

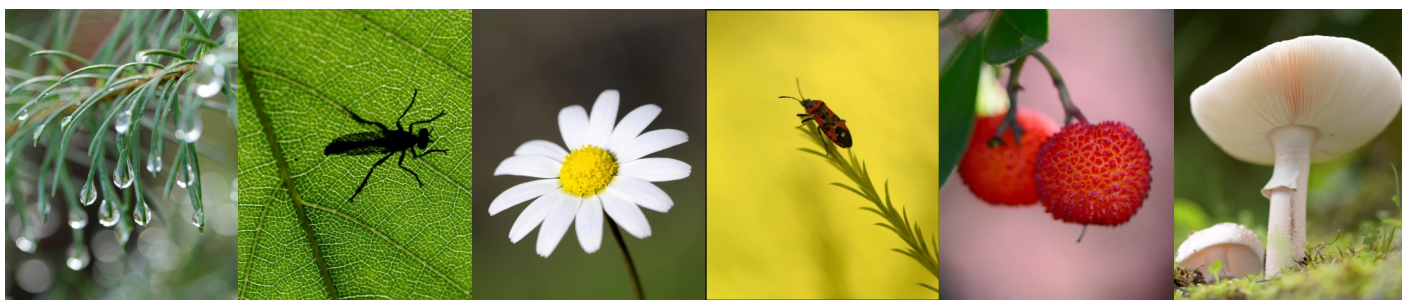


# CITAB | NEWSLETTER

Centre for the Research and Technology of Agro-Environmental and Biological Sciences

**issue 14**  
DECEMBER 2022

## Editorial and Highlights



The 14th issue of the CITAB newsletter highlights our main achievements in 2022, a very productive year, with 79 national and international projects underway and almost 300 SCOPUS-indexed articles, which reinforces the role of CITAB as the largest R&D unit in northern Portugal in Agrarian and Biological Sciences.

This year's funding of more than €4.0 million comes from a variety of sources, and stakeholder collaboration has reached an all-time high of €1.8 million. In 2022, private sector funding increased to 45% of CITAB's total funding. This strong partnership showcases the practical application of our research, promoting knowledge transfer and adding value to the agrarian value chains.

With our eyes set on the future, we believe in the research greatness that comes out of our laboratories, the restlessness of our researchers, and our scholarship's curiosity and willingness to learn.

We extend our heartfelt thanks to everyone that, directly or indirectly, contributed to our collective achievements, as our success is made possible by the daily efforts of all!

**João Santos** - CITAB's Director

## CITAB is strongly committed to PRR Vine&Wine Agenda

The Mobilizing Agenda "Vine and Wine Portugal - Driving Sustainable Growth Through Smart Innovation", funded by the PRR - Recovery and Resilience Plan and the NextGeneration EU European Funds, aims to create sustainable growth through technological innovation and an integrative vision in the viticulture sector, from North to South. The consortium of this project, coordinated by the Gran Cruz Porto group, consists of 47 entities, including 22 wine-producing companies, 16 technological companies, equipment manufacturers, 9 non-business entities from the R&D&I system (ENESII), of which 3 are associations. The total investment is 77 million euros in productive investment projects, research, development, and innovation (R&D&I), qualification and internationalization of sector entities, human resources training, and promotion of developed products/services. The funding corresponding to UTAD is around 7.8 million euros, making it the largest project of UTAD to date, involving a large team with extensive experience in the sector, integrating researchers from various UTAD research centers and poles, CECAV, CETRAD, CITAB, CQVR, INESC TEC) and beyond (BioISI, C-MADE, CIIMAR, REQUIMTE), distributed among 21 sub-projects organized in 7 Work Packages (WP).





Fontainhas Fernandes

## New Challenges of the Agricultural Sector

The exponential growth of the world population exerts strong pressure on agri-food systems, making it essential to produce more and more food, guaranteeing the sustainability of production processes.

According to FAO data, global agricultural production will have to increase 70% by 2050 to feed a population which, by the end of the century, is estimated to exceed 10 billion people. On the other hand, climate change, the rising cost of energy, the loss of biodiversity, competition from biofuels, the increasing scarcity of water and good quality soil for agriculture will condition agricultural productivity in the future, in an unpredictable changing geopolitical framework.

In global terms, the world has to produce more food with less land and water limitations, less carbon dioxide emissions, in a scenario marked by climate change and environmental problems. In the case of Europe, there is a dependence on the use of imported land, i.e. land outside its borders. It is estimated that most of the land used to produce the food and forestry products consumed in the European Union is located outside.

Given the complexity of this environment and the social, economic and financial crisis experienced by the country in recent years on a global level, Portugal should promote policies that encourage agricultural production in a more competitive way, aiming to reduce our dependence on imported food.

The focus is on preserving soils suitable for agriculture, increasing national agricultural production, valuing endogenous natural resources and products in which the country can be more competitive internationally. The country's dependence on imported energy and foodstuffs are factors that make it vulnerable to crises such as the one we are experiencing.

In Portugal, there is also the challenge of economic complexity, which implies accelerating structural transformation and changing the specialisation profile of the economy, namely in the agro-food sector, with the aim of increasing the production of goods and services with greater added value, which requires increasing investment in knowledge and innovation.

Likewise, it is essential to increase investment in research and in the national added value incorporated in what is exported, since it is not easy to reduce imports of certain products, such as cereals. However, it is important to change the profile of goods and services in exports, with the aim of achieving a positive balance of products and services.

It is in this context of globalisation and permanent change and uncertainty that investment in the qualification of human resources and in research and development in the agricultural sector worldwide must be encouraged, with the aim of increasing productivity and ensuring food safety.

Achieving this goal requires encouraging new formats of interaction and cooperation between the scientific system and economic agents, with a view to fostering the dissemination of knowledge to the business fabric. The growing interest in the interaction between companies and the scientific system can be enhanced in new interface structures, namely the Collaborative Laboratories, the Technological Interface Centres and the Competitiveness Clusters.

In summary, a world of contradictions, of abundance and scarcity, of technological advancement and resource restriction, of longer life expectancy and global threats, the agri-food sector is experiencing a challenging and demanding time, in which the scientific system must assume an increasingly relevant role.





