Drying
general aspects

**Roberto Moscetti*, Flavio Raponi,
Serena Ferri, Riccardo Massantini****

Affiliation: Department of Innovation in Biology, Agri-food and Forest systems, University of Tuscia,

Viterbo (Italy)

*corresponding author: rmoscetti@unitus.it

** scientific responsible: massanti@unitus.it

Outline

1. **MARKET GLOBALIZATION NEEDS AND DEMANDS**
2. **FOOD DRYING**
   - » An overview
   - » Quality and safety of food
   - » Impact on the production costs
   - » Type of drying technologies
   - » Impact of drying on product quality traits
   - » Consumer perception of dried food quality
   - » Changes in color
     - › *The enzymatic browning*
     - › *The non-enzymatic browning*
   - » Chemical composition among species and cultivars
   - » Energy efficiency
     - › *General aspects*
     - › *A quality by design approach*
   - » Innovative drying technology
     - › The smart drying
     - › Vis/NIR spectroscopy

Learning Outcomes

- Enhance technical knowledge required to optimize process and technologies to organic raw materials of organic production and the factors that need to be taken into account
- Develop knowledge and skills on food quality and safety and main criteria applied to organic produce
- Implement modern sustainability concepts

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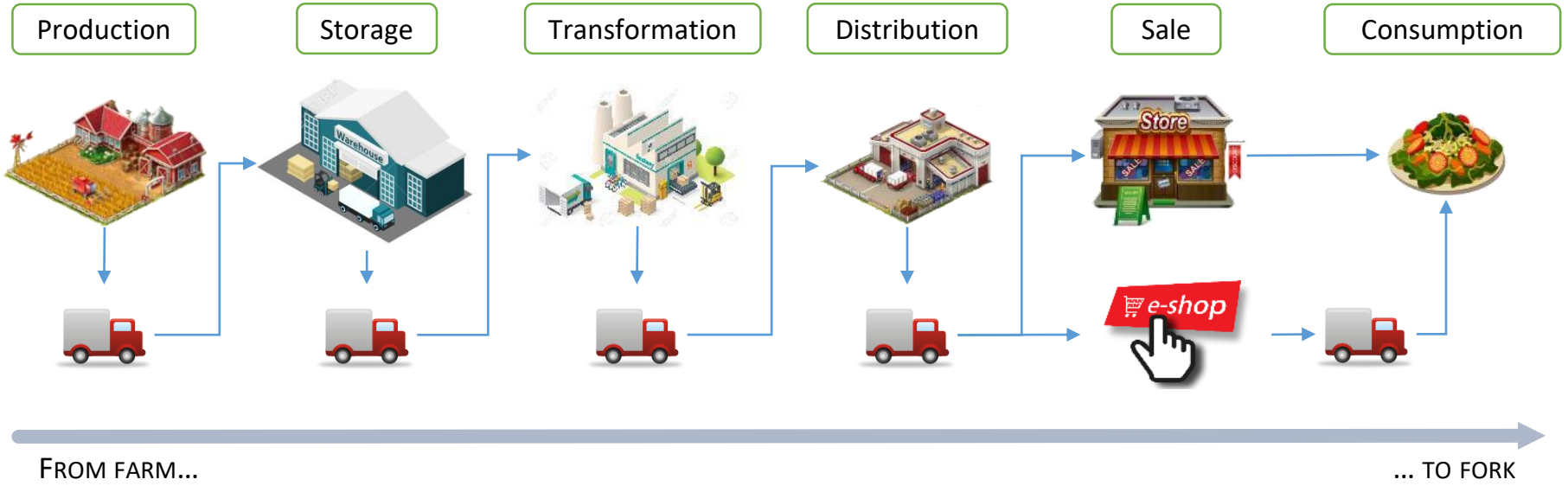
MARKET GLOBALIZATION NEEDS AND DEMANDS

Market globalization ensures constant availability of many foods regardless of their production date. Innovation in both products and processes across the entire agri-food chain yield foods with improved shelf-life, organoleptic quality, nutritional value, safety and healthfulness.



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FOOD DRYING – AN OVERVIEW

Drying may significantly extend the shelf-life and nutritional quality of fruit, vegetables, spices and herbs as well as meat and fish.

FRUITS

VEGETABLES

SPICES AND HERBS

MEAT

FISH

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FOOD DRYING – AN OVERVIEW

DRYING OF FOOD CONSISTS OF THREE STEPS...

