The Effectiveness of Common Fingerprint Techniques to Visualize Latent Fingerprints on Tim Horton’s Cups

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Abstract: Tim Horton’s cups are commonly found at crime scenes, but are not usually collected for fingerprint analysis, as there has been no previous research on visualizing fingerprints on Tim Horton’s cups. The effectiveness of common fingerprint techniques, black magnetic powder, fluorescent magnetic powder, 2,2-Dihydroxyindane-1,3-dione (Ninhydrin), 1,2-Indanedione, and 1,8-Diazafluoren-9-one (DFO), was evaluated in this study using alternate light sources to visualize latent fingerprints on Tim Horton’s cups after 24 hours of being laid. Magnetic powder, Ninhydrin, and Indanedione were not found to be effective methods to visualize fingerprints on Tim Horton’s cups. Fluorescent powder developed low quality visible prints. Whereas, DFO developed the highest quality fingerprints on most areas on cup.

Keywords: black magnetic powder, DFO, fluorescent magnetic powder, Indanedione, Ninhydrin,

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Introduction

Tim Horton’s is a popular brand in Canada and their cups have been left at various crime scenes, though not collected to be analyzed for fingerprints by many investigators. There has been no previous research to determine which fingerprint method is best to visualize and analyze fingerprints left on Tim Horton’s cups. These cups are unique due to the fact that they are multi colored and depending on the time of year the cup design changes, as well as the inner surface of the cup is a waxy material. Our goal was to determine which, if any, common fingerprint methods show the best results, to create awareness and encourage investigators to collect these cups, which will allow them to have another surface to investigate. If prints are found on the cup, and there is a match, the individual will have to explain why their prints were present on the cup and why the cup was located at the crime scene.

Five common fingerprint techniques will be tested on Tim Horton’s cups; DFO (1,8-Diazafluoren-9-one), Ninhydrin (2,2-Dihydroxyindane-1,3-dione), Indanedione (1,2-Indanedione), black magnetic powder and fluorescent magnetic powder. Alternate light sources will be used to enhance the prints; UV, and five different wavelengths; 415nm, 450nm, 505nm, 530nm, 545nm, along with red, orange, and yellow goggles.

Every individual has a unique fingerprint, due to the ridge detail, which allows investigators to use this as a tool in identifying people. There are two common fingerprint types, latent and patent. Latent prints are invisible and need an alternate light source to visualize the print, such as fingerprint powders, chemical reagents, or alternative light sources\(^1\). Patent prints are prints that are visible and are formed when the impression is made in blood, dirt, ink, paint, etc\(^1\). Forensic investigators use an ACE-V (analysis, comparison, evaluation, and verification) method for identification of fingerprints\(^2\). Analysis is used to examine the document and prints\(^3\). Comparison is when the examiner finds features in the unknown prints and the known prints separately\(^3\). Evaluation is when the examiner compares the unknown print to the known print and determines whether there is an identification, exclusion, or if it is inconclusive\(^3\). Verification is when a second qualified expert repeats the process to come up with their own identification, exclusion, or determines if it is inconclusive\(^3\).

DFO is a chemical that reacts with amino acids present in the fingerprint impression to create a red-coloured visible product\(^4\). To create maximum fingerprint development the object is heated, for an example in an oven, at 200\(^\circ\)F. Since DFO is usually used before Ninhydrin, it is believed that DFO does not react will all types of amino acids, which allows Ninhydrin to produce further results\(^4\). DFO is used on porous surfaces, such as paper or unpainted wood\(^5\).

Ninhydrin is another chemical that reacts with amino acids that are present in the fingerprint impression, but forms an intense purple called Ruhemann’s purple\(^4\). To make sure the
fingerprint is at its maximum development, the object is heated in an oven, with water present to create humidity, at 200°F. This process is also used on porous surfaces, such as paper or unpainted wood.

Indanedione reacts with amino acids and is considered a substitute for DFO, as in some tests it produces a more detailed fingerprint impression. It is also used on porous surfaces and produces a pale pink colour when treated and placed in an oven at 200°F for at least 10 minutes.

