Hungarian University of
Agriculture and Life Sciences

Institute of Food Science and Technology

The application of near infrared spectroscopy and hyperspectral imaging for the quality assessment of fruits

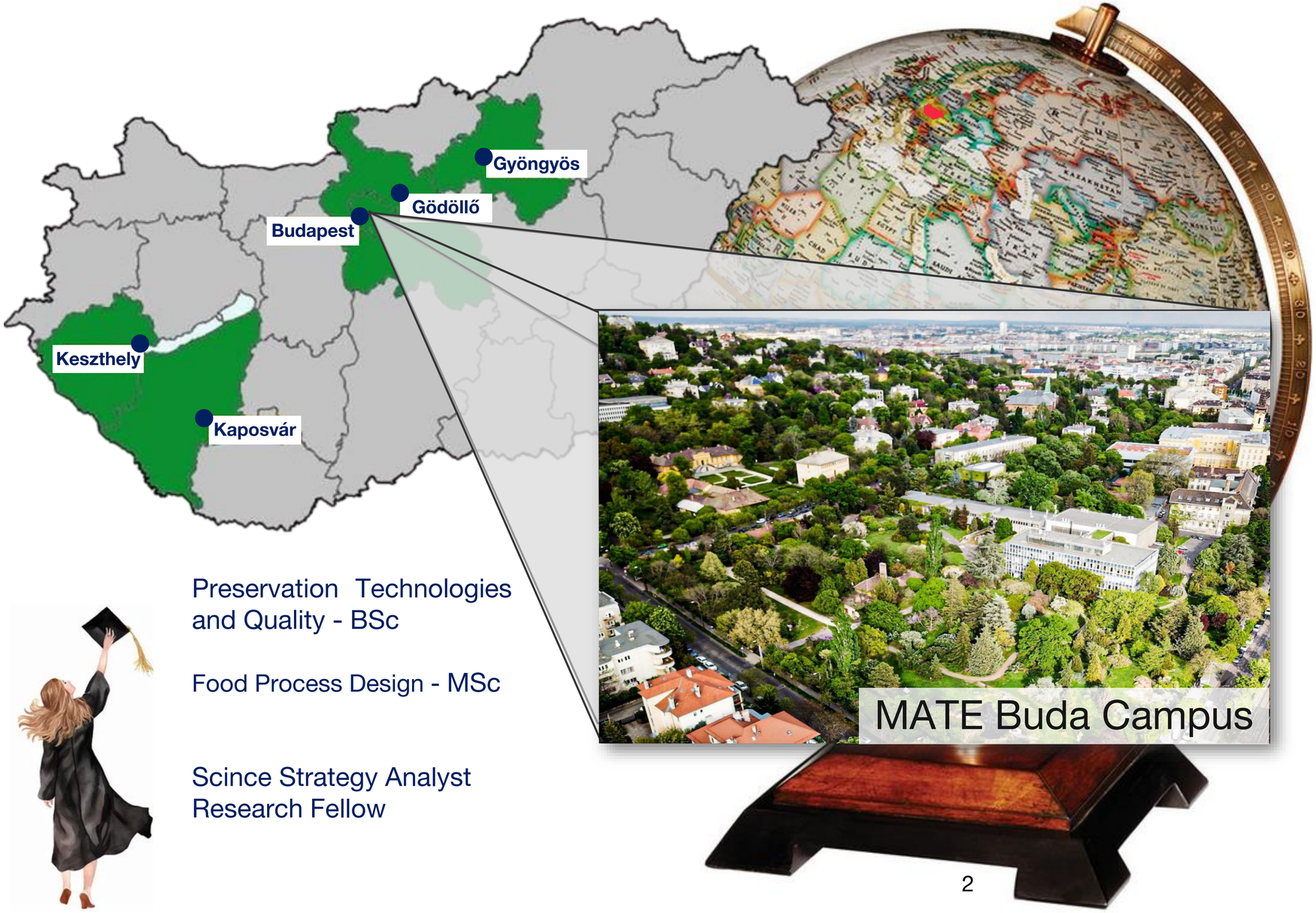
FLORA VITALIS

Zoltan Kovacs, Zoltan Gillay, Marietta Petróczy, Juan Pablo Aguinaga Bósquez, Matyas Lukacs

Day of Femtoscopy

2024

Introduction



Preservation Technologies and Quality - BSc

Food Process Design - MSc

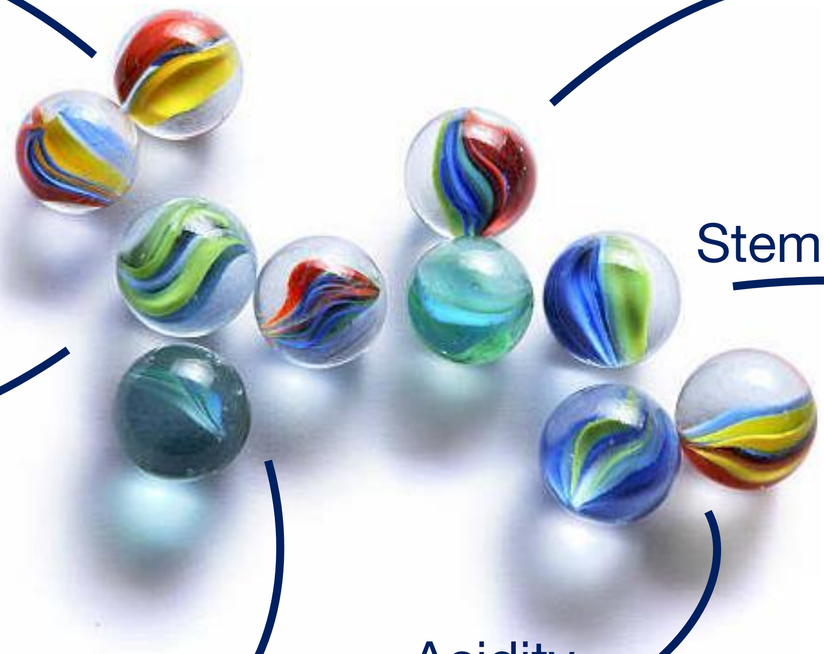
Scince Strategy Analyst Research Fellow

Challenges from farm to fork...

...Generally in food quality control...

Sugar content

Colour



Stem detachment

Weight

Starch

Acidity

Firmness

...About non-targeted methods...

Multiple uses

Fast and non-destructive

Digitised measurement output

In situ / online analyses

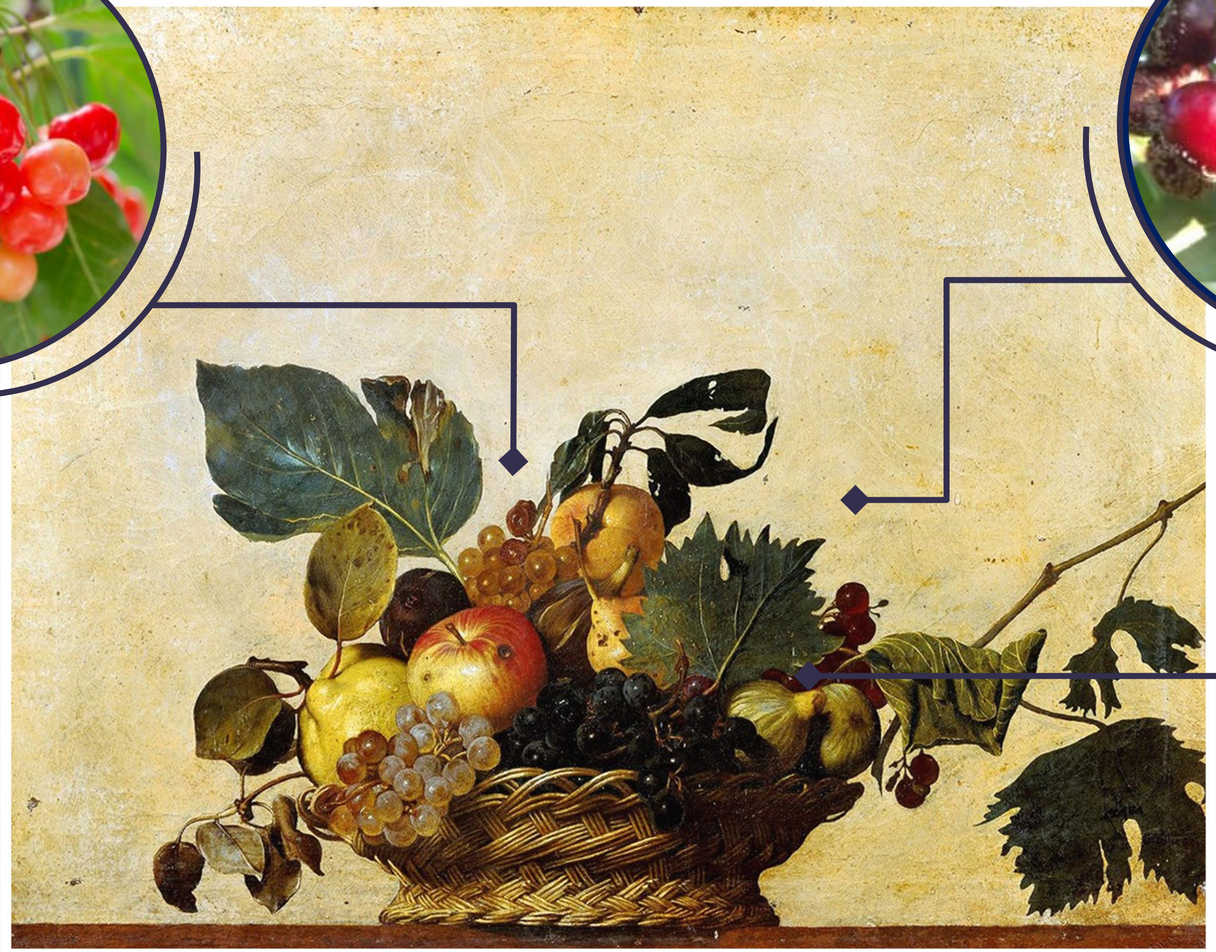
Substantially cheaper

Parallel parameter estimation

In the focus of my researches… fruits

Fruit ripeness

Fruit decaying



Caravaggio: Fruit basket (c. 1599.)

