



# CITAB | NEWSLETTER

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

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Editors: José Lousada, Ana Coimbra, Lúcia Pinto and Daniel Faíões.

## Editorial and Highlights



The 12<sup>th</sup> issue of CITAB's newsletter features 2020 prime accomplishments, in the year where the world faced the Covid-19 pandemic, a new funding cycle was initiated and CITAB researchers faced their activities adjustment to this reality. The present edition "Hot topic" anticipating the beginning of UN proclaimed "Decade of Ocean Science for Sustainable Development" addresses how microplastics are present in water environments and are a threat to aquatic organisms. Relevant cases of ongoing international and national projects and applied research are highlighted, along with the CITAB new Doctorates. The Outreach section underlines CITAB researchers' efforts to the return to face-to-face activities.

Thanks to all CITAB researchers. It is in adversity that we show our commitment and unity.

Ana Barros, CITAB's Director

## The climate change impacts and how to mitigate them in the Côa Valley



Côa river valley

The main objectives of CoaClimateRisk project are to assess the impacts of climate change on the main agricultural crops in the Côa Valley region, such as vineyards and olive groves. These projections will serve as tools for decision support by the agents of the agri-food sector in the Côa Valley region, in the medium and long term. Another objective is to estimate the economic impacts that climate change will have in the region, as well as to evaluate strategies to mitigate/ adapt to these impacts. This project (COA/CAC/0030/2019) was approved for funding by the Portuguese Foundation for Science and Technology (FCT) and is coordinated by the researcher Helder Fraga, from UTAD's Centre for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB), and started in September 2020. With a funding of over 250.000€, this project has a

vast multidisciplinary team, with CITAB/UTAD specialists, members of "Associação Desenvolvimento Da Viticultura Duriense" (ADVID), the "Fundação CôaParque", the "Sogrape Vinhos S.A." and from the University of Minho. It also has the participation of two specialist consultants from two top international institutions, such as the University of Florence (Italy) and the Luxembourg Institute of Science and Technology (Luxembourg). For more information, including some publications and preliminary results from the CoaClimateRisk project, please go to: <http://coaclimaterisk.utad.pt/>



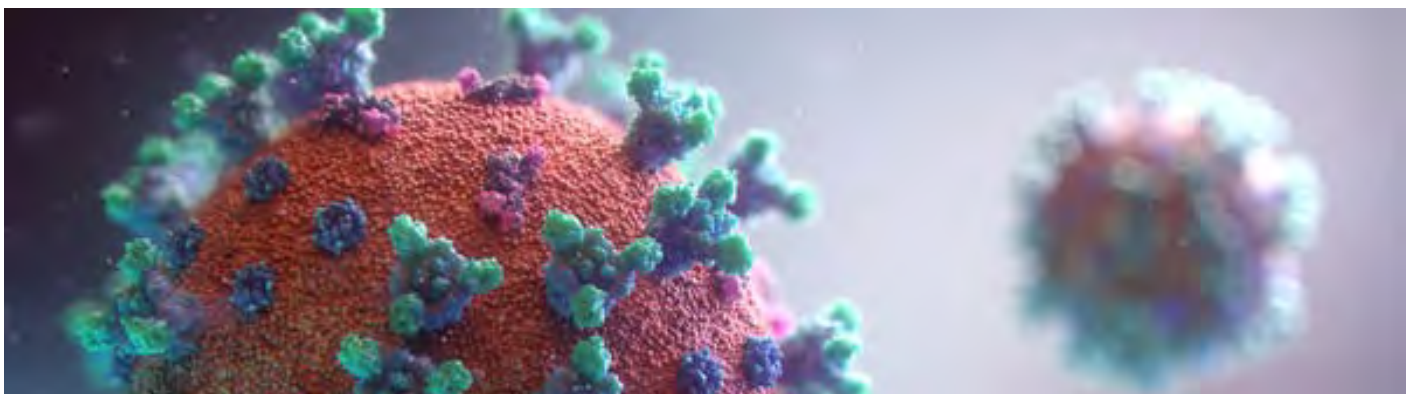
Ana Sampaio, Guilhermina Marques and Maria José Saavedra

## Coronavirus pandemic (COVID-19): Science at the heart of a global response

March 2021 marked 1 year since the World Health Organization (WHO) had declared COVID-19 a pandemic. Since then, more than 3 million lives were lost due the Infection with this new coronavirus (Severe Acute Respiratory Syndrome CoronaVirus 2, or SARS-CoV-2). Coronaviruses are a family of viruses known to cause disease in humans and are quite common worldwide. The infection gives rise to unspecific symptoms such as cough, fever or difficulty breathing, or presents as the most serious disease, pneumonia. The new coronavirus SARS-CoV-2, the agent of the disease COVID-19, was first identified on December 2019 in the city of Wuhan, Hubei province (China). Although the epicentre of the epidemic occurred in Wuhan, the risk of infection is not limited to that city, but to any region with confirmed cases where there is active and sustained transmission of the virus. SARS-CoV-2 spreads easily in the community through respiratory droplets released when an infected person speaks, coughs, sneezes, breathes, or sings, less than 1.5 to 2.0 m away. Although most people with COVID-19 have mild to moderate illness and recover without requiring special treatment, the disease can cause severe medical complications and lead to death. Older adults or people with certain medical conditions, like cardiovascular disease, diabetes, chronic respiratory disease, and cancer, are at greater risk of getting seriously ill. The pandemic has highlighted the importance of rethinking and reprogramming our entire health system. In the context of the national testing strategy, a holistic approach to diagnostic tests was developed in a record time.

In this perspective, we all realise that a fast diagnosis of the COVID-19 is essential to fight against the pandemic. The fight against COVID-19 has seen vaccine development move at record speed. Presently, there are seven vaccines approved and many other vaccines are in the pipeline. The rapid development of effective COVID-19 vaccines is an extraordinary achievement showing a global effort, at unprecedented levels of international cooperation and massive public investment in R&D and manufacturing capacity.

