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> How do genetics, development and drought affect polyphenols in goji?

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> 1. Context

> 2. Effect of genetic and developmental factors

> 3. Impact of drought

> 1. What are goji berries ?

- Solanaceae family

- Goji/wolfberry -> 3 species:

  Lycium barbarum
  Lycium chinense
  Lycium ruthenicum

- Traditionally eaten in Asia for their high nutritional value

- Consumption is growing in Europe, only cultivars from *L. barbarum* can be commercialized

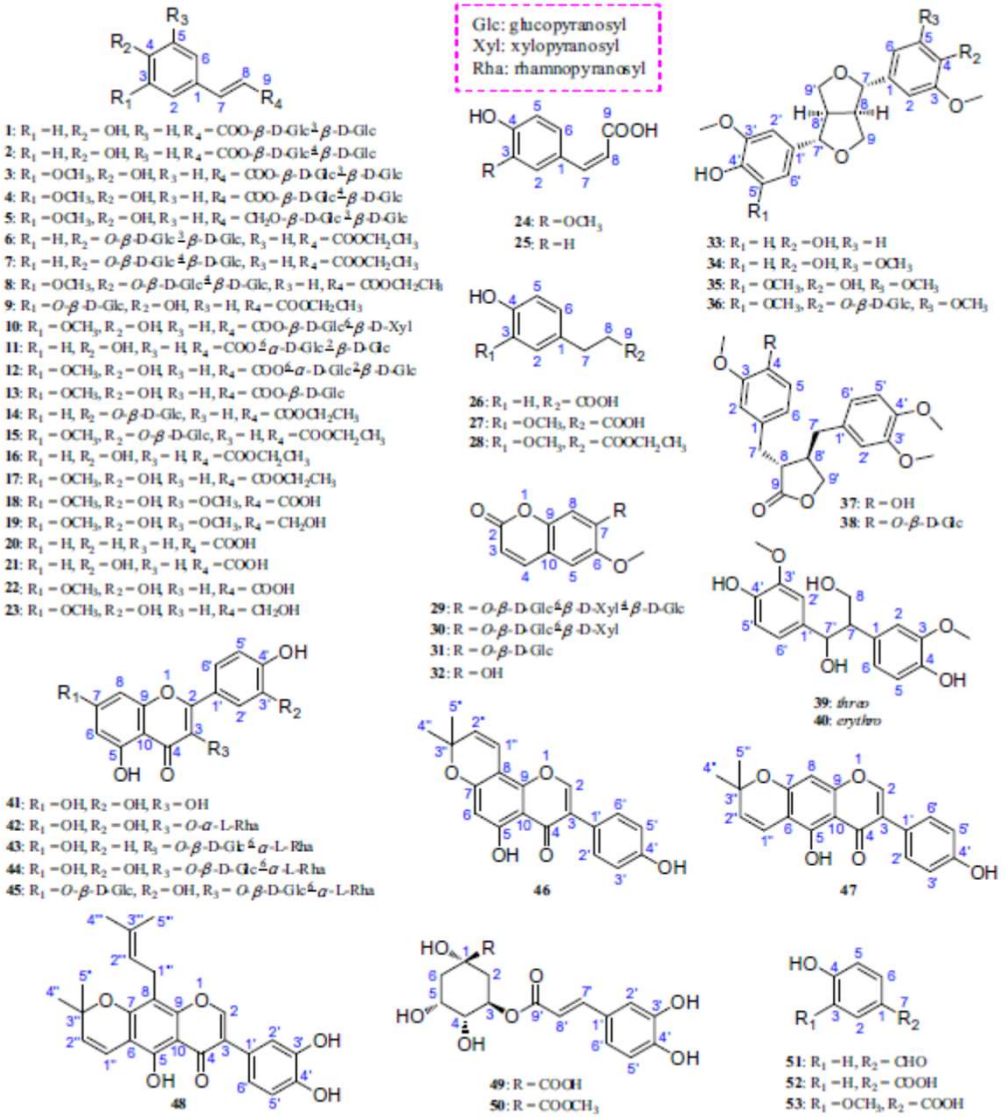
Amagase and Farnsworth. 2011, *Food Res. Int.*
Wetters et al.. 2018, Frontiers in Plant Sc.

> 1. “Superfood”

- Fresh weight: 0.5 – 1 g (10-20% of dry matter content)
- Polysaccharides: 1 – 2.5 × 10^3 mg 100 g^{-1} FW
- Carotenoids: 10 – 50 mg 100 g^{-1} FW
- Vitamin C: 20 – 50 mg 100 g^{-1} FW
- **Polyphenols: 10 – 50 mg 100 g^{-1} FW**

Guil-Guerrero and Rebolloso-Fuentes. 2009, *J. Food Comp. Ana.*
Amagase and Farnsworth. 2011, *Food Res. Int.*

> 1. A complex composition in polyphenols at maturity



- 52 compounds (phenolic acids + flavonoids) isolated and 15 identified using HPLC-DAD-ESI-MS (Inbaraj *et al.* 2010)

- 53 polyphenols identified using spectroscopic and chemical analyses and comparison with NMR data (Zhou *et al.* 2017)

> Genetic and developmental controls remain poorly characterized as well as the impact of drought

Inbaraj et al. 2010, *J. Pharm. Biomed.*
Zhang et al. 2016, *Food Chem.*
Zhou et al. 2017, *Food Chem.*

> 1. Context

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> 2. Intraspecific comparisons: metabolite contents of ripe fruits

