Apple quality....

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1. Maturity and ripening process in connection with Quality parametes

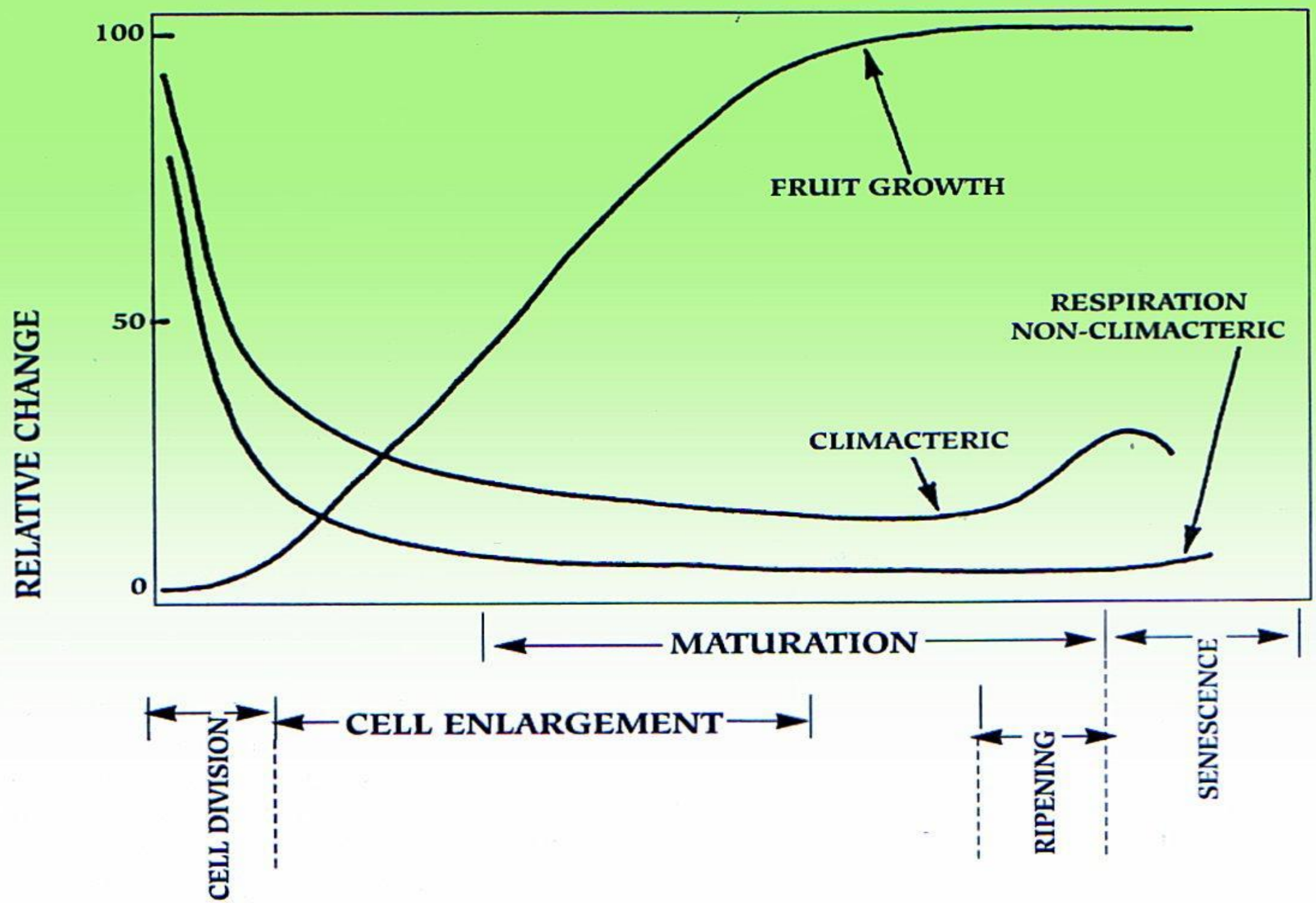
2. Quality parameters - measurement

maturity ⟷ ripening

Stage of development of the fruits on the parental plant (only)

Stage when biochemical changes convert inedible fruit into an edible product

Respiration during climacteric and nonclimacteric fruit development (Biale, 1964).



maturity	ripening
that process occurs only when fruit is attached to the parental plant a minimum period of development must be undergone by any fruit before harvest time	• stage when biochemical changes convert mature but inedible fruit into an edible product • can occur on or off the plant • ripening processes: softening, biosynthesis of volatile aroma, conversion of starch into sugar etc

Fruit can be harvested when,

1. has acceptable eating quality at the time of harvest (non-climacteric)

or

2. has the potential to ripen into a product of accetable quality (climacteric)

At harvest time fruit must be mature but can be unripen (climacteric)

Non-climacteric

- Fruits which mature slowly while attached to the parent plant
- do not exhibit an increase in respiration rate when ripening begins,
- low ethylene production rate, low respiration rate
- their eating quality can not be improved after harvest
- blueberry, cherry, grape, pineapple, potatoes

Climacteric

- fruits, vegetables with relatively rapid increase in respiration rate
- rapid ripening period = climacteric period
- high ethylene production during ripening
- can also be provoked to ripen by ethylene treatment
- apple, apricot, avocado, banana, kiwi, tomato

How to estimate optimal Harvest Time ?

CLIMACTERIC fruits (or vegetables)

pre-climacteric
- ripen slower
- respiration rate slower
- not yet producing significant quantities of ethylene
- maintain quality for longer

BUT

- fruit picked up too early; does not develop its full potential

Climacteric period

post-climacteric
- ripening proces is speeded up
- respiration rate increase faster
- producing ethylene
- quality cannot be kept for long

How to estimate optimal Harvest Time ?

Determination of harvest date:

- There are the principles which decided on which maturity and ripen stage fruit should be picked
- It is crucial for storage, marketable life and quality

- It is important to use objective criteria to decide when crop is ready to pick
- Several maturity standards has been set for the major crops

Maturity standards can be:

- starch,
- firmness,
- titratable acidity,
- color changes,
- soluble solids content

Starch index / Harvest index

- *starch SV*
- *solid soluble concentration RE*
- *firmness PE*

- *STREIF index of ripeness:* $\dfrac{PE}{RE \times SV}$

Starch Index

Tool

- potasium-iodide test

How?

