E61 Bradford Reagent and Ninhydrin: Chemical Approaches for Biological Sex Identification From Fingerprints

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After attending this presentation, attendees will understand that fingerprints can be used as more than just a picture for comparison and can be used for identifying certain attributes of the fingerprint originator based solely on the composition of the fingerprint content. Attendees will also learn that this concept is possible even when the target analyte population is narrowed from 23 amino acids to 6.

This presentation will impact the forensic science community by providing new methods for the analysis of fingerprints in order to generate essential information about suspected individuals directly at a crime scene. This concept will provide a simple YES/NO response within minutes to confirm originator attributes. In addition, these systems can potentially be incorporated into field-deployable devices (similar to glucometers) or connected to hand-held Smart Devices, which will allow for rapid analyses that can be used and interpreted by operators -— in a manner similar to water test kits and the VOCkit system, which is a small strip that has a grid of several dozen indicator chemicals imprinted on it that is used by the Army for the detection of threat agents such as anthrax, sarin, and mustard gas -— with minimal scientific training.

It has been established that the contents of fingerprints are produced by multiple hormone-based control mechanisms and are, thus, a function of physical properties such as age, ethnicity, or biological sex. It has been demonstrated that fingerprints have the potential to generate much more information because they are samples of biological origin analogous to other body fluids. One of the greatest setbacks in fingerprint analysis is that if a matching fingerprint is not saved in a database or if the person of interest is not physically present for comparison, the print is reduced to merely exclusionary evidence, despite being stored in a separate database for future use with newly obtained fingerprints. The same can be said about DNA. Even though DNA can provide the most significant information about the fingerprint originator, DNA analysis can take weeks or months, not to mention that only a few nanograms of DNA at most can be recovered from a fingerprint as the majority is lost during collection and extraction. Ultimately, even if DNA was collected, it is possible that a matching profile may not exist. The research displayed here investigates the use of fairly well-known chemical assays for the purpose of identifying the biological sex of the fingerprint originator.

The ninhydrin method is the most well-known and widely used. Federal, state, and city crime laboratories have been implementing this technique for nearly 50 years. This method has proven to be durable and reliable because of the stability of amino acids — ninhydrin has been used to detect and develop fingerprints that are more than 30 years old. Ninhydrin is a chemical that reacts with amino acids in the fingerprint content to produce the blue-purple color known as Ruhemann's purple. Here, a modified approach to the traditional ninhydrin method for fingerprint development is combined with an optimized extraction protocol and the concept of determining biological sex from fingerprints.

Despite the success of the ninhydrin method, this group's intentions are to establish a method in which only one metabolite corresponds to one originator attribute. Multianalyte assays that target a larger number of amino acids are not completely reliable because more than one attribute can ultimately affect the output of the assay. This convolutes the intentions of the assay altogether since it would be difficult to identify which attribute is ultimately responsible for causing the difference in the assay's response. For example, if attribute A causes amino acid 1 to increase, but attribute B causes the same amino acid to decrease, the change is negated and neither attribute can be identified. To eliminate this possibility, it is important for systems to be restricted to one analyte (amino acid) or a specific combination of analytes that are correlated to the desired originator characteristics. To do so, a chemical assay involving the Bradford Reagent (traditionally used for protein quantification) used to target a small group of amino acids was developed to begin the transition toward focusing on a single amino acid.

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