

## Developing Latent Fingerprints from Surface of Eggshell using Physical Methods

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**How to cite this article:** Nithin S, Swapna Gowri C S, Sona Mariya. Developing Latent Fingerprints from Surface of Eggshell using Physical Methods. *Medico-Legal Update* / Vol 25 No. 4, October - December 2025

### Abstract

The development of latent fingerprints on unconventional surfaces, such as eggshells, presents unique challenges due to their fragile and porous nature. This study focuses on evaluating the effectiveness of two physical methods – black powder and fluorescent powder – in developing latent fingerprints on eggshell surfaces under both normal conditions and when covered with plastic bubble wrap. A total of ten samples were tested for each condition. Results indicate that black powder consistently produced better fingerprint contrast, with five samples showing excellent visibility under normal conditions and moderate success even under plastic wrap. In contrast, fluorescent powder demonstrated poor performance overall, with no samples displaying excellent contrast and a significant number yielding weak or no visibility, especially when surface conditions were altered by plastic covering. The findings suggest that black powder is more suitable for fingerprint development on eggshell surfaces, while fluorescent powder is limited in its effectiveness, particularly under textured or wrapped conditions. This study highlights the importance of selecting appropriate physical methods for latent print development on delicate biological surfaces.

**Keywords:** Latent fingerprint, Egg shell, Black powder, fluorescent powder, Plastic bubble wrap

### Introduction

Fingerprints are patterns made up of ridges and furrows on the finger tips. Fingerprints are part of biometrics, which is the study of identifying people based on their physical characteristics.<sup>1,2</sup> Fingerprints are ideal for this purpose since they are inexpensive to obtain and analyze, and they do not change with age.<sup>1</sup> Fingerprints are a natural, distinctive pattern generated by disunion on epidermal crests and furrows that emerge on the pads of the fingers and thumbs.<sup>1,2</sup> Although these epidermal crests are located on the fingers, palms, and soles, they are commonly referred to as fingerprints.<sup>1</sup> They have

never been observed to repeat in any mortal entity in the history of dactylography.<sup>1</sup> Fingerprints are sometimes termed dactylograms.<sup>1</sup>

A person's fingerprint is produced based on two factors: genetics from parents and the state of the baby in the mother's womb.<sup>2</sup> The patterns indicate that two people are related because they share various physical characteristics, such as facial features or hair color. This is because children inherit half of their DNA (genetic blueprints) from both parents.<sup>2</sup> Fingerprints are used to identify persons because each person's fingerprint is unique; nevertheless, people can have similar fingerprint

patterns. Whether fingerprint patterns are random or influenced by heredity.<sup>2</sup>

Fingerprints are unique patterns of ridges and furrows on the fingertips, formed by the separation of epidermal crests, and are commonly referred to as dactylograms.<sup>1</sup> Though similar patterns may occur among family members due to genetic influence, each individual's fingerprints are distinct, shaped by both heredity and fetal development conditions.<sup>2</sup> These patterns are permanent and have never been found to repeat in any two individuals, making fingerprints a reliable means of identification.<sup>1,2</sup> Their uniqueness and stability have led to their widespread use in forensic science, biometric security, and identity verification, playing a crucial role in law enforcement, border control, and cybersecurity in modern society.<sup>1,2,3</sup>

Fingerprint identification has ancient roots, with early uses traced back to Babylon around 2000 BCE for business transactions on clay tablets and to ancient China, where thumbprints were used as signatures under the Qin Dynasty.<sup>1</sup> But these practices were not based at the time on scientific knowledge of the uniqueness of fingerprints. In the 17th century, European anatomists such as Nehemiah Grew and Marcello Malpighi began to examine skin ridge patterns, although the forensic value was not appreciated for centuries.<sup>1</sup> Contemporary fingerprinting began in the nineteenth century, when Sir William Herschel used fingerprints as a technique of identification in India in the 1850s.<sup>1</sup> Dr. Henry Faulds later recommended its use in criminal investigations,<sup>4</sup> while Sir Francis Galton's 1890s research provided scientific verification of fingerprints' uniqueness and permanence.<sup>1</sup> Sir Edward Henry expanded on Galton's work, creating a classification system that was later used by British India and Scotland Yard.<sup>1</sup> Fingerprinting became regular forensic science at the turn of the twentieth century, revolutionizing personal identification and crime investigation around the world.<sup>1,2</sup>

## Methodology

### Aim

This study is intended to identify effective ways of fingerprint development and visualization on

Surface of eggshells that may expand the variety of forensic evidence.

