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High Carbon Use Efficiency is Not Explained by Production of Storage Compounds

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The efficiency with which microbes use substrate to make new microbial biomass (Carbon Use Efficiency or CUE; mol C / mol C) is an important variable in soil and ecosystem C cycling models. Estimates of CUE in soil microbial communities vary widely. It has been hypothesized that high values of CUE are associated with production of storage compounds following a sudden increases in substrate availability during CUE measurements. In that case, these high CUE values would not be representative for balanced microbial growth (i.e. the production of all compounds needed to make new microbial cells).

To test this hypothesis, we added position-specific 13C-labeled glucose isotopomers in parallel incubations of a ponderosa pine and piñon-juniper soil. We compared the measured pattern of CO_2 release for the six glucose C atoms with patterns of CO_2 production expected for balanced growth with a low, medium, or high CUE, and with CO_2 production patterns associated with production of storage compounds (glycogen, lipids, or polyhydroxybutyrate).

The measured position-specific CO_2 production did not match that for production of glycogen, lipids, or polyhydroxybutyrate, but agreed closely with that expected for balanced growth at high CUE and high pentose phosphate pathway activity. We conclude that soil microbial communities utilize glucose substrate for biomass growth with high CUE, and that addition of small amounts of 13C-labeled glucose tracers do not affect CUE or induce storage compounds production. We submit that the measurement of position-specific CO_2 production offers a quick and easy way to test biochemically explicit hypotheses concerning microbial growth metabolism.