Food adulteration

Preparation of fruit ripeness studies

Sweet cherries

Bigarreau Burlat

Valerij Cskalov

Sour cherries

Kántorjánosi

Újfehértói

Plums

Elena

Stanley

Apples

Golden

Idared

Green ripe ► ► ► fully ripe fruits

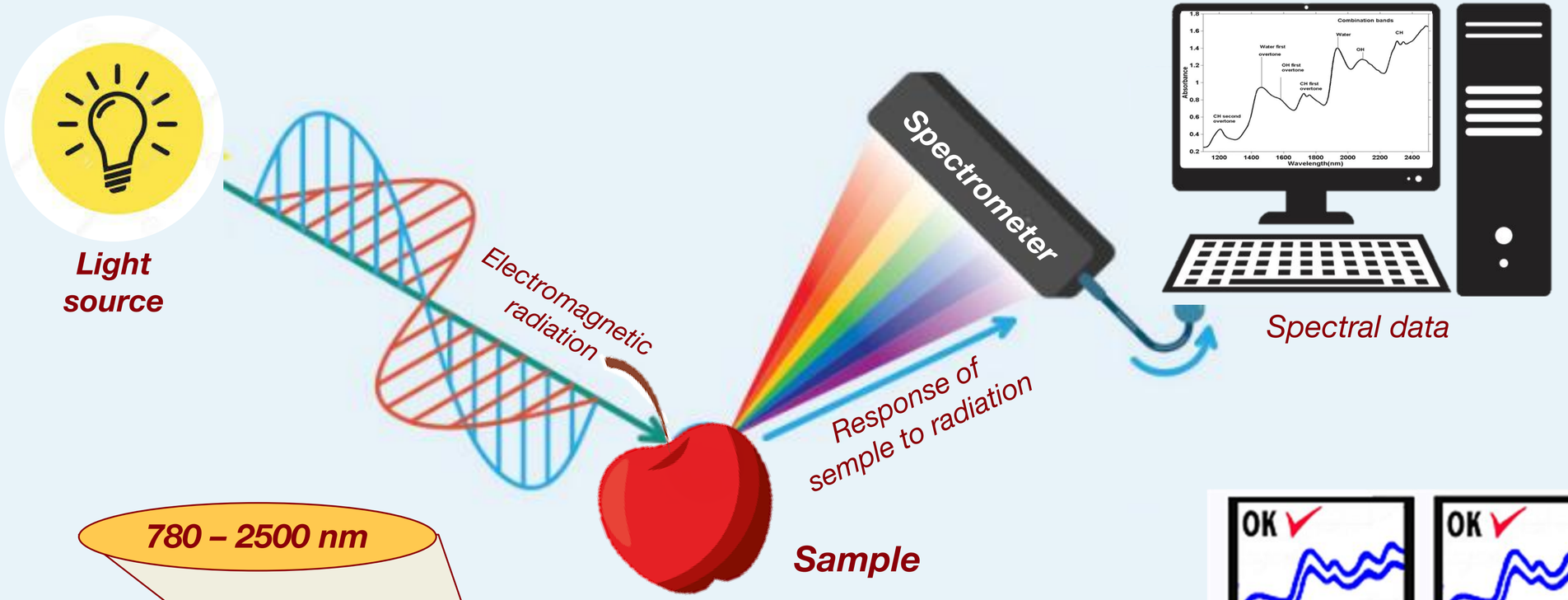
Reference quality attributes

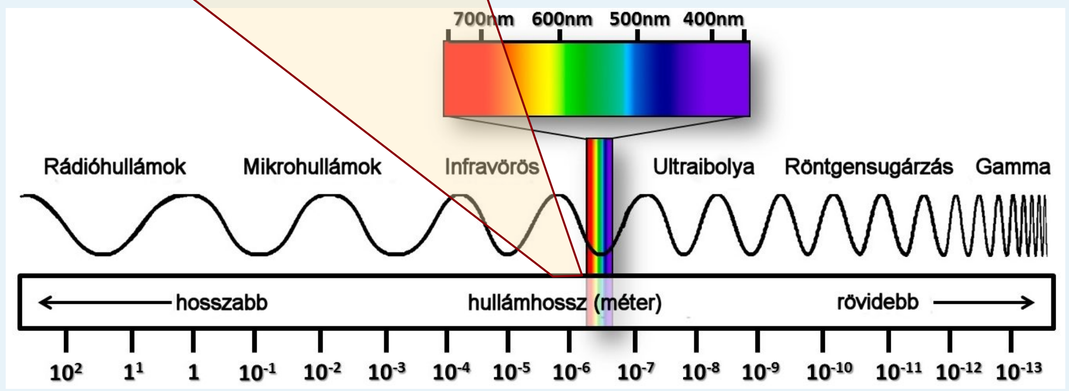
- Colour properties – L* a* b*
- Dry matter content
- Soluble solids
- Total acidity
- Total anthocyanin content

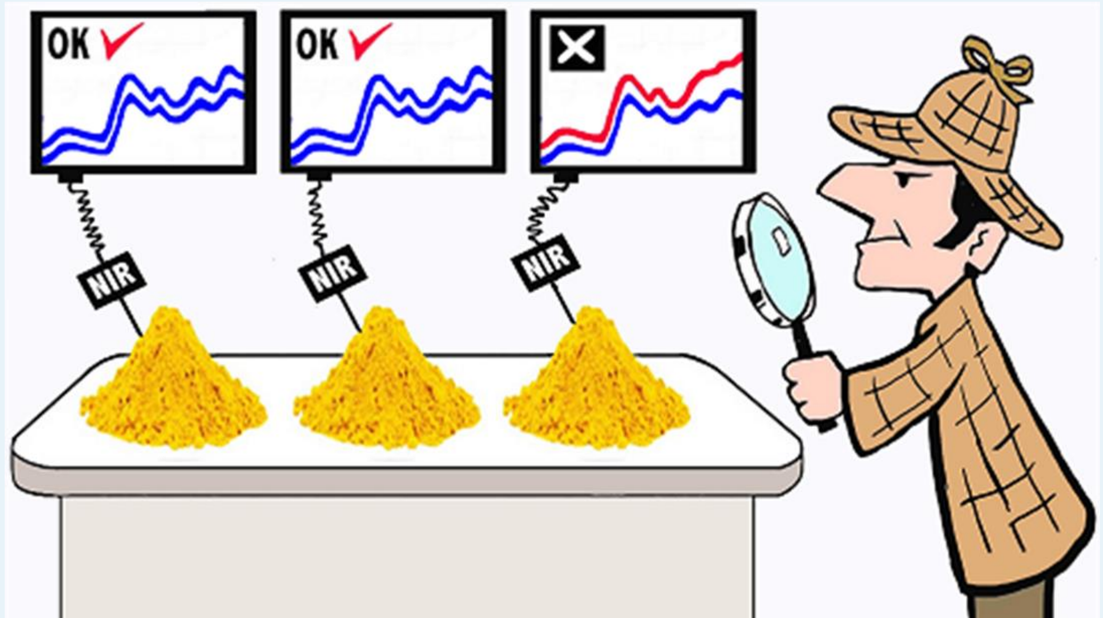
Near infrared spectroscopy

- ✓ 900 – 1700 nm
- ✓ Spetrum recording on the mature and immature sides
- ✓ 3 consecutive scannin

Fingerprint methods I.
Near infrared spectroscopy

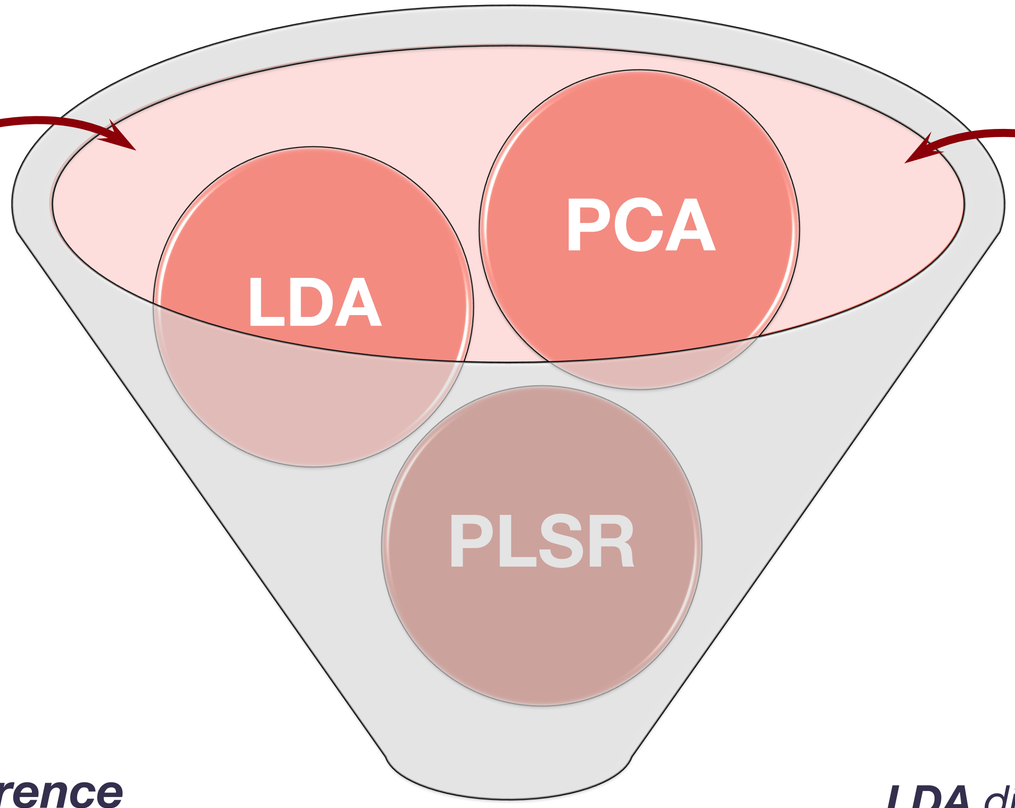






Chemometric analyses

NIR spectra



Spectral pretreatments

- *Savitzy-Golay smoothing*
- *Scatter correction,*
- *Detrending,*
- *1st derivatives*
- *2nd derivatives*