COVID-19 has had astronomical impact on health, economy and overall world well-being. This is not the first time that WHO has responded to a pandemic, and it won't be the last – but the current COVID-19 is the most challenging crisis we have ever faced, and the global answer draws on the lessons learned from other disease outbreaks over the past decades. The cohesive approach amongst researchers across the globe has delivered high-end viral in diagnostics and prevention. There was an urgent need to strengthen surveillance strategies, to understand the ecology of coronaviruses to prevent and anticipate epidemics in the future, with science playing a priority role. Global attention to the development of treatments, immunotherapies, vaccines and control options to combat the COVID-19 pandemic are current public health concerns. We are facing the most serious global public health emergency since the end of World War II. Suddenly, COVID-19 has hit over 192 countries/regions, affected more than seven billion people around the world and claimed more than 3 million precious lives. SARS-CoV-2 has come to challenge the world community in building a shared future, rethinking and strengthening the nexus of scientific evidence, policy-making and community. Our experience with this pandemic situation, showed that the research community have collaborated on a global scale and the much part of that collaboration has naturally occurred in the virtual world, opening up opportunities for partnerships that otherwise might not have materialized. Members of Research Centres and Universities could meet and discuss projects or take part in conferences they normally couldn't have attended. At the same time, undergraduate students (masters and PhDs) have been able to interact more readily through online meetings. We will have to work together to build a global community with health for all.



The coronavirus SARS-CoV-2, the cause of the COVID-19 pandemic





## cLabel +: Ensuring the food security

With this project, which has the involvement of three CITAB researchers (Ana Barros, Berta Gonçalves and Eduardo Rosa), it is intended to develop processes and products that are understood by the consumer as consistent with products with natural ingredients, with limited use of a high number of additives, and that allow, due to their physical, chemical, and nutritional properties, maintain the food security. Thus, the project proposes to achieve outputs that result in concrete mentions on product labels and that customers and consumers will recognize as associated with a product consistent with the Clean Label concept.

In this regard, the aims of the cLabel + project are: i) nutritional valorization of products through macronutrients and processing conditions; ii) innovative solutions and "clean label" for reducing sugar and modeling the sweetening power in foods; iii) stabilization and "clean label" conservation of sauces, meat products, and confectionery; and iv) new methodologies for the integration and optimization of the consumer response.

Within the scope of the "Sistema de Incentivos à Investigação e Desenvolvimento Tecnológico (SI I&DT)" of the Portugal 2020 Program, the project cLabel +: Innovative natural, nutritious, and consumer-oriented "clean label" foods was approved, with a funding of more than 5.7 million euro, and the start date was June 2020.

This is a project promoted by a consortium led by Sumol + Compal, bringing together a total of 20 entities, including nine companies (Sumol+Compal Marcas, S.A.; Associação Integralar; Sense Test Lda; Mendes Gonçalves, S.A.; Wedotech Lda; Vieira de Castro, S.A.; Frulact, S.A.; Primor Charcutaria, S.A.; SPI, S.A.), eight universities (UTAD, UMinho, ISA, UAveiro, UCoimbra; UPorto; UCP; NOVA Lisboa), one International Laboratory in Nanotechnology (LIN), one Associated Laboratory (REQUIMTE) and one public entity of the Agrarian and Veterinary sector's R&I system (INIAV), with the general objective of responding to the challenges that the consumer poses to the food industry.

## rePLANT: The forest as a whole

The rePLANT project is the first major project that will enable the ForestWISE Collaborative Laboratory to be operationalized. This is an unprecedented effort to take the priority business initiatives outlined in the ForestWISE R&D Agenda to the ground. The project brings together all ForestWISE associates -forestry, energy companies and universities - which together represent all the diversity of the national forestry sector, working together with hi-tech companies. Promoted by Navigator Forest Portugal, bringing together 20 entities. It was supported under the "Sistema de Incentivos à Investigação e Desenvolvimento Tecnológico (SI I&DT) - Programas Mobilizadores" of the Portugal 2020 Program, with a funding of 5.602 million euro.

The main purpose of this mobilizer project is to contribute to the greater appreciation of the Portuguese forest through the implementation of collaborative strategies for integrated forest and fire management. These strategies will lead to new products and services, mostly supported by digital technologies, contributing to fire risk reduction and introducing a high degree of innovation to improve forest and energy companies' management and decision-making processes, with positive impacts throughout the chain, including its service providers and forest producers, with a major impact on the economy of rural areas. RePLANT will contribute to consolidate the national market in technologies and equipment for the forest sector.

The project rePLANT-Implementation of collaborative strategies for integrated forest and fire management began in July 2020 with the involvement of 6 CITAB researchers (Domingos Lopes, José Aranha, José Louzada, M. João Gaspar, M. Emília Silva, Paulo Fernandes).

This multidisciplinary consortium will implement major 8 collaborative strategies, structured in industrial research activities of three major PPS (Products, Processes and Services): Forest and fire management, risk management and circular economy and value chains.





## FungiTech: Mushrooms as a solution

The project “FungiTech - Technology and innovation in the shiitake and other nutraceutical and medicinal mushrooms production chain” (2019-2021), is a I&DT co-promotion project funded by NORTE2020. The partnership was established between the promotor Floresta Viva, a producer of shiitake mushrooms, and a multidisciplinary team of UTAD, from CITAB and Chemistry Centre, coordinated by Guilhermina Marques (CITAB).

