

ANNUAL REPORT - 2022

INSTITUTE OF PLANT BIOTECHNOLOGY



Universidad
Politécnica
de Cartagena

MEMBER OF



EUROPEAN
UNIVERSITY OF
TECHNOLOGY



FONDS EUROPEOS



Human Resources Strategy
for Researchers (HRS4R)



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FROM THE VICEPRESIDENT FOR RESEARCH

The Spanish Circular Economy Strategy, Spain Circular 2030 lays the foundations for promoting a new model of production and consumption in which the value of products, materials and resources are maintained in the economy for as long as possible, in which the generation of waste is minimised and those which cannot be avoided are exploited to the greatest extent possible. The Strategy thus contributes to Spain's efforts to achieve a sustainable, decarbonised, resource-efficient and competitive economy.

The Plant Biotechnology Institute is carrying out many projects aimed at this purpose, the sustainability of the planet. The scientific research has the potential to transform the planet by addressing global environmental crises, such as climate change, and improve the welfare of the poorest communities. The United Nations Sustainable Development Goals (SDGs), a set of 17 targets that address the biggest global challenges, including poverty, hunger and clean energy, are increasingly being used to measure that impact.

Impact on society is the main reason for research. In fact, in recent years a process of modification of the research evaluation has been initiated removing relevance to traditional metrics such as the number of scientific publications in high-impact journals or the h-index. The current priority involves the need, therefore, to promote the teaching and learning of science for society, at those early and intermediate stages of the citizen. In this sense, the purpose sought through scientific literacy is to promote critical thinking and systemic analysis for the design and implementation of solutions to current and future problems. Thus, all IBV units have participated in scientific outreach actions to make known to the new generations what is done in the university and thus awaken scientific vocations.

The figures for funding of research projects with and for companies have been very relevant in 2022, reaching more than 1 million euros. This is a great indicator that we are on the right track. I therefore encourage all those who make up the IBV to continue promoting the transfer of knowledge to industry and society in general and to continue disseminating and communicating their lines

of research to put value in our work. We need to move away from the saying "what is not known does not exist".

Prof. Dr. Catalina Egea Gilabert



FROM THE DIRECTOR

The year 2022 has been an important year for us as we decided to apply for the highly competitive Severo Ochoa/María de Maeztu excellence program for institutions.

Our institute has a different personality from others which are dedicated to basic research. Being part of a Polytechnical university means having technology development and innovation in our DNA. The impact of technology development and innovation cannot be directly measured in terms of publications. Instead, work performed for industrial partners, or the public administration are key to understand our work and the imprinting created around the University.

The IBV units have been involved in a very diverse number of projects aimed to solve technological issues, help the administration with decision making or policy and governance. Some projects were developed with local authorities such as Cities, local communities or Regional governments. These included the revival of near extinct species such as *Astragalus nitidiflorus*. Important work has been developed to improve environmental policies. These include the development of pilot bioreactor plants to decrease the nitrates in sewage water from irrigation. The use and recycling of pig manure required by local authorities is developed in three chairs from different municipalities, and a fourth is involved in management of contaminated soils. The Chair of the Port Authority is improving the environmental impact around the port.

Additional work has gone to help with quarantine and fight against possible invasive pests together with the Regional Government of Murcia. Beyond these activities, the IBV members have also important roles in helping international authorities. Prof. Dr. Pablo Fernández Escámez, serves as scientific expert of the European Food Safety Authority (EFSA) having a major impact in the decision making, policies related to food security across Europe.

Our work for the private sector is mostly related to direct contracts to solve different technological challenges. The total amount of extramural funding that we have been able to recruit exceeds a million Euros per year on average, with peaks of over 2 million. This shows that our work cannot be considered purely

academic, and we envision our impact as something beyond scientific publications.

Prof. Dr. Marcos Egea Gutiérrez Cortines



**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 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.

This year Diverfarming has finished. Some of the main results obtained along the project development have been:

-A Decision Support Tool (web-based and free app), which places the best research results in the hands of end-users, who are guided to tailor the most suitable diversified cropping system, low-input practices and most adapted machinery to improve land productivity, revenues and ecosystem services, with mechanisms to adapt their value chains to new agribusiness models and market demands.

-Guidelines for sustainable diversified cropping systems, aimed at end users to improve farm productivity, product quality standards, revenues and ecosystem services with crop diversification.

-Protocol for the correct implementation of diversified systems, easy-to-follow by end-users.

-Methodological guidelines and toolbox for value chain adaptation in response to innovative agribusiness models and market demands.

-Qualified machinery prototype, to improve soil tillage by reducing environmental impacts.

-'Communities of Practitioners' as volunteer early adopter farmers and agribusinesses recruited to develop diversified cropping systems in their farming systems as real scenarios, and ensure longevity beyond the project;

All information is available on www.diverfarming.eu and our social networks (@diverfarming)



DIVERFARMING
H2020 728003

Partners



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.



Tools for screening anti-resistance potential of novel compounds



Biological control agents (BCA)

The Research Unit 'Resistance to insecticides' participates in 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. In 2022 the Webinar "Modern tools for Integrated Pest Management, in the new Era of Plant Protection", open to general audience, was organized with the next objectives:

- ✓ To present the projects and their results so far
- ✓ To provide information and training for specific IPM components
- ✓ To initiate policy recommendation discussions for modern IPM

As the SuperPests_EU comes to an end, the list of 60 peer reviewed publications were produced in frame of the project was shared. Here those published in 2022:

Intradiol ring cleavage dioxygenases from herbivorous spider mites as a new detoxification enzyme family in animals. <https://doi.org/10.1186/s12915-022-01323-1>

Biochemical and insecticidal effects of plant essential oils on insecticide resistant and susceptible populations of *Musca domestica* L. point to a potential cross-resistance risk. *Pestic Biochem Physiol.*; doi: 10.1016/j.pestbp.2022.105115.