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library("aquap2")
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Pollner and Kovacs (2018)

*Spectral **difference***

***PCA** loadings*

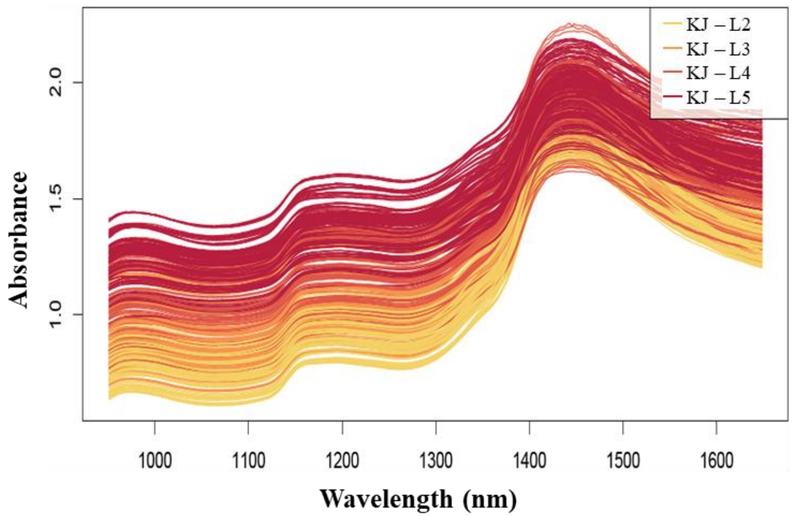
***LDA** discriminating power*

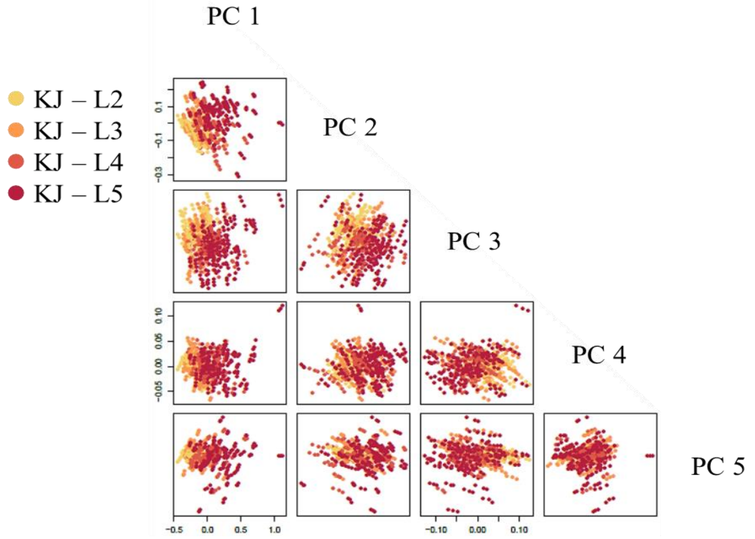
***PLSR** regression vectors*

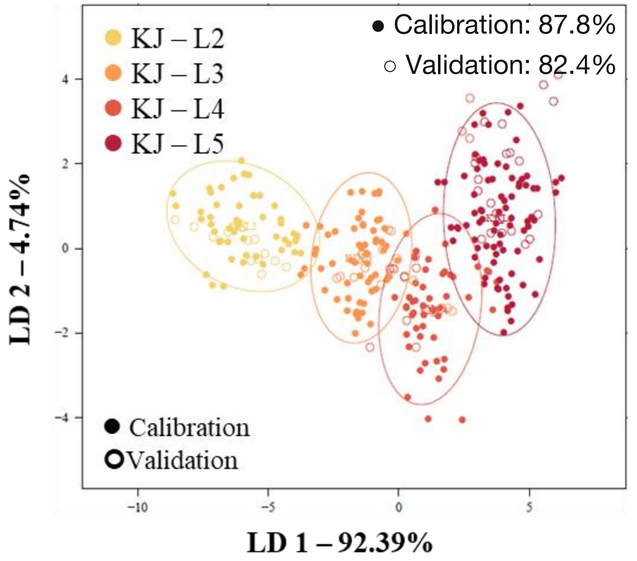
OriginPro® Graphing & Analysis

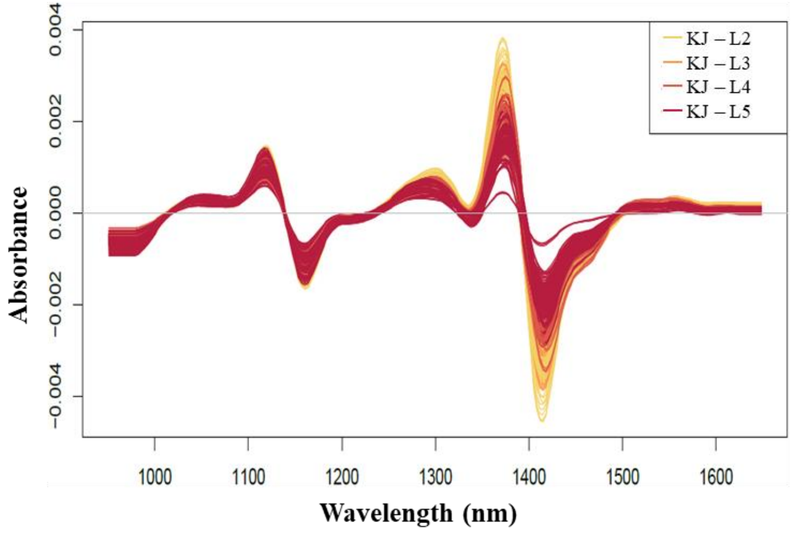
Fingerprint methods I.
Near infrared spectroscopy