The project aimed the development of innovative solutions to the mushroom sector, in particular, to optimize the mushroom yield and quality, to increase the scientific knowledge on beneficial bioactivities in shiitake and other fungal species and evaluate processing methods of the wastes generated into added-value products. New substrates and production methods were developed aiming to recycle agroforestry wastes and increase the biological efficiency in the conversion into edible mushrooms. Another important goal was the development of novel functional foods, namely selenium and vitamin D enriched mushrooms, as well new mushroom-based foods, such as the “broa of shiitake”, based in the traditional Portuguese bread, which is being launched in the market.

The antimicrobial activity of shiitake and other cultivated and wild edible mushrooms extracts, was evaluated in multi-drug resistant bacteria showing that some mushroom species are a promising source of new antimicrobials.

Shiitake (*Lentinula edodes*) is one of the most heavily cultivated and widely consumed mushrooms in the world due to their organoleptic and medicinal properties, vigorous growth and undemanding cultivation conditions. Nutritionally, shiitake and other edible mushrooms are a valuable source of healthy food nutrients. Numerous bioactive mycochemicals from medicinal mushrooms have been described that appear to enhance immune responses, and exhibit anti-tumour activities. These bioactivities were reported for various extracts and isolated compounds, from fermentation broth, mycelia or mushrooms.

## T-Lamp: The power of light

The maintenance and fast recovery of natural turf for sports activities such as football, as well as its cost of investment, are a big concern to clubs, especially in top-division leagues. The modern architecture of stadiums produces several impacts on lawns, including the reduction of direct solar radiation. Given the importance that light plays in the plants growth, artificial lighting systems have been used to offset for the lack of natural light recorded in a persistent way. The most common technology used in the field is high-pressure sodium lamps (HPS lights), but this expensive technology fails in light sources with different absorption colours to help plant growth and in energy efficiency.

The T-LAMP project (Turf Lighting Advanced Mobile Platform) aims to develop an artificial lighting system with LED technology, intelligent, adjusted and optimized for the specific physiological parameters of plants used in lawns for high sports competition. It is expected that the LED system, once optimized, can promote significant gains in energy efficiency and at the same time ensure a more sustainable model of maintenance of the lawns.

LOKI, Unipessoal Lda., jointly with CITAB/UTAD and MORE CoLab pretend to become pioneer in the creation of an advanced LED lighting solution for the optimal growth of natural lawns, minimizing current maintenance problems, with direct gains in economic and environmental terms.

CITAB team, led by the researcher José Moutinho Pereira, is involved in biological studies of plant physiology and biochemistry, in order to evaluate the effects of the applied technology on grasses performance and select the most appropriate spectrum and light intensities to different stadium conditions. CITAB team includes Carlos Correia, Aureliano Malheiro and Lia-Tânia Rosa Dinis.







## The PyroLife Project: towards integrated fire management

The current and future challenges posed by global change and increasingly severe wildfire events and seasons call for novel approaches under the paradigm of Living with Fire. As a Marie-Curie Action, the PyroLife project is funded as an Innovative Training Network with an overall budget of 4 million euro and was awarded in the frame of the H2020-MSCA-ITN-2019 call. PyroLife is coordinated by Dr. Cathelijne Stoof from Wageningen University, Netherlands, and involves 21 partners, including FAO and organisations from overseas countries (USA, Canada, New Zealand), of which 10 are European beneficiaries, namely UTAD.

PyroLife is an ambitious project, as it seeks to contribute to a new generation of fire scientists trained in integrated fire management, following an holistic approach that is increasingly supported by governments and fire policies in Europe and globally. As the first of its kind effort worldwide, 15 PhD students with various backgrounds are being trained by PyroLife in cross-disciplinary, interacting and creative research projects, pursuing intersectional and transferable skills and knowledge through a number of network and exchange initiatives. PyroLife acknowledges the relevance of knowledge transfer between regions, for example by combining how the European North solves community problems with the fire experience of the European South. PyroLife works along three axes, respectively risk quantification, risk reduction, and risk communication. CITAB hosts the PhD student Mariña Fernandez, who is characterizing the behavior of extreme wildfires and its drivers in southern Europe under the supervision of Prof. Paulo Fernandes and in the frame of the risk quantification work package.



## Viticulture: The climate change impacts as a focus of discussion

In 2020, the Clim4Vitis project (<https://clim4vitis.eu/>) implemented two international workshops. The first event was organized at the Luxemburg Institute of Science and Technology (LIST), in February 2020, whereas the second was held on December 2020, having been organized by the Potsdam Institute for Research on Climate Impacts (PIK), in close collaboration with the University of Geisenheim (HGU), and CITAB/UTAD. Both events were dedicated to the thematic of the impacts of climate change on viticulture. However, the former was more focused on pests and diseases, while the latter was mostly devoted to viticulture in the most northern regions of Europe. Given the current pandemic situation, the second event was undertaken online.

In both international workshops, it was possible to count on the presence of approximately 100 participants, including researchers, academics, winegrowers, associations of wine producers, wineries, among others, mostly from wine regions in Central and Northern Europe. Speakers in the various scientific communications highlighted the role of climate change in viticulture, as well as the current challenges in identifying adaptation measures in both emerging and traditional wine regions. Some communications have also focused on oenological aspects and the benefits of organic viticulture. Fruitful discussions between speakers and participants were also carried out, thus potentiating knowledge change, and promoting future collaborations with both academic/scientific units and the wine industry.

Within the framework of Clim4Vitis, three seminars/webinars for stakeholders were also organized in Portugal, Luxembourg, and Italy. Staff exchanges were possible at the beginning of 2020 but not afterward due to the pandemic control restrictions. Several capacity-building activities, knowledge transfer, dissemination, and outreach actions were also organized. The end of the project will be in February 2022 and a final Open Day is foreseen at UTAD in late November 2021.