- 5 commercial cultivars (*L. barbarum*) grown in the same field in the south of France

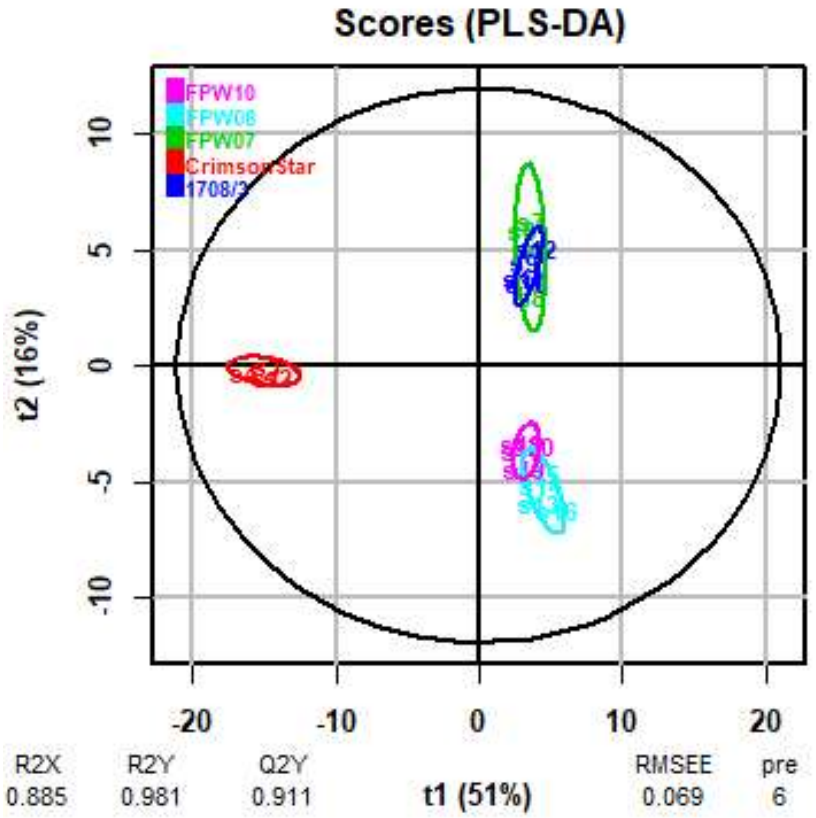
- At maturity: 4 samples of at least 10 berries collected from 4 plants

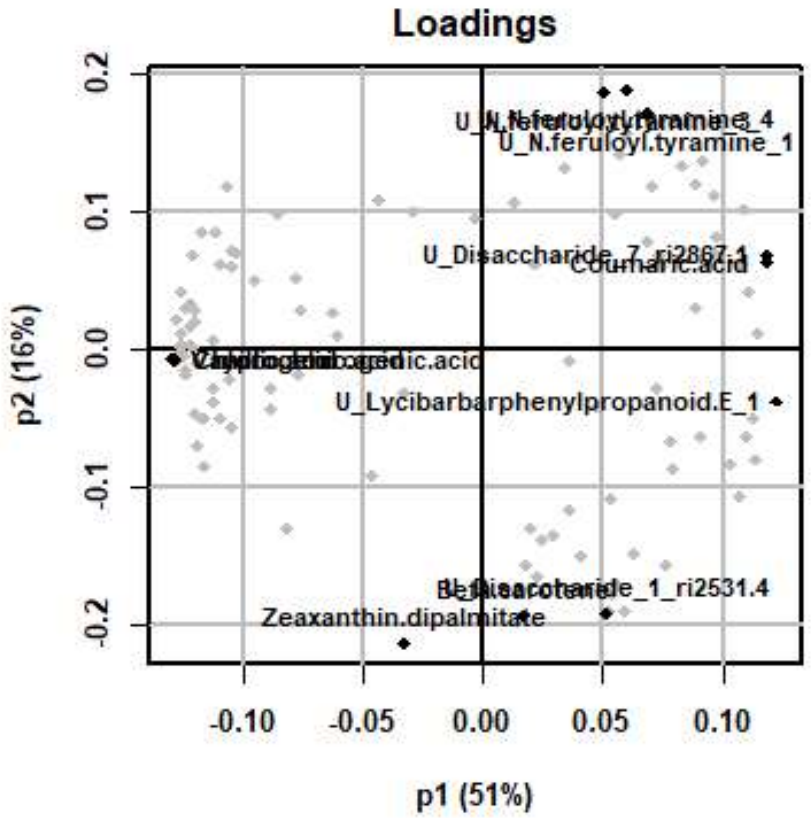
- multi-targeted metabolite analysis:
  - metabolites I > GC-EI-TOF
  - carotenoids
  - polyphenols

  > UPLC-DAD-ESI-TQ

> 2. Metabolite contents of ripe fruits: determination of biomarkers

- Comparison of the 5 cultivars on the basis of 117 metabolites (41 polyphenols) -> supervised multivariate analysis (PLS-DA) to find discriminant features/metabolites

