Bacterial release of dissolved organic matter during cell growth and decline: Molecular origin and composition

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ABSTRACT: Heterotrophic bacterial growth and the chemical composition of dissolved organic matter (DOM) produced by bacteria from freshwater and marine environments were monitored during experiments with artificial media containing glucose as the sole carbon source. Glucose was quickly consumed, and DOM was released during bacterial growth. Percentages of extracellular release of DOM from bacteria ranged from 14% to 31%, indicating that bacterial production and growth efficiency are underestimated when only cellular carbon is measured. Relatively high concentrations of D-alanine (D-Ala) were observed in DOM released during exponential growth, whereas the concentrations of muramic acid and other D-amino acid components of peptidoglycan were not detected or were in low concentration. The selective release of D-Ala occurred during cell growth and division when peptidoglycan is cleaved and newly synthesized subunits are incorporated into the cell wall via transpeptidation. Most of the D-Ala released during exponential growth was rapidly consumed. Following exponential growth, bacterial abundance decreased due to grazing and possibly viral lysis. The DOM remaining in the incubations after one or more months included a mixture of D-amino acids commonly found in peptidoglycan and the amino sugars glucosamine and galactosamine, which were highly resistant to decomposition. The percentage of D-amino acids was much higher in DOM than in cells due to the preferential release of D-amino acids and decomposition of L-amino acids. The final concentrations of dissolved organic carbon (DOC) ranged from 20 to 30 μmol L^{-1} regardless of the initial concentration of glucose or the source of inoculum. The observed abundances of D-amino acids and amino sugars in DOM from diverse aquatic environments indicate a bacterial source and common decomposition processes.

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