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Research Article

Development of Latent Fingerprints Using Food Coloring Agents

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Abstract

Aim and objective: The current study aims to explore the effectiveness of food dyes as potential agents for the formation of latent fingerprints on non-porous substrates.

Introduction: The development of fingerprints is a long-established forensic technique crucial for identifying perpetrators. Traditional methods often use various powders to reveal latent fingerprints on different surfaces, but these methods can be costly and pose health risks when exposed to humans. Consequently, there is an increasing demand for alternative techniques that are cost-effective while still providing high-resolution fingerprint visibility.

Materials and methods: In this study, Colormist Super whip food powder red, blue, orange, turquoise, and pink was used for the Development of Latent fingerprints on different non-porous surfaces (CD, Mobile screen, Glass bottle, Mirror, Steel bottle).

Results: The ColorMist Super Whip edible powders proved successful in developing high-quality finger marks with visible level 1 and level 2 fingerprint details across all substrates, showcasing its effectiveness in latent fingerprint enhancement.

Conclusion: Food dyes provide a simple, cost-effective, and eco-friendly method for developing latent fingerprints on nonporous surfaces. Red and black dyes consistently deliver clear ridge detail, while turquoise performs well on glass. Surface type plays a crucial role in dye effectiveness; making food dyes a practical, non-invasive alternative for on-site forensic use.

More Information

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Introduction

Fingerprints are essential in forensic investigations because they are unique to each individual, making them highly reliable in identifying suspects. When fingerprints are discovered at a crime scene, they can be compared to fingerprints in a database or to a suspect's fingerprints to determine who was there. It can link a suspect to a crime scene, confirm identity, and help solve cases by providing indisputable evidence. In addition, fingerprints can also be used to eliminate innocent people who are not involved in crime. Fingerprints are small ridges formed during the embryological development of the volar pads of the fingers, which allow you to grip surfaces without slipping. Although researchers have raised concerns about the uniqueness of fingerprints over time, they remain a popular way to distinguish between different individuals, including identical twins. In addition, fingerprints are permanent and do not change over time. These characteristics make them valuable evidence at crime scenes. Criminal investigations involving the use of fingerprints have been documented for over a century [1-5]. The discovery of latent fingerprints is based either on chemical reactions between the fingerprint residue and chemical substances or on the physical attachment of the resulting substances to the surface of the fingerprint residue. Fingerprints are considered one of the most important pieces of evidence in civil and criminal cases. The individuality of fingerprints is admissible in court. The most common fingerprint found at a crime scene is a latent fingerprint, which goes unnoticed by the criminal. The use of the latent fingerprint depends only on the surface type, efficiency, and simplicity. A fingerprint is unique to everyone, making it a powerful tool for linking suspects to a crime scene and establishing their presence. Over the years, forensic scientists and investigators have continued to strive to improve fingerprint identification and development methods. Traditional techniques such as powder dust, chemical treatments, and alternative light sources have helped reveal hidden fingerprints on surfaces [6]. However, these methods may have limitations in terms of sensitivity, specificity, and the type of surfaces that can be processed effectively. One area of ongoing research and innovation in forensic science is the study of unusual materials to develop fingerprints Food colorings, commonly used in cuisine and food decorations, have recently received attention for their potential applications in forensic fingerprint analysis [7,8]. These substances, often in the form of powders or liquids, have properties that make them suitable candidates for improving latent fingerprints on various surfaces. The focus of this research project is the development of latent fingerprints using Colormist Super Whip edible powder on different surfaces Colors, including red, blue, orange, turquoise, and pink. These food colors were chosen for their bright colors, non-toxicity, and compatibility with many surfaces, both porous and non-porous. By investigating the effectiveness of Colormist Super Whip edible Powder in developing latent fingerprints, this study aims to provide valuable information to the field of forensic science. The development of latent fingerprints is a multi-step process involving several factors such as surface type, environmental conditions, application technique, and developer characteristics. Non-porous surfaces such as glass, metal, and plastic present challenges compared to porous surfaces such as paper, cardboard, and fabric. The ability of the fingerprint development method to produce clear and recognizable marks on both surfaces is critical to its practical utility in forensic investigations [9]. Colormist Super Whip Edible Powder offers several potential advantages as a fingerprint developer. First, its fine powder form allows for easy application and adhesion to various surfaces, ensuring even coverage for optimal fingerprint imaging. Second, the colors available offer the versatility to enhance different types of latent prints, especially surfaces left in harsh environments or complex backgrounds [10,11]. In addition, the non-toxic and food-grade nature of Colourmist Super Whip Food Powder makes it forensic. Safe specialists who deal with and reduce potential risks associated with chemical-based development methods. This aspect is particularly important in forensic laboratories and crime scene investigations, where safety protocols and environmental considerations are paramount. The use of food dyes in forensic fingerprint analysis is not entirely new, as previous studies have explored the potential of various foods and pigments.

