

# PDO Tuscan Bread and Food technology research: an indissoluble marriage able to merge tradition, innovation and sustainability

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# PDO TUSCAN BREAD

*Bread made by a typical method in Tuscany which requires:*

- ✓ type '0' soft-wheat wholegrain flour + wheatgerm
- ✓ wheat varieties grown in Tuscany
- ✓ water; no salt due to historical reasons
- ✓ use of "an exclusive sourdough" starter

## *Organoleptic characteristics*

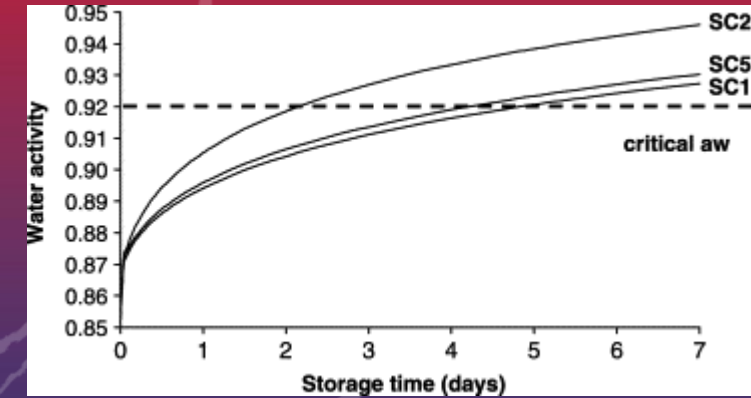
- ✓ aroma of roasted hazelnuts
- ✓ crunchy crust
- ✓ crumb's irregular holes
- ✓ white-to-ivory colour of crumb





# CPT DOP ↔ Pisa University projects

- ✓ The best operating conditions to be adopted in sourdough bread making
- ✓ Moisture migration in multicomponent product
- ✓ Modified atmosphere packaging for bread shelf-life extension bread
- Natural preservation: clean label solutions against molds and yeasts and packaging



# PDO Tuscan sourdough bread properties

## **TASTE AND FLAVOUR**

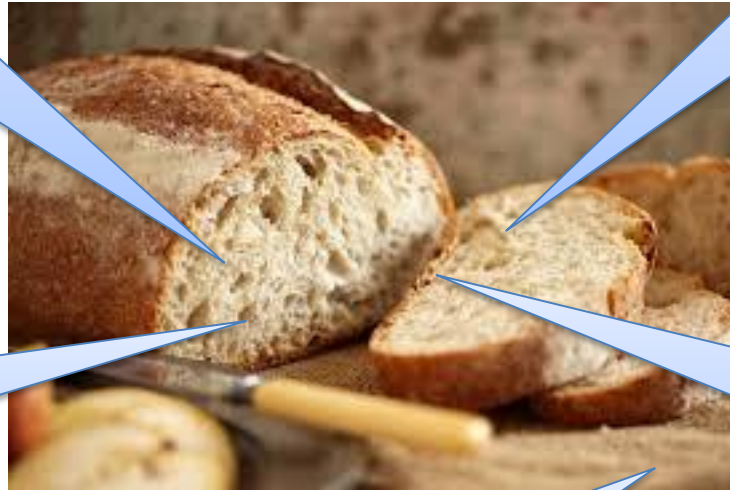
*LAB: production of L-Lactic and Acetic acids and secondary products*

## **SHELF-LIFE**

*Mould and bacterial spoilage: reduced  
Staling process: delayed*

## **VOLUME AND TEXTURE**

*In presence of lactic acid the mesh of gluten becomes more springy*



## **NUTRITIONAL VALUE**

*Stimulation of phytase  
Partial degradation of gluten*

**No salt (NaCl)**

# BAKERY PRODUCTS WITH REDUCED SHELF-LIFE\*, WHY? IT DEPENDS BY INTERNAL AND/OR EXTERNAL FACTORS

## PRODUCT PROPERTIES

(aw, pH, nutritional value, oxygen content, moisture content, recipe)

## PACKAGING PROPERTIES

(Gases barrier, Thermal stability, UV barrier, Antimicrobial/Antioxidant activity, Mechanical properties)



