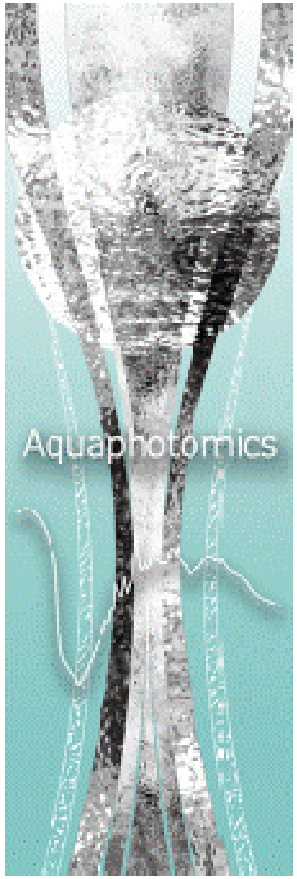

Aquaphotomics new approach for studying food quality

Tiziana M.P. Cattaneo

Marina Buccheri, Maurizio Grassi
CREA-IAA, Milan, Italy

Yuanyuan Pu
UCD, Dublin, Ireland

Stefania Barzaghi
CREA-FLC, Lodi, Italy

Aquaphotomics: Understanding Water in Biology – 2nd Int. Symposium – Kobe, Japan

OUTLINE

- ✓ Introducing myself
- ✓ Assumption
- ✓ Aim
- ✓ Applications in food science
  - o Fruits
  - o Fish
  - o Cheese
- ✓ Conclusions
- ✓ Acknowledgements

The Council for Agricultural Research and Economics (CREA)

The reorganization of 2015 creates 12 research centers with a wide distribution throughout the country to meet the needs of the territories, but at the same time with a more compact structure that facilitates the coordination of research and makes it more effective and efficient management.

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Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria


Agricoltura e Ambiente


Alimenti e nutrizione


Cerealicoltura e Colture Industriali


Colture Arboree


Difesa e Certificazione


Foreste e Produzioni del Legno


Genomica e Bioinformatica


Ingegneria e Trasformazioni Agroalimentari


Orticoltura e Florovivaismo


Politiche e bioeconomia


Viticoltura ed Enologia


Zootecnia e Acquacoltura

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Sede

Laboratorio

12 Centri di Ricerca
28 sedi e 10 laboratori

GB	Genomica e Bioinformatica
AA	Agricoltura e Ambiente
DC	Difesa e Certificazione
IT	Ingegneria e Trasformazioni agroalimentari
AN	Alimenti e Nutrizione
PB	Politiche e Bioeconomia
ZA	Zootecnia e Acquacoltura
FL	Foreste e produzioni Legnose
CI	Cerealicoltura e colture Industriali
VE	Viticoltura ed Enologia
OF	Orticoltura e Florovivaismo
CA	Colture Arboree

Unità di ricerca per i processi dell'Industria AgroAlimentare
Research Unit for Food Technology (CREA-IAA)

The study of the global quality of the agri-food products through the expression of several quality indexes: technological, biochemical, nutritional and sensory attributes.

STAFF

Permanent

2 Research Managers

1 Senior Scientist

9 Scientists

6 Technicians

4 Administrative Staff

Temporary

International guests (scientists)

International grants

PhD Students

Technicians

Graduating Students

Appointed on the projects

PHYSICAL LABS: Dinamometers Instron, reflectance colorimeters, differential calorimeters (DSC), viscometers, osmometers, Aw-meter, NIRS, MSI

ASSUMPTION

Information on the absorbance bands can provide a distinctive knowledge of water vibrations and intrinsic interactions between water and other components of the aqueous (BIOLOGICAL) systems

FOOD ?????

WHAT HAPPENS IN FOOD?

Active systems: soluble compounds, dynamic balance among constituents, fermentation processes, enzymatic processes, hydrolytic processes, water distribution and hydratation rearrangements

FOOD are BIOLOGICAL SISTEMS!!!

AIM

To check and demonstrate the suitability of Aquaphotomics approach applied to food sector for the evaluation of:

- **Fruits ripening trend and maturation stage**
- **Fish freshness, identifying fresh and thawed fish (frauds detection)**
- **Water distribution in non-homogeneous cheese: centripetal maturation**

