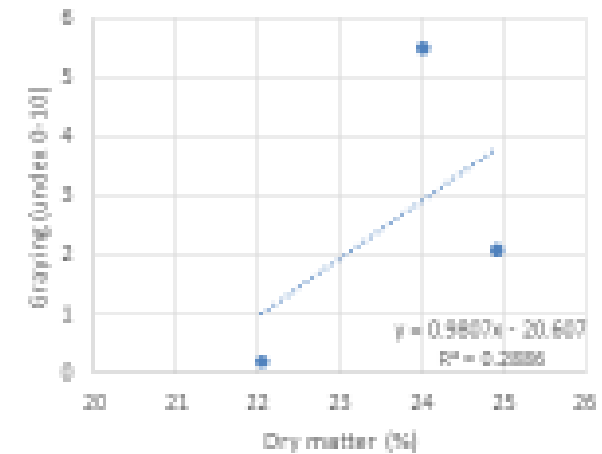
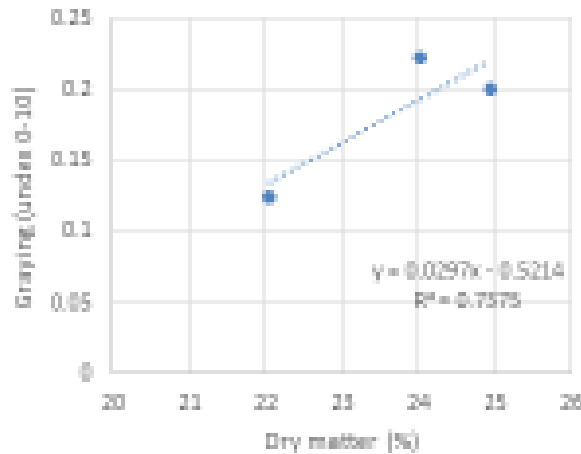
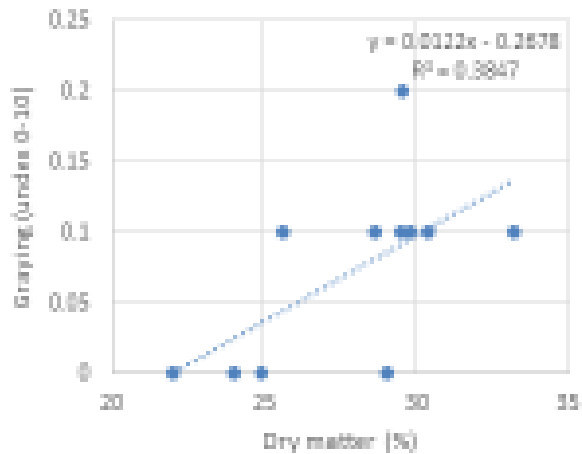
Eyal



Sitria

Cfar- Glicson

Eyal

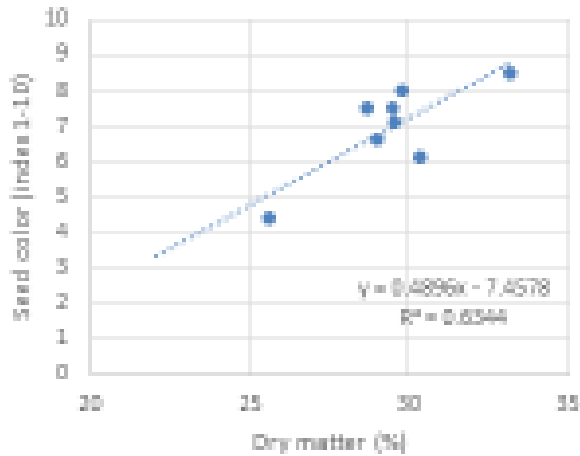


As the dry matter weight increase, increase the grey color

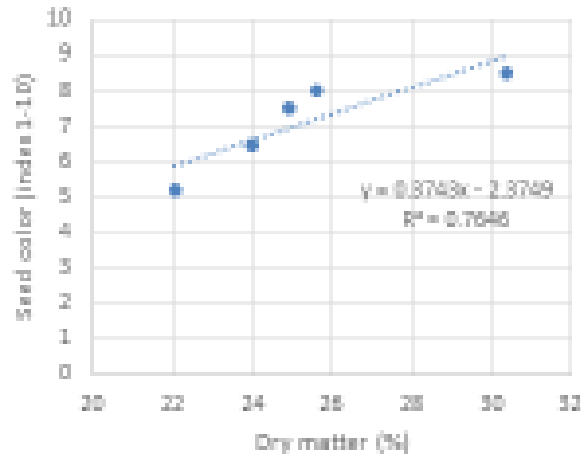
# Effect of the percent of dry matter weight on seed germination and internal color of avocado seed



