

INSTITUTO DE BIOTECNOLOGIA VEGETAL

ANNUAL REPORT - 2019



Universidad
Politécnica
de Cartagena

Campus
de Excelencia
Internacional



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FROM THE VICEPRESIDENT FOR RESEARCH

Food systems cannot be resilient if they are not sustainable. We need to redesign our food systems, which today account for almost a third of global greenhouse gas emissions, consume large amounts of natural resources, generate loss of biodiversity and negative impacts on health (due to both malnutrition and overnutrition) and they do not allow fair economic returns and livelihoods for all actors, particularly primary producers.

The new president of the European Commission, Ursula von der Leyen, aware that society demands an immediate response to the climate emergency, has made the European Green Deal the central axis of her policy and strategy "From farm to table" it is in its heart. The objective is to make food systems fair, healthy and respectful with the environment. Putting our food systems on a sustainable path will also open up new opportunities for operators in the food value chain. New technologies and scientific discoveries, combined with increased public awareness and demand for sustainable food, will benefit all stakeholders.

This context will be the great deal for the scientific work of our researchers belonging to the IBV, in areas such as environmental sciences, horticulture, technology and food sciences, water resources, agronomy, ... and agriculture in general during the coming years. Their past successful research will be the guiding light for the future of our University.



Prof. Dr. Beatriz Miguel Hernández

FROM THE DIRECTOR

The Instituto de Biotecnología Vegetal has continued with its task of generating knowledge and transferring knowledge to undergraduates, master and PhD students. It has also developed a strong activity of University extension with a strong push of contracts with the private sector. The researchers with double adscriptions to the IBV and other Schools or faculties had on average 117% of the maximum teaching capacity, demonstrating our activity in all aspects of the teaching duties, typical of University faculty. Nevertheless, we fully support a model whereby high-quality research leads to high quality teaching. Indeed, the median IBV member has four “six-year tracks” officially recognized by the Ministry of Education.

While the data of 2018-19 in our portal of Transparency shows a total budget with 58.28 M€ of income, total expenditure was 60.09 M€. Importantly, the self-generated income amounts 7.46 M€ from learning fees and 5.93M€ from research projects. The conclusion from the aforementioned data is that keeping a strong research effort is a requirement in order to maintain our University.

Since 2017 we started to offer our infrastructure and pay for its use in order to obtain additional funding for maintenance and acquisition of small infrastructure. During the 2019 we obtained over 5000€ for the use of our equipments, helping us maintain ourselves. We were also able to obtain 349600€ of FEDER extramural funding. This was a timely success as we will develop a new climate change laboratory. In order to avoid obsolescence, we need to renew our research lines. Our aim is to keep up with new directions required by the society, and stemming from new discoveries and technologies.

The IBV has maintained its activity as sponsor of teaching the Curso Internacional de Tecnología Postcosecha y Procesado Mínimo, the Online Course on Postharvest and Fresh Cut Technology. Researchers of the IBV teach at a Bayer-Crops master for their employees with the Universidad Politécnica de Valencia. Our teaching duties included the formation of technicians of the program “*Ayudas a la contratación en prácticas de titulados en Formación Profesional de Grado Superior*”. This allowed us to form three persons in 2019. One of them was headhunted by a private company and left before ending the

contract, due to the high skill level achieved in our facilities and working with our research units.

Despite this success and as in previous years, our aim is to go into a model whereby technical persons dedicated to research and teaching undergraduate, graduate and PhD students in techniques during their projects, form a substantial part of our University system.



Prof. Dr. Marcos Egea Gutiérrez Cortines

Director

**COLLABORATIVE
RESEARCH PROJECTS**

Project title: DIVERFARMING: Crop diversification and low-input farming across Europe: from practitioners engagement and ecosystems services to increased revenues and chain organization

Coordinator: Dr. Raúl Zornoza (UPCT).



DIVERFARMING

H2020 728003



Diverfarming is a project financed by the Horizon 2020 Programme of the European Commission, within the challenge of 'Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy'. It seeks a paradigm shift in European agriculture through the diversification of crops and the rational use of resources.

With the intention of exploring the potential for crop diversification to improve productivity, provide ecosystem services and make the value chains more sustainable and efficient, over 200 people attended the first European Conference on Crop Diversification held between the 18th and 21st of September in Budapest. The Diverfarming team was present with eleven oral communications and eight posters on the topics researched to date. The project coordinator, Raúl Zornoza, presented the results of the organic combination of melon and cowpea as an option to improve productivity in the melon harvest. He also moderated, together with Sören Thiele – Bruhn (University of Trier), the session on microbial functional diversity of the soil improved by the diversification of the cropping systems.

The advances in crop diversification of the European Diverfarming project were present in the '1st Training Days in Ecological Agriculture', organised by the Regional Ministry for Water, Agriculture, Fisheries and the Environment of Murcia and held in CIFEA in Lorca on the 27th of September. The professor from

IBV-ETSIA-UPCT Josefina Contreras was in charge of detailing the project's breakthroughs.

After two-and-a-half years of work, the Diverfarming project research group has drawn up the crop diversification map for Europe according to the different edaphoclimatic regions, and now is looking for members of the agricultural community to put that diversification into practice.