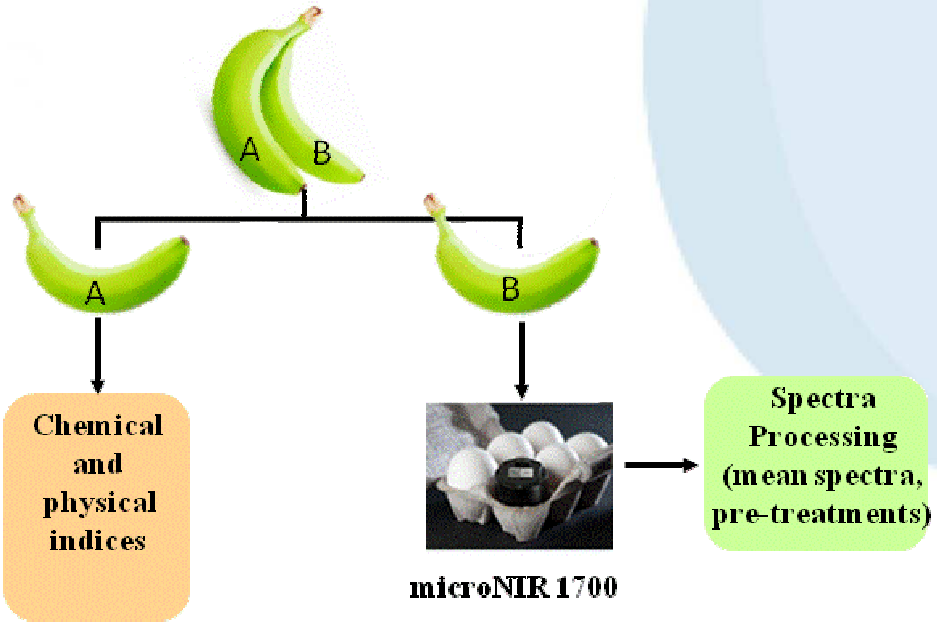
FRUITS

RIPENING TIME: DAYS

WHOLE FRUIT

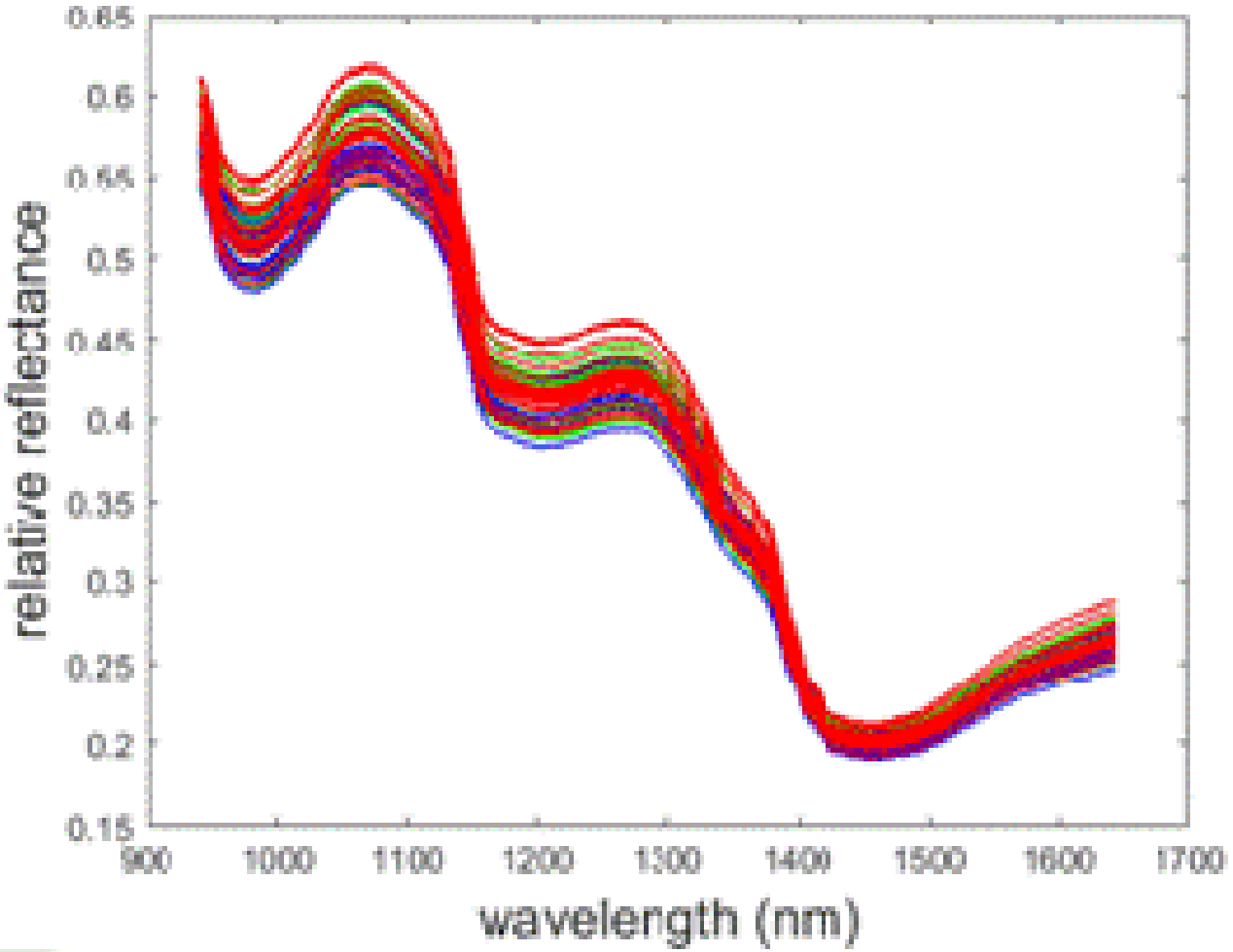
PEELED FRUIT

- Smaller size
- Sweet and creamy
- Heath benefits



AQUAGRAM

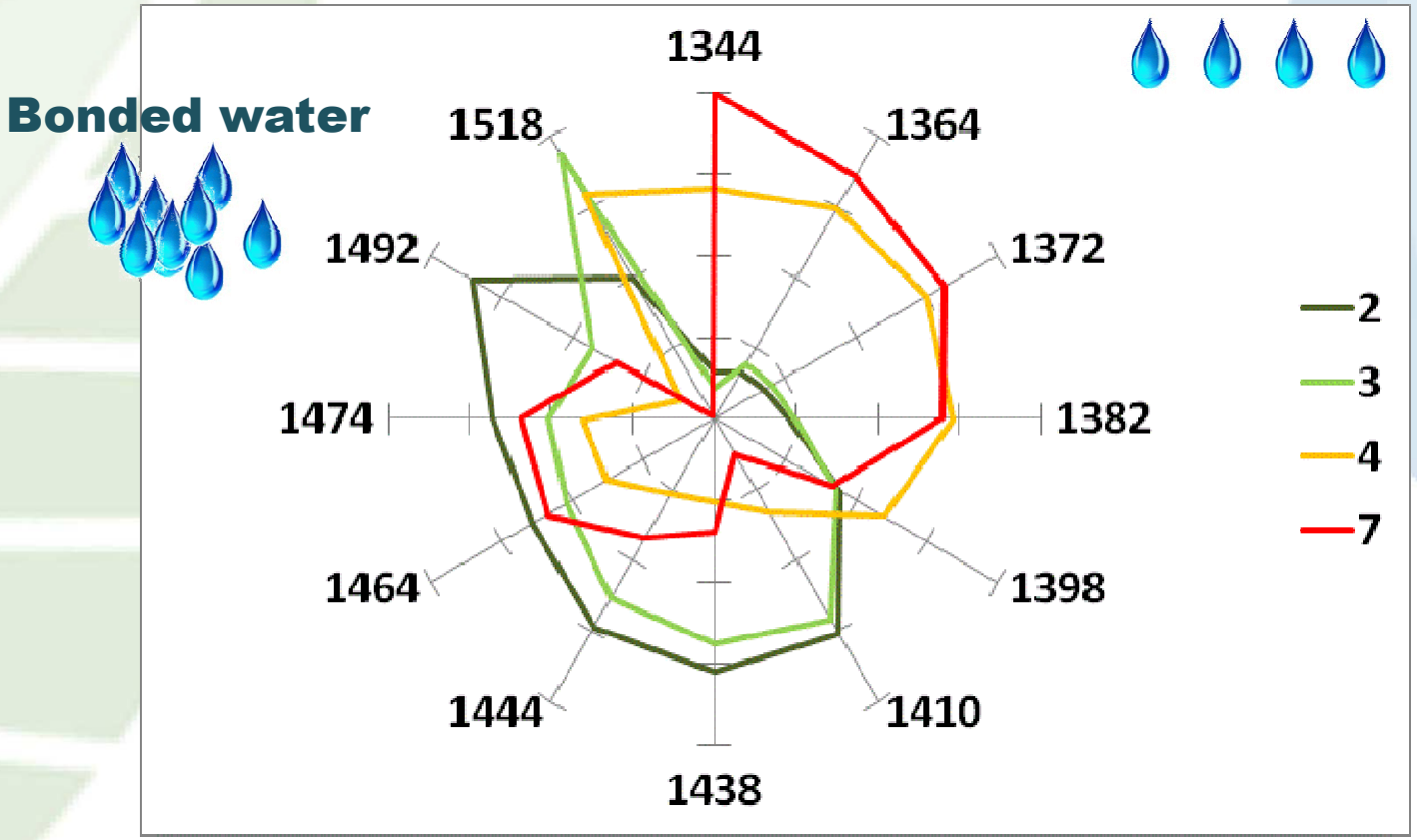
FRUITS


relative reflectance
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
900
1000
1100
1200
1300
1400
1500
1600
1700
wavelength (nm)

Whole fruits

Free water

Bonded water

