MICROALGAL-BASED SYSTEMS FOR INNOVATIVE AND SUSTAINABLE WASTEWATER TREATMENT, A CIRCULAR ECONOMY MODEL

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Global population could reach and even exceed 9 billion by 2050, raising unavoidable challenges for natural resources management. Water is a potentially renewable resource, that is subjected to growing pressure of globalized economy. High water footprint comes from agriculture, industry, and municipality. Despite current wastewater treatment systems reduce organic and inorganic impurities, ranging from microplastics, nutrient loads and heavy metals, the process is expensive and not enough efficient leading to secondary pollution and eutrophication once released into the environment. In this scenario, novel sustainability models are under the focus of circular economy approaches and an imminent challenge of our time is to meet the industrial demand and to soften the use of non-renewable resources along with the reduction of greenhouse gases (GHGs) emission. Microalgae are a wide and diversified evolutionary group that currently represent one of the most promising platforms to be placed at the end of the water treatment chain so to valorise the wastewater and invert this trend. In fact, microalgae are easy cultivating, growing by light energy and CO_2, fixing it more efficiently than terrestrial plants, without the need of high land demand. Furthermore, microalgae represent a promising platform for sustainable production of bioactive molecules, such as fuel, pigments, or pharmaceuticals. What is hindering this passage is the need to optimize microalgal biomass productivity and yield in bio-compounds to lower the cost. Many approaches have been employed, such as the setting of optimal parameters (pH, light period, and nutrients) for microalgal growth and compounds' production, among which the exploration of stressing conditions. Indeed, stress induction by nutrient deprivation demonstrated to increase by three times the levels of produced lipids; however, due to the high nutrient content in wastewater new approaches must be exploited. Here we propose the investigation of microalgae stress sensing mechanisms aimed at unravelling novel microalgae optimization routes, with particular attention to acoustic stress. Sound treatment was demonstrated to alter phytohormone levels and to be an effective abiotic stress inducer in higher plants leading to an increase in the levels of secondary metabolites (glucosinolate, saponin and the alteration of the antioxidant capacities). The finding of the sound responsive *ald* cluster in superior plants, paves the way towards the future usage of microalgae targeted genetic engineering for metabolite yield improvement. An evolutionary study of mechanosensitive apparatus along with the study of microalgal genome looking for sound responsive genetic cluster, will give us a more comprehensive understanding of the microalgal cell, thus allowing the exploitation of all the locked microalgae potentialities so to place them at the centre of a circularity model.