### WEBINAR

Challenges to decision-making in vitiviniculture in the face of climate change Sector perspective in the search for solutions

## Summer courses: science and students

The Portuguese Science and Technology Foundation, under the programme 'Verão Com Ciência', financed with a total of 57.262 million euro two summer courses coordinated by CITAB researchers Ana Coimbra (Practical Course - Application of biological models to ecotoxicology studies) and Carlos Afonso Teixeira (Ecocampus Living Lab-Education for Sustainable development). Aiming to bring students to research activities, the first attributed 9 scholarships for graduated students and 8 to undergraduates, while the second assigned 15 scholarships to undergraduate students. Both summer courses had a three months duration and counted with the participation of several CITAB's and outsiders' researchers. The opening section was performed by the Portuguese Minister of Science, Technology and Higher Education, Manuel Heitor.



'Practical Course' class



Opening session with the Minister of Science

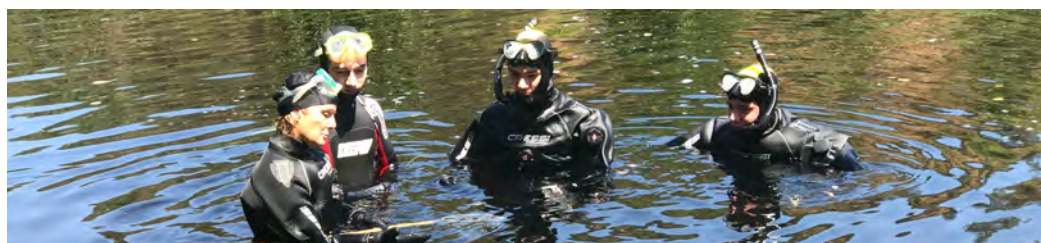


'Ecocampus Living Lab' class

## High school students looking for science in the river water

CITAB participated in the "Ciência Viva in the Laboratory - Scientific Occupation of Young People on Vacation" with the action "Microbiological analysis and antibiotics susceptibility profile from river water and mussels: environmental impact". This action was coordinated by Maria José Saavedra and Simone Varandas that received two students from the high school "S/3 São Pedro", from Vila Real.

The activity initiated at the 15<sup>th</sup> July and during one month the participants had the opportunity to collect and identify different species bivalve mussels at the Tua catchment. Isolated bacteria from the water and mussels were used for antibiotics susceptibility profile determination and assessment of the water quality.



Collecting bivalve mussels at the Tua river

## Immeasurable science in just 7 days

Researchers from CITAB were involved in several activities from the "Science and Technology Week", 23<sup>rd</sup> to 29<sup>th</sup> of November. The actions promoted were: "Vem conhecer a composição do teu corpo"; "O impacto das alterações climáticas na viticultura: o projecto CoaClimateRisk"; "Água é vida, mas qualidade da água é saúde"; "Diagnóstico Laboratorial: Como vivem as bactérias com os antibióticos?"; "Workshop Laboratorial: Estado fisiológico da vinha"; "Contributos de metodologias inovadoras de previsão de tendências de espécies, comunidades e ecossistemas para a conservação da biodiversidade: conceitos teóricos e implementação prática" and "À descoberta dos rótulos dos alimentos".

While some activities were developed for a wider audience online, others received a limited number of participants in the laboratories.



Online sessions with the students



Lab. activities





## The plastic Era: Major environmental concerns

Plastic pollution is a global problem of the 21<sup>st</sup> century, with a detrimental impact on ecosystems and living organisms. Plastics are used in everyday life, with the largest plastics producers being the packaging (39%) and construction (21%) sectors, followed by transportation, agriculture, household and electronics. According to the Plastics Europe report (2020), the annual global generation of plastic increased from 1.5 million tons in 1950 to approximately 370 million tons in 2019, showing an exponential increment trend. Despite efforts, the accumulation of synthetic polymers in the environment has increased constituting one of the most worrying environmental topics nowadays. The poor management and plastic deposition, combined with its high durability, resistance to degradation, low weight and low recycled volume, led to the dissemination and accumulation of plastics in landfills and, as garbage, in terrestrial and aquatic habitats worldwide. It is estimated that about 4.8 to 12.7 million metric tons of poorly managed waste reach the oceans through coastal countries every year, through runoff of rainwater, municipal and industrial wastewater and the wind.

Microplastics, defined as particles with < 5 mm in diameter by the National Oceanic and Atmospheric Administration of the United States of America (NOAA), are receiving special attention. Their presence has been documented in most marine habitats, from the ocean, seas and beaches, and more recently, in freshwater systems, including river systems, streams, lakes, pond, creek, and estuarine rivers. Microplastics constitute a threat to marine organisms, as they are often mistaken as food. Consumption of microplastics has led to the damage of digestive organs and a reduction in growth and reproductive rate, and could even result in high mortalities by the ingestion of plastics with a greater size. Additionally, microplastics can adsorb contaminants present in water, such as persistent organic pollutants and heavy metals, known to be acutely toxic for aquatic life.

The prevalence of microplastics in aquatic environments directly impacts commercial fisheries and aquaculture industries, since its presence may affect the safety of seafoods. Due to these rising concerns, the Marine Strategy Framework Directive (MSFD N° 2008/56/EC) highlights microplastics and their associated chemicals as one of the major policy descriptors whose impact need to be assessed in the marine environment.

Concerning freshwater ecosystems, it is generally agreed that they are the main route for transporting most of the plastic debris from the land to the marine environment, being estimated that 1.15 to 2.41 million tons of plastic waste is released into the ocean annually. Nevertheless, most of these polymers are trapped along the river course (remaining in the banks or instream), subsequently affecting the ecosystem and environmental health. According to scientific reports, 61% of the water samples collected in the Portuguese coast contained microplastics, with higher concentrations observed in the Vicentina Coast and Lisbon compared to Algarve and Aveiro areas.

Despite recognizing the importance of microplastics in freshwater ecosystems, few studies have been carried out on the occurrence of microplastics (ex, distributions, category, types of polymer) and the impacts of this debris in the freshwater environment.