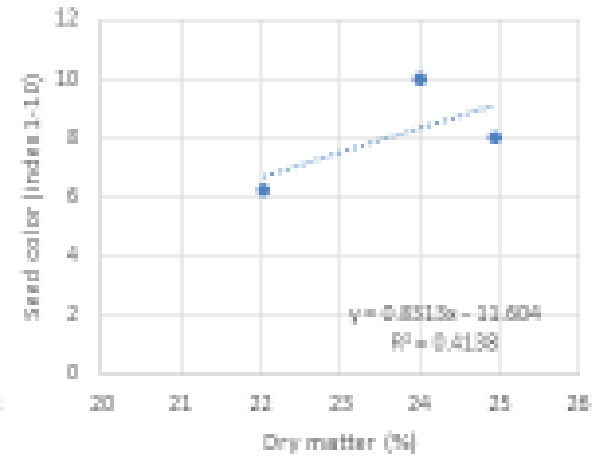
Sitria



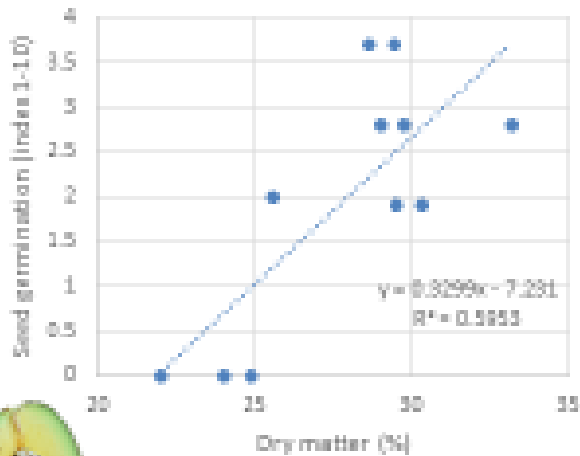
Yad-Hana



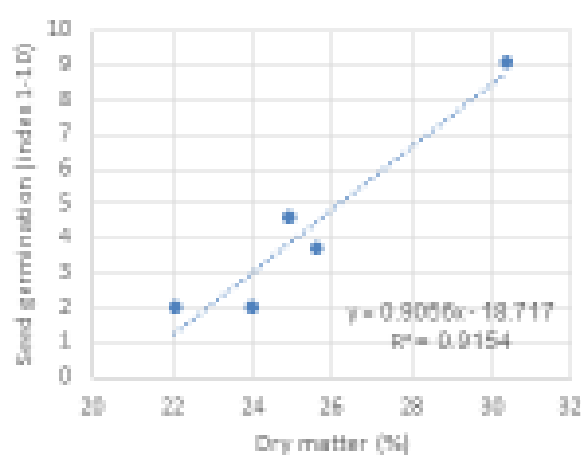
Eyal



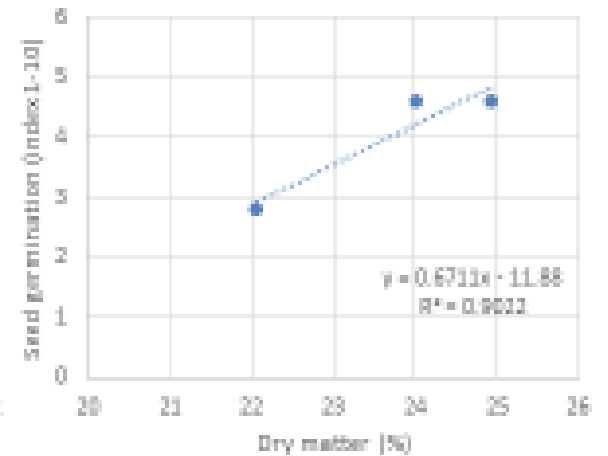
Sitria



Yad-Hana



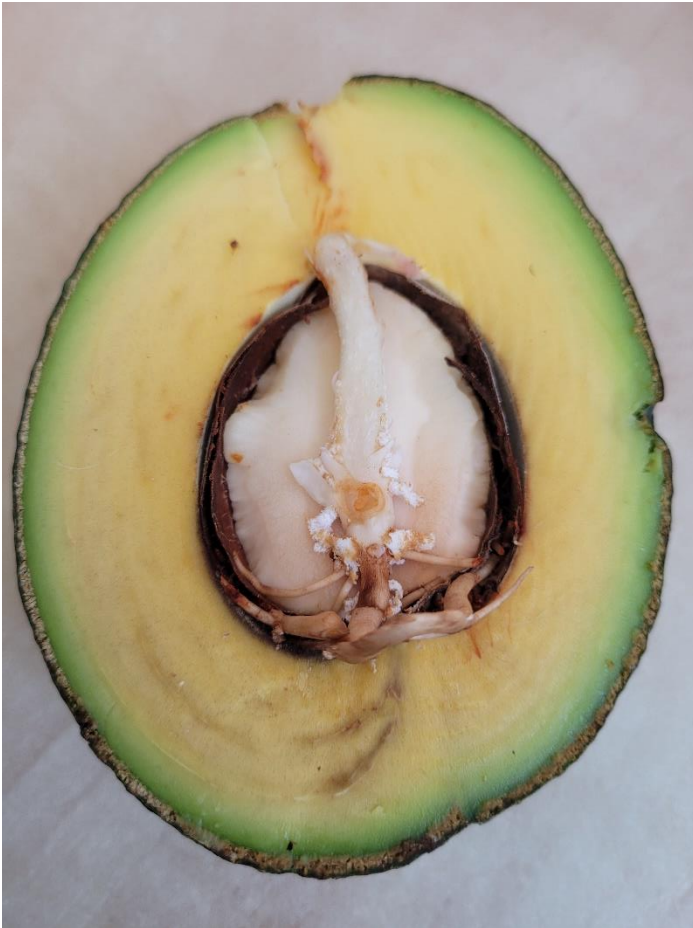
Eyal



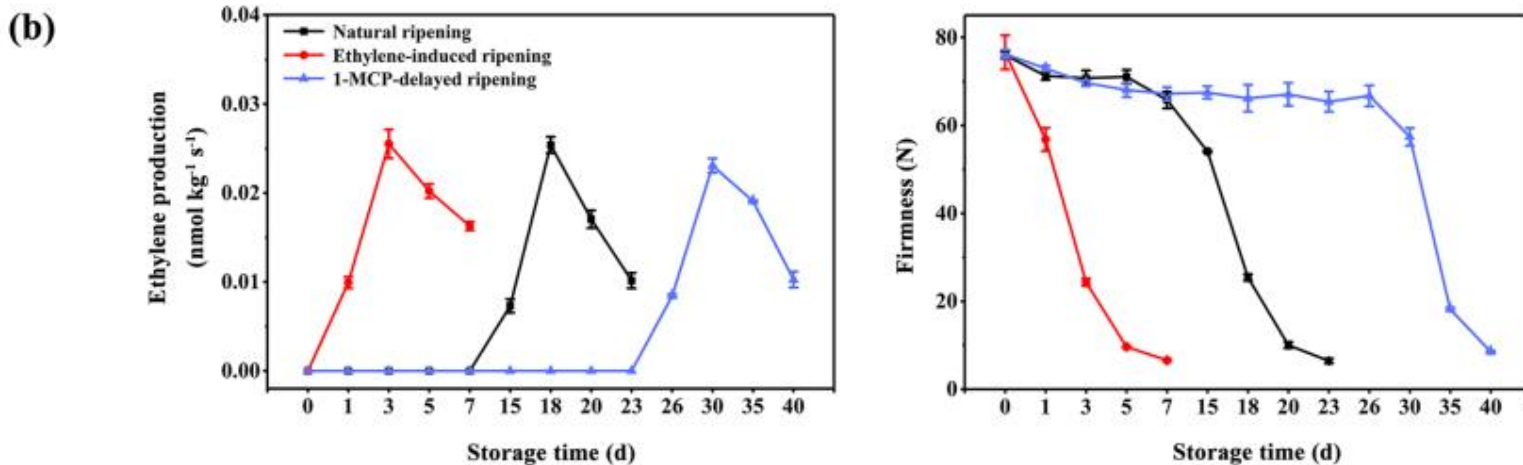
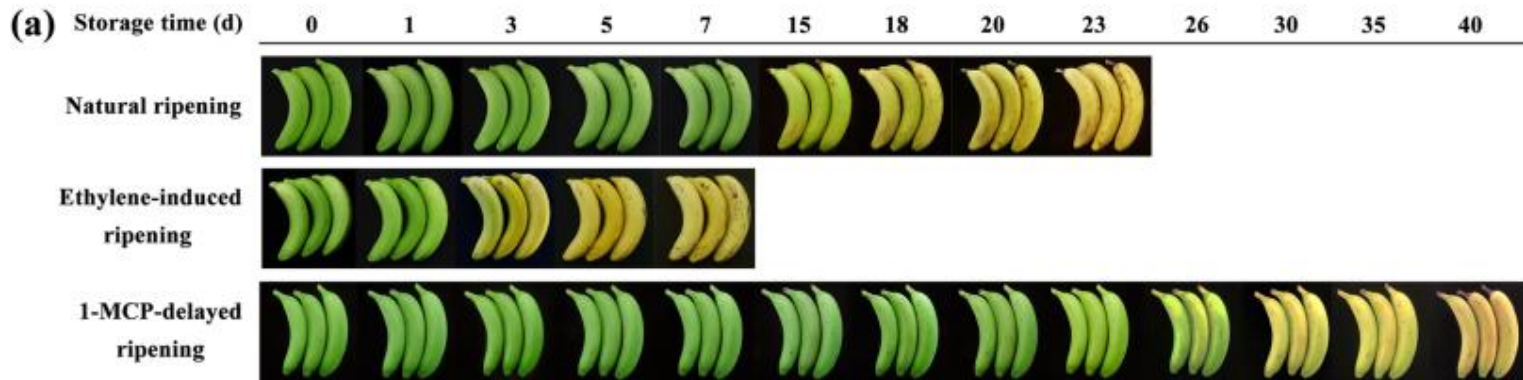
As the dry matter weight increases, there is an increase in the grey color of the flesh

# Chemical changes that occur during the ripening of fresh produce

As the dry matter weight increase, increase the grey color



Bananas with (a) 3 different ripening behaviors: natural (control), ethylene-induced, and 1-MCP-delayed ripening.(b) Changes in ethylene production and fruit firmness during fruit ripening.



# Biosynthesis of carotenoid

Geranyl-geranyl diphosphate (GGPP)

phytoene synthase (PSY)

phytoene desaturase (PDS)