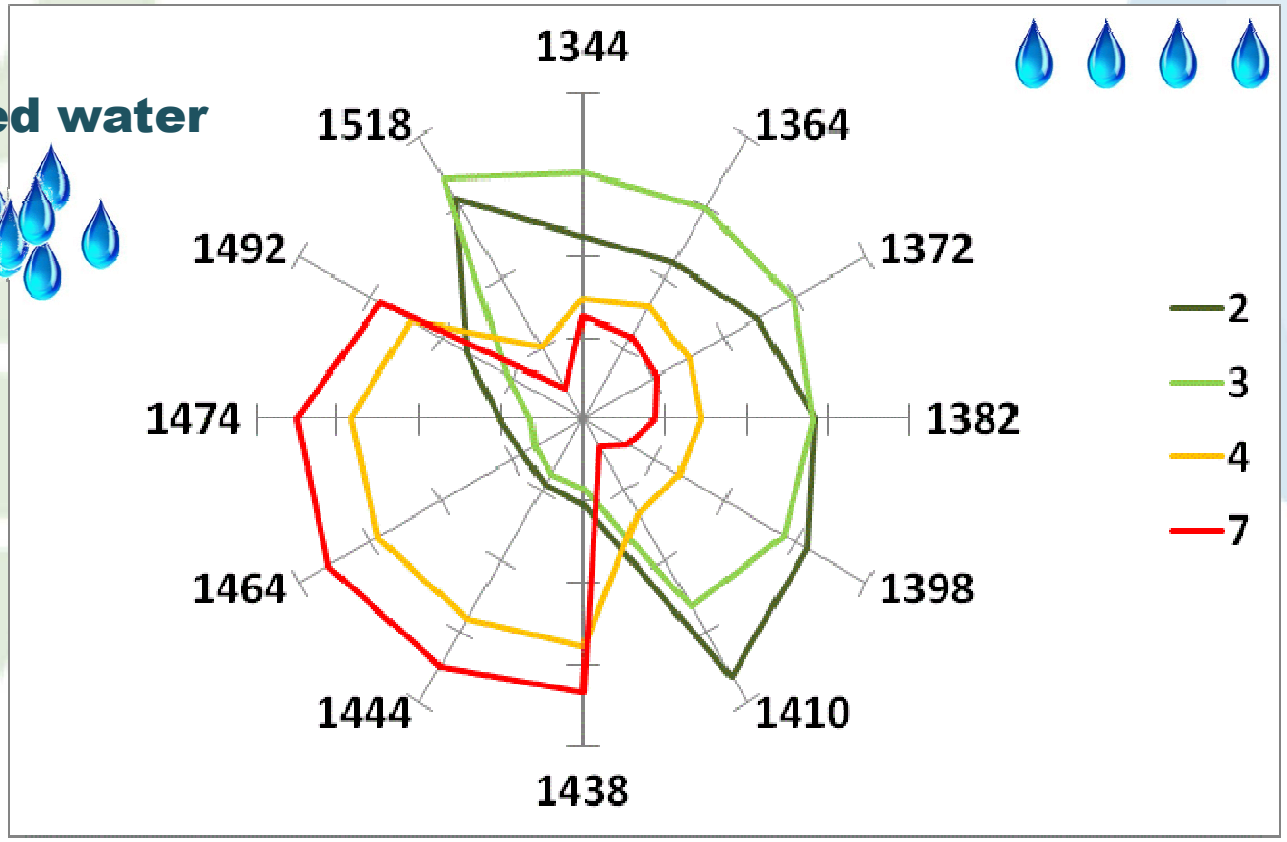


FRUITS

Peeled fruits

Free water

Bonded water



Conclusions

-Sampling influence

Operating on whole or peeled fruits an opposite response was highlighted as a function of ripening stage

- Whole fruits

Longer ripening period higher number of free water molecules (skin influence)

- Peeled fruits

Longer ripening period higher number of bonded water molecules (hydration of soluble compounds – metabolites)