Project title: SUPERPESTS: Innovative tools for rational control of the most difficult to manage pests ("super pests ") and the diseases they transmit

Coordinator: Prof. Dr. John Vontas, Agricultural University of Athens.

UPCT Coordinator: Prof. Dr. Pablo Bielza.



The Research Unit 'Resistance to insecticides' within the frame of the European project 'Innovative tools for rational control of the most difficult to manage pests and the diseases they transmit (Superpests)', funded by the Horizon 2020 Framework Program, participates in the achievement of several milestones:

- Identification and validation of seven new resistance markers in four different pests. Knowledge of the associated resistance genotype will help decide which pesticides should, or should not, be applied in order to successfully restrain these pests, and avoid a further spreading of resistance.
- There have been performed several tests of non-conventional chemistry formulations, which revealed very good potential for the control of resistant pests. Appropriate targets for RNAi-based spider mite control have been identified.
- It has been developed a web-based app for exploring the dynamics of tri-trophic predator-prey model. The model has already produced some suggestions, e.g. addition of carnivore has significant and positive effects.
- A virtual insectary of most highly resistant SuperPests has been created. In vitro assays based on SuperPest cytochrome P450s has been developed, as well as recombinant fruit-flies bearing defined resistant traits have been developed and used.

- Tomato defense mutants are ready to be used. Testing on the first predator-prey community combination has been completed. Work is ongoing to evaluate the genetic variability and biodiversity of BCAs.
- Review documents on biopesticide pest control options and regulatory pathways have been drafted. A workshop on translation research and regulatory pathways for biopesticides has been planned. E-learning units are outlined. A series of quizzes by using a web platform for quiz hosting has been designed. Implementation of practice abstracts is ongoing.

Partners:



SPIN OFF companies

BIOENCAPSULATION AND iPACKAGING, S.L. (BIO-iPACK)



This spin off, created in June of 2017 by the Research Unit Biotechnological Processes, Technology and Engineering headed by Prof. Dr. Antonio López Gómez is Located in Parque Tecnológico de Fuente Álamo (Murcia, Spain). They have dedicated a big effort in the research of formulations of essential oils and their components, and micro and nanoencapsulates.

The company is mainly focused on placing on the market products and technologies associated to patents. One of these patents develops the concept of active cardboard packaging for fresh fruits and vegetables, in bulk or in flow-pack.

Essential oil formulations have been developed to be applied in vapour form or as nanoemulsion in refrigerated packaged products. The generation and application of steam from essential oils to solid foods, at an industrial level, is carried out according to patented and proven technology.

They have also established nanoencapsulated formulations of essential oils to be applied in:

- ✓ The manufacture of active packaging - cardboard or plastic, or wood - with antimicrobial and antioxidant activity and, in certain

cases, with anti-germinating activity and control of ethylene production.

- ✓ The product during its preparation and / or packaging, to achieve antimicrobial and antioxidant activity.
- ✓ The manufacture of ice becoming ice with antimicrobial and antioxidant activity, applicable in the preservation of fish and shellfish, and for the preservation of certain vegetables.
- ✓ The manufacture of ice for the stunning and slaughter of aquaculture fish, according to patented technology.

Web site: <http://bio-ipack.com/producto>

Private-funded CHAIRS

SUSTAINABLE AGRICULTURE



The Chair in Sustainable Agriculture of the UPCT is supported by the FECOAM and COAG associations, thirteen agriculture cooperatives of the Campo de Cartagena and the Fundación Bancaria “La Caixa”.

Main Results

A new plant of evaporation to generate a concentrated by-product using the calorific contribution of a biomass boiler has been developed. The clean water is released as steam, and concentrate the brine by the boiler with a cooling tower evaporation system.

The boiler is fed with almond shells to heat the brine. In the coming months, researchers will begin testing flash evaporation systems to crystallize the brine and thus obtain a solid residue of crystallized salt and zero effluents.

Researchers are also carrying out tests with water resulting from a double osmosis, a technique that was common until a few years ago in the Campo de Cartagena to be able to use well water for irrigation, with twice the concentration of nitrates and salinity than in previous tests. A denitrification yield of up to 97% was achieved. The process is carried out leaving the water obtained from osmosis 24 hours in contact with the pruning resulting from orange and lemon trees.

Director of the Chair: Prof. Dr. Juan José Martínez Sánchez.



AWARDS

HONORIS CAUSA PROF. FRANCISCO ARTÉS

The University of Foggia, in the Italian region of Apulia, awarded Prof. Emeritus Francisco Artés Calero, former Director of IBV, the title of Doctor Honoris Causa in Food Science and Technology.

The recognition was based on his decisive contribution to postharvest physiology and technology studies. The Italian university highlighted his career, universally recognized as pioneering in combining engineering, microbiology, chemistry and agronomy to preserve quality and safety of fruits and vegetables.