Trans-driven variation in expression is common among detoxification genes in the extreme generalist herbivore. doi: 10.1371/journal.pgen.1010333.

QTL mapping suggests that both cytochrome P450-mediated detoxification and target-site resistance are involved in fenbutatin oxide resistance in *Tetranychus urticae*. doi: 10.1016/j.ibmb.2022.103757.

Selectivity and molecular stress responses to classical and botanical acaricides in the predatory mite *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae). doi: 10.1002/ps.6747.

Interactions With Plant Defences Isolate Sympatric Populations of an Herbivorous Mite. doi: 10.3389/fevo.2022.819894

Enhanced top-down control of herbivore population growth on plants with impaired defences. doi: 10.1111/1365-2435.14175.

Integrated taxonomy supports the identification of some species of Phytoseiidae (Acari: Mesostigmata) from Georgia. doi: 10.24349/m2Rp-WodG

Potential of two omnivorous iolinid mites as predators of the tomato russet mite, *Aculops lycopersici*. <https://doi.org/10.1007/s10340-022-01544-x>.

A H258Y mutation in subunit B of the succinate dehydrogenase complex of the spider mite *Tetranychus urticae* confers resistance to cyenopyrafen and pyflubumide, but likely reinforces cyflumetofen binding and toxicity. doi: 10.1016/j.ibmb.2022.103761.

Overexpression of UDP-glucuronosyltransferase and cytochrome P450 enzymes confers resistance to sulfoxaflor in field populations of the aphid, *Myzus persicae*. doi: 10.1016/j.ibmb.2022.103743.

Next-generation molecular diagnostics (TaqMan qPCR and ddPCR) for monitoring insecticide resistance in *Bemisia tabaci*. doi: 10.1002/ps.7122.

The H92R substitution in PSST is a reliable diagnostic biomarker for predicting resistance to mitochondrial electron transport inhibitors of complex I in European populations of *Tetranychus urticae*. doi: 10.1002/ps.7007.

A mutation in chitin synthase I associated with etoxazole resistance in the citrus red mite *Panonychus citri* (Acari: Tetranychidae) and its uneven geographical distribution in Japan. doi: 10.1002/ps.7021.

Over-expression in cis of the midgut P450 CYP392A16 contributes to abamectin resistance in *Tetranychus urticae*. doi: 10.1016/j.ibmb.2021.103709.

The Role of Cytochrome P450s in Insect Toxicology and Resistance. doi: 10.1146/annurev-ento-070621-061328.

Multiple TaqMan qPCR and droplet digital PCR (ddPCR) diagnostics for pesticide resistance monitoring and management, in the major agricultural pest *Tetranychus urticae*. doi: 10.1002/ps.6632.

Artificial selection for emamectin benzoate resistance in the biological control agent *Orius laevigatus*. doi: 10.1016/j.biocontrol.2022.105024 (2022).

Partners



Project title: SoildiverAgro: Soil biodiversity enhancement in European agroecosystems to promote their stability and resilience by external inputs reduction and crop performance increase

Coordinator: David Fernández, Universidade de Vigo. **UPCT Coordinator:** Raúl Zornoza.



Two Units of IBV (Genetic Resources and Soil Ecology and Biotechnology) participate in this Project (Ref. Ares (2020)7409280 - 07/12/2020) funded by the European Union's Horizon 2020 Research and Innovation Programme under the Grant Agreement number 817819.

Main outputs at UPCT

On March of 2022, UPCT group started the third crop cycle in case study 1 (CS1), located in Cartagena, SE Spain, and based on multiple cropping and rotations.

The trial started with the growth of potatoes (December 2020-May 2021), followed by broccoli (September 2021-January 2022) and then was the melon turn, as the third crop in the rotation sequence in the same field. In all crops the same experimental design was followed, with the application of the following treatments:

- ✓ Mineral fertilization applied at 100% of plant demand.
- ✓ Mineral fertilization applied at 30-50% (depending on the crop) of plant demands.
- ✓ Mineral fertilization at 30-50% and addition of a biofertilizer based on bacteria and developed by the partner Fyneco.
- ✓ Mineral fertilization at 30-50% and addition of a biofertilizer based on bacteria and fungi and developed by the partner Fyneco

The objective was to assess if mineral fertilization can be partially replaced by microorganisms, and check the effect of these microorganisms on soil health and crop performance, including the incidence of pests and diseases.

Raúl Zornoza presented the preliminary results found with the application of biofertilizers based on bacteria (bactoneco) and fungi/bacteria (nuve), developed by the partner Fyneco in the ERRIN Bioeconomy working group celebrated on 15th of March of 2022. The main objectives of CS1 are, with the application of biofertilizers, to increase agro-diversity, to reduce the input of chemical fertilizers and pesticides, to increase the availability of soil nutrients and to reduce the incidence of pests and diseases. In this line, it has been shown that the use of biofertilizers reduced the incidence of *Agriotes* sp and *Rhizoctonia solani* in the potato tubers, and so they contribute to increase crop quality and reduce the use of pesticides. There was no effect however on crop yield. Researchers are still working on soil analyses to assess the effects on soil quality and fertility.

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 of IBV and 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 related to nano and micro encapsulates of bioactive compounds as essential oils and their components, and microorganisms to develop new products for active packaging.

The company is mainly focused on placing on the market products and technologies associated to patents.