SALMON

Fresh (F) and frozen/thawed(T) samples

Market label declaration

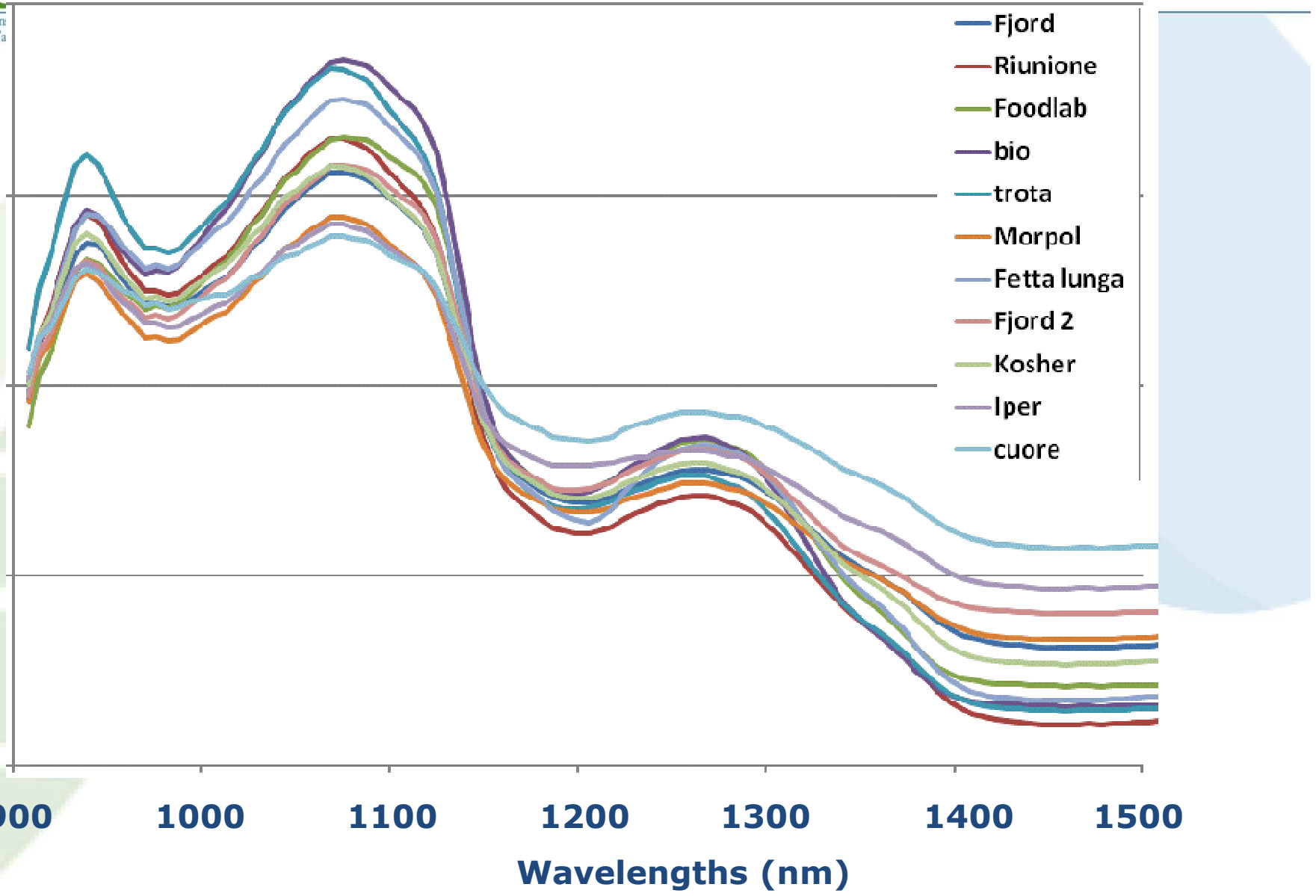
Whole and grounded samples

Known and unknown samples (un)

MicroNIR 1700 (VIAVI): three different sampling points (up, down, medium)

Reflectance to absorbance
Pretreatments (mean spectra, MSC, 1° derivative)

SALMON


Fjord
Riunione
Foodlab
bio
trota
Morpol
Fetta lunga
Fjord 2
Kosher
Iper
cuore
900
1000
1100
1200
1300
1400
1500
Wavelengths (nm)

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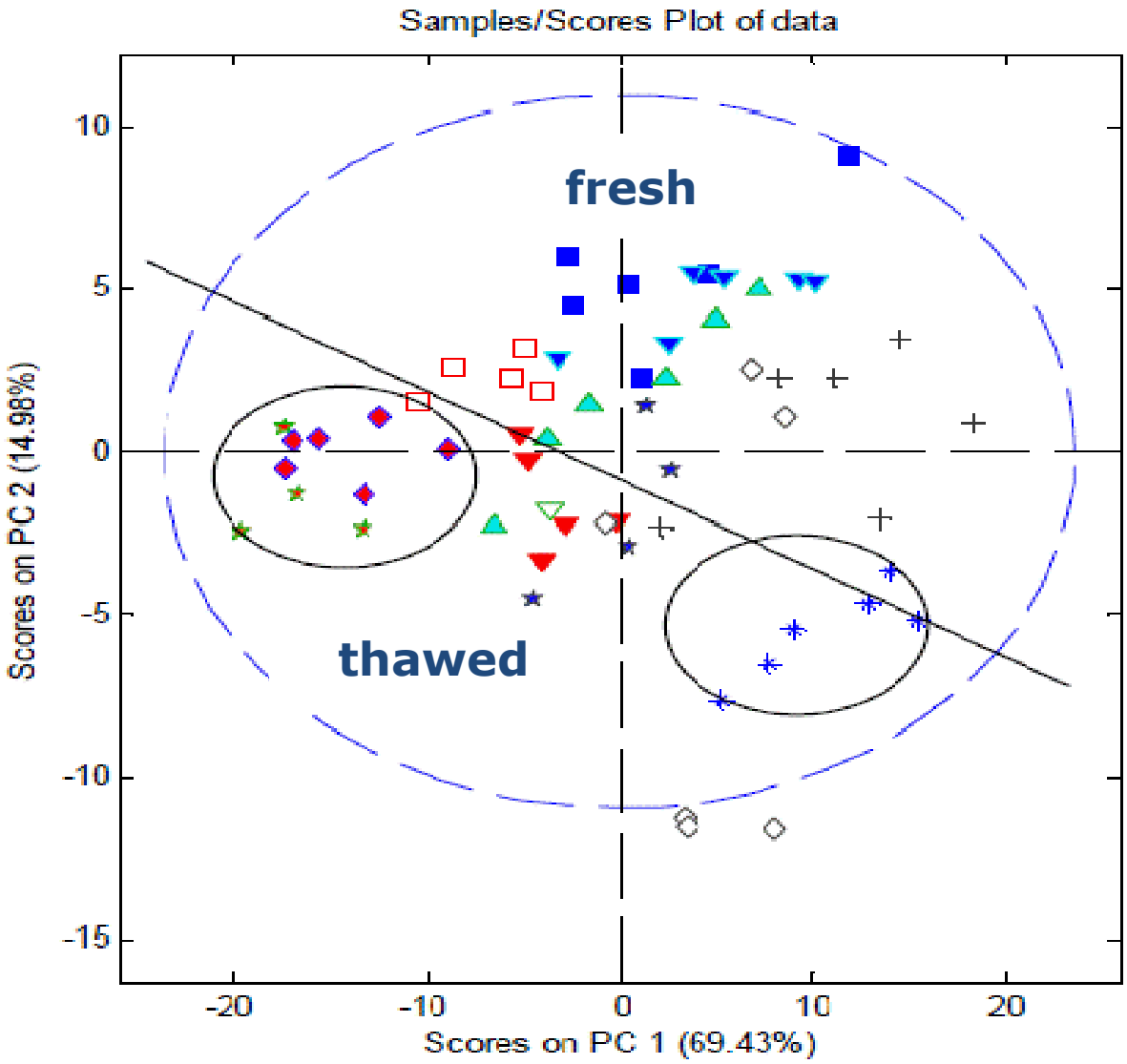
BEST RESULTS

