NIR applications in the food industry

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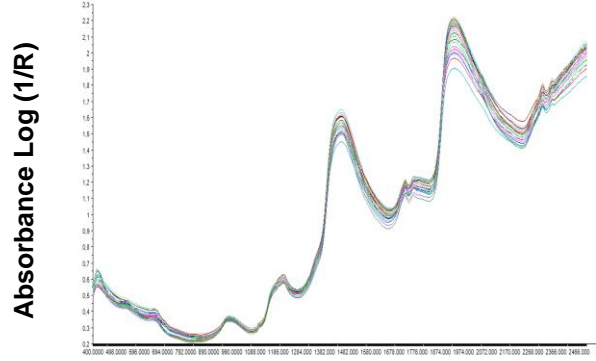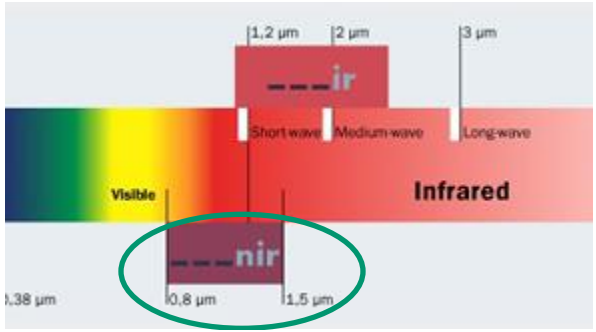*E-mail: o.abbas @cra.wallonie.be*

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NIR spectroscopy: rapid, non destructive and environnemental friendly analysis

Reference methods

Alternative methods

Near infrared spectroscopy

CHEMOMETRICS

Use of NIR spectroscopy at CRA-W

European projects

National projects
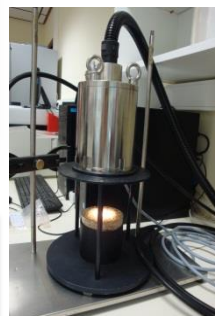
Regional projects

Collaboration with industries

MARSHALL PLAN:

Wallonie

WALNUT-20

CAPPLE

POLYOIL

and

consalim

cra-w

Centre wallon de Recherches agronomiques

Wallonie

Extension of the duration of the life of food through comprehension and control of the mechanisms leading to their adulteration (1 Jan 2009 - 31 Dec 2012)

The studies concerned 3 groups of food:

·   The refrigerated products of vegetal or animal origin, simple or complex.

·   The regional products like fermented beverages (beers and malts).

·   The live products like lactic ferments and yeast

Development and application of rapid non-destructive analytical techniques and applicable during on-line controls.

Results will allow to determine the compositional and physico-chemical modifications in relation with the state of the product

