MARIE SKŁODOWSKA-CURIE POSTDOCTORAL FELLOWSHIPS 2021

EXPRESSION OF INTEREST FOR HOSTING MARIE CURIE FELLOWS

HOST INSTITUTION

NOVA University Lisbon | ITQB NOVA - Instituto de Tecnologia Química e Biológica António Xavier

RESEARCH GROUP AND URL

iPlantMicro
https://www.itqb.unl.pt/research/plant-sciences/Plant-Microbiome-Interaction/iplantmicro

SUPERVISOR (NAME AND E-MAIL)

Juan Ignacio Vilchez
nacho.vilchez@itqb.unl.pt

SHORT CV OF THE SUPERVISOR

Over the last few years, I have developed my career in the field of beneficial plant-microorganism interactions. In this sense, I have been able to approach the area from many points, making very relevant contributions in each of them. Thus, within a leading research group at the **University of Granada (Spain)**, were I get my PhD title, we defined the first index to catalogue microorganisms with biotechnological interest based on their degree of environmental and human biosafety. Our publication in Frontiers in Microbiology (Q1), was pioneer in the field, providing insights on the regulation of production and use of biofertilizers. Also, within the same group, and using a multi-omics approach, I could define previously undescribed strategies of plant protection from drought through a beneficial microorganism, yielding 3 publications in Frontiers of Microbiology (Q1). In these publications we had the collaboration of groups in Ireland and Germany (**IT Carlow and Universität Bielefeld**). During the last years, working in the group of Plant Growth Promoting Bacteria at the **Shanghai Center for Plant Stress Biology (China)**, I have been able to go further and define the first direct relationship between epigenetically regulated environmental stress, changes in composition of root exudates and selective attraction of a beneficial bacterial strain, published in Nature Plants (Q1). To do this, we followed a very novel approach in the field, using mutants in genes that regulate the methylation status. With this same technique, we could also define changes in natural microbiomes linked to multiple epigenetic regulators (Microbiome, Q1). In this same group and in the context of beneficial interactions, I have collaborated in trials involving the effects of volatile organic components (EMBO Journal, Q1), phenols in the rhizosphere and epigenetically regulated late defensive patterns (currently in a second round of review in Nature Plants). The experience in this group allowed me to generate a multilevel and interdisciplinary vision of this field of study. In these years, we have also defined the genomes of 7 strains with biotechnological interest and in beneficial interactions with plants. Based on these strains, we could promote 6 international patents (2 of them are pending final validation). Along my research experience, I have been able to present my work at international conferences in **Italy, Ireland, China and Uzbekistan**. In both Spain and China, I have taught in undergraduate and doctoral courses, and also supervised undergraduate, Master and Doctoral students. Since January 2021, I have obtained a position as **Auxiliary Researcher** through GREEN-IT research unit, to establish my own group (**iPlantMicro**) at the António Xavier Institute of Chemical and Biological Technology (ITQB NOVA) where I already started teaching master and doctoral students regarding the progress in microbiome biotechnology for plant improvement. In the coming years, I aim to consolidate a stable group of top-level researchers capable of facing the greatest challenges in microbiome bioengineering, beneficial interactions and technology transference. I also want to contribute for their development as scientists, aware of their responsibilities towards the planet and the society, caring for the environmental sustainability and a healthy economy.

5 SELECTED PUBLICATIONS

1. Kaushal, R., Peng, L., Singh, S.K., Zhang, M., Zhang, X., **Vílchez, J.I.**, Wang, Z., He, D., et *al*. Dicer-like proteins influence Arabidopsis root microbiota independent of RNA-directed DNA methylation. Microbiome 9, 57 (2021). https://doi.org/10.1186/s40168-020-00966-y/**h-index:62/IF-11.61/Q1/Cites:0**

2. Vílchez, J.I., Yang, Y., He, D., Zi, H., Peng, L., Lv, S., Kaushal, R., Wang, W., Huang, W., Liu, R., Lang, Z., Miki, D., Tang, K., Paré, P.W, Song, C.P., Zhu, J.K. and Zhang, H. (2020) DNA demethylases are required for *myo*-inositol-mediated mutualism between plants and beneficial rhizobacteria. Nature Plants, 2020. 6(8): p. 983-995. doi.org/10.1038/s41477-020-0707-2/**h-index:55/IF-13.3/Q1/Cites:7**

3. Morcillo, R.J.L., Singh, S.K., He, D., An, G., **Vílchez, J.I.**, * (2020) Rhizobacterium-derived diacetyl modulates plant immunity in a phosphate-dependent manner. The EMBO Journal. 39: e102602. doi.org/10.15252/embj.2019102602/**h-index:381/IF-9.96/Q1/Cites:16**

4. Vílchez, J.I., García-Fontana, C., Román-Naranjo, D., González-López, J., Manzanera, M. (2016) Plant drought tolerance enhancement by trehalose production of desiccation tolerant microorganisms. Frontiers in Microbiology. 7,1577. doi: 10.3389/fmicb.2016.01577/**h-index:108/IF-4.24/Q1/Cites:43**

5. Vílchez, J.I., Navas, A., González-López, J., Arcos, S.C., Manzanera, M. (2016) Biosafety test for plant growth-promoting bacteria: proposed Environmental and Human Safety Index (EHSI) protocol. Frontiers in Microbiology. 6, 1514. doi.org/10.3389/fmicb.2015.01514 /**h-index:108/IF-4.24/Q1/Cites:26**

PROJECT TITLE AND SHORT DESCRIPTION

Soil microbiome bioengineering to anticipate stress responses in plants

The current trend of growing population versus food production capacity may become unbalanced in the coming decades. One of the most promising alternatives in agriculture is the use of biofertilizers, biocontrollers or enhancers of tolerance. However, these biotechnologies are facing applicability problems because of losing efficiency when used in natural systems. In this regard, environmental context is reaching more relevance in studies such as on metagenomics. Technological advances and coordinated analyses are making possible to overcome the mentioned limitations, as well as to innovate with new biotreatments. Present project aims to better profit from bioengineering of beneficial microorganisms. This will specifically use tomato as model plant as a crop model of high commercial, feeding and economical relevance.

Boosting local beneficial strains is still costly, so this promising tailor-made solution is not yet available. I propose to establish an innovative approach with which to identify changes in the composition of root exudates under stress, in order to use them to define synthetic cocktails (SynCocktails) able to modify microbiome composition and enhance the presence of beneficial microbes. I will define and adapt these cocktails after imposition of environmental stresses (pathogens, water deprivation) that limit plant productivity. Phenols, sugar-alcohols and organic acids will be especially considered as promising compound candidates. This system will include metagenomic profiling of natural soil systems to prepare synthetic microbiomes (SynComs). They will serve to validate SynCocktails capacity and reference beneficial communities along the project. Finally, when each profile (exudates and microbiomes) is defined under stressing conditions, I will explore which strains of the community are selected by the plant, colonize its organs and pass to the next generation. Inheritance of beneficial microorganisms will help crop adaptation to the environmental context and improve response to stresses. Bioengineering next generation crop plants in this way will allow bypassing the use of transgenic modifications and ensure crop productivity in a sustainable and ecosystem-friendly context.

SCIENTIFIC AREA WHERE THE PROJECT FITS BEST*

Life Sciences (LIF)