



13C/12C and 15N/14N Isotope Analysis to Characterize Natural Degradation of Atrazine: Evidence from Parent and Daughter Compound Values

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The mobile and still herbicidal metabolites desethylatrazine (DEA) and desisopropylatrazine (DIA) are frequently detected together with its parent compound atrazine (Atz) in the aquatic environment. Interpretation of their transformation state is often difficult with current methods, which are mainly measuring concentrations. Alternatively, compound specific isotope analyses (CSIA) has become a novel tool to detect degradation processes of contaminants in groundwater. The aim of our study was to investigate on the lab scale $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ isotope trends in parent and daughter compounds associated with different degradation scenarios of atrazine likely to occur in the environment. Thus atrazine was dealkylated with (i) permanganate and (ii) the bacterium *Rhodococcus* sp. NI86/21. In both transformations, $^{13}\text{C}/^{12}\text{C}$ ratios of atrazine increased strongly (epsilon carbon/permanganate = -4.6 ± 0.6 ‰ and epsilon carbon/*Rhodococcus* = -3.8 ± 0.2 ‰ whereas nitrogen isotope fractionation was small. $^{13}\text{C}/^{12}\text{C}$ ratios of DEA showed the following trends. (i) When DEA was formed as only product (Atz + permanganate) $^{13}\text{C}/^{12}\text{C}$ remained constant, close to the initial value of Atz. (ii) When DEA was formed together with desisopropylatrazine (biodegradation of Atz) $^{13}\text{C}/^{12}\text{C}$ increased, but only within 2‰ (iii) When DEA and DIA was further biodegraded, $^{13}\text{C}/^{12}\text{C}$ increased for both metabolites up to 9‰ Thus strong enrichment of $^{13}\text{C}/^{12}\text{C}$ in the metabolites in comparison to Atz can give strong testimony for further breakdown of the metabolite.