PRE-DRYING PROCESSING

DRYING

POST-DRYING HANDLING

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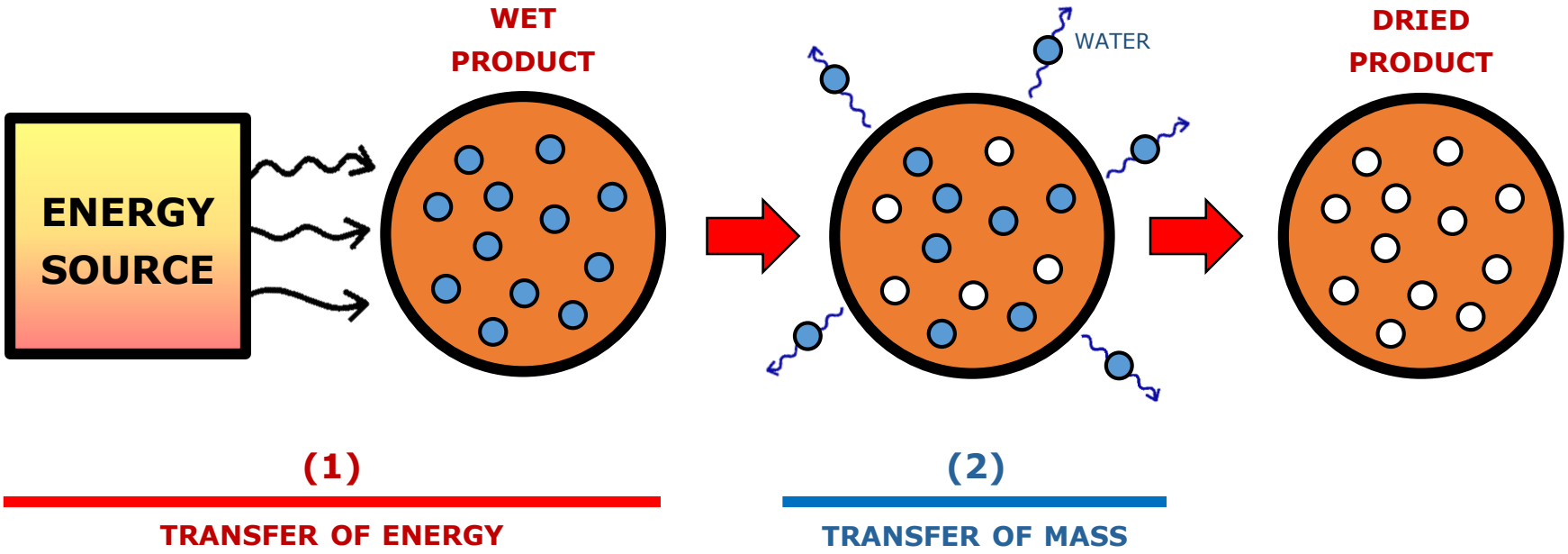
FOOD DRYING – AN OVERVIEW

Drying consists in two simultaneous processes

(1) transfer of energy from an energy source to a wet solid

(2) transfer of mass as water vapor



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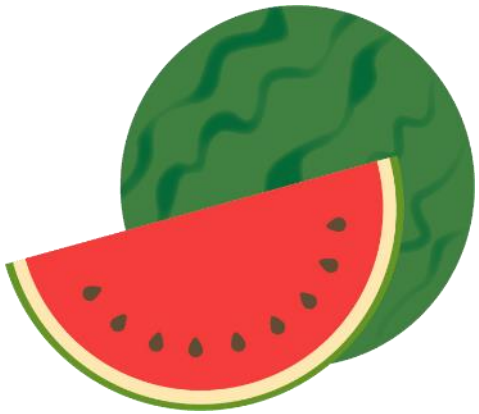
FOOD DRYING – QUALITY AND SAFETY OF FOOD

Fruits and vegetables are rich in water



Watermelon

93%

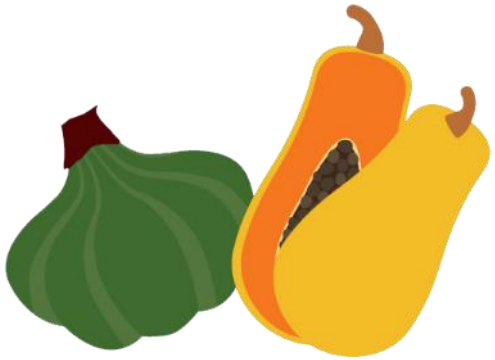
water

Salad
Greens
Berries
Tomatoes

Radishes
Cauliflower
Zucchini
Peppers

90%

water



Acorn squash
Butternut squash

85%

water

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FOOD DRYING – QUALITY AND SAFETY OF FOOD

Drying slows down deteriorative processes

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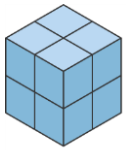
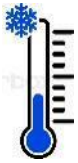
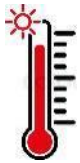
FOOD DRYING – IMPACT ON THE PRODUCTION COSTS

Drying reduces storage and shipping costs

WET PRODUCT

VS

DRIED PRODUCT

High size/volume		Low size/volume 
High weight		Low weight 
Must be stord at low temperature		 Can be stored at room temperature

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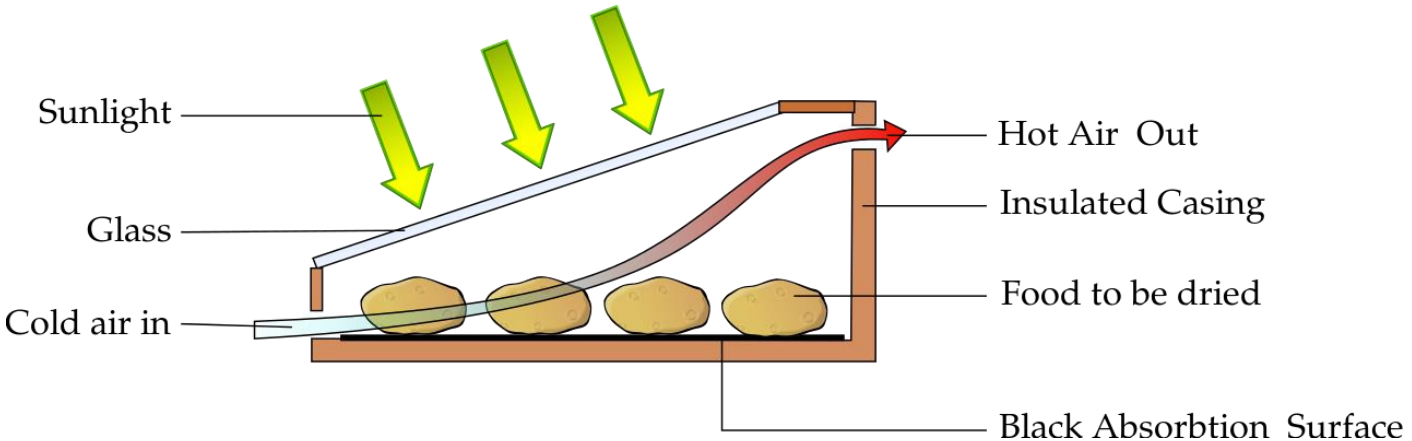
FOOD DRYING – TYPE OF DRYING TECHNOLOGIES

