Abiotic synthesis of acylglycerols under simulated hydrothermal conditions and micelle formation

B. Simoneit (1), A. Rushdi (1)and D. Deamer (2)

(1) College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331, U.S.A. (2) Department of Chemistry and Biochemistry, University of California, Santa Cruz, CA 95064, U.S.A.

Abiotic formation of aliphatic lipid compounds (i.e., fatty acids, alcohols, and acylglycerols) has been reported to occur at elevated temperatures and pressures under simulated hydrothermal conditions (McCollom et al., 1999; Rushdi and Simoneit, 2001, 2006). Although abiotic chemistry may occur at these conditions, the prebiotic self-assembly of micelles to bilayer to vesicles (protocells) may have occurred elsewhere. Amphipathic compounds such as fatty acids and acylglycerols are important candidates for micelle/bilayer/vesicle formation. Thus, it is of interest to demonstrate that abiotic lipids (amphiphiles), precursor compounds for abiotic cellular membranes (Deamer, 1997), can be synthesized under hydrothermal conditions.

Hydrothermal experiments were conducted to study condensation reactions of model lipid precursors in aqueous media to form acylglycerols (glyceryl alkanoates) at elevated temperatures under confining pressures. Stainless steel vessels (316SS Sno-Trik high pressure couplings) with internal capacities of 286$\pm$2 μl were used for the condensation reactions using a mixture of 0.14 mM glycerol and 0.35 mM of n-alkanoic acid. Nine different alkanoic acids ranging from C_7 to C_{16} (except C_8) were used in these experiments. The condensation products were two isomers each of monoacylglycerols and diacylglycerols, as well as the corresponding triacylglycerol. The product yields were 13-28% for monoacylglycerols, 6-13% for diacylglycerols and 1-4% for triacylglycerols. The results indicated that: (1) lipid esters can be formed at relatively high temperatures in the presence of excess aqueous polyols, (2) condensation (dehydration) reactions are possible under aqueous pyrolysis conditions, and (3) abiotic synthesis and subsequent condensation reactions of aliphatic lipid compounds are possible under hydrothermal conditions and warrant further research.

References:

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