Presence of microplastics (Mp) in the digestive system of *Corbicula fluminea*, the Asian clam



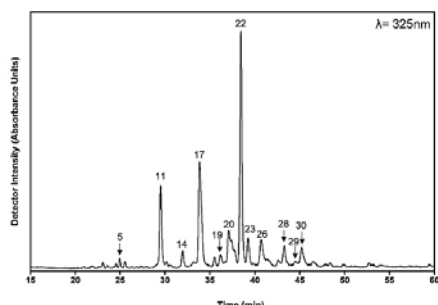
Meriem Taghouti

## Chemical composition and biological activity of a range of thyme species in Portugal under a changing environment

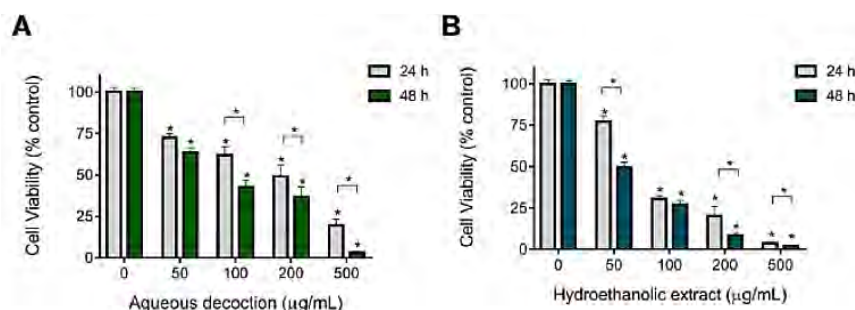
CITAB researcher Meriem Taghouti successfully defended her doctoral thesis entitled "Chemical composition and biological activity of a range of thyme species in Portugal under a changing environment", in May 2020. Her supervisors were Professor Amélia Silva (CITAB-UTAD), Professor Fernando Nunes (CQ-VR, UTAD) and Professor João Santos (CITAB-UTAD). It was developed in collaboration with researchers from the Department of food chemistry and phytochemistry (IAB – KIT), Karlsruhe, Germany.

The thesis aimed to give a better understanding of bioactivities of selected thymus species from Portugal and its correlation with the chemical composition, through the comprehensive characterization of phenolic compounds. Interest in thymus species is increasing for their promising phytochemical composition and exploring the chemical compounds gives valuable information to monitor the production chain and ensure standardized contents and bioactivity. The main achievements of the thesis were to give detailed polyphenol composition of 5 thymus species and to unveil their cytotoxic and anti-radical potentials.

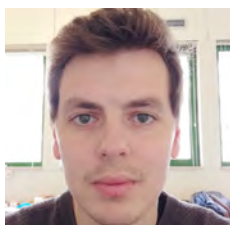
Meriem was funded by the Portuguese Foundation for Science and Technology PhD individual grant SFRH/BD/52563/2014, under the Doctoral Program 'Agricultural Production Chains - from fork to farm'. Research was also funded by the projects: INTERACT no. NORTE-01-0145- FEDER-000017 in its line of research entitled ISAC; PEst-OE/UID/AGR/04033/2019 (CITAB) and PEst-OE/QUI/UI0616/2014 (CQ-VR).



Chromatogramme of hydro-ethanolic extract of *Thymus mastichina* at 325 nm



Anti-proliferative activity of *Thymus mastichina* extracts in Caco-2 cell line



Richard Breia

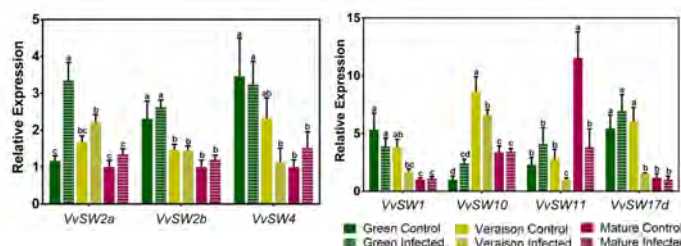
## Biotic stress in grapevine – elucidation of the role of the newly identified SWEET transporters on plant-pathogen interaction

CITAB researcher Richard Breia (PD/BD/113616/2015) successfully defended his doctoral thesis "Biotic stress in grapevine – elucidation of the role of the newly identified SWEET transporters on plant-pathogen interaction", in July 2020. His supervisors were Professor Hernâni Gerós (CITAB-UM), Professor Antonio Granell (IBMCP-UPV) and Junior Researcher Artur Conde (CITAB-UM). Sugars perform vital functions in the grapevine as the quality of the wine depends on the sugar concentration in the grape berry. Different sugar transporters are present in the genome of grapevine to fulfill the task of

transmembrane sugar transport, which is pivotal for long distance transport. In this study, the main objective was to elucidate the role of VvSWEETs and VvERD61 in grapevine response to fungal attack (*Botrytis cinerea* or *Erysiphe necator*) and abiotic stress, including drought. Overall, results showed that *E. necator* infection caused more pronounced modifications in VvSWEET gene expression than *Botrytis* infection. Moreover, the majority of grapevine SWEET genes were down-regulated in berries from drought stressed vines. Also, VvSWEET7 was functionally characterized as a low-affinity, high-capacity glucose and sucrose transporter, with a possible capacity to transport polyols. Another sugar transporter family (ERD61) was also studied. VvERD6113 was characterized as a sucrose transporter and is strongly up-regulated in infected grape berries with *Botrytis* or *E. necator*, suggesting that it plays an important role during pathogen-host plant interaction. In sum, VvSWEET and VvERD61 transporters are important players in sugar mobilization during grape berry development and their expression is transcriptionally reprogrammed in response to biotic and abiotic stress.

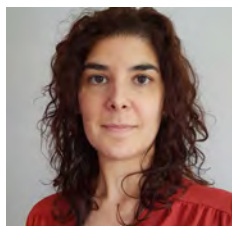


Grape berry bunches infected with *Botrytis cinerea* (A, B) and *Erysiphe necator* (C).



