How can we avoid...reduce water loss and rachis browning?

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August 17th &18th, 2020.

Despite the rachis is not the edible part of the cluster...it is actually the key “freshness indicator”
CHALLENGES WE ARE FACING FOR MAINTAINING RACHIS QUALITY

CHALLENGE 1

WISHING LIST FOR CONSUMER?

APPEARANCE
- Color
- w/o decay
- Berry size
- Rachis

TEXTURE
- Firmness
- Juiceness
- Crunchiness

SEEDLESSNESS

OVERALL QUALITY

FLAVOR
- Sweetness (Total soluble solids)
- Acidity (Titratable acidity)
- Aroma
...some of them changes during postharvest

✓ TSS keeps steady.
✓ TA may decrease.
✓ Berry texture could change.
✓ Berry damage and decay usually increase.
✓ Water loss increases in berry and especially rachis.

The “table grape route” for export countries

Trade Map, ITC, 2019
A massive availability of new genotypes....Chile as an example

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<tbody>
<tr>
<td></td>
<td>Ralli</td>
<td>Timpco</td>
<td>Prime</td>
<td>Arra 15</td>
<td>Midnight</td>
<td>Sable Seedless</td>
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<td></td>
<td>Others</td>
<td>Sweet</td>
<td>Others</td>
<td>Blanc Seedless</td>
<td>Beauty</td>
<td>Maylen</td>
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<td></td>
<td>Celebration</td>
<td>Allison</td>
<td>Timpson</td>
<td>Prime</td>
<td>Beauty</td>
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<td>Others</td>
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Source: Adapted from IQonsulting

And many other challenges...

- Lack of *knowledge* about rachis physiology.
- Harvest time mainly based only on *sugar (TSS)* content.
- Inadequate *harvest & postharvest practices* (Temperature/RH).
- *Environmental* phenomena (heat stress and water deficit)
- Little availability of *technologies* for extending rachis quality.
BASES OF RACHIS DETERIORATION

Rachis contributes a **3-8%** of cluster’s total fresh weight

- Respiration rate is **10-50 time higher** than berry.
- A very high area:volumen ratio.
- Important amount of stomata and lenticels.
- Small amount of wax in cuticle...almost absent.
I. Cluster water loss

- **What is it?**
  Cumulative process of water loss from the berry and rachis.

- **Visual symptoms?**
  - Dehydration
  - w/ or w/o rachis browning

- **More susceptible structure?** Vegetative tissues w/o waxy protection, i.e. the rachis.

What are the thresholds of cluster water loss for getting damage?

- >2% = a negative effect on **rachis**
- 2-4% = a negative effect in **berry texture**
- >5% = probably berry with water loss symptoms

(Crisosto et al., 2001; Lichter et al., 2011)
Cluster water loss for 78 grape varieties
(After 30 d. at 0°C. Season 2018/19)

FONDECYT 11161044; CORFO 09PMG-7229

Effect of temperature on WVPD and rachis transpiration

T = 25°C
RH = 100%
VP = 23.76 mBAR
WVPD = -11.88
Water vapor

T = 0°C
RH = 100%
VP = 4.58 mBAR
WVPD = -0.36
Water vapor

RH = 50%
VP = 11.88 mBAR

RH = 90%
VP = 4.12 mBAR
II. Tissue browning

- A senescence regulated process.
- Tissue browning as the main symptom (PPO, PAL, others)
- Involves oxidative stress metabolism.

Figure 2. Determination of the total antioxidant capacity (TAC) in tissues of various strains (A, control) and foliar disease symptoms (B, symptoms) affected disease-resistant (A) and disease-susceptible (B) coffee (Coffea Arabica) genotypes. Data correspond to the average of three replications. Differences in the TAC between genotypes A and B at each sampling date were statistically significant (ANOVA tests). (Campos-Vargas et al. 2012)
Phenotype = Genotype + Environment

High Heredability
- Berry Size
- Seedlesness

Low heredanility
- Rachis vigor
- Taste

Rachis quality
Shattering
Berry firmness
Berry size

Climate
Cultural managements
Maturity stage at harvest
Postharvest handling

Rachis color profile for 78 grape varieties

AT HARVEST

AFTER STORAGE

FONDECYT 11161044; CORFO 09PMG-7229
**MATURITY AT HARVEST**

**Main questions:**

- Maturity stage at harvest?
- Harvest window?
- Harvest index?
- Storage potential?