- 10 apples should be taken from the ten different trees
- cut apples equatorially into two halves
- the cut sides of apple dip in the potassium-iodine solution
- leave for 1-2 minutes
- compare apples with the color chart


56
57
1
1,5
2
2,5
3
3,5
4
4,5
5
>5

What is quality?

What is quality?

- „fitness for use”
- „is to meet the expectations of the consumer”

Quality means different for different people:

1. for the growers: quality is to achive high yield and big fruit size
2. for the transporters: quality is long storage potential
3. for the consumers: quality is nutritional value, eating quality (good taste and nice aroma, flavour)

Sometimes those requirements are in conflict.

What is quality?

- *Quality includes several characteristics of the products that consumers find or believe that are good indices of overall quality*

QUALITY

NUTRITIONAL

SENSORY

appearance

texture

aroma

taste

What is quality?

- *Quality includes several characteristics of the products that consumers find or believe that are good indics of overall quality*

QUALITY

OBJECTIVE MEASUREMENTS

- *chemical parameters (sugar, water, starch etc)*

SUBJECTIVE MEASUREMENTS

- *feel*
- *taste*
- *aroma*

Table 5-3. Physical and Chemical Alterations That Occur During the Ripening of Fleshy Fruits

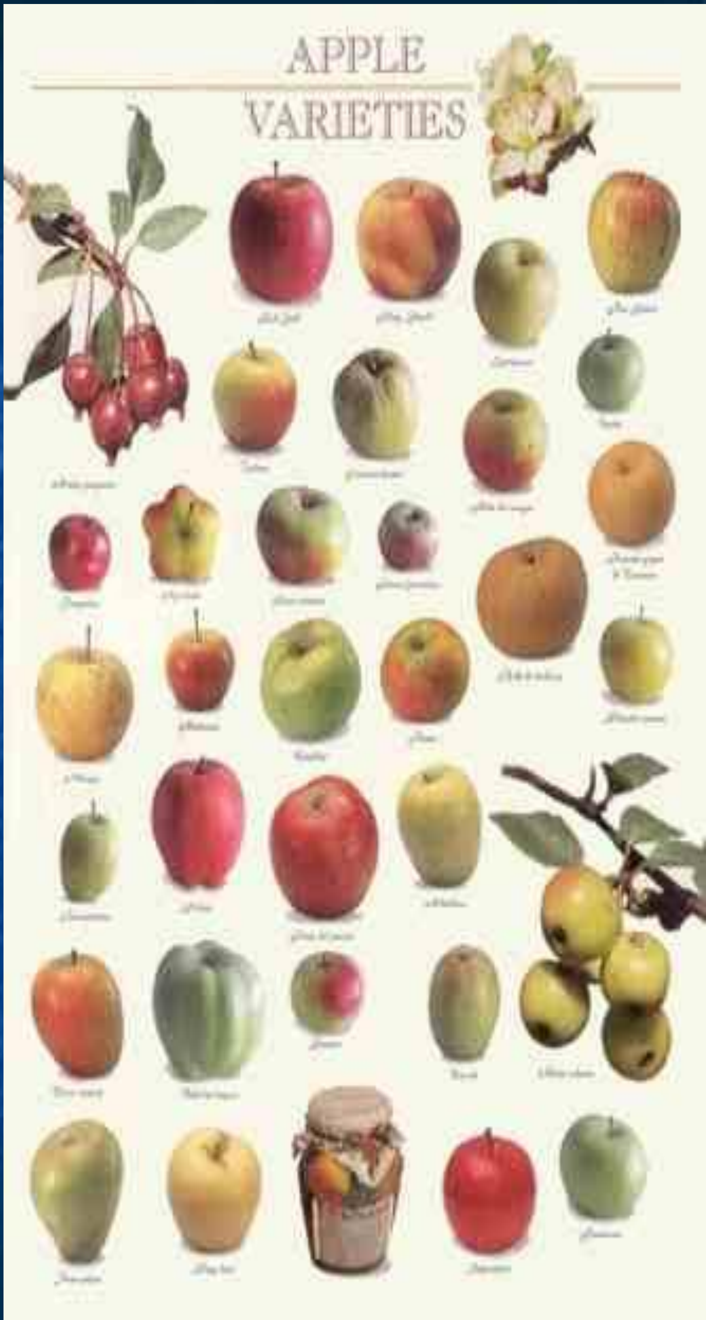
	Important Quality Attributes
1. Seed maturation	
2. Changes in pigmentation	Color
a. degradation of chlorophyll	
b. unmasking of existing pigments	
c. synthesis of carotenoids	
d. synthesis of anthocyanins	
3. Softening	Texture
a. changes in pectin composition	
b. possible alterations in other cell wall components	
c. hydrolysis of storage materials	
4. Changes in carbohydrate composition	Flavor
a. starch conversion to sugar	
b. sugar interconversions	
5. Production of aromatic volatiles	
6. Changes in organic acids	
7. Fruit abscission	
8. Changes in respiration rate	
9. Changes in the rate of ethylene synthesis	
10. Changes in tissue permeability	
11. Changes in proteins	
a. quantative	
b. qualitative	
1. enzyme synthesis	
12. Development of surface waxes	

Quality parameters:

- *<u>Size and shape</u>*
- Skin color
- Firmenss/texture
- Starch / sugar (soluable solids content)
- Titratable acidity
- Volatile compounds / aroma / odour
- Taste
- Flavour (taste and odour)

Size and shape

- *Size* is an individual unit of the product, but can significantly affect consumer appeal
- Often the quality is discriminated based on size (consumer shopping), which is mistaken
- Size can also affect handling precise or storage potential
- *Shape* is indyvidual factor in distinguishing between idyvidual cultivars
- *Shape* can eliminate product from potential market




Braeburn
Cortland
Fuji
Gala
Ginger Gold
Golden Delicious
Red Delicious
Granny Smith
Honeycrisp
Jonathan
Jonagold
McIntosh
Pacific Rose
Paula Red
Wealthy