Magnetic powders can be used on porous or non-porous substances, such as rubber, Styrofoam and plastics. Using a magnetic wand, the iron filaments connect with the oily residues that are left on the surface of the object to create a visible print. Fluorescent magnetic powder is typically used on multicoloured, textured, and non-porous surfaces. UV light or an alternate light source should be used when viewing the results for fluorescent powders.

In the present research prints were left on the Tim Horton’s cups for 24 hours to be analyzed during this experiment to see if these chemicals will work for “fresh” prints. Three individuals placed three prints (strong, medium, weak) to be processed by three chemicals (DFO, Ninhydrin, and Indanedione) and two powders (black magnetic and fluorescent magnetic) then photographed.

Materials

- 20 Large Tim Horton’s Cups
- DFO HFE-7100 Solution (spray)
- Ninhydrin (spray)
- 1,2-Indanedione (spray)
- Black Magnetic Fingerprint Powder
- Magnetic Brush x2
- Fluorescent Magnetic Fingerprint Powder
- Fingerprint scales
- Printer Paper
- Flashlights of different wavelengths (UV, 415nm, 450nm, 505nm, 530nm, 545nm)
- Goggles (Red, orange, yellow)
- Scalpel
- Fingerprint pencil (black)
- Black Permanent Marker
- Digital Camera- Nikon D300 DSLR
- Computer

Methods
Five methods will be discussed to correspond with the five different chemicals/powders that we used; to compare DFO to Ninhydrin two cups will have their fingerprints cut in half, DFO and Ninhydrin (as Forensic Identification Officers would normally do), Indanedione, magnetic powder, and fluorescent magnetic powder. Before the chemicals are used the three subjects must lay three fingerprints (strong, medium, weak) down on the 10 cups, which have labelled sections with the subject’s initials. These three impressions are to show the results of different oil compositions that could be laid. For example, a person with a very “sweaty” fingerprint impression may be smudged, or have little to no ridge detail in the print. The deposition force and the time the print makes contact with the cup should be as consistent as possible. 24 hours after the prints have been laid, they were processed with their respective chemicals. Two cups were used for each chemical, while the overall experiment was replicated once. In order to show realistic results, we used prints from groomed, sweaty and natural prints. Groomed prints were used from our sebaceous glands, sweaty were from keeping hands in non-latex gloves, and natural were as prints are. For the first trial Melinda’s prints were the groomed prints, Steve’s prints were natural prints, and Brooke’s prints were sweaty prints. For the second trial Melinda’s prints were sweaty prints, Steve’s prints were the groomed prints, and Brooke’s prints were natural prints.

Comparing DFO to Ninhydrin (D/N)

1. Divided the cup into three sections by labelling the top with the initials of the three subjects
2. Placed three circles in each section (9 on each cup)
3. Each subject touched the cup three times in the designated areas
4. Cups were stored in a closed box for 24 hours
5. After 24 hours, the cups were taken out of the box
6. Cut the fingerprint impressions in half by cutting the cup into 4 sections, as shown in Figure 1

![Figure 1: Diagram of D/N Cup](image-url)
7. Divided and labeled the sections- For the First cup (Cup A) into 4 sections- 1,2,3,4 and the second cup (Cup B) into 4 sections- 1,2,3,4; 1B, 3B, 2A, 4A were processed with DFO and 1A, 3A, 2B, 4B were processed with Ninhydrin
8. Using proper personal protection equipment (PPE) we sprayed the designated strips and test papers with DFO and the others with Ninhydrin, twice
9. Placed the DFO strips and test paper into an oven at 200°F for 20 minutes
10. Let the DFO strips and test paper sit for 24 hours, by placing them in a closed box
11. Place the Ninhydrin strips and test paper into an oven with a cup of water (to produce humidity) at 200°F for 20 minutes
12. Let the Ninhydrin strips and test paper sit for 24 hours, by placing them in a closed box
13. After 24 hours we looked at the test paper and determined the wavelength and goggles that produced the best result; DFO- 505nm with orange goggles, Ninhydrin- 450nm with yellow goggles
14. Photographed all results and enhanced any visible prints that show using Photoshop CS6

