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Effect of Temperature on Development of Latent Fingerprint by Ninhydrin Method

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***Abstract*: This paper discusses the importance of fingerprints in forensic investigations, categorizing them into three types: latent, patent, and plastic. Latent fingerprints, which are invisible and composed of sweat and oil, require specific methods for development, with the Ninhydrin method being the most common for porous surfaces. The Ninhydrin method, first utilized in 1959, involves a chemical reaction between ninhydrin and alpha-amino acids in proteins, resulting in a colored compound that reveals the fingerprints. While effective, the method has drawbacks, including its carcinogenic nature and the need for humidity for optimal development. The study investigates how temperature affects the development time of latent fingerprints using the Ninhydrin method. Various surfaces, including plain paper, bond paper, cheques, and currency notes, were tested at different temperatures. Results indicated that higher temperatures significantly reduced the time required for fingerprint development, demonstrating a beneficial impact of temperature on the process. Overall, the findings suggest that optimizing temperature can enhance the effectiveness of the Ninhydrin method in forensic applications, leading to quicker and clearer fingerprint development.**

***Keywords*: Carcinogenic, Development, Fingerprints, Latent, Ninhydrin, Temperature.**

1. Introduction

Fingerprints are crucial evidence in forensic investigations, with three main types: latent, patent, and plastic. Patent prints are visible and easily visible, while latent prints, made up of sweat and oil, are invisible and require additional processing. These fingerprints can be affected by factors such as age, gender, stimuli, occupation, disease, and substances the subject may have touched before deposition. Plastic fingerprints are three-dimensional impressions created by pressing fingers in paint, wax, soap, or tar. They are easily seen by the human eye and do not require further processing. Criminals often try to leave no trace of their actions, making patent fingerprints easily destroyed or contaminated. There are various methods for developing latent fingerprints, including rock phosphate powder, rhodamine B method, and ninhydrin method.

The Ninhydrin method is the most common method used to reveal latent fingerprints on porous surfaces, first used in 1959 for forensic purposes. It is a white solid crystalline powder that is soluble in ethanol and acetone, cheap, sensitive, and easily available in the market. The process usually takes 1-2 hours, with some prints developing within seconds or 24-48 hours. The main disadvantages of using ninhydrin as a chemical for developing latent fingerprints include its carcinogenic nature, long development time without humidity, and difficulty in storage due to its degradation over time. However, ninhydrin is a hydrate of indane-1, 2, 3-trione, which reacts with alpha-amino acids found in proteins to give an intensely colored purple anion (570 nm). Conditions that can affect the development of latent fingerprints include environmental conditions, surface type, donor ability, contact time, and object force. This paper aims to investigate the effect of temperature on the development of latent fingerprints using the ninhydrin method. The objective of this study is to study the effect of temperature on the development of latent fingerprints using the ninhydrin method.

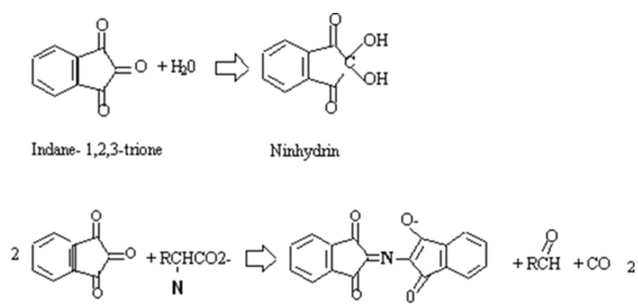


Fig. 1. Chemical interaction for the conversion of indane- 1, 2, 3- trione to ninhydrin and its reaction with fingerprint residue

The development of latent fingerprints from porous and non-porous materials disposed in water has been a challenge for forensic researchers. This study aims to develop latent fingerprints from porous and non-porous materials using black powder and Cyanoacrylate. The results show that it is possible to develop prints from non-porous substances like glass and plastics using black powder and Cyanoacrylate, but Iodine fuming can initially yield negative results after prolonged disposal in water. Ninhydrin (ether-based) proves to be ineffective in developing latent finger prints from porous surfaces disposed in water. Mahipal Singh and Rajeev (2018) developed a crime engineering technique for developing