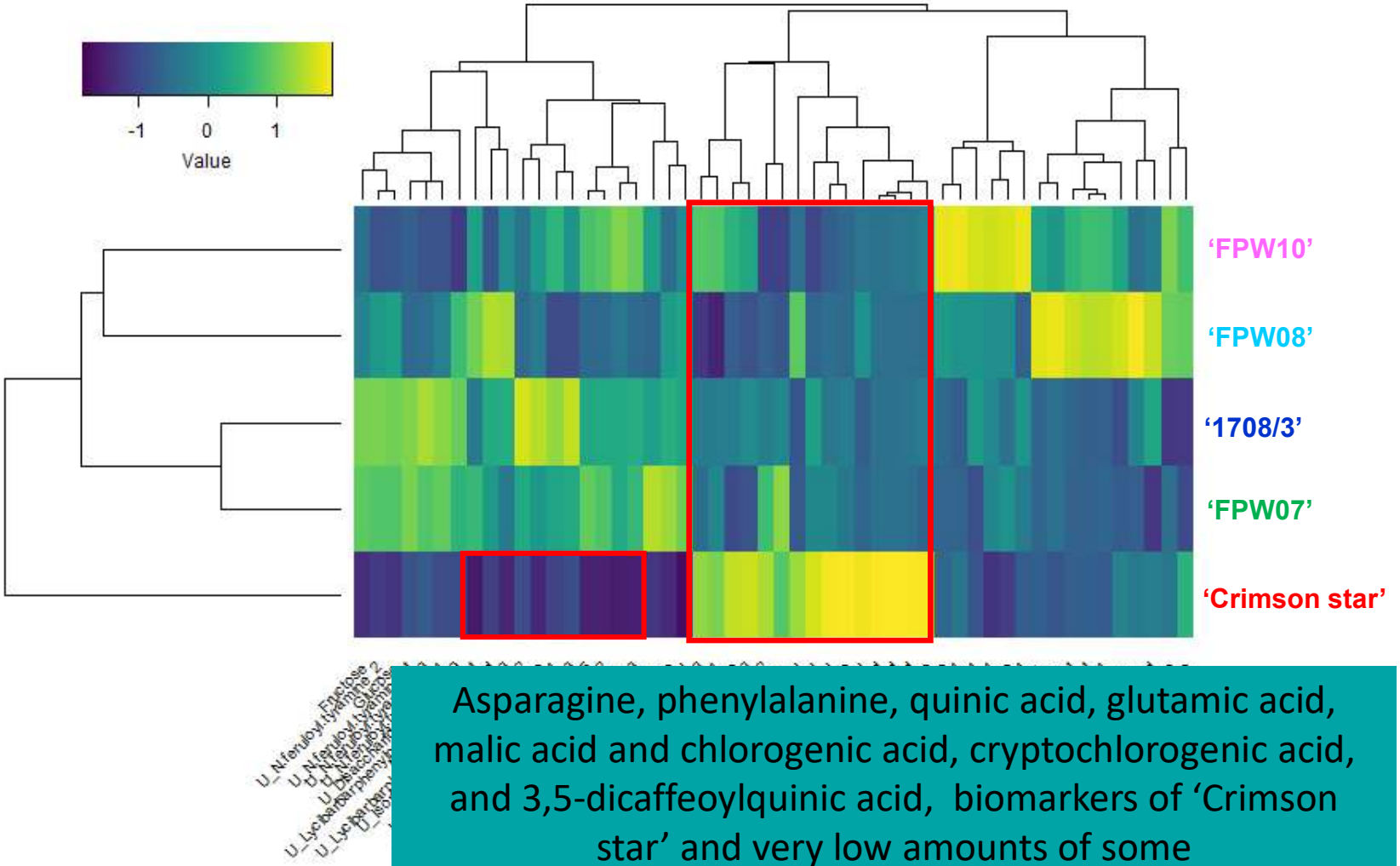




'Crimson star' differs from the 4 other cultivars

> 2. Metabolite contents of ripe fruits: determination of biomarkers

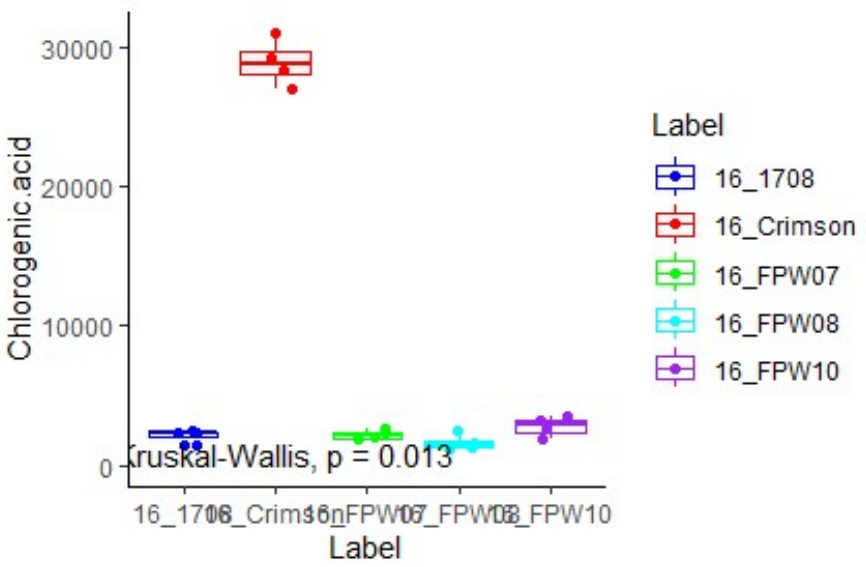
- 53 metabolites with VIP > 1

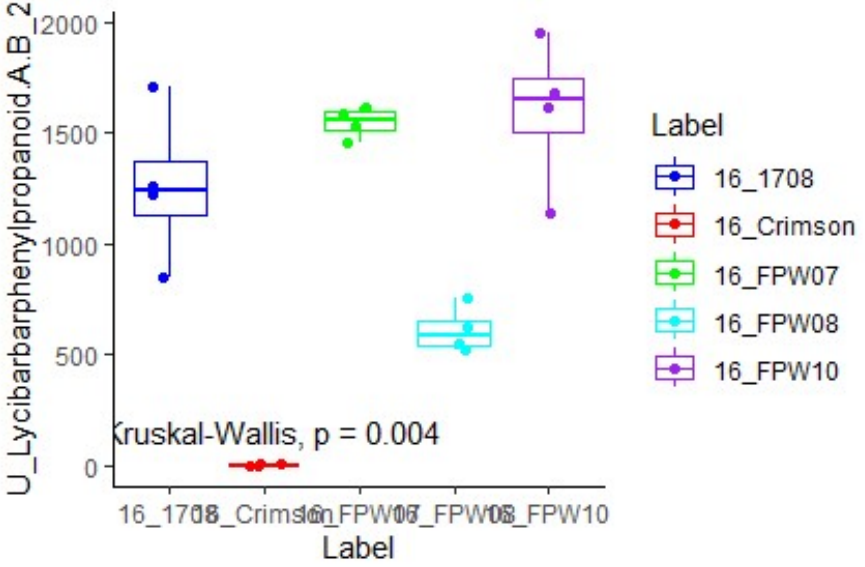


Asparagine, phenylalanine, quinic acid, glutamic acid, malic acid and chlorogenic