SALMON

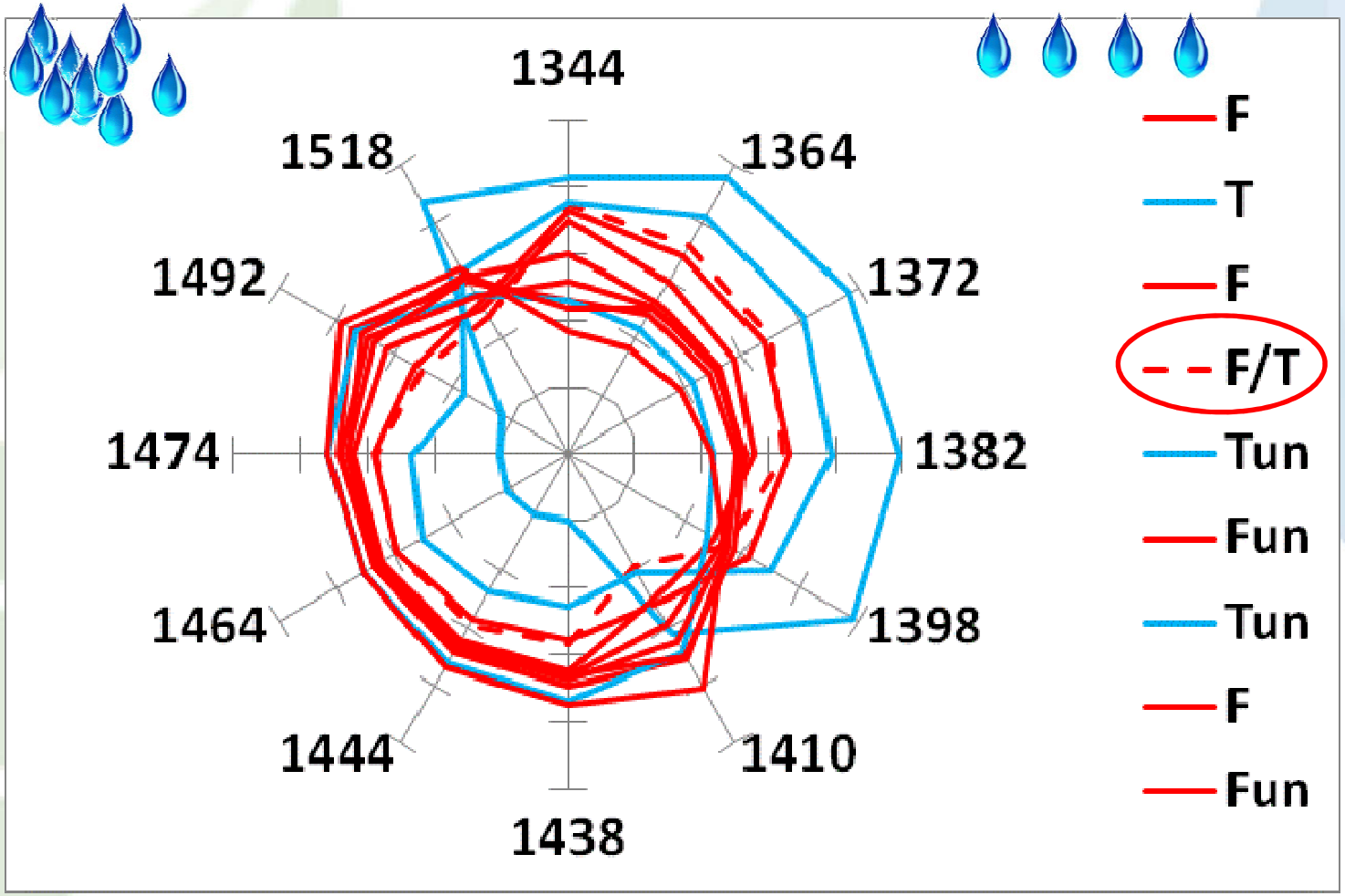
Obtained on grounded samples



SALMON

Bonded water

Free water



Conclusions

-Sampling influence

Analysis of homogenized samples allowed the identification of suspected false declaration

- First results

Also If this was just a preliminary test, it was proving the suitability od Aquaphotomics approach in classifying unknown samples

- Identification

Frozen/thawed samples showed aquagrams profiles where the large amount of free water molecules are due to the thawing process before commercialisation