*Corresponding author: bhaveshmali815@gmail.com invisible fingerprints on surfaces using rock phosphate powder. Fingerprints were developed on ten different surfaces, such as paper, plywood, plastic sheets, granite marble, iron, wood, and utensils. Quantum dots were used to recognize sweat latent fingerprints with green-emitting carbon dots, which produce light due to their discrete and quantized energy level. Factors discussed include the type of surface, pH, and developing time. Richa Rohatgi and A.K. Kapoor (2014) developed new visualizing agents for developing latent fingerprints on various porous and non-porous surfaces using different household food items. The temperature at which the study was conducted was 31-42°C. Latent fingerprints were not developed on rubber using any product, and negative results were found on white ceramic tile, transparent polythene, and thermocol due to poor contrast in case of custard powder, corn flour, baking soda, and black salt. Small particle reagent based on crystal violet dye was commonly used to develop latent fingerprints from non-porous wet surfaces. The samples were disposed in both clean and dirty water for a few days, and clear prints could be developed by SPR. SR Bacon, JJ Ojeda, R. Downham, VG Sears, and BJ Jones (2013) studied the effects of polymer pigmentation on fingerprint development techniques, finding that polymer pigments can develop latent fingerprints with visible sharp ridges. Kapoor S, Gurvinder S. Sodhi, and Sanjiv K (2015) developed a new method using Rhodamine B, which reacts with amino acids present in the sebum of the print and shows blue-purple color. Ninhydrin-based forensic investigations for fingerprints are used only on porous surfaces. Om Prakash Jasuja, M.A. Toofany, Gagandeep Singh, and G.S. Sodhi (2008) investigated the effect of physical factors on the quality of ninhydrin-developed fingerprints.

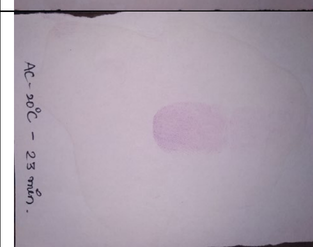
2. Materials and Methods

This study uses ninhydrin crystals, acetone, a beaker, measuring cylinder, glass rod, spray bottle, hot air oven, freezer, weighing machine, bond paper, plain paper, currency notes, cheque, and latex gloves. The initial stage involves making a ninhydrin solution with 50 ml of acetone and 0.25 g of ninhydrin crystals. Carefully, this solution is poured into a spray bottle. The further step involved is to create fingerprints on four surfaces: plain paper, bond paper, cheque, and currency notes. Fingerprints are taken on each surface, ninhydrin is sprayed, and samples are kept in a hot air oven and freezer at different temperatures, with a temperature difference of 10°C. Time is recorded for each fingerprint's development.

3. Observations and Result

A. Plain Paper

Table 1
Development of fingerprint on plain paper

S.No.	Temperature	Time Taken	Developed Fingerprint
1.	0°C	20 hr	
2.	20-30°C	7 min	
3.	30-40°C	6 min	
4.	23°C (AC)	23 min	
5.	60-70°C	3 min	
6.	80-90°C	1 min	
7.	100°C	30 sec	