Braeburn
Cortland
Fuji
Gala
Ginger Gold
Golden Delicious
Red Delicious
Granny Smith
Honeycrisp
Jonathan
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McIntosh
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Wealthy

Quality parameters:

- Size and shape
- *Skin color*
- Firmness/texture
- Starch / sugar (soluble solids content)
- Titratable acidity
- Volatile compounds / aroma / odour
- Taste
- Flavour (taste and odour)

Color

<u>Types of change in pigmentation:</u>

1. Degradation of chlorophyll

Color changes during apple maturation and ripening are largly results of <u>chlorophyll breakdown</u> $\xrightarrow{\textbf{Chlorophyllases}}$ less chlorophyll

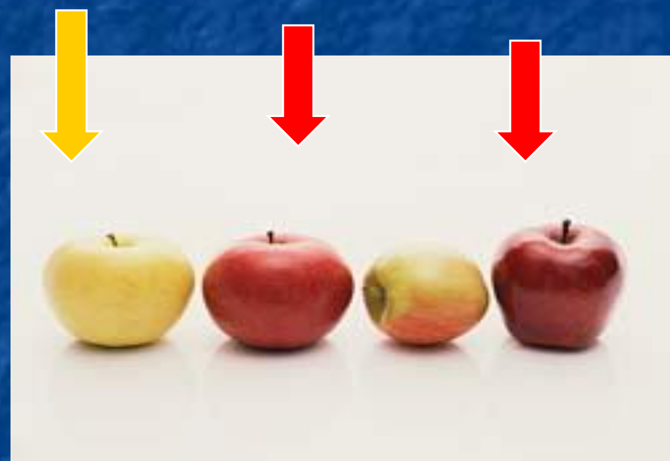
2. Unmasking of existing pigments
3. Synthesis of carotenoids
4. Synthesis of anthocyanins

Color

- The loss of **chlorophyll** results in decreasing green color

- Synthesis and/or unmaksking of **anthocyanins** result in red color
- Synthesis and/or unmaksking of **carotenoids** result in yellow color

carotenoid anthocyanin



Color

- *Anthocyanins* are the most important in red apples

- *Anthocyanins* are formed via 1. sugar path and 2. path of PAL enzyme activity

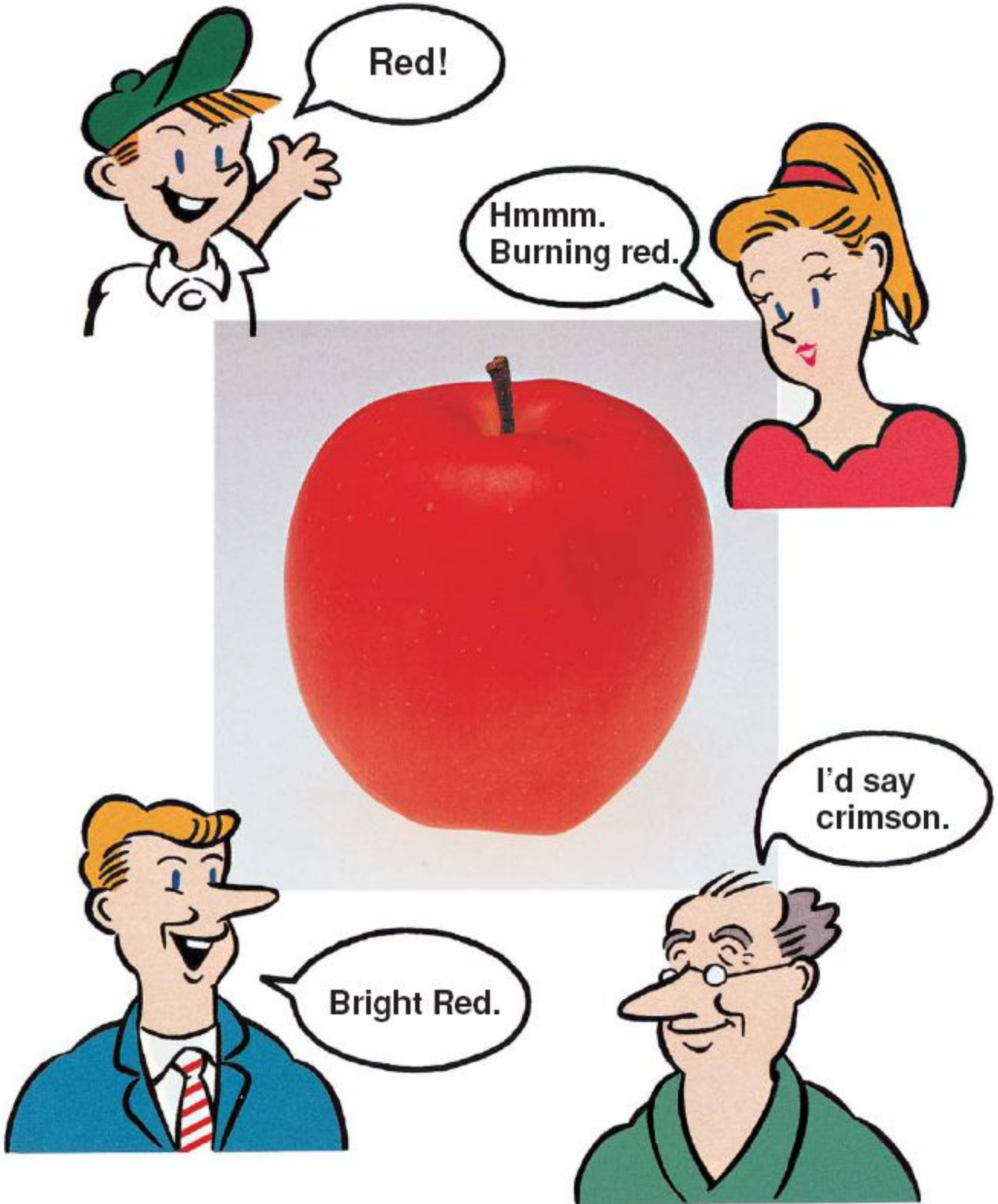
- Many factors can affect coloring process:
- *Light* is required for anthocyanin accumulation

- *Low temperature* increases anthocyanin synthesis

- *High nitrogen* availability and uptake delay the maturation process and also delay the synthesis of anthocyanin

- *Ethylene exposure* stimulates PAL enzyme and anthocyanins accumulation

What color is this apple ?