Near infrared techniques used
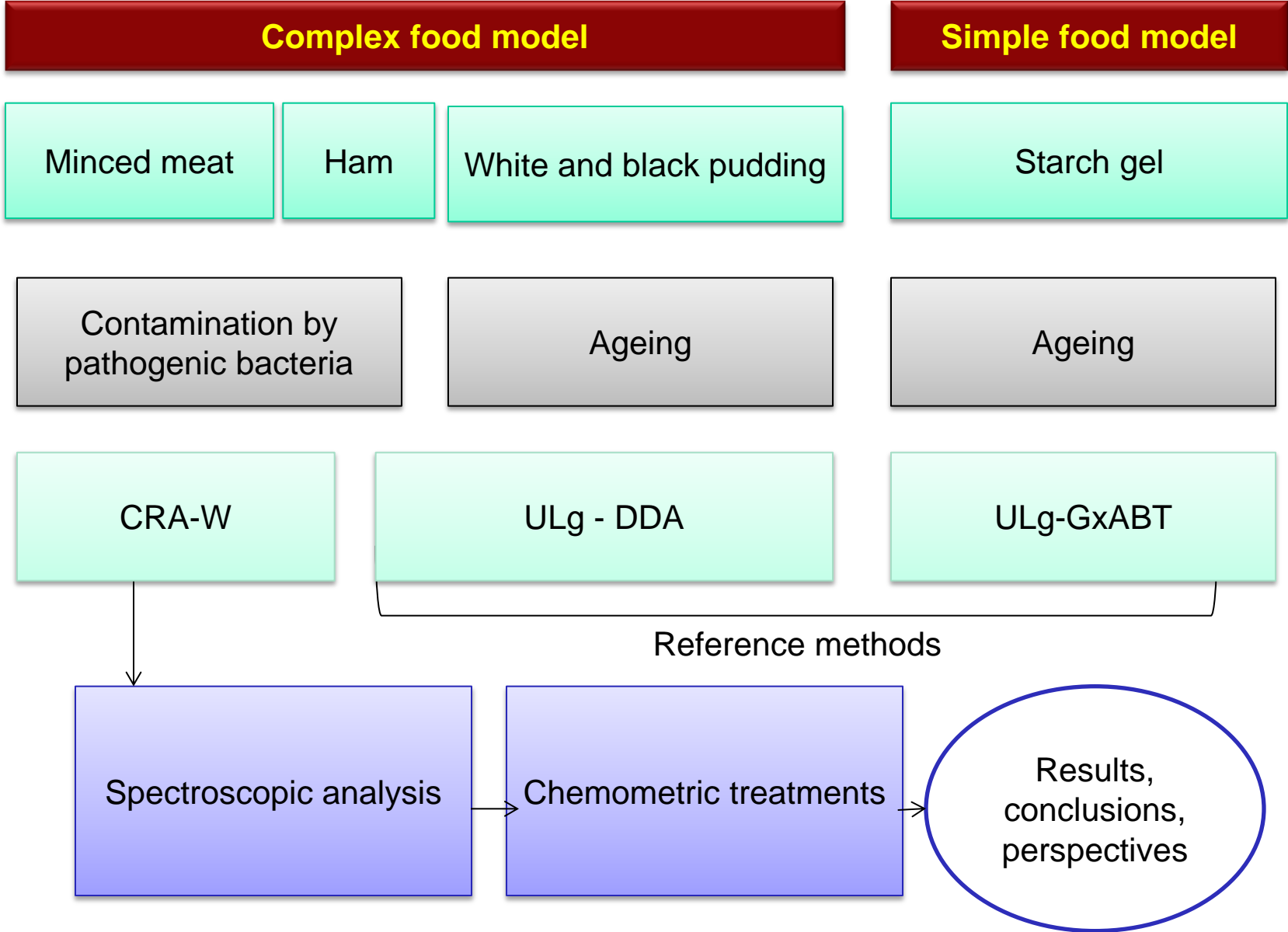
Spectra were collected

NIR spectroscopy

NIR imaging

Transmission mode

Reflexion mode (on-line camera)

Treatment of spectra with chemometric tools

Some applications in the field of CONSALIM project

Complex food model			Simple food model
Minced meat	Ham	White and black pudding	Starch gel
Contamination by pathogenic bacteria		Ageing	Ageing