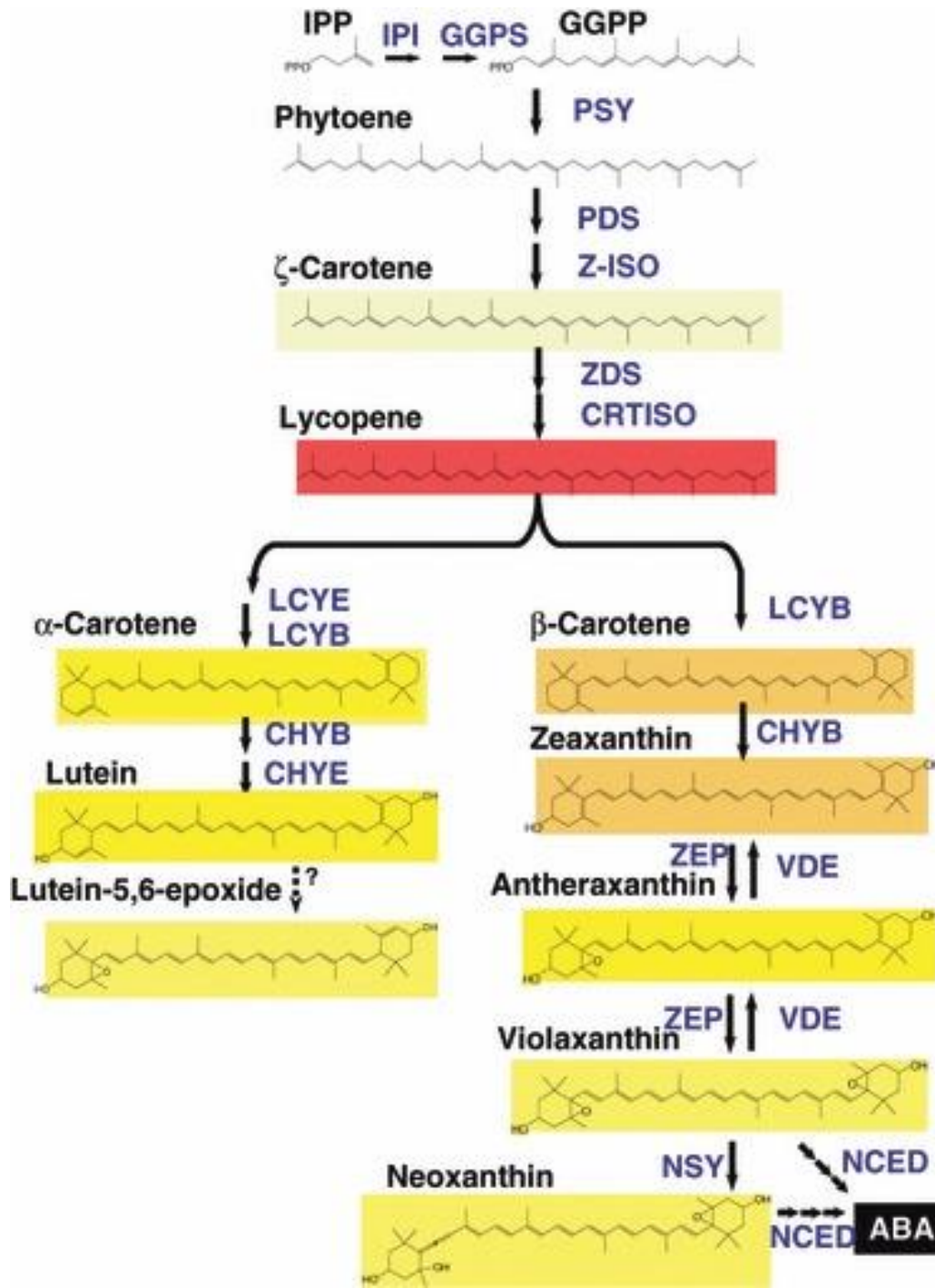
zeta-carotene desaturase (ZDS)

Lycopene  $\beta$ -cyclase (LCYB)

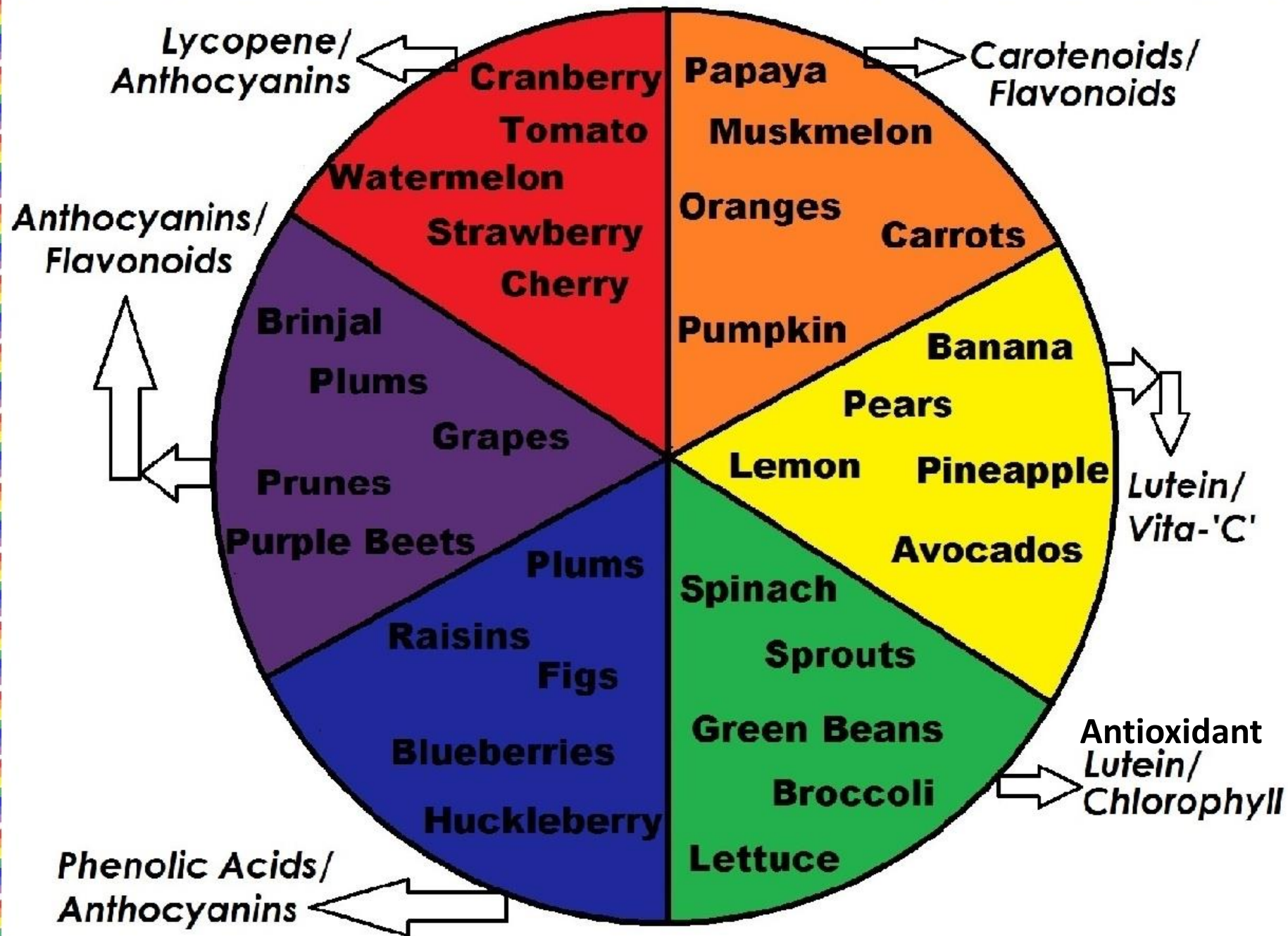
Carotenoid beta-ring hydroxylase/Imported (CHYB)