**DFO then Ninhydrin (D-N)**

1. Divided the cup into three sections by labelling the top with the initials of the subjects
2. Each subject touched the cup three times in the designated areas
3. Cups stored in a closed box for 24 hours
4. After 24 hours, we took the cups out of the box
5. Using proper PPE, sprayed the two cups with DFO, twice
6. Placed cups in oven at 200°F for 20 minutes
7. Allowed the cups to cool
8. Using proper PPE, sprayed the two cups with Ninhydrin, twice
9. Placed in oven with a cup of water at 200°F for 20 minutes
10. Allowed the cups to sit for 24 hours
11. Determined which wavelength and goggles produces the best results which was 450nm with red goggles
12. Photographed all results and enhanced any visible prints using Photoshop CS6

**Indanedione (I)**

1. Divided the cup into three sections by labelling the top with the initials of the subjects
2. Each subject touched the cup three times in the designated areas
3. Cups stored in a closed box for 24 hours
4. After 24 hours, took the cups out of the box
5. Using proper PPE, sprayed the two cups with Indanedione, twice
6. Placed cups in oven at 200°F for 20 minutes
7. Allowed the cups to sit for 24 hours
8. Determined which wavelength and goggles produces the best results; 505nm with orange goggles
9. Photographed all results and enhanced any visible prints using Photoshop CS6

**Magnetic Powder**

1. Divided the cup into three sections by labelling the top with the initials of the subjects
2. Each subject touched the cup three times in the designated areas
3. Cups stored in a closed box for 24 hours
4. After 24 hours, took the cups out of the box
5. Using proper PPE, dusted the two cups with a magnetic brush
6. Allowed the cups to sit for 24 hours
7. Analyzed the prints with the naked eye
8. Photographed all results and enhanced any visible prints using Photoshop CS6

**Fluorescent Magnetic Powder**

1. Divided the cup into three sections by labelling the top with the initials of the subjects
2. Each subject touched the cup three times in the designated areas
3. Cups stored in a closed box for 24 hours
4. After 24 hours, took the cups out of the box
5. Using proper PPE, dusted the two cups with a magnetic brush
6. Allowed the cups to sit for 24 hours
7. Determined which wavelength and goggles produces the best results; 450nm with yellow goggles
8. Photographed all results and enhanced any visible prints using Photoshop CS6

To further show how the prints were laid for each method refer to Figure 2.
### Method 1 | Method 2 | Method 3 | Method 4 | Method 5
---|---|---|---|---
D | N | D-N | I | M | F
Steve-Strong | Steve-Strong | Steve-Strong | Steve-Strong | Steve-Strong | Steve-Strong
Steve-Medium | Steve-Medium | Steve-Medium | Steve-Medium | Steve-Medium | Steve-Medium
Steve-Weak | Steve-Weak | Steve-Weak | Steve-Weak | Steve-Weak | Steve-Weak
Brooke-Strong | Brooke-Strong | Brooke-Strong | Brooke-Strong | Brooke-Strong | Brooke-Strong
Brooke-Medium | Brooke-Medium | Brooke-Medium | Brooke-Medium | Brooke-Medium
Brooke-Weak | Brooke-Weak | Brooke-Weak | Brooke-Weak | Brooke-Weak | Brooke-Weak
Melinda-Strong | Melinda-Strong | Melinda-Strong | Melinda-Strong | Melinda-Strong | Melinda-Strong
Melinda-Medium | Melinda-Medium | Melinda-Medium | Melinda-Medium | Melinda-Medium | Melinda-Medium
Melinda-Weak | Melinda-Weak | Melinda-Weak | Melinda-Weak | Melinda-Weak | Melinda-Weak

*Figure 2: Table of how the prints were laid on each cup for all methods.*

**Results & Discussion**

*Trial 1:*

1) Magnetic Powder:
   a. Cup 1: strong, medium, and weak groomed prints were visible, though no ridge detail was observed, as shown in Figure 3. No prints were observed for sweaty or natural prints on this cup.
   b. Cup 2: no indication of visible prints on groomed, sweaty, or natural prints on this cup.
Figure 3: Trial 1 Cup 1 Magnetic powder method showing all three of groomed prints laid by Melinda.