Main results

The company has continued with the development of 100% natural compounds. These are natural active agents approved for organic farming, effectively eliminating synthetic chemical products. Moreover, on the product level, residue-free treatments have been developed, and, on the packaging segment, technologies capable of eliminating plastic formats have been pursued with interesting results.

Additionally, the developed technologies enable an extension of shelf life of fresh produce, contributing to a reduction in decay and rejects throughout the food supply chain.

Vacuum cooling is known because it maintained freshness, recovers aroma and increases fresh food quality and safety. In that way, the results obtained from the application of the surface decontamination technology through exposure to vapours of essential oils in the vacuum cooling process were highly promising. This innovative technology has proven to be extremely effective in mitigating major pathogenic microorganisms such as *Salmonella*, *Listeria*, and *E. coli*, as well as significantly reducing altering agents.

Specifically, there was an observed decrease in the microbial load of these pathogens and altering agents within an notable range, going between 2 and 5 log CFU/g. This significant achievement not only supports the efficacy of the method but also suggests a direct positive impact on food safety by providing an advanced level of surface decontamination. This development significantly contributes to ensuring the integrity and quality of products, thereby reinforcing assurance in the food supply chain.



Use of essential oils as vapours.



Active packaging

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



BIODIVERSO, sustainable and natural cosmetics



This spin off was created in 2021 by Prof. Dr. Encarna Aguayo Giménez, Head of the Research Unit Food Quality and Health. It is located in Parque Tecnológico de Fuente Álamo (Murcia, Spain).

BIODIVERSO was born from a concept of sustainability and circular economy, placing on the market products and technologies associated to patents.

BIODIVERSO works with all kinds of fruits and vegetables, regardless of whether they are deformed, excessively small, or very large. All of them are considered healthy and nutritious, rich in bioactive compounds or phytochemicals that nourish the skin. BIODIVERSO is engaged with biodiversity, natural wealth, and make efficient use of the natural resources, revaluing by-products and basing them on a circular economy model. Advocates for environmental sustainability, ensuring a balance between environmental care (planet), social well-being, and economic growth.

In facial creams, glass packaging is used as it is a material that can be fully recycled. It is a good example of sustainability and circular economy. The glass containers collected in bins are melted in high-temperature furnaces, moulded, and transformed into a new container without losing their quality or original properties.

The IV Awards for Environmental Sustainability from LA VERDAD, presented in November 2021 in Murcia, had the motto 'Nature is the air we breathe.' With this spirit, the jury recognized the following: the Hippocampus Association, awarded the Prize for the Conservation of Biodiversity, Natural Environment, and Rural Landscape; Salinera Española, awarded the Prize for Business Initiative for Sustainability; the Museum of Science and Water of Murcia, awarded the Prize

for Environmental Education; Biodiverso Cosmetic, awarded the Prize for Sustainable Production Processes and Products; Estrella de Levante, awarded the Prize for Business Transformation for Sustainability; the Iberoza Murcia Association, awarded the Prize for the Best Initiative for Nature Conservation; and El Costurero, from the Proyecto Abraham, received the LA VERDAD Scholarship.



Web site: <https://biodiversocosmetic.com/>

Private-funded CHAIRS

BIONET



Director of the Chair: Prof. Dr. Marcos Egea Gutiérrez-Cortines.

The UPCT-BIONET Chair, signed between the UPCT and the BIONET Company in 2019, establishes a common framework for technological development in the field of Biotechnology. BIONET is a leading international company in the development of fermenters and bioreactors.

Main Results

The Social Council of the Universidad Politécnica de Cartagena announced the winners of the 2022 Isaac Peral Awards, which recognize companies, institutions, and graduates. The Award for Cooperation with the Network of Chairs has been granted to the company Bionet, a global leader in the development of fermenters and bioreactors, as well as a service provider for companies wishing to produce biomolecules through microbial fermentation or cell culture processes. The company is located in the Fuente Álamo Technology Park.



CEFUSA



Director of the Chair: Prof. Dr. Angel Faz Cano.

The Chair in Sustainable Environmental Management of Pork Production that comprises Cefusa (Grupo Fuertes) and UPCT, worked on the environmental management of manure and in the reduction of gas emission.

Main Results

A renewal of the contract was signed this year. The recovery and use of the nutritional properties of the manure generated in pig farms to reduce the use of organic fertilizers has been one of the main goals.

The main activities have been focused on the development of the livestock sector as a model in environmental sustainability. As a fundamental pillar of the production, it was established as priority objectives the reduction of water footprint, the valorisation of water for use in irrigation and fertilization, and the decrease of odours and emissions of greenhouse gases. To achieve this, there were optimized feed production, aiming for increased and improved production with fewer inputs.



ENVIRONMENT, AUTORIDAD PORTUARIA DE CARTAGENA, CAMPUS MARE NOSTRUM

Director of the Chair: Prof. Dr. María José Vicente.



The Cartagena Port Authority (APC)-Campus Mare Nostrum Environment Chair has been created through a collaboration agreement between the Cartagena Port Authority and the public universities of the Region of Murcia: Universidad Politécnica de Cartagena (UPCT) and Universidad de Murcia (UMU), on 2015.

Main Results

The following research contracts within the framework of the "INTERUNIVERSITY CHAIR OF THE ENVIRONMENT PORT AUTHORITY OF CARTAGENA - MARE NOSTRUM CAMPUS" approved the following projects:

- 1: "Artificial Intelligence-based Technology for the Dissemination and Communication of Environmental Actions". Principal Invest.: Rodrigo Martínez Bejar - University of Murcia.
- 2: "Landscape Impact Study of Barlomar Port Terminal. An analysis using visual impact indicators based on the intrinsic values of protected areas of the Natura 2000 Network". Principal Invest. Salvador García Ayllón-Veintimilla - Universidad Politécnica de Cartagena.
- 3: "Monitoring the colonization of sustainable artificial reefs". Principal Invest: Carlos J. Parra Costa – Universidad Politécnica de Cartagena.

