Unveiling the Power of the HID NIMBUS™ Presto in Tackling Challenging Samples

Kayli Carrillo*, BS[1]; Natalia Czado, MS[1]; Jennifer Snedeker, BS[1]; Sheree Hughes, PhD[1,2]

[1]*Department of Forensic Science, Sam Houston State University, Huntsville, TX 77340*

[2]*Southeast Texas Applied Forensic Science (STAFS) facility, Sam Houston State University, Huntsville, TX 77340*

INTRODUCTION

Many forensic laboratories rely on automated platforms to increase sample throughput and minimize handling errors. However, automation may lead to DNA loss when compared to manual methods, thus affecting downstream genotyping. Therefore, it is crucial to evaluate the efficiency of any high throughput automated platform compared to manual extraction, especially for challenging forensic sample types.

The HID NIMBUS™ Presto System combines the ThermoFisher's KingFisher™ Presto Purification system with an automated liquid handling workstation. This system allows for hands-free processing while purifying 96 samples in approximately 90 minutes using magnetic rods to move the bound DNA across reagent plates for multiple wash steps (1).

Automated platforms must be reliable and robust to handle the most challenging of sample types. DNA from forensic samples is often low in quantity, damaged/degraded, and/or contain PCR inhibitors (2-5).

In this study, DNA recovery and resultant STR profiles from forensically challenging sample types, including fired cartridge casings, "touch" evidence, hair, nails, and teeth from decomposed cadavers, and bones recovered from burned, buried, and surface decomposed remains were processed using the HID NIMBUS™ Presto System in parallel with the recommended manual extraction protocol for either PrepFiler™ or PrepFiler™ BTA chemistry for comparison.

Figure 1: HID NIMBUS™ Presto system.

MATERIALS AND METHODS

***Sample Preparation*:**

Bones. Skeletal samples (n = 90) were collected from 36 cadavers donated to the Southeast Texas Applied Forensic Science Facility (STAFS) (Fig. 2). The surface of each bone was sanded and then sectioned using the Dremel and cutting disks into 0.5 cm^2 chips. Bone chips were washed (10% bleach, water, and ethanol), left to dry overnight, and powdered using a freezer mill (SPEX 6770, Metuchen, NJ).

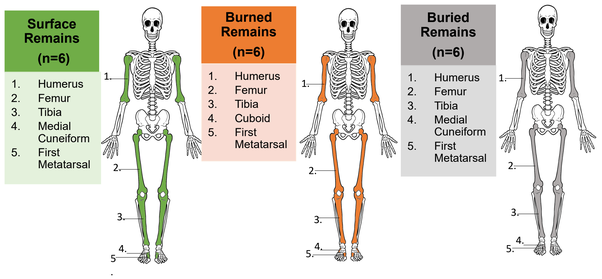

Figure 2: Bones sampled from cadavers.