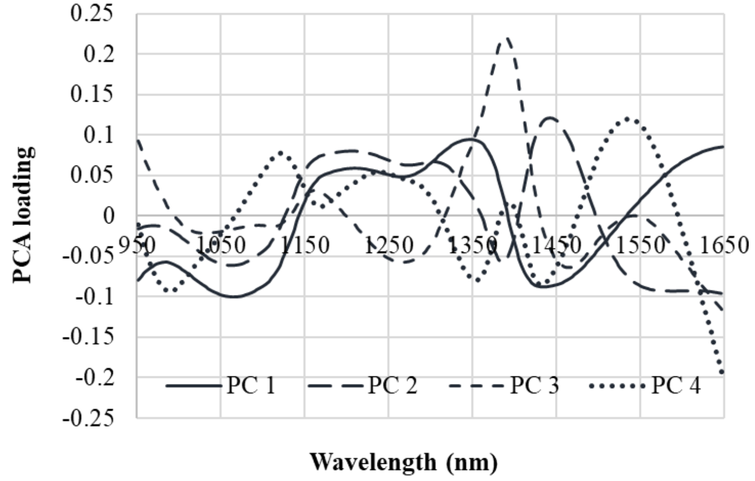
PCA, PCA-LDA

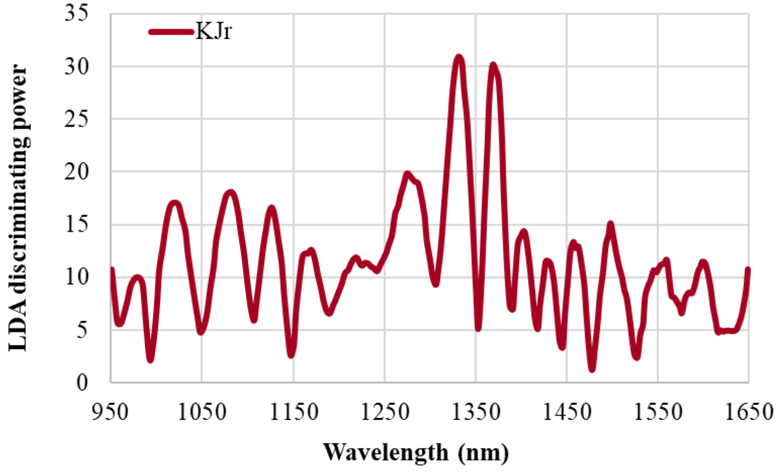






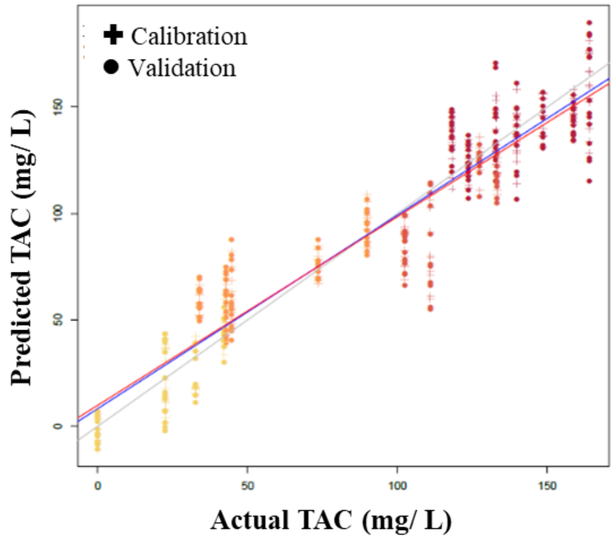






Fingerprint methods I.
Near infrared spectroscopy

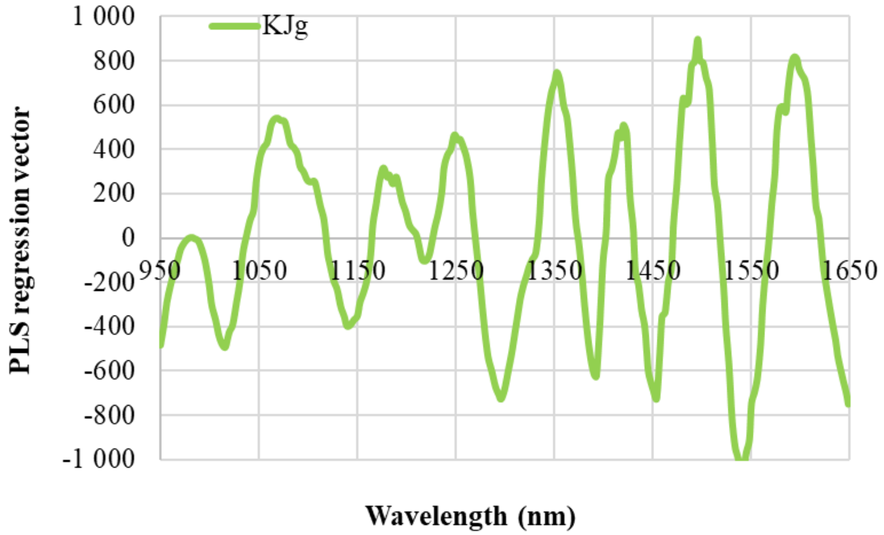
PLSR

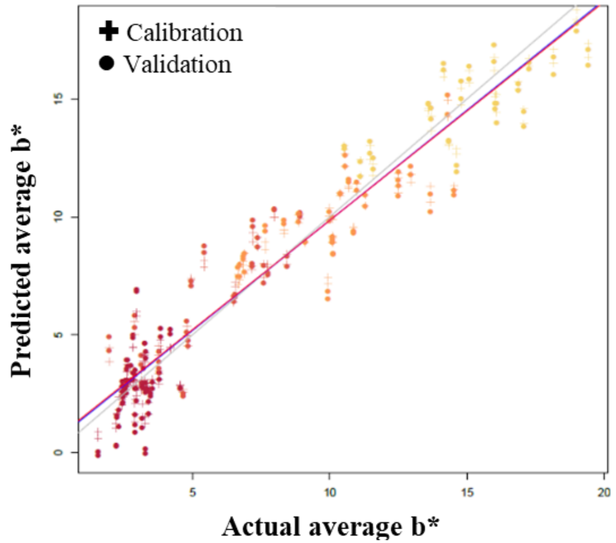


NrLV = 14

Rc^2 = 0.91
RMSEc = 15.14 mg/ L

Rcv^2 = 0.87
RMSEcv = 18.03 mg/ L

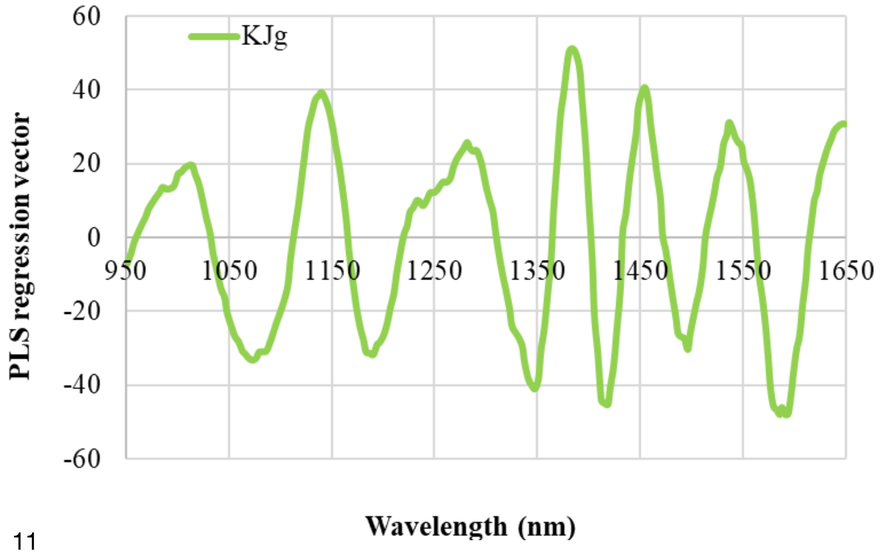




NrLV = 12

Rc^2 = 0.93
RMSEc = 1.26

Rcv^2 = 0.91
RMSEcv = 1.51



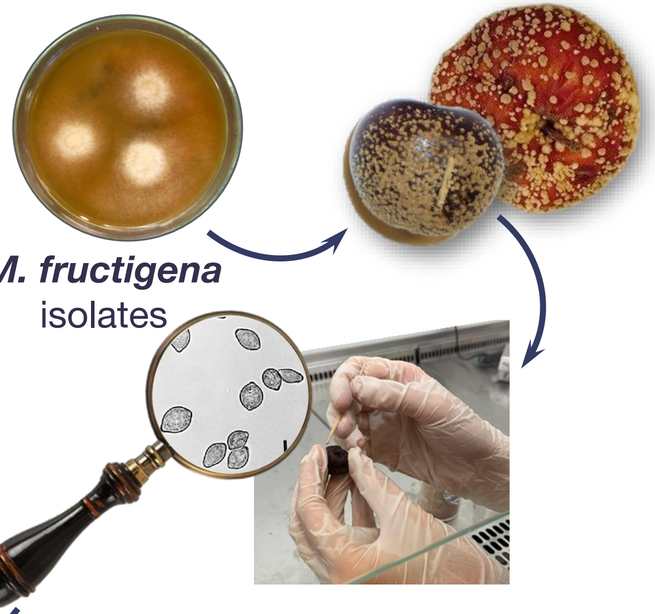
The process of brown rotting

Pomme and stone fruit cultivation and production are under threat.

Enter fruit through damage or by secreting cell wall-degrading enzymes

Monilinia fructicola *Monilinia laxa* ***Monilinia fructigena*** . . .

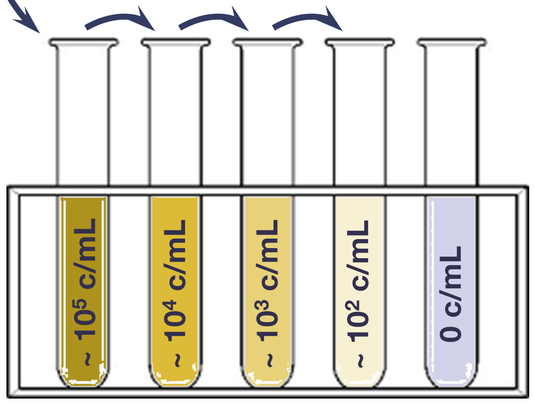
Preparation of brown rot detection studies

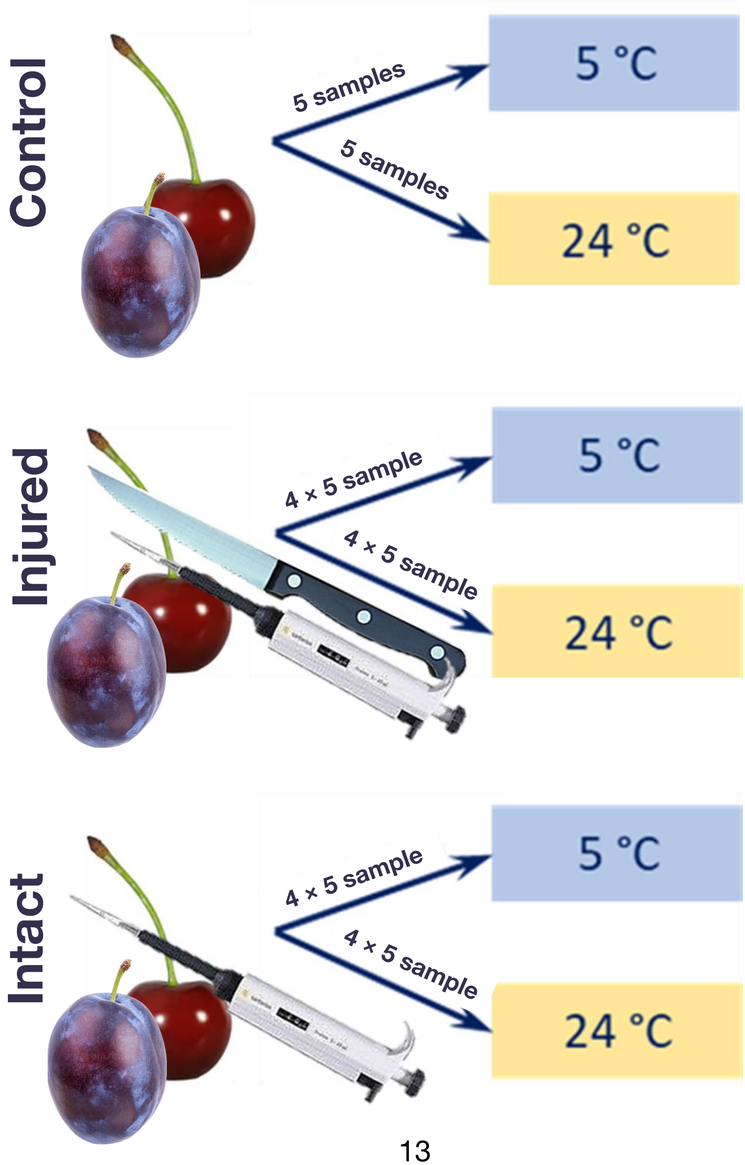


M. fructigena isolates

Collection of fungal conidia

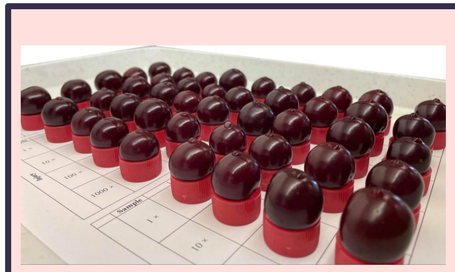
Conidium suspension preparation





Fruit samples

- Pre-selection according to size and soundness
- Surface disinfection with ethanol (70% *V/V*)
- 7 day long controlled storage



