

ANNUAL REPORT - 2021

INSTITUTE OF PLANT BIOTECHNOLOGY



Universidad
Politécnica
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MEMBER OF



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UNIVERSITY OF
TECHNOLOGY



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FROM THE VICEPRESIDENT FOR RESEARCH

In these last two years we have realized that our world can change overnight, we live in turbulent times with enormous uncertainty, encouraged by disinformation and the proliferation of fake news. But these circumstances have also made us reflect as a society and have valued the importance of knowledge, research and ultimately science. For centuries, science has been a symbol of progress and lucidity. Without science, society has no future.

One of the greatest challenges for the future that we must urgently address is the care of the planet. Thus, the way in which we produce and process our food has a huge impact on the environment, so it is necessary to develop an intelligent and sustainable agri-food chain, capable of producing healthy food in sufficient quantity for a growing population, in an environment of circular and digitized economy.

To achieve this, we must apply biotechnology, big data analytics techniques and data mining, cloud services, and artificial intelligence, among other strategies in the context of agriculture, to optimize the quality of the crop products, preserve natural resources and protect the environment more effectively.

The biotechnological and digital transformation of the primary sector not only involves introducing more technology in the field and in the processing methods. Machines are not the engine of change but people. We will reach that transformation when we understand that there is only one world in which the digital and the real come together in people's minds.

People such as the young PhDs of the IBV (named in this memory) and people such as the researchers from the different IBV units able to give a holistic approach from the academy that is then transferred to companies to make the agri-food sector more productive, with higher quality and more sustainable.

Much remains to be done, but we have a well-marked roadmap by UNESCO in the 2030 Agenda with the sustainable development goals, and through the motto of our European University of Technology (EUt+): Think human first - European values empowering technology. Let's foster these values and build together the world we want, through science.

Prof. Dr. Catalina Egea Gilabert



FROM THE DIRECTOR

The year 2021 has seen again a vigorous activity of the IBV and its research units. As working conditions improved throughout 2021 and the pandemic measures eased the work, research units adapted their work again to tackle projects where several persons need to work in parallel. However, the new online culture is here to stay. It has shown some benefits such as an increase in online activities of seminars, and research meetings. These include national and international congresses but also the possibility of having a more direct relation with research groups during the different projects developed. These actions have increased the local, national, and international impact of the IBV.

In 2012, the IBV started to analyze in detail the energy requirements of our research infrastructure. Since then, we have organized all our research space in such a way that the energy consumption would be lower than the expected for each unit, distributing the apparatus with higher energy demands in specific parts of the IBV. In June 2021, well before the current crisis started, we unanimously decided to coordinate the experiments in such a way that we would avoid extreme energy costs.

Since we started working in our facilities at the I+D+I building, a large number of students have been trained in different disciplines. Compared to other technological branches, the number of women is significantly higher, and many of them are today highly successful professionals. The basic function of the University is to train highly qualified manpower to serve the society. The highest academic degree granted by universities around the World is the doctorate or PhD.

As a result of the intense work in research and technology we have been able to train a sizable number of professionals that today are part of academia, research centers and private companies. The so-called change in economic model, considered by many as the future of our country, and the World as a whole, requires highly trained manpower leading the innovation in all fronts of society.

In 2021 we present a group of brilliant PhD students. We selected 9 out of over 90 that have studied at the IBV in one way or another. Their current positions

include academic jobs in highly competitive countries such as Switzerland or the United Kingdom, or positions in the industry. These range from R&D to management or Intellectual Property management. They are also working in regional, national and multinational companies. Our current bet is to work towards a high impact in terms of training manpower. Women and men trained at the IBV should lead to change the current paradigm of low-quality jobs by a model based on high quality jobs in science and technology. We expect to have an additional impact through the EUT+ system, creating projects and training schemes in our field of work.

Prof. Dr. Marcos Egea Gutiérrez Cortines



SUCCESS STORIES

Dr. Sonia Soto Jover. Intellectual Property Manager at Special New Fruit Licensing Limited-AMC Group Fresh & Juices S.A. (Murcia, Spain)

Agricultural Engineer and Dr. by the UPCT, she worked as researcher at IBV in different Projects, being the Main Researcher the Prof. Dr. Ing. Antonio López Gómez.

Her main research lines were related to the design optimization and methodology enhancement for formulating dough for the industrial production of gluten-free pasta and croquettes based on rice. Products made with rice flour were rich in gamma oryzanol, a compound with antioxidant and beneficial properties for health. She developed a new formulation of gluten-free croquettes that originated a product with an oil absorption during frying 50% lower when compared to traditional croquettes made with wheat flour.

She also worked on the development of active packaging including encapsulated essential oils (EOs) to increase the shelf life of horticultural products due to the high antimicrobial activity of EOs in the vapour phase through a controlled release from the packaging.

Dr. Soto Jover is currently the Intellectual Property Manager of Special New Fruit Licensing Limited at AMC Group in Murcia.

<https://snflgroup.com/>



Dr. Juan Guillén Rubio. Compliance Officer at Coregeo Ltd. (Watlington, United Kingdom)

Agricultural Engineer and Dr. by the UPCT, he worked as researcher at IBV being the Main Researcher Prof. Dr. Ing. Pablo Bielza Lino.

During his stay at the IBV, he worked analysing the effects of the incorporation of new products and strategies for the management of resistance to insecticides, specially on *Frankliniella occidentalis*.

He is Compliance officer at Coregeo Ltd., the leading specialist in intellectual property, brand management and marketing services for the fresh produce industry. He works with breeders and growers, retailers and the food service industry across the globe to create and manage fresh produce brands and grow them into successful household names, like the UK's top two fresh produce brands, Pink Lady® apples and Tenderstem® broccoli, and Bimi® in Europe.

<https://www.coregeo.com/>



Dr. Alberto Garre Pérez. Ramon y Cajal Contract at UPCT (Cartagena, Spain)

Engineer and Dr. by the UPCT, he worked as researcher at IBV in different Projects, being the Main Researchers Prof. Dr. Alfredo Palop Gómez and Pablo S. Fenández Escámez.

During his stay at IBV he worked on the mathematical modelling for the microbiological risk assessment of food by following mild preservation treatments. Then, he worked for 3 years as a Postdoctoral Scientist (Marie Curie fellow) at Wageningen University & Research, The Netherlands.