Color - analysis

Tool

- Colorimeter Minolta

How?

- Apple should be scanned by a colorimeter around its diameter a couple of times,
- Results presented by units:

L = lightness

a = chromaticity coordinate between red and green

b = chromaticity coordinate between blue and yellow

- L^*= 43.31
- a^*= 47.63
- b^*= 14.12

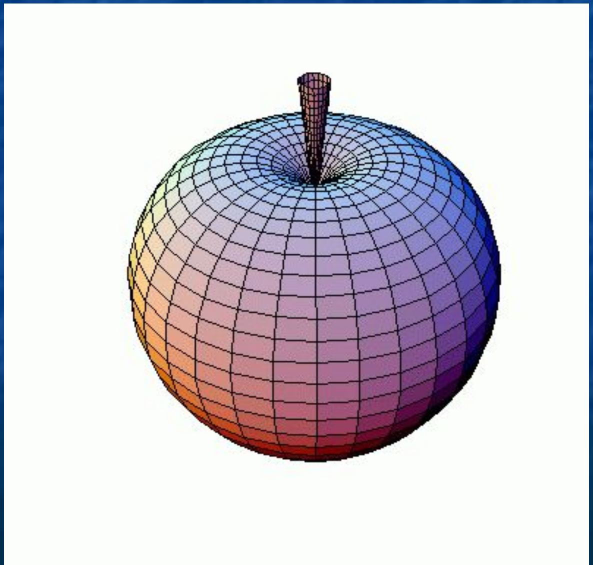
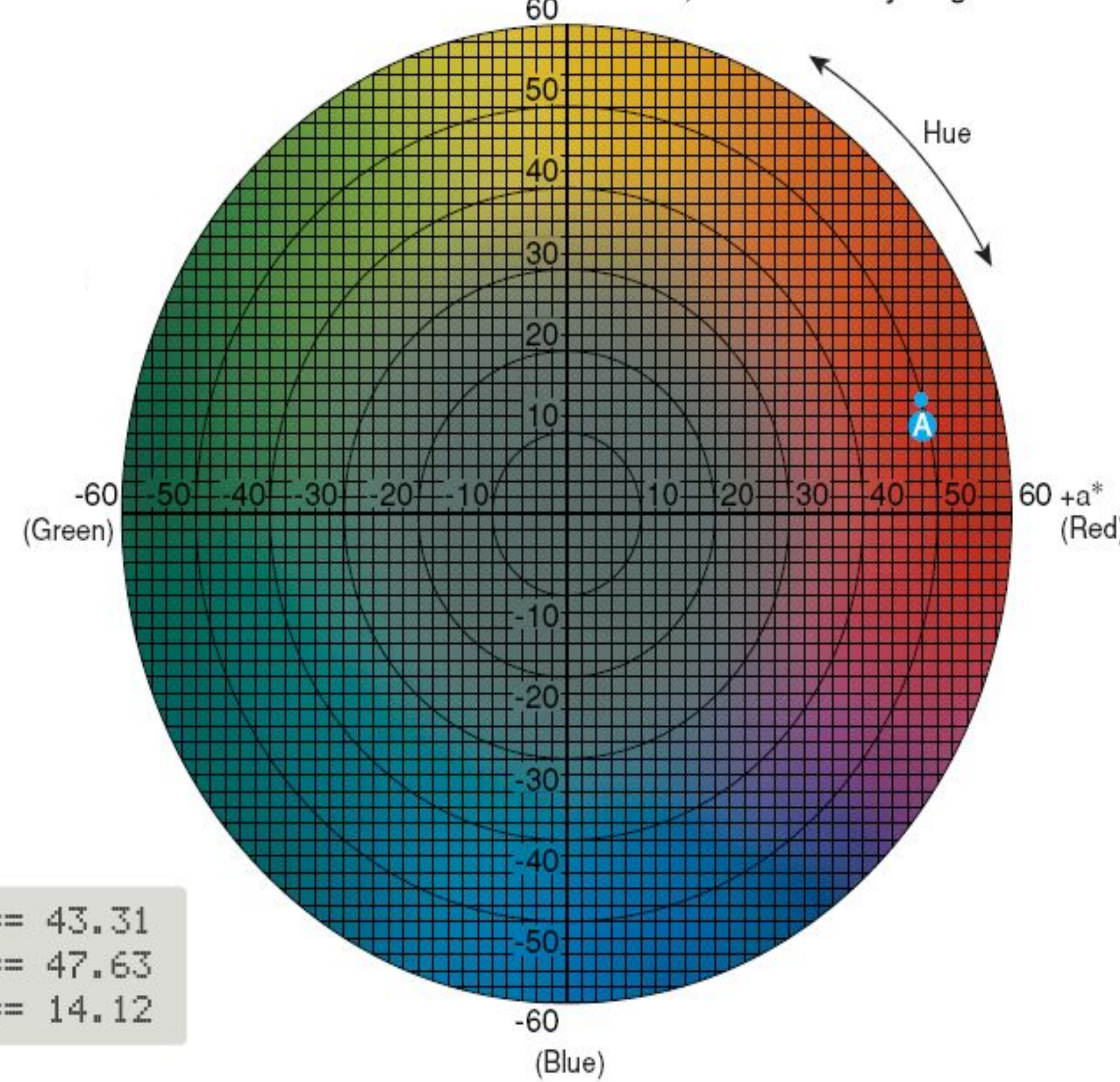


Figure 8:
a*,b* chromaticity diagram



L*= 43.31
a*= 47.63
b*= 14.12

Quality parameters:

- Size and shape
- Skin color
- *Firmenss/texture*
- Starch / sugar (soluble solids content)
- Titratable acidity
- Volatile compounds / aroma / odour
- Taste
- Flavour (taste and odour)

