

# Monitoring of humidity conditions during hazelnut processing

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# Topics

- ◎ **Hazelnut roasting**
- ◎ **Experiment within HIT Project activities:**
  - *Process humidity measurements and quality of roasted hazelnut*
  - *Protein quality of hazelnut as affected by the type of processing*

# Hazelnut



- Health promoting properties; good source of energy due to a fat content of about 60%
- Protein content about 15%

## Hazelnut roasting

- To inactivate enzymes
- To destroy microorganisms
- To reduce water activity
- To remove the pellicles of kernels
- To improve the colour, texture and the flavour
- Leads to physical changes (dehydration, colour modifications, biochemical changes – lipid structure modification, Maillard reactions)
- Modifies protein structure - may affect level of protein allergenicity



**Is it possible to implement a technology  
for real time monitoring of product  
quality during processing ?**

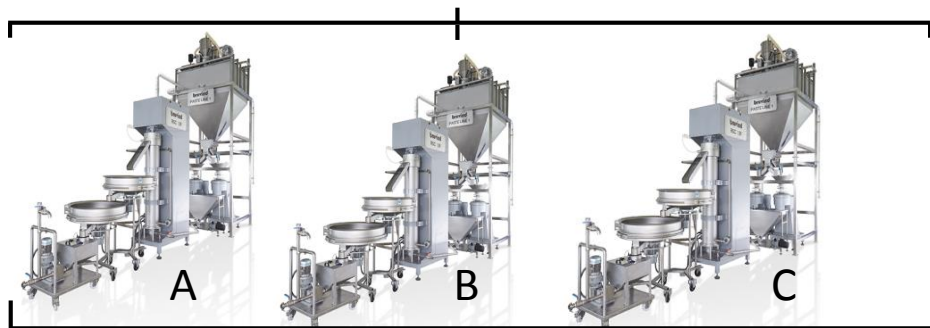


## **Measuring real-time water loss during Hazelnut Roasting**



# Aims

- 1 - To demonstrate the possibility to monitor the water loss of hazelnuts during a roasting process by means of dew-point real-time measurements
- 2 - To characterize the different roasting procedures by means of a metrology-sound temperature and humidity control approach
- 3 – To correlate humidity/air-temperature measurements and quality of processed hazelnuts



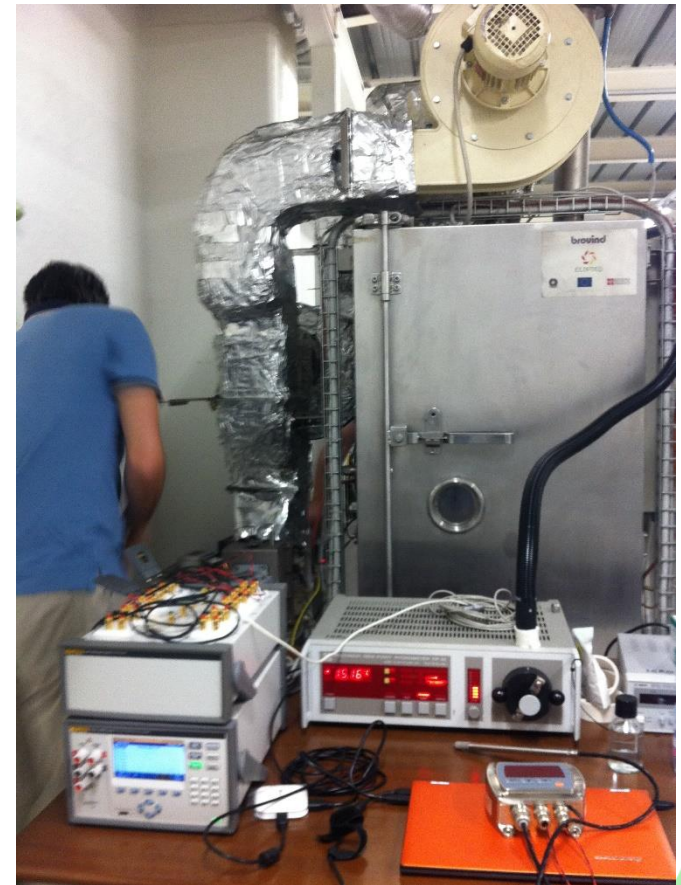


# Hazelnut Roasting on a pilot scale @ Brovind srl



**Pilot scale Infra Red Oven**

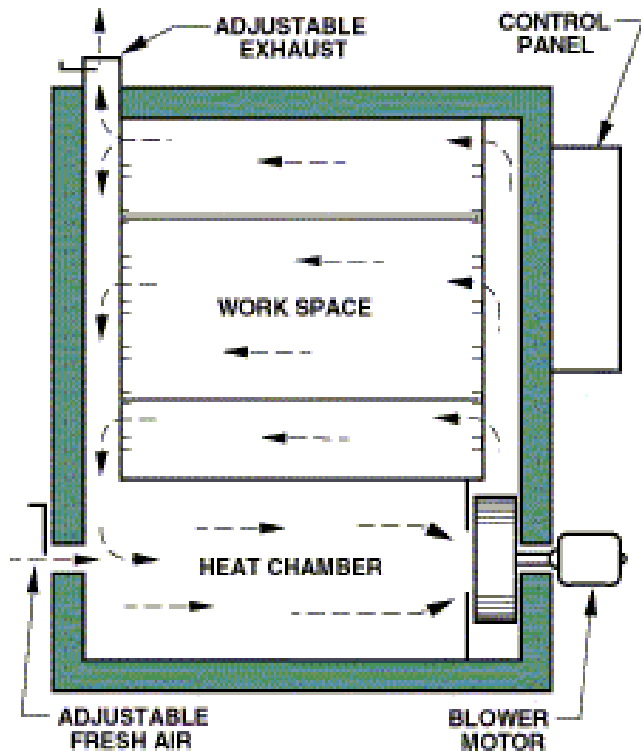
Hazelnut, cv Tonda Gentile  
Trilobata (TGT)



**Pilot scale Hot Air Oven**

## Hot Air roasting

Forced air circulation



Drying process is due to hot air forced in the work space by means of a blower motor.