## STORAGE CONDITIONS

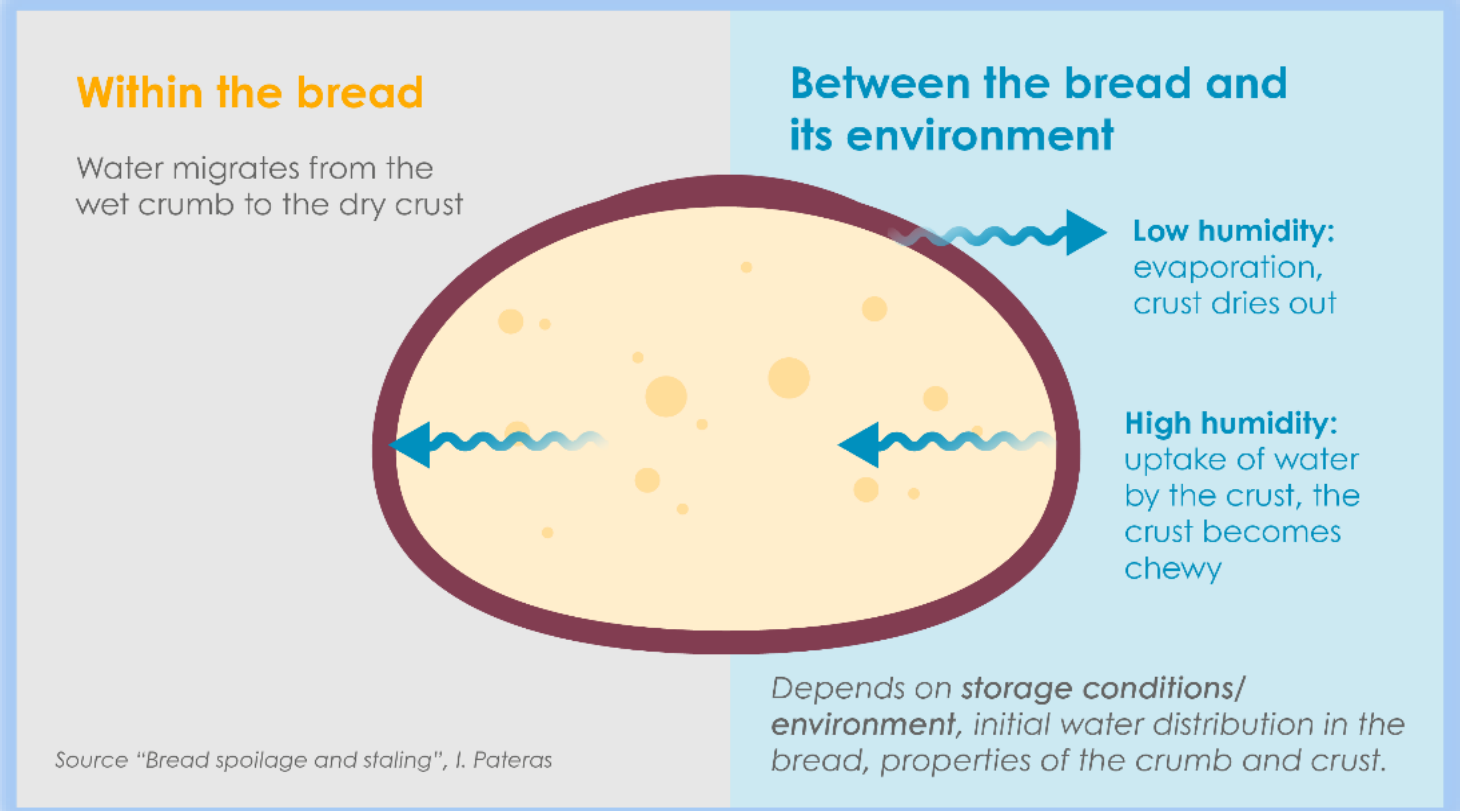
(Light, Environmental temperature, Humidity, Storage conditions)

## PROCESS CONDITIONS

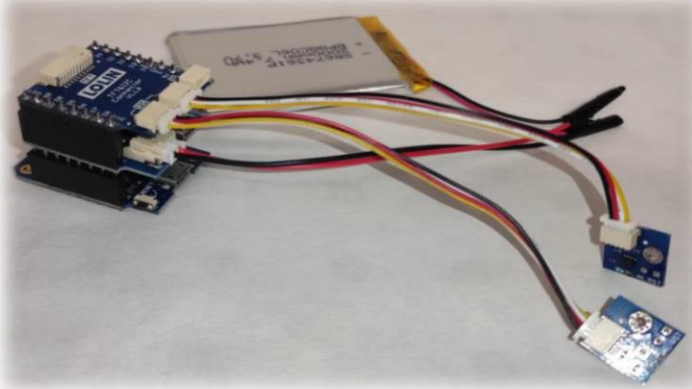
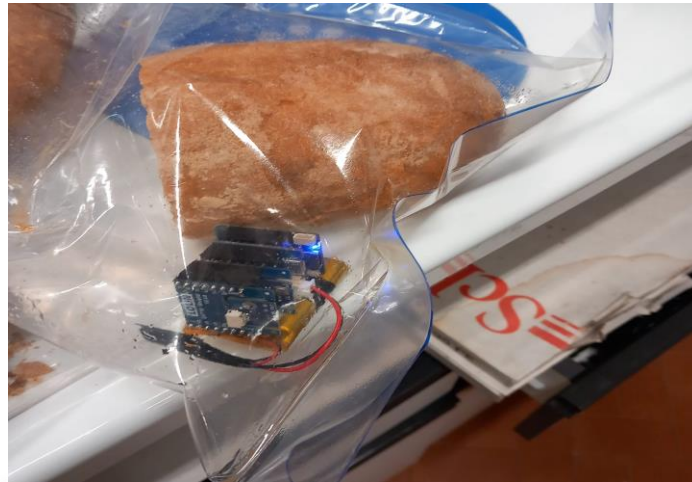
(Baking time/temperature, Cooling time management, Hygiene of processing environment)



# ANALYSIS AND MONITORING OF THE THERMAL PROFILE AND THE MIGRATION OF WATER



## DEVELOPMENT AND ADOPTION OF INNOVATIVE ON-SITE AND ON-TIME SENSORS



**SHT30 sensors connected to a microcontroller that are inserted inside the bread (in the crust and crumb). These measure the RELATIVE HUMIDITY and TEMPERATURE inside the bread during the shelf-life, from cooling to the appearance of the first fungal colony;**



