Rapid ion exchange purification of Zn and Cu from biological matrices for isotope analysis via MC-ICP-MS

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Zinc and copper are extremely important elements for living organisms and their isotopic composition in biological media has become a source of great interest in metallomics research. This is owing to the elemental and isotopic fractionation of these elements that can be induced by dyshomeostasis, and both Zn and Cu have shown exceptional promise as diagnostic tools for diseases such as Alzheimer's and cancer. As the medical applications of these isotope systems continue to scale upwards and outwards, so too must the methodologies used to isolate these elements from relevant matrices. Moreover, the longitudinal success of isotope metallomics beckons for element purification protocols that can be easily integrated into existing workflows and meet the high throughput demands of clinical application.

Here we have designed two ion exchange chromatography procedures for the rapid purification of Zn and Cu from biological samples (e.g. blood) for subsequent MC-ICP-MS isotope analysis. For Zn, the purification protocol is similar to hydrobromic/nitric acid media methods in the literature, emphasizing low acid and total reagent volumes (~ 15 mL). For Cu, element-specific CU Resin is utilized for its high Cu retention and selectivity, significantly reducing acid and total reagent volumes compared to traditional techniques (~ 30 mL vs. 60 mL).

In a novel procedural leap forward, the hydraulic pressure during column chemistry has been tightly modulated via centrifugation to prescribe enhanced flow rates, thereby dramatically reducing processing time. Both protocols have been optimized for integration into existing medical equipment and workflows, and allow for Zn and Cu purification on timescales of hours instead of days.