GRUPO AGROPOR I+D+I A.I.E



Director of the Chair: Prof. Dr. Angel Faz Cano.

The Agropor I + D + I A.I.E. Group is a subsidiary of the Agropor Group committed to research, development and innovation of the activities carried out by the different companies of the Group. These are focused on feed manufacturing, piggy production, pig feeding and agricultural production.

Main Results

The AGROPOR-UPCT Chair, created in December 2018, aims of promoting and collaborating in the broader dissemination and understanding of all aspects related to the comprehensive water management in pig farming by the application of the footprint water protocol.

The best practices in the sustainable development of the "Integral water management in swine production" have been identified. Savings can be achieved at each stage, and a series of recommendations for efficient water use has been published. This is because all the activities carried out on a farm can contribute to the impact it has on the environment. Therefore, it becomes necessary for these activities to be conducted in a controlled, responsible, organized manner, and under criteria of sustainability and efficiency.



AYUNTAMIENTO DE FUENTE ALAMO



Director of the Chair: Prof. Dr. Angel Faz Cano.

On June 2020, the Chair on "Environmental management for the sustainability of intensive pig farming" was signed between the UPCT and the Fuente Álamo City Council. The Chair is also supported by Adespofa, Agropecuarias Casas Nuevas SA, Agropork SL, Cefu SA, Inga Food SA, Juan Jiménez García SAU, Pienso Cartagena SL and Porcisan SA.

Main Results

Alternatives for sustainable management and valorization of slurry were analyzed, primarily focused on available technical improvements such as emission mitigation, conservation, and sustainable nutrition of agricultural soil. The goal is to obtain quality fertilizers, minimize bothering the neighbours due to odours, and mitigate ammonia and greenhouse gas emissions.

The chair promoted meetings with experts and collaborated in the practical training of students interested in carrying out end-of-study projects of special relevance in this sector.



MARNYS



Director of the Chair: Prof. Dr. Antonio López Gómez.

The Chair was created to promote innovation related to food supplements and natural cosmetics.

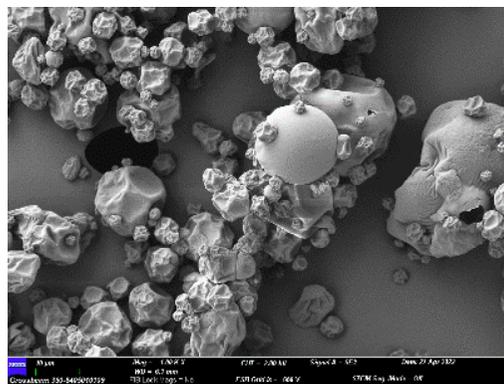
Main Results

MARNYS®- Martínez Nieto S.A. was founded in 1968 as a result of the Martínez Nieto family's business project. It delivers more than 400 products as food supplements and natural cosmetics in over 60 countries.

The chair awarded scholarships to two university graduates for the development of R&D activities and recognized the best final degree project economical support. Additionally, MARNYS has a UPCT-employed Ph.D. on staff.



RESEARCH UNITS



1. Main results

In this year 2022, 4 research articles have been published in international journals (Journal of Food Composition and Analysis, Clean Technologies, Postharvest Biology and Technology); 1 patent (ES2930557B2) and 8 Book chapters (Proc. 2022 CYTEF Int Congress). Prof. A. López Gómez is Editor of the International Journal “Food Engineering Reviews” (IF 6.6 in 2022, Springer), and Editorial Board Member of the Int. J. “Clean Technologies” (IF 3.8 in 2022, MDPI). Dr. Ginés Benito Martínez Hernández is Editorial Advisory Board Member of ACS Food Science & Technology (ACS Publications).

2. Projects (most relevant)

- Determination of the inhibitory effect of essential oils in the ethylene production of fruits and vegetables to develop innovative active packaging systems (ref. PID2020-119882RB-I00). Funding organization: Spanish Ministry of Science and Innovation; Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad. Project Budget = 112,530 Euros; from 5. Sep. 2021-Sep.2024. Principal Researchers: Ginés Benito Martínez Hernández and Antonio López Gómez.

- Research and development of a new symbiotic and its industrial manufacturing process as a food supplement (SYMBIO) (ref. IDI-20211211). Funding organization: Centro para el Desarrollo Tecnológico Industrial (CDTI). Participating entities: Universidad Politécnica de Cartagena and the Company Martínez Nieto S.A. Project Budget =577,226,00 Euros; from Feb. 2021-Mar. 2023. Principal researchers: Antonio López Gómez and Ginés Benito Martínez

Hernández.

3. Selected publications

Barón Yusty, M., Martínez Hernández, G. B., Ros Chumillas, M., Navarri Segura, L., López Gómez, A. 2022. Encapsulated EVOO improves food safety and shelf life of refrigerated pre-cooked chicken nuggets. *Clean Technologies*, 4(1), 53-66.

Martínez Hernández, G. B., López-Gómez, A. 2022. Potential of released essential oils from active packaging to reduce refrigeration needs of fruit and vegetables. *Clean Technologies*, 4(4), 1255-1268.

4. Others. Most relevant contracts

Award/Recognition (18 February 2022) to Prof Dr Ing. Antonio López Gómez, as distinguished scientist and Science leadership, new Fellow of IAFoST (International Academy of Food Science and Technology, IAFoST, University of Guelph, Ontario, Canada).