Sun drying is the oldest drying method



Example of sun-dried tomato in south of Italy

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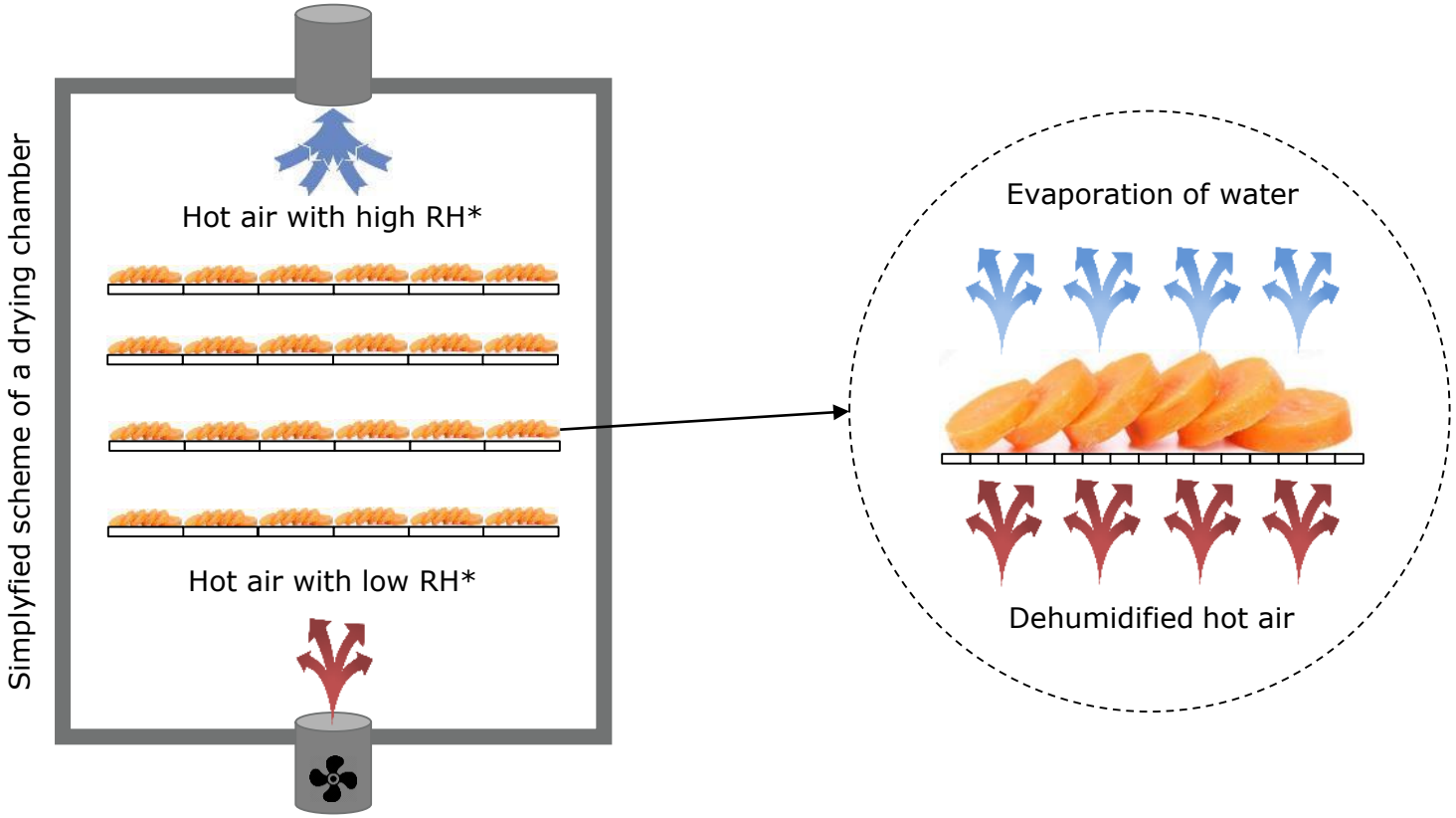
FOOD DRYING – TYPE OF DRYING TECHNOLOGIES

Hot-air drying is the most used drying method



*RH - relative humidity

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IMPACT OF DRYING ON PRODUCT QUALITY TRAITS

PHYSICOCHEMICAL CHANGES

- Moisture content and water activity
- Shape and size
- Firmness and texture
- Pigments content
- Enzymatic and non-enzymatic browning

ORGANOLEPTIC CHANGES

- Aspect
- Odor
- Taste
- Texture

NUTRITIONAL CHANGES

- Vitamins content
- Carotenoids content
- Total polyphenolic content
- Antioxidant capacity
- …

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CONSUMER PERCEPTION OF DRIED FOOD QUALITY

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On the basis of color perception, consumer obtains critical but also biased information about quality of food by acquiring clues as to edibility as well as identity and intensity of flavor.