developed by some physics of INFN-CERN



## STORAGE TESTS WILL BE CARRIED OUT USING MODIFIED ATMOSPHERES AND INNOVATIVE PACKAGING METHODS

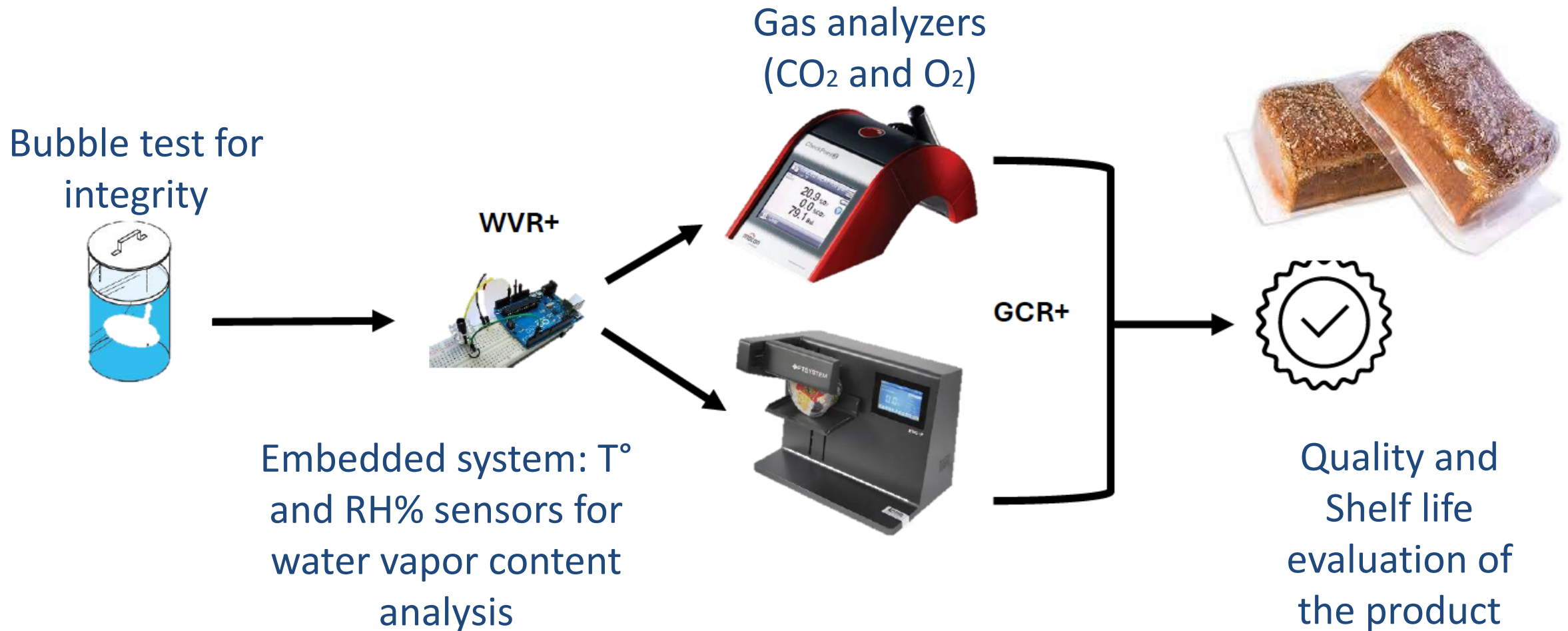


- **CONTROL**: Standard packaging used commercially for product distribution.
- **AIR FILM**: Plastic film impermeable to  $O_2/CO_2$  but permeable to  $H_2O$  vapor.
- **Bag in bag AIR/AIR**: Double wrap consisting of an inner film permeable to  $O_2/CO_2$  and an outer film impermeable to  $O_2/CO_2$  but not to  $H_2O$  vapor.
- **Bag in bag AIR/MAP**: Double wrap that has air inside the first package and an atmosphere with high  $CO_2$  concentration in the second



## Test 1 - Analysis protocol to select packaging materials

- The testing executed is based on the previously established protocol for evaluating the packages integrity:




# Results of Test 1


**Table 1:** Film types ranked by CO<sub>2</sub>, mass retention, and water vapor content: PET (1st), PP (2nd), PBS/PBS-CHT (3rd), and PLA (4th).

	Film Type (Ranking)					RANKING
	PBS (3)	PBSCHT (3)	PLA (4)	PP (2)	PET (1)	
CO <sub>2</sub> retention	Low	Low	Low	Medium	High	1. PET
Mass retention	Low	Low	Very Low	High	High	2. PP
Water vapor content	constant	constant	Not constant	constant	constant	3. PBS/CHT



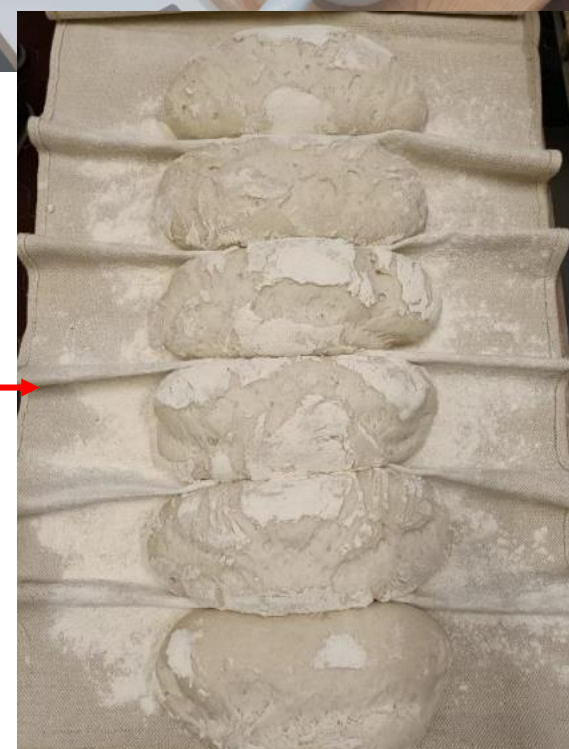
**Compostable**



**NOT Compostable**

## Test 2 - Bread making process

- *Breadmaking 1*: A total of 12 pieces of *Tuscan Bread PDO* were made for the experiment.