Gene expression of several SWEET genes in infected and control grape berries.





Bruna Carbas

## Potential of *Phaseolus vulgaris* L.: nutritional value, functional properties and development of innovative tools for their assessment

CITAB researcher Bruna Carbas successfully defended her doctoral thesis "Potential of *Phaseolus vulgaris* L.: nutritional value, functional properties and development of innovative tools for their assessment", in May 2020. Her supervisors were Professor Ana Barros (CITAB-UTAD), Professor Eduardo Rosa (CITAB-UTAD) and Doctor Nelson Machado (Vines&Wines CoLab).

Common beans (*Phaseolus vulgaris*) are the most consumed worldwide and produced for direct human consumption, due to their rich nutritional and functional value. Concomitantly, over the past years, have been developed innovative methodologies, which allow the quality evaluation of food products, in order to replace conventional analysis, reducing the use of chemicals and time. In this alignment, the main objectives of Bruna's thesis is the characterization of beans quality and to study their uses in the enrichment of food products to develop new routine methods in the laboratory, for evaluation of beans quality, using Fourier Transform Infrared Spectroscopy (FTIR).

Navy, black and pink eyed cultivars were the most promising protein and amino acids sources, which can be used for nutritional enrichment. Red kidney and arikara yellow cultivars offer the best functional proprieties, which can offer an important protective role in the prevention and treatment of cardiovascular diseases, diabetes and cancer. On the other hand, the results of Bruna's work proved that the FTIR techniques, allows the evaluation of relevant compounds.

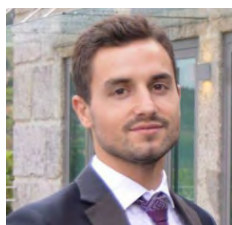
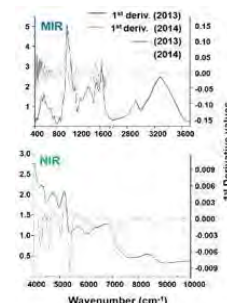
The funding was provided by the FCT-Portuguese Foundation for Science and Technology (PD/BD/128277/2017), under the International Doctoral Programme "Agricultural Production Chains – from fork to farm" (PD/00122/2012).



Potential uses of each bean cultivar in food products due to their nutritional and functional properties



Typical spectra from FTIR equipment of bean cultivar

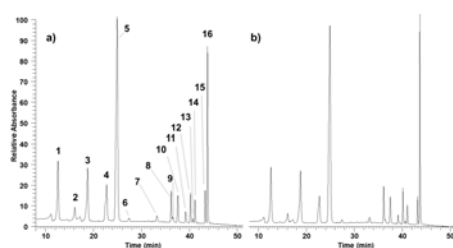


André Lemos

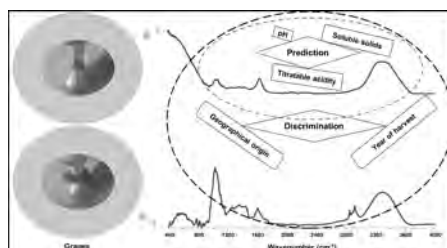
## Selection of 'Tinta Roriz' clones for excellence in winery industry

CITAB researcher André Lemos successfully defended his doctoral thesis "Selection of 'Tinta Roriz' clones for excellence in winery industry", in May 2020. His supervisors were Professor Ana Barros (UTAD-CITAB), Professor Marcos Egea-Cortines (UPCT-IBV) and Doctor Nelson Machado (Vines&Wines CoLab). The clonal selection process is an important tool to varietal improvement, which uses the intra-varietal genetic variability to select superior genotypes. The Tinta Roriz variety (syn. Aragonez, Tempranillo), has been improved through the process of clonal selection in several countries, such as Spain and Portugal. In this alignment, the main objectives of Andre' thesis were the evaluation of the performance of 30

'Tempranillo' grape clones in two distinct sub-regions (Baixo Corgo and Cima Corgo) of Douro Demarcated Region (DDR), in respect to the oenological potential parameters and phytochemical content; assessment of quality parameters and organoleptic features of wines made with 'Tempranillo' grape clones; and the ability of Attenuated Total Reflectance – Mid-Infrared (ATR-MIR) spectroscopy combined with multivariate analysis to discriminate the origin and harvest year of 'Tempranillo' grape clones and to predict its contents in soluble solids, pH and titratable acidity. A set of 10 distinct 'Tempranillo' grape clones with complementary characteristics and stable performances, were proposed, potentially leading to the obtainment of polyclonal vegetative materials. The wines made with the set of 10 grape clones showed to be effectively richer in phenolic compounds than the wines made with the 20 grape clones in both sub-regions. Besides that, the results demonstrated the usefulness of ATR-MIR combined with multivariate analysis to assist the clonal selection process of 'Tempranillo'. The funding was provided by FCT (PD/BD/113613/2015), under the International Doctoral Programme "Agricultural Production Chains – from fork to farm".



Anthocyanins chromatographic profile (520 nm) of 'Tempranillo' grape clones from Baixo Corgo (a) and Cima Corgo (b).



Representative FTIR-MIR (ATR) normalized spectra from 'Tempranillo' grape clones homogenates and skins



'Tempranillo' grape clones (powder and hydromethanolic extract).

