E21 A Microscopic and Elemental Analysis of Anthropological and Modern Buried Hair Compared to Soil Composition: A Case Study of a Male Child and Adult Female From the Arch Street Project in Pennsylvania

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Learning Overview: After attending this presentation, attendees will have learned about the forensic value of buried hair through simulated modern burials and a case study of anthropological remains recovered from the site of the former First Baptist Church of Philadelphia (FBCP) in Pennsylvania.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by further contributing to the existing literature on the forensic value of hair as well as the effect of degradation over time and environmental exposure on the microscopic characteristics and elemental composition of hair.

Several hundred human remains were unearthed during a 2016–2017 construction project at 218 Arch Street, site of the former FBCP. Local archaeologists launched a salvage archaeological project to recover and relocate these remains in what became known as the Arch Street Project. The large quantity of hair recovered on the skulls of two of the remains (a male child [G-9] and adult female [G-33]) provided a unique opportunity to conduct a case study of anthropological hair from the FBCP cemetery, analyzing its morphological features and intrinsic chemical composition as compared to the surrounding soil after years underground. The value of buried anthropological hair as well as the effect of different sample preparation procedures on the hair samples (i.e., hair washing procedures to remove exogenous contamination without damaging the hair) was investigated through visualization with light microscopy and chemically using Inductively Coupled Plasma/Optical Emission Spectroscopy (ICP/OES) multi-elemental analyses.

Simulated burials of modern hair provided insight as to the degradative effects of the environment through various burial intervals (from one week to one year across different soil types), the efficacy of the different hair washing procedures, and the prevalence of hair morphologies typically associated with postmortem hair across antemortem hair samples as a result of burial. Root morphologies on plucked hair samples provided by living donors were analyzed under transmitted and polarized light microscopy. Microscopic comparisons between modern hair from the same donor exposed to different burial durations and washing procedures were also conducted showing various degrees of degradation from burial and potential damage or removal of external soil contaminants from washing.

ICP/OES multi-elemental analysis focused on the parts per million (ppm) level of 14 elements, including major and trace elements in hair and soil (Calcium [Ca], Chromium [Cr], Copper [Cu], Iron [Fe], Potassium [K], Magnesium [Mg], Manganese [Mn], Sodium [Na], Nickel [Ni], Phosphorus [P], and Zinc [Zn]) as well as heavy metal toxins (Arsenic [As], Cadmium [Cd], and Lead [Pb]) found at levels below the detection limits (<2ppm) of the method.[1-5] Statistical analysis (*t*-tests and Analysis of Variance [ANOVA]) of the simulated burial remains yielded significant results across experimental conditions for some, but not all, of the elements studied. Washed versus unwashed hair showed significant (p <0.05, two-tailed *t*-test) differences for Zn in unburied controls and Ca in buried hair samples as well as significant (p <0.01, two-tailed *t*-test) differences in Na, K, Cu, and Zn levels between the burial durations compared to unburied controls. The anthropological hair samples from G-9 (male child) and G-33 (adult female) were chemically distinct from each other (Mg, Na, Ca, Fe, Mn, P, Pb) as well as chemically distinct from the soil (Fe, K, Mg, Na, Mn, Zn). Results indicate that burial has a significant effect on the mineral content of hair and that surrounding soil should be investigated along with hair samples in these cases, but that even after centuries of soil exposure, anthropological hair retains elemental distributions unique to the individual.

Reference(s):

1. Chojnacka, Katarzyna, Agnieszka Zielinska, Izabela Michalak, and Henryk Górecki. The Effect of Dietary Habits on Mineral Composition of Human Scalp Hair. *Environmental Toxicology and Pharmacology* 30 (2010): 188-94.
2. Gonzalez, Liliana M. Hernandez, Vivien A. Rivera, Colin B. Phillips, Loren A. Haug, Shelby L. Hatch, Loren E. Yeager, Haebin Chang et al. Characterization of Soil Profiles and Elemental Concentrations Reveals Deposition of Heavy Metals and Phosphorus in a Chicago-Area Nature Preserve, Gensburg Markham Prairie. *Journal of Soils and Sediments* 19, no. 11 (2019): 3817-3831.
3. Huang, Lily, and Diane Beauchemin. Ethnic Background and Gender Identification Using Electrothermal Vaporization Coupled to Inductively Coupled Plasma Optical Emission Spectrometry for Forensic Analysis of Human Hair. *Journal of Analytical Atomic Spectrometry* 29, no. 7 (2014): 1228-1232.
4. Mikulewicz, Marcin, Katarzyna Chojnacka, Thomas Gedrange, and Henryk Górecki. Reference Values of Elements in Human Hair: A Systematic Review. *Environmental Toxicology and Pharmacology* 36, no. 3 (2013): 1077-1086.
5. Moreda-Pineriro, Jorge, Elia Alonso-Rodriguez, Purificacion Lopez-Mahia, Soledad Muniategui-Lorenzo, Dario Prada-Rodriguez, Antonio Moreda-Pineiro, and Pilar bermejo-Barrera. Determination of Major and Trace Elements in Human Scalp Hair by Pressurized-Liquid Extraction with Acetic Acid and Inductively Coupled Plasma-Optical Emission Spectrometry. *Analytical and Bioanalytical Chemistry* 388, no. 2 (2007): 441-449.

Anthropology, Hair Analysis, Burial