## Infra Red Roasting

Patented system using a vibrating helical track and a ventilation system.

Drying process is due to infra-red lamps which heat up the hazelnuts placed in the work space.



# Experimental Design

Processing method	Hot air						Infra-red					
Temperature	HT		LT		HT		LT					
Cycle time	a	b	c	d	e	f	h	i	l	m	n	o
Replicates	3						3					
Batch Weight	1.5 kg						4.0 kg					



# INRIM measurements @ Brovind srl (Italy)

## Measurement set-up for Hor Air over

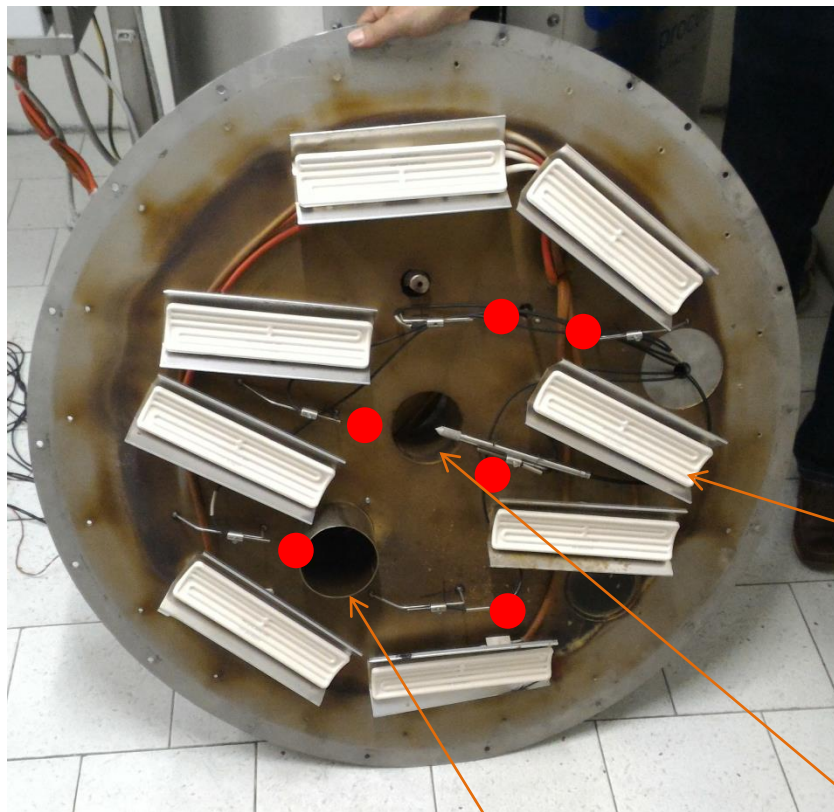
Arrangement of 5 temperature sensors in the oven work space and a chilled-mirror dew-point meter sampling gas from the air-outlet chimney.



# INRIM measurements @ Brovind srl (Italy)

## Measurement set-up for Infra-red Oven

Arrangement of 6 temperature sensors in the oven work space and a chilled-mirror dew-point meter sampling gas from the exhaust gas chimney.