## Objectives

1. To evaluate the effectiveness of various physical techniques, i.e., powder dusting, for the development of latent fingerprints on eggshells
2. To identify the efficiency of physical methods in recovering latent fingerprints from eggshells under various conditions.
3. To optimize the developed methods for enhancing the quality of latent fingerprints recovered from eggshells.
6. To explore the potential applications of the developed methods in forensic science, particularly in the investigation of crimes involving eggshells or other fragile evidence.
7. To optimize the developed methods for enhancing the durability of latent fingerprints recovered from eggshells.

## Research Question/Problem Statement

1. How effective are different physical methods particularly powder dusting in developing the latent fingerprints on egg shell surfaces?
2. What modifications to existing physical methods can improve the clarity and ridge details of latent fingerprints recovered from egg shells?
3. How does the effectiveness of black powder compared to fluorescent powder in developing and visualizing the latent fingerprints on egg shell surfaces under different environmental conditions?

## Research Design

For this study the purposive and experimental study design will be employed. The type of research design is sampling method.

## Universe, Sample Size, Sampling Techniques

For this study, researcher has collected samples of 10 under each condition with the informed consent

from the participants. The study conducted in Kerala, Ernakulam.

**Materials Required**

1. Egg
2. Black powder
3. Fluorescent powder
4. Feather brush
5. Cello tape
6. OHP sheet
7. Tissue paper
8. Plastic wrapper
9. Magnifying lens

**Procedure**

- The fingerprint has been deposited on the surface of the egg. And the prints have been suspended under two different conditions: normal and plastic wrap. The samples under each condition are been developed and examined in the following ways,
- The black and fluorescent powder was applied to each surface to produce the fingerprint using a feather brush. The researchers had applied the powder to the surface where the fingerprint has been deposited. The fingerprint became apparent to the human eye shortly after its creation. Excessive powders are removed, and the developing area's surroundings are cleansed. Use a camera lens to photograph the print. The print has been lifted using cellophane tape and adhered to the OHP sheet. The fingerprint's quality was then assessed using the Magnifying lens.
- The quality of the fingerprint has been examined under the following grades and contrasts

Grade	Friction Ridge Detail	Contrast
0	No development	No contrast
1	<1/3 of continuous ridge detail, some evidence of contact.	Poor contrast

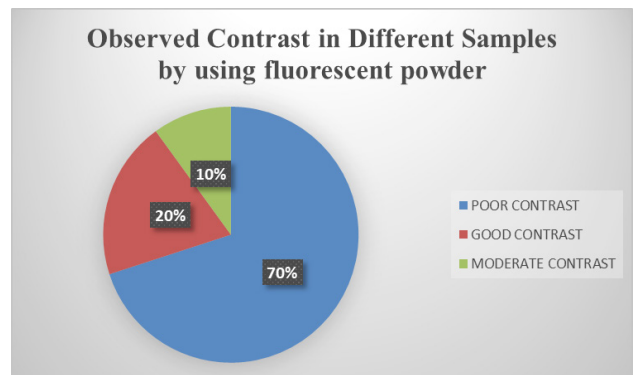
2	1/3-2/3 of the developed fingermark is continuous ridge detail.	Moderate contrast
3	>2/3 of the developed fingermark is continuous ridge detail.	Good contrast
4	Full development; whole fingermark visible with continuous ridges.	Excellent contrast

