Integrated biorefinery for the complete valorisation of residual biomasses

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Abstract:
Urban settlements produce huge amounts of waste: sewage, food scraps, industry byproducts among many others. The employment of biorefineries offers the opportunity to use residual biomasses as feedstock to obtain fine and bulk chemicals. In this context, biodiversity can provide us with tools for their valorisation.
Considering cascading principles, this work aims to the complete valorisation of two residual biomasses of urban origin: spent coffee grounds (SCG), collected from vending machines of the Veneto region; and mulberry tree bark (MTB), as part of the green waste from the maintenance of Bosco della Besozza, in the Milan metropolitan city area.
In this project the goal is to develop a platform able to valorise such biomasses into microbial based biorefineries. For this purpose, both biomasses were subject to enzymatic hydrolysis to release sugars. The obtained SCG or MTB hydrolysates are then used as growth medium available for microbial fermentation. Specifically, *Rhodosporidium (Rhodotorula) toruloides* is here used as microbial cell factory. *R. toruloides* is an oleaginous yeast, naturally able to produce carotenoids, such as β-carotene, which are both essential nutrients for humans and important compounds for the animal feed and cosmetic sectors. Results show that *R. toruloides* can grow on both SCG and MTB derived medium, while producing carotenoids.
To develop a complete valorisation in an integrated biorefinery, MTB is subject to further valorisation through extractions to obtain tannins, catechins, terpenes and lignin. Two byproducts of said extractions are cellulose and hemicellulose, which can be in turn saccharified for microbial consumption. In parallel, thanks to the collaboration with the Department of Earth and Environmental Sciences (DISAT), the side stream of biomass hydrolysis is analysed for further valorisation. Regarding SCG biomass, aromatic compounds released will be metabolized by recombinant *Saccharomyces cerevisiae* strains into complex fine chemicals, while fermenting the sugar saccharified from the biomass.