Contract title: “NEW TYPES OF VINEGARS WITH IMPROVED TECHNOLOGICAL FUNCTIONALITY”. Funded by CDTI (ref IDI- IDI-20220259). Participants: UPCT and the Company JR SABATER S.A. (Murcia); from 01-09-2021 to 31-08-2023. Principal Researcher: Antonio López Gómez.

Staff: Head of the Unit: Prof. Dr. Ing. Antonio López Gómez. Researchers: Prof. Dr. Ing. Asunción Iguaz Gainza; Dr. Ing. Ginés Benito Martínez Hernández; M.Sc. and Ph.D. Students: Marta Barón Yusty; Alejandra Navarro Martínez; Mariano Saura Mendoza; Miguel Tomás Gómez Hernández; María de los Ángeles Martínez Sánchez.

GENETIC RESOURCES



1. Main results

During 2022, the Unit have continued working on the introduction and fine-tuning of production techniques for new horticultural and ornamental species, on the hydroponic cultivation of baby leaf vegetables, developing a production technology to obtain a high-quality product and adequate postharvest life, the molecular characterization of marginal crops and possible reuse. Also, we started working on the project “Next Generation” focused on the optimization of organic fertilization versus to conventional in crop rotation systems.

On the other hand, the Unit continues working on the conservation and recovery of the jara de Cartagena, a species declared in a critical situation by the Spanish government. In addition, we have carried out the annual collection of indigenous wild plant material and their conservation in the Germplasm Bank-UPCT.

2. Projects (most relevant)

- 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).

- Consolidación de acciones de recuperación de la jara de Cartagena en la Región de Murcia. Orden del Consejero de Agua, Agricultura, Ganadería, Pesca y Medio Ambiente de la Comunidad Autónoma de la Región de Murcia. 2022-2023. Principal investigator: María José Vicente Colomer.

- Innovative urban agriculture for a sustainable production. Ministerio de Ciencia e Innovación. PID2020-114410RB-I00. Principal investigators: Juan A. Fernández and Jesús Ochoa (UPCT). 2021-2024.

- Efecto del carbón vegetal o biochar en el uso eficiente del nitrógeno y fósforo en la agricultura murciana. Plan Complementario en el área de Agroalimentación. Comunidad Autónoma de la Región de Murcia - y programa de la Unión Europea NextGeneration EU, Transición ecológica. Principal investigador: María del Carmen Martínez-Ballesta.

3. Selected publications

Amoruso, F.; Signore, A.; Gómez, P.A.; Martínez-Ballesta, M.C.; Giménez, A.; Franco, J.A.; Fernández, J.A.; C., Egea-Gilabert. 2022. Effect of Saline-Nutrient Solution on Yield, Quality, and Shelf-Life of Sea Fennel (*Crithmum maritimum* L.) *Plants Horticulturae* 8(2).

Fernández, J.A.; Ayastuy, M.E.; Belladonna, D.P.; Comezana, M.M.; Contreras, J.; de Maria Mourão, I.; Orden, L.; Rodríguez, R.A. 2022. Current Trends in Organic Vegetable Crop Production: Practices and Techniques. *Horticulturae*, 8(10).

García-García, M.C.; Martín-Expósito, E.; Font, I.; Martínez-García, B.C.; Fernández, J.A.; Valenzuela, J.L.; Gómez, P.; Río-Celestino, M. 2022. Determination of Quality Parameters in Mangetout (*Pisum sativum* L. ssp. *arvense*) by Using Vis/Near-Infrared Reflectance Spectroscopy. 2022. *Sensors*, 22(11).

Gruda, N.S.; Fernández, J.A. 2022. Optimising Soilless Culture Systems and Alternative Growing Media to Current Used Materials. *Horticulturae*, 8(4).

Montoya, D.; Fernández, J.A.; Franco, J.A.; M.C., Martínez-Ballesta. 2022. Enriched-biochar application increases broccoli nutritional and phytochemical content without detrimental effect on yield *J Sci Food Agric*, 105;753-7362.

Pignata, G., ertani, A.; Casale, M.; Niñirola, D.; Egea.Gilabert, C.; Fernández, J.A.; Nicola, S. 2022. Understanding the Postharvest Phytochemical Composition Fates of Packaged Watercress (*Nasturtium officinale* R. Br.) Grown in a Floating System and Treated with *Bacillus subtilis* as PGPR. *Plants*, 11(5).

Staff: Head of the Unit: Prof. Dr. María José Vicente. Researchers: Prof. Dr. Sebastián Bañón, Prof. Dr. Encarnación Conesa, Prof. Dr. Catalina Egea-Gilabert, Prof. Dr. Juan Esteva, Prof. Dr. José A. Franco, 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 Dr. Almudena Giménez Martínez.

MICROBIOLOGY AND FOOD SAFETY



1. Main results

During 2022 the Unit has continued working on the microbiological aspects of food safety, focussing mainly on the inactivation kinetics of microorganisms exposed to food preservation treatments and on the growth kinetics of the survivors to these treatments.

The Unit received financial support during this period from two research projects, funded by the Spanish and Regional Governments, and from one contract. Members of this Unit also participate in a spin-off company. Ten articles were published in indexed journals.

2. Projects (most relevant)

- Decontamination along the processing line using nanoemulsified natural antimicrobials alternatives to guarantee safety of mildly or non pasteurized vegetable liquid foods and smoothies. MICINN (ref PID2020-116318RB-C32) Principal investigator: Pablo S. Fernández.
- Plan Complementario de I+D+i en Agroalimentación. Agroalnext. MICINN and CARM. Principal investigator: Alberto Garre

3. Selected publications

Garre, A., Fernández, P.S., Truchado, P., Simón-Andreu, P.J., Lindqvist, R., Allende, A. 2022. The use of bayesian networks and bootstrap to evaluate

risks linked to the microbial contamination of leafy greens irrigated with reclaimed water in Southeast Spain. *Microbial Risk Analysis* 22, 100234.