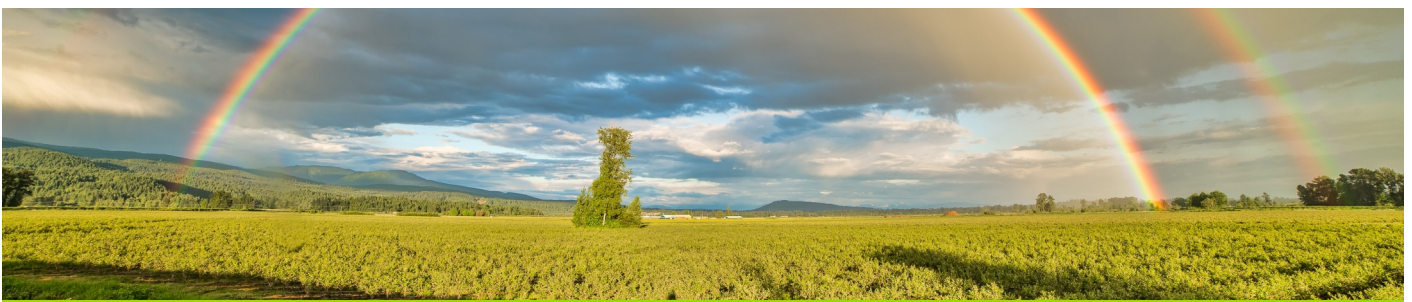
## ECONUTRI

ECONUTRI is a consortium of scientific experts and researchers from different disciplines, private companies, farmers' associations, and stakeholders. ECONUTRI is partnering with six Chinese Institutions, four from public research and two from industry, to complement activities and to strengthen the scientific collaboration between Europe and China. The project will scientifically support the EU's Green Deal in its target to reduce fertiliser use by least 20% by 2030, thereby reducing by 50% losses of nutrients associated with negative environmental impacts. More specifically, ECONUTRI will address water pollution caused by  $\text{NO}_3$  and P leaching and run-off from cultivated soils, manure/slurry and plant residues, as well as greenhouse gas ( $\text{N}_2\text{O}$ ,  $\text{CO}_2$ ,  $\text{CH}_4$ ) and  $\text{NH}_3$  emissions from cultivated soils, barns, and organic biomass during storage, composting, and land application. ECONUTRI will optimise, validate, and demonstrate 24 innovative technologies that currently have a TRL of 4-6, and will increase their TRL to 7-8. These technologies are integrated parts of a holistic concept based on recycling of nutrients and organic material, novel machinery and fertilisers, novel decision support systems (DSS), and novel nutrient management plans incorporating nature-based solutions to reduce nutrient losses and to increase nutrient use efficiency. The expected results include hyperspectral analysis algorithms, advanced on-line DSS platforms to develop smart nutrient management plans for organic and conventional crops, protocols for circular cropping systems in open field and greenhouses, advanced emission monitoring feedback systems, novel manure spreaders, variable rate technologies for precision fertilisation, smart fertilisers, and biostimulants increasing N use efficiency. ECONUTRI will establish eight demonstration sites and deploy a comprehensive range of dissemination, communication, and exploitation activities to maximise the impact of the expected results and technologies.



## AGROSERV

Developing a resilient and sustainable agriculture system, and the agroecological transitions requires a deep understanding of agroecosystems, their interactions with the environment, and management practices. AgroServ features a large consortium of research infrastructures, most of them being on the EU roadmap, and a vast offer of services at all scales, from the molecule to the organism, to the ecosystem, to the society. AgroServ will facilitate a systemic and holistic approach to understand the threats and challenges agriculture is facing, towards the implementation of a resilient and sustainable agri-food system. We propose a transdisciplinary offer of services, integrating the actors of the agriculture system in the research process, of which the farmers are the first, thanks to a wide offer of living labs across Europe. Most of the relevant field of sciences are represented in AgroServ, from natural to social sciences. We will develop a wider catalogue of integrated and customized services, thanks to a specific approach of service pipelines designed from a gap analysis, stakeholder and user demands. A strong community building and training program for access managers and users will be implemented to facilitate multi- and transdisciplinary research with all relevant actors. Results from the research performed under AgroServ will be synthesized to be used in the scope of evidence-based policy making. Data from AgroServ will be open and compliant with FAIR practices, and made available on the long-term to the communities, and be linked with the main European initiatives, as the EOSC. Strong links will be established with existing or future programs under H2020 and Horizon Europe, such as the partnerships agroecology, living labs and research infrastructures, and agriculture of data, as well as the two CSA AE4EU and ALL-READY, and the missions soil and plant health, and waters. AgroServ will collaborate with other relevant initiative in the Pillar II to of HE.





### VINEPROTECT

Mediterranean vineyards are challenged by climate change that jeopardize the high-quality and typicity of its grape and wine. Also, diseases and pests are limiting factors for grapevine production. Wine Industry management leads to a decrease of the vineyard ecosystem biodiversity, (over)uses of chemical fertilizers and synthetic pesticides and may also overuse of irrigating water. Thus, it urges to implement sustainable local strategies towards increasing biodiversity, reducing agrochemicals, increasing the resilience of the vineyard to climate change associated stressors like prolonged drought, common vineyard diseases (e.g., mildews).

VINEPROTECT's aim is to implement an operational-toolbox of sustainable agroecological practices oriented to local vineyards specificities, increase Mediterranean vineyards' resilience to climate change and diseases, reduce the agrochemicals use, and boost local circular agriculture. This operational-toolbox integrates four interconnected and sustainable bio-approaches: (i) isolation of vineyard-associated root endophytes/rhizo-bacteria and -fungi that show potential to promote plants' growth and/or resilience to severe drought; (ii) isolation of local vineyard-associated *Trichoderma* species, showing potential to be used against common vine pathogens, mostly mildews; (iii) the use of bio-hydrogels produced from agricultural wastes to help retaining soil-water; iv) the survey of local N-fixing plants (e.g., clover) and implementation of these landscape-covers to protect soil from erosion, reduce water loss and excessive soil-heating, work as natural fertilizers and attract pollinizers. These strategies will be validated in partners' local vineyards, to increase the vineyard's biodiversity. The socio-economic impacts on the local vineyards' resilience and value-chain will be assessed at the end of the VINEPROTECT project.

