Simple improvement in latent fingerprint detection with Ninhydrin/water glue on thermal paper

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Abstract. Thermal paper is a special type of paper that is coated with chemicals on the paper layer to change color when exposed to heat. When discovering fingerprints by using chemical reagents such as ninhydrin solution with thermal paper, it shows black staining background on the heat-sensitive front side. Thus, the latent fingerprints cannot be discovered. In this study, we have reported the first utilization of ninhydrin with water glue in different ratios for the development of latent fingerprints on the thermal papers. The results showed that at 0.020-0.060 g/mL of water glue in ninhydrin solution reduced the black strain after tested with thermal paper and made the appearance of the fingerprint more clearly. So, the detectable minutiae can be used for visualization and identification of latent prints. Using an Automated Fingerprint Identification System (AFIS), it is showed between 59-87 points of minutiae. As the results, this method could be used as an alternative method to developing latent fingerprints with non-hazardous materials, reduce costs and easy to find.

1 Introduction

Thermal paper has been used widely for image printing, for example in fax machines, ATM receipts, stores or shops receipts and bus tickets. When exposition to heat, thermal paper usually changed color to black. In the criminal investigation, detection of latent fingerprints deposited on the surface of thermal paper is an increasing problem. Conventional techniques like ninhydrin in petroleum ether or 1,8-Diazafluoren-9-one (DFO) solution caused black background staining on the heat-sensitive front side [1-2]. Consequently, fingerprints and information on the thermal paper will be destroyed [3].

Therefore, much effort has been devoted to the latent fingerprints development and background coloration on thermal paper. For example, in 2013, Ya-Ping Luo reported using a DFO/Polyvinylpyrrolidone (PVP) solution to detect latent fingerprints on thermal paper. PVP could reduce black on the background of the paper and made appearance of the fingerprint more clearly [4-5]. Some specially modified solvents or reagents were prepared to avoid the darkening of thermal paper, for example, ThermaNin, HFE-7100, DABCO. However, ThermaNin working solution is particularly
unstable, and HFE-7100 is very expensive [6]. In the same way, Jasuja and coworkers reported the use of iodine fuming of thermal paper with good results, although this method has been known for as a general technique for paper [7]. In addition, Leuco crystal violet, Amido back and Hungarian red can be detected the fingerprint in blood deposited on the surface of thermal paper [8].

Ninhydrin is commonly used in forensic investigators for detecting amino acids on porous surfaces. After spraying ninhydrin solution on the surface, the amino acid finger ridge is turned to purple. However, when using ninhydrin on the thermal paper, the latent fingerprints were in visualized due to the decrease of background blackening in contrast in the developed fingermarks on thermal paper [1-2]. Here, we are interested in combination of ninhydrin solution with water-based adhesives, which containing polymer components for simple improvement in latent fingerprint detection. Study of the optimal ratio of ninhydrin/water glue solution was investigated to detect the latent fingerprints and increase in the appearance of latent fingerprints.

2. Materials and method

2.1. Materials

Ninhydrin was purchased from BVDA International and water glue was purchased from One Company Ltd., Thailand. All the solvents were AR grade. There are two brands thermal paper of Sakura and Casio.

2.2. Sample preparation

Fingerprints were deposited upon the surface of each new thermal paper by one female donor. The fingertips along the forehead and side of nose were briefly wiped onto the thermal papers for the sebaceous fingerprints. The thermal papers were kept in the plastic zipper bags for 24 hours after deposited.

2.3. Preparation of the ninhydrin working solution

36.5 g of ninhydrin crystal is fully dissolved in 425 ml absolute ethanol and 35 ml ethyl acetate and 40 ml acetic acid are added to give 500 ml of ninhydrin stock solution, this is divided solution 65 ml then mixed thoroughly with 935 ml HFE-7100 solvent.