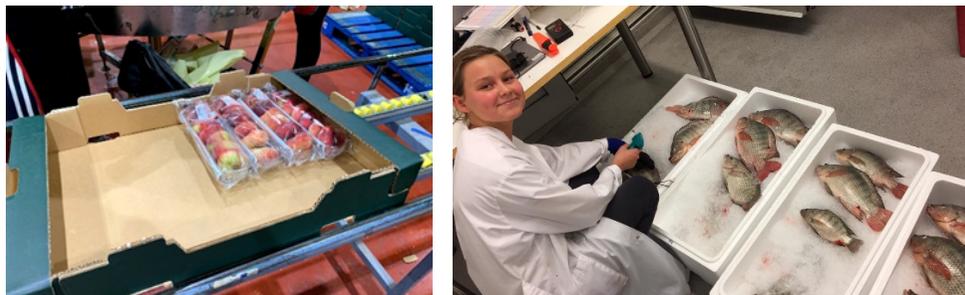
The honored acknowledgment was proposed by Professors Agostino Sevi and Giancarlo Colelli. During the ceremony, the Rector of the UPCT, Alejandro Díaz Morcillo, stated that this bestowment 'is a personal recognition to the figure of Professor Artés but it is also for the Universidad Politécnica de Cartagena, being the first honorary doctorate in UPCT's 20-year life.

Agostino Sevi, Director of the Department of Agriculture, Food and Environmental Sciences of the University of Foggia, recalled that the nomination of Professor Artés was unanimously approved 'due to the great depth of his scientific profile and considering that his studies are a point of reference on the international scientific scene and the results of his research have found application in the productive reality of many countries around the world'.



RESEARCH UNITS

BIOTECHNOLOGICAL PROCESSES, TECHNOLOGY AND ENGINEERING



1. Main results

In this year, 6 articles have been published in international journals (Postharvest Biology and Technology, LWT, Food and Bioprocess Technology, Aquaculture, PloS one) with high impact factor in its fields. One patent of an active packaging has been published as US Patent and European Patent (also published as patent in Brazil, Chile, Peru, and Mexico). In international congresses, 4 communications have been presented to ISFSI 2019 (3rd International Conference on Fish & Shellfish Immunology, Spain), and to the International Congress of Refrigeration (ICR2019, Canada). Prof. Antonio López Gómez is Editor of the International Journal “Food Engineering Reviews”.

2. Projects (most relevant)

-New multi-active cardboard packaging solution to extend the shelf-life of fresh fruits and vegetables by 40% - freshtray. Phase - 2, Call: H2020-SMEInst-2018-2020-2: (ref Agreement FRESHTRAY - 812001). Topic: SMEInst-02-2016-2017. Acelerating the uptake of nanotechnologies advanced materials or advanced manufacturing and processing technologies by SMEs. Participants: UPCT and SAECO company (Molina de Segura, Murcia), June 2018/January 2020. Principal Investigator: Antonio López Gómez.

-Innovative technology based on the integration of natural substances in ice to improve animal welfare and extend shelf-life of farmed fish phase - 2. Call H2020-SMEInst-2-2016-2017, in the area of SMEInst-08-2016-2017; Supporting SMEs efforts for the development - deployment and market replication of innovative solutions for blue growth (ref Agreement ICE2LAST -

804493). May 2018/April 2020. Principal Investigator: Antonio López Gómez.

3. Selected publications

Buendía-Moreno, L., Soto-Jover, S., Ros-Chumillas, M., Antolinos, V., Navarro-Segura, L., Sánchez-Martínez, M.J., Martínez-Hernández, G.B., López-Gómez, A. 2019. Innovative cardboard active packaging with a coating including encapsulated essential oils to extend cherry tomato shelf life. LWT, 116, 108584.

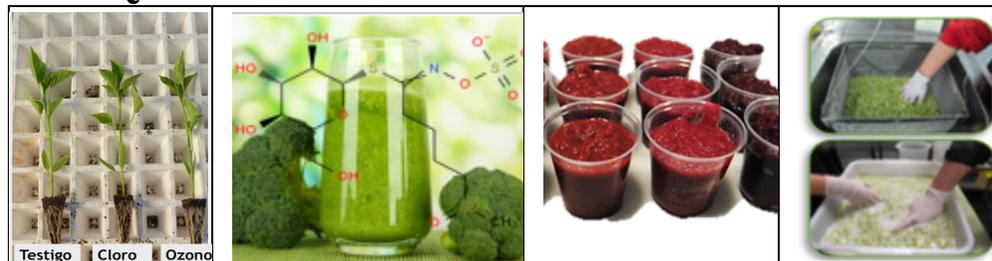
López-Cánovas, A. E., Cabas, I., Ros-Chumillas, M., Navarro-Segura, L., López-Gómez, A., García-Ayala, A. 2019. Nanoencapsulated clove essential oil applied in low dose decreases stress in farmed gilthead seabream (*Sparus aurata* L.) during slaughter by hypothermia in ice slurry. Aquaculture, 504, 437-445.

4. Others: Most relevant contracts

-Refrigerated meat products without gluten and healthier. Funded by CDTI - R&D Project 2017 (IDI- 20170705). Participants: UPCT and SEDIASA ALIMENTACIÓN S.A. Company (Madrid). 1/04/2017 to 31/03/2020. Principal Investigator: Antonio López Gómez.

Staff: Head of the Unit: Prof. Dr. Antonio López Gómez. Researchers: Prof. Dr. Ing. Asunción Iguaz Gainza; Dr. María Ros Chumillas; Dr. Vera Antolinos López; Dr. Ing. Ginés Benito Martínez Hernández; M.Sc. and Ph.D. Students: María José Sánchez Martínez; Laura Navarro Segura; Laura Buendía Moreno; Marta Barón Yusty; Alejandra Navarro Martínez.