VINEPROTECT consortium has 7 partners from Portugal (FCUP, coordinator; and UTAD-CITAB), Italy, Turkey and Morocco, in a synergic complementarity (more details in <https://vineprotect-prima.com>).



### LIFE FAGESOS

LIFE FAGESOS aims to address and remediate one of the most severe threats associated to global Climatic Changes: The outbreak of Alien Invasive Plant Pathogens, adversely impacting natural and semi-natural forest ecosystems. *Phytophthora* diseases are increasing their impact and distribution range in evergreen oak and chestnut ecosystems of the Mediterranean basin, boosted by temperature increase and higher frequency of extreme weather events such as flooding and drought. Scarce public awareness of the problem, severe human impact on forest areas and the new EU regulation on fertilizers, that limits the use of K-phosphonate, the most efficient and eco-friendly molecule to mitigate disease impact, further increase the risk of epidemic spread of these diseases. Challenged Forest Ecosystems need improved tools & strategies to enhance their adaptation to the outlined issue, finally ensuring their preservation as important natural carbon sinks. Indeed, FAGESOS will introduce tools to contrast diseases and enhance forests' resilience, by:

- i) The delivery of regional maps for risk- and impact assessment of *Phytophthora* diseases in the Mediterranean basin in diverse current and predicted climatic scenarios, as a tool for policy makers and forest managers;
- ii) The development, validation, implementation and dissemination of Integrated Pest Management (IPM) protocols, tailored to the specific target ecosystem, including a strictly scheduled use of new biomolecules and microorganisms with proven efficacy. Treatment protocols will be complemented by hygiene measures to prevent disease-spread;
- iii) The delivery of fully accessible monitoring protocols, based on validated, innovative models & technologies;
- iv) Intense communication, dissemination and capacity building activities, targeting different stakeholders to raise awareness and induce adaption of behaviour. The project will be implemented in Italy, Spain and Portugal through a multi-actor approach.







## The disruptive 2022 summer in Portugal

The 2022 summer was the warmest in Portugal, as well as in most of Europe. A heat wave is commonly defined as a period of at least 6 consecutive days with maximum temperature anomalies greater than 5°C, typically having greater impacts on human activities when occurring in the summer months. Several heat waves hit mainland Portugal this summer, particularly the innermost regions, such as the “Trás-os-Montes e Alto Douro” region. According to the Portuguese Weather Service (*Instituto Português do Mar e da Atmosfera*, S.A.), more than 40 heat wave days were reported in several weather stations in the northeast of Portugal, an unprecedentedly warm period, with record-breaking maximum temperatures. Furthermore, the European Commission COPERNICUS Climate Change Service corroborates the extremely high temperatures throughout Europe in 2022, experiencing the hottest summer ever recorded, accompanied by increasing atmospheric greenhouse gas concentrations. In Portugal, as in other southern European countries, the extremely warm summer conditions combined with a severe-to-extreme meteorological, hydrological and agricultural drought, very high levels of solar radiation, locally strong winds and very low relative humidity, triggered widespread fire activity.

These alarming conditions corresponded to one of the severest extreme compound events in Portugal, which brought many detrimental impacts to agriculture, forestry, water resources, energy, human health and the environment. As an illustration, at the end of this summer, several water reservoirs were at less than 10% of their full capacity, whilst the soils were mainly at permanent withering status. The lack of water for irrigation, hydropower generation, and even for human



Alvão Dam in a state of extreme drought



João Santos

consumption, was quite dramatic in some locations, with strong socioeconomic impacts and economic losses. This extreme compound event was also highly disruptive for many ecosystems and left a strong footprint on the landscape.

The 2022 summer was, nonetheless, a clear indicator of a future to come. The climate projections for the upcoming decades in Portugal indeed hint at a significant warming and drying trend. Therefore, not only climate change mitigation measures should be implemented, ideally on a global scale, but also adaptation strategies, at a local-to-regional scale, should be outlined. Adaptation should respond, as much as possible, to a changing climate in a timely, sustainable and cost-effective manner. The strategies should be defined not only by considering the specificities of each sector or system, but also the site-specific conditions. As such, a given strategy may not be necessary, or even suitable, everywhere. Knowing the climate change projections for a given location is critical information for long-term planning and management, as the magnitudes of the general warming and drying trends can vary significantly from one place to the other, thus requiring *ad hoc* options. For this purpose, climate research based on simulations generated by ensembles of state-of-the-art climate models and greenhouse gas emission scenarios (anthropogenic radiative forcing) is a key tool. When these simulations are coupled with hydrological models or species models, among others, it is possible to assess the potential impacts of climate change and extreme events on water resources, forestry, ecosystems or crops. Moreover, the adaptation potential of different measures can also be tested by these modelling experiments, thereby guiding decision-making and representing valuable information to stakeholders.

## Science superheroes

On the 30th of September in Vila Nova de Gaia, the European Night of Researchers action 'Science Multiverse - Meet the heroes of our research cosmos,' promoted by INOVA+, had the participation of CITAB. Open to the general public, the Wonderbio action, organized by CITAB researchers Ana Coimbra, Isaura Castro, João Carrola and Márcia Carvalho, included activities with earthworms, daphnia, zebrafish, and various vegetable genetic resources.



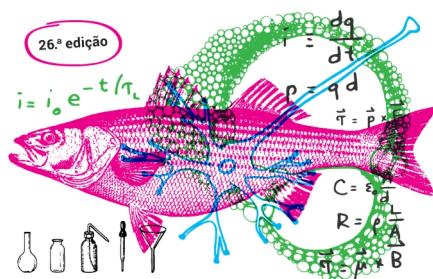
Microscope to see everything up close

Superheroes joined the activities

Vegetable genetics resources off all colors

## To make the most of the holidays

Once again, CITAB researchers received high school students under the program 'OCJF 2022 - Scientific Occupation of Young People on Vacation.' This year, nine students joined and benefited from our activities. The actions were coordinated by Ana Coimbra, Fernanda Leal, Isaura Castro, Manuela Matos, Marta Roboredo, Paula Oliveira, and Maria João Pires and allowed the participants to learn about the discovery of ancient DNA, micropropagation of aromatic plants and their uses, the use of animal models, and even how earthworms are excellent bio-recyclers.