He obtained a Ramón y Cajal contract at the UPCT for working on different projects related to the application of mathematical modelling to gain insight into problems related to food safety. His activities include the application and development of kinetic models, stochastic modelling, optimal experiment design and development of scientific software.



Dr. Izaskum Mallona. Senior Research Associate at the Department of Quantitative Biomedicine. University of Zurich (Zurich, Swiss)

Dr. by the UPCT, she worked as researcher at IBV in projects headed by Prof. Dr. Marcos Egea Gutiérrez-Cortines and Julia Weiss.

During her stay at IBV she studied flower development using a bioinformatics-driven candidate discovery and conducted the reverse genetics approaches to validate these findings. Then, she did a 5-year postdoctoral work at the IMPPC and IGTP (Germans Trias i Pujol Health Research Institute). There, she worked with Dr. Miguel A. Peinado on the development of novel frameworks to integrate and visualize high throughput cancer epigenomics data.

Now, she is a senior research scientist specialized in data analysis, at the Department of Molecular Life Sciences and Magdalini Polymenidou (Department of Quantitative Biomedicine) in the University of Zurich.



Dr. Natalia Falagan Sama. Lecturer at University of Cranfield (Cranfield, United Kingdom)

Graduated at UPV, she did her PhD at UPCT supervised by Prof. Dr. Francisco Artés Calero and Encarna Aguayo Giménez. Her research was focused on studying the effects of deficit irrigation management on stone fruit quality and postharvest behaviour.

She is a Lecturer in Food Science and Technology Soils, Agrifood and Biosciences at the University of Cranfield. She investigates the underlying ripening and senescence mechanisms of fruit and vegetables and develops innovative strategies for postharvest management. Recent projects include Next generation modified atmosphere materials to extend farm storage and reduce waste (BBSRC), Postharvest technology and improved agricultural practice to reduce avocado waste in Mexico (QR GCRF) and Urban Revolution (Global Food Security's Resilience of the UK Food System Programme, with support from BBSRC, ESRC, NERC and the Scottish Government).

Dr. Falagan teaches on the Food Systems and Management and Future Food Sustainability MSc programmes and is the module leader of Postharvest Technology.



Dr. Antonio López Orenes. Grower Consultant at Agromediterranea S.A. (Murcia, Spain)

Agricultural Engineer and Dr. by the UPCT, he worked as researcher at IBV in different Projects, being the Main Researchers Prof. Dr. Antonio Calderón García and María Ángeles Ferrer Ayala.

During his stay at IBV, he worked on the expression patterns of antioxidant network in pioneer plants from mine tailings polluted with high levels of heavy metals. Moreover, he analysed plant elicitation with salicylic acid as a way for regulating plant growth and productivity.

Currently at Agromediterranea S.A. he is a specialist in growing and producing agricultural products straight from the fields including different kinds of lettuces, vegetables and herbs, comprising varieties such as round courgettes, sweetcorn, radishes and microgreens, as well as other specific varieties aimed at the food processing industry (fresh-cut produce).



Dr. Nicolas Bériot. Project Coordinator at Wageningen University (Wageningen, The Netherlands)

Born in France and Dr. by UPCT in a PhD shared program with SLM-WUR. His research was focused on soil pollution by plastic debris and effects on agricultural sustainability. During his stay at IBV he analysed the effects of plastic mulch on the soil-microorganisms-plant system and potential synergies with pesticides. For that, he evaluated plastic debris, pesticide residues and microbial communities in SE Spain. His research was supervised by Prof. Dr. Raúl Zornoza Belmonte, Violette Geissen and Esperanza Huerta Lwanga.

Now, he works as a Postdoc at Wageningen University as Project Coordinator of H2020 project MINAGRIS (<https://www.minagris.eu/>)

The MINAGRIS project, will assess the impact of plastic debris in agricultural soils on biodiversity, plant productivity and ecosystem services and their transport and degradation in the environment.



Dr. Carolina Díaz García. Associate Researcher at Illinois University (Illinois, United States of America)

Dr. by UPCT she worked at different projects related to water denitrification in woodchip bioreactors and saturated buffers. Her research was supervised by Prof. Dr. Juan José Martínez Sánchez and José Álvarez Rogel.

Now, she is Postdoc Associate Researcher at Illinois University. She works as Project Manager at the Illinois Drainage Research and Outreach Program (I-DROP) (<http://draindrop.cropsi.illinois.edu/index.php/our-group/>).



Dr. Diana Niñirola Campoy. Breeder Assistant at Sakata Vegetable Europe (France)

Dr. by UPCT, she worked on research activities related to the optimization of baby leaf production technologies and development of new vegetable varieties. Her studies were supervised by Prof. Dr. Juan A. Fernández Hernández. Since June 2021 she is a member of EUCARPIA, the European Association for Research on Plant Breeding.

Now, she works as a Brassica Breeder Assistant for Sakata Vegetable Europe S.A.S (France), a subsidiary of Sakata Seed Company (Japan). In this company she carries out genetic improvement and selection activities.



**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.

The final results achieved during this last year have been:

A Handbook and factsheets with the best strategy of crop diversification in terms of crop type and pedoclimatic region to achieve agronomic, environmental and agronomic benefits. If properly designed and tailored, crop diversification can contribute to increase gross margins for farmers, increase overall production and the delivery of ecosystem services such as biodiversity, soil health, reduced erosion and landscape improvement. The study of soil microbial communities by Next Generation Sequencing developed in the IBV has concluded that, in general terms, crop diversification is related with higher relative abundance of beneficial microorganisms related to soil fertility and health and plant protection.

A White Paper has been launched with the identification of the main barriers for the adoption and spread of crop diversification in Europe, and establishment of some police recommendations, such as finance extension services operating at territorial level, finance research and innovation aiming at

finding new technology and machineries, design policies that promote the cooperative and collective approaches, raise awareness on the role of farmers in protecting the environment and in providing ecosystem services, promote and disseminate existing best practices or facilitate the access to credit and to insurances.

The Decision Support Tool "SusDiver" is available for download as App for Android and Apple in their respective Stores. It places the best research results in the hands of end-users, who can visualize the most suitable diversified cropping system in their area to improve land productivity, revenues and ecosystem services, with mechanisms to adapt their value chains to new agribusiness models and market demands.

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



DIVERFARMING
H2020 728003

Partners:



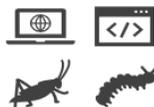
Project title: SUPERPESTS: Innovative tools for rational control of the most difficult to manage pests ("super pests ") and the diseases they transmit

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

UPCT Coordinator: Prof. Dr. Pablo Bielza.