acid, cryptochlorogenic acid, and 3,5-dicaffeoylquinic acid, biomarkers of 'Crimson star' and very low amounts of some lycibarbarphenylpropanoids (*L. chinense*)

> 2. Metabolite contents of ripe fruits: determination of biomarkers

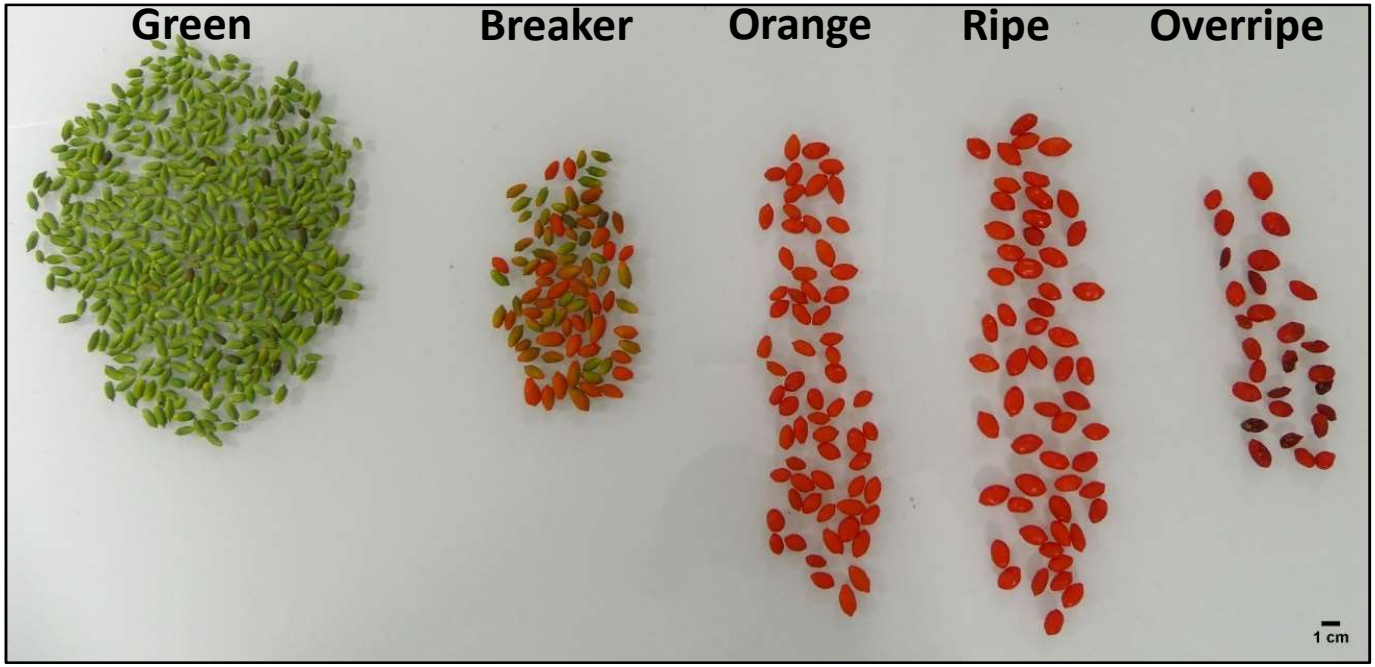
- Examples: Changes in chlorogenic acid and lycibarbarphenylpropanoid A B_2





