Recovery of touch DNA: a comparison of four collection methods on various substrates

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Introduction

Globally, human trafficking presents itself as an ever-growing issue. Often the individuals subjected to this are forced into the manufacturing industry, and commonly, they are children.

It is well established that when a person comes in contact with an object, epithelial skin cells are transferred from person to surface in varying amounts. Therefore, it can be suggested that victims of forced child labor inadvertently shed their epithelial skin cells onto the items they are manufacturing. These cells can then be recovered from protected interior surfaces where only the person manufacturing the item would have touched.

DNA isolated from shed cells is commonly known as touch DNA. Donor age estimation of touch DNA samples is currently being researched using DNA methylation analysis and shows great promise. The ability to estimate the age of a donor of shed cells on manufactured goods will allow investigators to expose companies using illegal child labor. However, in the steps prior to estimating age, it is crucial to choose a collection method that optimizes the recovery of as many shed cells as possible.

There are several methods currently employed for touch DNA collection within accredited crime laboratories, including the wet/dry double swab method and the mini-taping method.[1,2] However, there is no globally accepted standard for recovery from different substrates. An extensive search of published literature revealed a wet/dry double swab method, a sodium dodecyl sulfate (SDS) swab method[3], and a mini-taping method to yield the most consistently high quantities of touch DNA. More recently, a novel gel film was suggested as an ideal method for touch DNA collection, with the added benefit of visualizing the cells microscopically on the gel surface prior to extraction.[4]

Research Aim

- To investigate the wet/dry double swab, SDS swab, mini-tape, and gel film methods for efficient recovery of shed cells (touch DNA) from a variety of substrates.

Materials and Methods

Following ethical approval from the Institutional Review Board (IRB), with informed written consent, one volunteer was selected to deposit touch DNA on all samples to ensure consistency. All samples were performed in triplicate and included a blank control, thereby resulting in 128 samples.

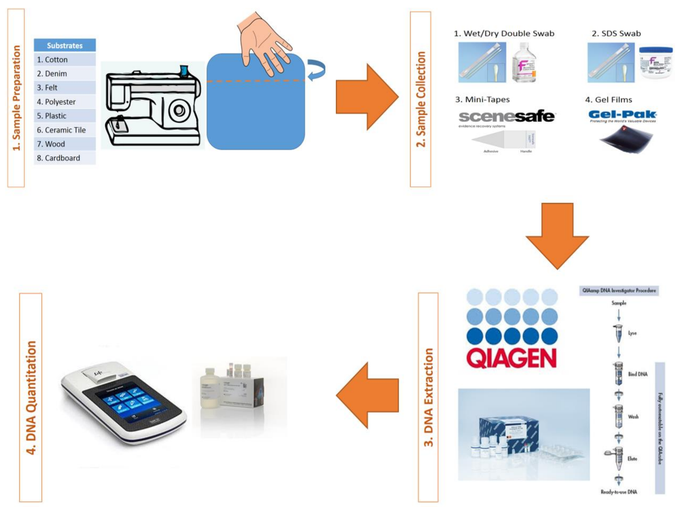

Figure 1. Flow chart of research process

Results

Varying DNA yields were obtained from all surfaces with each collection method. The gel film yields ranged from 0-.180 ng/µL. The wet/dry double swab method yields ranged from 0-2.68 ng/µL. The SDS swab method yields ranged from 0-0.134 ng/µL. The mini-taping yields ranged from 0-.188 ng/µL. On the fabric samples, the mini-tapes appeared to produce the most consistently high yields of DNA. On the other surfaces, the wet/dry double swab method appeared to produce the most consistently high yields of DNA.

Table 1. Average concentration (in ng/µL) of DNA recovered for each substrate

	Cotton	Denim	Felt	Polyester	Plastic	Tile	Cardboard	Wood
Gel films	0.035	.044	.034	.139	0	0	.060	0
Double swab	.316	.205	0	.128	.221	2.093	.443	1.003
SDS swab	.143	.080	0	.038	.036	.041	.039	0
Minitape	.075	.139	.085	.201	0	.047	.074	.122