Consequently, dried strawberries have more chances to be bought because of more intense color in comparison with dried apples.

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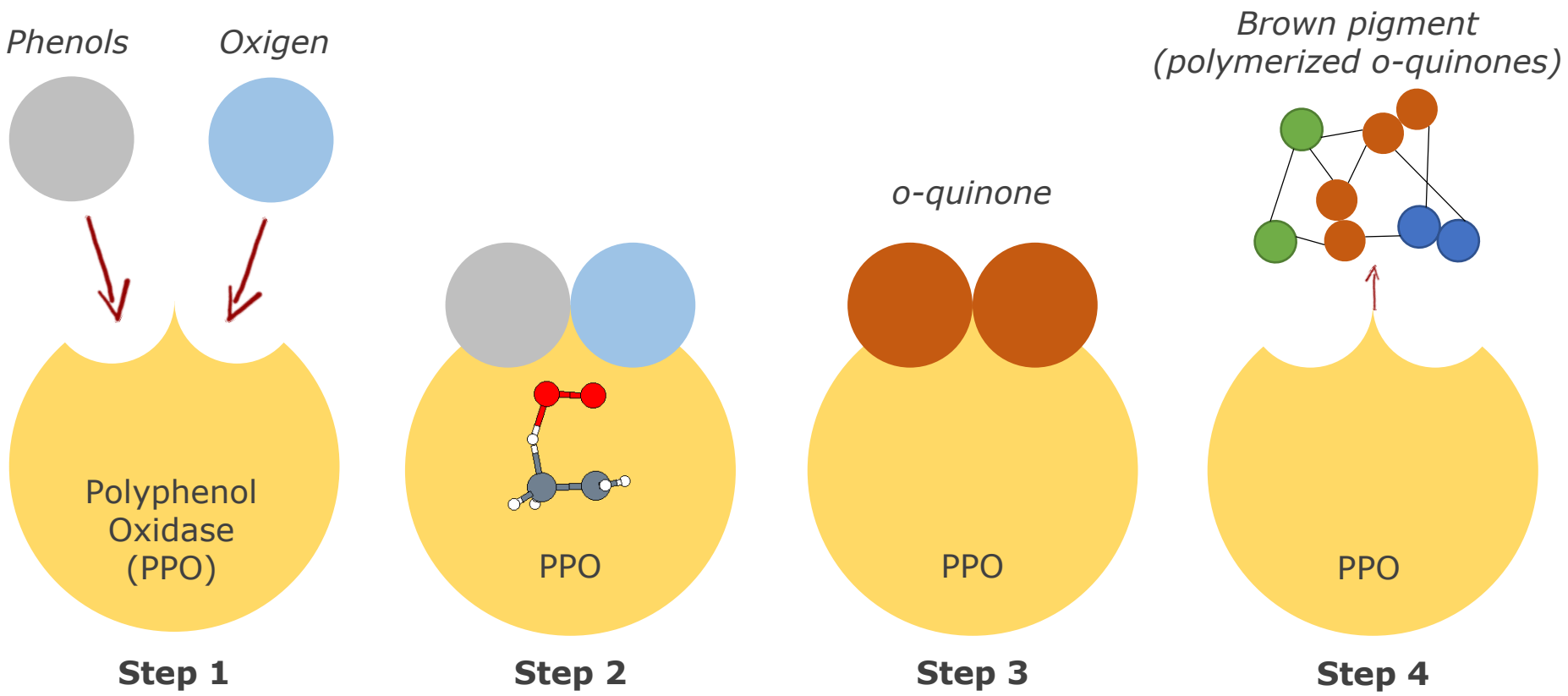
CHANGES IN COLOR - THE ENZYMATIC BROWNING



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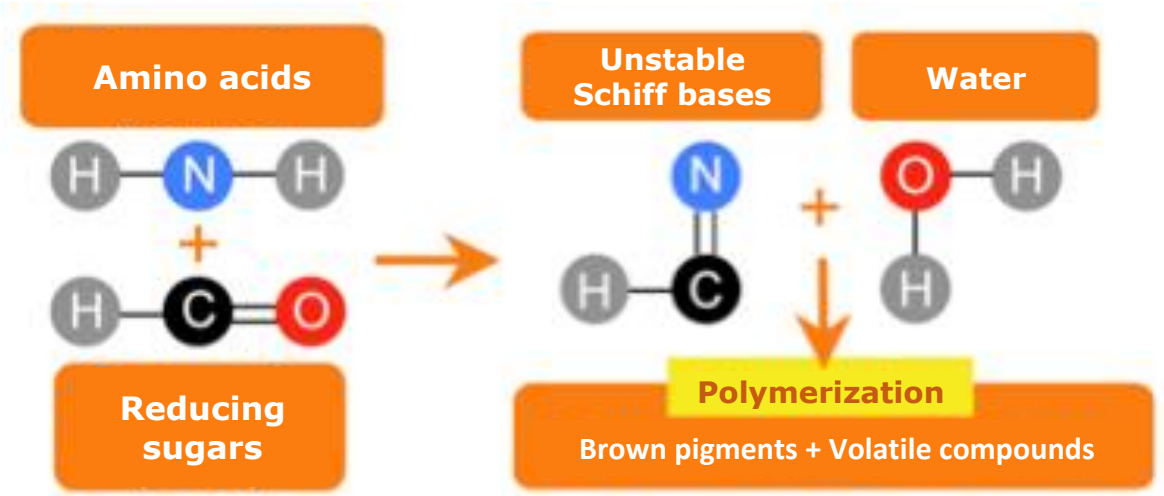
CHANGES IN COLOR - THE NON-ENZYMATIC BROWNING

