VALIDATION, PROTOTYPING AND SCALE UP OF THE ZERO MILE SYSTEM®

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This PhD project deals with an often-overlooked issue, critical to water resources management: wastewater and its treatment and up-cycling. Particularly, the consumption of water by household appliances, *e.g.* dishwashers, is an underestimated problem and wastewaters from appliances are rarely taken into account as a recoverable resource. Although dishwasher wastewaters (DWWs) are nutrient-rich (due to leftovers) and have low levels of pathogens, heavy metals, and pharmaceuticals, they are not reused due to the small amount produced by point sources. The Jetsons' Kitchen Project has been designed to face this issue, *i.e.* to reuse dishwasher wastewater. The system has been recently patented by Tor Vergata and Polytechnic University of Milan (2019); it consists of a prototype of dishwasher integrated with an indoor vertical garden which, in combination, allow the reuse and up-cycling of the DWW in the cultivation of edible and ornamental plants. Since the system produces healthy and safe, zero-mile food it has been nicknamed 'Zero-Mile system'. A biofilter is the core of the Zero-Mile system: it contains an *ad hoc* engineered microbial consortium, which can thrive in raw DWW ameliorating its chemical-physical characteristics and allowing for wastewater re-use and up-cycling.

The main objective of this PhD project is the biofilter prototype scale-up, in terms of size and degradative capability. As regard size, the microbial consortium will be up-scaled from the lab-volumes (ml) to a real DWW volume (about 10 L), preserving both the effectiveness and the efficiency of the lab-scaled biofilter. As regard the degradative capability, the biofilter will be challenged with several different DWWs, to evaluate its degradative capacity versus a variety of nutrient loads and amounts. To this end, the implementation of the microbial consortium is aimed to increase microbial diversity (also in functional terms).
Biofilter effectiveness, as survival and growth, will be evaluated as photosynthetic pigments content and culture turbidity, while its taxonomic composition assessed by Next Generation Sequencing (NGS). The efficiency of DWW rehabilitation will be chemically quantified as nutrient removal. The increase of biofilter complexity will be achieved by isolating other bacterial strains from different DWWs to be included into the consortium; standard microbiological techniques and identification by Sanger Sequencing will be used along with NGS, which will provide composition of the more complex consortia, and relative incidences of each strain.

The biofilter scale-up is aimed to reach the final goal of climbing the Technology Readiness Levels (TRLs), *i.e.* the Zero-mile system implemented up to its possible commercialization.

Actually, other parts of the system still need to be implemented (integration of the biofilter into the system, optimization of cultivation system, nutraceutical analysis of plants, interactive management of lighting, watering, etc.), I will collaborate with the interdisciplinary teams involved in the project to push the Zero Mile System to its final design.

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