CIÊNCIA VIVA 25

## CIÊNCIA VIVA NO LABORATÓRIO

Ocupação Científica de Jovens nas Férias junho • setembro 2022

#CienciaViva #CienciaVivanoLaboratorio

Nine high school students joined OCJF 2022

## CITAB researchers on the road

CITAB joined the 'Science and Technology week' from the 21st to the 25th of November. This year, 10 activities were organized, which included visits to some schools, while in other cases, the students visited the laboratories of CITAB. During the week, the participants could enjoy and learn from a wide range of expertise, ranging from DNA to plants and animals, up to biotechnology and climate changes.



Learning with earthworms

Young scientists in the making

Students eager to learn



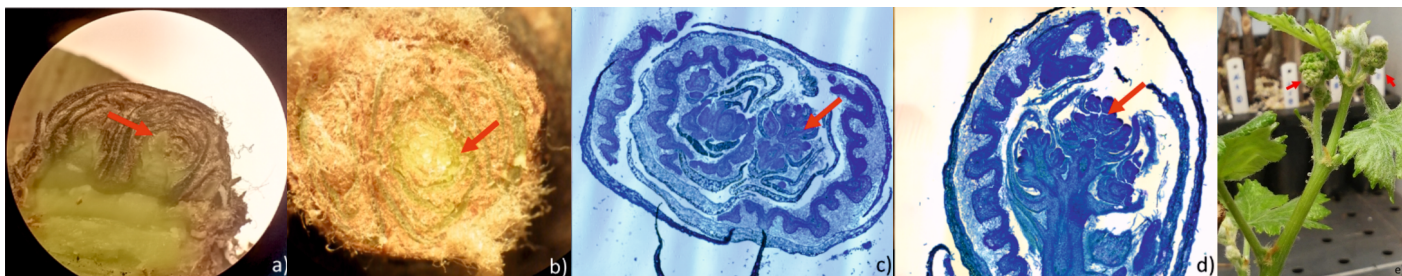


Ana Monteiro

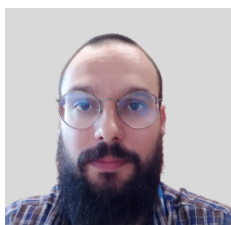
## Study of bud fruitfulness in three white varieties from the Vinho Verde Demarcated Region

On March 2022, the CITAB researcher Ana Monteiro successfully defended her doctoral thesis entitled "Study of bud fruitfulness in three white varieties from the Vinho Verde Demarcated Region.". This work was supervised by Professor Eunice Bacelar (CITAB) and Professor Aureliano Malheiro (CITAB) and was funded by INTERAC project ( NORTE-01-0145-FEDER-000017. The study was also funded by the VITISHIDRI project – "Estratégias para a gestão do stress hídrico da vinha no Douro Superior" (BI/UTAD/45/2020), and project "To Chair–The optimal challenges in irrigation", PTDC/MAT-APL/28247/2017 with reference POCI-01-0145-FEDER-028247, funded by FCT (BIM/UTAD/56/2019 and BI/UTAD/21/2020).

Alvarinho, Fernão-Pires, and Loureiro are three white grapevine varieties with high adaptability to local edaphoclimatic conditions and high oenological potential to produce Vinho Verde white wines. Thus, the main objective of the thesis was to contribute to a better understanding of the productive potential of those three varieties based on the study of fruitfulness and biochemical changes in the buds, as well as to contribute to the knowledge of the morphological characteristics of the reproductive structures throughout the growing season. Considering the variation in fruitfulness among variety and seasons, the present study highlights the importance of bud fruitfulness assessments, allowing to improve vineyard management (e.g., bud load adjustment), particularly in the growing seasons when yield potential for the next growing season will be lower. The results obtained were also presented in national and international conferences and published in journal articles.



Different methodologies for analysis to assess fruitfulness in grapevine buds during dormancy: bud dissection (a, b), histological analysis (c, d) and forcing dormant buds in controlled environmental conditions (e).



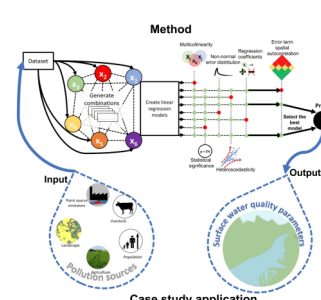
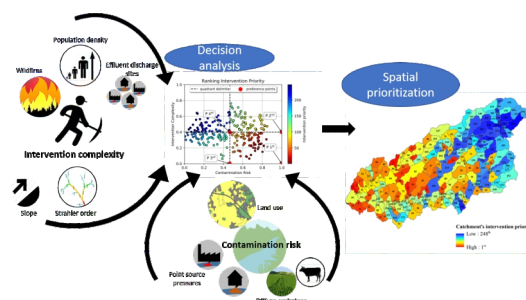
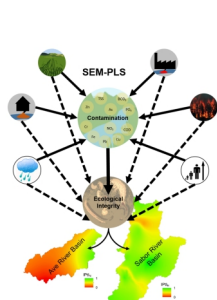
António Fernandes

## Statistical Modeling of Surface Water Quality in the Ave River Basin

CITAB researcher António Fernandes defended his doctoral thesis, "Statistical Modeling of Surface Water Quality in the Ave River Basin" in January 2022. Under the supervision of Doctor Luís Fernandes (CITAB) and Doctor Fernando Pacheco (CQVR), the research was developed in a multidisciplinary and cooperative environment with researchers from CITAB. The work was developed using Geographical Information Systems, Data Analysis, and Statistical Modeling.

His thesis work aimed to understand which pollution sources are decreasing the surface water quality of the Ave River Basin. Already in the first half of the 20th century, the Ave River was classified as one of the most polluted rivers in Europe. At that time, the known causes were effluent discharges. Nowadays, the river water quality has improved, but not to a desirable point, because the ecological status of some catchments is poor. To understand the pollution dynamics, the effects of effluent discharges, diffuse emissions from agriculture and livestock production, and land use configuration and composition were accessed to determine which could be the major threats to water quality. Under different modeling approaches, it was possible to conclude that all these pollution sources contribute to the decrease of water quality in the river basin. However, the effect of land use configuration and composition revealed higher impacts on water quality rather than contaminant of emissions.

This thesis was funded by CITAB, and also during the first two years by the INTERACT project and in the last two years by the Portuguese Foundation for Science and Technology, under a PhD Research Scholarship, Grant: SFRH/BD/146151/2019.