ZEP, zeaxanthin epoxidase

VDE, violaxanthin de-epoxidase









# Taste and Aroma



"IT WAS MADE IN CHINA."

## Sweet

- Fructose
- Glucose
- Sucrose
- Arabinose

## Acid

- Malic acid
- Citric acid
- Formic acid
- Acetic acid
- Tartaric acid

## Bitterness

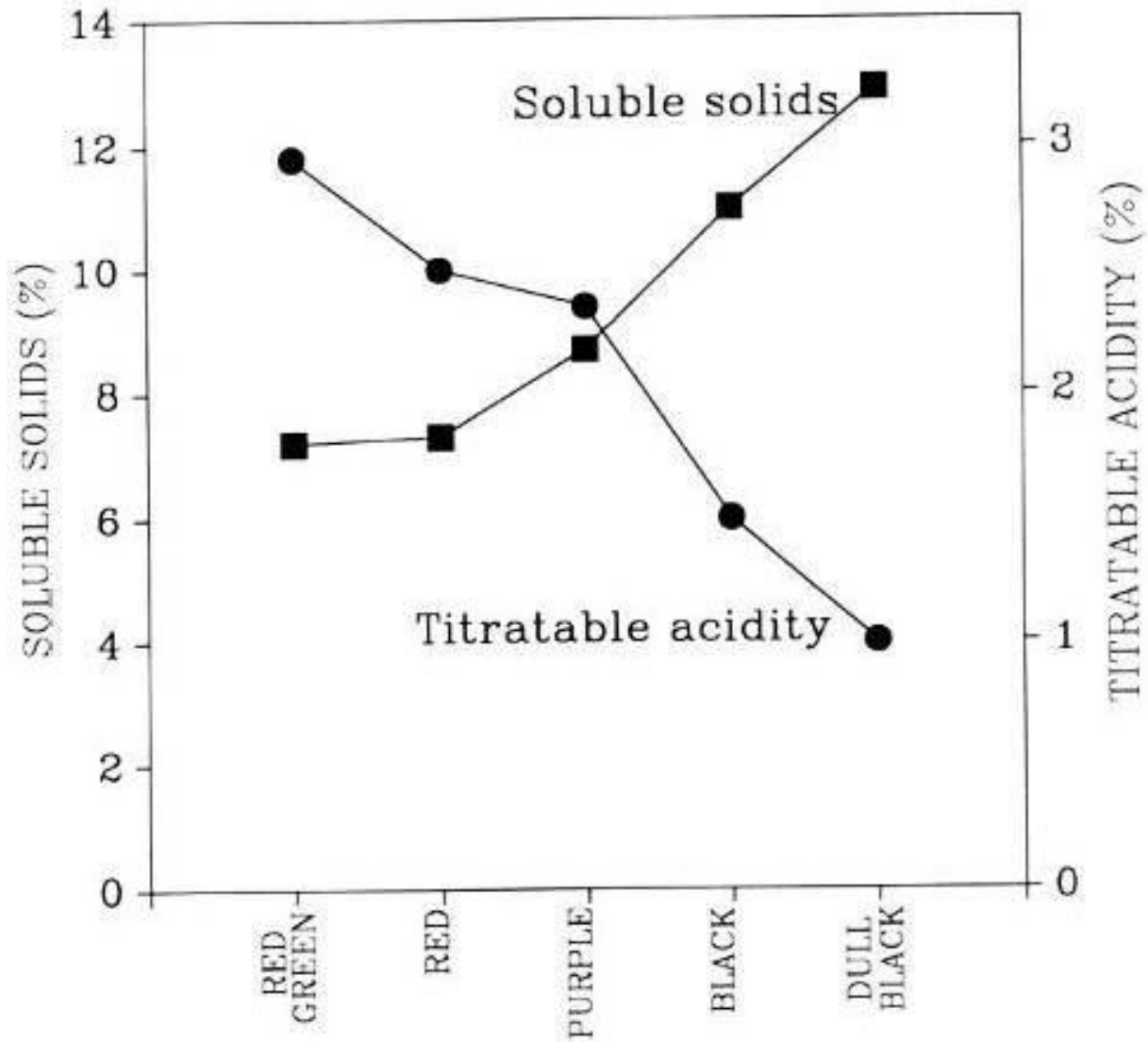
