Spectroscopic and Biophysical Methods to Determine Differential Salt-Uptake by Primitive Membraneless Polyester Microdroplets

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Abstract: α-Hydroxy acids (αHAs) are prebiotically available monomers that can undergo dehydration synthesis to form polyester gels, which assemble into membraneless microdroplets upon aqueous rehydration. These microdroplets have been proposed as protocells which could segregate and compartmentalize primitive molecules or reactions. Different primitive aqueous environments with a variety of salts could have hosted chemistries that formed polyester microdroplets. These salts could be essential cofactors of compartmentalized prebiotic reactions or even directly affect protocell structure. However, fully understanding polyester-salt interactions remains elusive, partly due to the technical challenges of understanding quantitative measurements in condensed phases. Here, we apply spectroscopic and biophysical methods to analyze salt uptake by polyester microdroplets. Inductively coupled plasma mass spectrometry (ICP-MS) is applied to measure the cation concentration within polyester microdroplets after the addition of chloride salts. Combined with methods to determine the effects of salt uptake on droplet turbidity, size, surface potential and internal water distribution, we demonstrate that polyester microdroplets can selectively partition salt cations, leading to differential microdroplet coalescence due to ionic screening effects reducing electrostatic repulsion forces between microdroplets. Through applying existing techniques to novel analyses related to primitive compartment chemistry and biophysics, the current study suggests that even minor differences in analyte uptake could lead to significant protocellular structural change.