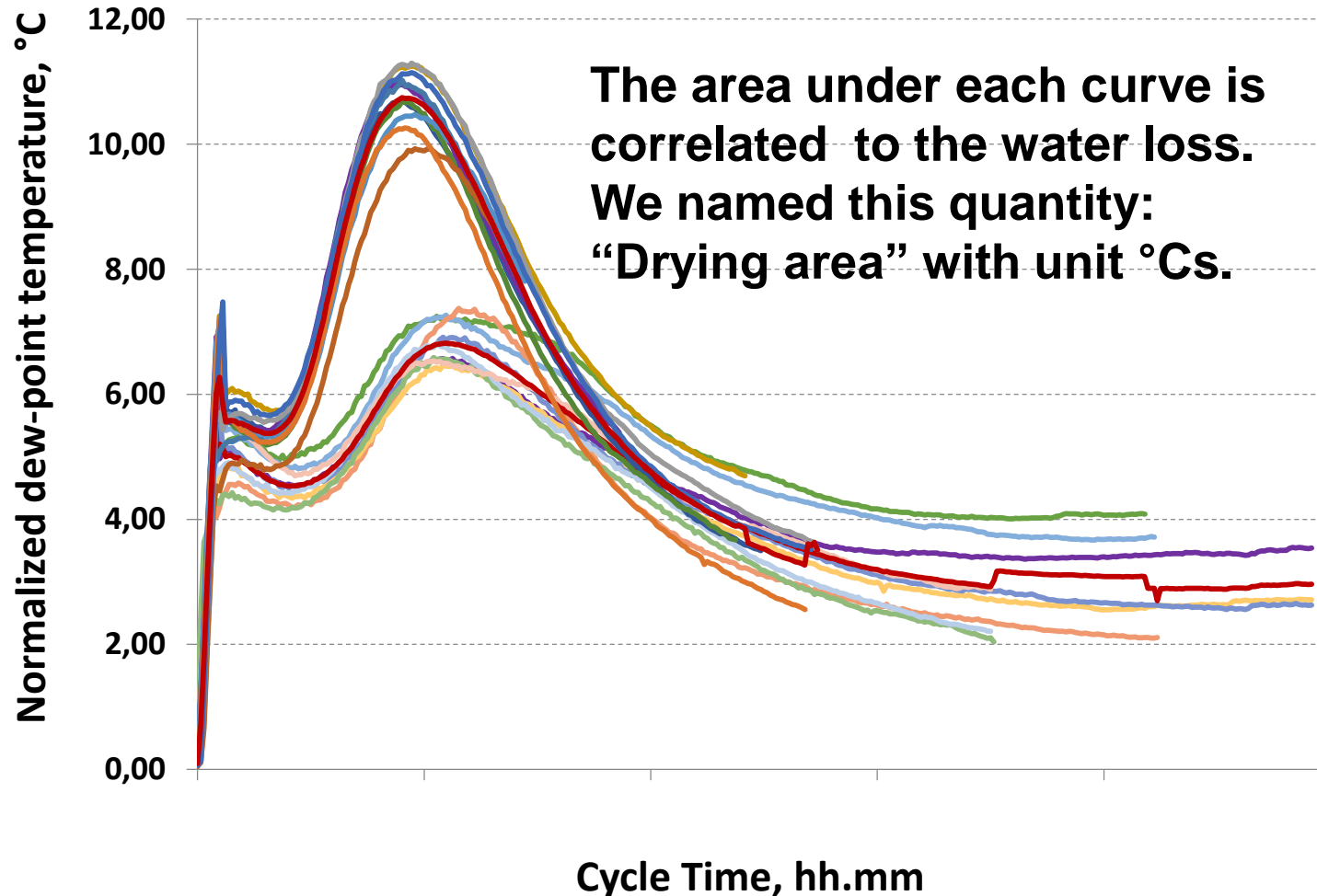
● Air temperature sensor

IR heater lamp

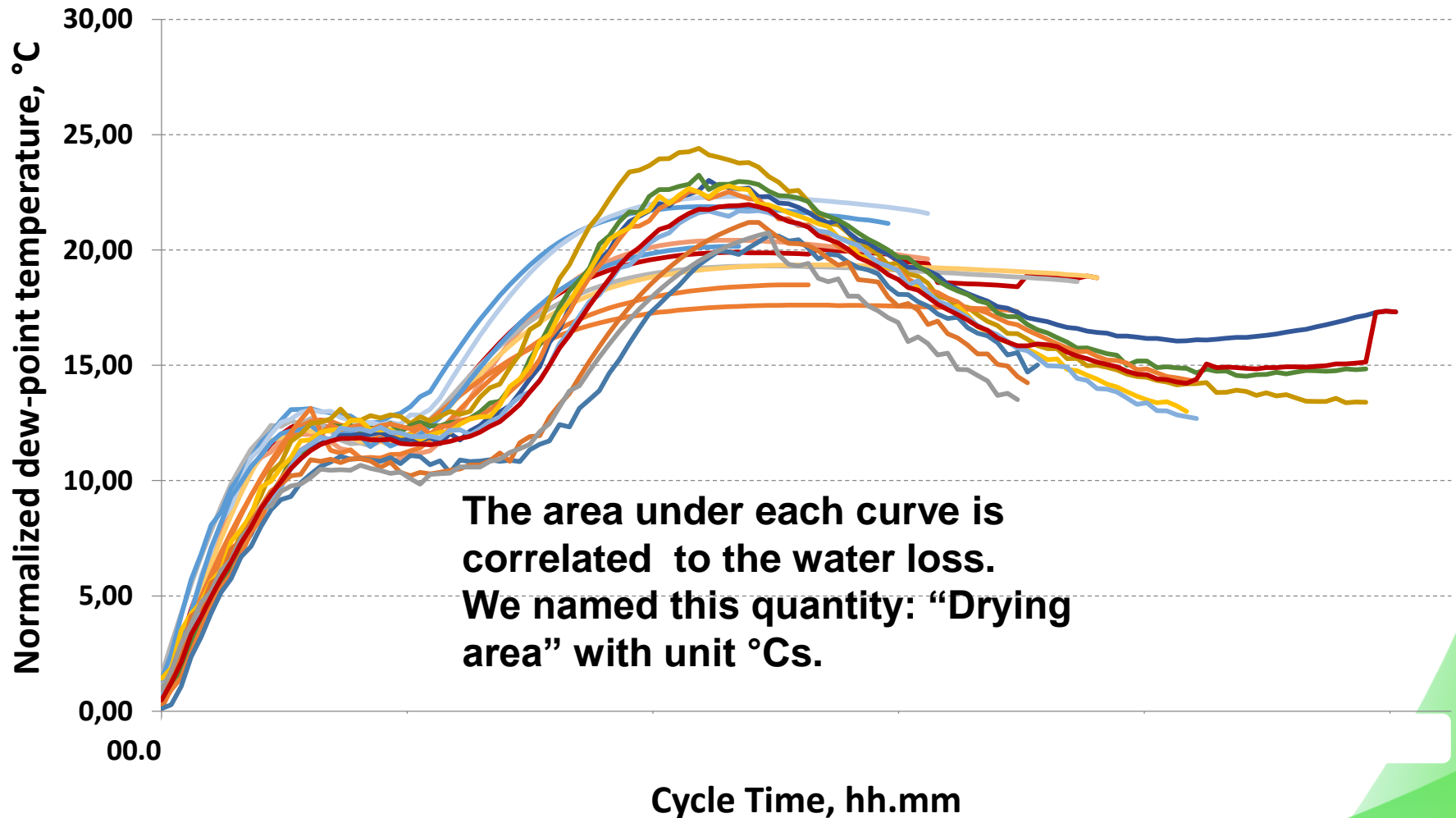
Air outlet (sampled by the dew-point meter)