CRA-W		ULg - DDA	ULg-GxABT

Reference methods

Spectroscopic analysis → Chemometric treatments → Results, conclusions, perspectives

Applications on simple food model

Simple food model

Starch gel

Ageing

ULg-GxABT

Reference methods

Spectroscopic analysis → Chemometric treatments → Results, conclusions, perspectives
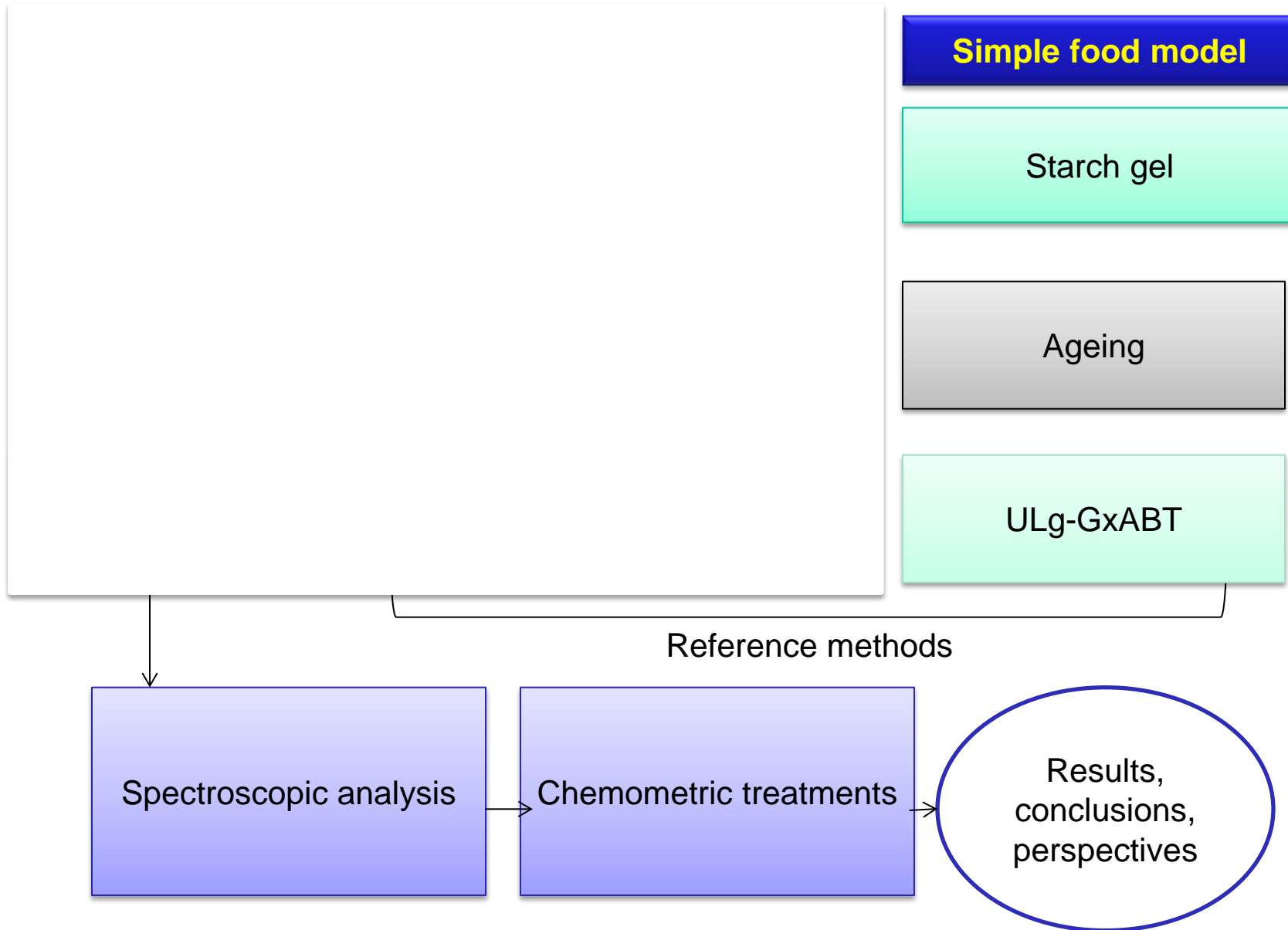
Study freeze / thaw starch gels