FOOD QUALITY AND HEALTH



1. Main results

- Preharvest hormetic low doses of UV-C increases vitamin C and antioxidant capacity and induces fungal resistance in spinach.
- Glucoraphanin/sulforaphane system can be stabilized with cyclodextrines, which are also useful to reduce browning in High Hydrostatic Pressured (HPP) apple juice.
- Irrigation with ozonated water on capsicum and watermelon seedlings provides an increase in catalase activity preventing the lipid peroxidation and reducing the microbial load in the water.
- Adding lycopene microspheres to fresh-cut apples reduced browning and enhanced bioactive quality.
- Development of innovative ethylene scavenging systems to extend the shelf life of fruit/vegetable.

2. Projects (most relevant)

- Optimización de la cadena de valor del sector hortofrutícola desde una perspectiva holística: análisis de ciclo de vida ambiental, social y económico (Karp0-LIFE). Principal investigator: Encarna Aguayo.
- Desarrollo y procesado mínimo en fresco de germinados de elevada saludabilidad mediante técnicas ecosostenibles. evolución de la calidad y seguridad durante la vida útil. FRESHGERM. Principal investigator: Francisco Artés-Hernández.
- Dispositivo electrónico comercial para la medición de vitamina C en la industria alimentaria (e-DiVITA). Principal investigators: Encarna Aguayo, Antonio J. García Sánchez.

- Desarrollo de una alternativa sostenible para reducir el aporte de nitratos en la fertirrigación del pimiento en la comarca del Mar Menor. CARM- SULCA (AEIA). Principal investigators: Francisco Artés Calero, Francisco Artés-Hernández.

3. Selected publications

- Álvarez-Hernández M.H., Martínez-Hernández G.B., Ávalos-Belmontes F., Castillo- Campohermoso M.A., Contreras-Esquivel J.C., Artés-Hernández F. 2019. Potassium permanganate-based ethylene scavengers as an active packaging system for fresh horticultural produce. *Food Eng. Rev.*, 11(3): 159–183.
- Collado E., Klug T.V., Martínez-Hernández G.B., Artés-Hernández F., Martínez-Sánchez A., Aguayo E., Artés F., Fernández-Hernández J.A., Gómez P. A. 2019. Nutritional and quality changes of minimally processed faba (*Vicia Faba L.*) beans during storage: Effects of domestic microwaving. *Postharvest Biol. Technol.*, 151: 10–18.
- Collado, E., Klug, T.V., Artés-Hernández, F., Aguayo, E., Artés, F., Fernández, J.A., Gómez, P.A. 2019. Quality changes in nutritional traits of fresh-cut and then microwaved cowpea seeds and pods. *Food Bioprocess Technol.*, 12: 338-346.
- Martínez-Sánchez, A., Aguayo, E. 2019. Effect of irrigation with ozonated water on the quality of capsicum seedlings grown in the nursery. *Agr. Water Manag.*, 221: 547-555.
- Martínez-Sánchez, A., Guirao-Martínez, J., Martínez, J.A., Lozano-Pastor, P., Aguayo, E., 2019. Inducing fungal resistance of spinach treated with preharvest hormetic doses of UV-C. *LWT - Food Sci. Technol.*, 113. 108302.
- Martínez-Sánchez, A., Lozano-Pastor, P., Artés-Hernández, F., Artés, F., Aguayo, E., 2019. Preharvest UV-C treatment improves the quality of spinach primary production and postharvest storage. *Postharvest Biol. Technol.*, 155: 130-139.

Staff: Head of the Unit: Prof. Dr. Encarna Aguayo. Researchers: Prof. Dr. Francisco Artés-Hernández, Prof. Dr. Juan P. Fernández-Trujillo, Prof. Dr. Francisco Artés-Calero, Dr. Ascensión Martínez-Sánchez, Dr. Ginés B. Martínez-Hernández, Dr. Bárbara Fernández-Lobato. M.Sc. and Ph.D. Students: Noelia Castillejo, Elena Collado, Hazel Álvarez.

GENETIC RESOURCES



1. Main results

During 2019, the Unit have continued working on the conservation, characterization and evaluation of genetic resources, mainly in the framework of a Project financed by the Ministerio para la Transición Ecológica of the Spanish Government. Also, we have carried out the annual collection of indigenous wild plant material and their conservation in the Germplasm Bank-UPCT. We have also continued working on the project AGL2017-84085-C3-3-R, demonstrating that some agroindustrial composts show promise as an alternative to peat for use as organic substrate in a sustainable soilless production system for baby leaf lettuce and spinach, improving the yield and quality of the product.

2. Projects (most relevant)

-Validación de compost como inductores de propiedades funcionales y de resistencia frente a patógenos para la producción sostenible de hortalizas de hoja pequeña. MINECO (AGL2017-84085-C3-3-R). Participants: UPCT, CEBAS-CSIC, UMH. Principal investigator: Catalina Egea-Gilabert at UPCT. 2018 – 2021.

-Actuaciones para la recuperación de la jara de Cartagena en la Región de Murcia. 2018-2019. Consejería de Empleo, Universidades, Empresa y Medio Ambiente de la CARM. Principal investigator: María José Vicente Colomer.