- Cucurbitacin
- Limonoid

## Salty

- Sodium
- Calcium

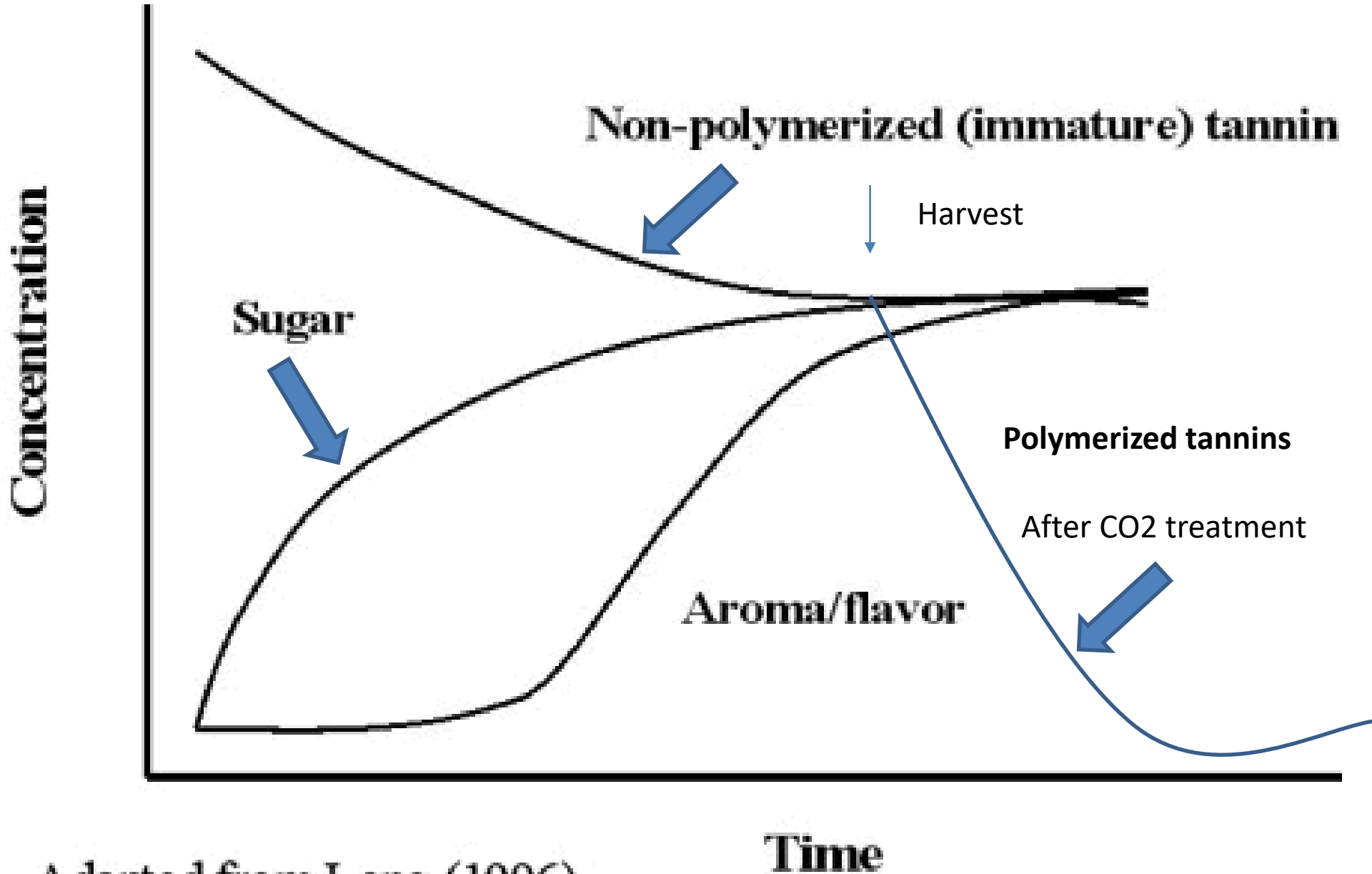
# Taste and Aroma

# Changes in sugar and acid in cherry fruit (flavor and aroma)





# Sensing changes in persimmon over time



Adapted from Long (1996)