Firmness/texture

- texture comprises those properties of a product that can be appraised visually or by touch

- textural properties may also be assesed by muscle sense in the mouth so human perception of texture is determined by the way that fruits flesh breaks down during chewing

Texture is a quality factor, which include:

1. Firmness
2. Crispness
3. Juiciness
4. Mealiness

Firmness/texture

- texture is a creation of composition of cells and their structure, therefore the turgor of cells is important in fleshy products

- texture depends on maturity stage and storage conditons:
  - Advanced maturity: apples becoming soft, beans/peas become fibrous and hard
  - Chilling storage: potatoes hardcore – center of potatoes becoming woody and inedible

Firmness/texture

Texture is a quality factor, which include:

1. Firmness
2. Crispness
3. Juiciness
4. Mealiness

- *Firmness* is a resistance to deformation by applied force
- *Firmness* is the most used to descibe texture, sometimes it is only one quality parameter (New Zealand-kiwifruits)

- *Mealiness* in sensory profiling is described by: softness, dryness, flouriness, granularity
- *Mealiness* is mostly perceived as unpleasent by consumers (exception older people generation)

Firmness/texture - analysis

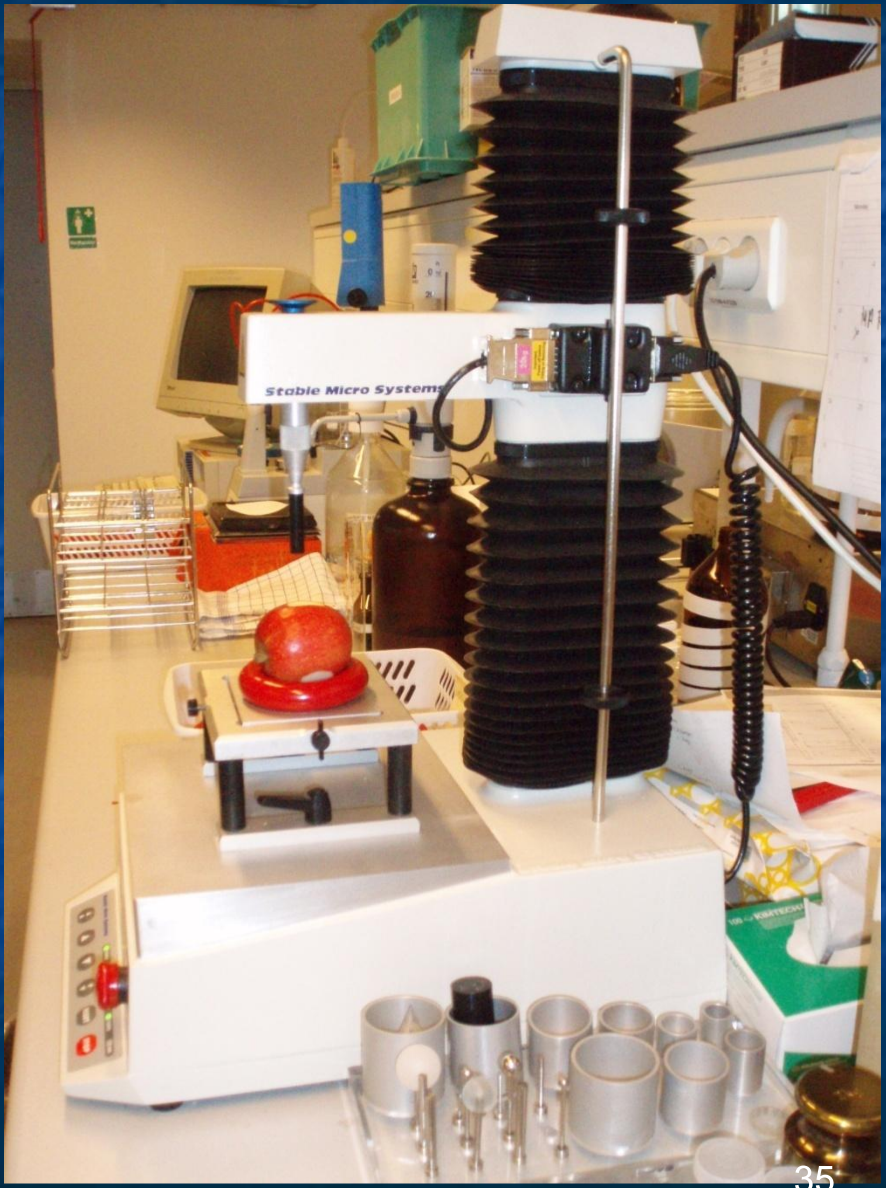
Tool

- firmness can be measured by **penetrometer,** a simple pressure gauge also by Texture Analyser TA

