Geophysical Research Abstracts
Vol. 16, EGU2014-686, 2014
EGU General Assembly 2014

Effect of environmental conditions on the fatty acid fingerprint of microbial communities

Mikhail Biryukov (1,2), Michaela Dippold (2), Yakov Kuzyakov (2,3)

(1) Faculty of Biology, Lomonosov Moscow State University, 119991 Moscow, Russia (Biryukov@mail.bio.msu.ru), (2) Agricultural Soil Science, Georg-August-University of Goettingen, Germany, (3) Soil Science of Temperate Ecosystems, Georg-August-University of Goettingen, Germany

Lipid biomarkers, especially phospholipids, are routinely used to characterize microbial community structure in environmental samples. Interpretations of these fingerprints mainly depend on rare results of pure cultures which were cultivated under standardized batch conditions. However, membrane lipids (e.g. phopholipid biomarker) build up the interface between microorganisms and their environment and consequently are prone to be adapted according to the environmental conditions.
We cultivated several bacteria, isolated from soil (gram-positive and gram-negative) under various conditions e.g. C supply and temperature regimes. Effect of growth conditions on phospholipids fatty acid (PLFA) as well as neutral lipid fatty acids (NLFA) and glycolipid fatty acids (GLFA) was investigated by conventional method of extraction and derivatization, followed by assessments with gas chromatography mass spectrometry (GC-MS). In addition, phospholipids were measured as intact molecules by ultra high performance liquid chromatography – quadrupole – time of flight mass spectrometer (UHPLC-Q-ToF) to further assess the composition of headgroups with fatty acids residues and their response on changing environmental conditions.
PLFA fingerprints revealed a strong effect of growth stage, C supply and temperature e.g. decrease of temperature increased the amount of branched and/or unsaturated fatty acids to maintain the membrane fluidity. This strongly changes the ratio of specific to unspecific fatty acids depending on environmental conditions. Therefore, amounts of specific fatty acids cannot be used to assess biomass of a functional microbial group in soil. Intracellular neutral lipids depended less on environmental conditions reflecting a more stable biomarker group but also showed less specific fatty acids then PLFA. Therefore, combination of several lipid classes is suggested as more powerful tool to assess amounts and functionality of environmental microbial communities.
Further information was gained from the analysis of intact polar lipids. Ethanolamines and cholines were the most abundant head groups within bacteria and are mainly combined with one specific and one unspecific fatty acid. Reactions on changing environmental conditions occurred mainly by modifications of fatty acids and rarely by a change of the headgroup fingerprint. This approach thus enables to categorize a certain amount of formerly unspecific fatty acids towards a specific microbial group.
Ecological understanding for the interface between surrounding environment and cellular metabolism could be deepened by investigating the intact compounds e.g. intact phospholipids of microbial membranes. However, data from further organisms as well as diverse microbial communities are needed to continue the databases of intact phospholipids. Further investigations of diverse microbial communities under changing environmental conditions have to follow these first studies to 1) assess the effects of soil environment on microbial membranes (e.g. associations in biofilms) and 2) assess the effect of interspecific microbial interactions on their membrane properties and lipid fingerprints. Thus, combination of various lipid biomarkers as well as their intact characterization enables a more detailed look into microbial community structure and their respond on environmental conditions, improves our understanding of microbial functioning in ecosystems and enables a more specific estimation of biomass of various microbial groups.