2.4. Optimization of ninhydrin/water glue staining solution

The water glue was weighted and dissolved with ninhydrin working solution to the concentration of 0.010, 0.020, 0.030, 0.040, 0.050, 0.060, 0.070, 0.080, 0.090 and 0.100 g/ml. The solution was stirred for 20 min, filtered after that the samples were each immersed in various concentrations of ninhydrin/water glue solution for 10 seconds, repeat 3 times. The samples were kept in the plastic bags for 24 hours. The results were scanned with the Epson Perfection 4990 Photo Scanner with 1000 dpi details and using Dell Latitude AFIS for detectable minutiae.

3. Results and discussion

3.1. Initial study of the background color of the thermal paper with ninhydrin solution and ninhydrin/water glue

From the figure 1, the results showed Casio and Sakura thermal papers after dipping with ninhydrin solution. Sakura brand shows the background dark black staining rather than Casio brand. In addition, it was found that the thermal paper dipped with ninhydrin/water glue showed the reducing the blackness of the paper background.
Figure 1. A comparison of the background color of Casio and Sakura thermal paper (a) Casio (b) Sakura with ninhydrin solution and (c) Casio (d) Sakura with ninhydrin/water glue solution

3.2. Optimization of ninhydrin/water glue staining solution

The development of latent fingerprint on Casio brands of thermal paper by using different ratio of water glue in ninhydrin working solution was reported. (Figure 2) From the naked eye observation, there is a change in the background color of the thermal paper in the area where the fingerprints are deposited.

The optimum ratio of water glue with ninhydrin working solution was 0.020 - 0.060 g/ml and showed a medium quality level of detectable minutiae between 68-79 points by Automated Fingerprint Identification System (AFIS). After that, When the amount of water glue increases, it affects to reduces black background. The visibility of the fingerprint is also reduced. That result can be seen in Table 1.

Table 1. The average number of minutiae with water glue/ninhydrin at different ratios on Casio thermal paper

| water glue/ Ninhydrin (g/ml) | 0.010 | 0.020 | 0.030 | 0.040 | 0.050 | 0.060 | 0.070 | 0.080 | 0.090 | 0.10 |
|-----------------------------|------|------|------|------|------|------|------|------|------|------|
| Minutiaes                   | 36   | 79   | 68   | 72   | 74   | 76   | 6    | 12   | 0.0  | 8    |
| Quality level               | D    | C    | C    | C    | C    | E    | E    | E    | E    | E    |

The best (A) = (117-145), Good (B) = (88-116), Medium (C) = (59-87), Poor (D) = (30-58), the poorest (E) = (0-29)
Figure 3 showed a comparison of latent fingerprint and the background color of Sakura brand thermal paper. It was found that the optimum ratio of water glue with ninhydrin working solution was 0.020 - 0.050 g/ml. The results of the evidence were clear and detectable minutiae can be used for visualization and identification by using AFIS between 71-83 points. (Table 2)

![Figure 3. A comparison of the background color of Sakura with different concentration of water glue (g/ml) in ninhydrin solution](image)

**Table 2.** The average number of minutiae with water glue/ninhydrin at different ratios on Sakura thermal paper

| Water glue/Ninhydrin (g/ml) | 0.010 | 0.020 | 0.030 | 0.040 | 0.050 | 0.060 | 0.070 | 0.080 | 0.090 | 0.10 |
|---------------------------|------|------|------|------|------|------|------|------|------|------|
| Minutiae                  | 56.3 | 71.3 | 83.0 | 72.7 | 81.7 | 22.7 | 26.7 | 16.0 | 22.7 | 22.3 |
| Quality level             | D    | C    | C    | C    | C    | E    | E    | E    | E    | E    |

**4. Conclusions**
This study showed that fingerprints on thermal papers are more effectively developed using ninhydrin solution with water glue. The sample fingerprints were left for 24 hours later before examination. The results showed that using concentration of water glue in ninhydrin solution 0.020 - 0.050 g/ml on thermal paper evidenced the clear, detectable minutiae. This can be used for visualization and identification of latent fingerprints which reduced the background black of thermal paper. This study might be interested in the application for developing latent fingerprints as an alternative to reducing toxicity to human, costs and easy to find.

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