Georgalis, L., Psaroulaki, A., Aznar, A., Fernandez, P.S., Garre, A. 2022. Different model hypotheses are needed to account for qualitative variability in the response of two strains of *Salmonella* spp. under dynamic conditions. *Food Res. Int.* 158-111477.

González-Tejedor, G., Garre, A., Egea, J.A., Aznar, A., Artés-Hernández, F., Fernández, P.S. 2022. Application of High Hydrostatic Pressure in fresh purple smoothie: Microbial inactivation kinetic modelling and qualitative studies. *Food sci. technol. int.* 10820132221095608.

Peñalver-Soto, J.L., Muñoz-Guillermo, M., Garre, A., Iguaz, A., Fernández, P.S., Egea, J.A. 2022. Multiobjective Optimization of a Frying Process Balancing Acrylamide Formation and Quality: Solution Analysis and Uncertainty Propagation. *Foods* 11, 3689.

Somrani, M., Debbabi, H., Palop, A. 2022. Antimicrobial and antibiofilm effect of essential oil of clove against *Listeria monocytogenes* and *Salmonella* Enteritidis. *Food Sci. Technol. Int.*, 28: 331-339.

Zambon, A., Perez, A.G., Spilimbergo, S., Fernández Escámez, P.S. 2022. Training in tools to develop quantitative microbial risk assessment along the food chain of Spanish products. *EFSA J.* 20, e200903.

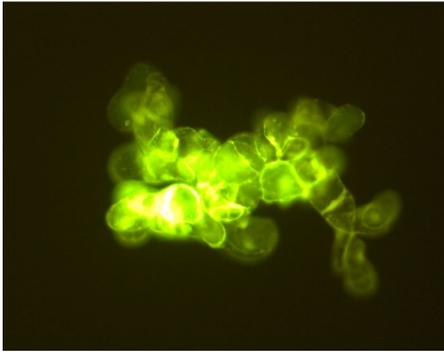
4. Others:

Contracts: Company: Aurum Process Technology, S.L. Contract leader: Alfredo Palop

Spin-off Company: Bioencapsulation and iPackaging, S.L. Fuente Álamo.

Staff: Head of the Unit: Prof. Dr. Alfredo Palop. Researchers: Prof. Dr. Pablo S. Fernández, Prof. Dr. Paula M. Periago, Dr. Alberto Garre Pérez. **EUFORA Grants:** Alessandro Zambon, Daniel Pleva, Ioana Bodea. Ph.D. and Master Students: Leonidas Georgalis, Antonio Luciano, Noel Espailat, Natanael Espailat.

MOLECULAR GENETICS



1. Research interest and main results

The following research lines build the focus of our research:

- 1) The usage of “gene knock out” by Crisp/Cas technologies in plants for studying the genetic programs related to plant development including: the plant circadian clock and *in vitro* growth capacity. Our model plants are: *Petunia hybrida*, *Nicotiana benthamiana*, *Antirrhinum majus*, *Arabidopsis thaliana*.
- 2) Characterization of *Cannabis sativa* varieties with differences in compounds such as CBD, THC and terpenoids on the transcriptomic, genomic and metabolomic level. We focus on the identification of genetic differences involved in the regulation of the synthesis of these compounds using bioinformatic and molecular techniques such as the yeast one hybrid system.
- 3) *In vitro* experiments, both callus and cell suspension culture, using *Arabidopsis thaliana* and *Nicotiana benthamiana* mutants. We analyze *in vitro* growth parameters (*germinability, callus quality, cell suspension quality*) for further usage in molecular farming in bioreactors.

2. Projects (most relevant)

- Diverfarming H2020;2017-2022.
- MELOMUR-RIS3;2018-2022.
- Proyecto MICINN PID2021-127933OB-C21- Validacion de genes que coordinan crecimiento y emisión de volátiles con potencial biotecnológico
- Cannabi+. Empresa Linneo Health S.L

3. Selected publications

Cuartero, J., Pascual, J.A., Vivo, J.M., Özbolat, O., Sánchez-Navarro, V., Egea-Cortines, M., Zornoza, R., Martínez Mena, M., García, E., Ros, M. 2022. A first-year melon/cowpea intercropping system improves soil nutrients and changes the soil microbial community. *Agriculture, Ecosystems & Environment*, Vol. 328, 107856. ISSN 0167-8809.

Navarro, P.J., Miller, L., Díaz-Galián, M.V., Gila-Navarro A., Aguila, D.J., Egea-Cortines, M. 2022. A novel ground truth multispectral image dataset with weight, anthocyanins and brix index measures of grape berries tested for its utility in machine learning pipelines. *GigaScience*, Vol. 11, giac052.

Pozzer, A.C., Gómez, P.A., Weiss, J. 2022. Volatile organic compounds in aquatic ecosystems – Detection, origin, significance and applications. *Science of The Total Environment*, Volume 838, Part 2, 156155, ISSN 0048-9697.

4. Others

Staff: Head of the Unit: Prof. Dr. Julia Weiss. **Researchers:** Prof. Dr. Marcos Egea Gutiérrez-Cortines. **M.Sc. and Ph.D. Students:** Fuensanta Verdú Navarro, Onurçan Özbollat, Alberto Gila Navarro

INTEGRATED PEST MANAGEMENT



1. Main results

Biological control in protected crops mainly relies on omnivorous predators, such as *Orius laevigatus* (Hemiptera: Anthocoridae) and *Macrolophus pygmaeus* (Hemiptera: Miridae). Despite its success as biological control agents, there are several limitations that hinder a wider adoption. Our group is carrying out a selective breeding program to select strains of these predators better adapted to agrosystems.

