Enhancing proton efflux enables CO_2-containing flue gas valorization with microalgae

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Microalgae have garnered considerable interest as CO_2 reduction platforms as well as next-generation energy and food sources. Despite the potential, actual utilization of microalgae as a CO_2 reduction technology through large-scale cultivation is limited mainly due to the biological platforms' low tolerance to environmental fluctuations. Especially, microalgae's inherent low tolerance to high CO_2 is largely responsible for the limitation. To solve the problem, we tried to maximize microalgal ability to maintain pH homeostasis by heterologous expression of proton (H^+) pumping plasma membrane ATPase since it is widely accepted that pH tolerance governs CO_2 tolerance of microalgae. As a result, pH tolerance of a green microalga, Chlamydomonas reinhardtii was markedly increased at low pH regime. Thanks to the heterologous protein expression, CO_2 tolerance was simultaneously increased and thus CO_2 fixation under a high CO_2 level (ca. 15%) was almost doubled.