

FRESHNESS LAB FOR FRUITS AND VEGETABLES

Facilities and Achievements • December 2015

The **Freshness Lab** of the University of Lisbon is a translational research unit specialized in fruit and vegetable supply chains. The **Freshness Lab** operates the most complete and sophisticated facility in Portugal specifically designed to understand and improve freshness, flavor, and nutritional value of fruits and vegetables, with a team that combines scientific excellence with executive experience in knowledge translation and innovation management in the agrifood sector.

The **Freshness Lab** is located in Lisbon in the logistic hub of Portugal, 15 min from the airport, and near the main ports, roads and railways for produce logistics. The warehouses of major food retailers, fruit and vegetable import-export businesses, the main service suppliers to the produce business, and the main Portuguese fruit and vegetable growing regions are within 60 min of the lab. Therefore, the **Freshness Lab** is a unique position to support the supply chain of fruits and vegetables within Portugal, inbound or outbound.

In addition to the operation in Europe, the **Freshness Lab** represents the University of Lisbon in the World Food Preservation Center LLC and is committed to the reduction of postharvest losses in developing countries.

Follows a brief presentation regarding the Freshness Lab describing:

1. Facilities
 - 1.1. Pilot plant and storage facility
 - 1.2. Instrumentation laboratory
 - 1.3. Laboratory of postharvest biochemistry and physiology
 - 1.4. Sensory analysis room
2. Methodologies
3. Main achievements in 2015
4. Research highlights
5. Contact information

More information is available at <http://www.isa.ulisboa.pt/en/freshness>.

FACILITIES

The **Freshness Lab** facilities are divided into four functional areas:

1. Pilot plant and storage facility;
2. Instrumentation laboratory;
3. Laboratory of postharvest biochemistry and physiology;
4. Sensory analysis room.

These combined pilot and laboratory facilities provide a unique environment to explore the fundamental bases of freshness, flavor, and nutritional value of fruits and vegetables, and to help supply chain operators to improve their storage, transportation, and marketing protocols.

Pilot plant and storage facility

The pilot plant and storage facility is equipped with the main technologies to perform applied research on cooling, storage, simulated transportation, packaging and retail display of fruits and vegetables. This modern infrastructure uses technologies similar to those used in the most advanced commercial storage settings dimensioned to provide the faster adjustments and more precise measurements required in research.

The facility is equipped with:

- Cold rooms (51 m³) capable of fast cooling and precise control of temperature and relative humidity;
- "Last mile" room simulating retail, food service, and household conditions;
- Indirect expansion refrigeration system using glycol as a secondary heat transfer fluid;
- Experimental controlled atmosphere installation with 12 independent cabinets designed for continuous and precise control of partial pressure of oxygen, carbon dioxide, nitrogen, and ethylene, and their continuous measurements and registration;
- Proprietary device for fast cooling and precise temperature maintenance to study temperature effects on the kinetics of quality changes;
- Cabinets for short-term postharvest treatments, e.g. with 1-methylcyclopropene;
- Gas mixing system;
- Gas analyzers for oxygen, carbon dioxide, nitrogen and ethylene;
- Nitrogen generator;
- Carbon dioxide scrubber;
- Vacuum pump;
- Air compressors.

Instrumentation laboratory

This laboratory has state-of-the-art equipment for chemical separations and analyses and for analyses of physical properties. The main equipment available are:

- Platform of chromatography, including gas chromatography with single quadrupole mass spectrometer and flame ionization detectors;
- Universal texture analyzer with two load cells and several probes and clamps to measure a wide range of mechanical properties of fruits and vegetables;
- Acoustic detector with microphone and pre-amplifier with high sensitivity to the frequencies emitted by brittle products and low sensitivity to mechanical noise used to analyze the sound related to the perception of crunchiness or crispiness;
- Tristimulus colorimeter for surface color analyzes;
- Digital camera and lighting system for photography and software for image analysis;
- Devices for nondestructive assessment of quality based on radiation reflectance or transmittance, including a chlorophyll meter (SPAD 502) and a near infrared reflectance spectroscopy device (DA meter);
- Several temperature sensors and data loggers.

Laboratory of postharvest biochemistry and physiology

Multipurpose wet lab equipped to study the biochemistry and the physiology of fruits and vegetables and support the engineering of produce quality, with the following functions:

- Metabolites and enzymes related to quality and its changes - beneficial and detrimental - during logistic operations, in interaction with packaging, or caused by postharvest treatments;

- Physiology and biochemistry of the respiratory metabolism, color changes, softening and other textural changes, and postharvest disorders;
- Identification and quantification of organic volatiles emitted by fruits and vegetables, including flavor-important volatiles related to sensory quality, and volatile markers for ripening, physiological disorders or decay;
- Characterization of phytochemicals and nutrients in fruits and vegetables, including changes in dietary fiber;
- Physiology and biochemistry of maturation, ripening and senescence.