Hazelnut inlet

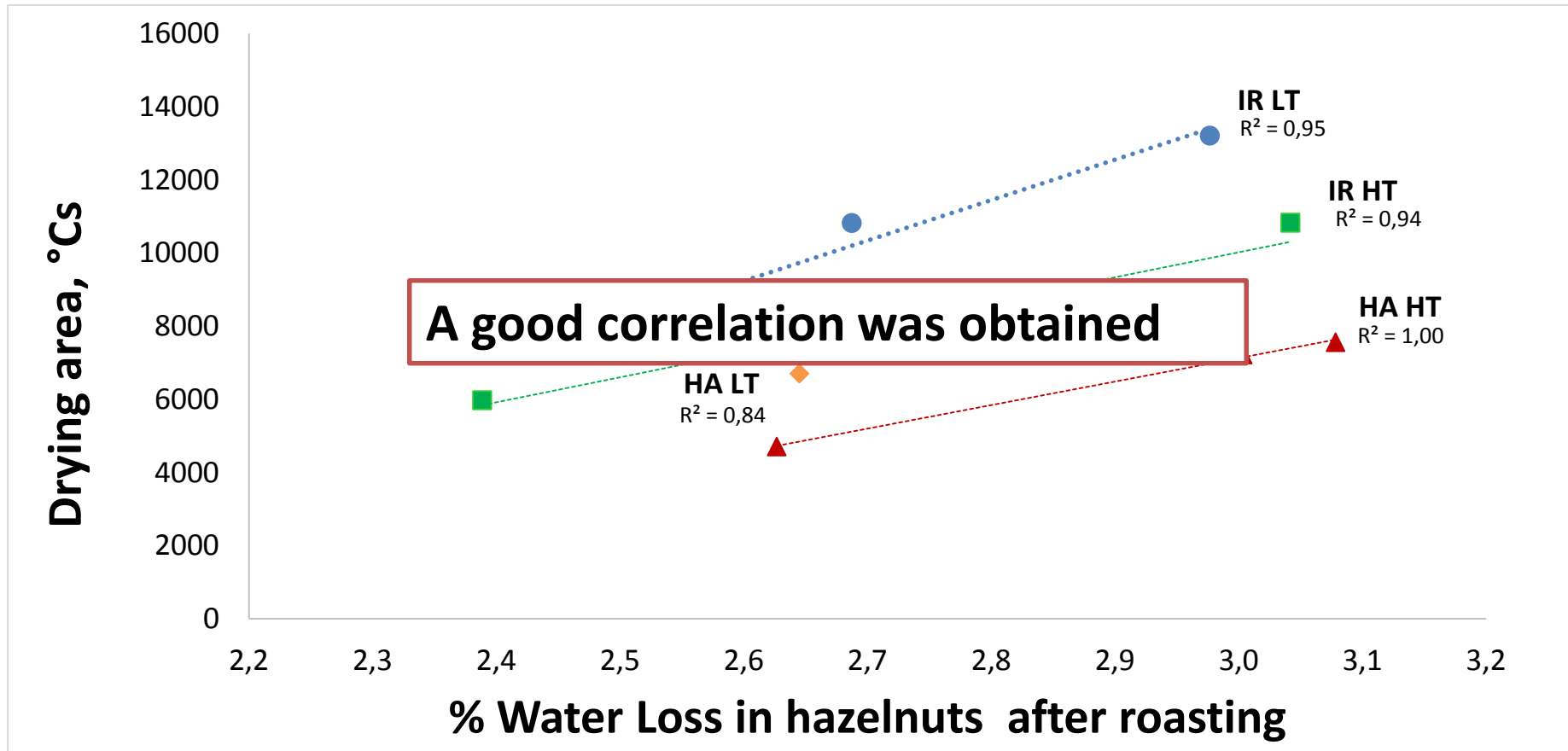
# Normalized dew-point temperature measurements during roasting process in hot-air oven.



# Normalized dew-point temperature measurements during roasting process in infra-red oven



# Correlation between the percentage water loss during roasting measured by gravimetric method and by the real-time method





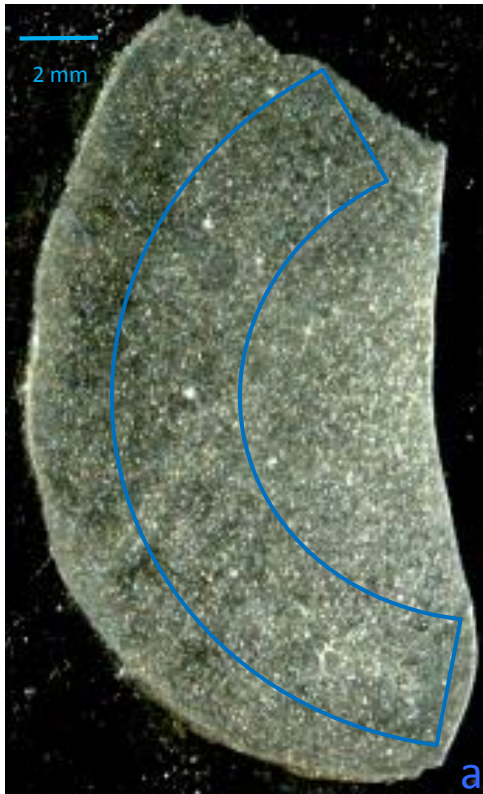
# Hazelnut Quality Assessment in relation to real time humidity measurement



- Water Activity
- MDA
- Lipid Peroxides
- Protein profile and allergenicity



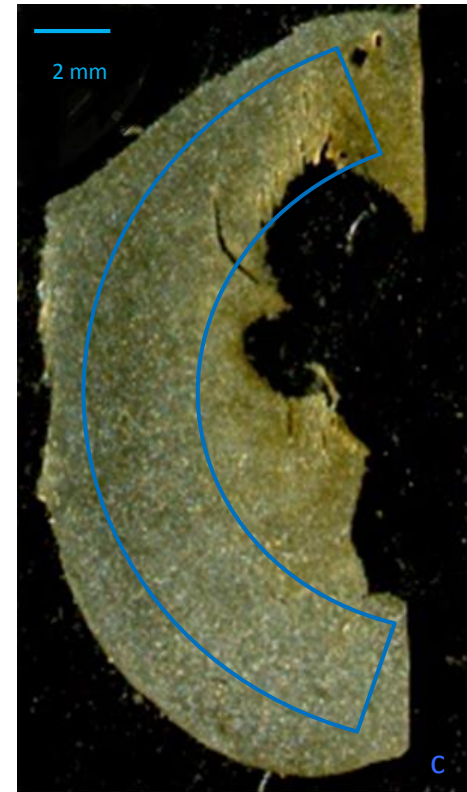
# Hazelnut observed at Optical Microscopy