**Observation**

**Observation under normal condition of surface of the egg shell**

**Table1. Observed Contrast in Different Samples by using Black Powder**

SAMPLE NO	OBSERVED CONTRAST
Sample 1	Excellent contrast
Sample 2	Excellent contrast
Sample 3	Excellent contrast
Sample 4	Good contrast
Sample 5	Moderate contrast
Sample 6	Moderate contrast
Sample 7	Good contrast
Sample 8	Excellent contrast
Sample 9	Excellent contrast
Sample 10	Moderate contrast



**Figure 1: Observed contrast in different samples by fluorescent powder**

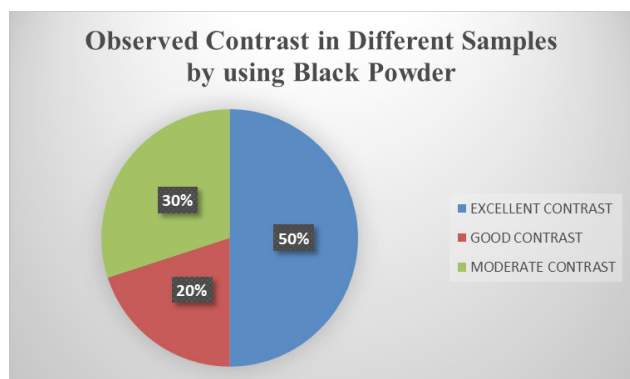


Figure 2: Observed contrast in different samples by black powder

Table 2. Observed Contrast in Different Samples by using fluorescent powder

SAMPLE NO	OBSERVED CONTRAST
Sample 1	Poor contrast
Sample 2	Poor contrast
Sample 3	Good contrast
Sample 4	Good contrast
Sample 5	Poor contrast
Sample 6	Poor contrast
Sample 7	Moderate contrast
Sample 8	Poor contrast
Sample 9	Poor contrast
Sample 10	Poor contrast

Observation under plastic bubbled wrap condition of surface of the egg shell

Table 3. Observed Contrast in Different Samples by using Black Powder

SAMPLE NO	OBSERVED CONTRAST
Sample 1	Moderate contrast
Sample 2	Moderate contrast
Sample 3	Excellent contrast
Sample 4	Poor contrast
Sample 5	Good contrast
Sample 6	Poor contrast
Sample 7	Poor contrast
Sample 8	Moderate contrast
Sample 9	Excellent contrast
Sample 10	Good contrast

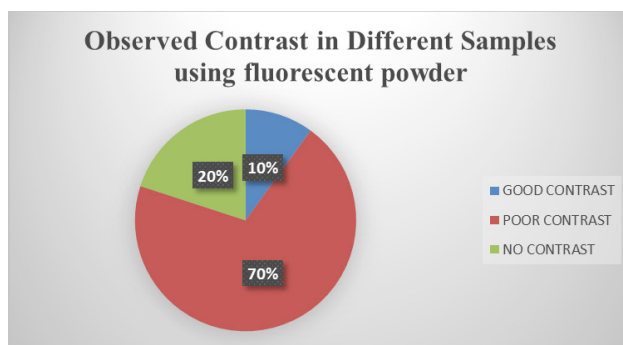


Figure 3: Observed contrast in different samples by fluorescent powder

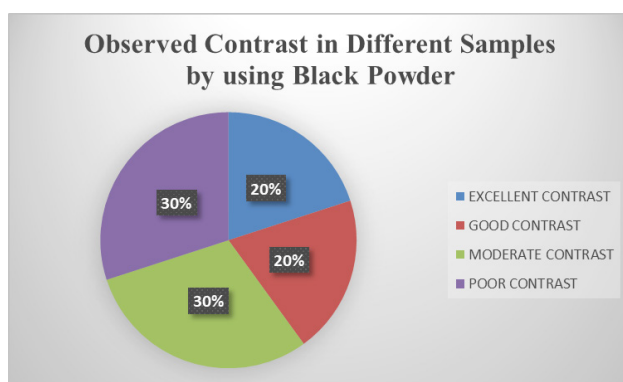


Figure 4: Observed contrast in different samples by black powder

Table 4. Observed Contrast in Different Samples using fluorescent powder

SAMPLE NO	OBSERVED CONTRAST
Sample 1	Poor contrast
Sample 2	Poor contrast
Sample 3	Good contrast
Sample 4	No contrast
Sample 5	Poor contrast
Sample 6	Poor contrast
Sample 7	Poor contrast
Sample 8	No contrast
Sample 9	Poor contrast
Sample 10	Poor contrast