Partners: ULg-GxABT + CRAW

Objective:

1. Comparison of different freezing processes :

T= -196°C
T= -50°C
T=-20°C

2. Comparison of different thawing processes:

T= 4°C
T= 20°C

Comparison of different freezing processes

Data: NIR imaging spectra
Pretreatment: smoothing, SNV, detrend

PLS-DA: wheat starch gel

T thawing	(°C)	20°C	
(-)196°C	0.995	0.005	0
(-)50°C	0.025	0.82	0.155
(-)20°C	0.005	0.15	0.84
classification rate	0.8867		

(T freezing (°C) on vertical axis)

PLS-DA: potato starch gel

T thawing	(°C)	20°C	
(-)196°C	1	0	0
(-)50°C	0.015	0.87	0.115
(-)20°C	0	0.08	0.92
classification rate	0.93		

Possibility to differentiate gels according to their mode of freezing

Comparison of different thawing processes

PLS-DA: wheat starch gel

T Congélation (°C)	-196		
T Décongélation (°C)	20 puis 4		
24 h	0.905	0.09	0.005
1 sem	0.1	0.86	0.04
3 sem	0.015	0.04	0.945
Taux de classification		0.9033	

T Congélation (°C)	-196		
T Décongélation (°C)	4		
24 h	0.875	0.12	0.005
1 sem	0.155	0.835	0.01
3 sem	0.02	0.01	0.96
Taux de classification		0.89	

T Congélation (°C)	-50		
T Décongélation (°C)	20 puis 4		
24 h	0.89	0.015	0.095
1 sem	0.045	0.885	0.07
3 sem	0.065	0.05	0.885
Taux de classification		0.8867	

T Congélation (°C)	-50		
T Décongélation (°C)	4		
24 h	0.83	0.075	0.095
1 sem	0.12	0.855	0.025
3 sem	0.1	0.06	0.84
Taux de classification		0.8417	

T Congélation (°C)	-20		
T Décongélation (°C)	20 puis 4		
24 h	0.88	0	0.12
1 sem	0	1	0
3 sem	0.075	0	0.925
Taux de classification		0.935	

T Congélation (°C)	-20		
T Décongélation (°C)	4		
24 h	0.84	0	0.16
1 sem	0	1	0
3 sem	0.13	0	0.87
Taux de classification		0.9033	