**RAW**



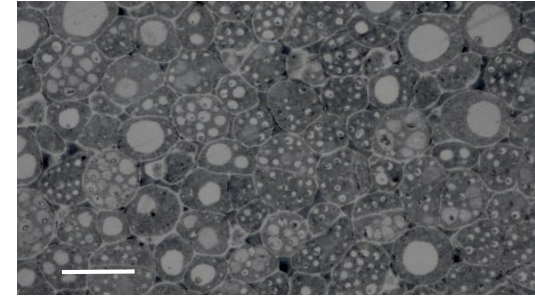
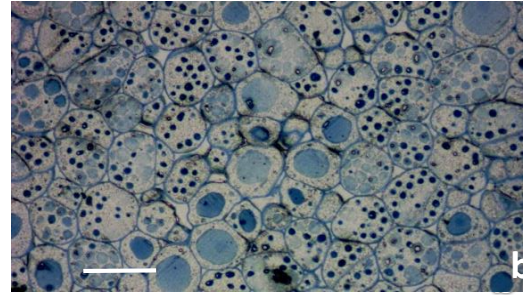
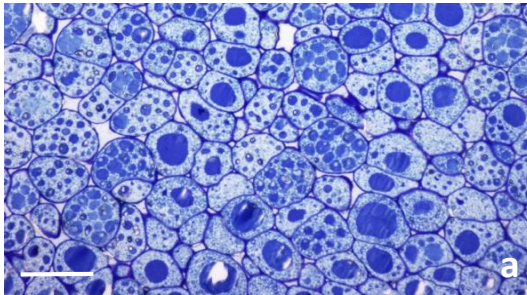
**HA ROASTED at LT**



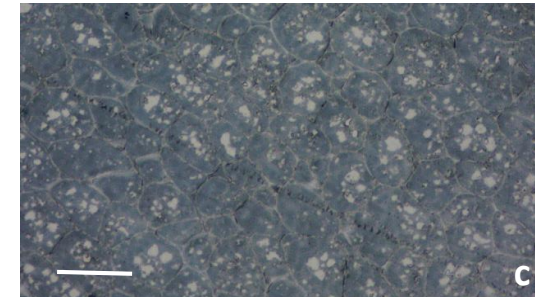
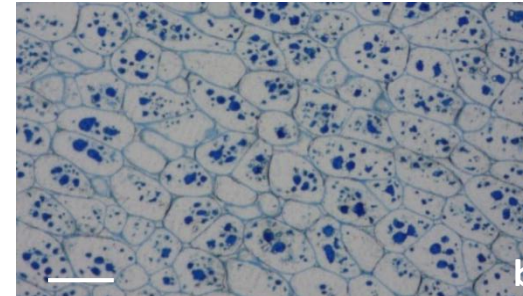
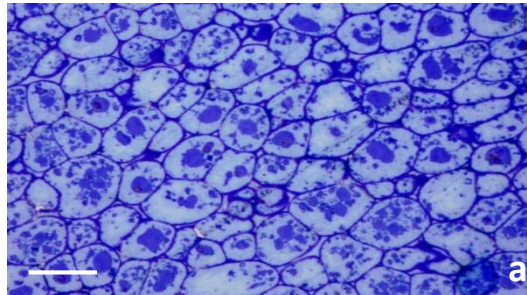
**HA ROASTED at HT**

# Hazelnut observed at Optical Microscopy

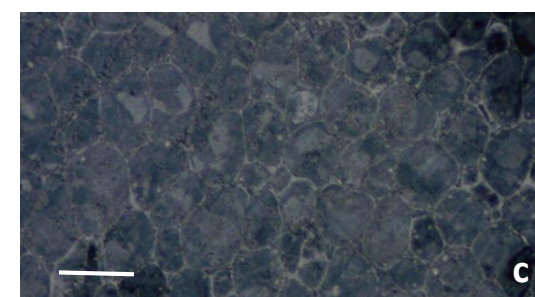
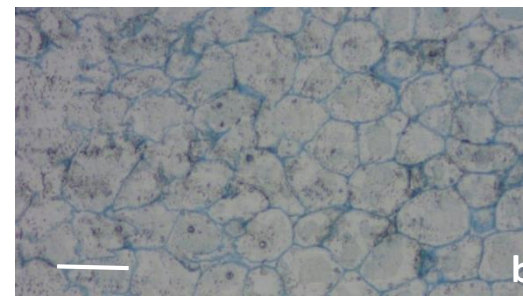
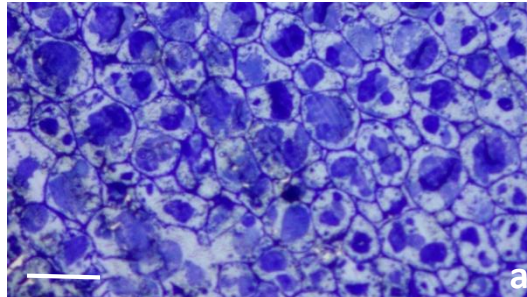
RAW