Materials and methods

Surfaces

In this study, non-porous surfaces were used for the development of latent fingerprints collected on various non-porous surfaces: CDs, Glass, Mirror, and Steel bottles. The test latent prints were collected from the subjects on different surfaces.

Materials for development

In the present study, Colormist Super Whip Edible Food Powders (red, blue, orange, turquoise, and pink) were explored for their potential to develop latent fingerprints on non-porous surfaces. These powders, commonly used in the food and beverage industry for adding bright, consistent colors, are known for their fine texture, which allows them to blend smoothly into mixtures without changing the overall texture of the product. The combination of their fine consistency and a wide variety of colors makes them a promising candidate for fingerprint development, providing a potentially safe and cost-effective alternative to traditional methods for enhancing prints on smooth surfaces in forensic investigations. These food powders, purchased from the market, were assessed for their effectiveness as an alternative to conventional fingerprint powders.

Methods

The experiment was carried out in April 2024 when the average maximum temperature was 23.6 (±1) °C, and the average humidity was about 45%. Non-porous surfaces namely glass, CD (polycarbonate plastic), steel bottles, and mirrors were used for the development of latent fingerprints. The standard method [12] was followed for the generation and attainment of fingerprints. The latent fingerprints were taken by pressing the finger of the subject individual onto the surface. The produced latent fingerprints were then developed using the powder dusting method [13] using Colormist Super Whip food powders in red, blue, orange, turquoise, and pink, applied with a soft cosmetic brush. To ensure clear prints, excess powder was gently removed by tapping. This process was repeated for each powder on all surfaces, with a total of 20 latent prints developed per powder on each surface. The most distinct and well-developed prints were selected for analysis and subsequent computation of results. The developed prints were then scored according to the Fingerprint Visibility Scoring System as shown in Table 1 [14-16].

A comparative analysis was conducted to evaluate the effectiveness of Colormist Super Whip edible food powders in developing latent fingerprints on various non-porous surfaces. The results were classified into three categories Complete Identifiable (both pattern and minutiae visible), Partial Identifiable (pattern visible but minutiae not visible), and Least Identifiable (neither pattern nor minutiae visible).

Result and discussions

The latent fingerprint development was carried out using Colormist Super Whip Edible food powders and yielded promising outcomes, on all the non-porous surfaces (Table 2).

Table 1: Fingerprint visibility scoring system.

Grade	Criteria
1	No fingermark developed
2	Poor fingermark development: very few ridges visible, poor contrast
3	Medium fingermark development: either contrast or ridge detail was not good
4	Good fingermark development: either contrast or ridge detail was visible
5	Excellent fingermark development: contrast, as well as ridge details, are very clear

Table 2: Quality of developed fingerprints on Non-porous surfaces.

Non-porous surface	Food colourants				
	Red colorant	Orange colorant	Pink colorant	Turquoise colorant	Black colorant
CD	4	3	3	2	4
Glass bottle	4	2	4	5	2
Mirror	5	4	3	4	3
Steel bottle	5	3	3	4	3

Latent fingerprints developed using **Red dye** demonstrated excellent performance on mirror and steel surfaces (Score 5), with discernible first and second-level ridge details, and good development on CD and glass surfaces (Score 4), exhibiting visible contrast and ridge clarity. **Orange dye** showed good ridge clarity on the mirror surface (Score 4), moderate development on CD and steel surface (Score 3), with visible level 1 detail but only a few ridge details were visible, and poor development on glass (Score 2), with minimal ridge visibility and poor contrast. **Pink dye** produced good results on glass (Score 4), while CD, mirror, and steel surfaces displayed moderate development (Score 3), lacking sufficient ridge clarity. For **Turquoise dye,** excellent results were achieved on glass (Score 5), with clear contrast and well-defined ridge details, good development on mirror and steel surfaces (Score 4), and poor development on CD (Score 2), where only a few minutiae were visible, and contrast was inadequate. Lastly, **Black dye** showed good development on CD (Score 4), with discernible contrast and ridge details, moderate performance on mirror and steel surfaces (Score 3), and poor development on glass (Score 2), characterized by minimal ridge visibility.

