Chemical and Degradation Characteristics of Soil Microbial Biomass

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Declaration

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Abstract

Soil organic matter (SOM) contains substantial amounts of carbon and nitrogen and plays an important role in regulating anthropogenic changes to the global carbon and nitrogen biogeochemical cycles. It also plays essential roles in agricultural productivity, water quality, immobilization and transport of nutrients and anthropogenic chemicals, while also concealing exciting opportunities for the discovery of novel compounds for potential use in industry and medicine. Despite these critical roles and potential, many uncertainties exist regarding the size of the labile and refractory SOM pool, carbon dynamics within the SOM pool, and the role of SOM in carbon sequestration. Several studies have investigated the contribution of plant litter and crop residues to SOM. However, the contribution of soil microbial biomass to carbon-cycling is seriously underestimated and its turnover poorly understood.

To address these knowledge gaps, a study utilizing ^{13}C and ^{15}N isotopically enriched soil microbial biomass was undertaken to determine the transformation dynamics of major microbial (bio)macromolecules degraded under ambient and prolonged ultraviolet (UV) conditions. The application of advanced nuclear magnetic resonance (NMR) approaches revealed a relative increase in aliphatic-C with a concomitant decrease in carbohydrates and proteinaceous materials, indicating that aliphatic species are selectively preserved. Further analysis of the lipid fractions by gas chromatography-mass spectrometry (GC-MS) indicated that *n*-alkanes, mono- and poly-unsaturated n-C_{16} and n-C_{18}, and fatty acids having chains of less than 14 C are relatively labile. Conversely, saturated n-C_{16} and n-C_{18} are highly recalcitrant. Bio-refractory proteins surviving degradation were subsequently identified as membrane proteins and enzymes using in-gel tryptic digestion, matrix assisted laser desorption ionization-time of flight-mass spectrometry (MALDI-TOF-MS) and/or electrospray ionization-time of flight-mass spectrometry (ESI-TOF-MS) analysis. To determine the role of soil minerals in SOM turnover, clay-microbial complexes were investigated. X-ray diffraction analysis coupled with scanning electron microscopy, elemental X-ray analysis and NMR spectroscopy revealed that aliphatic species, proteins and carbohydrates are preferentially adsorbed to clay surfaces where they are physically protected from degradation.

***Table of contents*:**