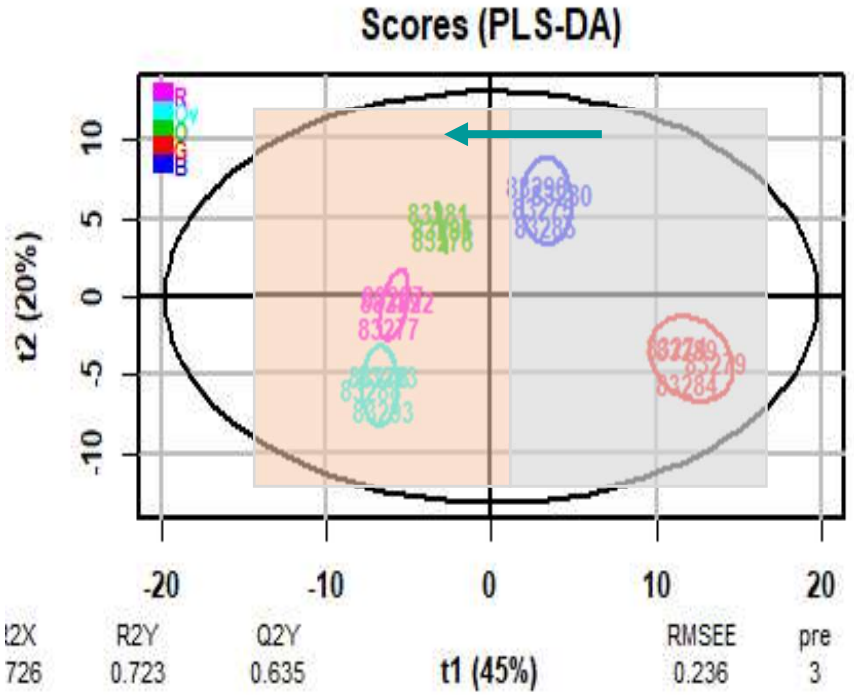
> 2. Variations in metabolite contents during fruit development and ripening