*Environmentally-friendly
biopesticides*



*Optional combinations for
effective and sustainable
IPM*

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. On 27 January 2020 the SuperPests Annual Consortium Meeting took place in Montpellier, France, where partners had the chance to review tasks and activities in preparation of the EU Report, clarify technical and/or managerial issues and define the action plan for Y2.

We have identified and validated 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.

We have performed 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.

We 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.

Summarizing, the main results reached this year have been:

- Were identified and validated new resistance markers indifferent pest species.
- It was tested the anti-resistance potential of novel candidate insecticidal compounds.
- Were identified and validated environmentally-friendly biopesticides

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.

Project objectives and outputs:

SoildiverAgro is organized around 8 Work Packages which are defining the main technical activities to be implemented around 6 geographical areas where 15 case studies are performed to better understand how soil organism's benefits can be applied to improve resource uptake, plant growth development and health. The case studies are organized around 3 different crops (potatoes, wheat and vegetables) in mono and diversified cropping systems.

A survey to stakeholders was performed during this year. It has helped to identify the most relevant agri-environmental problems and related end-users' needs in each of the 15 case studies of SoildiverAgro and to assess the practical potential for the integration of farming practices that enhance soil biodiversity in the different cropping systems. The agri-environmental problems and objectives for actions identified are consistent with the specific nature of the agricultural system analysed in each case study. Most relevant priorities for action identified by stakeholders are concerned with the improvement of soil conditions (organic matter content, structure and fertility), but also with the control of pest, diseases and weeds.

The survey results illustrate how stakeholders perceive that each agricultural system could be oriented towards a more sustainable production. Although there is a controversy between the use of conventional tillage and less intensive tillage options, and conventional tillage is the preferred tillage alternative in some of the case studies. Most of stakeholders consider that shifting to less intensive tillage alternatives is a must to face the agri-environmental problem in their corresponding study area, with a preference for minimum and shallow tillage. Regarding fertilization practices, stakeholders coincide in choosing both the addition of solid organic matter and manures and the use of green manure as the most effective fertilization alternatives. The preferred soil conservation practices seem to be, in general, more oriented towards improving soil conditions than to avoiding soil loss. More precisely, crop diversification and the addition of solid organic matter are perceived as the most effective alternatives in many case studies.

Regarding the control of pest and diseases, while stakeholders in several case studies clearly opt for crop diversification and increasing invertebrates soil biodiversity, in other case studies they opt for the use of pest alerts and trap crops as more effective alternatives.

The survey results were presented to a wider audience of stakeholders in discussion groups in each case study area, where they engaged into a plenary discussion about their agreement with these. In general, participants in discussion groups confirmed the validity of the results from the survey. A consensus with the major agronomic problems and end-users' needs identified in the survey across case study areas come out from the discussion groups.

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

Nanoencapsulated formulations of essential oils have been established to be applied in:

- Active packaging (paper or cardboard) with antimicrobial activity, antioxidant and, in some cases, anti-sprouting and control of ethylene emission.
- Ice with antimicrobial activity for the conservation of fresh sea food (fish and shellfish) as well as for the conservation of fresh vegetables (patented technology).
- Active ice for stunning and slaughter of fish from aquaculture systems according to animal welfare and product quality and safety (patented technology).

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. Its application in vacuum cooling maintains freshness, recovers aroma and increases food quality and safety.

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.

Worldwide, one-third of all food produced is lost annually, which means 1.3 billion tonnes. This loss of natural resources is not sustainable and endangers the global ecosystem. At Biodeverso, all fruits and vegetables are used despite they are small or large, standard or misshapen. The company is focused on producing creams and scrubs, made from natural ingredients obtained from those fruit and vegetables.

One of the most important products is the moisturizing facial cream, that incorporates betaine obtained by fermentation of beetroot. The other one, antioxidant cream, is made from oil and extracts of grape seed, obtaining a cream rich in polyphenols. Olives and olive leaves are used for the anti-aging facial cream, whose main components are hydroxytyrosol and maslinic acid, recognized for their antioxidant and anti-inflammatory activity.

The packaging is also carefully taken into account. For example, for facial creams glass containers are used, since it is a material that can be fully recycled. It is an example of sustainability and circular economy. The glass containers collected in the containers are melted in ovens at high temperatures, shaped and converted into a new container without losing its original quality or properties.

For body creams and scrubs plastic containers are used, polypropylene (PP) and polyethylene terephthalate-polyester (PET). The goal is to use recycled plastic.

In body creams and scrubs, the use of a cardboard box to pack the product is avoided, reducing in that way the over-packaging.

For the facial creams, the water has been supplanted by aloe vera, 100% certified organic. Aloe vera is a plant with low water requirements. Its water footprint is very low, making it an ideal crop for arid areas of the Mediterranean Basin. Its cultivation prevents the rejection of semi-desert agricultural areas, generating an opportunity for small farmers.



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

Private-funded CHAIRS

SUSTAINABLE AGRICULTURE



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

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

This year, the Chair of Sustainable Agriculture and Golftat tested a system for denitrification of highly concentrated brines. The prototype was built by the Chair and the Golfrat company and allowed numerous tests to be carried out with both sugar and molasses provided by the Murcian company Zukan.

With very concentrated brines (more than 550 mg/L of nitrates), removals of over 90% were achieved with very short treatment times. The excess of sugary substances that were not used for the elimination of nitrates, were removed by an aerobic purification system coupled to the bioreactor that allowed obtaining a final brine practically without nitrates and with very little organic matter,

Thus, this new system allowed to advance in the search for solutions for the denitrification of brines highly concentrated in salts and nitrates to complement the system of bioreactors with wood chips in more limit situations.

Although this system with wood chips has been shown to be excellent due to its performance and low cost for agricultural drainage or low-concentration brines, bioreactors fed with sugar molasses are ideal for highly concentrated brines with a high nitrate load.

The good performance shown with molasses provided by the Zukan company opens the door to collaboration with new companies in the agri-food sector

that can convert their waste into "fuel" for this type of bioreactor, contributing to a circular economy that is increasingly established in the Region of Murcia. Now, the future steps are to install a full-scale prototype for which both farmers and the administration has been contacted.