David Frazão

## Valorisation of *Cistus ladanifer* L.: From production to evaluation of raw materials

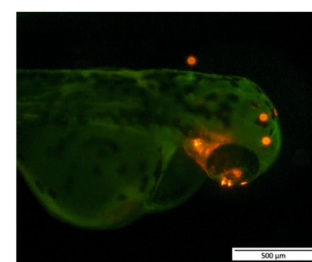
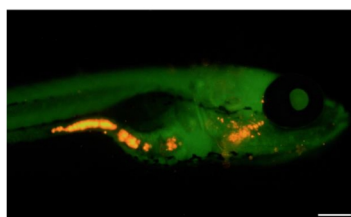
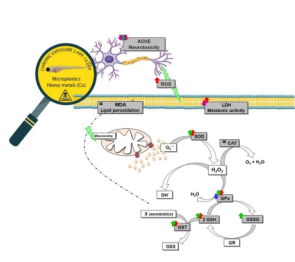
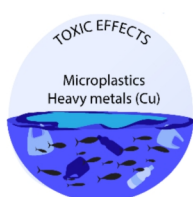
David Franco Frazão, former PhD Agrichains student and CITAB's researcher, successfully completed his PhD program in September of 2022. This was achieved by presenting and defending his PhD thesis, entitled "Valorisation of *Cistus ladanifer* L.: From production to evaluation of raw materials". The research work aimed to explore the valorisation of rockrose (*C. ladanifer*), a natural resource widely and abundantly distributed in Iberian Peninsula and North Africa, in an approach aligned with the PhD program "Agricultural Production Chains – from fork to farm". The goal was to contribute with knowledge about this resource, addressing existent gaps from production to added-value applications, for an integrative exploitation and for the development of a sustainable value chain. Rockrose shrublands, natural or cultivated, may be properly managed in a non-destructive and periodic way to yield products such as labdanum resin and seeds, besides biomass. In turn, labdanum resin may be further valorised in cosmetics and pharmaceuticals because of its UV protection, anti-inflammatory, anti-diabetic, neuroprotective, and anticarcinogenic potential activities, besides its highly valued aromatic and fixative properties. In addition, seeds were found to have a very interesting nutritional composition between the carbohydrate rich cereals and lipid rich nuts, constituting also a source of protein and calcium, and a good source of fibre, unsaturated fatty acids, and of several minerals. This rockrose is therefore an existing and abundant source of energy (biomass), bioactive or well-being (labdanum), and food (seeds). This work was supported by a multidisciplinary team of supervisors, namely Prof. Amélia Silva (UTAD/CITAB), Prof. Fernanda Delgado (IPCB/CERNAS/CBPBI), and Prof. José Carlos Gonçalves (IPCB/CERNAS/CBPBI). The work was funded by FCT - Portuguese Foundation for Science and Technology (PD/BD/135332/2017), under the Doctoral Program "Agricultural Production Chains – from fork to farm" and by Project InovEP (CENTRO-01-0247-FEDER-033815), Project CULTIVAR (CENTRO-01-0145-FEDER-000020), Project INTERACT (NORTE-01-0145-FEDER-000017) and CITAB (UIDB/04033/2020).



Dércia Santos

## Interaction between microplastics and copper: toxicity assessment in zebrafish (*Danio rerio*) and blackspot seabream (*Pagellus bogaraveo*)

Microplastics (MPs) have been recognized as ubiquitous in ecosystems worldwide and potentially toxic to aquatic organisms. MPs can easily adsorb and accumulate other waterborne pollutants, such as copper (Cu), which is a heavy metal of great concern. Thus, this THESIS aimed to assess the toxicological effects of MPs and Cu, alone or combined, in two fish species, the zebrafish (*Danio rerio*) and the blackspot seabream (*Pagellus bogaraveo*). Overall, the results demonstrated that MPs and Cu, alone or combined, decrease survival of early life stages, induce oxidative stress, cell damage, neurotoxicity and, consequently, disrupt the locomotor, avoidance and social behaviors in fish. However, these effects were dependent on several factors, including the development stage, the uptake route, the exposure duration, and species. In the acute exposure (96 h), these effects were mostly noticed in Cu and mixture (Cu+MPs) exposed groups, with MPs alone not producing significant effects. When exposed subchronically (14 days) or chronically (30 days), it was observed that MPs alone and Cu+MPs had a higher toxic effect on fish, highlighting that the toxicity of the plastic particles may arise after longer exposures. Besides, concerning the potential interaction between MPs and Cu, the overall outcome of this THESIS was that MPs modulated Cu toxicity. Taking into account the main results, it can be suggested that the excessive generation of ROS, followed by the induction of oxidative stress and/or the activation of apoptosis pathways, may potentially precede molecular and major signaling pathway changes, which in turn could lead to disruption of critical neurocircuits and changes in fish behavior. In general, the results have enhanced our knowledge regarding the effects of MPs and Cu in fish early life and adult stages, particularly at the neurological and behavioral levels. The work was supervised by Prof. Sandra Monteiro (UTAD/CITAB) and Prof. Juan Bellas Bereijo (COV/IEO/CSIC).



