Detecting DNA in Magnetic Fingerprinting Powder

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Abstract

Deoxyribonucleic acid (DNA) is found amongst all living organisms. Organisms' DNA are unique to themselves. In many cases, fingerprints are deposited at crime scenes. Often with a fingerprint, the investigators are unable to determine the suspect. Due to the advancement in technology, DNA can be quantified, amplified, and analyzed from the fingerprint residue and then utilized in court.Because of the improvements in DNA recovered, it can be found fingerprints, and the ease at which contamination can occur when fingerprinting at a crime scene, raises the concern of improper identification of the DNA. Numerous crime scene investigators utilize the same fingerprinting powder and brush or wand every time they try to develop a print. The only changing variable is the tape used to collect the developed impression. Previous work has been cited examining DNA contamination of fingerprint brushes. No previous study before this looked at the magnetic wands, used to apply magnetic fingerprint powders, for their possible contamination influence.

Introduction

A major aspect of forensic science entails the concept of DNA, known as the genetic code. This code is generally unique to an individual, thus DNA is a method to differentiate one person to another through individualizing characteristics. When discovering minute amounts of DNA, it must be quantitated to determine if DNA is present and the amount present. Once located, the DNA must be amplified. Amplification means to multiply a specific amount of DNA in order to obtain a successful profile. With the advancement of technology, DNA can be extracted from friction ridge impressions. Analyzing DNA is the last step, where STRs are examined to note the similarities and differences.

Friction ridge impressions are two dimension images on a surface formed by contact from the friction ridges on the inner surfaces of digits and palmar surfaces of the hands and digits and soles of the foot[1]. They are unique to an individual and do not change over time. There are three major types of fingerprint patterns: loop, whorl, and arch. Within these categories Three different types of print: patent, plastic, and latent, can exist. Patent prints are visible and recognizable without enhancements or development. Plastic prints are visible 3-D images of the fingerprint. Latent prints cannot be seen by the naked eye until they are enhanced[1].

The most common method utilized to enhance latent friction ridges on a nonporous surface is to use powder to dust the suspected are[1]. This method involves using standard powder with a brush or magnetic powder with a magnetic wand. When using the black or white powder, powder adheres to the filaments of a brush and is gently brushed on the surface until the examiner sees a visible print. The excess powder is gently swept away. Investigators then photograph and lift the developed impression. A similar concept applies when using magnetic powder. the excess magnetic powder is then picked up by a magnetic wand and placed back into the container with the magnetic powder.[2]

Magnetic powder, consisting of iron particles, works in combination with a magnetic wand.[3] Typically, the wand consists of a hollow tube with a magnet at the end of a rod. Pushing the rod down into the hollow tube engages the magnet to attract iron particles and pulling the rod up from the hollow tube will release the iron particles as there is no magnetic attraction at the end of the tube.[3] The magnetic powder stays on the latent print and the magnetic wand is then used to sweep the developed impression removing excess powder.

Methods

Subject one thoroughly washed their hands with soap and water. Once dry, physical exercise was performed to produce sweat and was conducted by rubbing hands together as vigorously as possible for one minute and thirty seconds, resting two minutes, then rubbing the fingers over the Subject's forehead, and deposited the print onto the glass slide by placing the index finger on the flat broad side of the slide. The latent print was then enhanced by gently brushing magnetic powder with the magnetic wand. The excess magnetic powder was placed into a one and a half mL flip top centrifuge tube. Subject one was the control. The same process was repeated for subject two, but a new plastic wand cover was replaced to prevent contamination. Subject three's hands were thoroughly washed with soap and water. The depositing of the latent impression followed identical to that of subject one. Reusing the powder from subject two enhanced the latent print. The excess powder was gathered and replaced into the same tube.

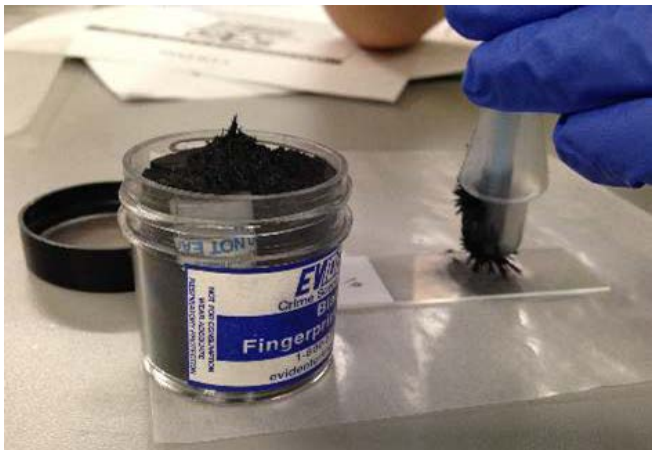

Figure 1: Gently brushing the magnetic powder over the deposited fingerprint residue.