There are two types of non-enzymatic browning reactions:

1) Caramelization (a pyrolytic process of sugars)
2) Maillard reaction (a chemical reaction between amino acids and reducing sugars). This reaction was first described by Louis Maillard in 1912.

Louis Camille Maillard



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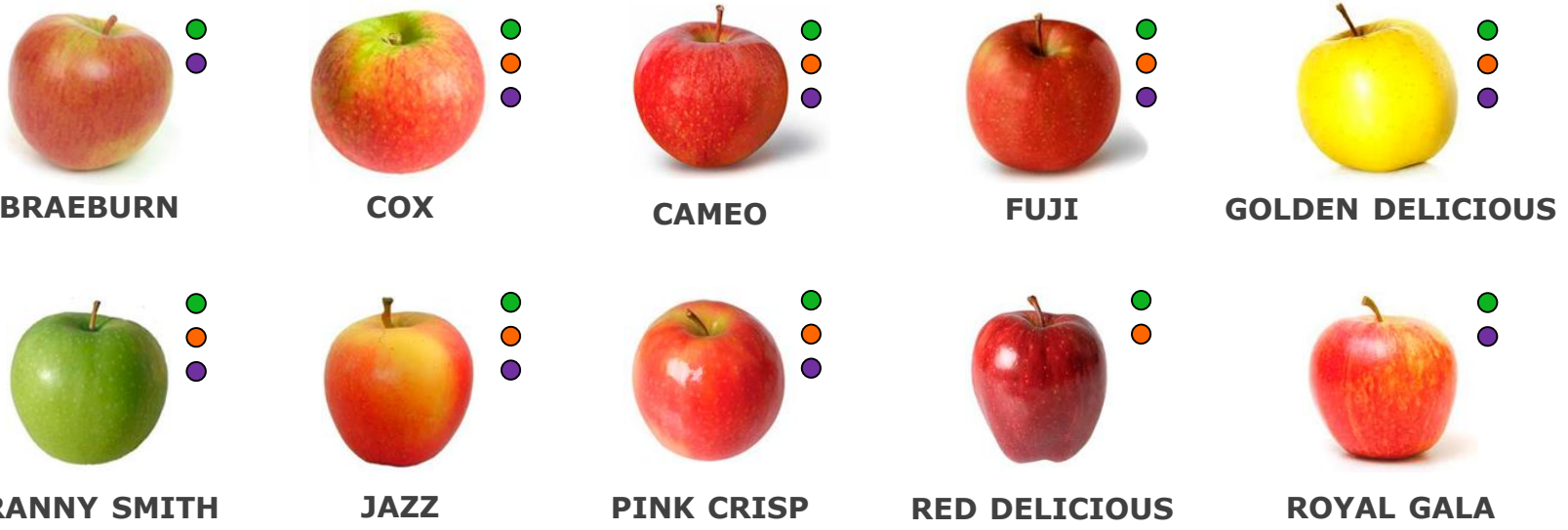
CHEMICAL COMPOSITION AMONG SPECIES AND CULTIVARS

Species, cultivars and other agronomic variables (e.g. harvest date, soil type and water availability) severely affect chemical composition and functional property of fruits and vegetables.