**Possibility to classify wheat starch gels as a function of ageing time irrespective of the thawing process**

Applications on complex food model

Complex food model

| Minced meat | Ham | White and black pudding |

| Contamination by pathogenic bacteria | Ageing |

| CRA-W | ULg - DDA |

Reference methods

Spectroscopic analysis → Chemometric treatments → Results, conclusions, perspectives
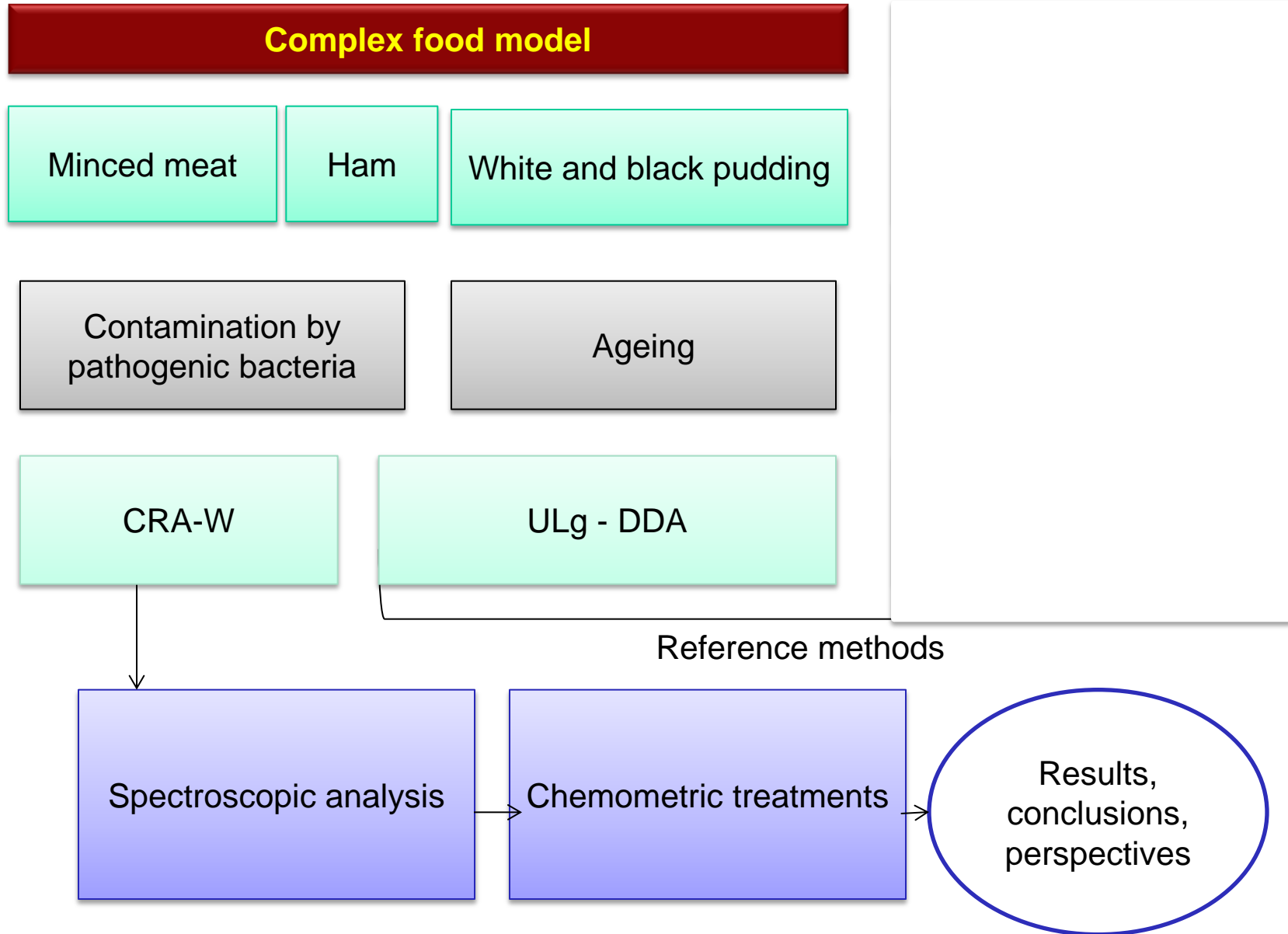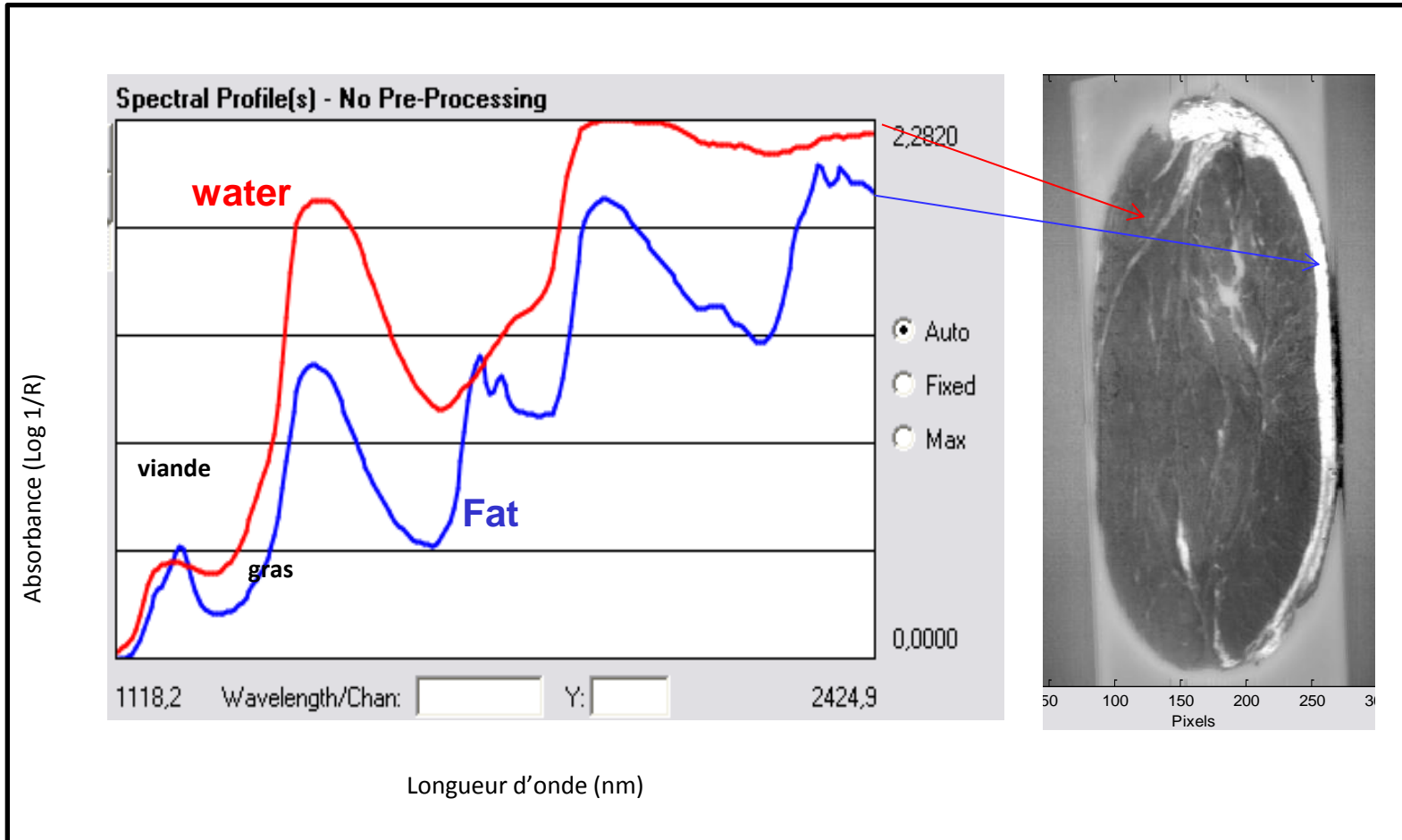
Application on minced meat