The Chair of Sustainable Agriculture of the UPCT, was born in 2017 as an initiative of the Federation of Agricultural Cooperatives of Murcia (Fecoam), the Coordinator of Farmers and Breeders Organizations (COAG), together with different companies and agricultural cooperatives of Campo de Cartagena. The agri-food firms FRUVEG, SURESCO, COTA 120, SOLTIR, SAN CAYETANO, COAGACART, CAMPOSEVEN, LA PACHECA, GREGAL, SURINVER, HORTAMIRA and ANVID are currently part of the Chair. Likewise, it has the collaboration of AQUAINNOVA MEDITERRÁNEO and the Fundación La CAIXA and CAJAMAR Organizations.



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 UPCT-BIONET Chair develops R + D activities aimed at improving the competitiveness of the services offered by BIONET. This includes the development of new processes and improvement of bioreactors. The production options comprise plant cells, animals, bacteria and yeasts, and the products obtained are aimed at the pharmaceutical, agri-food and cosmetic industries. The activities of the Chair comprise business internships, final degree and master's projects and training of doctors. In the field of R + D, activities are articulated through research projects.

ROSITA, a specific software for bioreactors controlling, has been optimized. Its main features are:

- ✓ Highly intuitive in all its configuration and monitoring options across the screens, thanks to a range of symbols, notifications, and alarms.
- ✓ Scalable, by following the same workflow as in the industrial bioreactors and the same control, visualization, registration and management tools.
- ✓ Expandable functionalities, derived from its modular design that allows the Plug&Play of additional sensors and bSmart modules.

Moreover, a new bioreactor Bionet F0-BABY has been installed at the IBV in the Unit of Biotechnological processes, technology and engineering, with the following characteristics:

- ✓ User-friendliness, while providing advanced instrumentation and automation options.

- ✓ Cost-effectiveness and premium quality of components, which eases maintenance and enhances fast delivery.
- ✓ Modularity derived from the Plug&Play -concept, which allows for expansion of additional functionalities in the future.

The F0-BABY is delivered with 3 precise and linear peristaltic fixed speed pumps and the option of the integration of up to 4 additional pumps with variable speed, which allows fed-batch and continuous processes among others. Moreover, a precise and adaptable agitation module with simple maintenance based on top agitation provides additional flexibility to agitator geometry.



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.

Through the comprehensive slurry treatment system developed by the researchers of the chair, it has been possible to reduce by 40% the agricultural area needed for the recovery of the entire volume of slurry generated in a pilot farm, valued both as an agricultural resource and as a water resource.

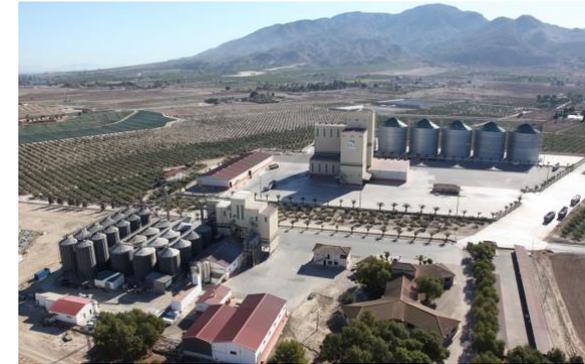
The reduction in the use of fertilizers was important, achieving up to 80% saving in dry farming of cereals. The agronomic use of slurry as an organic fertilizer can mitigate the water deficit and the deterioration of soil fertility, since it improves its edaphic conditions and is a source of nutrients.

The main goal of the chair is that the feedlot itself could have systems for slurry treatment. In this way, it is thought that in the future they can take advantage of the nutritional properties of pig manure to fertilize their own farms. They also purify the water and reuse it. This leads to a significant reduction in greenhouse gas and ammonia emissions. In this way, Cefusa company improves its water footprint, reduces its carbon footprint, and alleviates emissions in its production process within a bioeconomy context.

In order to fulfill the objectives of the Chair, research, training, dissemination and monitoring actions have been also carried out. Thus, farm consisted of

leaching tests, agronomic valorisation in cereals and studies in biofilters with different types of plantations and times in order to determine the purification efficiency.

Currently, work is being done with four types of biofilters, with cane, soda and oleander, while gas emission measurements are being made in each of the purification phases to obtain recognition as a validated technique in the mitigation of gas emissions.



MEDIO AMBIENTE, 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 purpose of this Chair is to establish a permanent collaboration between the APC, the UPCT and the UMU, involving research, development, technical assistance and training related to environmental issues. The contribution of other Research Centers, professionals or collaborating entities is also considered.

This year, a 25 h Course was developed, Directed by Dr. Francisco Robledano Aymerich and Dr. M. José Vicente Colomer, and with D. Antonio Guillén Beltrán as Technical advisor.

The course provided specialized training to students of Environmental Sciences, Biology, Veterinary Medicine, Geology, Geography, Engineering, and other disciplines related to the knowledge, analysis and management of the natural environment and environmental quality. Moreover, it provided up-to-date knowledge of practical application, based on recent local research, to all professionals and technicians from the public and private sectors related to the study, evaluation and management of the environment of the industrial port and in close interrelation with areas of high ecological interest and environmental sensitivity.

The main objectives were:

- ✓ To describe the policies and actions in the field of environmental management and biodiversity conservation developed by the Cartagena

Authority, and the initiatives to promote research launched under the APC_CMN Interuniversity Chair.

- ✓ To present examples of the main lines of research financed by the Interuniversity Chair.
- ✓ To analyse, from a multidisciplinary point of view and with the participation of different agents involved (scientists, technicians, social ...), the opportunities and demands of the management and conservation of the Cartagena coast as a model of a port city engraved in a natural both terrestrial and marine environment of high ecological value.
- ✓ To promote the acquisition, by professionals, researchers, and technicians, of the knowledge, skills and attitudes required to get involved in the evaluation and integration of port and maritime activity with the conservation of the coastline. To analyse and discuss prospects in the context of the new challenges of port management, collaboration between the institutions involved and the academic sector, and participation and information to society.



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 to promote and collaborate in dissemination and knowledge of all aspects related to the integral management of water in pig farming by the application of the footprint water protocol.

The best available technologies for the treatment, management and reuse of water resources were reviewed, such as desalination and denitrification, as well as the applicable legislation for the economic-social and environmental sustainability of water resources management.

This year, the objectives were focused in a solid commitment to respect the environment as we consider it a fundamental value of our identity and an essential part of the sustainable development of our activity.

The best practices in the sustainable development of the "Integral water management in swine production" have been identified.



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.