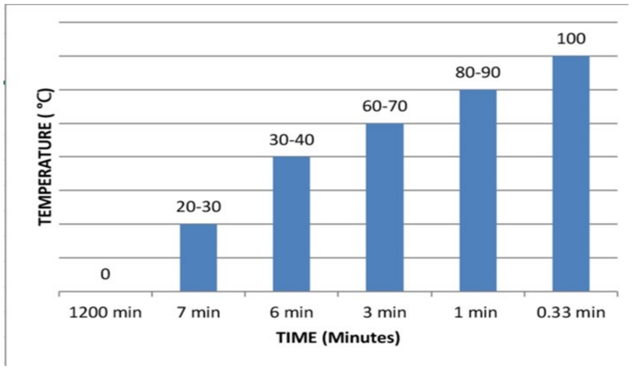
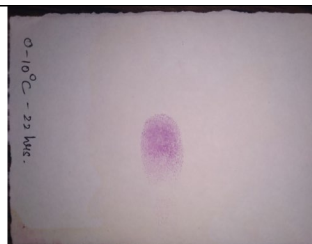
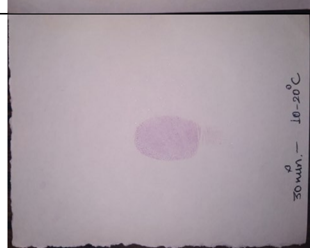
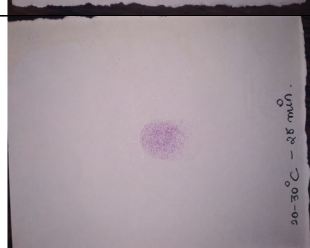
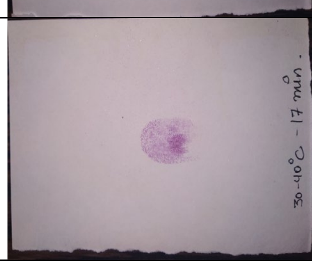
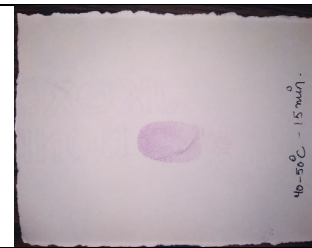
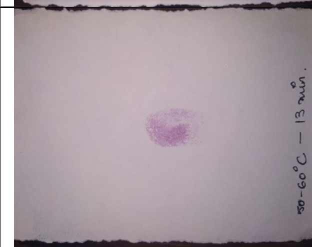


Fig. 2. Temperature vs. time graph for developed prints on plain paper

B. *Bond Paper*

Table 2
Development of fingerprint on bond paper

S.No.	Temperature	Time Taken	Developed Fingerprint
1.	0°C	22 hr	
2.	16°C (AC)	27 min	
3.	10-20°C	30 min	
4.	20-30°C	25 min	
5.	30-40°C	17 min	
6.	40-50°C	15 min	
7.	50-60°C	13 min	
8.	60-70°C	8 min	
9.	70-80°C	6 min	
10.	80-90°C	4 min	
11.	90-100°C	1.5 min	

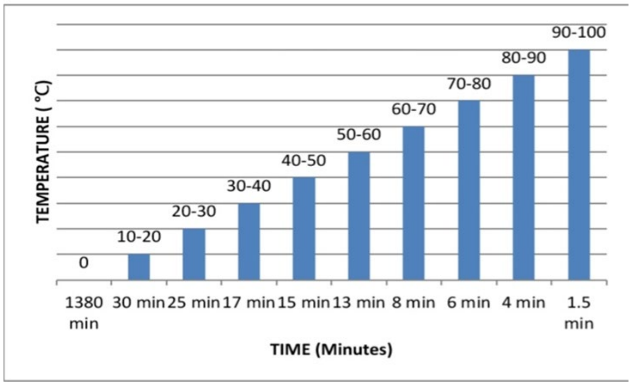
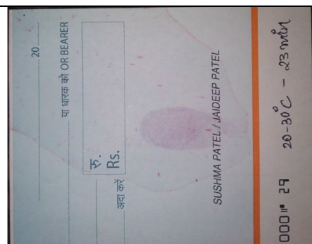
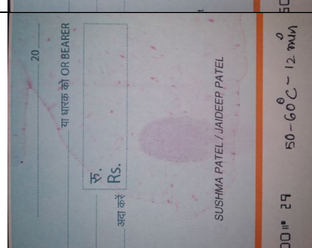
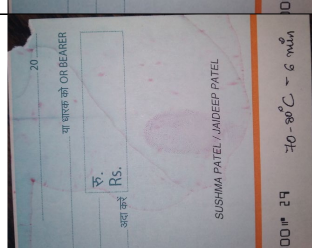
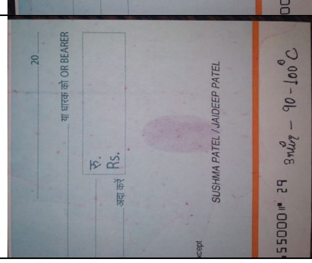