# Relative concentrations of volatiles in melons during storage at 21 C and humidity of 93%

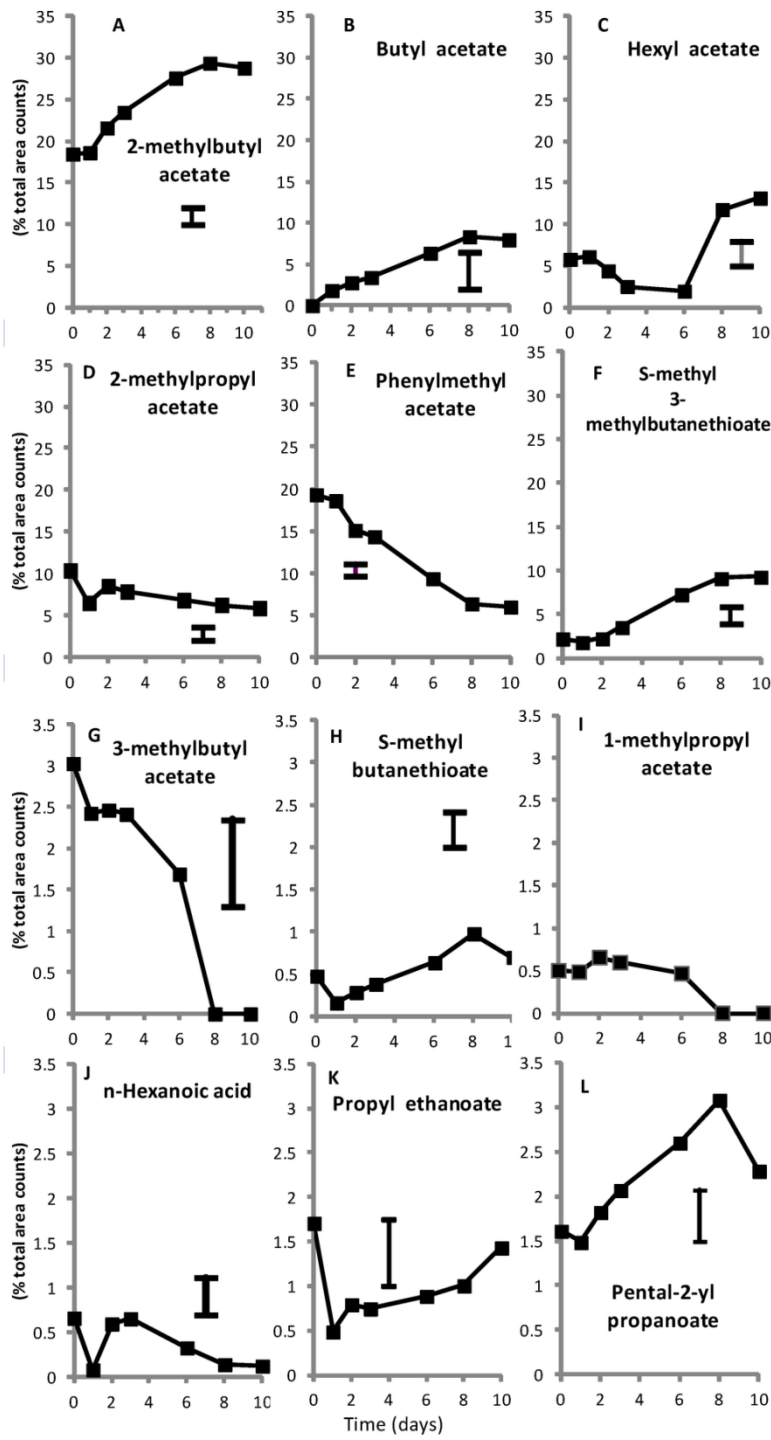
Fruity and Flory 2-methylpropyl acetate

like banana 3-methylbutyl acetate

Fruity 3-methylbutyl acetate

Over ripe (acetone) 2-methylbutyl acetate

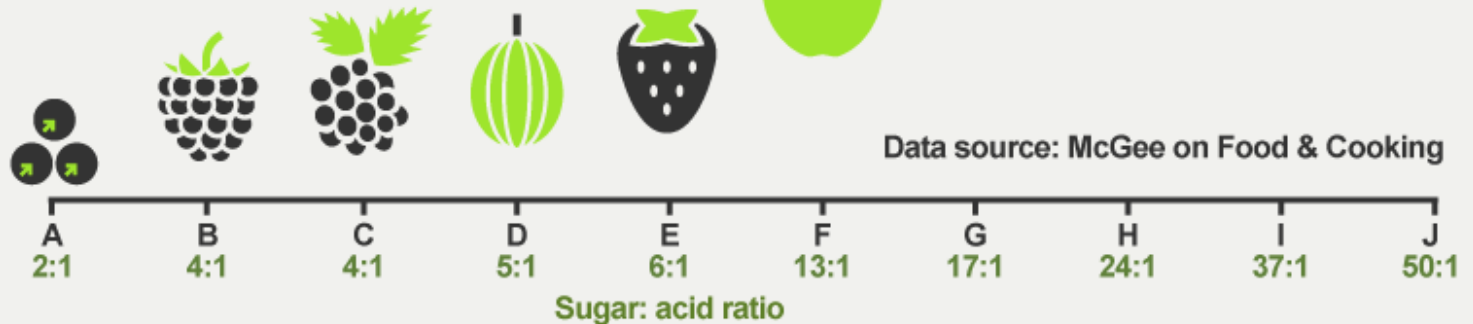
Fruity and Flory Butyl acetate



# The sweet and sour ratio of British fruit

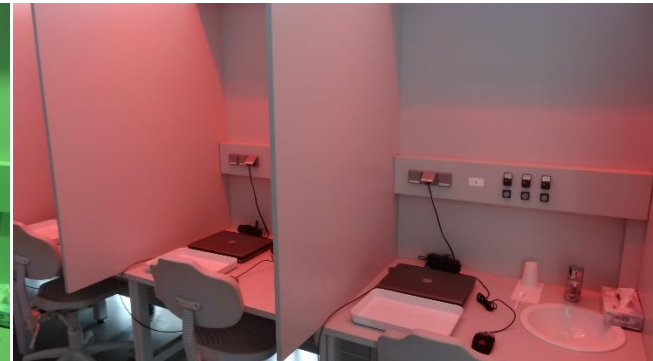
- A Blackcurrant
- B Raspberry
- C Blackberry
- D Gooseberry
- E Strawberry
- F Apple
- G Plum
- H Cherry
- I Blueberry
- J Pear