-Soil biodiversity enhancement in European agroecosystems to promote their stability and resilience by external inputs reduction and crop performance increase. SoildiverAgro. 2019-2023. Comisión Europea. H2020. nº 817819. Principal investigator: David Fernández (Universidad de Vigo).

3. Selected publications

Martos-Fuentes, M., Egea-Gilabert, C., Mezaka, I., Fernández, J.A., Egea-Cortines, M., Weiss, J. 2019. Distance analysis among northern and southern European

legume accessions using next-generation sequencing reveal discrepancies between geographic and genetic origins. *Sci. Horticulturae*, 243: 498-505. <https://doi.org/10.1016/j.scienta.2018.09.007>.

Giménez, A., Fernández, J.A., Pascual, J.A., Ros, M., López-Serrano, M., Egea-Gilabert, C. 2019. An agroindustrial compost as alternative to peat for production of baby leaf red lettuce in a floating system. *Sci. Horticulturae*, 246: 907-915. <https://doi.org/10.1016/j.scienta.2018.11.080>.

Pennisi, G., Blasioli, S., Cellini, A., Maia, L., Crepaldi, A., Braschi, I., Spinelli, F., Nicola, S., Fernández, J.A., Stanghellini, C., Marcelis, L.F.M., Orsini, F., Gianquinto, G. 2019. Unraveling the role of red:blue LED lights on resource use efficiency and nutritional properties of indoor grown sweet basil. *Frontiers Pl. Sci.* 10:305. Q1. doi: 10.3389/fpls.2019.00305.

García-García, M.C., Del Rio Celestino, M., Gil Izquierdo, A., Egea-Gilabert, C., Galano, J. M., Durand, T., Oger, C., Fernández, J., Ferreres, F., Domínguez-Perles, R. 2019. The value of legume foods as a dietary source of phytoprostanes and phytofurans is dependent on species, variety, and growing conditions. *Eur. J. Lipid Sci. Technol.* 121: 1800484-1800496.

Pennisi, G., Sanyé-Mengual, E., Orsini, F., Crepaldi, A., Nicola, S., Ochoa, J., Fernandez, J.A., Gianquinto, G. 2019. Modelling environmental burdens of indoor-grown vegetables and herbs as affected by red and blue LED lighting. *Sustainability*, 11, 4063.

Pennisi, G., Orsini, F., Blasioli, S., Cellini, A., Crepaldi, A., Braschi, I., Spinelli, F., Nicola, S., Fernández, J.A., Stanghellini, C., Gianquinto, G., Marcelis, L.F.M. 2019. Resource use efficiency of indoor lettuce (*Lactuca sativa* L.) cultivation as affected by red:blue ratio provided by LED lighting. *Sci. Reports*, 9, 14127.

Ochoa, J., Sanyé-Mengual, E., Specht, K., Fernández, J.A., Bañón, S., Orsini, F., Magrefi, F., Bazzocchi, G., Halder, S., Martens, D., Kappel, N., Gianquinto, G. 2019. Sustainable community gardens require social engagement and training: a users' needs analysis in Europe. *Sustainability*, 11, 3978.

Staff: Head of the Unit: Prof. Dr. María José Vicente Colomer. Researchers: Prof. Dr. Sebastián Bañón, Prof. Dr. Encarnación Conesa, Prof. Dr. Catalina Egea-Gilabert, Prof. Dr. Juan Esteva Pascual, Prof. Dr. José A. Franco Leemhuis, Prof. Dr. Juan A. Fernández, Prof. Dr. Juan J. Martínez Sánchez, Prof. Dr. Jesús Ochoa. Prof. Dr. María del Carmen Martínez Ballesta. M.Sc. and Ph.D. Students: Almudena Giménez Martínez.

MICROBIOLOGY AND FOOD SAFETY



1. Main results

The Unit received financial support during 2019 from two research projects and has led one national network, funded by the Spanish Government and the Fundación Séneca, and from one contract with an American Foundation. Members of this Unit also participate in a spin-off company, recently created. One article was published in an indexed journal.

2. Projects (most relevant)

-Validation of new tools and processes for analysis and improvement of microbial food safety. MINECO (ref AGL2017-86840-C2-1-R). 2018-2020. Principal investigator: Alfredo Palop, Principal co-invest.: Pablo Fernández.

-Development of the structure needed to carry out a quantitative biological risk prioritization and assessment in Spain. MINECO (Ref. AGL 2016-82014-REDT). 2017-2019. Principal investigator: Pablo S. Fernández.

CE marking for the thermoresistometer Mastia. Fundación Séneca. (Ref. 20526/PDC/18). 2019. Principal investigator: Alfredo Palop.

3. Selected publications

Garre, A., Egea, J.A., Esnoz, A., Palop, A. and Fernández, P.S., 2019. Tail or artefact? Illustration of the impact of uncertainty of the serial dilution and cell enumeration methods has on microbial inactivation. Food Res. Int., 119: 76 - 83.