### Major Findings

- Under normal circumstances, black powder produced the most excellent contrast results, with 5 out of 10 samples displaying exceptional fingerprint visibility.

- Under normal circumstances, the fluorescent powder produced substantially less favourable results; none of the samples displayed exceptional clarity, and 7 out of 10 merely produced poor contrast.
- Black powder's performance decreased when exposed to plastic wrap; only the two samples (3 and 9) demonstrated exceptional contrast when compared to 5 under normal circumstances, suggesting wrap interference.
- Under plastic wrap, fluorescent powder did the poorest; two samples (4 and 8) showed no contrast at all, while the majority (7 out of 10) showed weak contrast.
- Under both circumstances, black powder continuously dominated fluorescent powder, generating more excellent, good, and moderate contrasts.
- Regardless of surface condition, fluorescent powder results showed moderate to poor contrasts, indicating that it is less appropriate for eggshell surfaces than black powder.
- Under plastic wrap, black powder still provided some usable results (e.g., good or moderate) in 6 samples, whereas fluorescent powder yielded only one good contrast (Sample 3).
- The application of plastic bubble wrap significantly reduced the contrast quality, especially for fluorescent powder, likely due to texture interference or reduced powder adherence.
- Overall, black powder is more reliable for fingerprint development on eggshell surfaces, while fluorescent powder showed limited applicability, especially under altered surface conditions like wrapping.

### **Recommendation and Suggestion of The Study**

1. **Prefer Black Powder for Eggshell Surfaces:** Given its consistently higher contrast results, black powder should be the primary choice for

fingerprint development on eggshell surfaces under normal conditions.

2. **Avoid Fluorescent Powder for Eggshells:** The overall weak and inconsistent performance of fluorescent powder suggests it is not suitable for use on eggshell surfaces, especially where high clarity is required.
3. **Minimize Use of Plastic Bubble Wrap:** Plastic wrapping negatively impacts fingerprint visibility, particularly with fluorescent powder. Avoid wrapping evidence surfaces if preservation without distortion is possible.
4. **Further Investigate Wrap-Induced Interference:** The significant drop in contrast under plastic wrap, especially for fluorescent powder, warrants further study into the nature of texture interference or powder adherence issues.
5. **Standardize Handling Procedures:** Implement guidelines to maintain natural surface conditions during collection and examination of delicate surfaces like eggshells to preserve fingerprint integrity.
6. **Explore Alternative Powders or Methods:** Future research should explore other fingerprint development techniques (e.g., cyanoacrylate fuming or magnetic powders) to improve results on challenging surfaces like eggshells.
7. **Use Fluorescent Powder with Caution:** If fluorescent powder must be used, it should be restricted to smoother, non-porous surfaces, and not on fragile or irregular textures like eggshells.
8. **Train Forensic Personnel Appropriately:** Ensure that forensic professionals are well-trained in selecting and applying appropriate powders depending on surface type and condition to optimize evidence recovery.

### **Discussion**

The present study aimed to evaluate the effectiveness of black powder and fluorescent

powder in developing latent fingerprints on eggshell surfaces under normal and plastic wrap conditions. The results clearly indicate that black powder consistently produced higher quality contrasts compared to fluorescent powder, both under direct application and when surfaces were altered by plastic covering.

These findings are consistent with previous research which emphasizes the versatility and reliability of conventional black powders on non-porous and semi-porous substrates. Sodhi & Kaur<sup>8</sup>, highlighted that carbon-based powders adhere effectively to sweat and oily residues, providing clear ridge details in most practical forensic conditions. Similarly, Moreno et al.<sup>14</sup> demonstrated that the chemical composition of black powders contributes to strong adherence and stable contrast, making them a robust option even when surface texture presents challenges.