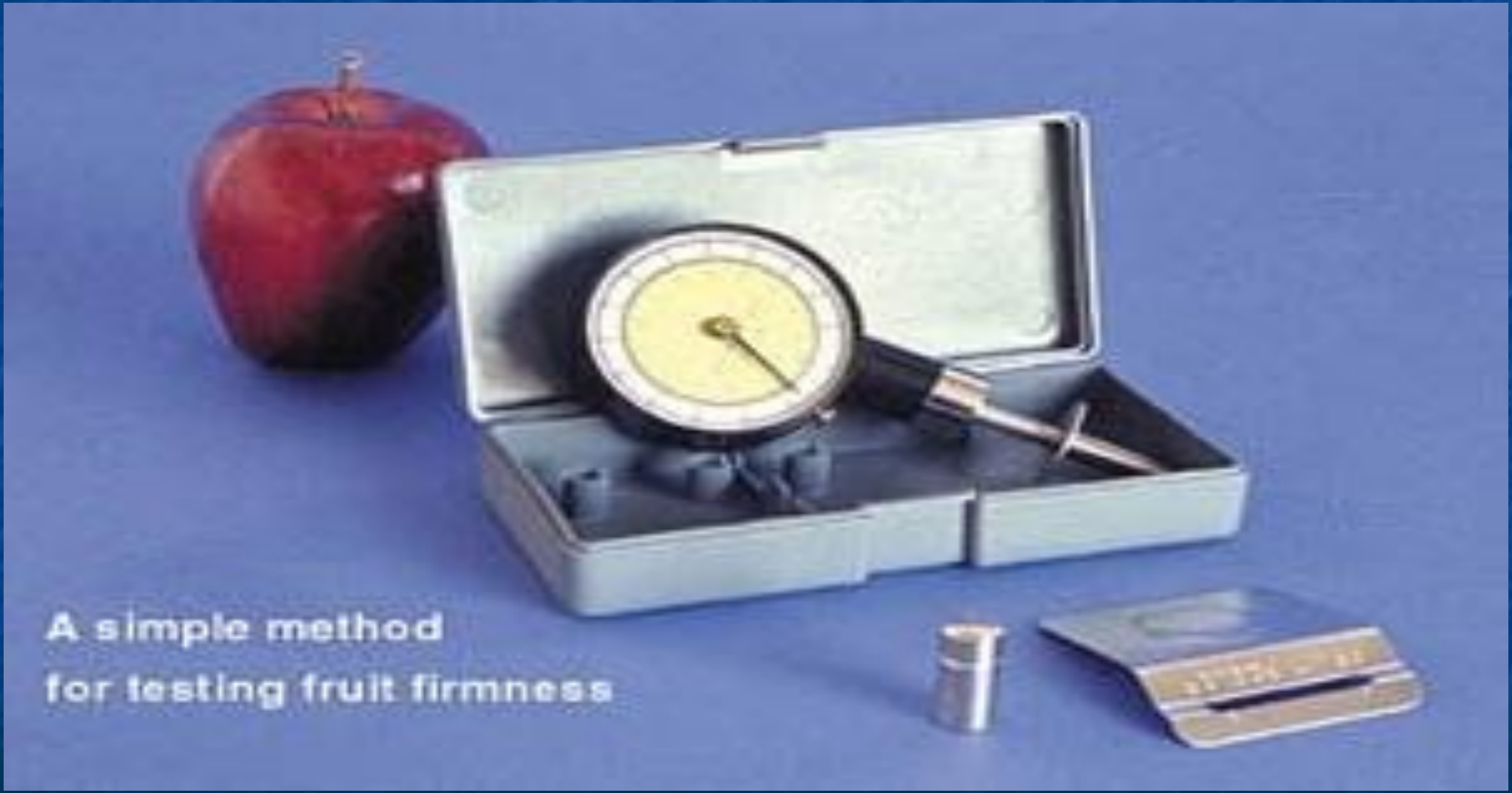
How to do it?

- approximately 10 apples should be analysed
- a piece of peel is taken off at the widest diameter of each apple (both opposite sides)
- the pin of the penetrometer should be gently thrust into this area
- the device shows the resistance measured
- the process is repeated on both apple sides
- the value should be an average from two measurements.

Texture Analyser



Firmness-exercise



Quality parameters:

- Size and shape
- Skin color
- Firmenss/texture
- *Starch / sugar (soluble solids content)*
- Titratable acidity
- Volatile compounds / aroma / odour
- Taste
- Flavour (taste and odour)

Starch

- Starch is composed of two glucose polymers amylose and amylopectin,
- During ripening process starch breaks down and converts into sugar, into the complex sugar *sucrose* and the reducing sugars *glucose* and *fructose*
- The less starch the riper the fruit,
- There is a relationship between starch loss and ethylene production
- Sugars released during starch breakdown are utilized for respiratory metabolism
- Sugar is an important measurement of internal quality because the taste of the fruit is primarily dependent on the sugar and acidity content
- many factors can influence the sugar content of ripening fruit:exposure to the sun and shade, irrigation, rootstock, fertilization, weather conditions etc

Sugar - analysis

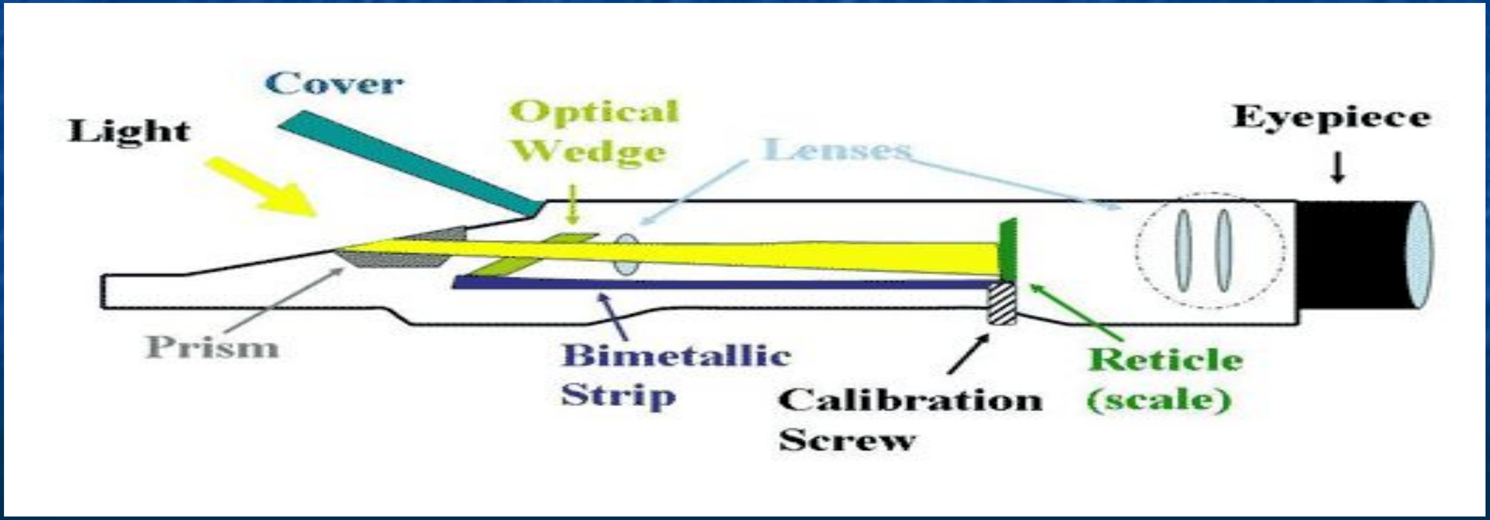
Tool

- To determine the amount of total sugar in the fruit **the hand refractometer/refractometer** can be used

How?

