Abstract

Vibrio natriegens is an emerging microbial chassis, but physiological constraints that limit growth under fluctuating nutrient or high-density culture conditions remain unclear. Here, a morphological stress response induced by acute nutrient depletion was demonstrated using time-lapse bright-field microscopy and Cellpose-based segmentation. Dilution into 20–30% growth medium triggered pronounced cell elongation, whereas more severe or milder nutrient conditions produced weaker responses. Pharmacological perturbation and time-resolved inhibitor-addition experiments indicated that elongation is tightly associated with transcriptional activity and begins shortly after nutrient downshift. Translation inhibition permitted limited extension, particularly in small cells, suggesting that early elongation can partly proceed using pre-existing cellular machinery in a cell-state-dependent manner. Nutrient-depleted elongated cells showed impaired growth upon acetate exposure, linking stress-associated morphology to reduced acetate tolerance. Together, these findings suggest that nutrient stress and acetate-associated metabolic stress converge to restrict growth and identify morphology regulation and acetate sensitivity as targets for improving *V. natriegens* cultivation.

Keywords: *Vibrio natriegens; Cell Length; Microscopy; Nutrient; Cell Morphology; Acetate Toxicity*