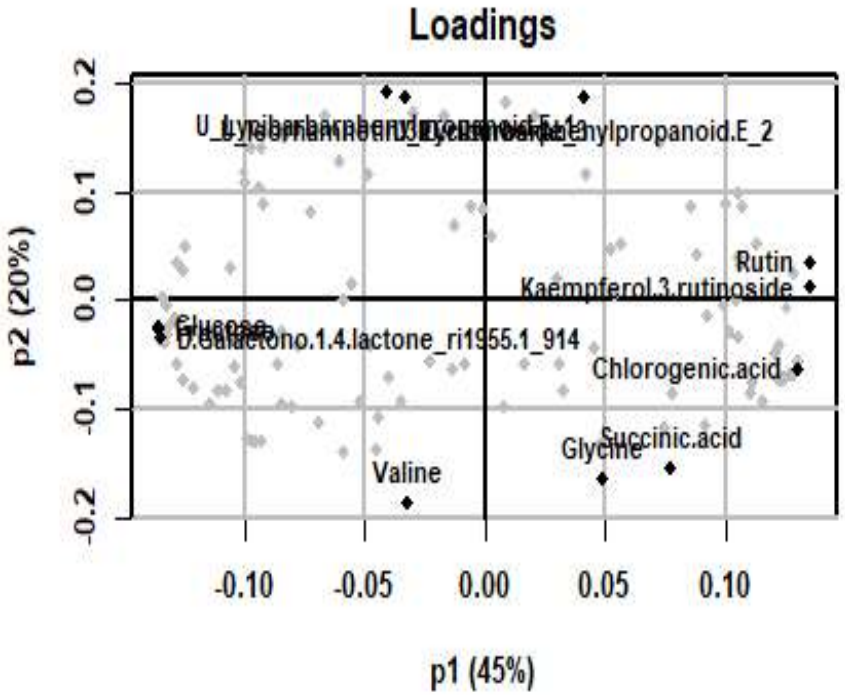
- Analysis of 5 developmental stages



> 2. Variations in metabolite contents during fruit development and ripening

- Determination of discriminant metabolites between the 5 stages

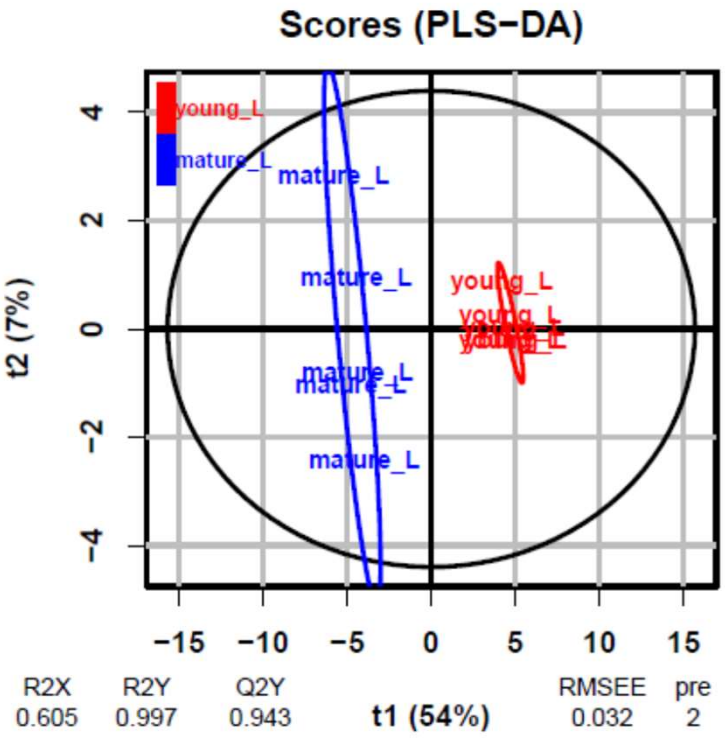


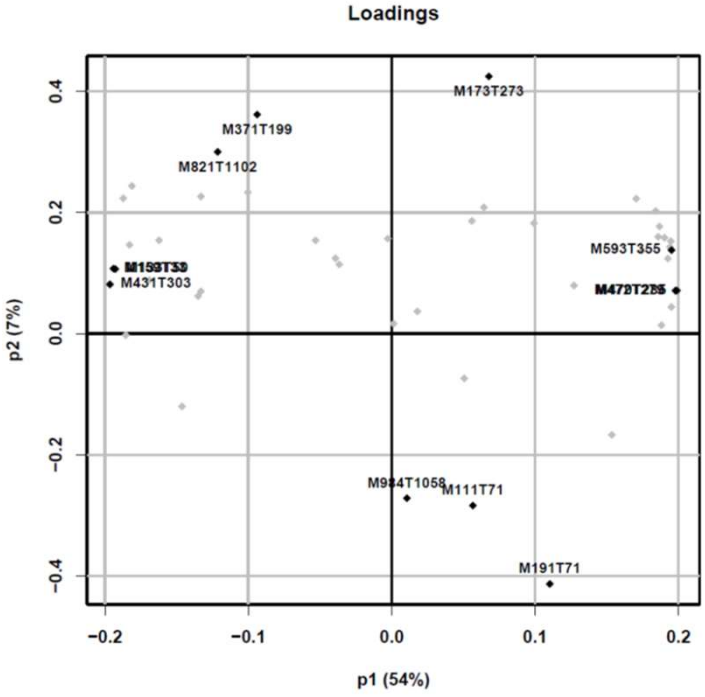


- From green to ripe and overripe: ↗soluble sugars and carotenoids
- The highest contents in polyphenols were found at green and breaker stages (+ 79% when compared to overripe)

> 2. Comparison of young and mature leaves

- Analysis of metabolites from young and mature leaves with an untargeted approach -> UPLC-MS/TOF and data processing, statistical analysis, and annotation with W4M

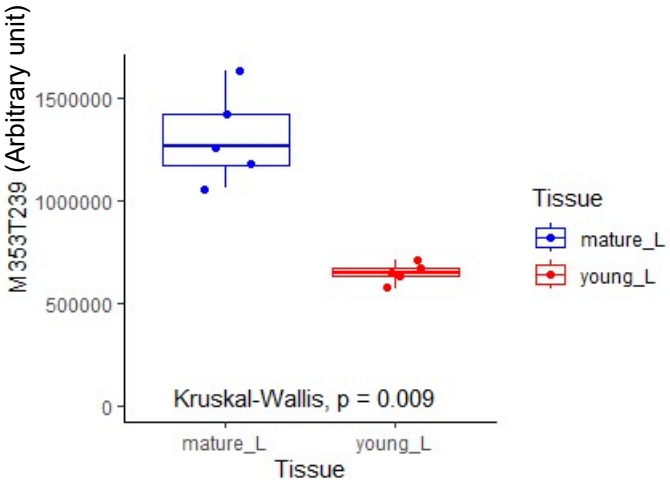




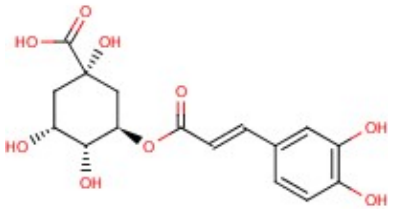
10 features with VIP>1 associated with mature leaves and 15 with young leaves

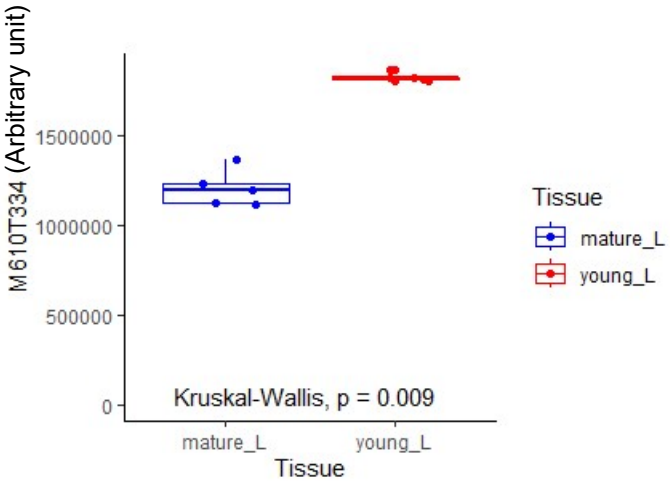
> 2. Comparison of young and mature leaves