Main Results

This year, the Chair was strongly focused on promoting the following activities:

- ✓ Meetings with experts and collaboration in the practical training of students interested in carrying out projects of special interest in this sector.
- ✓ Analysis of alternatives for sustainable management and recovery of slurry, looking for procedures that mitigates gas emissions as well the conservation of soils.
- ✓ Minimisation of odours emissions as well as ammonia and GHG emissions.



MARNYS



Director of the Chair: Prof. Dr. Encarna Aguayo Giménez.

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

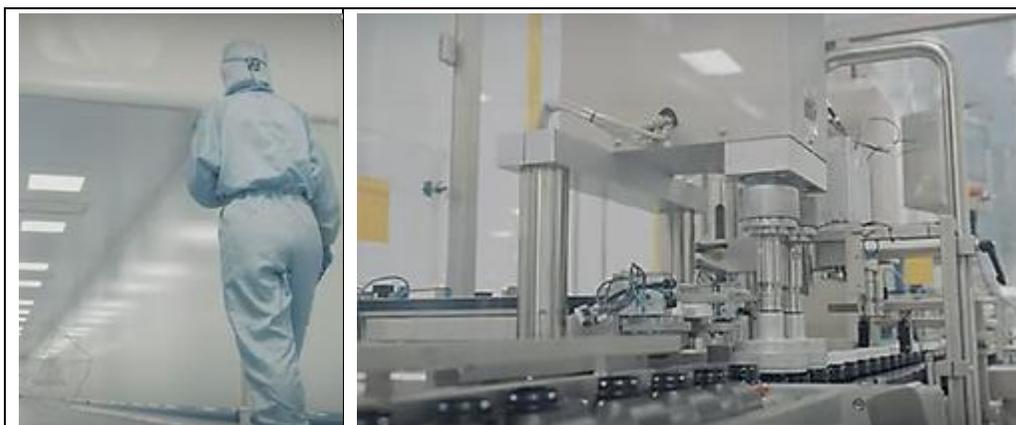
Main Results

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.

Among the products that MARNYS develops, drinkable vials, syrups, capsules, tablets, essential oils and organic certified natural cosmetics, UPCT has collaborated by optimizing processes and studying quality.

The Cartagena-based laboratory manufactures and markets natural products of the highest quality to take care of health and beauty through all the stages of life.

The company collaborates with the University executing and developing projects within the framework of innovation, excellence, and sustainability.



RESEARCH UNITS

BIOTECHNOLOGICAL PROCESSES, TECHNOLOGY AND ENGINEERING



1. Main results

Ten research articles have been published this year in international journals (Food Packaging and Shelf Life, Food and Bioprocess Technology, Food Science and Technology International, ACS Food Science & Technology, and Foods); and three Book chapters. Prof. Antonio López Gómez is Editor of the International Journal "Food Engineering Reviews" (IF 6.738 in 2021), and Editorial Board Member of the International Journal "Clean Technologies" (from 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. Ministry of Science and Innovation. Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad. PID2020-119882RB-I00. Principal researcher: Ginés Benito Martínez Hernández and Antonio López-Gómez. 2021-2024.

-Research and development of a new symbiotic and its industrial manufacturing process as a food supplement (SYMBIO). Centro para el Desarrollo Tecnológico Industrial (CDTI). Participal entities: UPCT and the Martínez Nieto S.A. IDI-20211211. Principal researcher: Antonio López-Gómez and Ginés Benito Martínez Hernández. 2021-2023.

3. Selected publications

López-Gómez, A., Ros-Chumillas, M., Navarro-Martínez, A., Barón, M., Navarro-Segura, L., Taboada-Rodríguez, A., Marin, F., Martínez-Hernández, G.B. 2021. Packaging of fresh sliced mushrooms with essential oils vapours: a new technology for maintaining quality and extending shelf life. *Foods*. 10(6): 1196. <https://doi.org/10.3390/foods10061196>

Navarro-Martínez, A., López-Gómez, A., Martínez-Hernández, G. 2021. Potential of essential oils from active packaging to highly reduce ethylene biosynthesis in broccoli and apples. *ACS Food Sc. Technol.* 1(6): 1050-1058. <https://doi.org/10.1021/acsfoodscitech.1c00071>

4. Others. Most relevant contracts

Award/Recognition to Prof Dr. Eng. Antonio López Gómez for its notable technology transfer activities. Ministry of Business, Employment and Universities; Government of the Region of Murcia. 2021.

Contract: New sustainable packaging with active and recyclable materials of interest for the meat industry. CDTI (*IDI-20210052*). Participants: UPCT, ElPozo Alimentación S.A. (Alhama, Murcia), and other companies. 2021-2022. Principal researcher: Antonio López-Gómez.

Staff: Head of the Unit: Prof. Dr. Eng. Antonio López Gómez. Researchers: Prof. Dr. Eng. Asunción Iguaz Gainza, Dr. María Ros Chumillas, Dr. Eng. Ginés Benito Martínez Hernández, M.Sc. and Ph.D. Students: Laura Navarro Segura, Marta Barón Yusty, Alejandra Navarro Martínez, Mariano Saura Mendoza, Miguel Tomás Gómez Hernández.

FOOD QUALITY AND HEALTH



1. Main results

- Higher risk of cross-contamination via polypropylene (reusable plastic crates-RPCs) compared with cardboard and wooden boxes. RPCs have a lower environmental impact than those containers with single-use but RPCs must guarantee the hygiene of this type of container.
- There are frictions between microbial safety and environmental sustainability in the fresh produce supply chain and effects on environmental, economic, and social sustainability aspects must be considered.
- Preliminary identification of some genes with potential impact in non-climacteric melon flesh firmness during ripening by transcriptomic analysis.
- LED lighting during sprouting and storage improved the synthesis of health-promoting compounds fostering product quality, suggesting that different spectral wavebands enhance antioxidants and reduce microbial risks.
- LED lights in saline conditions improved yield and quality of microgreens, reducing antinutritional compounds.
- Bimi by-products were optimized to develop an innovative kale pesto.

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 researcher: 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 researcher: Francisco Artés-Hernández.
- 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 researcher: Francisco Artés-Hernández.

-Obtención a escala semiindustrial de dos tipos de vinos a partir del subproducto de una fruta. Principal researcher: Arantxa Aznar and Encarna Aguayo.