4. Others

Contract

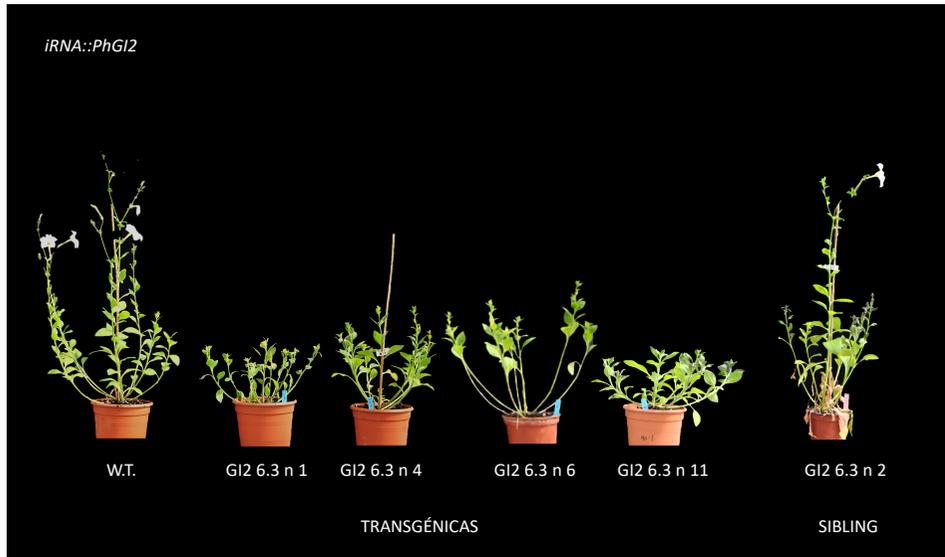
-Reference 6014/19IA. Company: Fundación Tecnológica de Panamá. Contract leader: Arturo Esnoz Nicuesa.

Spin-off Company

-Bioencapsulation and iPackaging, S.L. Fuente Álamo.

Staff: Head of the Unit: Prof. Dr. Alfredo Palop Gómez. Researchers: Prof. Dr. Pablo S. Fernández Escámez, Prof. Dr. Paula M. Periago Bayonas. Ph.D. and Master Students: Mariem Somrani, Marta Clemente.

MOLECULAR GENETICS



1. Research interest and main results

Our research focuses on studying circadian clock related genetic programs as well as the genetic background of environmental factors controlling different aspects of plant development. We use Crisp/Cas technologies for genome editing. Plant developmental aspects include the vegetative growth, flower development and volatile production, both by leaves and flowers. Characterization of plant development includes the use of computer vision and machine learning (ML) algorithms for automatic phenotype data analysis. The development of bioinformatics applications for automated analysis of GC-MS data of volatiles is also part of our investigation.

2. Projects (most relevant)

-Diverfarming H2020- 2017-2022.

-CDTI- Artificial vision and plant development-2017-2019.

-MELOMUR-RIS3 2018-2022.

-BFU-2017 88300-C2-1-R. Análisis de genes de control del desarrollo floral y la emisión de volátiles. Desarrollo de fenotipado automático mediante visión artificial basado en máquinas de aprendizaje.

3. Selected publications

Díaz-Galián, M.V., Pérez-Sanz, F., Sánchez-Pagán, J.D., Weiss, J., Egea-Cortines, M., Navarro, P.J. 2019. A Proposed Methodology to Analyze Plant Growth and Movement from Phenomics Data. *Remote Sensing*, 11, 2839.

Terry, M.I., Pérez-Sanz, F., Navarro, P.J., Weiss, J., Egea-Cortines, M. 2019. The Snapdragon LATE ELONGATED HYPOCOTYL Plays A Dual Role in Activating Floral Growth and Scent Emission. *Cells*, 8 (8), 920 2019.

Terry, M.I., Pérez-Sanz, F., Díaz-Galián, M.I, Pérez de los Cobos, F., Navarro, P.J., Egea-Cortines, M., Weiss, J. 2019. The Petunia CHANEL gene is a ZEITLUPE ortholog coordinating growth and scent profiles. *Cells*, 8(4)343.

4. Others

Ph.D. Dissertation: Desarrollo de un Sistema de fenotipado basado en visión artificial para el estudio de la cinética de crecimiento en plantas.. Author: Fernando Pérez Sanz. Supervisors: Marcos Egea Gutiérrez- Cortines and Pedro Javier Navarro Lorente.

Staff: Head of the Unit: Prof. Dr. Julia Weiss. Researchers: Prof. Dr. Marcos Egea Gutiérrez-Cortines. M.Sc. and Ph.D. Students: Raquel Alcantud-Rodríguez, Claudio Brandoli, Marta I. Terry López, María Victoria Díaz-Galián, Semih Arbatli, Onurcan Özbollat.

RESISTANCE TO INSECTICIDES



1. Main results

Trioza erytreae is the vector of the bacteria *Candidatus Liberibacter africanus*, one of the pathogens causing the citrus greening disease known as Huanglongbing. As the molecular data of this specie is nowadays limited, we wanted to provide gene and genome sequences through *de novo* assembly of next-generation sequencing reads. The genome assembly size is 805 Mb, made of 47,828 scaffolds and a scaffold N50 of 27 Kb. Genome annotation, improved by Oxford nanopore technologies (ONT) direct RNA sequencing, retrieved 47,391 protein-coding genes producing 66,540 unique protein products and a total of 154,592 non-coding transcripts. Functional labels could be assigned to 35,713 proteins according to gene ontology (GO). Within these proteins, a total of 409 transcripts have been related to insecticide resistance mechanisms. The data here obtained are intended to contribute to future genomic and functional studies that facilitates the identification of this insect and the design of new insecticides and preventive control strategies.