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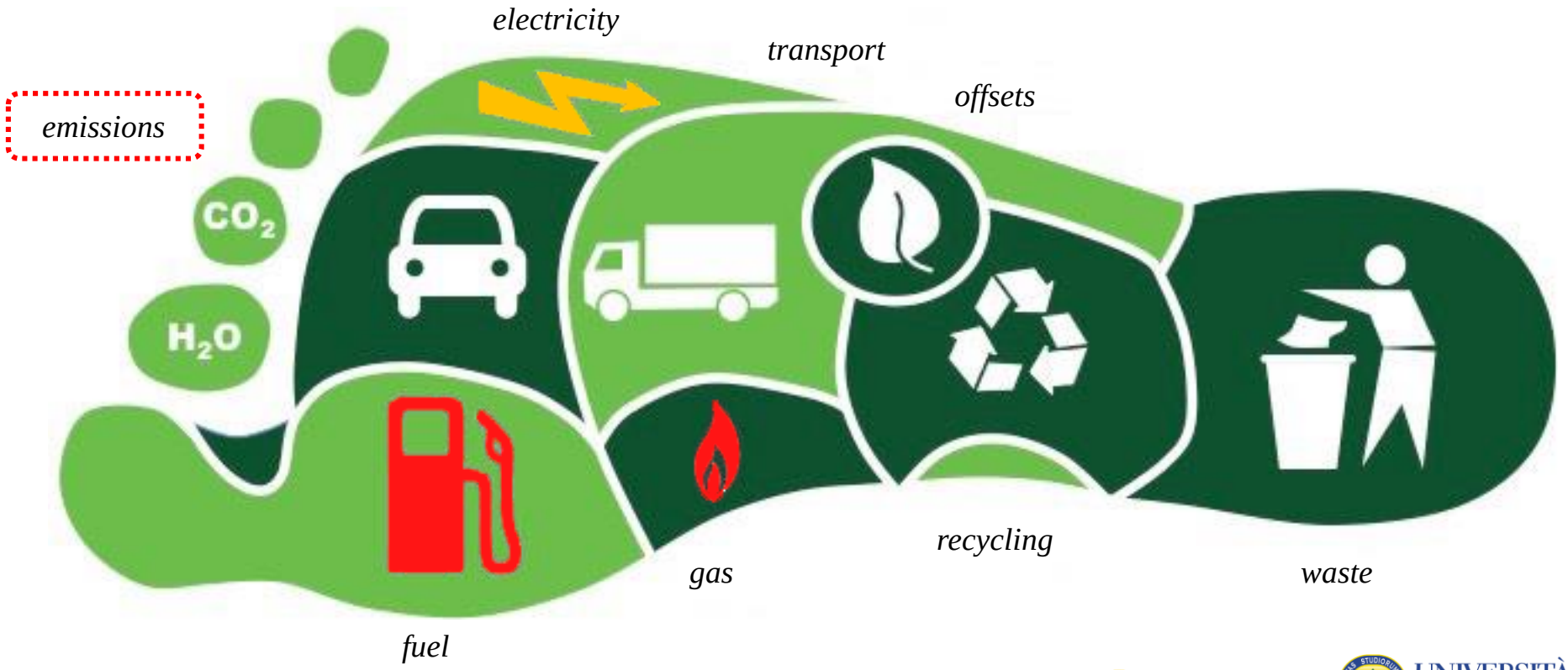
ENERGY EFFICIENCY OF FOOD DRYING

Food drying is a highly energy-intensive operation which has an adverse effect on the environment (greenhouse gas emissions).



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DRYING EFFICIENCY – A QUALITY BY DESIGN APPROACH

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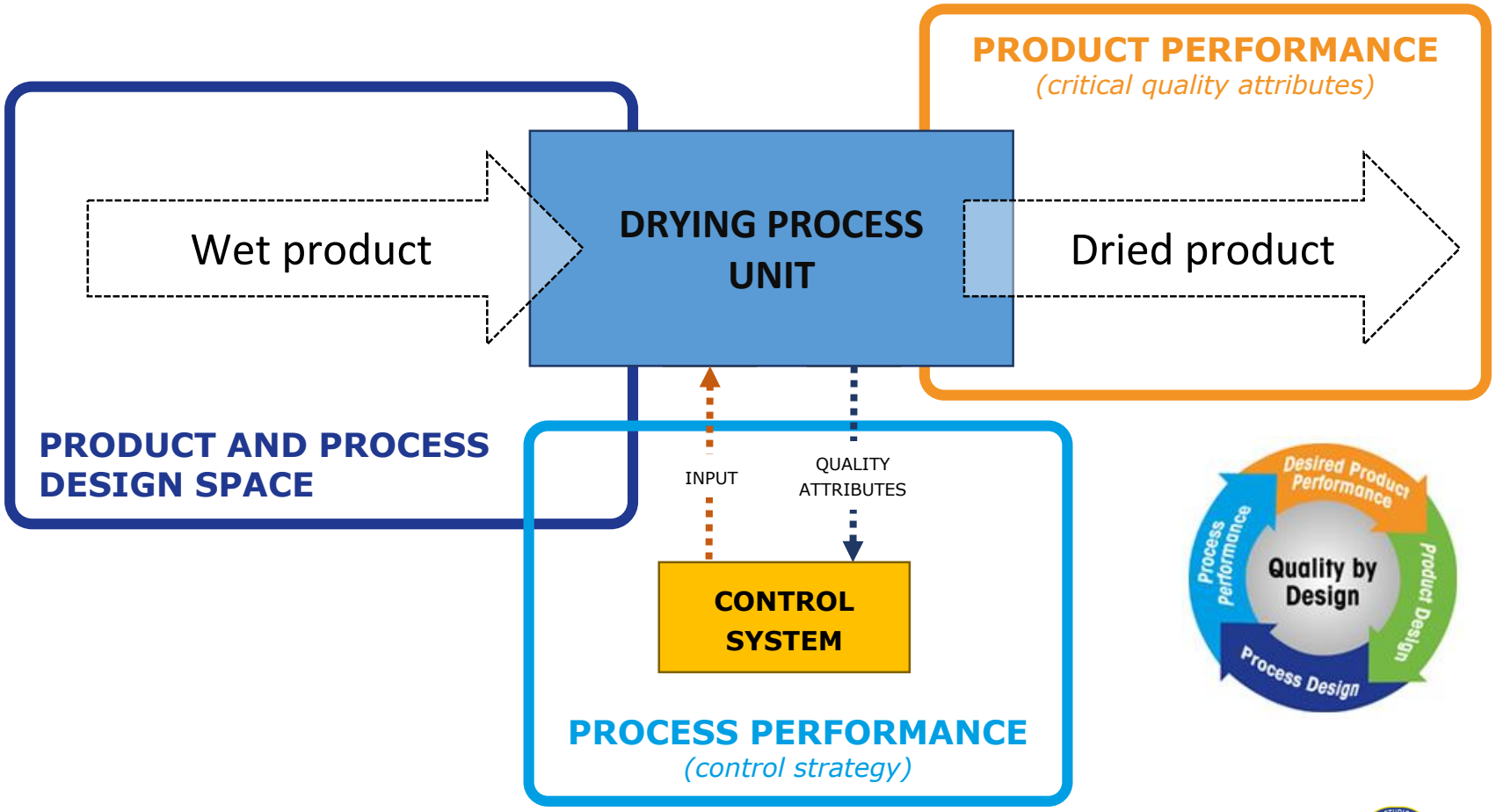