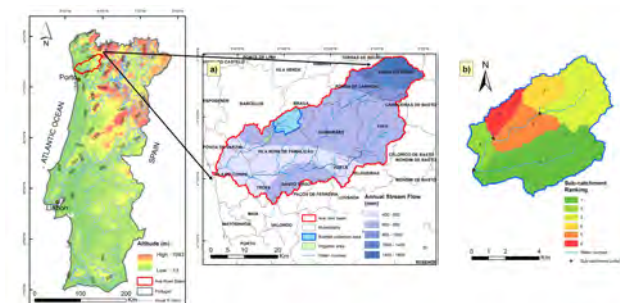


Daniela Terêncio

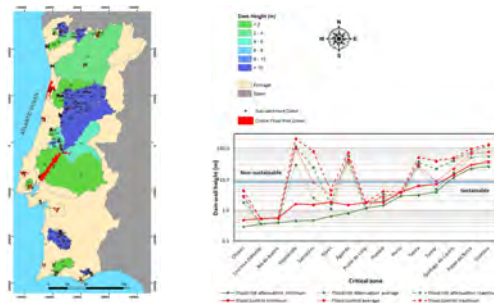
## Decision Support Systems for Rainwater Harvesting and Runoff Control in Watersheds

CITAB researcher Daniela Terêncio successfully defended her doctoral thesis "Decision support systems for rainwater harvesting and runoff control in watersheds", in January 2020. Her supervisors were Professor Luís Filipe Sanches Fernandes (CITAB-UTAD), Professor Rui Cortes (CITAB-UTAD) and Professor Fernando Pacheco (CQ-UTAD).

This work aimed to study ways of storing surface water. Having an interest not only in the use of rainwater for certain purposes such as environmental, agricultural, forestry, but also for the control of natural disasters (floods and droughts), two lines were developed a) Rainwater Harvesting (RWH), which are small infrastructures to store water for agriculture; b) Flood Detention Basins (FDB), which may be small or large infrastructures with the purpose to control floods. Taking into account all water-related problems, we developed an in-depth study and an assessment of the potential of rainwater harvesting and floodwater detention for multiple agro-forestry applications and flood control in Ave River and Sabor River basins located in the northern part of Portugal. To accomplish the goal, RWH allocation and flood detention methods were developed and tested in the aforementioned basins that make it possible to plan the retention of rainwater in catchments, allowing the later use for the benefit of crop irrigation, wildfire fighting and mitigation of flood risk areas. In this regard, the RWH allocation methods were embedded in decision support tools, such as Geographic Information Systems, and validated by univariate and multivariate analysis and advanced use of spreadsheets. This research was funded by the INTERACT project.



Allocation map indicating the rainfall collection area and the application area



Spatial distribution of dam wall heights

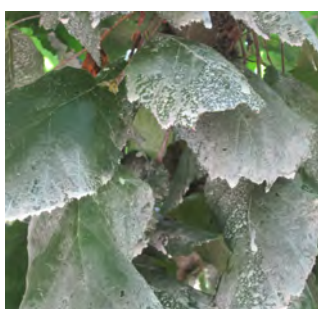


Sandra Cabo

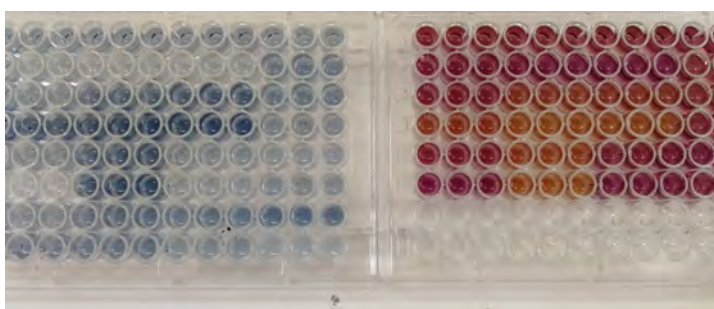
## Innovative strategies to mitigate effects of climate change for sustainable hazelnut production

CITAB researcher Sandra Cabo defended her doctoral thesis "Innovative strategies to mitigate effects of climate change for sustainable hazelnut production", in September 2020. Her supervisors were Professor Berta Gonçalves (CITAB-UTAD), Professor Ana Paula Silva (CITAB-UTAD) and Professor Núria Pascual Seva (Universitat Politècnica de València).

The main objective of this Doctoral Thesis is to contribute with strategies to mitigate effects of climate change and to enhance the quality and production of hazelnut by different approaches. To achieve these goals, an evaluation of the suitability of preharvest foliar spray treatments was performed, gaining a further insight in the agricultural management strategies by understanding the plant physiological and biochemical response, enhance hazelnut quality, environmental sustainability and economic viability for hazelnut production. In addition, regarding the massive amounts of bio-wastes, the determination of the suitability of husks (hazelnut by-product) as a source of bioactive compounds was also studied. Results showed that kaolin, natural bioestimulant *Ascochyllum nodosum* and salicylic acid improve the hazelnut tree physiological response, without compromising the hazelnut chemical and sensorial quality. The valorization of hazelnuts husks gives an important contribution for the isolation and purification of bioactive molecules. Received a PhD studentship from the FCT (PD/BD/113615/2015), under the Doctoral Programme 'Agricultural Production Chains - from fork to farm'.



Hazelnut leaves treated with kaolin

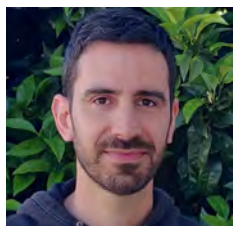


Antioxidant activity of hazelnut extracts



Leaf gas exchange asurements with IRGA





Miguel Oliveira

## Introducing legumes in Mediterranean cropping systems: nitrogen supply, soil carbon sequestration and greenhouse gas emissions

CITAB researcher Miguel Oliveira successfully defended his doctoral thesis "Introducing legumes in Mediterranean cropping systems: nitrogen supply, soil carbon sequestration and greenhouse gas emissions" in February 2020. His research was supervised by Prof. Henrique Trindade (CITAB-UTAD), with the collaboration of Prof. Iñigo Virto (UPNA - Public University of Navarre, Spain). The main aim of his thesis was to improve the knowledge on the agronomic and environmental impacts of introducing pulses (grain legumes) in Mediterranean cropping systems in order to promote their cultivation in the European Union (EU).