By contrast, fluorescent powders—while highly sensitive and effective on smooth, reflective, or colored surfaces—show limitations on irregular or porous substrates. Boonyaras et al.<sup>7</sup> and Bhati et al.<sup>13</sup> both observed that fluorescent substances require optimal surface-sample compatibility to yield satisfactory ridge detail. This aligns with the present findings, where eggshells' porous and fragile nature hindered the adherence of fluorescent particles, resulting in weak or no contrast in most cases, particularly under plastic wrapping.

The interference caused by plastic wrap further reduced the visibility of ridge details, suggesting that surface modifications significantly impact powder adherence. Previous studies have also noted that external coverings or textured substrates create additional barriers for fluorescent powders compared to traditional carbon-based powders. Qiu et al.<sup>6</sup>, Abebe et al.<sup>15</sup>, In this study, black powder still produced moderate to good contrasts in several samples under wrapped conditions, reinforcing its reliability, whereas fluorescent powder largely failed to provide usable results.

An important contribution of this research is its focus on eggshell surfaces, which represent delicate

biological substrates rarely investigated in forensic practice. Prior work on unusual or porous surfaces, such as paper, supports this observation. O'Neill<sup>5</sup>; Pounds et al.<sup>5</sup>, Our results confirm that eggshells, like other porous surfaces, are poorly suited for fluorescent powder application but respond adequately to traditional black powder dusting.

Moreover, the reproducibility of fingerprint features plays a critical role in forensic reliability. Studies on fingerprint microfeatures and pore-level analysis Preethi et al.<sup>12</sup>, emphasize the importance of clarity and continuous ridge detail for valid comparison. In this context, black powder's ability to consistently yield clear ridge continuity, even under less-than-ideal conditions, makes it superior for fragile substrates like eggshells.

An important aspect of fingerprint analysis lies in micro- and third-level features such as sweat pores and ridge edge details. Woo and Park<sup>10</sup>, demonstrated that sweat pore mapping using polymer-based films could significantly enhance fingerprint visualization, emphasizing the value of pore-level information for identification. Similarly, Parsons et al.<sup>11</sup>, introduced rotationally invariant statistical models to objectively evaluate pore features, highlighting their forensic relevance. Although our study primarily evaluated ridge contrast, the observed limitations of fluorescent powder on eggshells suggest that future research could incorporate pore-focused techniques to improve evidentiary value.

Overall, this study contributes to forensic science by demonstrating that conventional black powder remains the most reliable method for fingerprint visualization on eggshell surfaces, whereas fluorescent powders should be applied with caution, restricted to smoother non-porous substrates. These findings are in line with prior reviews Sodhi & Kaur<sup>8</sup>, Abebe et al.<sup>15</sup>, which recommend tailoring powder selection to the nature of the substrate to maximize evidential recovery.

## Conclusion

For the above study the researchers would like to conclude, Based on the comparative analysis

of black and fluorescent fingerprint powders on eggshell surfaces under normal and plastic bubble wrap conditions, it is evident that black powder consistently outperforms fluorescent powder in terms of contrast and clarity. Under normal circumstances, black powder yielded excellent results in half the samples, while fluorescent powder failed to produce any exceptional contrasts, with the majority showing poor quality. The effectiveness of both powders declined when plastic wrap was applied, but black powder still maintained a moderate level of usability, whereas fluorescent powder performance deteriorated significantly, with several samples showing no contrast at all. This indicates that plastic wrap interferes with powder adherence, particularly affecting fluorescent powders more severely. Overall, the study concludes that black powder is a more reliable and effective medium for developing fingerprints on delicate surfaces like eggshells, and fluorescent powder should be avoided in such contexts, especially when surface conditions are altered by wrapping.

**Funding:** Nil

**Ethical Clearance/Statement of Ethics:** Nil

**Conflict of Interest:** nil

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