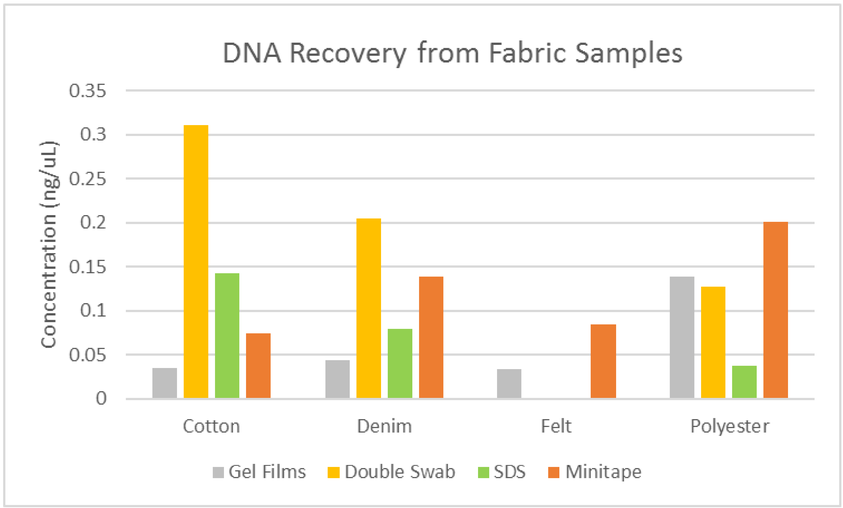

Figure 2. Results obtained from touch DNA collection off of fabric samples

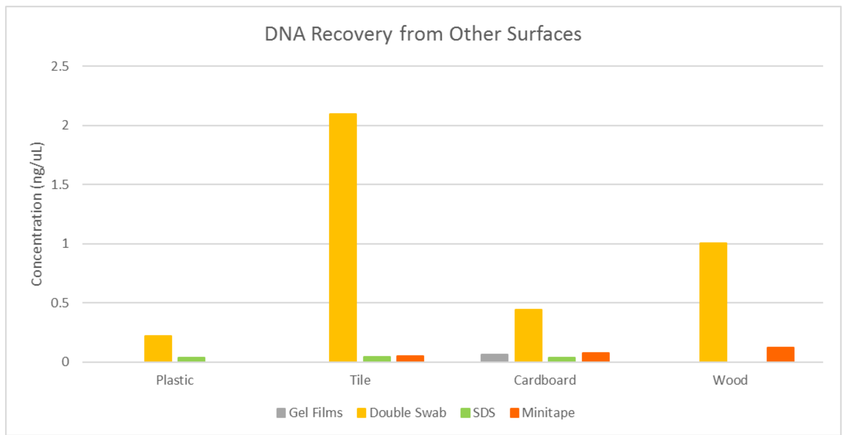

Figure 3. Results obtained from touch DNA collection off of other surfaces

Discussion

The results of this study show the wide range of yields which can be recovered from a variety of substrates, using different methods. The results support that the mini-taping method provides higher yields of DNA on fabric samples. Though the wet/dry double swab appears to recover a larger quantity of DNA on cotton and denim samples, it is still suggested to use the mini-taping method for ease of use and consistency. As for the other surfaces, the wet/dry double swab method provides consistently higher yields of DNA.

Potential sources of variation for amounts of DNA collected can include shedder status of an individual, area of collection, and physical collection process. Even though the same individual was responsible for depositing cells on all samples, there can still be variations based on other factors. For example, the time of day at which the samples were deposited and what the individual's routine was prior to deposition could affect the amount of touch DNA left behind. Another factor could be lab conditions, such as humidity at the time of deposition.

Different methods for collecting touch DNA are currently utilized in forensic laboratories worldwide as there is no standardized approach. In the U.S., labs typically use the double swab method for all surfaces. In contrast, labs outside of the U.S. often use the mini-taping method for textiles and the wet/dry double swab method for non-porous surfaces. The results of this research suggest making the mini-taping method the universal method for textiles and the wet/dry double swab method the universal method for other surfaces, due to the yields obtained.

Conclusions

The results of this study provide a valuable contribution to the forensic science industry by highlighting optimal touch DNA collection methods for particular surfaces. It can be suggested to use the mini-taping method for processing of touch DNA evidence on fabric substrates and the wet/dry double swabbing method for processing of touch DNA evidence on other surfaces. Additionally, this research contributes to the ongoing efforts for age-estimation of touch DNA samples to combat forced child labor.

Further Research

- Collection of known quantities of DNA or cells off of surfaces to account for loss of DNA during recovery
- Optimization of extraction methods based on each collection method
- STR profiling of a representative set of samples

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