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Comparative Study Of Natural Substances For Cost-Effective Latent Fingerprint Development

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ABSTRACT

Latent fingerprint development is a critical tool in forensic identification due to the uniqueness and permanence of fingerprints. However, traditional methods using commercial powders like black, aluminum, and magnetic powders, while effective, have several drawbacks. These powders are often toxic, expensive, and not easily accessible in rural or under-resourced areas, hindering timely forensic investigations. This study explores the use of 12 natural powders, including turmeric, rice flour, banana peel powder, and gram flour, as alternatives for developing latent fingerprints. The powders were chosen for their fine texture, color contrast, environmental safety, and availability. Results show that natural powders like turmeric, gram flour, and rice flour effectively reveal clear fingerprint ridge patterns on both porous and nonporous surfaces, such as glass and steel. These findings suggest that natural powders can serve as eco-friendly, cost-effective substitutes for commercial fingerprint powders, particularly in areas with limited access to forensic supplies. This research supports the use of natural reagents in forensic science, especially in fieldwork and resource-limited regions.

1. Introduction

Fingerprint analysis continues to be a cornerstone in the field of forensic science, particularly in the realm of personal identification, due to its scientific reliability, universality, and permanence **(Saferstein, 2001; Maltoni et al., 2003).** Fingerprints are formed by the intricate patterns of friction ridges on the fingers, which remain unchanged throughout a person's lifetime **(Ashbaugh, 1999; Datta, 2001).** Among the different types of fingerprint impressions, latent fingerprints—those that are not immediately visible—are of special forensic interest. These are typically deposited when the skin comes into contact with a surface, leaving behind traces of biological substances such as sweat, sebum, amino acids, salts, and other organic residues **(Girod, Ramotowski, &Weyermann, 2012; Piérard-Franchimont et al., 2015).** Over time, these residues can persist on surfaces; making latent fingerprints a crucial form of physical evidence in criminal investigations **(Lee &Gaensslen, 2012; Wertheim, 2011).**

The successful visualization of latent fingerprints depends on enhancing the contrast between the ridges and the background surface. Conventional fingerprint development techniques involve the use of commercially prepared powders such as black powder, aluminum powder, and magnetic powder, which are designed to adhere to the moist and oily components of the latent print **(Sodhi&Kaur, 2001; Ramotowski, 2012).** Although these chemical methods are widely used and effective, they come with notable disadvantages—they are often toxic, environmentally harmful, and expensive **(Springer, 2014; Roux, Lennard, & Reedy, 2000).** Additionally, their usage demands a controlled setting and trained personnel, limiting their application in field-based or rural investigations **(Beavan, 2001; Mnookin et al., 2011).**

To overcome these challenges, the focus of forensic research has increasingly shifted toward ecofriendly, nontoxic, and low-cost alternatives that can be easily sourced and safely handled **(Chauhan& Kumar, 2017; Patil, Desai, & Joshi, 2022).** In this context, the present study investigates the potential of naturally derived household and agricultural powders such as turmeric, rice flour, gram flour, banana peel powder, and mango peel powder for the development of latent fingerprints **(Mishra, Singh, &Verma, 2016; Vadivel, 2021; Lohar et al., 2022)**. These powders were selected based on their natural adhesiveness, fine particle size,

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environmental safety, availability, and visual contrast properties when applied to both porous and nonporous surfaces, offering promising utility in modern forensic practice **(Verma&Chaturvedi, 2020; Niranjan, 2022).**

2. Aim and Objectives

Aim:

To systematically evaluate and compare the effectiveness of natural household powders for developing latent fingerprints on porous and nonporous substrates.

Objectives:

1. To identify natural household materials with potential for fingerprint visualization.
2. To standardize a methodology for applying these reagents across various surfaces.
3. To assess and compare the clarity, ridge detail, and contrast of developed prints.

3. Materials and Methodology

3.1 Materials Used

A total of 12 natural powders were selected based on physical texture, cost, and prior anecdotal evidence:

- Turmeric Powder
- Rice Flour
- Gram Flour (Besan)
- Cornstarch
- Wheat Flour
- Amla Powder
- Banana Peel Powder
- Mango Peel Powder
- Sandalwood Powder
- Reetha Powder

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- Shikakai Powder
- Chickpea Powder

3.2 Sample Collection

Latent fingerprints were collected from volunteers (ages 17–20) under controlled temperatures (5°C–15°C) on a variety of surfaces including:

- Glass
- White tiles
- Steel
- Wood
- Concrete

After fingerprint deposition, surfaces were preserved for 4–6 hours at room temperature to stabilize the secretions before powder application.

3.3 Method of Application

Natural powders were lightly brushed onto the surfaces using a soft camelhair brush. The powder adhered to oily and moist residues left by fingerprints. Excess powder was removed by gentle tapping, brushing, or blowing to avoid smudging. The developed prints were photographed and rated.

3.4 Evaluation Criteria

Prints were graded using a standardized scale:

- ++ (Clearly visible): High contrast, detailed ridge clarity.
- +(Partially visible): Ridge pattern present, but blurred.
- –(Not visible): Ridge details indistinct or missing.