3. Selected publications

- Aguayo, E., Martínez-Sánchez, A., Fernández-Lobato, B., Alacid, F. 2021. L-Citrulline: A non-essential amino acid with important roles in human health. *Appl. Sci.* 11: 3293. <https://doi.org/10.3390/app11073293>
- Artés-Hernández F., Castillejo N., Martínez-Zamora L., Martínez-Hernández G.B. 2021. Phytochemical fortification in fruit and vegetable beverages with green technologies. *Foods.* 10(11): 2534. <https://doi.org/10.3390/foods10112534>
- Castillejo N., Martínez-Zamora L., Gómez P.A., Pennisi G., Crepaldi A., Fernández J.A., Orsini F., Artés-Hernández F. 2021. Postharvest LED Lighting: effect of red, blue, and far red on quality of minimally processed broccoli sprouts. *J. Sci. Food Agric.* 101: 44-53. <https://doi.org/10.1002/jsfa.10820>
- López-Gálvez, F., Gómez, P.A., Artés, F., Artés-Hernández, F., Aguayo, E. 2021. Interactions between microbial food safety and environmental sustainability in the fresh produce supply chain. *Foods.* 10(7): 1655. <https://doi.org/10.3390/foods10071655>
- López-Gálvez, F., Rasines, L., Conesa, E., Gómez, P.A., Artés-Hernández, F., Aguayo, E. 2021. Reusable plastic crates (RPCs) for fresh produce (case study on cauliflowers): sustainable packaging but potential *Salmonella* survival and risk of cross-contamination. *Foods,* 10, 1254. <https://doi.org/10.3390/foods10061254>
- Martínez-Zamora L., Castillejo N., Artés-Hernández F. 2021. Postharvest UV-B and UV-C radiation enhanced the biosynthesis of glucosinolates and isothiocyanates in brassicaceae sprouts. *Postharvest Biol. Technol.* 181: 111650. <https://doi.org/10.1016/j.postharvbio.2021.111650>
- Martínez-Zamora L., Castillejo N., Artés-Hernández F. 2021. Periodical UV-B radiation hormesis in biosynthesis of kale sprouts nutraceuticals. *Plant Physiol. Biochem.* 165: 274-285. <https://doi.org/10.1016/j.plaphy.2021.05.022>
- Zarid, M., García-Carpintero, V., Esteras, C., Esteva, J., Bueso, M.C., Cañizares, J., Picó, M.B., Monforte, A.J., Fernández-Trujillo, J.P. 2021. Transcriptomic analysis of a near-isogenic line of melon with high fruit flesh firmness during ripening. *J. Sci. Food Agric.* 101:754-777. <https://doi.org/10.1002/jsfa.10688>

Staff: Head of the Unit: Prof. Dra. Encarna Aguayo. Researchers: Prof. Dr. Francisco Artés-Hernández, Prof. Dr. Juan P. Fernández-Trujillo, Prof. Dr. Francisco Artés-Calero, Dra. Lorena Martínez Zamora, M.Sc. and Ph.D.
Students: Noelia Castillejo, José Ángel Salas Millán, Laura Rasines Elena, Hazel Álvarez.

GENETIC RESOURCES



1. Main results

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 finished the project AGL2017-84085-C3-3-R demonstrating that some agroindustrial composts show promise as an alternative to peat for use as organic substrate for baby leaf lettuce and spinach, improving the yield and quality of the product.

Also, we started working on the project PID2020-114410RB-I00 “Innovative urban agriculture for a sustainable production (IRRUPTION)” granted by the Ministerio de Ciencia e Innovación and the Agencia Estatal de Investigación of the Spanish Government.

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 researcher: Catalina Egea-Gilabert and Juan A. Fernández. 2018–2021.

-Gestión de la diversidad genética de las poblaciones de Jara de Cartagena. Consejo de Gobierno CARM. Principal researcher: María José Vicente Colomer. 2020-2021.

-Soil biodiversity enhancement in European agroecosystems to promote their stability and resilience by external inputs reduction and crop performance

increase. SoildiverAgro. Comisión Europea. H2020. 817819. Principal researcher: David Fernández (Universidad de Vigo). 2019-2023.

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

3. Selected publications

Hernández-Lara, A., Ros, M., Pérez-Murcia, M.D., Moral, R., Andreu-Rodríguez, F.J., Fernández, J.A., Egea-Gilabert, C., Pascual, J.A., 2021. The influence of feedstocks and additives in 23 added-value composts as a growing media component on *Pythium irregulare* suppressivity. *Waste Manag.* 120: 351-363. <https://doi.org/10.1016/j.wasman.2020.11.053>

Sánchez-Navarro, V., Zornoza, R., Faz, Á., Fernández, J.A. 2021. Cowpea crop response to mineral and organic fertilization in SE Spain. *Processes*, 9(5), 822. <http://dx.doi.org/10.3390/pr9050822>

Labiad, M.H., Giménez, A., Varol, H., Tüzel, Y., Egea-Gilabert, C., Fernández, J.A., Martínez, M.C. 2021. Effect of exogenously applied methyl jasmonate on yield and quality of salt-stressed hydroponically grown sea fennel (*Crithmum maritimum* L.). *Agron.* 11: 1083. <http://hdl.handle.net/10317/9116>

Balliu, A., Zheng, Y., Sallaku, G., Fernández, J.A., Gruda, N.S., Tuzel, Y. 2021. Environmental and cultivation factors affect the morphology, architecture and performance of root systems in soilless grown plants. *Horticulturae*, 7, 243. <https://doi.org/10.3390/horticulturae7080243>

García-García, M.C., Font, R., Gómez, P., Valenzuela, J.L., Fernández, J.A., Del Río-Celestino, M. 2021. Effects of fertigation management on the quality of organic legumes grown in protected cultivation. *Horticulturae*, 7, 28. <https://doi.org/10.3390/horticulturae7020028>

Pennisi, G., Orsini, F., Castillejo, N., Gómez, P.A., Crepaldi, A., Fernández, J.A., Egea-Gilabert, C., Artés-Hernández, F., Gianquinto, G. 2021. Spectral composition from led lighting during storage affects nutraceuticals and safety attributes of fresh-cut red chard (*Beta vulgaris*) and rocket (*Diplotaxis tenuifolia*) leaves. *Postharvest Biol. Technol.* 175, 111500. <https://doi.org/10.1016/j.postharvbio.2021.111500>

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

This year the Unit continued working on the microbiological aspects of food safety, focussing mainly in 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 from two research projects, funded by the Spanish Government, and from two contracts. Members of this Unit also participate in a spin-off company, recently created (iPackaging, S.L.). Twelve 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 (PID2020-116318RB-C32) Principal researcher: Pablo S. Fernández, co-researcher: Alfredo Palop. 2020-2023.