Potential of NIR spectroscopy for monitoring the evolution of minced meat during its conservation
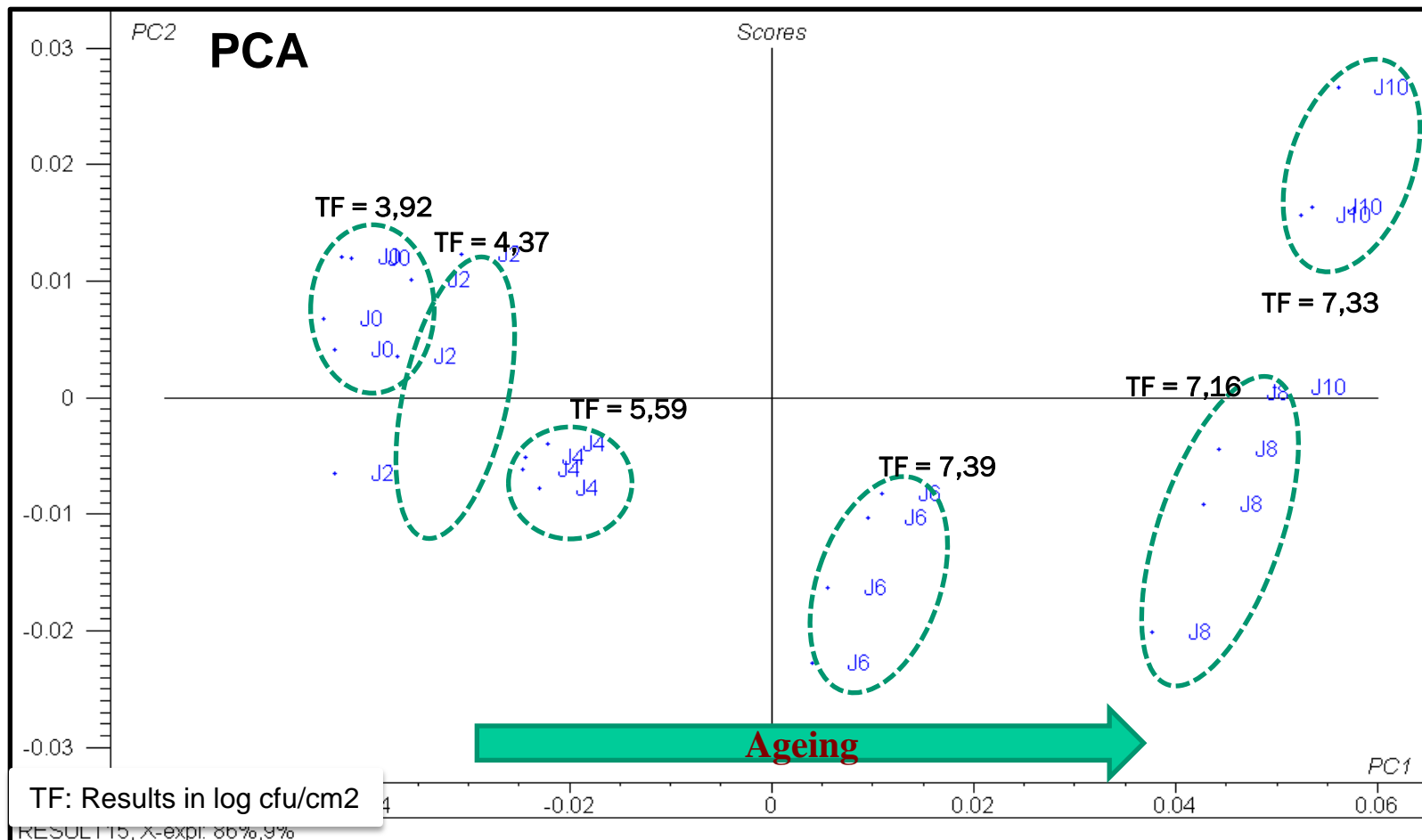
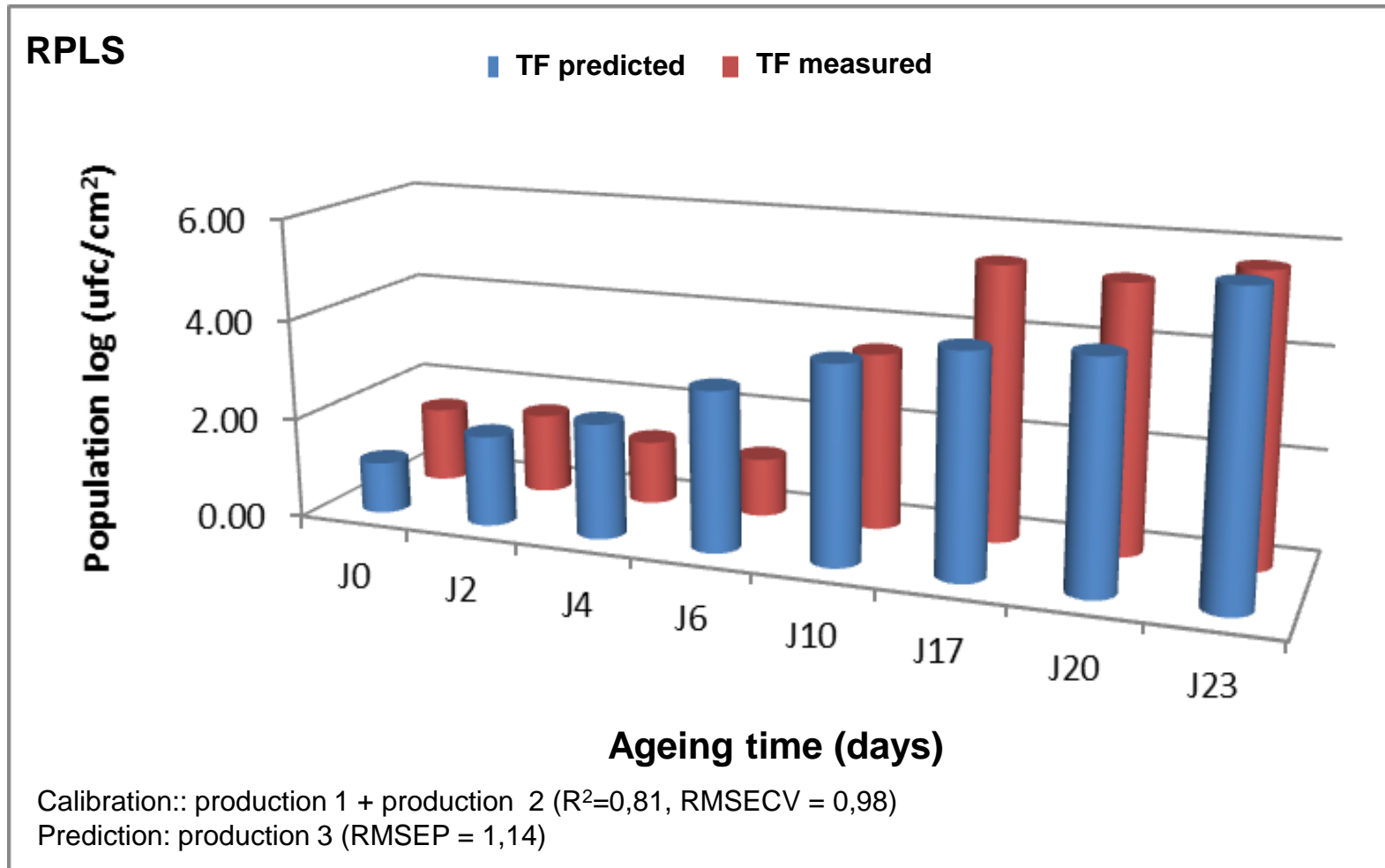**Differentiation of minced meat samples in function of ageing time**