## Test 2 - Bread making process

- Once ready, the samples were all divided in half.
- Of the total 24 half pieces, 12 were sliced and 12 were kept whole, identified by **AFF** and **INT**, respectively, and a serial number (1 to 24).
- The Samples were then used for testing 6 different types of production methods:

ID	METHOD DESCRIPTION
1 – 3	<b>Bag</b> PET, Air (1) - <b>Bag</b> PP, Air (2) – <b>Bag in Bag</b> , Air/Air
4	<b>Bag</b> PET, ATM
5	<b>Bag in Bag</b> , PET Extern w/ ATM, PP Internal w/ Air
6	<b>Bag in Bag</b> , PET Extern w/ 100%CO <sub>2</sub> , PP Internal w/ Air

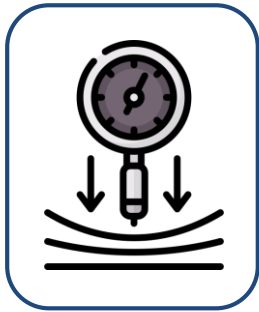




## Test 2 - Analysis protocol

- New sensor platforms were used in the testing combined with a more efficient software was used for collecting the data, which include the following parameters: **Temperature, Relative Humidity, Pressure, Water vapor content, Water vapor content, Absolute humidity, Dew point, and gas concentration (CO2 and O2).**

Pressure analysis for integrity

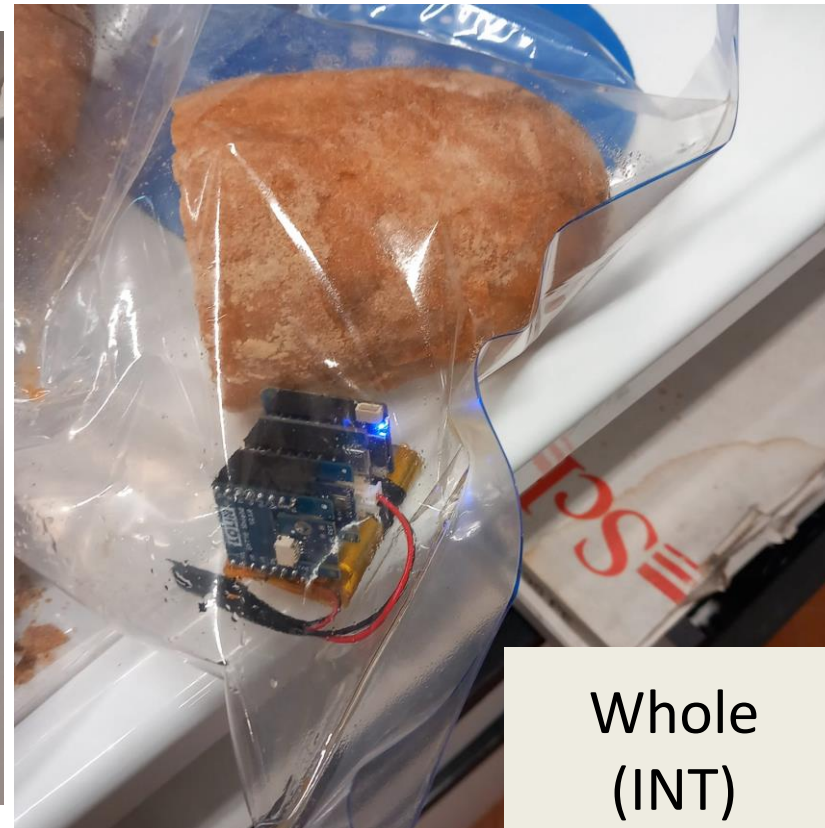
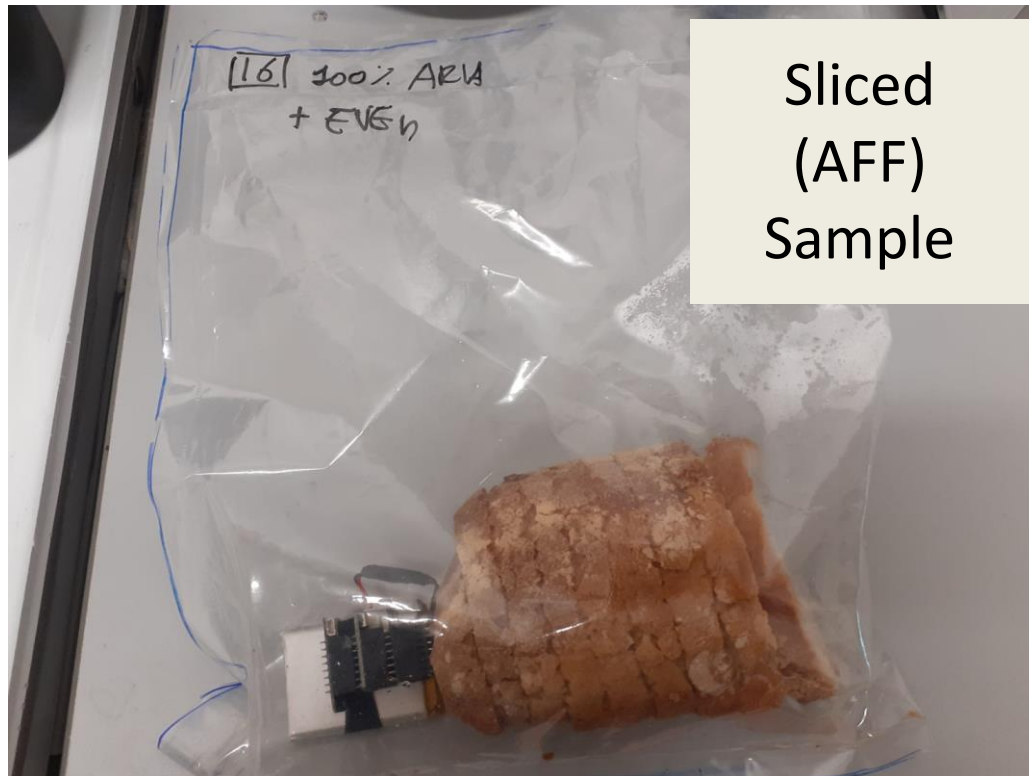