-Validation of new tools and processes for analysis and improvement of microbial food safety. MINECO (AGL2017-86840-C2-1-R). Principal researcher: Alfredo Palop, co-researcher: Pablo S. Fernández. 2018-2021.

3. Selected publications

Rodrigo, D., Palop, A. 2021. Applications of natural antimicrobials in food packaging and preservation. *Foods*. 10: 568.

<https://doi.org/10.3390%2Ffoods10030568>

Somrani, M., Debbabi, H., Palop, A. 2021. Antimicrobial and antibiofilm effect of essential oil of clove against *Listeria monocytogenes* and *Salmonella* Enteritidis. *Food Sci. Technol. Int.* 28: 331-339.

<https://doi.org/10.1177/10820132211013273>

Huertas, J.P., Ros-Chumillas, M., Garre, A., Fernández, P.S., Aznar, A., Iguaz, A., Esnoz, A., Palop, A. 2021. Impact of heating rates on *Alicyclobacillus acidoterrestris* heat resistance under non-isothermal treatments and use of mathematical modelling to optimize orange juice processing. *Foods*. 10: 1496. <https://doi.org/10.3390/foods10071496>

Clemente Carazo, M., Leal, J.J., Huertas, J.P., Garre, A., Palop, A., Periago, P.M. 2021. The different response to an acid shock of two *Salmonella* strains marks their resistance to thermal treatments. *Frontiers Microbiol.*, 12: 691248. <https://doi.org/10.3389/fmicb.2021.691248>

Garre, A., den Besten, H.M.W., Fernández, P.S., Zwietering, M.H. 2021. Not just variability and uncertainty; the relevance of chance for the survival of microbial cells to stress. *Trends Food Sc. Technol.* 118: 799. <https://doi.org/10.1016/j.tifs.2021.10.033>

4. Others:

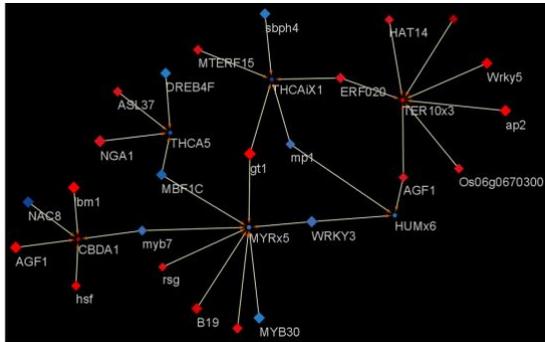
Contracts: Company: Adria Development. Contract leader: Pablo S. Fernández.

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. Ph.D. and Master Students: Leonidas Georgalis.

MOLECULAR GENETICS



1. Research interest and main results

Two research lines build the focus of our research:

- 1: The study of plant circadian clock and its impact in plant development. We use “gene knock out” by Crisp/Cas technologies. We are currently focusing a comparative analysis of the function of the clock gene *GIGANTEA* in the model species *Petunia hybrida*, *Nicotiana benthamiana* and *Antirrhinum majus*. We have started a biotechnology research line in plant cell cultures in bioreactors
- 2: Transcriptomic and genomic characterization of varieties of *Cannabis sativa* to improve cannabinoids and terpenoids. We search genetic differences underlying the regulation of synthesis of these compounds using bioinformatic and molecular techniques.

2. Projects (most relevant)

- Diverfarming H2020;2017-2022.
- 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. 2018-2021.

-Cannabi+ / Empresa Linneo Health S.L.

3. Selected publications

- Ruiz-Hernández, V., Joubert, L., Rodríguez-Gómez, A., Artuso, S., Patrick, J.G., Gómez, P.A., Eckerstorfer, S., Brandauer, S.S., Trcka-Rojas, C.G.I., Martínez-Reina, L., Booth, J., Lau-Zhu, A., Weiss, J., Bielza, P., Glover, B.J., Junker, R.R., Egea-Cortines, M. 2021. Humans share more preferences for floral phenotypes with pollinators than with pests. *Frontiers Plant Sc.* 12: 1762. <https://doi.org/10.3389/fpls.2021.647347>
- Pérez-Sanz, F.; Ruiz-Hernández, V.; Terry, M.I.; Arce-Gallego, S.; Weiss, J.; Navarro, P.J.; Egea-Cortines, M. 2021. gcProfileMaker: An R package for automatic classification of constitutive and non-constitutive metabolites. *Metabolites*, 11, 211. <https://doi.org/10.3390/metabo11040211>
- Terry, M.I., Ruiz-Hernández, V., Águila, D.J., Weiss, J., Egea-Cortines, M. 2021. The effect of post-harvest conditions in *Narcissus* sp. cut flowers scent profile. *Frontiers Pl. Sci.* 11: 540821. <https://doi.org/10.3389/fpls.2020.540821>

4. Others

Ph.D. Dissertations:

Estudio de nuevas herramientas para el fenotipado vegetal de alta resolución y sus aplicaciones en agricultura. Author: Díaz Galián, María Victoria. Supervisors: Egea Gutiérrez-Cortines, Marcos; Navarro Lorente, Pedro Javier.

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

Mendoza, J.E., Balanza, V., Cifuentes, D., Bielza, P. 2021. Genetic improvement of *Orius laevigatus* for better fitness feeding on pollen. Journal of Pest Science 94: 729-742. DOI: 10.1007/s10340-020-01291-x

Balanza V, Mendoza JE, Cifuentes D, Bielza P. 2021. Selection for resistance to pyrethroids in the predator *Orius laevigatus*. Pest Management Science 77: 2539-2546. DOI: 10.1002/ps.6288

Balanza V, Mendoza JE, Cifuentes D, Bielza P. 2021. Genetic improvement of spinosad resistance in the biocontrol agent *Orius laevigatus*. BioControl 66: 673-685. DOI: 10.1007/s10526-021-10093-8

Ruiz-Hernández Victoria et al. 2021. Humans share more preferences for floral phenotypes with pollinators than with pests. Frontiers in Plant Science 12: 1762. DOI: 10.3389/fpls.2021.647347

Omar Ruíz-Rivero, Andrés García-Lor, Borja Rojas-Panadero, José Carlos Franco, Fathiya M. Khamis, Kerstin Kruger, Dina Cifuentes, Pablo Bielza, Alejandro Tena, Alberto Urbaneja & Meritxell Pérez-Hedo. 2021. Insights into the origin of the invasive populations of *Trioza erytreae* in Europe using microsatellite markers and mtDNA barcoding approaches. Scientific Reports 11: 18651. DOI: 10.1038/s41598-021-97824-0

Kumar Saurabh Singh et al. 2021. Global patterns in genomic diversity underpinning the evolution of insecticide resistance in the aphid crop pest *Myzus persicae*. Communications Biology 4: 847. DOI: 10.1038/s42003-021-02373-x

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. M.Sc. and Ph.D. Students:, Virginia Balanza, Amador Rodríguez, Nerea López Celdrán.