**Example:**

<table>
<thead>
<tr>
<th>Berry color</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>High titratable acidity</td>
</tr>
</tbody>
</table>

*Selection 5.56 (known as Maylen)*
Weekly changes in TSS:TA ratio in Maylen

1. Rachis appearance

--- green

++ green

At harvest  60 d. 0°C  60 d. + 2 d. at 20°C

TSS: 18%  TA: 0.9%  TSS/TA: 20
TSS: 21%  TA: 0.7%  TSS/TA: 30
TSS: 23%  TA: 0.7%  TSS/TA: 33
But with longer term storage....

Take home message: Maturity and storage period
Knowledge is there for a while....

- Harvest time
- Temperature
- Cooling process
- Logistic (time between harvest and cooling)

Do the right thing and at the right time...

...and in the right way!!
PLANT GROWTH REGULATORS

External signals
- Light
- Quality
- Quantity
- Length
- Mechanical
- Variables
- Wind
- Relative humidity
- Temperature
- Nutrition
- Water
- Pathogens
- Gravity
- CO₂

Internal signals
- Hormones
- CKs
- Ethylene
- GAs
- Auxins
- ABA
- brassinosteroids

Mechanical related to growth
- Defense
- Jasmonic acid
- Salicylic acid
- Development
- Metabolites
- Sugars

Regulation of fruit growth and development
Anti senescence


“Anti senescence”

Senescence enhancer

Source: Professor Shang Fa Yang class

“Senescence enhancer”

Transcrip expression of ACO1 gene in the berry

Table grape berries also showed an increase in ethylene metabolism during veraison, but with differences among varieties.

(Muñoz-Robredo, 2013)
Effect of ethylene inhibition (1-MCP) at veraison on rachis appearance in Red Globe

* No consistent effects among seasons

(Li et al., 2015)
A >50% greener rachises with GA + CPPU application vs. GA alone.

(Navarro et al., 2001)

However, it is a must to get a suitable balance between CK’s benefits and detrimental effects in rachis and berry:

- Rachis rigidity
- Stem thickening
- Berry drop

Source: Julio Retamales...in the ‘90
- Red Globe
- Los Andes, Chile
- 400 μL L⁻¹ 6-benzyladenine (Valent Biosciences Corp, USA),
- Applied 1 d. before harvest
- Electrostatic sprayer
- Storage: 90 d. at 0°C under RA and CA (5%O₂ and 15% CO₂).

CONTROLLED AND MODIFIED ATMOSPHERE PACKAGING
Main effects in table grapes:

- Slow down fruit metabolism.
- Decay control (CO₂ > 12%).
- Reduces WVPD...(Increase in RH 92-97% under MAP)

Source: INIA-Subsole...late in the ‘90.

Use of controlled atmosphere......late in the ‘90s

T. Seedless stored 50 d. at 0°C + 6 d. at 20°C

w/ SO₂ pad  w/o SO₂ pad

Retamales et al., PBT 2003
But the use of MAP is able of preserving freshness of the rachis

![Graph showing green color percentage]

++ green

-- green

90 d. at 0°C

(Silva-Sanzana et al., 2016. Fondecyt UNAB-INIA)

Tranversal slices from rachis stained with phloroglucinol-HCl to facilitate recognition of lignified vascular tissue.

After 90 d. at 0°C

(Silva-Sanzana et al., 2016)
Final remarks for rachis.....actually for everything related to grape quality

• WVPD control is a must....think in the rachis more than in the berry. LOGISTIC!!

• A lot of to learn about new genotypes:
  ✓ Preharvest conditions (Climate and cultural management)
  ✓ Maturity at harvest
  ✓ Storage potential
  ✓ PGRs response

• Alternatives to SO₂ for decay control...what about the rachis?

• Rachis science & technology

Working team

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Funding

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Alonso Pérez

FONDECYT
Fondo Nacional de Desarrollo Científico y Tecnológico

CORFO
Fomento de Desarrollo Económico, Ciencia y Tecnología Nacional
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