HA ROASTED  
@LT



HA ROASTED  
@HT



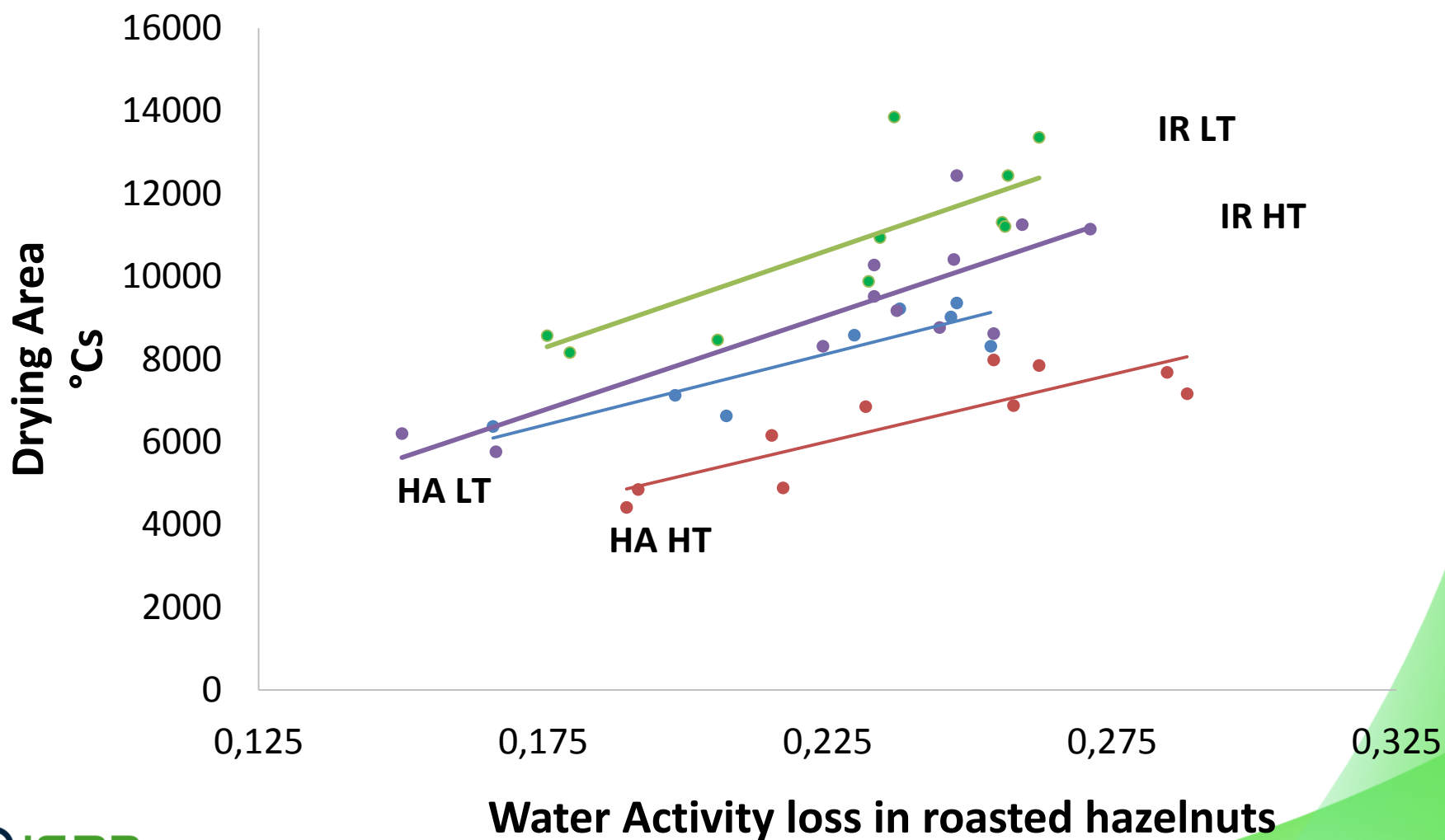
*a) Toluidin Blue*

*b) Protein staining  
(Coomassie Blue)*

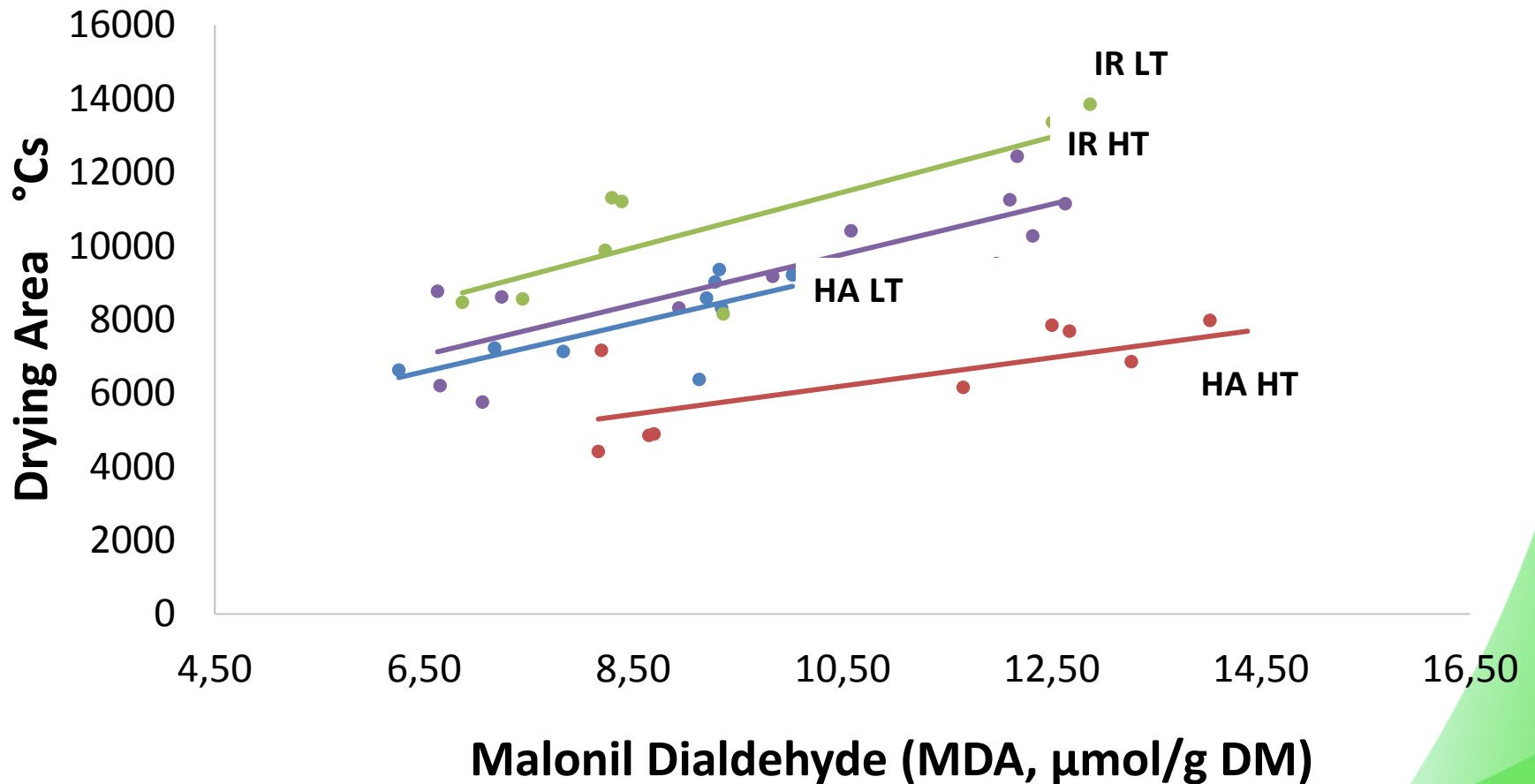
*c) Lipid staining  
(Sudan Black)*



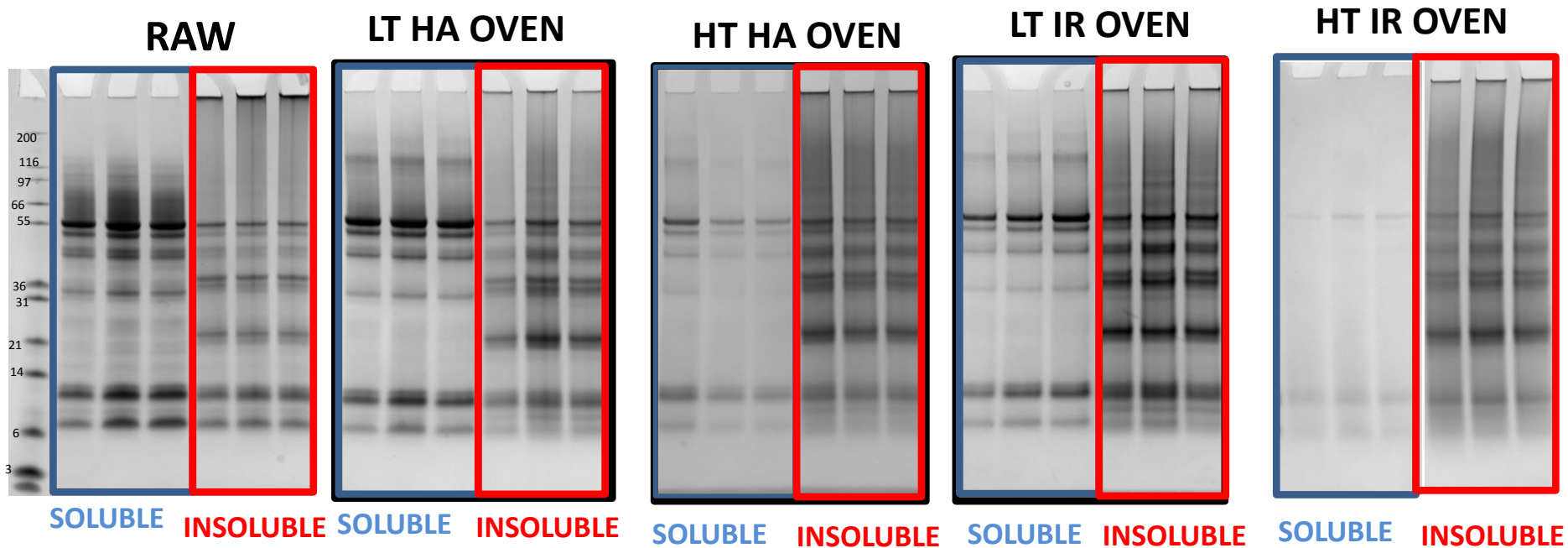