RESULTS & DISCUSSION

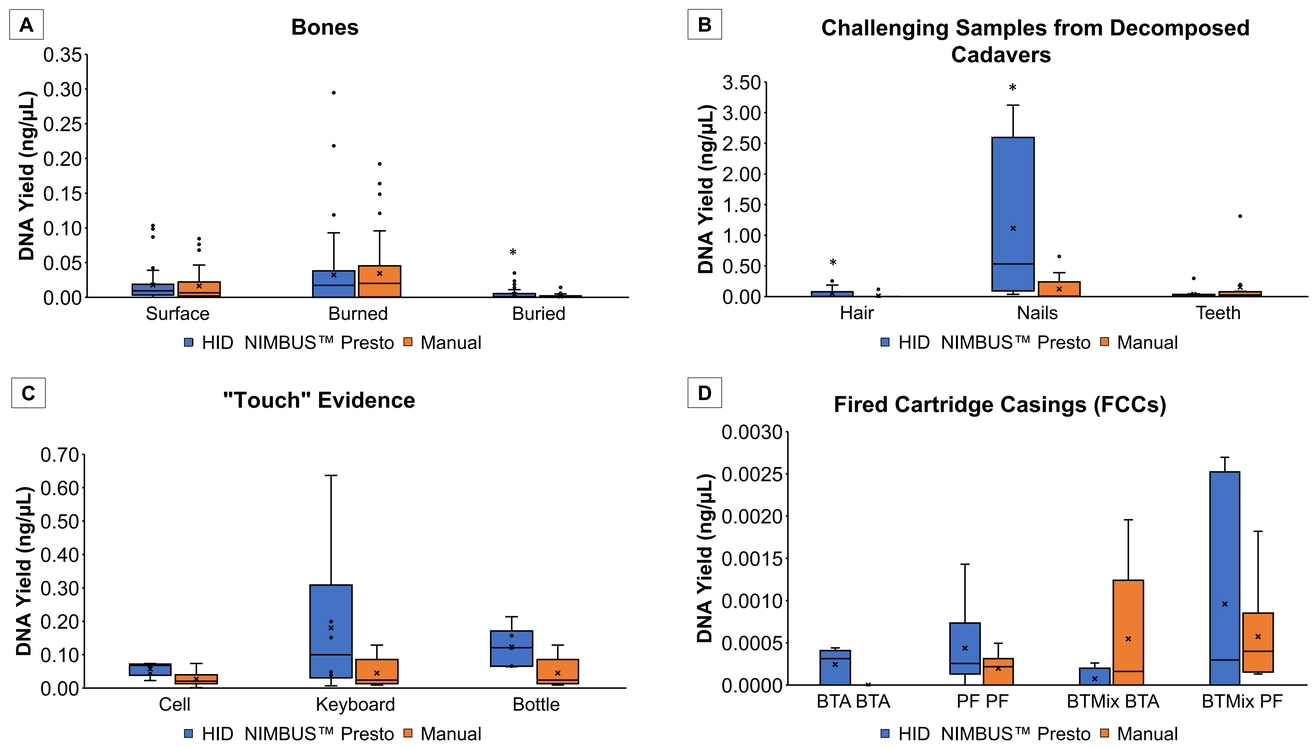

Figure 4: Comparison of DNA yield between the HID NIMBUS™ Presto System for A) bone samples, B) challenging samples from decamped cadavers, C) "touch" samples, and D) fired cartridge casings. N = 339. * indicates statistical significance ($p < 0.05$)

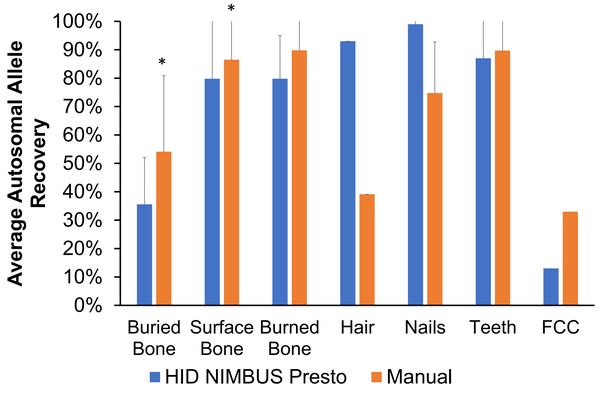

Figure 5: Comparison between the HID NIMBUS™ Presto system versus manual extraction of average autosomal allele recovery for all sample types

- Between the HID NIMBUS™ Presto system and manual extraction, no significant difference in DNA recovery was observed for fired cartridge casings, teeth, surface decomposed, and burned remains ($p > 0.05$) (Fig. 4).
- The HID NIMBUS™ Presto yielded statistically significantly higher DNA yields for "touch" evidence, hair, nail, and buried bone samples ($p < 0.05$) (Fig. 4).
- Significantly more alleles were recovered from DNA extracted using the HID NIMBUS™ Presto for all nail and hair samples ($p < 0.05$) (Fig. 5).
- For buried and surface decomposed samples, manual extraction significantly outperformed the HID NIMBUS™ Presto system in terms of autosomal allele recovery ($p < 0.05$) (Fig. 5).
- No significant difference in allele recovery was observed for "touch," fired cartridge casings, and surface decomposed samples ($p > 0.05$) (Fig. 5).