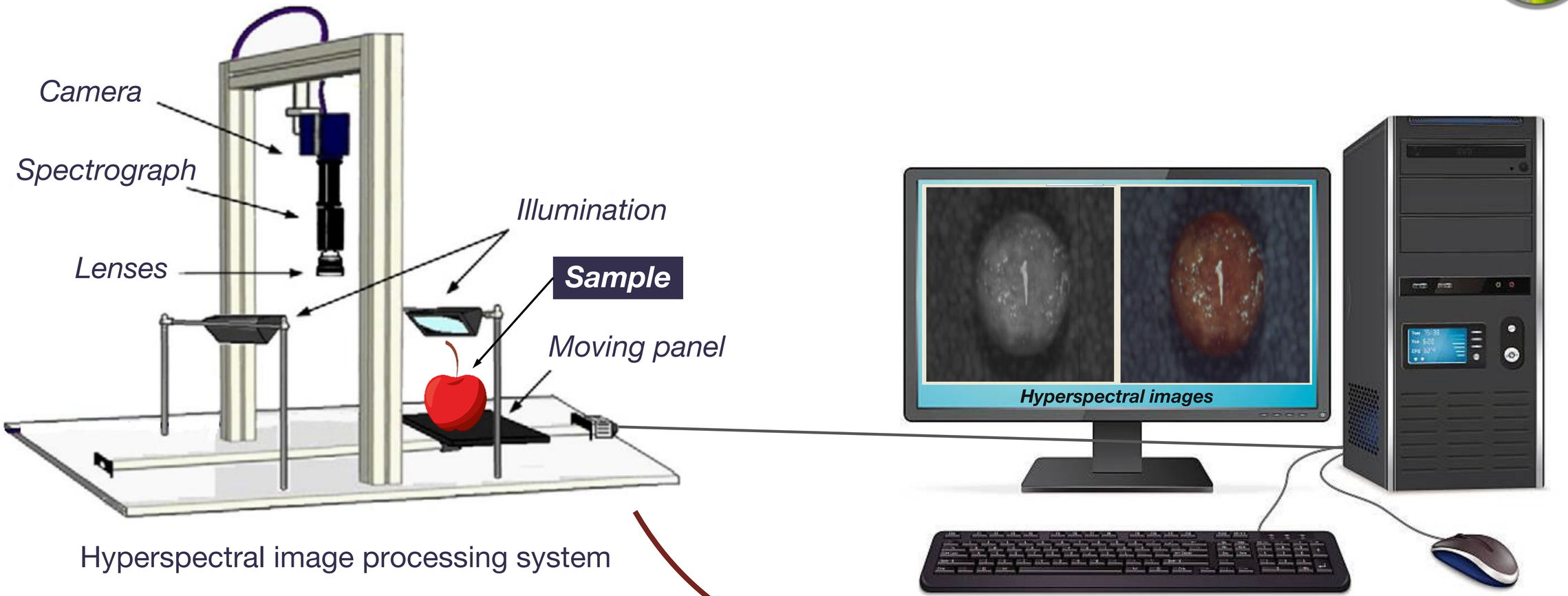
Érdi bőtermő

Újfehértói

Topend

Topend plus

Fingerprint methods II.
Hyperspectral imaging

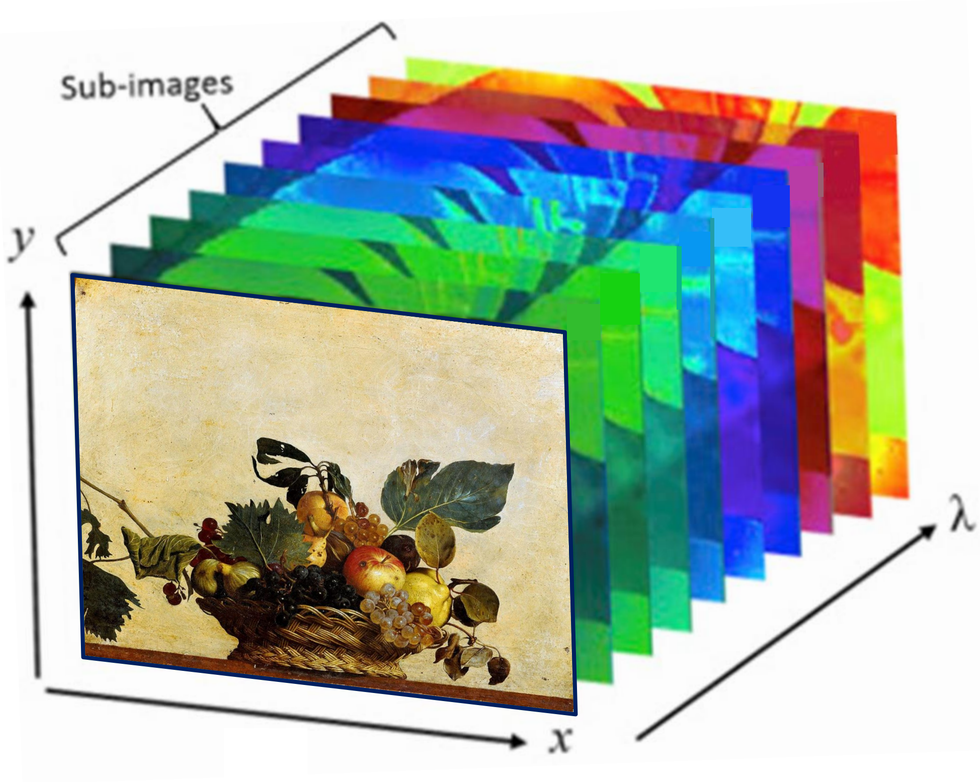


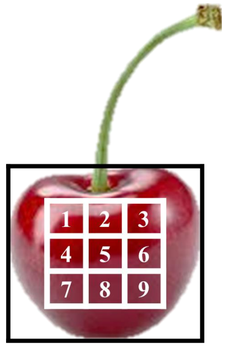
Hyperspectral image processing system

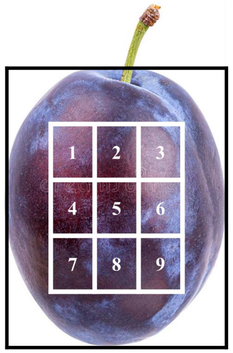
- ✓ Recording spectra pixel by pixel
- ✓ Surface and spectral information
- ✓ Measurement result: “**hypercube**”

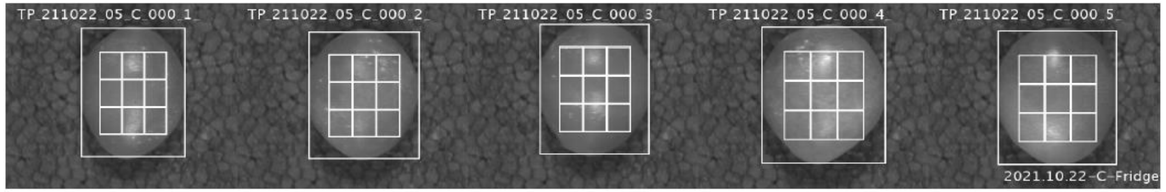
Fingerprint methods II.
Hyperspectral imaging

