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
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.
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: Zootechnia e Acquacoltura
- FL: Foresti e produzioni Legnose
- CI: Cerealicolture e colture Industriali
- VE: Viticoltura ed Enologia
- OF: Ortoicolture e Florovivaismo
- CA: Colture Arboree
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
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.
Active systems: soluble compounds, dynamic balance among constituents, fermentation processes, enzymatic processes, hydrolytic processes, water distribution and hydration rearrangements

FOOD are BIOLOGICAL SYSTEMS!!!
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
- Smaller size
- Sweet and creamy
- Health benefits
FRUITS

Whole fruits

Bonded water

Free water

- 2
- 3
- 4
- 7
Peeled fruits

Bonded water

Free water

FRUITS
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)
BEST RESULTS

SALMON

Obtained on grounded samples
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 of 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
Taleggio cheese/water distribution

ITALIAN PDO CHEESE
Centripetal maturation:
proteolytic and lipolytic reactions due to
surface micro-flora
Hyper Spectral Imaging – HSI (Burger-Metrics)

200 frozen/thawed samples
Average of absorbance at: 1342, 1364, 1372, 1382, 1398, 1410, 1438, 1444, 1464, 1474, 1492, 1518 nm
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.
Aquagrams of L2 and L3 vs S1….S7 are reported as significant of water distribution along lines.
Freezing/thawing effect

Surface

Bonded water

Inside

Bonded water + Free water

Bonded water

Free water

Free water > Bonded 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
Research Unit for Food Technology

Via Venezian 26
20133 Milano
Tel. +39 02239557217
Fax +39 022365377
@ iaa@crea.gov.it
@ tiziana.cattaneo@crea.gov.it