- press the juice from apple
- put a small drop of the juice into the glass part of refractometer
- repeat action several times in order to achieve a workable average
- Sugar content is usually expressed by %Brix degrees (the relative "sugar weight" of a sample compared to distilled water)

Sugar -analysis



Sugar - analysis

Refractometer without any sample

Properly calibrated refractometer

Sample of some real grapes - time to make wine

Quality parameters:

- Size and shape
- Skin color
- Firmenss/texture
- Starch / sugar (soluble solids content)
- *Titratable acidity*
- Volatile compounds / aroma / odour
- Taste
- Flavour (taste and odour)

Titratable acidity

- is a measurement of quality which gives clues as to determining the harvest date (brix:acid ratio)

- there are many organic acids, but generally two/one are mainly in the fruit:

Table 4-3. Organic Acids in Apple, Pear, Grape, Banana, and Strawberry

	Apple	*Pear*	*Grape*	*Banana*	*Strawberry*
Glycolic	+	+	+	+	tr
Lactic	+	+	+	+	
Glyceric	+	+	+	+	tr
Pyruvic	+		+	+	
Glyoxylic	+		+	+	
Oxalic	+		+	+	
Succinic	+	+	+	+	+
Fumaric	+		+		
Malic	++	++	++	++	+
Tartaric			++		
Citramalic	+	+		+	
Citric	+	+	+	+	+++
Isocitric	+		+		
Cis-aconitic			+		
Oxaloacetic	+		+	+	
α-Oxoglutaric	+	+	+	+	
Galacturonic	+	+	+		
Glucuronic	+		+		
Caffeic	+		+		
Chlorogenic	+	+	+		
p-Coumarylquinic	+				
Quinic	+	+	+	+	+
Shikimic	+	+	+	+	tr

Titratable acidity

- organic acids are utilized as respiratory substrates and as carbon skeleton for synthesis of the new compounds during ripening (respiration, create aroma compounds...etc)
- acidity decreases with increasing ripeness
- the acidity can vary greatly from year to year, influenced mainly by weather conditions

Titratable acidity - analysis

Tool

- To determine the acidity level in the fruit **titration method** is used

How?

- press the juice from apple
- measure 1ml of juice, add some water
- start titration with NaOH (sodium hydrate)
- acidity is expresed in malic acid g/l

Quality parameters:

- Size and shape
- Skin color
- Firmenss/texture
- Starch / sugar (soluble solids content)
- Titratable acidity
- *Taste*
- Volatile compounds / aroma / odour
- Flavour (taste and odour)

Taste

- Consumers try to correlate visual parameters with taste (round, shinny, red apple has to taste good) – unfortunately we can assess taste only after purchase of the product

- Taste is perceived by specialized taste buds on the tonque

- There are many tastes but most appear to primarily represent combinations of 4 sensations :
    1. Sweet
    2. Sour
    3. Bitter
    4. Salt

Taste

- Sweetness and sourness are predominant
- Taste changes as the ratio of sugar and organic acids changes
- Sweetness comes from amount and type of sugar in fruits (fructose>sucrose>glucose)
- Sourness comes from amount and type of organic acids

Taste - exercise

Quality parameters:

- Size and shape
- Skin color
- Firmenss/texture
- Starch / sugar (soluble solids content)
- Titratable acidity
- Taste
- *Volatile compounds / aroma / odour*
- Flavour (taste and odour)

Apple Aroma

- Over 300 volatile compounds have been measured in apples
- The change in production of volatile compounds by apple fruit is closely linked to ripening process so also to ethylene
- The types of apple aroma compounds produced typically belong to one of several groups, mostly esters, aldehydes, alcohols, ketons (others in smaller amounts)

Compound	Sensory description	Cultivar	Reference
Aldehydes			
acetaldehyde	green/sharp	Golden Delicious	Rizzolo et al. (1989)
trans-2-hexenal	green/sharp	Golden Delicious	Rizzolo et al. (1989)
	overall intensity	McIntosh	Panasiuk et al. (1980)
	green apple	Delicious	Flath et al. (1969)
	harmonious, fruity	many	Duerr (1979)
hexanal	green/sharp, earthy	Golden Delicious	Rizzolo et al. (1989)
	overall intensity	McIntosh	Panasiuk et al. (1980)
	good, green apple	Delicious	Flath et al. (1969)
	grass like	many	Duerr (1979)
Alcohols			
butan-1-ol	overall flavour, aroma, sweet aroma	Royal Gala, Golden Delicious	Young et al. (1996); Rizzolo et al. (1989)
hexan-1-ol	earthy, unpleasant	Golden Delicious	Rizzolo et al. (1989)
trans-2-hexenol	harmonious, fruity	many	Duerr (1979)
Esters			
butyl acetate	red apple aroma	Royal Gala	Young et al. (1996)
	Cox-like aroma	Cox's Orange Pippin	Williams & Knee (1977)
	harmonious	many	Duerr (1979)
	nail polish	Gala	Plotto (1998)
pentyl acetate	banana like	Cox's Orange Pippin	Williams & Knee (1977)
	apple, fruity	Golden Delicious	Rizzolo et al. (1989)
	Gala	Gala	Plotto (1998)
hexyl acetate	red apple aroma characteristic apple	Royal Gala	Young et al. (1996)
	Cox-like aroma	Cox's Orange Pippin	Williams & Knee (1977)
	ripe Golden Delicious sweet fruity, apple	Golden Delicious	Rizzolo et al. (1989)
	Gala, ripe, pear		Plotto (1998)
2 methyl butyl acetate	overall aroma, characteristic apple	Royal Gala	Young et al. (1996)
	solvent	Gala	Plotto (1998)
	banana like	Cox's Orange Pippin	Williams & Knee (1977)
ethyl butanoate	fruity, estery	Golden Delicious	Rizzolo et al. (1989)
	harmonious, fruity	many	Deurr (1979)
ethyl-2-methyl butanoate	fruity	Golden Delicious	Rizzolo et al. (1989)
	apple like	Delicious	Flath et al. (1967)
	sweet strawberry	Gala	Plotto (1998)
4-methoxyallyl benzene	spicy, aniseed	many	Williams et al. (1977)
methyl-2-methyl butanoate	sweet fruity	Gala	Plotto (1998)
propyl-2-methyl butanoate	very sweet, strawberry	Gala	Plotto (1998)
butyl-2-methyl butanoate	fruity, apple	Gala	Plotto (1998)
hexyl-2-methyl butanoate	apple, grapefruit	Gala	Plotto (1998)
butyl hexanoate	green apple	Gala	Plotto (1998)
hexyl propanoate	apple	Gala	Plotto (1998)
butyl butanoate	rotten apple, cheesy	Gala	Plotto (1998)
butyl propanoate	fruity, apple	Gala	Plotto (1998)
hexyl butanoate	apple	Gala	Plotto (1998)
hexyl hexanoate	apple	Gala	Plotto (1998)