Humidity and Gas analysis for shelf-life



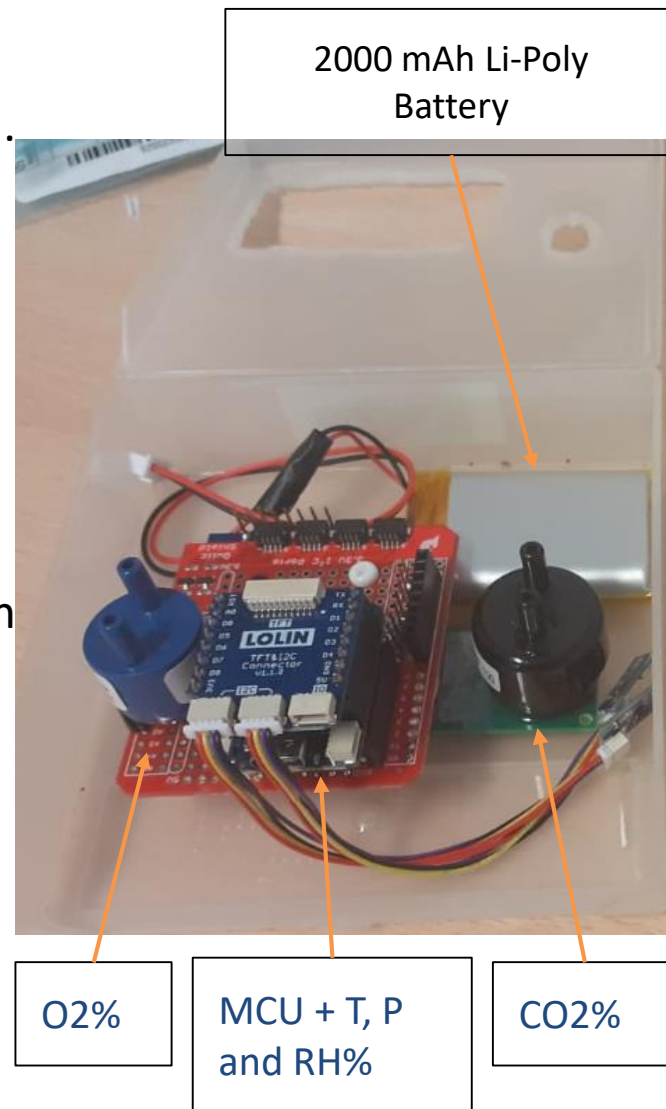
## Test 2 - Monitoring system

- Two types of sensors were used for the testing:
  - **D1 Mini Data Logger:** sensor device based on the ESP8266 MCU. Two sensors were integrated in the device (SHT30 Temp. + RH%, and HP303B Temp. + Abs. Pressure). The device is battery powered and estimated battery life-time is 80 days for a 2000mAh charge.



## Test 2 - Monitoring system

- **Gas Analyzer Data Logger:** sensor device also based on the ESP8266 MCU. This platform includes two gas sensors: 0-100% CO2 sensor, and 0-20% O2 sensor.
- Allows Periodic tracking of the internal atmosphere content inside the packages.
- However, the gas sensors operates with high currents (life-time is currently 20 h).
- The gas analyzers were used for the Bag-in-Bag samples