Among all the dyes tested, red dye emerged as the most effective, consistently delivering high-quality development across various substrates. It achieved excellent results on mirror and steel surfaces and good results on CD and glass. However, minor smudging was noted due to pressure during fingerprint deposition. These findings highlight the potential of Colormist Super Whip edible food colorants in enhancing latent fingerprint visibility, with the surface type significantly influencing the clarity and detail of the developed prints, where plain surfaces yielded the most promising results [Figure 1].

Comparison with conventional fingerprint development techniques

In comparing the performance of Colormist Super Whip edible food powders with traditional forensic fingerprint powders, the findings highlight several key differences and similarities. Traditional fingerprint powders, such as black powder, are widely used in forensic science due to their effectiveness and consistency across a variety of surfaces, especially non-porous materials like glass, metal, and plastic. Black powder generally provides a strong contrast, allowing for clear ridge details, but may leave residue, which can interfere with further analysis. In comparison, Colormist powders, particularly the red dye, demonstrated similar effectiveness on smooth surfaces such as mirrors and steel, where they provided clear ridge details and high-quality development.

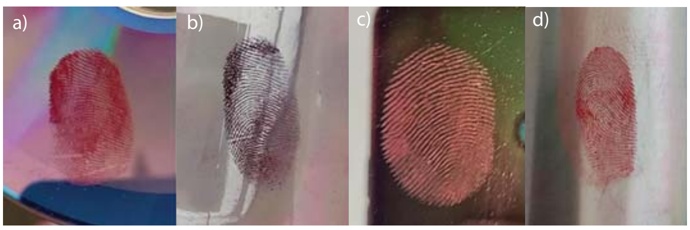

Figure 1: Fingerprint developed on a) CD, b) Glass bottle, c) Mirror, d) Steel Bottle.

Fluorescent powders, another common forensic tool, offer enhanced visibility under UV light, making them especially useful in low-light conditions. However, they require additional equipment, which may not always be available in the field. Color mist powders, on the other hand, perform well under standard lighting conditions, making them more accessible and practical in routine forensic work. Their performance was comparable to fluorescent powders in terms of clarity, though they lacked the UV-enhanced contrast offered by fluorescent variants.

Magnetic powders, known for their precision in adhering to ridge details without smudging, also showed superior performance in comparison to standard fingerprint powders. These powders are particularly valued for their ability to produce clean, detailed prints on smooth, non-porous surfaces. While Colormist powders demonstrated effective ridge visibility, particularly with the red and turquoise dyes, they showed some minor smudging during fingerprint deposition, a concern not typically encountered with magnetic powders. Despite this, Colormist powders proved effective on smooth surfaces such as mirrors and steel, though their performance on textured surfaces, such as CDs, was less consistent.

In conclusion, while Colormist Super Whip edible food powders may not fully replace traditional forensic powders, they offer a viable alternative, particularly in environments where food-safe materials are required, or when a cost-effective solution is necessary. Their wide range of colors and ease of application make them a promising addition to forensic methods, especially for enhancing latent fingerprints on smooth, non-porous surfaces. However, further refinement and testing are needed to address the smudging issue and to evaluate their performance across a broader range of surfaces.

Conclusion

This study evaluated the use of food colorings to develop latent fingerprints on nonporous surfaces like CDs, glass bottles, mirrors, and steel bottles. Red and black dyes proved to be the most effective, providing clear ridge details. Other colors, like turquoise and pink, showed varied results depending on the surface. The findings suggest that food dyes, especially red and black, can be reliable alternatives to traditional fingerprint powders in forensic applications. The study also highlighted that the surface type plays a significant role in dye performance, which is crucial for forensic professionals when choosing materials for fingerprint enhancement. The use of non-toxic, readily available powders highlights a novel approach in forensic science, offering practical applications in scenarios requiring environmentally friendly and safe fingerprint visualization techniques. They turn out to be an excellent promising candidate for further study in developing latent fingerprints from various surfaces. However, this method is effective in latent fingerprint development, successfully achieving high-resolution level 1 and 2 details. Nevertheless, it has notable limitations. The process is inherently messy, as it tends to leave stains on surfaces, making it difficult to control. These stains often spread beyond the targeted area, contaminating surrounding regions and creating an overall untidy environment. This issue not only complicates the cleanup but also risks compromising the integrity of the investigation by introducing unwanted traces. This method can be applied to study a wider range of substrates, including textured and more complex materials like paper. Additionally, it can be used to investigate the impact of environmental variables on its effectiveness. Future research could also focus on aging studies to examine how the method performs over time and under different conditions, providing a deeper understanding of its long-term applicability and reliability.

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