Temperature-dependent bacterial alkyl glycerol ether lipid composition: towards new tracers of seawater paleotemperature changes?

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In addition to acyl glycerols which are commonly present in bacterial membranes, some bacteria also synthesize alkyl glycerol ether lipids (AGEs). Due to their widespread occurrence and apparent diagenetic stability, bacterial AGEs can be regarded as potentially useful biomarkers; little is known, however, on the physiological control of AGE-containing membranes and on the precise structural modification suffered by AGEs in response to changing environmental conditions.

Here, we investigated the influence of growth temperature on the qualitative and quantitative ether lipid composition of mesophilic anaerobic bacteria growing between 20 and 40°C. Comparison with a thermophilic strain growing in the range 54-84°C allowed characterizing specific changes in the chemical composition of ether-containing bacterial membranes in relation to temperature physiological preferences. Strains adapted to temperature by modifying the average structural composition of their membrane lipids. Structural changes mainly concerned the branching pattern (position and proportion of methyl branches) of alkyl and acyl chains. Interestingly, some of these adaptive traits appeared linearly correlated with growth temperature. Depending on the quality of the linear regressions describing these correlations, and on the initial AGE composition of the strains (mesophiles vs thermophile), different ratios of specific AGEs could be tentatively envisaged as new tools for tracing ancient sea water temperature changes. Additional culture experiments performed with the mesophilic strains further demonstrated that the selected temperature-dependent ratios of AGEs were not significantly influenced by salinity and pH. Based on these laboratory observations, we investigated the distributional variations in AGEs along ancient marine sedimentary settings where seawater temperatures have been previously reconstructed using well calibrated proxies. The significant linear correlation observed between variations in AGE distribution and the $U^{K'}_{37}$ index (based on alkenone distribution) confirmed the potential of AGEs to constitute new molecular tools for tracing ancient seawater temperature changes.