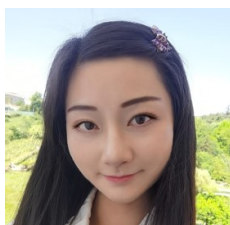




Ermelinda Silva

## The role of mineral nutrition in olive tree physiology, metabolism, and yield under rainfed conditions

CITAB researcher Ermelinda Silva successfully defended her doctoral thesis in December 2022. Her study intitled "The role of mineral nutrition in olive tree physiology, metabolism, and yield under rainfed conditions" was focus on the effect of application and lack of nutrients on the physiology, metabolism and production of rainfed olive groves, as well as the effects on fruit and oil quality. The olive tree is one of the most important crops in the Mediterranean region and in the Trás-os-Montes region. However, since olive groves are conducted in rainfed conditions, production and quality of olives and olive oil was severely compromised due to changes in temperature and precipitation patterns. The implementation of new fertilization practices was one of the mechanisms to ensure increases in the production, quality and sustainability of rainfed olive groves. The results of this study showed that application of N, P, K, and B promotes a better photosynthetic capacity, stomatal conductance and water use efficiency in olive trees. B also ameliorates water status and oxidative stress markers with greater relief during the cold season. The application of N, but 40 kg N ha<sup>-1</sup> yr<sup>-1</sup> or a little more might be the appropriate rate for these agro-ecological conditions. In fact, plants under these conditions showed better photosynthetic activity when the summer stress was more severe and enhanced the concentration of glomalin-related soil proteins. Regarding the fruits and oil quality NPKB not affect the olives and oil quality parameters, however, the application of higher doses of N decreases the oil quality. In this study was also verified that the application of controlled release fertilizers does not affect the performance of the olive trees directly but improved soil fertility and contribute to protect the soil from erosion, aspects that can benefit the agrosystem in the long-term. The works were carried out under supervisions of Carlos M. Correia (CITAB), Manuel Â. Rodrigues (CIMO-IPB) and José Moutinho-Pereira (CITAB). The study was funded by FCT - Portuguese Foundation for Science and Technology (PD/BD/128274/2017), under the Doctoral Programme "Agricultural Production Chains – from fork to farm" (PD/00122/2012) and from the European Social Funds and the Regional Operational Programme Norte 2020.

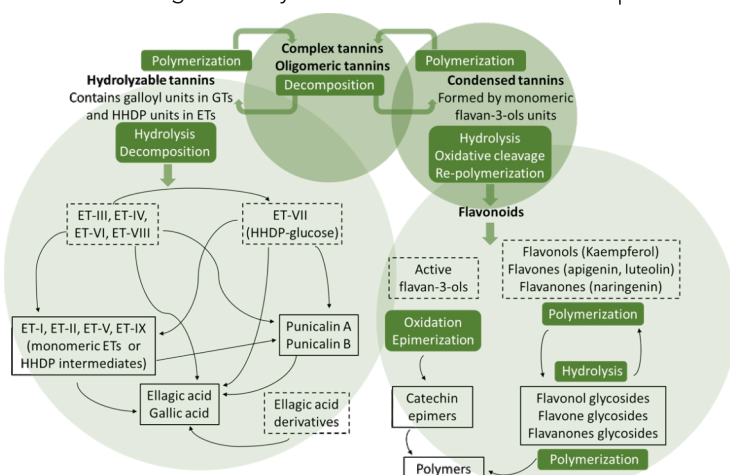


Manyou Yu

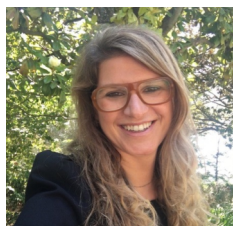
## Phenolic composition and antioxidant activity of *Punica granatum* L. (pomegranate) leaf for medicinal infusion with potential health benefits

CITAB researcher Manyou Yu, successfully defended her doctoral thesis entitled "Phenolic composition and antioxidant activity of *Punica granatum* L. (pomegranate) leaf for medicinal infusion with potential health benefits" in July 2022, in the University of Trás-os-Montes and Alto Douro. Pomegranate leaves (PGL), as agricultural and industrial wastes have got increasingly scientific interest recently, being a reservoir of beneficial nutrients and bioactive phytochemicals. However, more biochemical and pharmacological profiles of PGL need to be explored and illustrated by preclinical and clinic assays. Hence, this PhD study aimed to characterize the phenolic components and antioxidant properties of leaves collected from seven medicinal and food plants, including sage, rosemary, rue, peppermint, parsley, olive, and pomegranate. The variation of polyphenolic composition and antioxidant capacity of freshly prepared PGL infusions was evaluated during one-day storage to demonstrate the high stability of the infusion. The anti-neoplastic and

toxicological properties of PGL infusion was conducted in the transgenic mice carrying human papillomavirus (HPV) type 16 oncogenes to expand the future pharmacological application of PGL. Overall, the PhD work provided a cumulative in-depth information on the abundant phenolic composition, high levels of phenolic concentration and antioxidant capacities of PGL. Furthermore, highly stability of PGL infusion as well as its non-toxic nature and antitumoral properties against HPV16-induced neoplastic kidneys and chest skins in mice allowed to enrich the health beneficial profile of PGL and to suggested it towards future clinic trials and utilization in relevant industries. The study was funded by the FCT - Portuguese Foundation for Science and Technology (PD/BD/135333/2017), under the Doctoral Programme 'Agricultural Production Chains - From Fork to Farm' (PD/00122/2012).



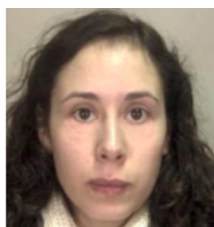
The good stability of the total polyphenolics and antioxidant properties might be related to the complex conversion and activity compensation among the individual



Rita Beltrão Martins

## A Circular Economy approach in the Agri-food chain: using by-products and underexploited raw materials as flours for gluten-free bakery and as coagulants for wastewater treatment

CITAB researcher Rita Beltrão Martins has successfully defended her PhD Thesis entitled: "A Circular Economy approach in the Agri-food chain: using by-products and underexploited raw materials as flours for gluten-free bakery and as coagulants for wastewater treatment". Her Supervisors were Professor Ana Barros (CITAB-UTAD), Professor Anabela Raymundo (LEAF-ISA), and Professor Alcides Peres (CQVR-UTAD). The objective of the thesis was to study the feasibility of a Circular Economy approach in the Agri-food chain, adding value to by-products (apple) and underexploited raw materials (acorn) as flours, to produce gluten-free (GF) bread, and also to assess the use of by-products as plant-based coagulants for wastewater treatment. Acorn flour has shown good nutritional and functional profile, revealing the importance of recovering its use as an ingredient in human diet, in particular to bake GF bread. Due to its own characteristics, has demonstrated potential to be added also in other bakery products. Apple flour revealed promising results in GF bread development, enhancing nutritional, and functional profile, in particular fiber, bioactive compounds content, and antioxidant capacity. Meeting healthy food demand, and contributing to fulfilling nutritional unbalances of the celiac patients, and GF consumers in general, acorn and apple flour GF bread formulation, could have a major contribution, whilst adding value to by-products and underexploited resources. Reaching the end of the production cycle, wastewater treatment with plant-based coagulants obtained from by-products (chestnut burr, acorn peel, olive leaf, grape stem), have shown to be efficient as a pre-treatment, improving photo-Fenton process results. The work was funded by the FCT-Portuguese Foundation for Science and Technology (PD/BD/135332/2017), under the Doctoral Program "Agricultural Production Chains – from fork to farm" (PD/00122/2012).