# Correlation between the Water activity loss in roasted samples and real time water loss during roasting



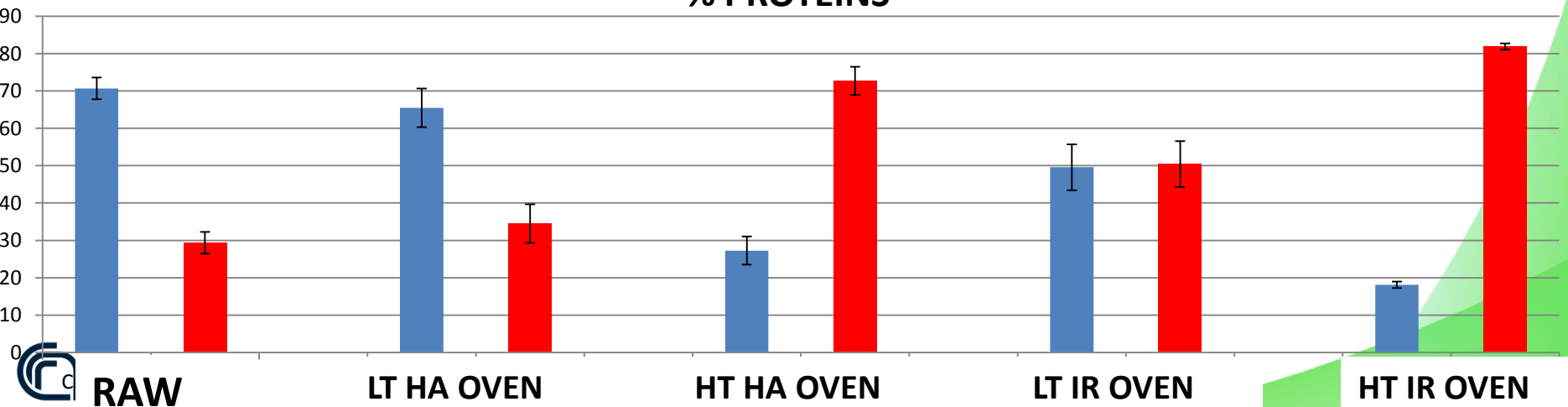
# Correlation between Lipid Oxidation in roasted hazelnuts and real time water loss during the roasting cycle