Application on Ham

NIR imaging can provide spectral and spatial information at the same time.

Application on white pudding

Potentiel of NIR spectroscopy for following of white pudding during its storage

RPLS

TF predicted   TF measured

Population log (ufc/cm²)

6.00
4.00
2.00
0.00

J0   J2   J4   J6   J10   J17   J20   J23

Ageing time (days)

Calibration:: production 1 + production 2 (R^2=0,81, RMSECV = 0,98)
Prediction: production 3 (RMSEP = 1,14)

Prediction of the total flora white pudding samples based on their near-infrared spectra

Application on black pudding

Potentiel of NIR spectroscopy for following of black pudding during its storage
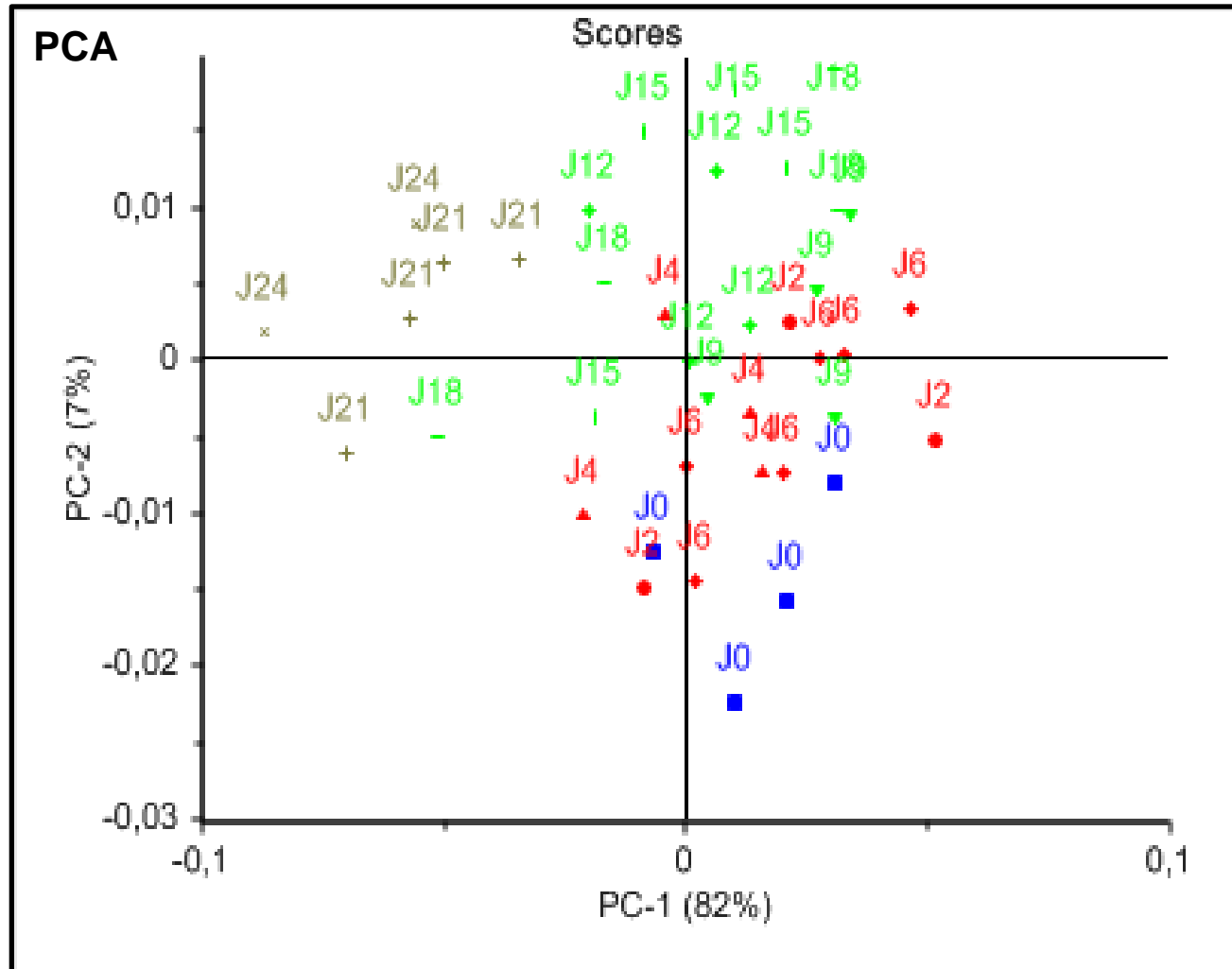
Differentiation of black pudding samples in function of ageing time