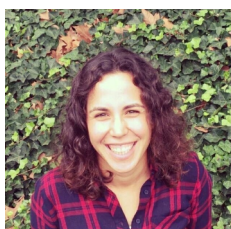
Sandrine Ferreira

## Chemical composition and potential health benefits of the main Portuguese elderberry cultivars (*Sambucus nigra* L.): a contribution to the valorisation of the Varosa Valley

Sandrine dos Santos Ferreira, successfully completed her PhD program in May of 2022. This was achieved by presenting and defending her PhD thesis, entitled "Chemical composition and potential health benefits of the main Portuguese elderberry cultivars (*Sambucus nigra* L.): a contribution to the valorisation of the Varosa Valley elderberries". The research work aimed to increase the knowledge about the chemical composition and potential biological activities of the three different *S. nigra* cultivars produced in Varosa Valley, namely Sabugueiro, Bastardeira and Bastardeira in order to be able to select the most profitable cultivar(s), aligned with the PhD program "Agricultural Production Chains – from fork to farm". In this work, the variation of physiochemical parameters was evaluated along 5 maturation stages (one green-immature, two immature, mature, and commercial stage) in 3 different harvesting years, for the 3 cultivars. Along the maturation stages, an increase in elderberries weight, total soluble solids, total phenolic content, total anthocyanin content, sugar content and antioxidant activity was observed, while, titratable acidity and flavonoids content decreased. Ten phenolic compounds were identified in all samples, being anthocyanins the major compounds. Elderberry extract (E) and rich-phenolic extract (M) showed promising bioactivities, such as: i) anti-tyrosinase activity; ii) anti-glycative potential by trapping methylglyoxal (MGO), which was shown for the first time; iii) capacity to decrease free MGO, decreasing its toxicity against HepG2 cells, being Bastardeira and Sabugueira the most effective cultivars; iv) anti-inflammatory activity (reducing NO release by LPS-stimulated RAW 264.7 cells), and v) cellular antioxidant activity (protecting HepG2 against oxidative stress). In conclusion, Sabugueiro is more profitable to produce elderberry juice concentrates; Bastardeira for colouring applications; and Bastardeira and Sabugueira for health-related applications, and specifically Sabugueira for anti-inflammatory purposes. Results obtained highlight the high quality of Portuguese elderberries concerning their industrial application and also show their potential health benefits. The work was supervised by Prof. Fernando Nunes (UTAD/DQ-VR) and Prof. Amélia Silva (UTAD/CITAB).







Sara Laranjeira

## Chickpea (*Cicer arietinum* L.) inoculation with beneficial microorganisms for increased productivity and resilience under a changing environment

CITAB researcher Sara Laranjeira, defended her doctoral thesis, “Chickpea (*Cicer arietinum* L.) inoculation with beneficial microorganisms for increased productivity and resilience under a changing environment”, in Agricultural Production Chains - from fork to farm (AgriChains) Doctoral Program, in July 2022. Development of sustainable and competitive legume-based agricultural systems is at the core of agricultural policies in Europe.

A significant driver of which, is the urgent need to improve the EU's autonomy in plant-based protein and the acknowledgment of legumes key role in sustainable cropping systems. Chickpea is a widely cropped grain legume mostly cultivated in areas where terminal drought stress, poor soil fertility, and limited use of chemical fertilizers are frequent and compromise plant growth and productivity. The main objective of this thesis was to contribute to increase the productivity and resilience of chickpea under climate change conditions, by focusing on smart agriculture practices such as suitability of the growing season and genotypes, irrigation management strategies and application of biofertilizers based on microbial inoculants. And to gain a deeper insight into the beneficial microorganisms associated with chickpea roots and seeds by exploring their biological mechanisms and understanding their phylogenetic relationships. Results show that the majority of the isolates possess two or more plant growth-promoting mechanisms, being phosphate solubilization and IAA production the most common traits. Molecular analysis showed isolates belonging to the *Agrobacterium*, *Rhizobium*, *Mesorhizobium*, *Burkholderia* and *Paraburkholderia* genera. Field trial to understand how the selected microbial inoculants influence plant performance under different irrigation regimes, showed that inoculation with plant growth-promoting bacteria (PGPB) had beneficial effects on plant performance and grain yield regardless the irrigation level, however, co-inoculation with PGPB and arbuscular mycorrhizal fungi (AMF) shows a far greater potential to improve productivity. As a result of this work, a National Patent n° 116424- “Microbial Biofertilizer Formulation” was published in the National Industrial Property Bulletin, n° 230/2021. The thesis was supervised by Prof. Guilhermina Marques (UTAD-CITAB) and Prof. Núria Pascual Seva (UPV). This study was supported by the project LEGSEEDCOAT – (PTDC/AGR-TEC/1140/2014), and by FCT grant (PD/BD/113617/2015), under the Doctoral Programme AgriChains.