# Total Hazelnut Proteins Extract

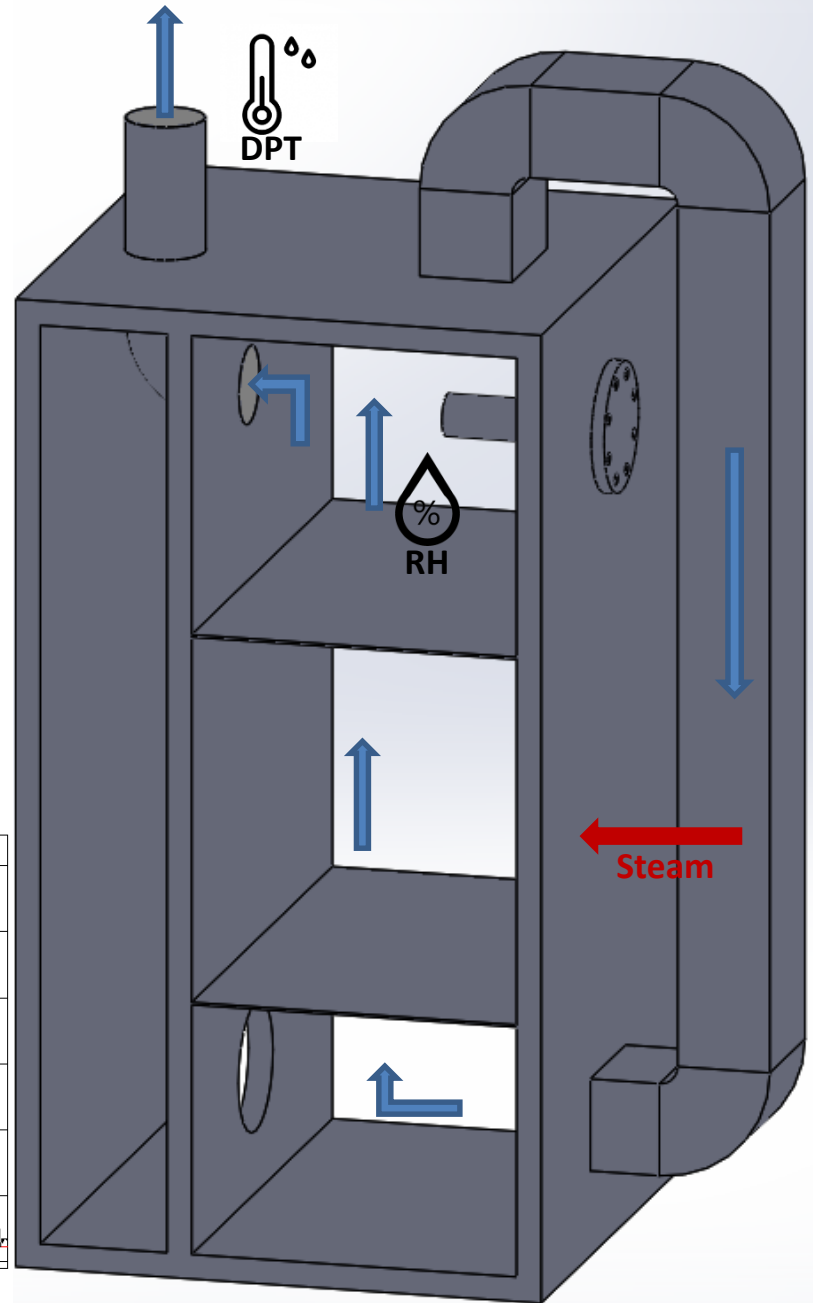
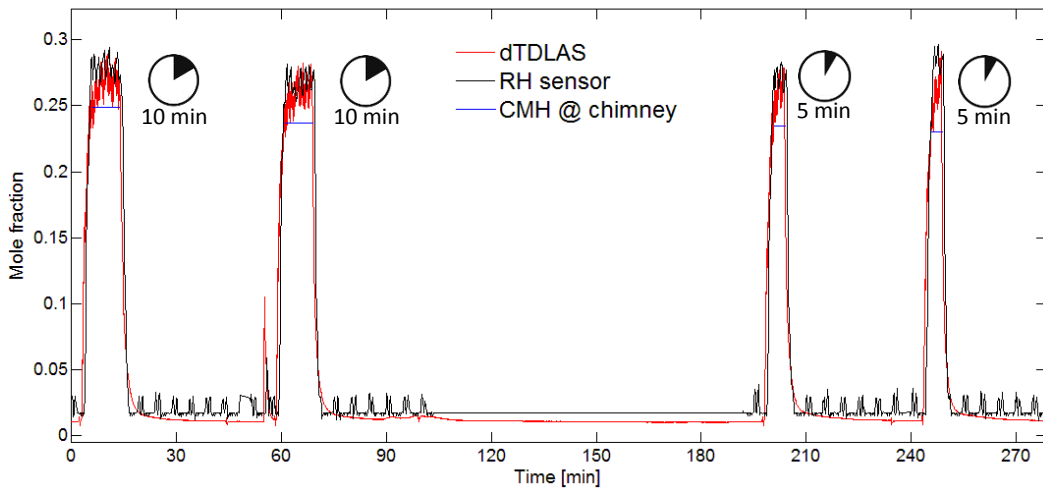


## % PROTEINS



## Generation and measurement of arbitrary humidity profiles

- A critical step in advanced food roasting/baking processes comes from a step-change in the tunnel oven humidity profile at a selected position due to steam injection to lower the ***potentially-hazardous acrylamide*** concentration.
- *INRIM* and *GBV* together with *TU-DA* and *PTB* have applied the dTDLAS hygrometer developed in A2.1.1 to demonstrate traceable transient high-temperature humidity measurements.





# Conclusions

- **Good reproducibility found between drying process repetitions, thus allowing to model the drying profile at different oven temperatures and heating methods(HA and IR)**
- **Issues due to oil contamination of the DP-meter was overtaken by means of the use of filter placed between the point of sampling and the mirror**
- **Rh capacitive probes revealed unsuitable for real time measurement due their low resolution, but revealed suitable for measurement with steam introduction during the process**
- **Good correlation between hazelnut water loss after roasting and real time water loss measurements during roasting**
- **Preliminary results on the correlation between humidity/temperature and roasted hazelnut quality are promising**

# Thanks to

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## **CNR**

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## **TU-DA**

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Bohlius

## **PTB**

Wagner