CHEESE

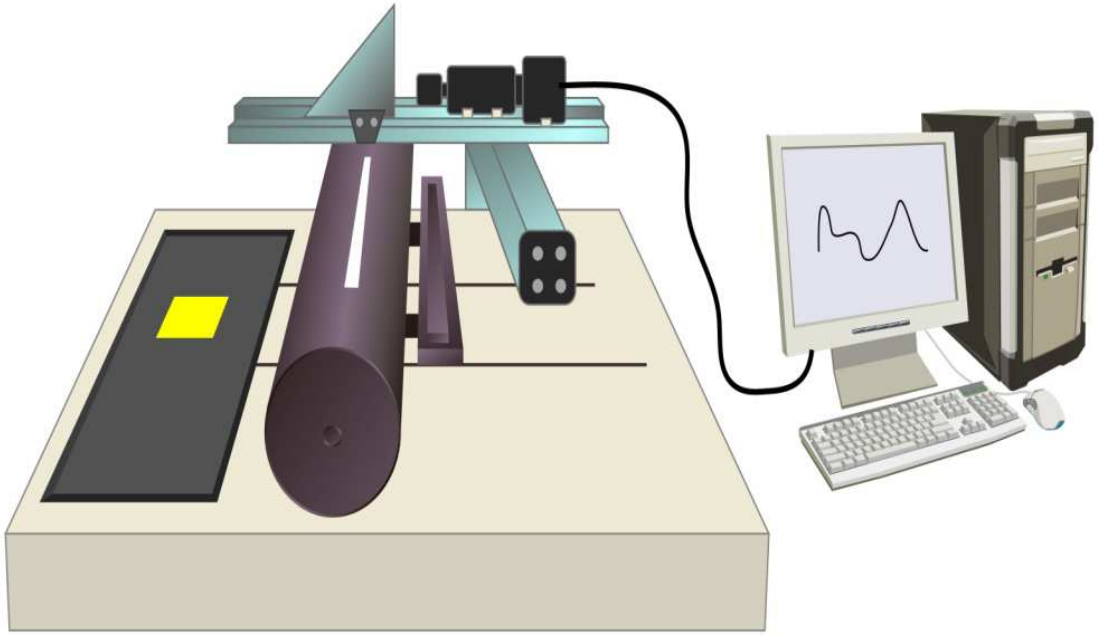
Taleggio cheese/water distribution

ITALIAN PDO CHEESE

Centripetal maturation:

proteolytic and lipolytic reactions due to surface micro-flora

CHEESE

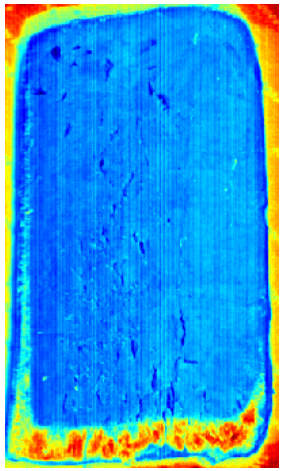


Hyper Spectral Imaging – HSI (Burger-Metrics)