Quarter Cup

Equation performances

Constituent	Type	N	Mean	SD	Est. Min	Est. Max	SEC	RSQ	SECV	1-VR
HUM	1	468	59.2152	9.8170	29.7642	88.6662	1.4692	0.9776	1.5922	0.9736
MG	1	430	15.5274	11.5288	0.0000	50.1136	1.7526	0.9769	1.9353	0.9718
MPT	1	459	19.3984	6.0317	1.3034	37.4934	1.0963	0.9670	1.1661	0.9625
HUMMPT	1	441	3.2383	1.1108	0.0000	6.5706	0.3063	0.9240	0.3376	0.9074
COL	1	156	1.7520	0.9591	0.0000	4.6292	0.4323	0.7968	0.6154	0.5856
CT	1	202	4.3008	2.5123	0.0000	11.8376	0.2996	0.9858	0.3995	0.9746

NIR spectroscopy is already implemented in some control laboratories in Belgium

Conclusion

Alternative methods

Near infrared spectroscopy

Absorbance Log (1/R)

Wavelength (nm)

+
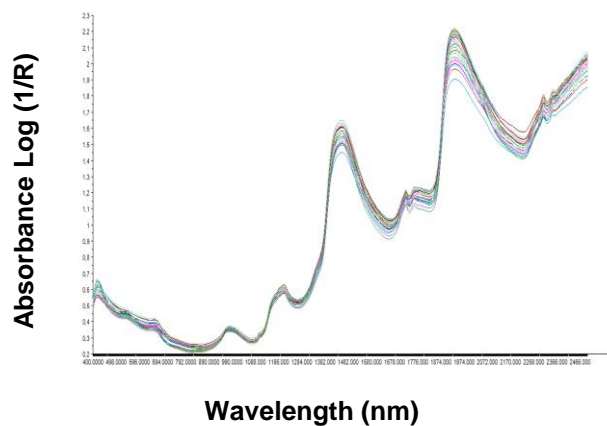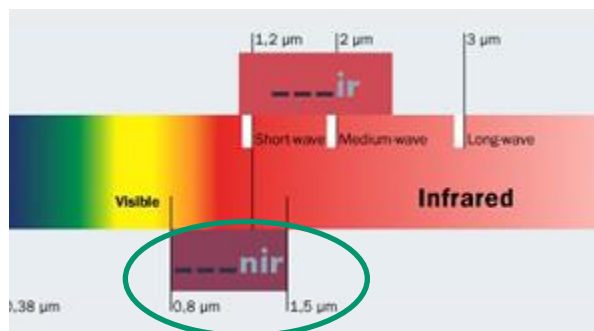
CHEMOMETRICS

NIR SPECTROSCOPY COMBINED TO CHEMOMETRICS:

A GOOD ALTERNATIVE TO CLASSICAL ANALYTICAL METHODS FOR FOOD ANALYSIS