Figure 2: The deposited patent fingerprint residue with the enhancement of magnetic fingerprinting powder.

Using a sterile one and a half mL flip top test tube, approximately 100 mg of magnetic powder from the original tube was weighed and placed into the sterile tube. Three hundred sixty µl of Buffer ATL and twenty µl of proteinase K was added to the centrifuge tube and it incubated at fifty-seven degrees C overnight. The tube was then briefly centrifuged. Three hundred µl of Buffer AL was added and vortex for ten seconds. The tube was heated in an orbital incubator at seventy degrees C with agitation at nine hundred rpm for ten minutes. The tube was centrifuged at fourteen thousand rmp for one minute. The supernatant was transferred to a new one point four mL microcentrifuge tube. One-hundred fifty µl ethanol was added and vortex for fifteen seconds centrifuged. The lysate was transferred to a QIAamp MinElute column without wetting the rim and centrifuged at eight thousand rpm for one minute. The QIAamp MinElute column was placed in a clean two mL collection tube. The QIAamp MinElute column was opened and six hundred µl buffer AW1 added without wetting the rim and centrifuged at eight thousand rpm for one minute. The QIAamp MinElute column was placed in a clean two mL collection tube, the flow- through discarded. The column was opened and seven hundred µl buffer AW2 added without wetting the rim and centrifuged at eight thousand rpm for one minute. A clean QIAamp MinElute column was placed in a clean two mL collection tube, and flow-through discarded. Seven hundred µl of ethanol was added without wetting the rim and centrifuged at eight thousand rpm for one minute. The QIAamp MinElute column was placed in a clean two mL collection tube, and the flow through discarded. The tube was centrifuged at fourteen thousand rpm for three minutes. The QIAamp MinElute column was placed in a clean one and a half mL microcentrifuge tube and the flow through discarded. The lid of the QIAamp MinElute column was opened and incubated at fifty-six degrees C for three minutes. Fifty µl of Buffer ATE was added to the center of the membrane and incubated one minute at room temperature and centrifuged at fourteen thousand rpm for one minute. [4]

Quantitation was performed using the Promega Kit to include a ladder to observe a standard curve. The standard curve was made by using dilutions with micropipettes and amplified to determine if DNA was present.

Results and Discussion

After fingerprinting the subjects, quantitation helped determine the amount of DNA present in the magnetic fingerprinting powder. The results concluded that DNA could not be detected. Therefore, not enough DNA was present in the magnetic fingerprinting powder for the 7500 Applied Biosystems Real-Time PCR to detect it. An allelic ladder was made to use as standard to ensure the primer and master mixed used was working properly. The standard curve did not give an ideal correlation, but $R = 0.98$, which is relatively still close to $R = 1$. This idea was further supported when amplification of the samples were performed. DNA could not be detected in the amplification process. Amplification means to copy the same DNA sequence numerous times in order for a scientist to analyze a small quantity of DNA.