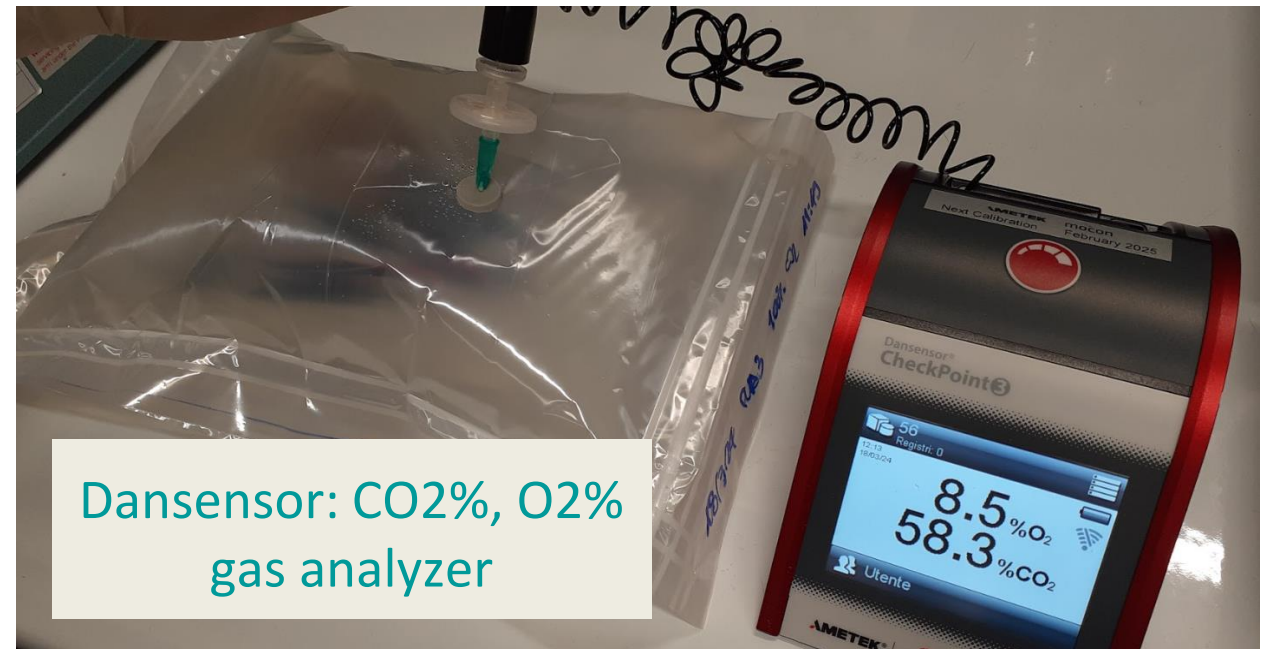


## Test 2 - Monitoring system

- The gas content measurements were compared with those obtained laser spectroscopy and a commercial gas analyzer (Dansensor).



FT Systems EVO-P (spectroscopy: CO<sub>2</sub>% and O<sub>2</sub>%)



Dansensor: CO<sub>2</sub>%, O<sub>2</sub>%  
gas analyzer



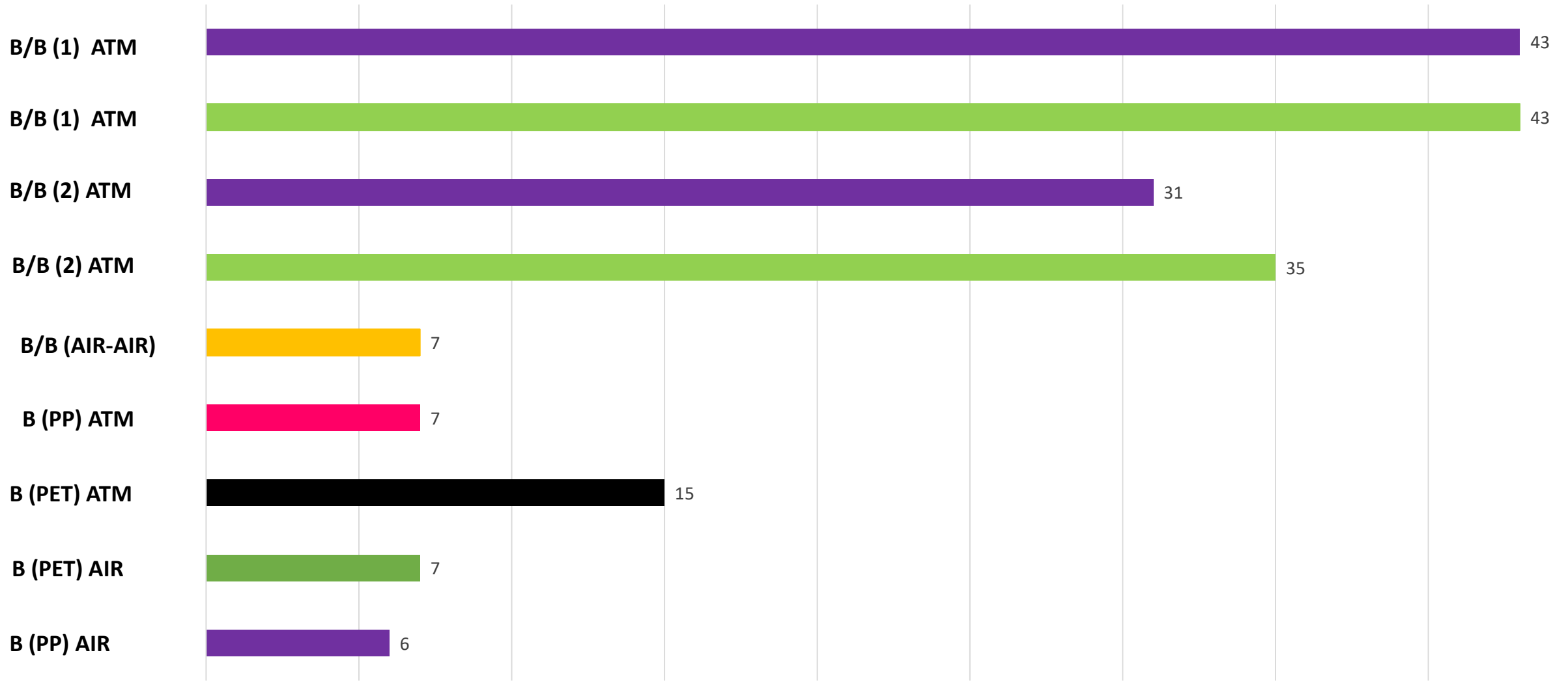
## Test 3 - Results

- The packages were prepared after the bread was left cooling down from the cooking process.
- During the test, the packages with bread and sensors were kept inside at temperature controlled chamber.
- Some samples presented condensation inside the packages, once placed in the temperature controlled chamber.