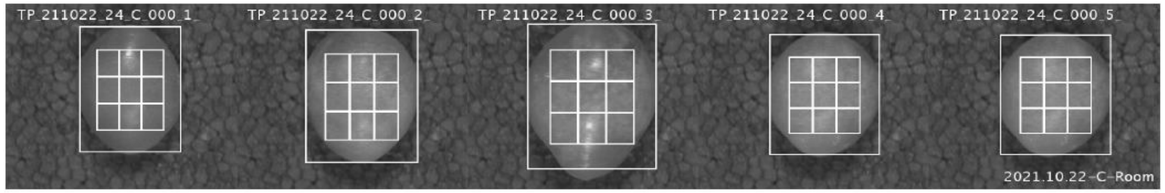
Image segmentation





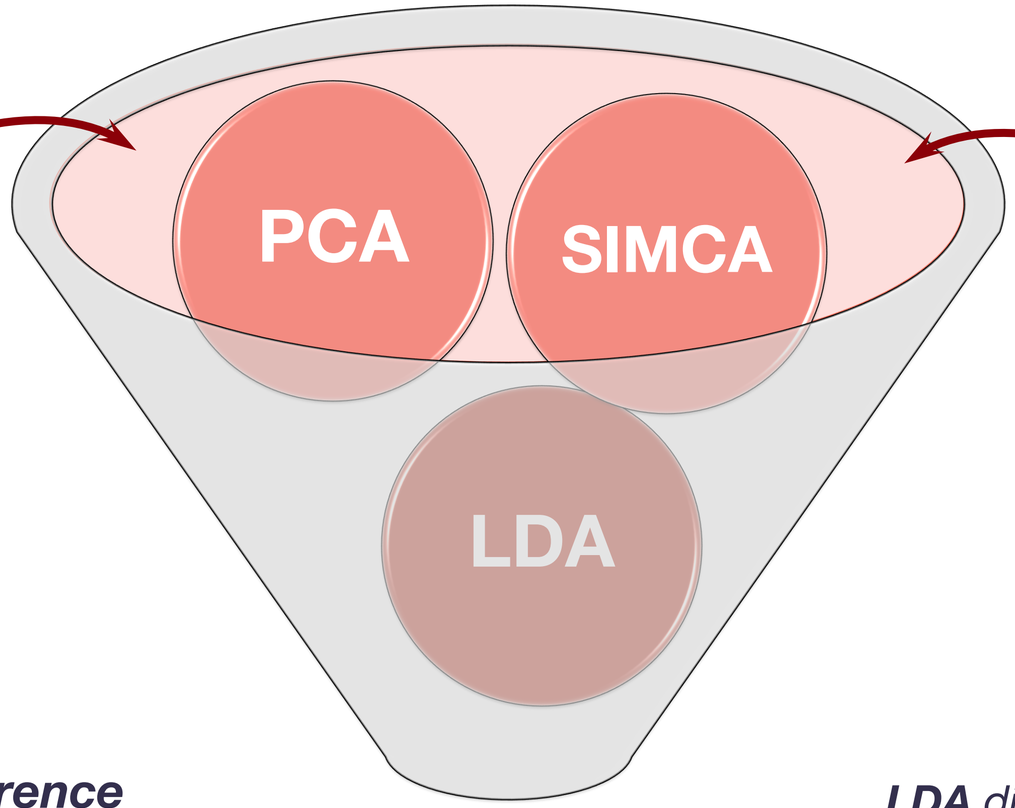






Chemometric analyses

Hyper spectra



Spectral pretreatments

- *Savitzy-Golay smoothing*
- *Scatter correction,*
- *Detrending,*
- *1st derivatives*
- *2nd derivatives*

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library("aquap2")
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Pollner and Kovacs (2018)

*Spectral **difference***

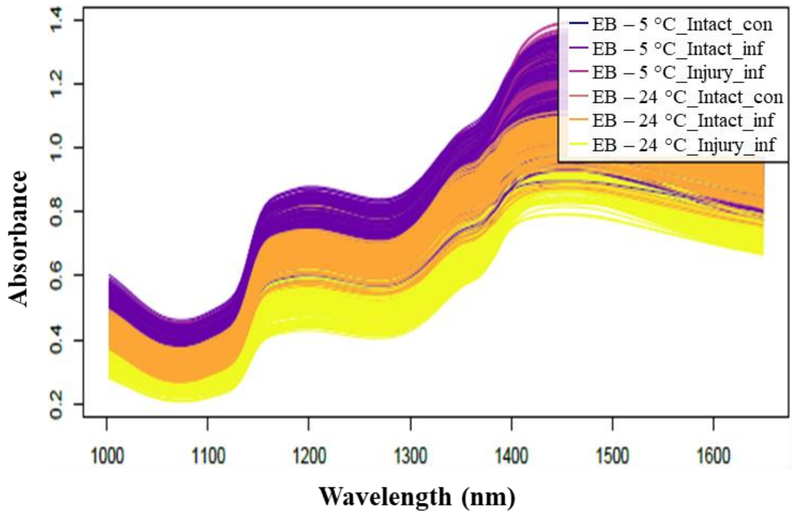
***PCA** loadings*

***LDA** discriminating power*

***SIMCA** discriminating power*

Fingerprint methods II.
Hyperspectral imaging

Raw spectra



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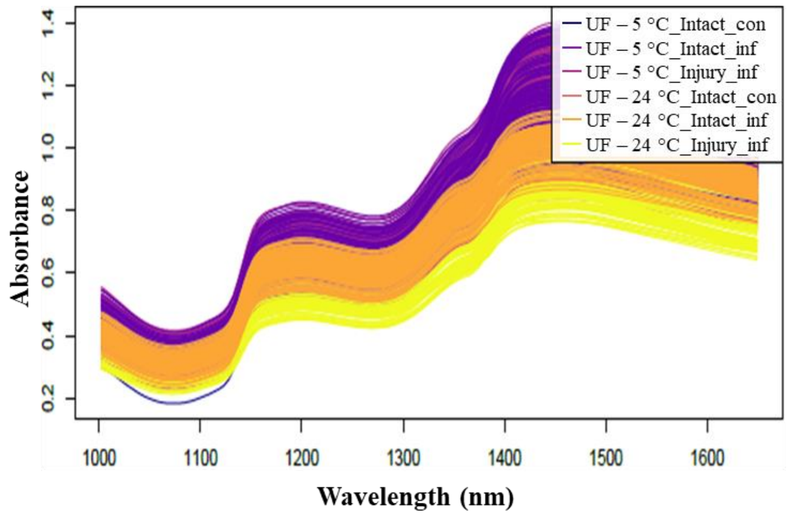

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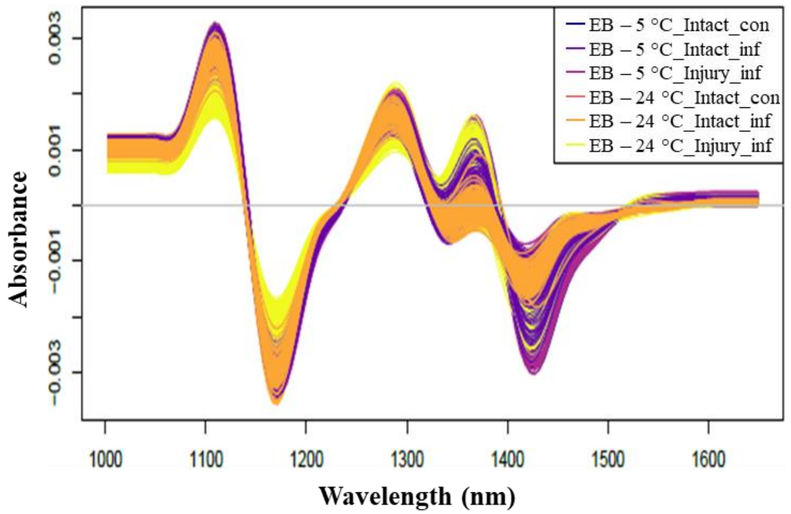

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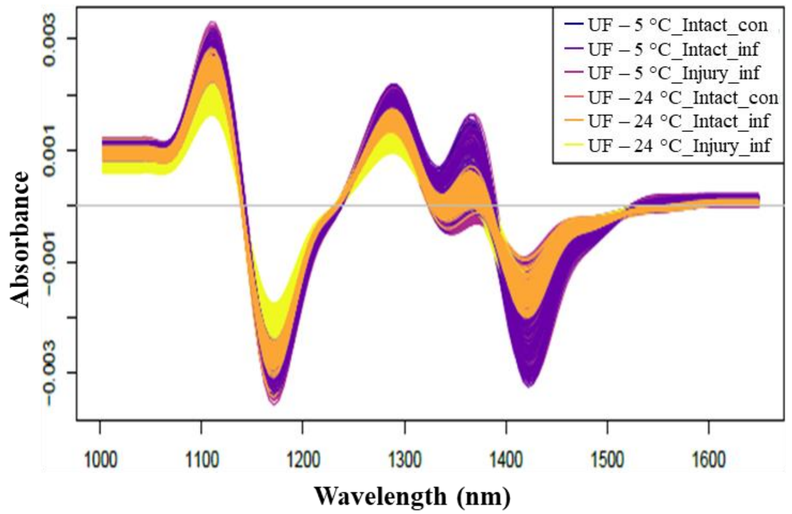
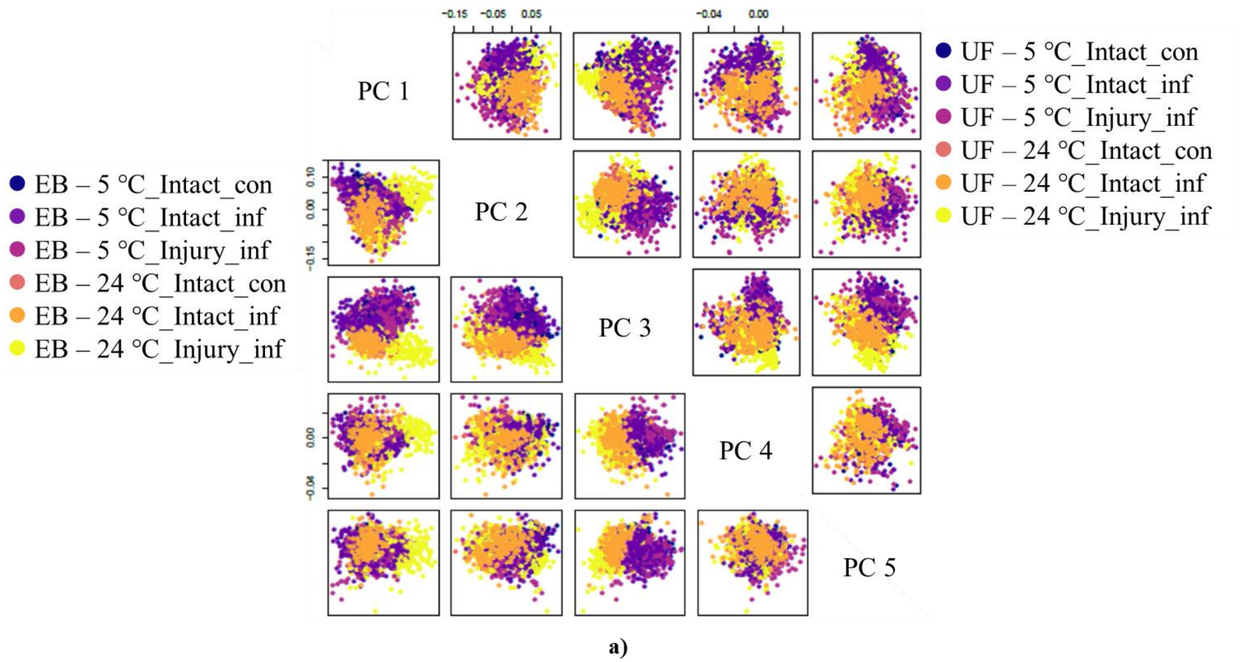


d)