SECONDARY METABOLITES



1. Main results

The effect of the plant growth regulators gibberellic acid (GA_3), chlorocholine chloride (CCC), and paclobutrazol (PBZ) on the metabolism of *Stevia rebaudiana* cultured *in vitro* was studied. The work aimed to assess the impact of those compounds on plant performance and both steviol glycosides (SGs) and phenolics accumulation. GA_3 -treated plants showed increased SGs and phenolic compounds content, as well as a downregulation of most of the SGs/GAs biosynthesis-related genes, with a more pronounced effect upstream of steviol. Following this trend, CCC downregulated some MEP pathway genes, including *SrDXS*, *SrDXR*, *SrCDPS*, and *SrKS*, and upregulated *SrUGT6G1*. PBZ also upregulated *SrUGT76G1* and inhibited five genes of the MEP pathway and all genes coding for kaurenoic pathway enzymes. Our results highlight the ability of GA_3 to reverse the effects of PBZ on the pattern of transcripts and to additionally increase the SGs content to levels comparable to those found in field-grown plants.

In another set of experiments, we demonstrated that the chronic exposure to low Pb doses may induce cytogenotoxicity and cell cycle delay/blockage, as well as oxidative stress in non-mining *Zygophyllum fabago* populations. In contrast, the seedlings adapted to mining soils showed an increased absorption and tolerance to Pb toxicity. The higher innate levels of antioxidant compounds and the differential organ-specific response of redox metabolites seem to contribute to the tolerance to Pb exhibited by *Z. fabago* seedlings from mining sites. The results point out that the seed provenance may be relevant when phytostabilization and restoration programs of polluted soils are being developed.

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). 2016-2021. Project manager: Francisca Sevilla (CSIC).
- Elicitación acústica de resistencia sistémica en plantas. MICINN (AGL2017-92217-EXP). 2018-2021. Principal investigator: Antonio A. Calderón.
- 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

- Ribeiro-Lucho, S., Nogueira do Amaral, M., Milech, C., João Bianchi, V., Almagro, L., Ferrer, M.A., Calderón, A.A., Bolacel Braga, E.J. 2021. Gibberellin reverses the negative effect of paclobutrazol but not of chlorocholine chloride on the expression of SGs/GAs biosynthesis-related genes and increases the levels of relevant metabolites in *Stevia rebaudiana*. *Plant Cell Tiss. Organ Cult.* 146: 171-184. <https://doi.org/10.1007/s11240-021-02059-6>
- López-Orenes, A., Santos, C., Dias, M.C., Oliveira, H., Ferrer, M.A., Calderón, A.A., Silva, S. 2021. Genotoxicity and cytotoxicity Induced in *Zygophyllum fabago* by low Pb doses depends on the population's redox plasticity. *Horticulturae* 7:455. <https://doi.org/10.3390/horticulturae7110455>

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



Enchytraeus cripticus culture.



Experimental plots in climate chamber.



Collecting potatoes grown with biofertilizers.



Soil ecotoxicity tests in chambers of the Laboratory of Climate Change.

1. Main results

- CGL2017-82264-R project. The role of soil amendments in determining soil microbiology at mining impacted soils was evaluated. At long-term, plant rhizospheres had a more determining effect on soil microbial composition than soil amendments.

- CGL2016-80981-R project. A time-lag occurred between the positive effects of the amendment (biochar+USR) on tailing soils and these improvements being translated into effective spontaneous plant colonization.

- Diverfarming project. Field trials and lab analyses have finished. Results on how crop diversification affects soil health indicators, including soil microbial communities, which are highly dependent on the specific crop and management.

- SoildiverAgro project. Field case studies in different pedoclimatic regions of Europe have been established and soil is being sampled to assess the relationship between crop production and soil biodiversity.

2. Projects (most relevant)

- Sustainability for the phytomanagement of mining polluted soil: an ecophysiological and microbiological approach (CGL2017-82264-R). MINECO. 2018-2021. 96,800€. PI: Héctor M. Conesa. (<http://suelos.upct.es/en/node/168>).

- 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>).

- Soil metal-pollution in a global warming perspective: ecotoxicological and functional aspects (CLIMTOXFUN, 21127/SF/19). Séneca Foundation-Murcia Region (Saavedra Fajardo Research Contract). 2020-2022. 123,000€. PI: M. Nazaret González. (<http://suelos.upct.es/es/node/204>).

-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

Beriot, N., Peek, J., Zornoza, R., Geissen, V., Huerta Lwanga, E. 2021. Low density-microplastics detected in sheep faeces and soil: A case study from the intensive vegetable farming in Southeast Spain. *Sci. Total Environ.* 755, 142653. <https://doi.org/10.1016/j.scitotenv.2020.142653>

Risueño, Y., Petri, C., Conesa H.M. 2021. A critical assessment on the short-term response of microbial relative composition in a mine tailings soil amended with biochar and manure compost. *J. Hazard. Mat.* 417, 126080. <https://doi.org/10.1016/j.jhazmat.2021.126080>

Peñalver-Alcalá, A., Álvarez-Rogel, J., Conesa, HM, González-Alcaraz, MN. 2021. Biochar and urban solid refuse ameliorate the inhospitality of acidic mine tailings and foster effective spontaneous plant colonization under semiarid climate. *J. Environ. Manag.* 292, 112824. <https://doi.org/10.1016/j.jenvman.2021.112824>.

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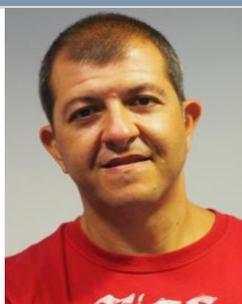
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