MATERIALS AND METHODS

Challenging samples from decomposed cadavers. Two hair, nails, and teeth were collected from 6 cadavers (Fig. 3). Hair was cut from the root to 3 – 5 mm. Samples were washed with Tergazyme™, water, and ethanol. Nails were cut to ~ 5 mm and were washed for 15 min in sterile water at 50°C by shaking, followed by 3 min in ethanol. Premolars and molars were washed, wrapped in Kimwipe and pulverized with a mallet before being powdered with the Freezer (SPEX 6770).

Cartridge Casings. 48 rounds of UV sterilized 9 mm brass cartridges (Sumbro X-Force 9 mm Luger 124 grain Full Metal) and were spiked with 10 µL of a buccal cell suspension (~ 217 cells/µL, or theoretical 10 ng DNA total). Shots were fired using a 9 mm Glock 19. DNA was collected using various swabbing methods (Fig. 3).

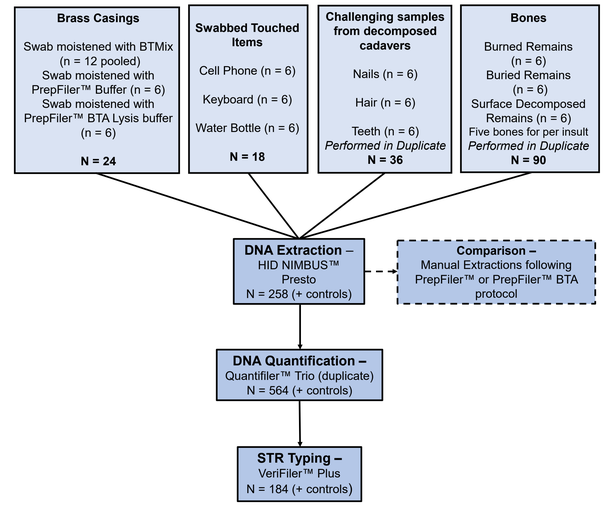

Figure 3: Workflow for the HID NIMBUS™ Presto system and manual extraction

CONCLUSIONS

- The HID NIMBUS™ Presto performs comparably to manual extraction for a wide variety of challenging forensic sample types in terms of DNA yield and STR success.
- The HID NIMBUS™ Presto system can save an analyst time by limiting hands-on requirements and allowing for 96 samples to be purified in approximately 90 minutes.
- The high-throughput, automated HID NIMBUS™ Presto system can streamline laboratory workflow without loss of DNA recovery or STR success from the most challenging forensic samples.

REFERENCES

1. ThermoFisher Scientific, HID NIMBUS Presto User Guide, USA, 2022.
2. V.G. Saragoni, R.C. Celis, M. Intriago, A.A. Melillán-Sanzana, P. Reyes, L. Prieto, P. Gill, Overcoming the undetected inhibition of bone DNA extracts obtained by total demineralization, Forensic Sci Int Genet. 48 (2020). https://doi.org/10.1016/j.fsigen.2020.102363.
3. L.I. Moreno, B.R. McCord, Understanding metal inhibition: The effect of copper (Cu2+) on DNA containing samples, Forensic Chemistry. 4 (2017).
4. R. Wickenheiser, Trace DNA: A Review, Discussion of Theory, and Application of the Transfer of Trace Quantities of DNA Through Skin Contact, J Forensic Sci. 47 (2002). https://doi.org/10.1520/jfs15284j.
5. Y. Tanigawara, T. Kita, M. Hirono, T. Sakaeda, F. Komada, K. Okumura, Identification of N-acetyltransferase 2 and CYP2C19 genotypes for hair, buccal cell swabs, or fingernails compared with blood, Ther Drug Monit. 23 (2001). https://doi.org/10.1097/00007691-200108000-00004.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the support of Thermo Fisher Scientific for providing the supplies, and the Department of Forensic Sciences at SHSU for support. We also wish to thank the STAFS facility, their donors and loved ones whom without their generous gift, this research would not be possible.