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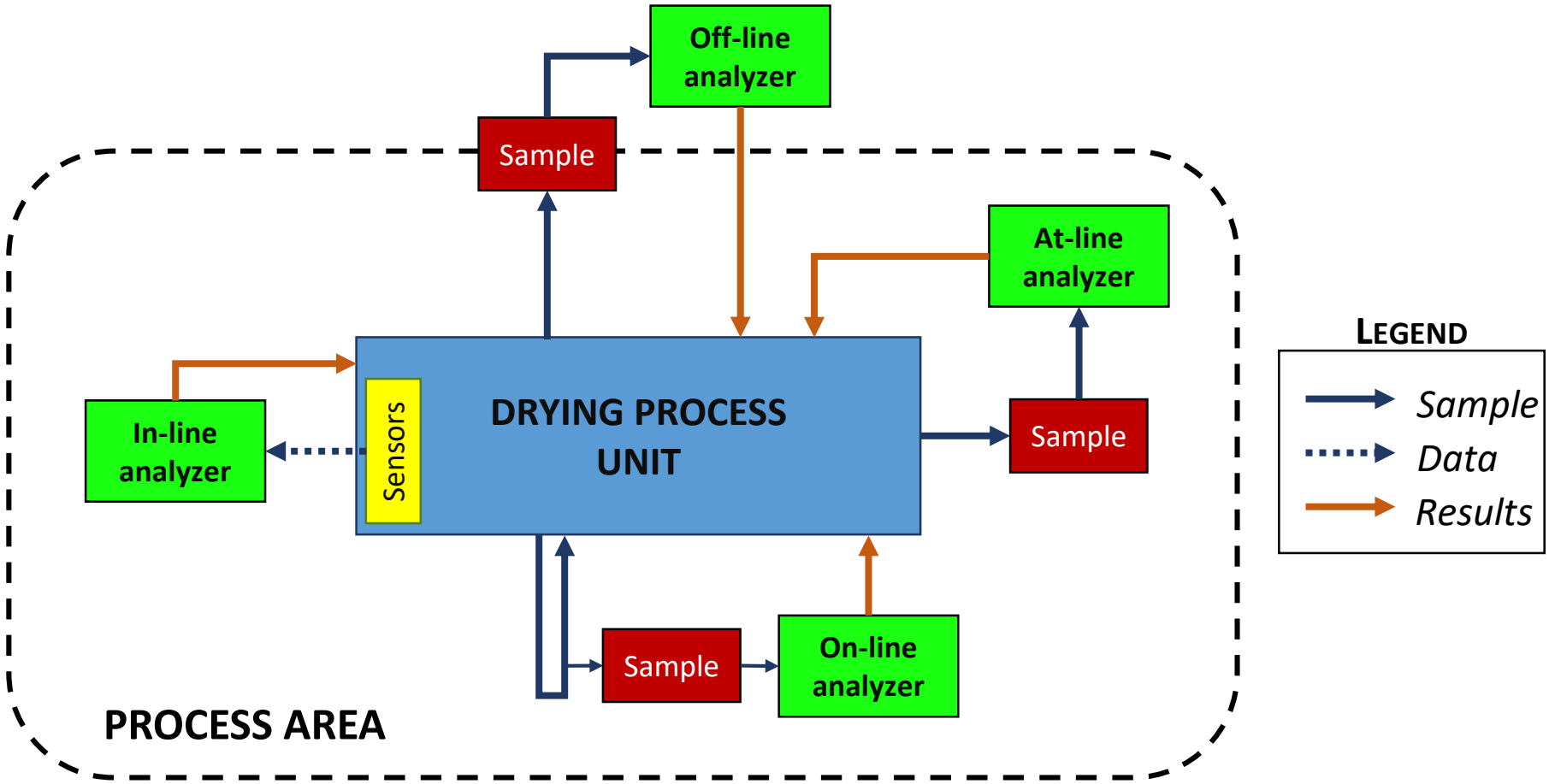
INNOVATIVE DRYING TECHNOLOGY - THE SMART DRYING



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INNOVATIVE DRYING TECHNOLOGY - THE SMART DRYING

1) Control systems for drying environment
   - *pressure*
   - *temperature*
   - *air velocity*
   - *humidity*

   ▶ Influence on the quality of the product

   ▶ Information about the progress of drying

2) Biomimetic systems
   - *odor-sensing system (electronic nose)*
   - *taste-sensing system (electronic tongue)*

   ▶ Smell and taste

3) Computer vision technology

   ▶ Size, shape and colour

4) Microwave/dielectric spectroscopy

5) Visible and/or Near Infrared spectroscopy
   - *single point*
   - *multi/hyperspectral imaging*