# Test 2 - Results

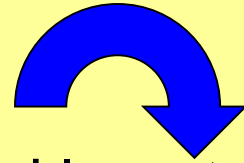
Shelf life (days)



# The future? .... It's now

COMBINE high quality sustainable raw materials, innovative protocol production and packages without the use of synthetic chemistry

in order to obtain



**Bakery products** of high quality and long-term shelf life which allows it to be marketed anywhere without the aid of synthetic additives



# Many thanks to each member of our multidisciplinary group

Consorzio Polo  
Tecnologico  
Magona

Department of  
Agriculture, Food  
and Environment -  
University of Pisa

Department of  
Pharmacy-  
University of  
Pisa



CPT DOP

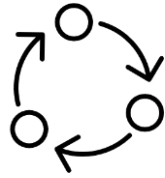
Department of  
Life Science -  
University of  
Siena

INFN



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**THANKS FOR YOUR ATTENTION  
BUT ... NOT ONLY BREAD**



# Investigation of the physical mechanisms influencing the chemical profile of wine unlocking the secrets of aquatic aging



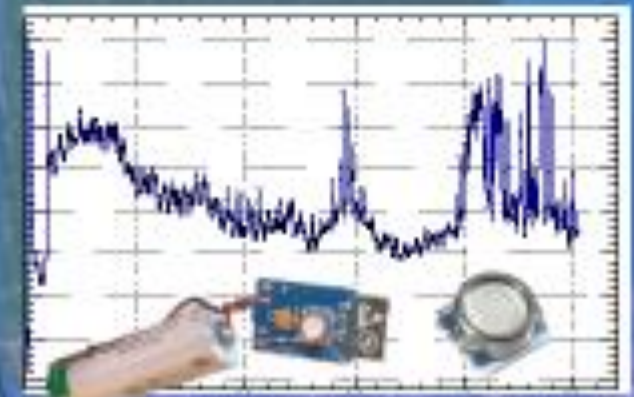
In recent years, the practice of ageing products under the sea has gained significant prominence. This unique method of refinement offers distinct advantages, such as enhanced flavor profiles and increased product quality but one of the main problems is the shortage of instruments to monitor the product during the refinement



The study aimed to elucidate the underlying mechanisms involved in the maturation of wines under sea conditions and compare them with traditional cellar aging



The sensors used were characterised by a piezoresistive material consisting of an elastic membrane that, as a result of physical deformations undergone, allows pressure differences to be measured



Research Results: Tailor made dynamic protocols creation for (unconventional or traditional) aging based on the data provided by the wines themselves (two ways communication approach)