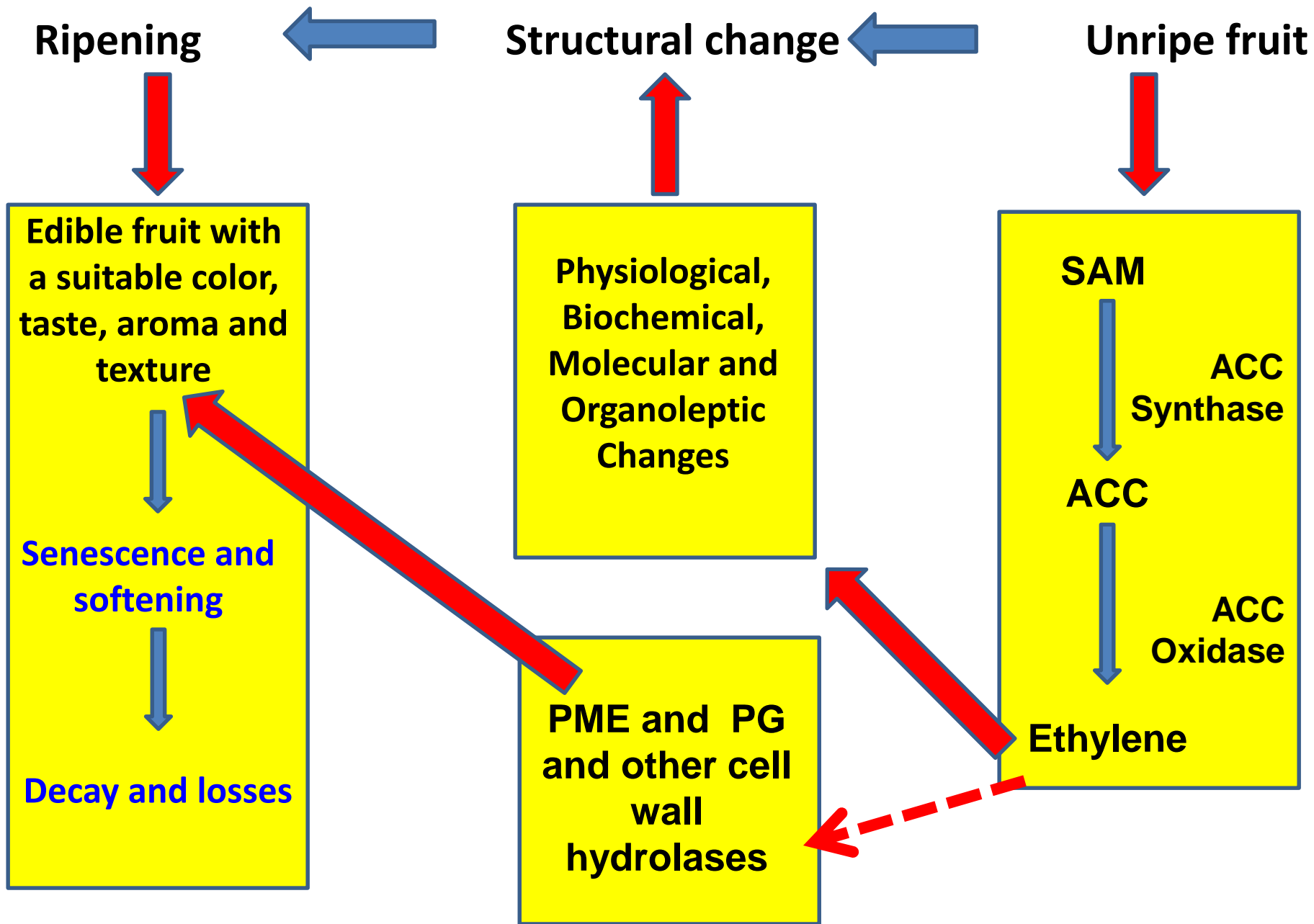
Sour



Sugar : acid ratio in different fruits

# Tasting tests and aroma by a team of trained tasters





# Summary

## Summary of the changes occurring during ripening

Fruit Change	Biochemical change
Color	<b>Breakdown of chlorophyll; the disintegration of the photosynthetic system; Synthesis and accumulation of pigments; (carotenoids and anthocyanin's)</b>
Texture	<b>Dissolve of pectin/cellulose; Dismantling the starch structure; Change in protein content; Watery of the cell walls; Increased activity of cell wall enzymes</b>
Metabolic	<b>Increase in respiration; Synthesis of ethylene; Changes in the metabolism of starch and organic acids</b>
Molecular changes and gene expression	<b>Synthesis of new RNA</b>
Expression of new protein	<b>De Novo synthesis of specific ripening proteins; Protein suppression</b>

# Physical and chemical changes during citrus fruit ripening