Fingerprint methods II.
Hyperspectral imaging

PCA, SIMCA



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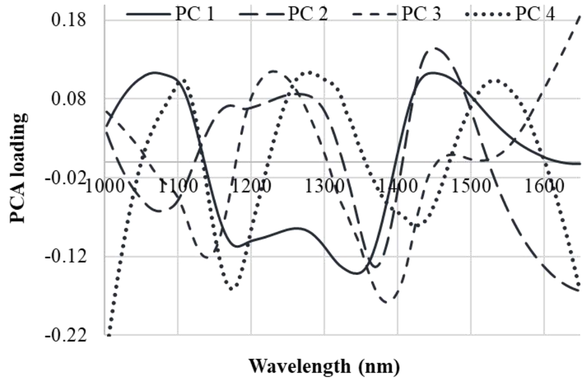

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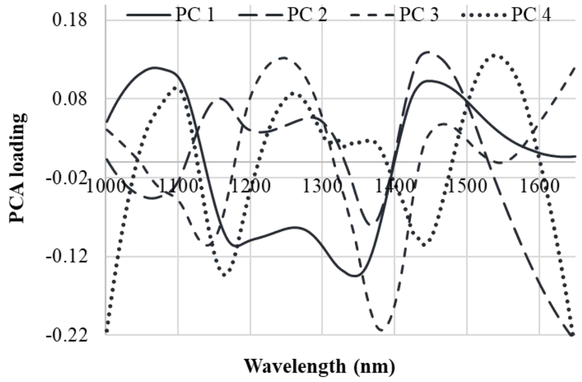

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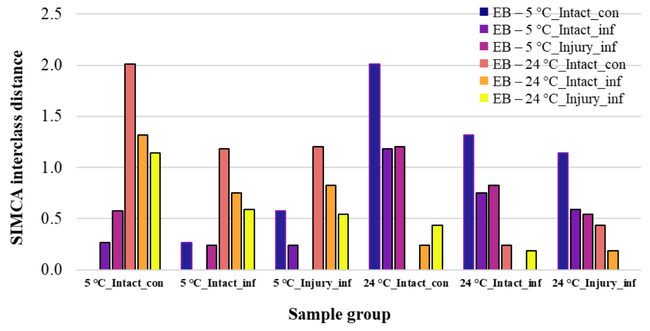

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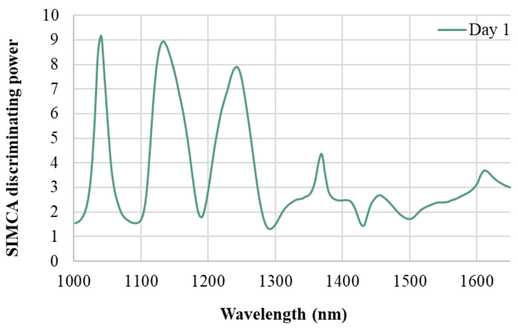

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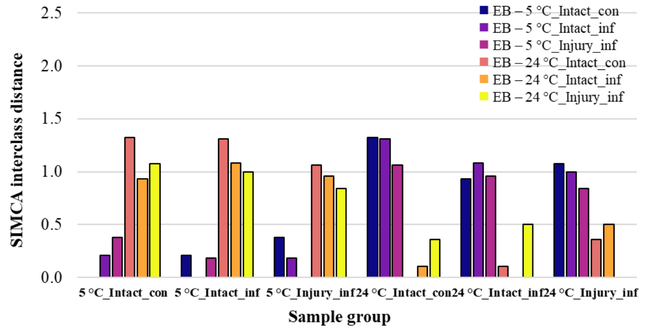

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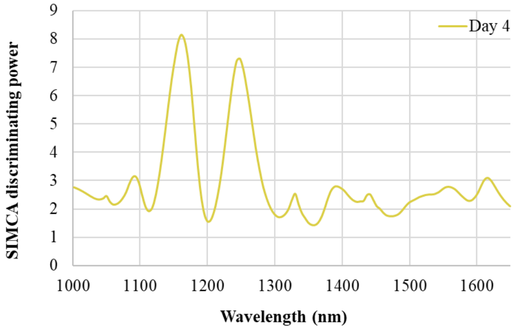

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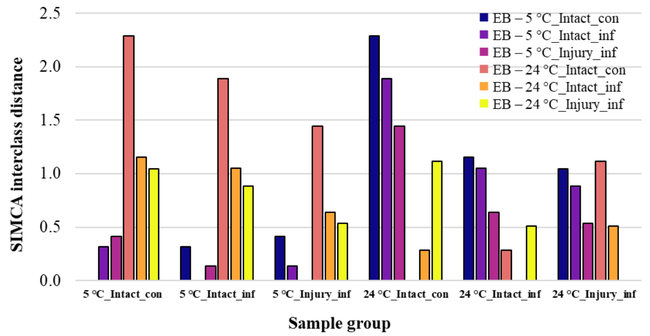

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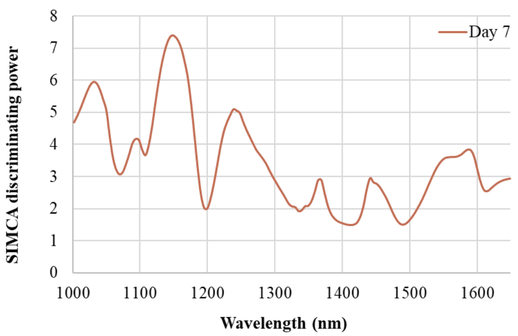
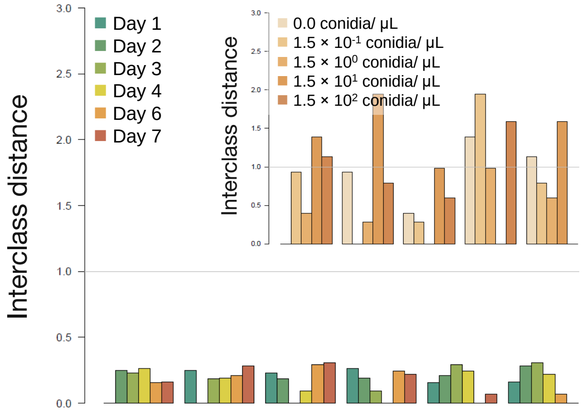


f)

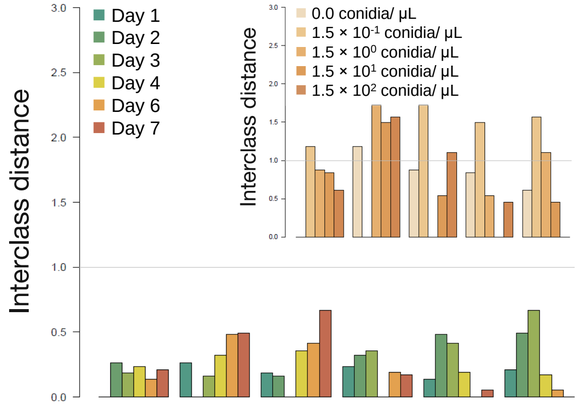
Fingerprint methods II.
Hyperspectral imaging