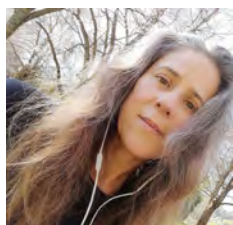
Miguel found that introducing faba bean (*Vicia faba*) or pea (*Pisum sativum*) crops in a rotation with triticale ( $\times$  Triticosecale) increased the cereal yields up to 30–59%, equivalent to an application of 72–153 kg fertilizer-N ha<sup>-1</sup>. Irrigated cowpea (*Vigna unguiculata* L. Walp) did not benefit yields but proved to be a suitable summer crop for sustainable intensification in Mediterranean conditions, as the overall productivity of the agroecosystem was increased with minimal inputs.

He also showed that pulse-cereal rotations cannot improve soil organic carbon storage in this soil in the short-term. Nevertheless, pulse-based cultivation reduced the cereal yield-scaled N<sub>2</sub>O emissions in a wet year when compared with fertilizer-based cultivation, and thus can help mitigate climate change in Mediterranean agroecosystems.

This research was supported by the European Social Funds and the Regional Operational Programme Norte 2020 (NORTE-08-5369-FSE-000054), under the Doctoral Program "AgriChains", and by the EUROLEGUME project (n° 613781) under FP7.



Field trials in UTAD with chambers for sampling gas emissions from soil in the Summer (cowpea crop and fallow plots ; on the left) and in the Winter (triticale crop; on the right).



Paula Botelho

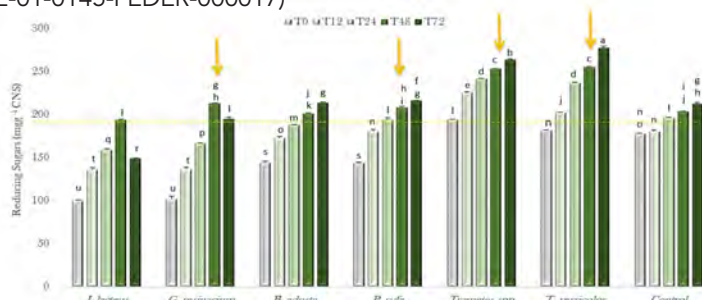
## Fungal bioconversion of agro-industrial by-products and modeling of laccase kinetics

CITAB researcher Paula Botelho Pinto defended her thesis "Fungal Bioconversion of Agro-Industrial By-Products and Modeling of Laccase Kinetics" in June 2020. Supervised by Professor José Albino Dias and Professor Rui Bezerra, both from CITAB-UTAD, her PhD work focused on the study of enzymatic processes involved in fungal bioconversion of lignocellulosic byproducts (wheat straw and chestnut shell) which was done through mathematical modeling aiming to predict/evaluate the behavior of the interveners allowing an optimization. The effect of some variables (hydrolysis time, enzymatic activity (e.g. laccase) and holocellulase

concentration) was estimated whilst a general predictive model of saccharification. A high consistency was found relating the effect of xylanase and laccase activities on the final release of reducing sugars from the chestnut shell. These results can be used for optimization planning in saccharification of this substrate. Also, several linear and nonlinear Michaelis-Menten models were applied to clarify the laccase inhibition mechanisms, that might influence the optimization of the processes. The models were submitted to a ranking methodology regarding the relative quality of kinetic models, using Akaike Information Criterion (AIC) with respective Akaike Weights, confirming chlorine as linear competitive inhibitor of laccase. When Bi-Bi substrate kinetic models were tested, including inhibition by reducing and/or oxidizing substrate, it was found that the catalytic efficiency of oxygen conversion to water appears to be compatible with a process relatively independent of reducing substrate and bisubstrate mechanism type. Lastly, the development of a new methodology and a new integrated equation concerning the interaction between inhibitors was attempted. This research was supported by INTERACT project (NORTE-01-0145-FEDER-000017)



Chestnut shell solid state fermentation



Saccharification of chestnut shell (CNS) pretreated by fungi

## Short notes & Upcoming events



Márcia Carvalho

### CITAB doctors are climbing the ladder

Márcia Carvalho was one of 157 researchers selected, from more than 2000 candidates, in the 3<sup>rd</sup> edition of the "Individual Call to Scientific Employment Stimulus", category "Junior Researcher", promoted by FCT.

Having been a student in the 1<sup>st</sup> edition of the international PhD program AgriChains, she has focused her research on the use of genetic diversity for the identification of water stress tolerant legume genotypes in organic farming. In her research path, she has already completed a 3-month internship at the University of California-Riverside (USA), developing molecular analysis in cowpeas, and three more months at the University of BOKU (Austria), in root phenotyping, using the latest technology in hyperspectral imaging.

Remember that in the two previous editions, also other elements of CITAB, Alexandre Gonçalves (2019) and Helder Fraga (2018) had been selected under the same competition.

### PhD AgriChains started its 6<sup>th</sup> edition

The international doctoral programme "AgriChains: Agricultural Production Chains - from fork to farm", coordinated by CITAB, has seven new students in the 6<sup>th</sup> edition, which started in October 2020, with a Kick-off webinar lectured by international speakers and recent AgriChains doctorates. Six of these students were granted a scholarship funded by FCT – Portuguese Foundation for Science and Technology and a seventh has enrolled in a part-time regime, since the student works in full-time in the wine sector.

This doctoral programme, held in association with the University of Minho, has 54 students since its creation in 2014, and already formed 17 doctors in the agri-food value chains. The existence of two European partners, the University of Wageningen (Netherlands) and the Polytechnic University of València (Spain) has already provided several thesis co-orientations and resulted in two European PhDs.



AgriChains 6<sup>th</sup> edition students and Board of Directors

## Upcoming events



## Location and contacts

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