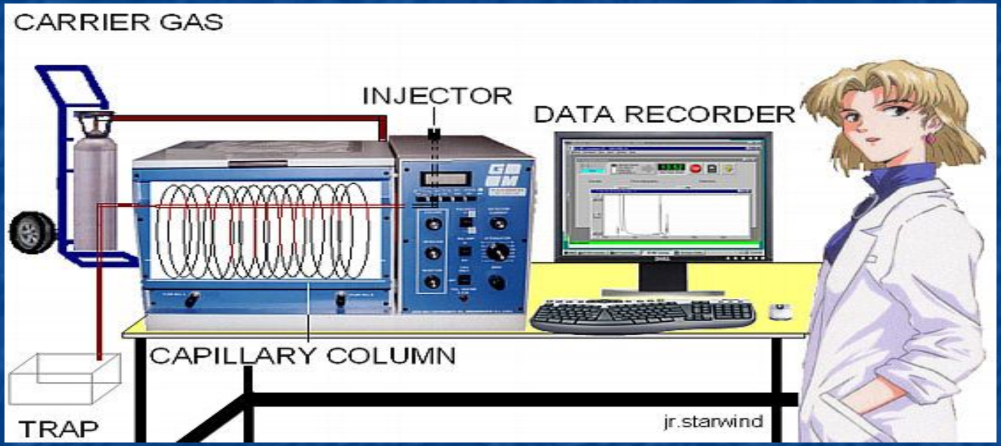
Apple aroma

- In pre-climacteric apples, aldehydes and alcohols are the largest quantitative groups of volatile produced, but after ripening begins ester production increases and becomes the largest quantitative group in many cultivars

- *The most important is the treshold of each compound not a quantity of compound! !*
- treshold = ability to percive the odour

Aroma/Odor - analysis

GC-MS



Aroma/Odor - analysis

Olfactory GC

Aroma - exercise

Quality parameters:

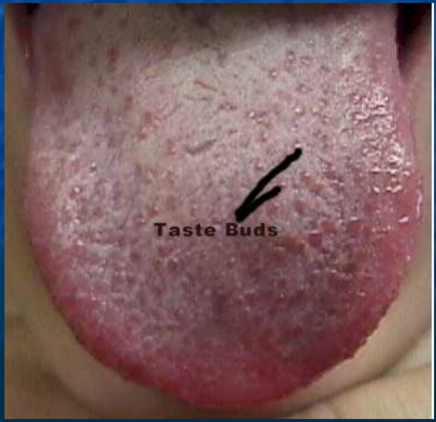
- Size and shape
- Skin color
- Firmenss/texture
- Starch / sugar (soluble solids content)
- Titratable acidity
- Volatile compounds / aroma / odour
- Taste
- **Flavour** (taste and odour)

Flavour

TASTE + ODOUR

PERCEIVED BY BUDS IN THE TONGUE

PERCEIVED BY OLFACTORY RECEPTORS IN THE NOSE



Flavour

TASTE + ODOUR

↓ PERCEIVED BY BUDS IN THE TONGUE

↓ PERCEIVED BY OLFACTORY RECEPTORS IN THE NOSE

"...This wine tastes so nice, because of its fruity and spicy notes..."

The sentence refers to pleasant odor sensed, when taste can be describe only by 4 sensations: sweet, salty, sour and bitter.

Exercise 3

- 10.03.2009
- Lab on the 4th floor (at my office T459)
- Each group = different time

Exercise 3

Group 1 (opponent to group …) at 15.15
Aslan, Ozlem
Østergaard, Anne
Betzer, Cathrine

Group 2 (opponent to group …) at 11.00
Zidova, Petra
Dedenroth, Stine Elise
Yilmaz, Tuba

Group 3 (opponent to group …) at 15.00
Demir, Kevser Burcu
Weinreich, Christine Frigaard
Desta, Zeratsion Abera

Group 4 (opponent to group …) at 14.00
Thach, Tine
Dobrynin, Aleksey
Stalmach, Joanna

Group 5 (opponent to group …) at 14.30
Gardin, Jeanne
Shahid, Aleena
Gruca, Marta
Helene

Group 6 (opponent to group …) at 13.00
Sarica, Gülsen
Hansen, Majbrit
Rodriguez Algaba, Julian

Group 7 (opponent to group …) at 13.30
Jacobsen, Stine Kramer
Orhan, Damla
Kemezys, Andrius

Group 8 (opponent to group …) at 11.30
Mutlu, Ayse Ceren
Kjeldgaard, Karina Juhlert
Mlynek, Janus Cronquist
Mengistu, Fekadu Gebretensay

Exercise 3 - delivery

- 13.03.2009
- Tåstrup 8-01
- Oral presentation of the exercise results (10+10min)
- Groups examine each other

Exercise 3 - delivery

- Oral presentation includes:
  - Objective introduction (why?, what are the diffrences? Is it important?)
  - Methods and material presentation
  - Results
  - Discussion (expected or surprising results...etc) - references

- Oponnent groups ask questions and examine other team on their knowledge