2. Projects (most relevant)

-Innovative tools for rational control of the most difficult-to-manage pests (“super pests”) and the diseases they transmit. SUPERPESTS. 773902. Horizon 2020 Framework Programme. 2018-2022. Total 2.991.525 €, UPCT: 240.000 €. Principal investigator: Pablo Bielza.

- Much better bugs for biological control: Genetic improvement of *Orius laevigatus* for better fitness on alternative food and at low temperatures (BugBetter). PID2020-116897RB-I00. MCI-AEI. 2021-2024. 242.000 €. Euros. Principal investigator: Pablo Bielza.

- Cultivos saludables en un mundo cambiante: enfoques multidisciplinares innovadores para reforzar simbióticamente la sostenibilidad de los cultivos.

(INNOSYMBIO). PLEC2021-007774. MCI-AEI. 2021-2024. 210.000 €. Euros. Principal investigator: Pablo Bielza.

- Rendimiento como agentes de control biológico de razas de *Orius laevigatus* resistentes a insecticidas. PDC2021-121383-I00. MCI-AEI. 2021-2023. 146.050 €. Euros. Principal investigator: Pablo Bielza.

3. Selected publications

Balanza, V., Villafranca, E., Mendoza, J. E., Grávalos, C., Rodríguez-Gómez, A., Cifuentes, D., Bielza, P. 2022. Artificial selection for emamectin benzoate resistance in the biological control agent *Orius laevigatus*. *Biological Control*, 174, 105024.

Gallego, F. J., Rodríguez-Gómez, A., Reche, M. D. C., Balanza, V., Bielza, P. 2022. Effect of the Amount of *Ephestia kuehniella* Eggs for Rearing on Development, Survival, and Reproduction of *Orius laevigatus*. *Insects*, 13(3), 250.

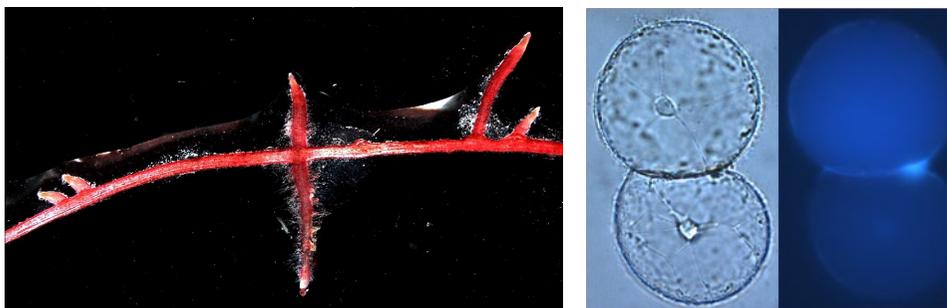
Mendoza, J. E., Balanza, V., Rodríguez-Gómez, A., Cifuentes, D., Bielza, P. 2022. Enhanced biocontrol services in artificially selected strains of *Orius laevigatus*. *Journal of Pest Science*, 95(4), 1597-1608.

Rodríguez-Gómez, A., Balanza, V., Donate, A., Abelaira, A. B., Reche, M. D. C., Sánchez-Martínez, I., Bielza, P. 2022. Effect of Parental Age and Mating Status on Reproductive Performance of *Orius laevigatus* (Hemiptera: Anthocoridae). *Insects*, 13(9), 827.

Rodríguez-Gómez, A., Donate, A., Sánchez-Martínez, I., Balanza, V., Abelaira, A. B., Reche, M. D. C., Bielza, P. 2022. Inheritance and Biological Characterization of an Orange-nymph Mutant in *Orius laevigatus* (Hemiptera: Anthocoridae). *Insects*, 13(11), 996.

Staff: Head of the Unit: Prof. Dr. Pablo Bielza. Researchers: Prof. Dr. Josefina Contreras, Prof. Dr. Dina Cifuentes, Prof. Dr. Juan A. Martínez López, Dr. Carolina Grávalos, Dr. Virginia Balanza M.Sc. and Ph.D. Students: Amador Rodríguez, M. Carmen Reche, Ana Belén Abelaira

SECONDARY METABOLITES



1. Main results

The physical and chemical stimulation of antioxidative responses are recognized as valid strategies aimed at reinforcing the resilience of plants against stress factors, as well as increasing the production of high value-added compounds by plant materials. By applying low-intensity microwave irradiation to *Drosera rotundifolia in vitro* plantlets our group has managed to increase the tissue levels of some naphthoquinones and flavonoids that are considered responsible for the pharmacological properties of this species. These results point to microwave elicitation as a clean, effective, and cheap physical treatment to induce secondary metabolism in plants.

Double chemical elicitation of grapevine suspension cultured cells with methyl jasmonate and cyclodextrins results in high trans-resveratrol production. In a series of experiments, our group analyzed the extent to which NaCl treatments alter the production of bioactive phenolic compounds and the expression/activity profile of enzymes involved in phenol metabolism and antioxidant networks in these cells. Triple elicitation led to marked increases in the content of intracellular hydroxycinnamic acids, as well as in the enzymatic activities of phenylalanine ammonia-lyase and polyphenol oxidase. The good correlation observed between salt-induced accumulation of phenols and the total antioxidant capacity values in cells suggests that redox homeostasis under saline conditions was to a great extent sustained by increased production of phenolic compounds.