Fig. 3. Temperature vs. time graph for development of fingerprints on bond paper

C. *Cheque*

Table 3
Development of fingerprint on cheque

S.No.	Temperature	Time Taken	Developed Fingerprint
1.	20-30°C	23 min	
2.	50-60°C	12 min	
3.	70-80°C	6 min	
4.	90-100°C	3 min	

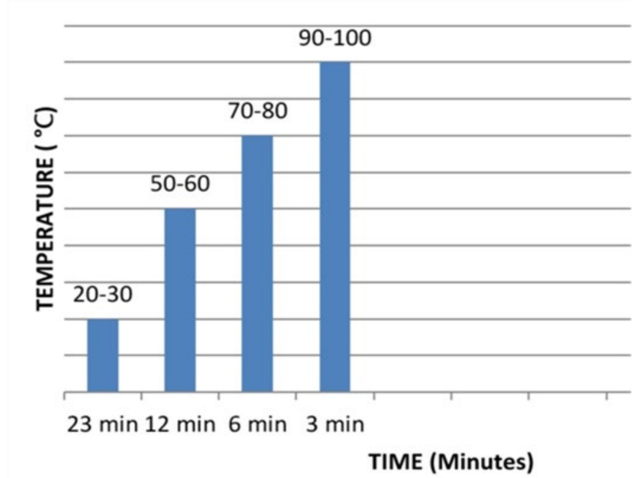


Fig. 4. Temperature vs. time graph for developed fingerprints on cheque

D. *Currency Notes*

Table 4
Development of fingerprint on currency note

S.No.	Temperature	Time Taken	Developed Fingerprint
1.	20-30°C	26 min	
2.	90-100°C	2 min	

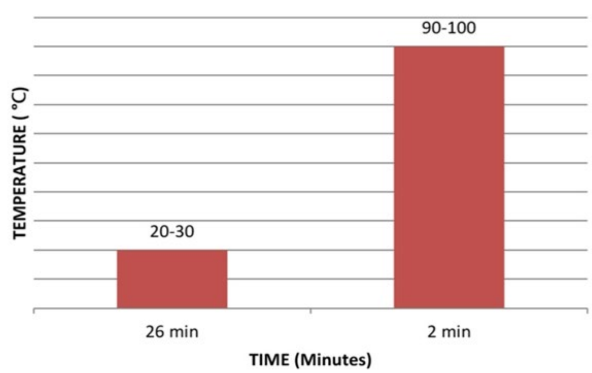


Fig. 5. Temperature vs. time graph for developed fingerprints on currency note

The experimental approach makes it evident that temperature has a beneficial impact on the ninhydrin reagent fingerprint creation process. As the temperature rises, the fingerprint development time decreases.

4. Discussion and Interpretation

Bond paper, currency notes, cheques, plain paper, and ninhydrin solution were among the materials utilized for the experiment. Following the application of the ninhydrin reagent, the cheque papers and currency notes had extremely faint fingerprint impressions, whereas the plain sheet of paper produced the best results across all paper types. Every type of paper has one thing in common: the temperature enhanced the fingerprint's development.

5. Conclusion

The purpose of the study was to use the ninhydrin method to determine how temperature affected fingerprint development. The study found that the time it takes for a fingerprint to develop following ninhydrin treatment decreases with increasing temperature. When money notes and checks were retrieved from the crime scene, this study also found that the ninhydrin approach was not the ideal choice since the fingerprints that developed on them were very faint, and the ridges on the fingerprints were hardly noticeable. Therefore, since a higher temperature shortens the time it takes for a fingerprint to grow, it can be used to speed up the analysis process.

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