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4. Results

4.1 Summary Table of Performance

S.No	Powder	Glass	Tiles	Concrete	Steel	Wooden
1.	Turmeric	++	++	-	++	-
2.	Wheat Flour	++	+	-	++	-
3.	Gram Flour	++	++	-	++	-
4.	Rice Four	++	++	-	++	-
5.	Corn Starch	++	++	-	++	+
6.	Amla Peel Powder	++	++	-	++	-
7.	Banana Peel Powder	++	++	-	+	-
8.	Sandalwood Powder	++	++	-	++	-
9.	Mango Peel Powder	+	++	-	++	-
10.	Shikakai	++	++	-	++	-
11.	Chick Pea Powder	++	++	-	++	-
12.	Reetha Powder	++	++	-	++	-

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Fig – 1 Reetha Powder in Tile

Fig – 2 Amla Powder in Glass

Fig –3Turmeric Powder in Glass

Fig – 4Wheat Flour in Tile

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Fig – 5Banana Peel Powder In Steel

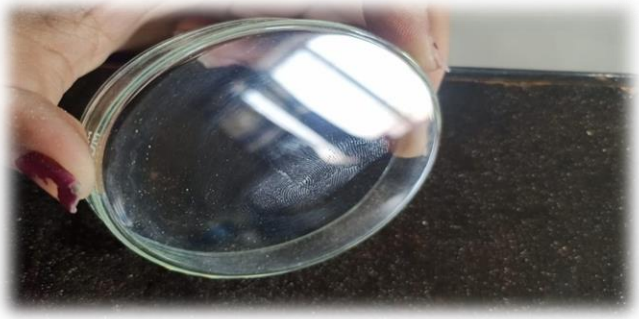

Fig –6Chandan Powder In Glass

4.2 Key Observations

The comparative evaluation revealed distinct differences in the performance of the tested natural powders.

- **Best Performing Powders:**

  Turmeric, rice flour, gram flour, and cornstarch were the most effective in developing latent fingerprints, especially on **smooth, nonporous surfaces** like glass, steel, and tiles. Turmeric provided high contrast due to its vivid color, while rice and gram flour adhered well to fingerprint residue, producing clear ridge details. Cornstarch also performed well and was the only powder to show **partial effectiveness on semi porous surfaces** such as painted wood, demonstrating its broader surface compatibility.

- **Least Effective Powders:**

Mango peel powder and **reetha powder** were the least effective. Mango peel lacked sufficient adhesion, possibly due to its coarser texture, while reetha's natural saponins likely removed rather than highlighted fingerprint residues, reducing development clarity.

- **Porous Surface Performance:**

  All powders tested failed to develop identifiable prints on **porous surfaces** like concrete. The high absorbency and rough texture of such surfaces likely caused the fingerprint residue to be absorbed, leaving insufficient contrast for visualization.

These observations suggest that natural powders are suitable alternatives for nonporous surfaces but require modification or supplemental techniques for effective use on porous materials.

5. Discussion

Natural powders demonstrated impressive performance on nonporous substrates such as glass, tile, and metal. The fine granularity of turmeric and rice flour allowed for excellent ridge adhesion and contrast. The yellow hue of turmeric also enhanced visibility on dark backgrounds.

Cornstarch was the only powder to demonstrate partial effectiveness on wooden surfaces, likely due to its absorbent nature and light color. Reetha Powder, known for its cleansing properties, often removed the fingerprint residue rather than developing it, rendering it ineffective.

Environmental and Practical Benefits:

- Natural powders are nontoxic, safe for human contact, and do not release harmful fumes.
- They are significantly cheaper than commercial reagents.
- Easily available even in rural areas or underresourced forensic laboratories.

Limitations:

- Not effective on porous or highly textured surfaces.
- Some powders (e.g., cornstarch) are sensitive to humidity and may clump.

- Lack of standardized application protocols may affect consistency.

6. Comparative Analysis with Conventional Methods

Natural powders like turmeric and gram flour can develop latent fingerprints with clarity similar to black or aluminum powders on nonporous surfaces (e.g., glass, plastic) due to good adhesion to oily residues. They are eco-friendly, safe, and cost-effective.

However, commercial powders outperform on porous and semi-porous surfaces because they contain chemical binders and have better surface penetration. These powders also offer greater contrast, consistency, and reliability across various backgrounds, making them more effective for complex surfaces and forensic casework.

In summary, natural powders are useful alternatives for smooth surfaces, while conventional powders remain superior for varied and porous materials.

7. Conclusion

This study affirms the forensic potential of using naturally available household powders as viable substitutes for conventional fingerprint development powders. Traditional powders, though effective, often come with drawbacks such as toxicity, high cost, and limited availability in field conditions. In contrast, natural reagents such as turmeric, gram flour, rice flour, and cornstarch demonstrated excellent performance, particularly on smooth, nonporous surfaces like glass, plastic, and metal. These powders adhered effectively to latent fingerprint residues, producing ridge details with good clarity and contrast, which are critical for identification purposes.

Moreover, these natural alternatives are biodegradable, non-toxic, and do not pose health hazards to forensic personnel, making them environmentally sustainable choices. Their widespread availability in households and local markets further enhances their appeal, as they eliminate the need for expensive, laboratory-grade chemicals or specialized storage. The cost-effectiveness and ease of application of these powders make them highly suitable for use in low-resource settings, such as rural crime scenes or developing countries, where

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forensic infrastructure may be limited. Additionally, their safe nature enables their use in educational settings and by first responders during preliminary investigations.

These findings contribute significantly to the evolving field of green forensics and support the development of accessible, sustainable forensic practices that uphold both scientific reliability and environmental responsibility.

8. Future Scope and Recommendations

- **Surface pretreatment:** Investigate organic solvents or surface preparations to improve development on porous substrates.
- **Powder modification:** Combine powders with natural binders to enhance adhesion and contrast.
- **Humidity resistance:** Test powders in varying environmental conditions to ensure field reliability.
- **Field Kits:** Develop readytouse, standardized forensic kits using the most effective natural powders.

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