Available equipment include:

- UV-Vis spectrophotometer;
- Refrigerated centrifuge;
- Water bath with reciprocal shaking;
- Several precision electronic balances;
- Conductivity meter;
- pH meter;
- Refractometer;
- Titrator;
- Hood;
- General multipurpose laboratory equipment and glassware.

Sensory analysis room

Two sensory analysis rooms are available. Consumer and trained sensory panels are available and most sensory analysis methodologies can be applied as required. The **Freshness Lab** has the ability to train sensory panels for specific projects. Currently a trained panel is maintained to assess the texture profile of pear according to the standard ISO 11036.

METHODOLOGIES

Methodologies most frequently used in the **Freshness Lab** are:

- Catalytic activity of enzymes related to the biochemical bases of quality, namely pigments and color changes, cell wall and texture, volatile compounds and aroma, phytochemicals and functional value, soluble compounds and taste;
- Primary and secondary plant metabolites;
- Gas chromatography with mass spectroscopy and flame ionization;
- Texture analysis;
- Image and color analysis;
- Sensory analysis;
- Nondestructive methods for quality assessment of fruits and vegetables;
- Mathematical modeling of mass and energy transfer phenomena in food, storage, and packaging systems.

MAIN ACHIEVEMENTS

In 2015 the Freshness Lab provided services to 23 companies including the major modern retailers, fruit growers and packing houses, companies representing more than 60% of the Portuguese pear production, and major producers' organizations of fresh and processing vegetables. In addition, the work of Freshness Lab is supported by long term agreements with the major players in the Portuguese fruits and vegetable sector. The main contributions in 2015 were:

- Implementation of the Postharvest Unit for Rocha Pear, an industry-sponsored research programme for postharvest of Rocha pear in a partnership with 14 export-oriented companies of Rocha pear producers;
- Development of a quality control system to improve fruit flavor and reduce losses in a leading company providing office water, coffee, and fruit snack services nationwide;
- Redesign of the supply chain of peach and nectarine in a leading retailer to improve fruit flavor and consumer satisfaction;
- Implementation of a cropping system in 45-hectare orchard of peach and nectarine with improvement of economic results via cost reduction, yield optimization, and improved fruit size, soluble solids content, and flavor;
- Proof of concept for achieving better flavor in beef-type tomato in a soilless growing system;
- Technical solution of a food safety issue in a food sector operator;
- In house training on fruit and vegetable supply chains for managers of two retail companies;
- Expert report at the court request related to greenhouse vegetable production;
- Training on postharvest of pome fruit for ca. 70 trainees from production and packing house companies (executive level).

RESEARCH HIGHLIGHTS (SINCE 2010)

- 42 articles published since 2010 indexed in the Web of Science (Thomson Reuters);
- 293 citations indexed since 2010 (Web of Science, Thomson Reuters);
- 1 “highly cited” paper (Web of Science, Thomson Reuters);
- Scientific publications (selected): <http://www.isa.ulisboa.pt/en/fl/research/publications>;
- Conference addresses & organization: <http://www.isa.ulisboa.pt/en/fl/research/conferences>;
- Patents. Members of the Freshness Lab team were inventors of the following family of patents: Lopes, C.M.B.S. & Almeida, D.P.F. 2012. Moldable protein matrix containing fruit, vegetables, chocolate or cocoa, for food applications, and process for its manufacture. Application number PCT/PT2012/000001; publication number WO2012096588A1. Also published as US20130330444 (USA), CA2824738A1 (Canada), EP2663199A1 (Europe). Under exploration by Frulact.

CONTACT INFORMATION

Domingos Almeida, PhD
Mobile: +351 964 310 788
Email: dalmeida@isa.ulisboa.pt
URL: www.isa.ulisboa.pt/en/freshness

ABOUT THE INSTITUTO SUPERIOR DE AGRONOMIA AND THE UNIVERSITY OF LISBON

Instituto Superior de Agronomia is the college of the University of Lisbon, Portugal, specialized in agricultural and food sciences. It is the most experienced, specialized and qualified research and higher education institution in Portugal in its scientific areas.

The University of Lisbon is the largest university in Portugal and a leading European university. It is the top Portuguese university in the international rankings and is among the 30 best European universities in agricultural sciences. It is a university from Lisbon to the world.