Treating plants with chemicals can also increase their tolerance to toxic metal(loid)s. The application of ascorbic acid to rice plants in the presence of As(V) reduced the accumulation of this metalloid in the roots and enhanced photosynthesis and antioxidant capacity of the shoots. In this study, it was found that proline levels in both roots and shoots can be considered as sensitive markers of As toxicity in rice.

2. Projects (most relevant)

-Factorías vegetales para la producción de anticancerígenos: Profundizando en el conocimiento de su biosíntesis, regulación y homeostasis redox en condiciones de elicitación. MICINN (PID2020-113438RB-I00). 2021-2024. Principal investigator: Javier Palazón Barandela (UB).

3. Selected publications

Almagro, L., Calderón, A.A., Pedreño, M.A., Ferrer, M.A. 2022. Differential response of phenol metabolism associated with antioxidative network in elicited grapevine suspension cultured cells under saline conditions. *Antioxidants* 11: 388.

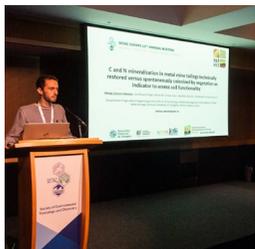
Álvarez-Robles, M.J., Clemente, R., Ferrer, M.A., Calderón, A.A., Bernal, M.P. 2022. Effects of ascorbic acid addition on the oxidative stress response of *Oryza sativa* L. plants to As(V) exposure. *Plant Physiol. Biochem.* 186: 132-141.

López-Orenes, A., Ferrer, M.A., Calderón, A.A. 2022. Microwave radiation as an inducer of secondary metabolite production in *Drosera rotundifolia in vitro* plantlets. *J. Nat. Prod.* 85: 2104-2109.

4. Others:

Staff: Head of the Unit: Prof. Dr. Antonio A. Calderón. Researchers: Prof. Dr. M. Ángeles Ferrer, Prof. Dr. Matías López Serrano.

SOIL ECOLOGY AND BIOTECHNOLOGY



Presentation of the WARMET project in the SETAC Europe 33rd Annual Meeting, Dublin.



Folsomia candida culture.

Quality parameters and incidence of diseases-pests in potatoes grown with biofertilizers.

Participation of the FiAmbRes project in the Science & Technol Week

1. Main results

- PID2020-118941RA-I00 WARMET project. Abandoned spontaneously colonized metal(loid) mine tailings develop functional soils; Soil functionality in technically restored tailings seems to be higher than in spontaneously colonized tailings; Vegetation and seasonality seems to play a more relevant role in spontaneously colonized tailings soils.
- PDC2021-121263-I00 FiAmbRes project. Application of biochar + compost from urban refuse improved mine tailing soil conditions and favoured plant development. Soil ploughing will contributed to root penetration and growth even without amendment addition.
- Diverfarming project. After 5.5 years, the project is finished and all results to assess the effect of crop diversification on production, environmental health and socioeconomic aspects is available on our [website](#) and [Zenodo](#). The SusDiver App with all project results is available on Google and Apple Stores.
- SoildiverAgro project. Soil was sampled for the second crop cycle in the field case studies in different pedoclimatic regions of Europe and analyses are being performed to assess the effect of management on soil biodiversity (bacteria, fungi, nematodes, earthworms) and their relationship with productivity.

2. Projects (most relevant)

- Application of phytomanagement techniques for environmental restoration of metalliferous mining waste deposits from semi-arid areas (FiAmbRes)

97.750 €. Project PDC2021-121383-I00 financed by MCIN/AEI/10.13039/501100011033 and the European Union Next GenerationEU/ PRTR. P.I. J. Álvarez. <http://suelos.upct.es/en/node/227>

- Functional aspects and soil ecotoxicity of abandoned mine wastes colonized by vegetation vs restored in semiarid areas: response to climate change (WARMET, PID2020-118941RA-I00). MICIN. 2021-2024. 169,400€. PI: M. Nazaret González. (<http://suelos.upct.es/en/node/225>).

-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. 2017-2022. 10,457,923€ (UPCT: 1.3 M€). PI: Raúl Zornoza. (<http://www.diverfarming.eu/index.php/en/>).

- 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. 6,999,889€ (UPCT: 794.375€). PI: Raúl Zornoza. (<http://www.soildiveragro.eu>).

3. Selected publications

- Álvarez-Rogel, J., Peñalver-Alcalá, A., González-Alcaraz, M.N. 2022. Spontaneous vegetation colonizing abandoned metal(loid) mine tailings consistently modulates climatic, chemical and biological soil conditions throughout seasons. *Science of the Total Environment* 838, 155945. <https://doi.org/10.1016/j.scitotenv.2022.155945>.
- Özbolat, O., Sánchez-Navarro, V., Zornoza, R., Egea-Cortines, M., Cuartero, J., Ros, M., Pascual, J.A., Boix-Fayos, C., Almagro, M., de Vente, J., Díaz-Pereira, E., Martínez-Mena, M. 2022. Long-term adoption of reduced tillage and green manure improves soil physicochemical properties and increases the abundance of beneficial bacteria in a Mediterranean rainfed almond orchard. *Geoderma* 429, 116218. <https://doi.org/10.1016/j.geoderma.2022.116218>

Staff: Head of the Unit: Prof. Dr. José Álvarez. Researchers: Dr. Héctor Conesa, Prof. Dr. Ángel Faz, Prof. Dr. Raúl Zornoza, Dr. María Nazaret González. Post-docs: Dr. Virginia Sánchez, Dr. Eva Lloret, Dr. Alicia Mourgán. M.Sc. and Ph.D. Students: Mohammed Mdaini, Irene Ollio, Marino Marcos, Matías Ceacero Moreno.

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