- Examples: variations of 2 features in young and mature leaves

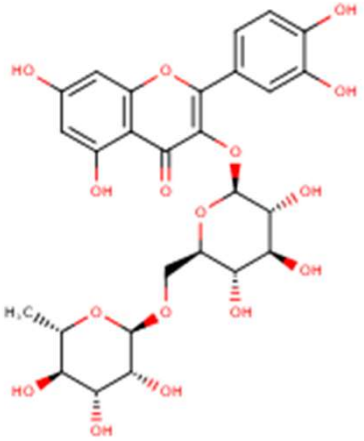


- Monoisotopic mass: 354.095
- Formula: C16H18O9
- Chlorogenic acid





- Monoisotopic mass: 610.153
- Formula: C27H30O16
- Rutin

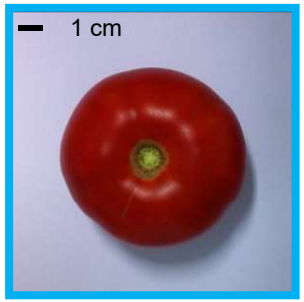


> 1. Context

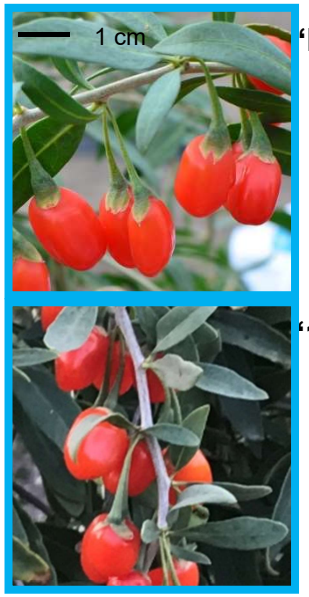
> 2. Effect of genetic and developmental factors

> 3. Impact of drought

> 2. Goji (*L. barbarum*) response to drought

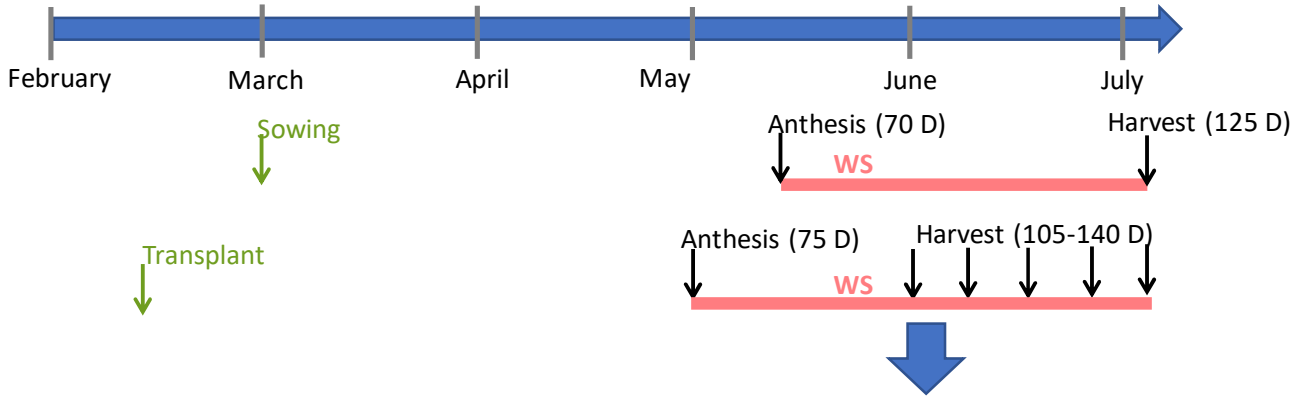


‘Levovil’



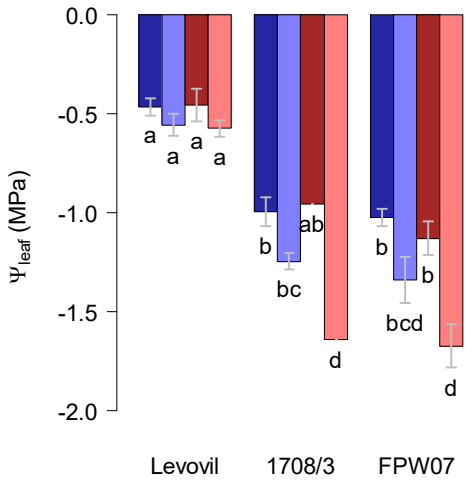
‘FPW07’

‘1708/ 3’