Several strains of *O. laevigatus* were obtained by selective breeding with enhanced cold tolerance, bigger body size, better response to non-prey feeding, and higher resistance to a number of insecticides, such as pyrethroids, natural pyrethrins, spinosad, and neonocotinoids..

2. Projects (most relevant)

-Mejora genética del agente de control biológico *Orius laevigatus*: potencial biótico y resistencia a insecticidas. AGL2017-89600-R. MINECO. 2018-2020. Principal investigator: Pablo Bielza.

-Innovative tools for rational control of the most difficult-to-manage pests ("super pests") and the diseases they transmit. SUPERPESTS. 773902. H-

2020 Framework Programme. 2018/2022. Principal investigator: Pablo Bielza.

-Gestión integrada de *Trioza erytreae*: resistencia a insecticidas, control biológico, muestreo y susceptibilidad varietal. E-RTA2015-00005-C06-06. INIA. 2017-2020. Principal investigator: Pablo Bielza.

-Efecto del tamaño corporal en las características como agente de control biológico de *Orius laevigatus*. 20791/PI/18. Fundación Séneca. 2019-2022. Principal investigator: Pablo Bielza.

3. Selected publications

Balanza, V., Mendoza, J.E., Bielza, P. 2019. Variation in susceptibility and selection for resistance to imidacloprid and thiamethoxam in Mediterranean populations of *Orius laevigatus*. *Entomol. Experimentalis et Applicata*, 167: 626-635. DOI: 10.1111/eea.12813.

Bielza, P., Moreno, I., Belando, A., Grávalos, C., Izquierdo, J., Nauen, R. 2019. Spiromesifen and spirotetramat resistance in field populations of *Bemisia tabaci* Gennadius in Spain. *Pest Management Sci.*, 75: 45-52. DOI: 10.1002/ps.5144.

Grant, C., Jacobson, R., Ilias, A., Berger, M., Vasakis, E., Bielza, P., Zimmer, C.T., Williamson, M.S., French-Constant, R.H., Vontas, J., Roditakis, E., Bass, C. 2019. The evolution of multiple-insecticide resistance in UK populations of tomato leafminer, *Tuta absoluta*. *Pest Management Sci.*, 75: 2079-2085. DOI: 10.1002/ps.5381.

Guedes, R.N.C., Roditakis, E., Campos, M.R., Haddi, K., Bielza, P., Siqueira, H.A.A., Tsagkarakou, A., Vontas, J., Nauen, R. 2019. Insecticide resistance in the tomato pinworm *Tuta absoluta*: patterns, spread, mechanisms, management and outlook. *J. Pest Sci.*, 92: 1329-1342. DOI: 10.1007/s10340-019-01086-9.

Staff: Head of the Unit: Prof. Dr. Pablo Bielza Lino. Researchers: Prof. Dr. Josefina Contreras, Prof. Dr. Dina Cifuentes, Prof. Dr. Juan A. Martínez López, Dr. Carolina Grávalos. M.Sc. and Ph.D. Students: María A. Parra, Lidia Martín, Virginia Balanzá, María Martínez, José E. Mendoza, Inmaculada Moreno.

SECONDARY METABOLITES



1. Main results

Studies conducted in order to assess factors influencing the accumulation of phytochemicals (steviol glycosides and phenolics) in *Stevia rebaudiana* tissues suggested that the application of MeJa could be a feasible way to enhance the biosynthesis of these high added value compounds. NaCl treatments also showed an enhancing effect on both antioxidant capacity and hydroxycinnamic acids levels and up-regulated several genes (CMS, CMK, HDR, and UGT76G1) encoding key enzymes of the steviol glycosides biosynthetic pathway.

2. Projects (most relevant)

-Functional analysis of antioxidant and redox systems in the abiotic stress tolerance of cultivated plants: new perspectives for their agronomical applications and their potential human health benefits. Fundación Séneca (19876/GERM/15). 2016-2020. Principal investigator: Francisca Sevilla (CSIC).

-Elicitación acústica de resistencia sistémica en plantas. MICINN (AGL2017-92217-EXP). 2018-2020. Principal investigator: Antonio A. Calderón.

3. Selected publications

Ribeiro-Lucho, S., Nogueira do Amaral, M., Milech, C., Ferrer, M.A., Calderón, A.A., João Bianchi, V., Bolacel Braga, E.J. 2019. Salt stress-induced changes in *in vitro* cultured *Stevia rebaudiana* Bertoni: Effect on metabolite contents, antioxidant capacity and expression of steviol glycosides-related biosynthetic gene. *J. Plant Growth Regul.* 38: 1341-1353.

Ribeiro-Lucho, S., Nogueira do Amaral, M., López-Orenes, A., Moraes Kleinowski, A., do Amarante, L., Ferrer, M.A., Calderón, A.A, Bolacel Braga, E.J. 2019. Plant growth regulators as potential elicitors to increase the contents of phenolic compounds and antioxidant capacity in stevia plants. *Sugar Tech.*, 21: 696-702.