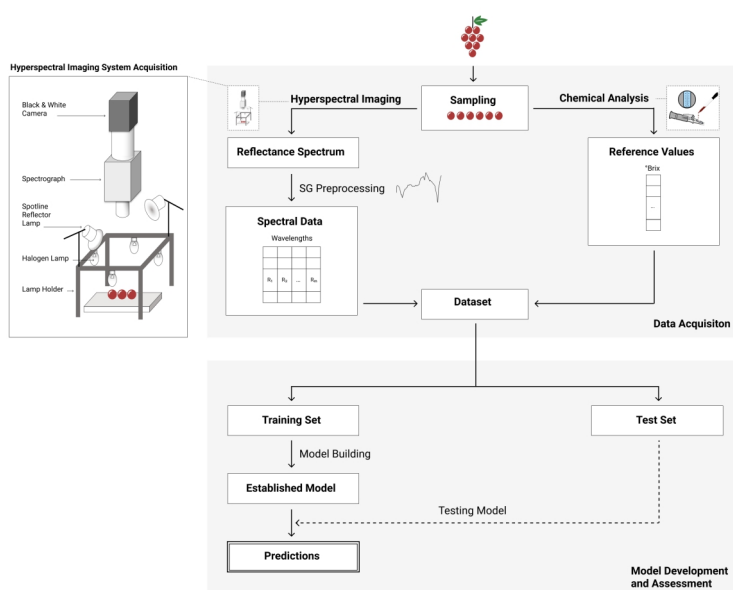


Véronique Gomes

## “Spectroscopy Data-Driven Models for Grape Quality Assessment in Precision Viticulture”

CITAB researcher Véronique Gomes, successfully defended her doctoral thesis entitled “Spectroscopy Data-Driven Models for Grape Quality Assessment in Precision Viticulture” in April 2022. Her thesis work contributes for the growing body of precision viticulture, providing the building blocks of a new approach to support wine producers in their efforts to achieve production excellence and consistency. The main objective was to explore and to obtain insights into the effectiveness of the applicability of non-destructive imaging spectroscopy technology, namely hyperspectral imaging in reflectance mode, coupled with different machine learning

algorithms (including the most recent deep learning class) in grape ripeness assessment (through the evaluation of relevant enological parameters during maturation process), and into how the models are influenced by the natural variability of the samples and the specific characteristics that may be present inside a vineyard (different vintages, varieties and growth conditions), representing an important step towards a more sustainable grape quality assessment. The evaluation of important spectral regions corresponding to the enological parameters under analysis was another topic covered in her thesis, opening new ways to reduce the cost of the equipment and the dimensionality of the data without losing predictive power, boosting the application of a non-invasive and non-destructive solutions for monitoring the grapes ripeness. The works were carried out under supervision of Pedro Melo-Pinto (CITAB), Francisco Rovira-Más (UPV) and Marco Seabra Reis (UC) and funded by the FCT-Portuguese Foundation for Science and Technology (PD/BD/128272/2017), under the International Doctoral Programme “Agricultural Production Chains – from fork to farm”.



# Short notes & Upcoming events

## 15 years of Excellence

CITAB celebrated its 15th anniversary, on December 5th, with a special event attended by the Rector of UTAD, Emídio Gomes, the Secretary of State for Higher Education, Pedro Nuno Teixeira, among other distinguished guests.

The celebration began with speeches by the Director of CITAB, João Santos, the Rector, and the Secretary of State, highlighting the center's contributions to research and education over the past 15 years.

After the speeches, Alexandre Quintanilha, a prominent researcher and professor, gave a special communication about the role of knowledge and democracy in promoting social progress. His talk, called "Conhecimento – o Pilar da Democracia", emphasized the importance of scientific research in addressing global challenges and ensuring that knowledge is accessible to all.

Following the talk, the guests enjoyed a delicious lunch and shared stories and memories of CITAB's history. The celebration concluded with the cutting of a large birthday cake and the singing of "Happy Birthday" to CITAB.

The event was a joyful and fitting tribute to CITAB's contributions to the field of agro-environmental and biological research. The 15th anniversary celebration highlighted the significance of CITAB's work and its continued commitment to excellence in research and education.



Opening session



Alexandre Quintanilha



The auditorium filled up to welcome the event



The event featured renowned personalities



CITAB's birthday cake

## Upcoming Events

**Webinar**  
Women in Food Science  
Sustainable Proteins

**Organizers:**  
Prof. Daniel Granato (ISL)  
Prof. Ana Barros (CITAB/DAGRO/UTAD)  
Dr. Fabiana Hoffmann (ISL)

**PROGRAM (ETM)**  
10th March 2023

- 14:00 Welcome  
Ana Barros (CITAB) | DAGRO | University of Trás-os-Montes and Alto Douro (UTAD)  
Daniel Granato | University of Limerick (ISL)
- 14:30 Plant-based food in vitro digestion: definition, challenges, and new perspectives  
Dr. Talita Comunian | Teagasc | Teagasc Food Research Centre – Ireland
- 15:00 A new approach to sustainability and health  
Dr. Ana Barros | UTAD
- 15:30 Food Science for sustainability  
Dr. Renata Ribeiro
- 16:00 Toward the design printing  
Dr. Danijela Burac
- 16:30 Final remarks

**Access link:**  
<https://www.citab.utad.pt/pt/2023/03/10/webinar-women-in-food-science-sustainable-proteins/>

**WORKSHOP**  
"Innovation towards a more sustainable agri-food production"

**16 DE FEVEREIRO**  
AUDITÓRIO DE CIÊNCIAS FLORESTAIS DA UTAD

**PROGRAM:**  
10H30 - 11H00 Sessão de abertura  
11H00 - 12H00 LINHA TEMÁTICA 1  
12H00 - 13H00 LINHA TEMÁTICA 2  
13H00 - 14H30 LINHA TEMÁTICA 3  
14H30 - 16H30 LINHA TEMÁTICA 4  
16H30 - 17H00 ENCERRAMENTO

**Logos:** CITAB, fct, GREENUPORTO

**WHY YOU ARE NOT WHAT YOU EAT**

**ISOPlexis**

**Roma**  
Professor e Coordenador

**Programa:**  
16:00 "Omni-nutrition" (10 convidados)  
16:20 "Why you are not what you eat" (Conferência)

**Apresentação do PEPAC**  
Análise e comentários

**23.27 pepac**  
Plano Estratégico de Políticas Agrícolas Comunitárias

**11 DE MAIO**  
AUDITÓRIO DE GEOCIÊNCIAS | UTAD

**Programa:**  
14H30 Sessão de abertura  
14H30 - 15H00 Palestra: O papel da UTAD na promoção da inovação  
15H00 - 16H00 Palestra: O papel da UTAD na promoção da inovação  
16H00 ENCERRAMENTO

**Logos:** CITAB, ISN, utad

## Location and contacts

**CITAB - Centre for the Research and Technology of Agro-Environmental and Biological Sciences**

University of Trás-os-Montes and Alto Douro  
Quinta de Prados, Laboratorial building,  
Room C1.10  
5000-801 Vila Real - Portugal

Phone: +351 259 350 920  
email: [citab@utad.pt](mailto:citab@utad.pt)  
website: [www.citab.utad.pt](http://www.citab.utad.pt)

[f /CITAB.UTAD](https://www.facebook.com/CITAB.UTAD)  
[in /company/88424757](https://www.linkedin.com/company/88424757)