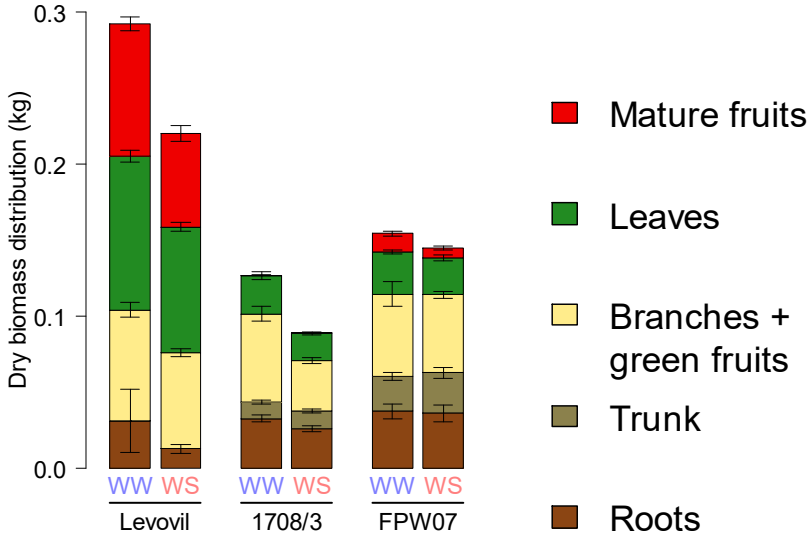


- Plant functioning
- Biomass production
- Leaf and Fruit metabolisms

> 2. WS affected water status, yield and carbon allocation



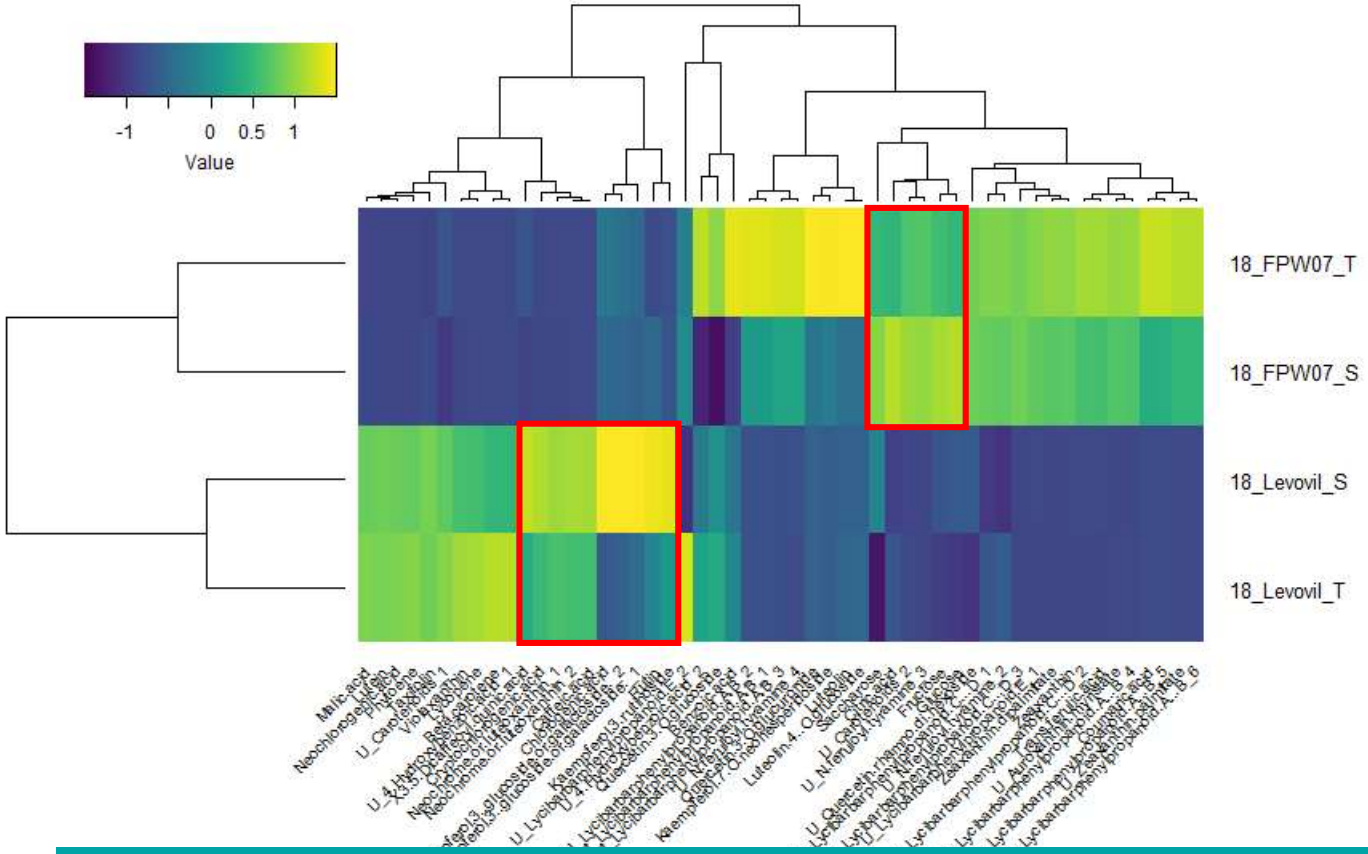
↘ midday leaf water potential of Goji plants under WS. Goji plants showed an anisohydric behavior



Tomato and Goji plants decreased carbon allocation to fruits

> 2. WS affected fruit metabolism

- Variations of metabolite contents expressed on a dry weight basis



Goji under WS: ↗soluble sugar and citric acid contents and
↘ almost all specialized metabolites (polyphenols-14%)
Tomato under WS: ↗soluble sugars and some polyphenols: chlorogenic acid, cryptochlorogenic acid, 3,5-dicaffeoylquinic acid, caffeic acid, kaempferol derivatives and rutin (polyphenols + 100%)

> Polyphenols of goji: take home messages

> Polyphenols (hydroxycinnamic acids and lycibarbarphenylpropanoids) are markers of inter and intra species differences

> The highest contents in polyphenols were found in early stages of berry development. The decrease in polyphenols is concomitant with the accumulation of soluble sugars

> A water stress during the reproductive period negatively impact yield (-50%) and polyphenol contents (-14%) probably through an effect on fruit maturity

> Acknowledgments

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Gojinov project

SYALSA
Gojiqual project

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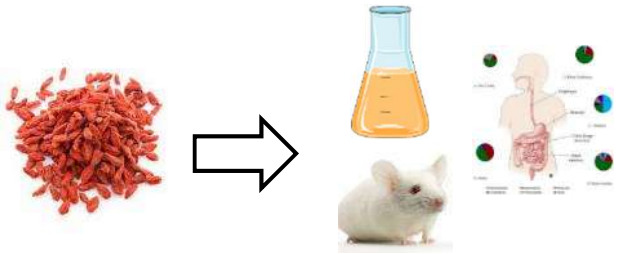
- Carine Le-Bourvellec
- Claire Cherbuy



VALEMA

> Thank you for your attention

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Polyphenols in red flesh apples