Efficacy of DNA Recovery and Room-Temperature Storage from Assault Rifle Magazines

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INTRODUCTION

Violent crimes committed with modern automatic firearms have a number of residual items that are likely to be discarded at crime scenes (1). During preparation, the perpetrators of these crimes have had direct contact with these components during magazine loading. This contact provides an opportunity to collect DNA from these discarded items that may be directly linked to the perpetrators. While it is possible to recover DNA from touched items, genotyping success using STRs can be negatively affected by low quantities of DNA (2). In addition, DNA obtained from swabbing touched items may not be processed quickly and have to be stored. Long term storage of these swabs can cause DNA to degrade and negatively affect the genotyping quality.

Therefore, this study examines the efficacy of a novel, room-temperature, storage device, the SwabSaver®(Fast Forward Forensics, LLC), to preserve biological samples for later testing over other room-temperature storage methods. The efficiency of the SwabSaver® to preserve DNA at room-temperature was tested against storing the swabs in microcentrifuge tubes. Three different collection devices were also examined (traditional cotton, cotton paper, and nylon flocked swabs), and swabs were stored at three different time intervals: no storage (time zero), one month and two months. Furthermore, aluminum and plastic polymer AR-16 magazines were used to examine differences in obtaining touch DNA from common substrates. All collections were performed in triplicate.

SwabSaver® Device

- The SwabSaver® is a device was designed for long-term room-temperature storage of swabs with biological materials.
- It is made of polypropylene plastic and contains a desiccant to absorb moisture and dry swabs within 24 hrs, therefore reducing the risk of DNA degradation.
- Swabs can also be broken off easily into the device to reduce the risk of contamination.

RESULTS

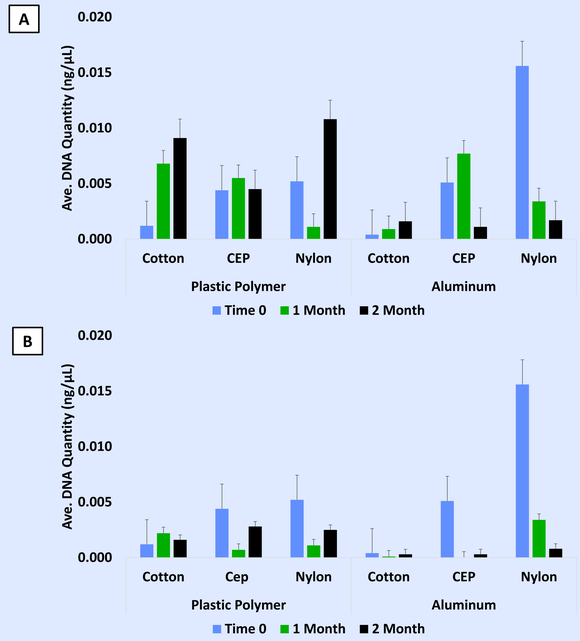

Figure 1. Autosomal quantification data for all swab types and storage time points stored in SwabSaver® devices **(A)** and centrifuge tubes **(B).** Error bars represent standard error.

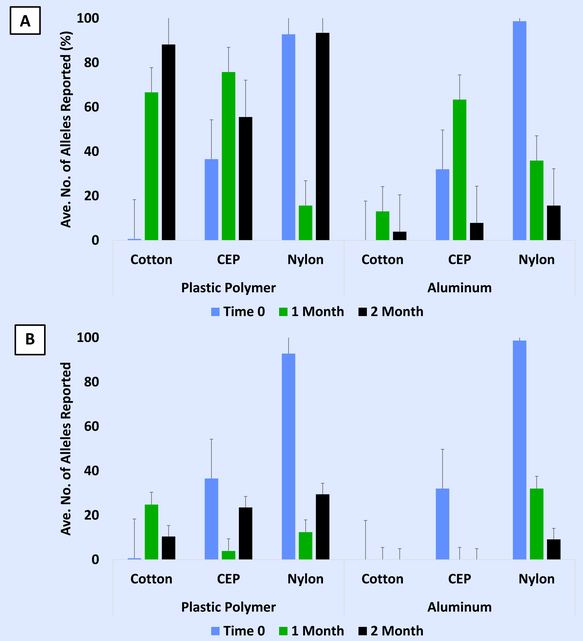

Figure 2. Average percent of alleles reported for all swab types and storage time time points stored in SwabSavers **(A)** centrifuge tubes **(B)**. Error bars represent standard error.