   ▶ Chemical, physical and physicochemical characteristics

6) Magnetic resonance imaging

7) Ultrasound techniques

   ▶ Information about the progress of drying

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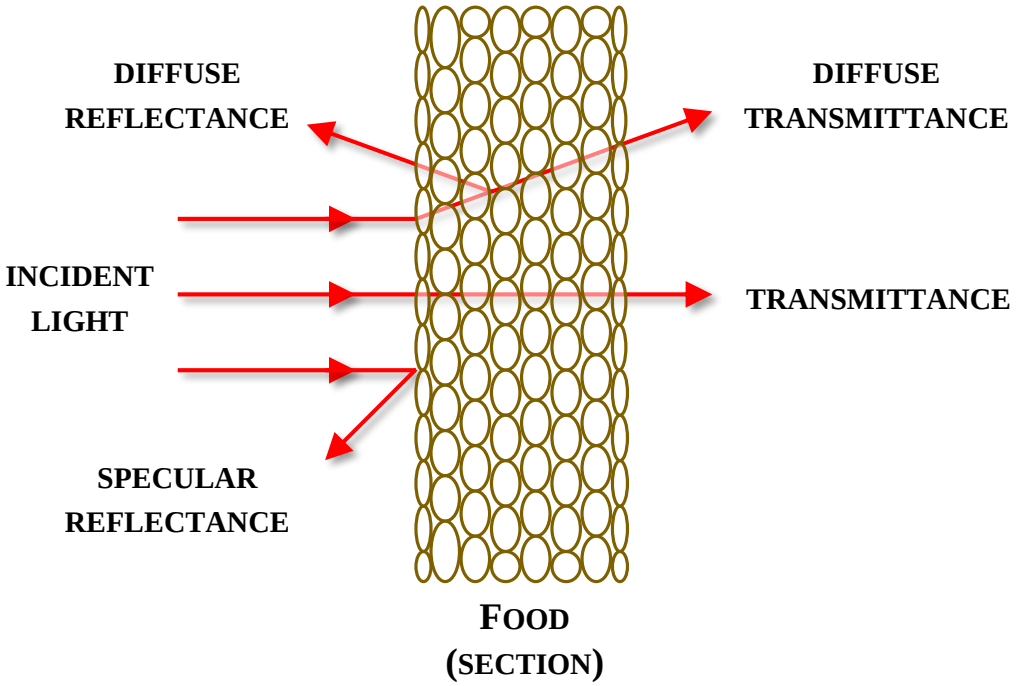
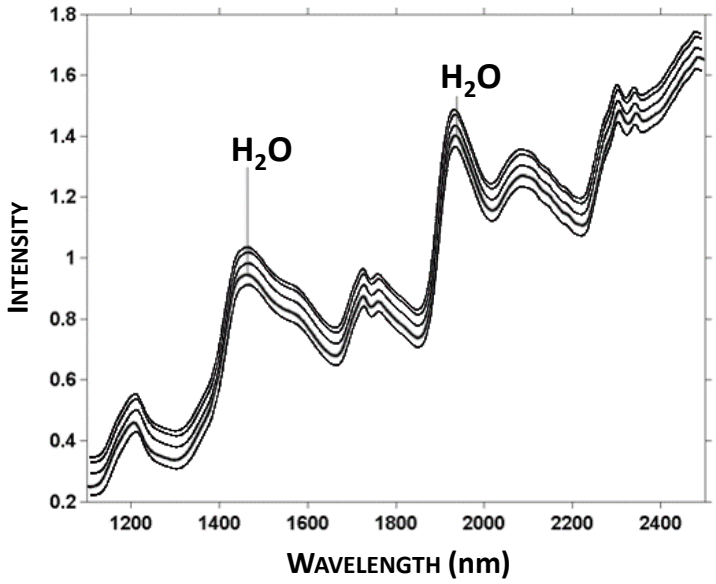
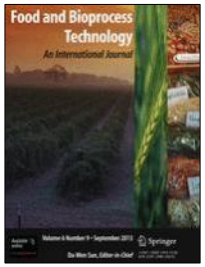
INNOVATIVE DRYING TECHNOLOGY - Vis/NIR SPECTROSCOPY

Visible (Vis) / Near-infrared (NIR) spectroscopy is a form of non-invasive imaging that applies visible and near-infrared radiation to chemicals or biological subjects to measure differential absorption.



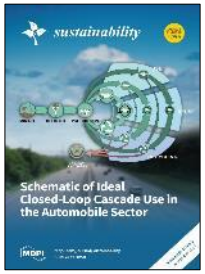


References



2017

Journal: Food and Bioprocess Technology
Authors: Moscetti R, Haff RP, Ferri S, Raponi F, Monarca D, Liang P, Massantini R
Title: Real-time monitoring of organic carrot (var. romance) during hot-air drying using Near-Infrared spectroscopy



2017

Journal: Sustainability
Authors: Raponi F, Moscetti R, Monarca D, Colantoni A, Massantini R
Title: Monitoring and optimization of drying fruits and vegetables process using computer vision: a review

2017

Journal: Journal of the Science of Food and Agriculture
Authors: Moscetti R, Sturm B, Crichton SOJ, Amjad W, Massantini R
Title: Postharvest monitoring of organic potato (cv. anuschka) during hot-air drying using vis/nir hyperspectral imaging

2018

Journal: Journal of Food Engineering
Authors: Moscetti R, Raponi F, Ferri S, Colantoni A, Monarca D, Massantini R
Title: Real-time monitoring of organic apple (var. Gala) during hot-air drying using Near-Infrared spectroscopy