SIMCA

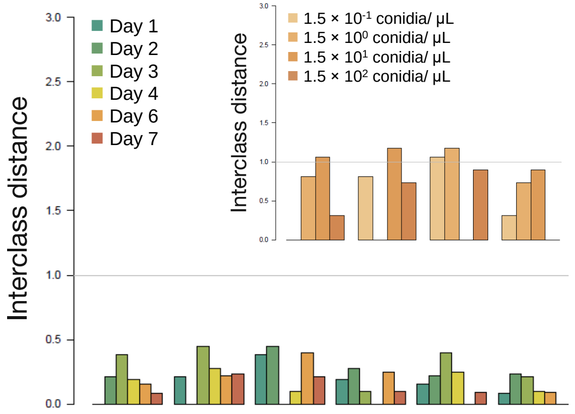
Érdi bőtermő
Intact, 5 °C



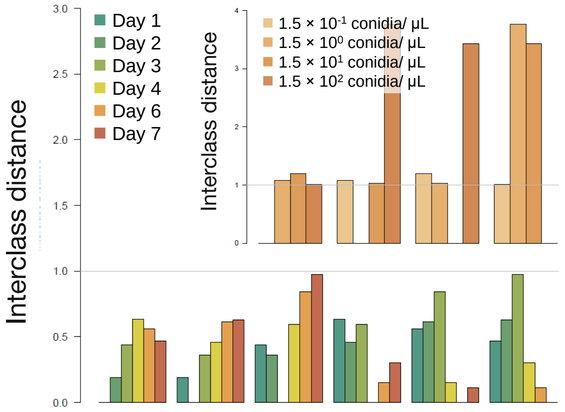
Érdi bőtermő
Intact, 24 °C



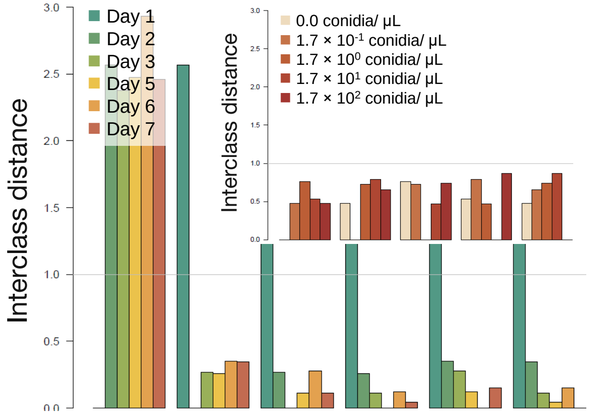
Érdi bőtermő
Injury, 5 °C



Érdi bőtermő
Injury, 24 °C



Újfehértói
Intact, 5 °C



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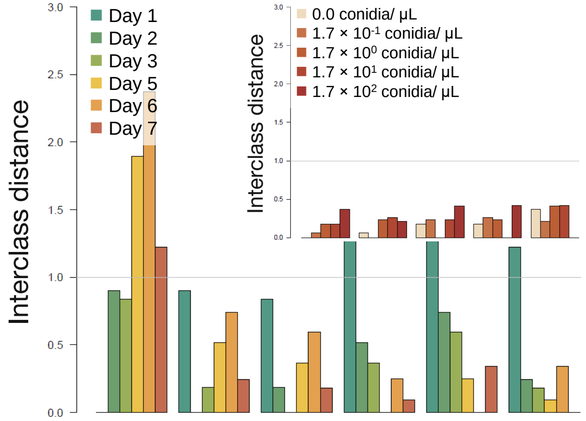
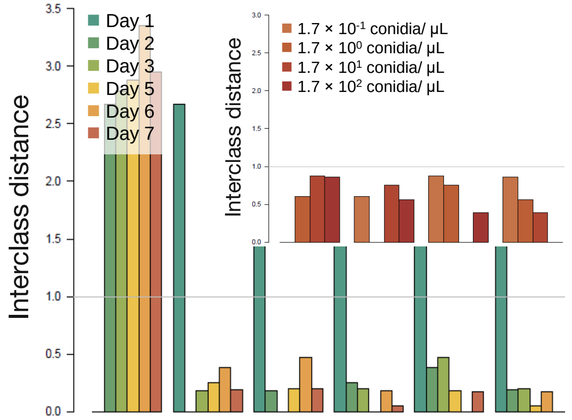
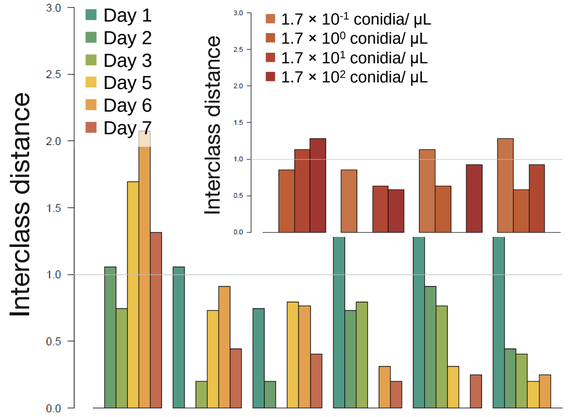
Intact, 24 °C



Újfehértói
Injury, 5 °C



Újfehértói
Injury, 24 °C

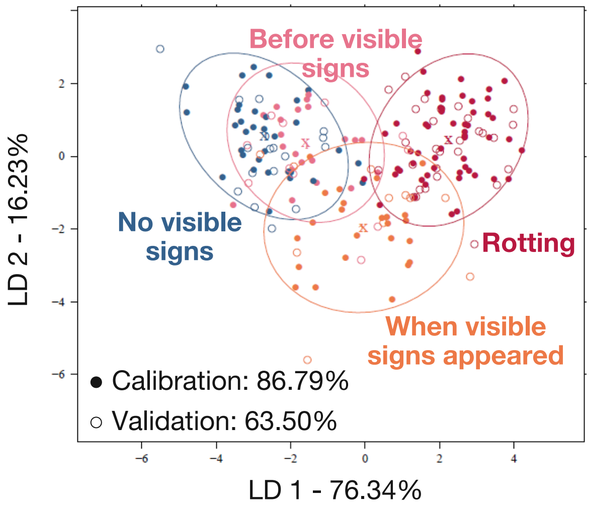


Fingerprint methods II.
Hyperspectral imaging

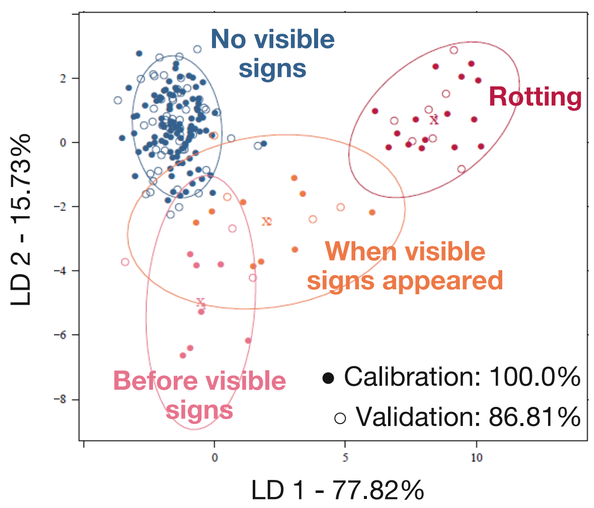
Injury, 24 °C

PCA-LDA

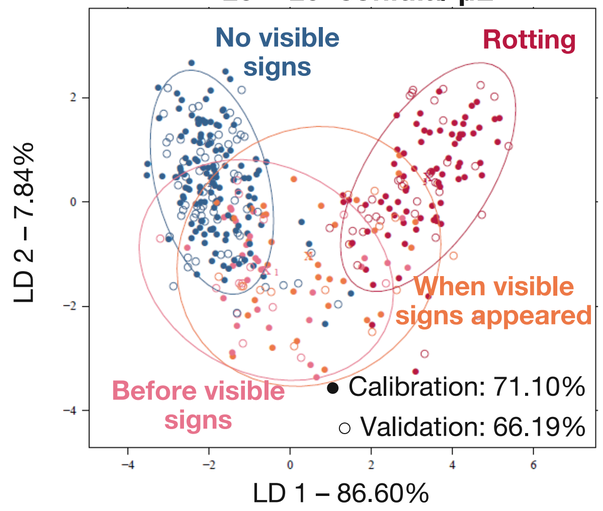
Érdi bőtermő
~ 10^2 conidia/ µL



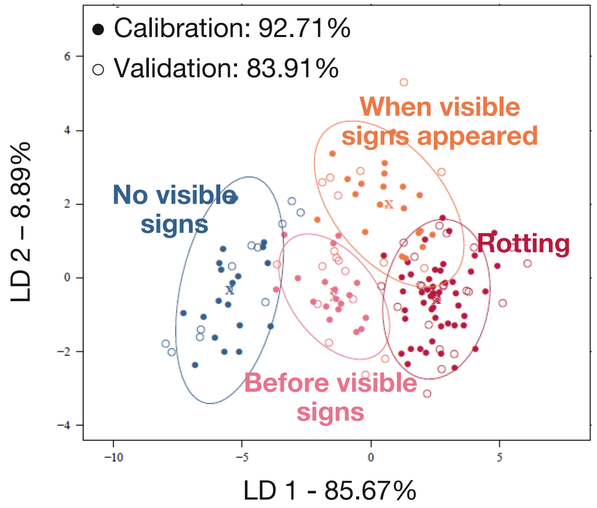
Érdi bőtermő
~ 10 conidia/ µL



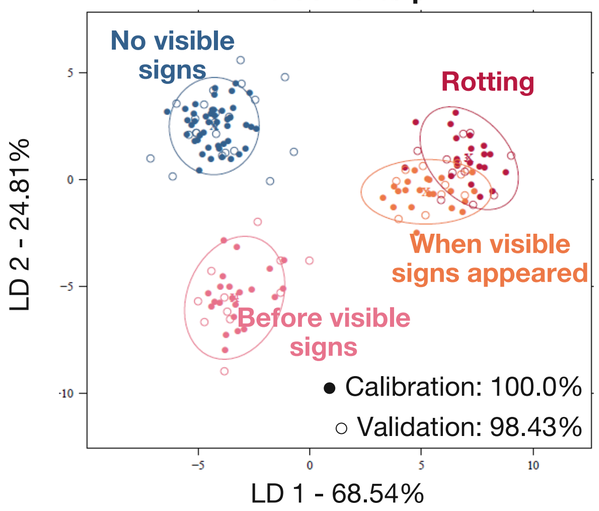
Érdi bőtermő
~ 10 + 10^2 conidia/ µL



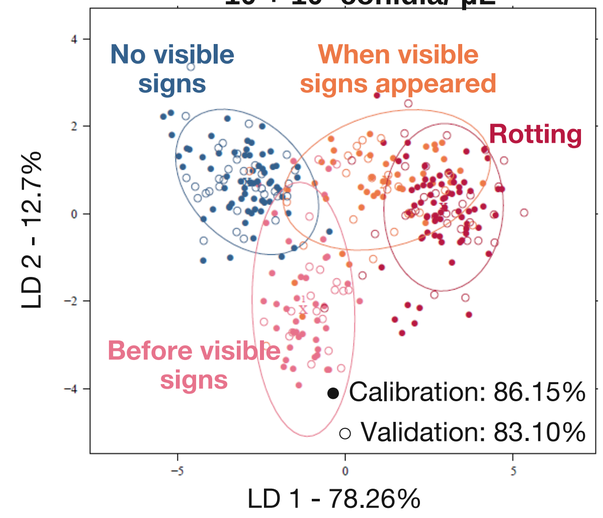
Újfehértói
~ 10^2 conidia/ µL



Újfehértói
~ 10 conidia/ µL



Újfehértói
~ 10 + 10^2 conidia/ µL



Concluding remarks

Thanks to digitalisation and miniaturisation, field and extreme investigations can be carried out.

Building massive databases required to build robust chemometric models!

Optimum harvest ripeness can be determined!

Post harvest losses can be reduced!

Fast and efficient intervention can be implemented!

Our developments are in line with the Digital Agri-Food Strategy!

*

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