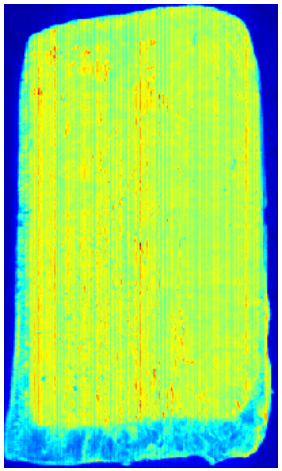
200 frozen/thawed samples

CHEESE

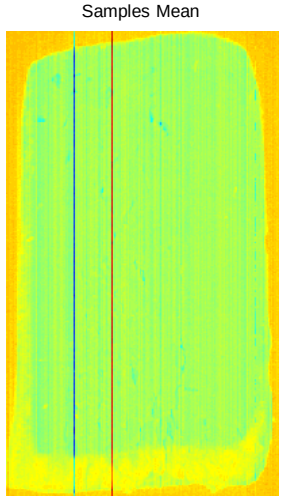
reflectance

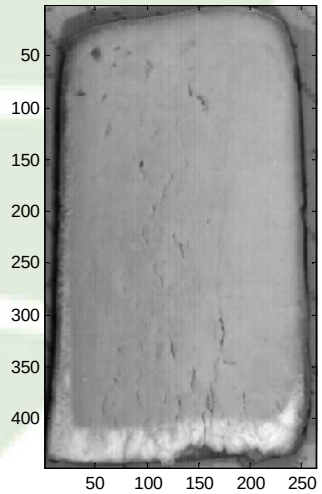


abs MSC d1



abs MSC d2

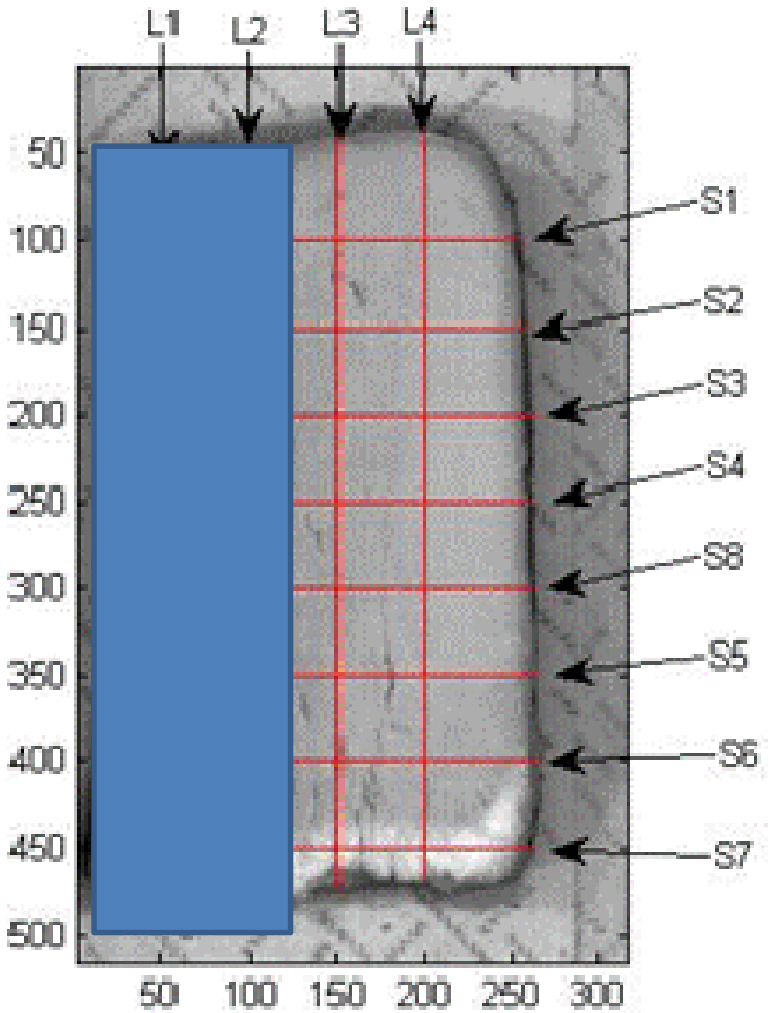




Average of absorbance at:
1342,1364,1372,1382,1398
1410,1438,1444,1464,1474
1492,1518 nm

CHEESE

Abs, MSC, first derivative

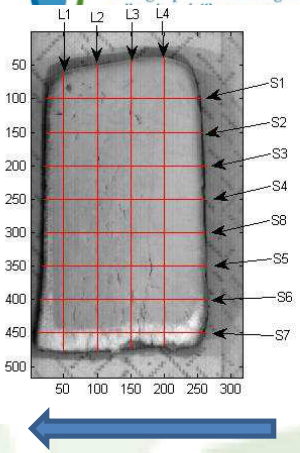


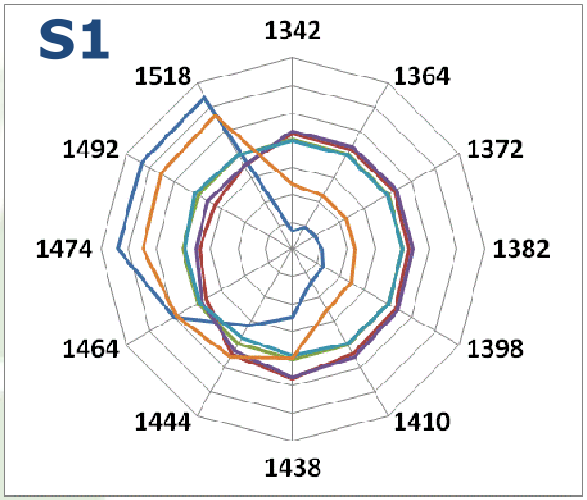
Cross point between L lines and S rows were considered for aquagram plots.

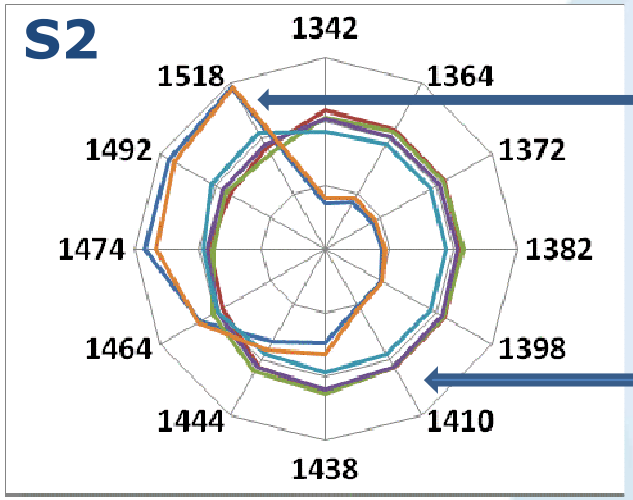
Centripetal maturation allowed the validation of results: cheese piece is a specular image= specular ripening trend.