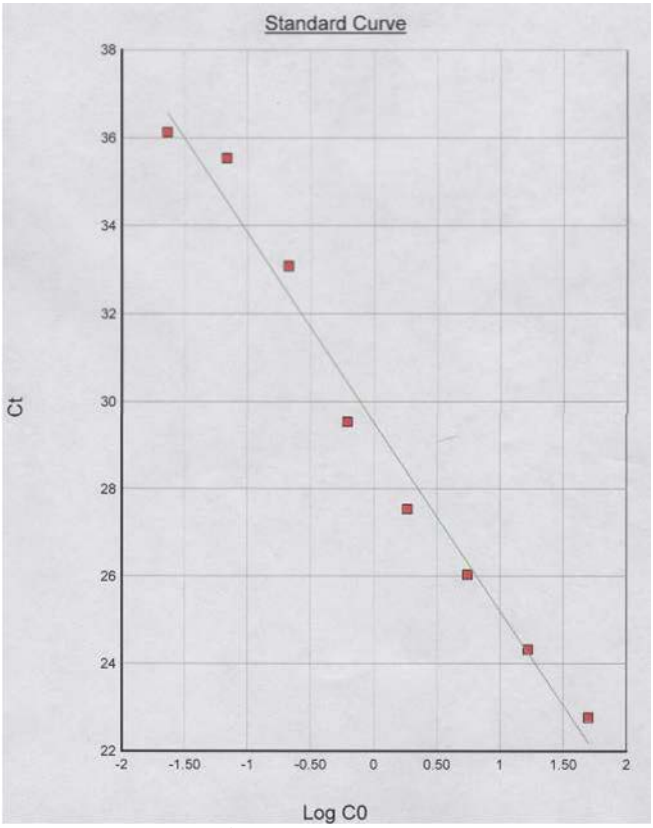

Figure 3: Standard Curve from allelic ladder

Well	Sample Name	Detector	Task	Ct	Qty
A1	POS	Human	Unknown	13.95	4012.77
		IPC	Unknown	29.99	
A3	50	Human	Standard	22.77	50.00
		IPC	Unknown	31.79	
B1	NEG	Human	Unknown	Undet.	
		IPC	Unknown	28.36	
B3	16.67	Human	Standard	24.32	16.67
		IPC	Unknown	29.03	
C1	1	Human	Unknown	Undet.	
		IPC	Unknown	28.24	
C3	5.56	Human	Standard	26.03	5.56
		IPC	Unknown	28.17	
D1	2	Human	Unknown	Undet.	
		IPC	Unknown	28.29	
D3	1.85	Human	Standard	27.54	1.85
		IPC	Unknown	28.06	
E1	3	Human	Unknown	Undet.	
		IPC	Unknown	28.36	
E3	0.62	Human	Standard	29.53	6.20e-001
		IPC	Unknown	28.09	
F3	0.21	Human	Standard	33.09	2.10e-001
		IPC	Unknown	28.14	
G3	0.068	Human	Standard	35.54	6.80e-002
		IPC	Unknown	28.24	
H3	0.023	Human	Standard	36.13	2.30e-002
		IPC	Unknown	28.32	

Figure 4: Results from the quantitation when using the 7500 Applied Biosystems Real Time PCR.

There are possible reasons behind why DNA could not be detected. Only two subjects were used to contaminate the magnetic fingerprinting powder. As oppose to a typical a jar of magnetic powder used at a crime scene, which has been used over hundreds of times, indicating that more epithelial cells are shed. The epithelial cells contain the DNA and without the cells, DNA cannot be detected. Thus to further this experiment, more subjects should be used to contaminate the magnetic powder to test for the presence of epithelial cells to find DNA.

Another issue regarding the experiment could have occurred during quantitation. The 7500 Applied Biosystems Real-Time PCR could not detect the DNA, but there might not have been enough DNA sample in the solution. 17.5 µl of DNA sample was used and 7.5 µl of the MasterMix was used as a dilution factor, these numbers from a reference experiment that also had minimal amount of DNA detection. In other words, if the amount of DNA sample was increased, it may also increase the chance that DNA could be detected.

Further experiments can be conducted to from another perspective to illustrate whether or not DNA contamination does exist. It is known that scientist have prosecuted suspects using fingerprint residues; therefore another method must be used to determine a way to be able to detect this extremely minute DNA. For this particular experiment, it was difficult to find a protocol to extract DNA from the magnetic fingerprinting powders because not many scientists have conducted an experiment similar to this particular one. Instead, the protocol was derived from extracting DNA from bone because they both contain the consistency of a fine powder, therefore extracting DNA from cells should not have been an issue. Overall, by finding a new protocol to extract DNA, there still could be a possible chance that DNA contamination does exist in the magnetic fingerprinting powder.

Conclusion

It was determined that even though scientists are able to detect DNA from fingerprint residues, the amount of DNA was not sufficient enough to be detected. Therefore this experiment supported the idea that DNA contamination does not exists in magnetic fingerprinting powder.

References

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Biography

Kelly Zhao is a senior majoring in Forensic Science and Biotechnology. Upon graduation, she anticipates to pursue further education in Cancer Biology to receive her Ph.D. She works for the Office of Residential Life as a Resident Assistant. She is a part of the Alpha Lamba Delta Honors Society, Forensic Science and Chemistry Club, American Chemistry Society, and ChargerTHON.