Interactions of microgreens and microbiomes as functional regulators of its quality, resistance and shelf-life – a case study for selected herbs (coriander, basil) and vegetables (radish, beet) in response to climate changes

Microgreens are edible seedlings that are usually harvested 7–20 days after germination when they have two fully developed cotyledon leaves. One major limitation to the growth of the microgreen agroindustry is the fast quality deterioration occurring soon after harvest, which restricts commerce to local sales and keeps prices high. After harvested, microgreens quickly dehydrate, wilt, decay and rapidly lose some nutrients. Available literature research has explored pre- and post-harvest interventions, such as light and temperature control, modified atmosphere packaging, and calcium treatments to maintain quality, increase nutritional value, and extend shelf-life. However, more work is required to optimize both production and storage conditions to improve the quality, safety, resistance and finally shelf-life of microgreens, **especially fundamental research on interactions and mechanisms between microgreens and microbiomes are missing and needed.**

This project will contribute to developing sustainable forms of microgreens superfood, including herbs and vegetables such as coriander, basil, radish and beet. The idea of the project is based on making use of the power and functional traits provided by the microbial-based solutions including arbuscular mycorrhizal fungi (AMF) and beneficial bacteria (BB), as well as understanding microgreens-microbiome interactions. **The overall goal of the project is to support effective increase of microgreens quality in sustainable cultivation including control of microgreens quality, safety, resistance and shelf-life and maintenance of beneficial microbiome of microgreens, by understanding the interactions between microbial-based solutions (AMF, BB) and microgreens in changing climate conditions.** In this project we hypothesize that microgreens interact effectively with the media/soil-inoculated or soil natural microbiome, thus generating microgreens that have reduced dependencies on external inputs while maintaining or increasing quality, safety and shelf-life of microgreens under non-stress as well as abiotic (drought) stress conditions. **Altogether, this project will generate a basic knowledge which will help to understand how to obtain a resilient microgreens cropping system better able to recover from abiotic stresses in changing climate.**

There are only 293 publications on microgreens in Scopus database, and any of them was not connected with microbial-based solutions and microgreens-microbiome interactions to improve their quality, safety, resistance and shelf-life. **Therefore, the project proposes an innovative approach to understand interactions relevant for future sustainable microgreens production, limiting its environmental impact.** The first and crucial steps towards enhanced sustainability lie in the recognition if microgreens interact with, and foster, a healthy microbiome, as well as with microbial inoculants.

As microgreens are novel functional food sources with great potential for sustainably diversifying global food systems, promoting human health, and facilitating the access of a steadily growing urban population to fresh microscale plants, there is a need to deepen knowledge in the context of microbiome-based solutions, their importance and understanding for microgreens superfood safety and quality. This is very relevant to improve understanding and knowledge, as well as to indicate new trends of development of agriculture and horticulture discipline.

This 4-year project includes interdisciplinary research activities, structured with a well-balanced division between various research fields contributing to the achievement of sustainable microgreens cropping by integrating biological, chemical, physical, genetic, bioinformatical and environmental dimensions while addressing smart breeding strategies, sustainable production and climate challenges. **The project nature represents breakthroughs in several fields: a)** understanding the mechanisms, functions and regulations of microgreens-microbiome interactions for sustainable superfood production strategies; **b)** improving knowledge on fundamental research concerning interactions and mechanisms between microgreens and microbial-based solutions to extending shelf-life, increase safety and quality of microgreens; **c)** improving knowledge, understanding and explanation of microgreens colonization by beneficial bacterial strains and arbuscular mycorrhizal fungi for developing new functional food products for the future; **d)** clarifying transformation and translocation of C and P by mycorrhizal fungi and soil microbial community to adapt to abiotic stress (drought) condition, as well as identifying and understanding the mechanisms controlling the positive effect of the microbiome on microgreens resistance enzymes activity, oxidative stress parameters or signalling pathways. **The overall approach of the project is based on transdisciplinary, integrative and innovative research methodology. In order to achieve the aim of the project including increasing the microgreens quality by new approaches and assays, that requires basic research concerning explanations of microbiome-microgreens interactions, metataxonomic, biochemical, chemical and microbiological analyses and transcriptomic approach to assess expression of the genes involved in the microgreens resistance to environmental abiotic stresses,** The experiments will also generate data on plant gene expression of the microgreens compartments microbiome, thus linking microgreens biochemistry, genomic, transcriptomic and metabolomic variation. Planned research for understanding mechanisms, functionality and interactions of microgreens and microbiome will be performed in order to improve health, protection, production and resilience of microgreens.