S vs L

CHEESE

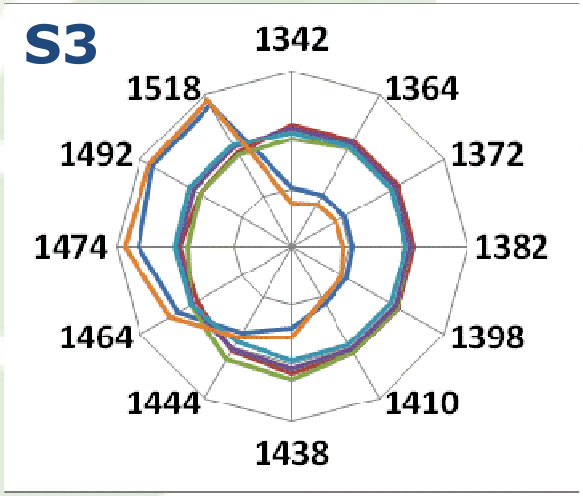


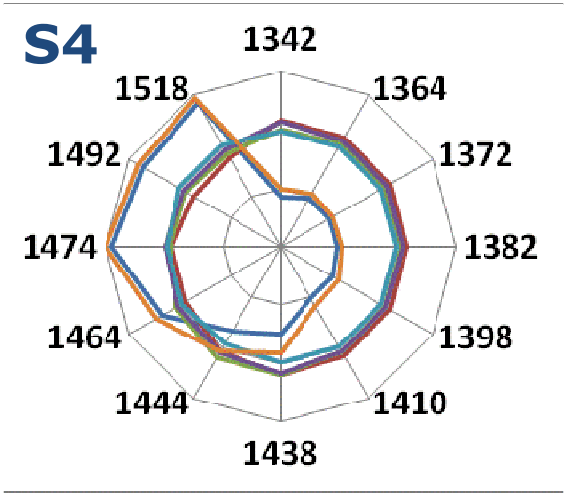


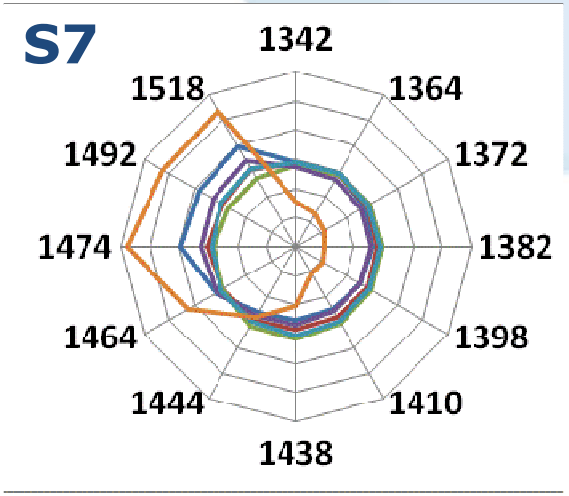


surface

inside

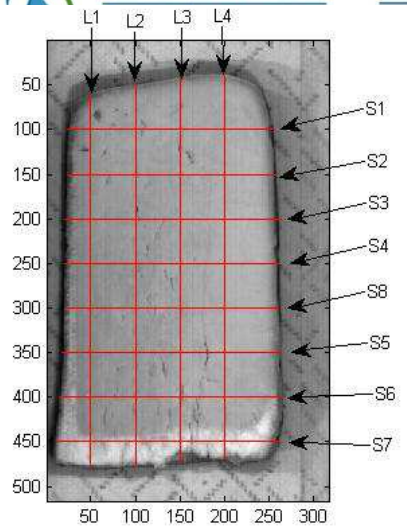






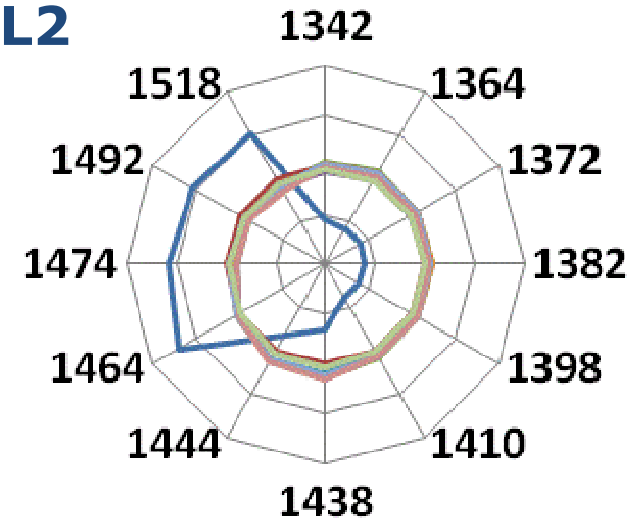
L vs S

CHEESE

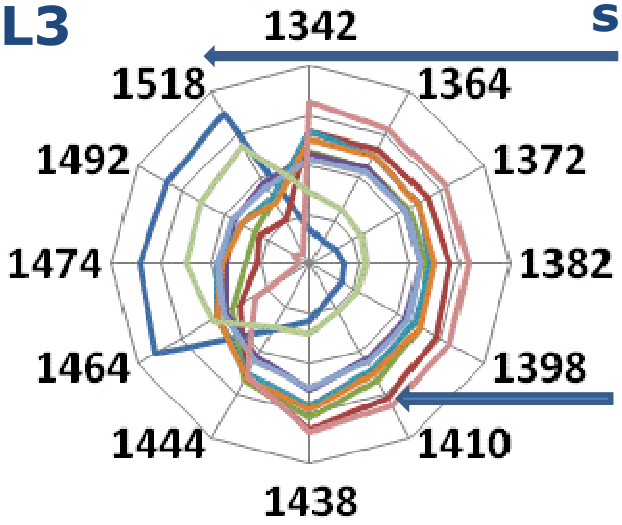


Aquagrams of L2 and L3 vs S1….S7 are reported as significant of water distribution along lines

L2



L3

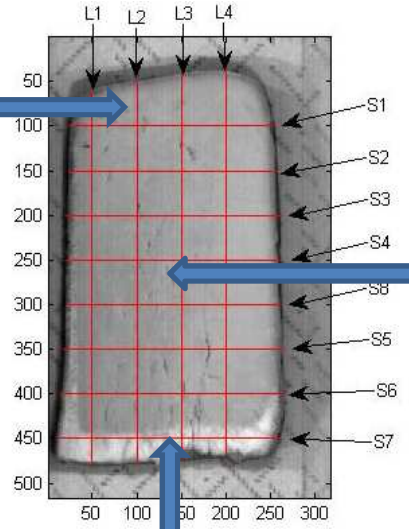


surface

inside

CHEESE

Surface



Inside

Bonded water

Bonded water

+

Free water

Freezing/thawing effect

Bonded water

>

Free water

Conclusions

- **Water distribution trend**

  From cheese surface to cheese core rearrangements in water molecules were highlighted according to the cheese-making technology.

  The presence of hydrogen bonds is abundant close to the surface where the ripening process started (soluble fractions, such as FFA, AA, OA, peptides, etc.).

  Inside the cheese, bonded and free water molecules seemed to be in equilibrium.

- **Freezing/thawing influence**

  The thawing process in particular was able to move the water molecules equilibrium with a new prevalence of bonded molecules, ascribable to partial loss of caseinic network after thawing

General conclusions

For the three food chains considered, the Aquaphotomics approach demonstrated to be a useful tool in:

- **Evaluating the different maturity, and the optimal ripening stage for fruits;**
- **Identifying at the market samples of packed "fresh salmon" from "frozen/thawed salmon"**
- **Studying the water distribution pattern inside Taleggio cheese slices, PDO Italian cheese, characterized by a centripetal ripeness.**

General conclusions

The correspondence with physical and chemical information about what happens in specific food allowed the confirmation of the findings by applying Aquaphotomics approach.

The application of adequate algorithms for data processing is a fundamental need in obtaining satisfactory results, independently from the spectroscopic technique (NIR, HSI, etc..) used to collect spectral data.

These results suggest the development of an Aquaphotomics APP for market and consumer.

Acknowledgements

Prof. Roumiana Tsenkova

Aquaphotomics Organizing Committee

CREA-IAA and CREA-FLC staff

Yuanyuan Pu
UCD, Dublin, Ireland

ALL PARTICIPANTS

Thank you for your attention

CREA

Reseach Unit for Food Technology

Via Venezian 26

20133 Milano

Tel. +39 02239557217

Fax +39 022365377

@ iaa@crea.gov.it

@ tiziana.cattaneo@crea.gov.it