**no**  
**additives**  
preservatives  
artificial ingredient  
animal proteins

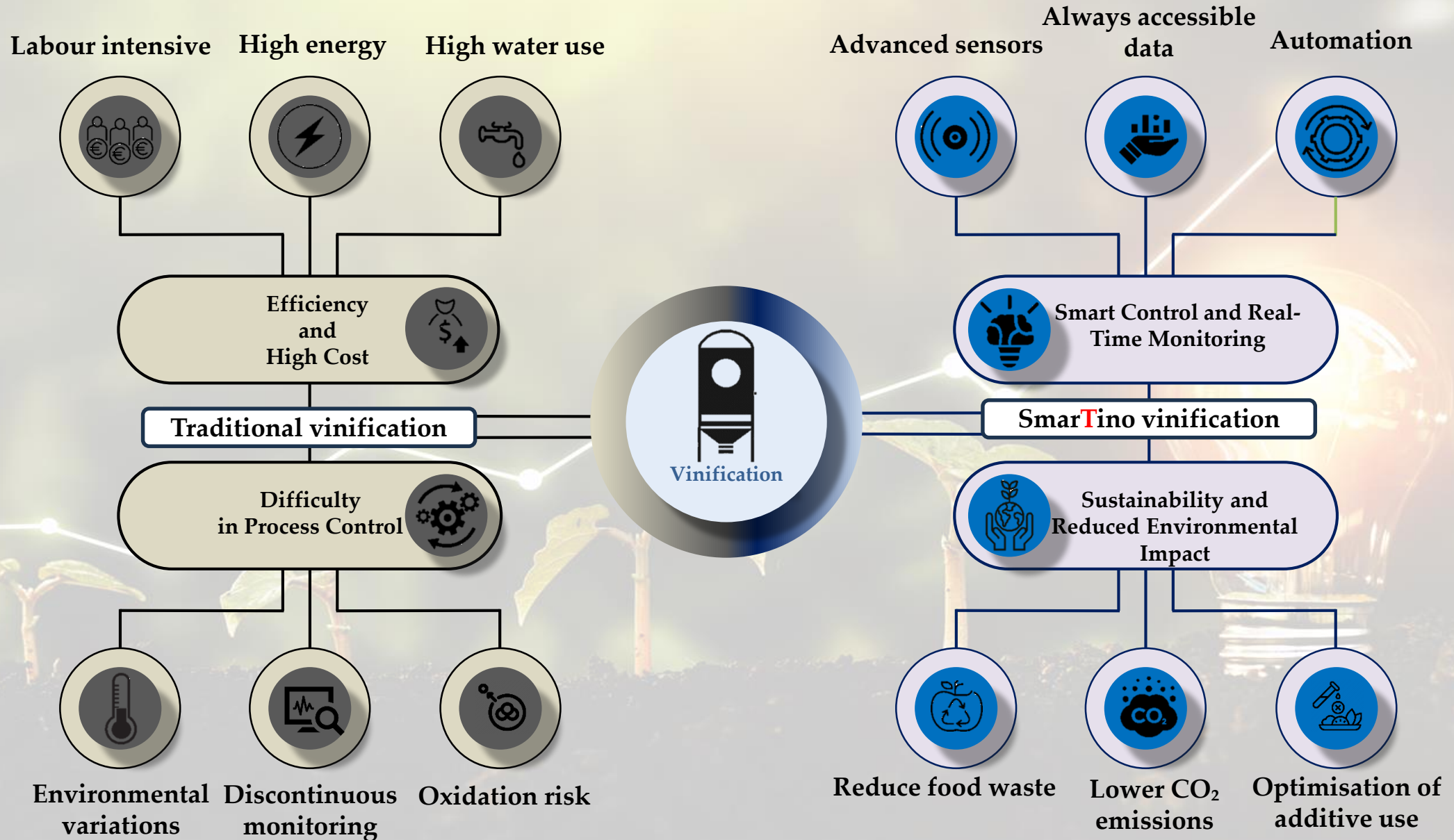


*Application of innovative technologies for the production of high quality and sustainable wines without chemicals added*





# SmarTino: The Future of Vinification between Automation and Real-Time Control



Results: Sustainable pollutants removal from wastewater



# High nutraceutical value oils that can be used both as supplements and as vegan ingredients for the preparation of high quality dishes



- Complex sensory profile



- High nutritional quality



- Significant Nutraceutical effect

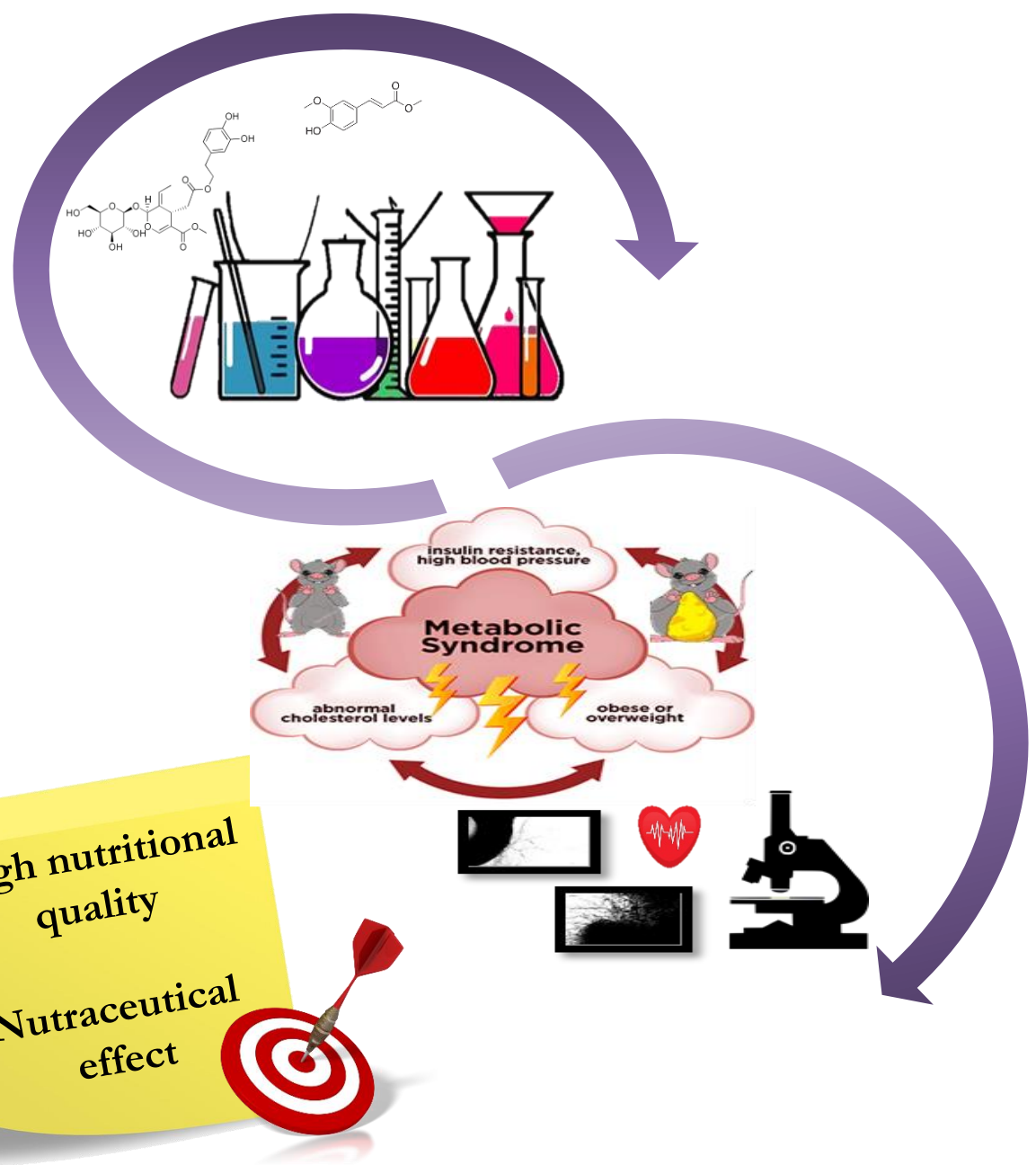




**PRODUCTION OF ANTI AGING COSMETIC CREAM WITH CITRUS FRUITS WASTE**







NEW HIGHER QUALITY OLIVE OILS STARTING FROM REFINED OLIVE OIL USING FOOD WASTES