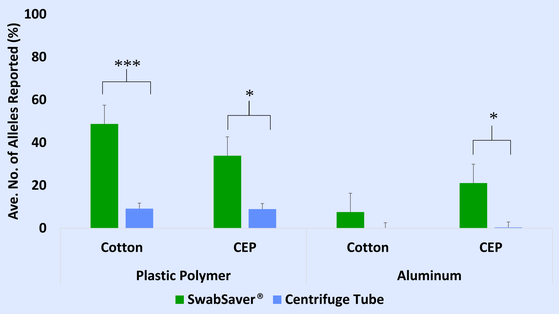

Figure 3. Combined percentage of allele calls for both participants. Significant differences were found between SwabSaver and centrifuge tube storage for cotton ($p < 0.001$) and CEP ($p < 0.05$) swabs on plastic polymer magazines, and between SwabSaver® and centrifuge tube storage for CEP swabs ($p < 0.05$) on aluminum magazines. Error bars represent standard error.

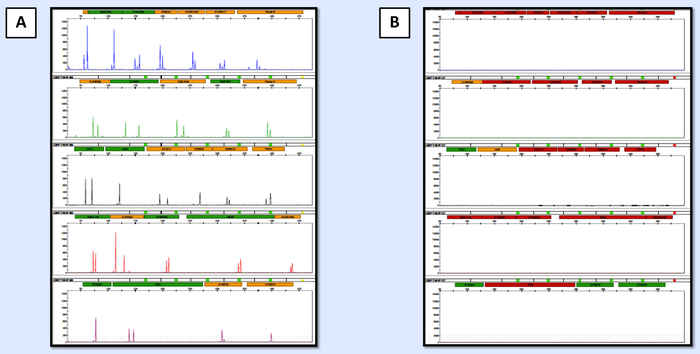

Figure 4. Example of one CEP swab replicate stored for 1 month in a SwabSaver® (**A**) and in a centrifuge tube (**B**). The DNA quantities for these samples are 0.0069 ng/µL and 0.0012 ng/µL, respectively.

CONCLUSIONS

- Regardless of the swab and substrate type, DNA obtained at time zero was variable within and between participants.
- DNA quantities on traditional cotton swabs were most impacted by storage time ($p < 0.001$) and magazine substrate type ($p < 0.001$), whereas CEP swabs were mostly effected by the storage device ($p < 0.01$).
- DNA quantities on nylon flocked swabs were significantly impacted by the magazine substrate and the amount of time stored ($p < 0.05$) for one donor only.
- A noticeable trend for higher DNA quantities and number of alleles reported with swabs stored in the SwabSaver® device was observed.
- One instance of contamination was observed, although a contributor or contributors could not be identified.
- However, the magazine substrate, swab, and storage device collectively affected the overall success of recovering and genotyping the touch DNA samples.

MATERIALS AND METHODS

- Participants (N = 2) rubbed their hands together for 10 s to evenly distribute epithelial cells across both palms (IRB # 2016-11-32804).
- Twenty cartridges were loaded into into each magazine (N = 3 per substrate type).
- Magazines were swabbed with one of three collection devices using a double-swab technique: 1) traditional cotton swabs (Puritan® Medical Products), 2) CEP cotton paper swabs (Fitzco®, Inc.), and 3) nylon flocked swabs (Copan Diagnostics Inc.).
- Swabs were dried for a minimum of an hour and were either extracted immediately (time zero), or stored at room temperature for one or two months in either the SwabSaver® or a 1.5 mL microcentrifuge tube.
- DNA from the swabs were extracted using the QIAamp® DNA Investigator kit on the QIAcube (Qiagen) using the "swab and surface protocol" and eluted in 60 µL.
- DNA extracts were quantified using the PowerQuant® System and assessed using the PowerQuant® Analysis Tool v. 1.0.0. (Promega)
- DNA extracts were amplified using the PowerPlex® Fusion 6C kit (Promega). The maximum input of 15 µL was added to each PCR reaction.
- STR data was analyzed using GeneMapper ID-X v 1.4 (Thermo Fisher Scientific) with an analytical threshold of 175 RFUs and stochastic threshold of 400 RFUs.
- ANOVA and t-tests were used to determine statistical significance.

REFERENCES

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2. K.M. Horsman-Hall, Y. Orihuela, S.L. Karczynski, A.L. Davis, J.D. Ban, S.A. Greenspoon, Development of STR profiles from firearms and fired cartridge cases, Forensic Sci. Int. Genet. 3 (4) (2009) 242–250.

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