2) Fluorescent Powder (using yellow goggles and 450nm wavelength):
   a. Cup 1: strong, medium, and weak groomed prints were visible with a little ridge detail visible, as shown in Figure 4. No sweaty or natural prints were detected on this cup.
   b. Cup 2: no indication of groomed, sweaty, or natural visible prints.

Figure 4: Trial 1 Cup 1 Fluorescent powder method showing all three prints for groomed prints laid by Melinda.

3) Indanedione (using orange goggles and 505nm wavelength):
   a. Cup 1: strong sweaty print visible, though no ridge detail was observed, as shown in Figure 5. No other sweaty, groomed, or natural prints were detected on this cup.
   b. Cup 2: no indication of groomed, sweaty, or natural visible prints.
Figure 5: Trial 1 Cup 1 Indanedione method showing a strong sweaty print laid by Brooke.

4) DFO-NIN (using red goggles and 450nm wavelength):
   a. Cup 1: strong, medium, and weak groomed prints visible. Weak groomed prints showed high level of ridge detail, as shown in Figure 6. Strong, medium, and weak sweaty prints were visible, though little to no ridge detail present. No natural visible prints.
   b. Cup 2: no indication of groomed, sweaty, or natural visible prints.

Figure 6: Trial 1 Cup 1 DFO-NIN method showing ridge detail in the weak groomed print (left) laid by Melinda in comparison to the enhanced print (right) using Photoshop CS6.

5) DFO/NIN (using orange goggles and 505nm wavelength and yellow goggles and 450nm wavelength, respectively):
   a. Cup 1: Strong sweaty print with minimal ridge detail, using orange goggles and 505nm wavelength. No other sweaty, groomed, or natural prints were visible.
   b. Cup 2: Strong sweaty print with high ridge detail, using orange goggles and 505nm wavelength, as shown in Figure 7. No other sweaty, groomed, or natural prints were visible.
Trial 2:
1) Magnetic Powder:
   a) Cup 1: no indication of groomed, sweaty, or natural visible prints.
   b) Cup 2: strong, medium, and weak groomed prints, with strong and weak having ridge detail visible. No sweaty or natural prints visible.

2) Fluorescent Powder (using yellow goggles and 450nm wavelength):
   a ) Cup 1: strong, medium, and weak groomed prints visible with little ridge detail. No sweaty or natural prints visible.
   b ) Cup 2: strong and medium sweaty prints visible with minimal ridge detail. Strong, medium, and weak groomed prints visible with ridge detail, with medium groomed prints shown in Figure 9. No natural visible prints.
3) **Indanedione** (using orange goggles and 505nm wavelength):
   a) Cup 1: no indication of groomed, sweaty, or natural visible prints, as seen in Figure 10.
   b) Cup 2: no indication of groomed, sweaty, or natural visible prints.

4) **DFO-NIN** (using yellow goggles and 505nm wavelength and orange goggles and 505nm wavelength, respectively):
   a) Cup 1: no indication of groomed, sweaty, or natural visible prints, as seen in Figure 11.
   b) Cup 2: no indication of groomed, sweaty, or natural visible prints.
Figure 11: Trial 2 Cup 1 showing no indication of prints for DFO-NIN method.

5) DFO/NIN (using orange goggles and 505nm wavelength and yellow goggles and 505nm wavelength, respectively):
   a) Cup 1: no indication of groomed, sweaty, or natural visible prints, as seen in Figure 12.
   b) Cup 2: no indication of groomed, sweaty, or natural visible prints.

Figure 12: Trial 2 Cup 1 DFO/NIN method showing no indication of prints.

Further research needs to be conducted to determine a better way to lay the fingerprints down, so that not all the oils in the prints are used up right away, as well as making the circles smaller to lay the prints in, so that the cut will be more directly in the middle of the prints. Interference of prints from employees of Tim Horton’s did not seem to be a factor while this research was conducted. Deposition force and time should continue to be taken into consideration while research is being conducted. A combination of methods could be used to produce results, such as with DFO in the areas which lacked results, due to the high intensity of colour.
Conclusion

In conclusion, DFO showed the most ridge detail on Tim Horton’s cups in the first trial, though no prints were visible in the second trial. Fluorescent powder was the next promising method, followed by magnetic powder. Indanedione and Ninhydrin did not produce any visible prints during both trials.

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References