Giménez A., Fernández, J.A., Pascual, J.A., Ros, M., López-Serrano, M., Egea-Gilabert, C. 2019. An agroindustrial compost as alternative to peat for production of baby leaf red lettuce in a floating system. *Sci. Hort.*, 246: 907-915.

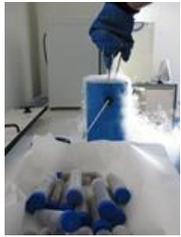
4. Others: Ph. D. Dissertations.

-Contract title: Valorización de residuos agroindustriales para la producción de antioxidantes naturales a través de métodos sostenibles. Funded by CDTI (5852/19IA-P). From 20/03/2019 to 30/09/2019. UPCT Contract: 53.777 €. Principal Investigator: Matías López Serrano.

-Contract title: Desarrollo de protocolos rápidos para evaluar la explotabilidad integral de plantas aromáticas y medicinales autóctonas. Funded by INFO (5333/18CTA-P) From 04/05/2018 to 04/05/2019. UPCT Contract: 21.538 €. Principal Investigator: M. Ángeles Ferrer.

Staff: Head of the Unit: Prof. Dr. Antonio A. Calderón. Researchers: Prof. Dr. M. Ángeles Ferrer Ayala, Prof. Dr. Matías López Serrano, M.Sc. Elena R. Sánchez Lorente.

SOIL ECOLOGY AND BIOTECHNOLOGY



Freezing samples with liquid nitrogen.



Experimental plots in climate chamber.



Measuring greenhouse gas emissions in almond orchards.



Earthworm sampling.

1. Main results

-The role of soil microbiology in the biogeochemical cycles at mining impacted soils is being evaluated (Proj. CGL2017-82264-R). Several scenarios without external inputs (bulk mine tailings) and with the addition of soil amendments are being monitored in on going experiments. The effects of plant growth and litter in the self-sustaining support of the functional attributes at each scenario are considered, as well as the role of transitional areas as a potential amendment for mine tailings (<http://suelos.upct.es/en/node/168>).

-The functionality of mine tailing soils colonized by native vegetation were assessed as well as the effects of changes in atmospheric CO₂, temperature and soil moisture in the functionality and resilience of these soils (CGL2016-80981-R project) (<http://suelos.upct.es/en/node/99>).

-Within Diverfarming (<http://www.diverfarming.eu/index.php/en/>) and AsociaHortus projects (<https://www.facebook.com/AsociaHortus/>), DNA of soil from field case studies (Spain, Italy, Netherlands, Germany, Hungary) was extracted and bacterial 16S region, sequenced. Measurement of greenhouse gas emissions are done to assess their role in climate change mitigation.

-Within the SoilDiverAgro project (<http://www.soildiveragro.eu>), a field trial across 8 pedoclimatic regions of Europe has been performed by sampling soil from cereal fields and extracting DNA for fungal, bacterial and nematodes community. Earthworms diversity has also been assessed.

2. Projects (most relevant)

-Sustainability for the phytomanagement of mining polluted soil: an ecophysiological and microbiological approach (CGL2017-82264-R). MINECO. 2018-2020. Principal investigator: Héctor Conesa.

-Functionality and resilience of soils polluted by mining wastes under climate change conditions in mediterranean environments: ecotoxicological aspects and the use biochar for remediation (CGL2016-80981-R). MINECO. 2017-2019. Principal investigator: José Álvarez Rogel.

-Crop diversification and low-input farming across Europe: from practitioners' engagement and ecosystems services to increased revenues and value chain organisation

-Diverfarming. GA 728003. H2020. Europ. Comm. 2017-22. Principal investigator: Raúl Zornoza.

- Soil biodiversity enhancement in European agroecosystems to promote their stability and resilience by external inputs reduction and crop performance increase. SoilDiverAgro GA 817819. H2020. Europ. Comm. 2019-2024. Principal investigator: Raúl Zornoza.

3. Selected publications

Sánchez-Navarro, V., Zornoza, R., Faz, A., Fernández, J.A. 2019. A comparative greenhouse gas emissions study of legume and non-legume crops grown using organic and conventional fertilizers. *Sci. Horticulturae* 260, <https://doi.org/10.1016/j.scienta.2019.108902>.

Martínez-Oró, D., Párraga-Aguado, I., Querejeta, J.I., Álvarez-Rogel, J., Conesa, H.M. 2019. Nutrient limitation determines the suitability of a municipal organic waste for phytomanaging metal(loid) enriched mine tailings with a pine-grass co-culture. *Chemosphere*. 214: 436-444.

Sánchez-Navarro, V., Zornoza, R., Faz, A., Fernández, J.A. 2019 Does the use of cowpea in rotation with a vegetable crop improve soil quality and crop yield and quality? A field study in SE Spain. *Eur. J. Agron.* 107, 10 - 17. <https://doi.org/10.1016/j.eja.2019.03.007>

Staff: Head of the Unit: Prof. Dr. José Álvarez Rogel. Researchers: Dr. Héctor Conesa, Prof. Dr. Ángel Faz, Dr. Raúl Zornoza, Dr. Martín Soriano. M.Sc. and Ph.D. Students: Obdulia Martínez, Nicolas Beriot, Onurçan Özbolat, Antonio Peñalver, Yolanda Risueño, Carolina Díaz García, Virginia Sánchez-Navarro.

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