ICFBE 2024

The 8th International Conference on Family Business and Entrepreneurship

DEVELOPMENT OF LATENT FINGERPRINT USING SAND

HERNAN B. BUNDA

West Visayas State University – Lambunao Campus, hernanb.bunda@wvsu.edu.ph

Abstract

This research project comprises of two studies. Study 1 aimed to create a fingerprint powder derived from sand and evaluate its acceptability based on fineness, adhesiveness, color, flow, and sensitivity, using a descriptive research design and survey method for assessment. Study 2 aims to examine the visibility of latent fingerprints developed with sand powder, utilizing an experimental research design and a Randomized Complete Block Design (RCBD) methodology. A purposive sampling was used to select 25 faculty members from various universities and colleges in Region 6, as well as 5 fingerprint experts from the PNP Crime Laboratory, to serve as expert evaluators. The mean and standard deviation were used as descriptive statistics, and the ANOVA was the inferential statistics. SEM-EDS mapping result revealed sand powder comprises of selenium (0.84%), carbon (13.01%), calcium (36.85%), oxygen (49.78%), aluminum (0.95%), magnesium (0.56%), silicon (3.63%), and sodium (0.13%). Sand's acceptability as a fingerprint powder, based on fineness, adhesiveness, color, flow, and sensitivity, was rated as very acceptable. The visibility of latent fingerprints developed using sand was also found to be very visible. No significant differences were noted between sand powder and commercial fingerprint powders when applied to non-porous surfaces such as glass, plastic bottles, ceramics, painted wood and doorknob.

Keywords: Sand, Fingerprint Powder, Latent Fingerprint, Development

1. Introduction

The search for innovative techniques to enhance latent fingerprint development remains to be a continuous challenge. This research explores the untapped potential of using sand, a material commonly found in riverbeds, as fingerprint powder. The unique component of sand ignite our interest to investigate its capability in developing latent fingerprints on non-porous surfaces.

Fingerprint powder is a fine substance primarily utilized as one of the method of developing latent fingerprint during crime scene investigation. These powders are typically composed of various ingredients depending on the formula. Most black fingerprint powders contain rosin, black ferric oxide, and lampblack. Further, they often include inorganic chemicals like lead, mercury, cadmium, copper, silicon, titanium, and bismuth (Scientific American, 2002). Miller (2019) further notes that these powders are available in various colors and material configurations, specifically tailored for different investigative needs. Dark powders are typically used for developing latent prints on light surfaces, while light powders are used on dark surfaces. The quality or visibility of developed latent fingerprints is influenced by the type of powder and the surface on which the latent print is located. According to Mopoung and Thongcharoen (2008), an effective fingerprint powder adheres well to sweat residue, does not collect in skin furrows, and remains intact when brushed. Kumar et al. (2017) added that the powder's adherence to the print depends largely on particle

size, with finer powders offering the potential to reveal more intricate fingerprint details compared to coarser powders. Forensic Tools (2020) further reveal several factors that affect the effectiveness of fingerprint powders, including fineness, sensitivity, color, flow, and adhesion to moisture. Thus, this attributes are also present to sand.

Sand is a loose granular material commonly found in beaches, riverbeds, and deserts. Its most prevalent component is silicon dioxide in the form of quartz (Castro, 2013). According to Writer (2020), sand has a high water-absorbing capacity due to the pores within its particles. This characteristic is determined by the texture of the grains, allowing sand to absorb moisture similarly to some commercial fingerprint powders, such as magnetic powders.

This study is grounded in Yamashita's (2011) Fingerprint Dusting Theory, which suggests that dusting fingerprints is a relatively simple process that relies on the powder's adherence to latent print residue to achieve good visibility and definition. Fingerprint powder is attracted to moisture, adhering preferentially to the residue left by friction ridge skin. This adherence is primarily driven by the mechanical attraction of the powder particles to the moisture and oily components of the print, with absorption playing a secondary role. Dubinin's (1994) Theory of Adsorption further supports this concept by explaining that adhesion occurs through molecular contact between two materials and the surface forces that develop. These forces, known as van der Waals forces, create a bond between the powder particles and the substrate.

The significance of fingerprint powder is felt not only in the field of law enforcement but also in academe. As Villarba (2008) highlights, fingerprints are one of the most convincing forms of evidence in establishing an individual's presence at a crime scene. In academic institutions offering a Bachelor of Science in Criminology, fingerprint powder is equally important, as it provides students with practical, hands-on experience in developing latent fingerprints. This training is designed not only develop their competence but also prepare them in a real-world crime scene investigations. However, the scarsity and the limited availability of this fingerprint powder in the local market would hamper this academic endeavor. Thus, this study proposes a novel technique for developing latent fingerprints using sand, presenting a cost-effective, easy-to-prepare, and practical solution that benefits both academic institutions and law enforcement agencies.

Objectives:

This study aims to develop a latent fingerprint using sand with the following specific objective:

1. To create a fingerprint powder made up of sand.
2. To determine the level of acceptability of a fingerprint powder made up of sand in terms of fineness, sensitivity, color, flow and adhesiveness.
3. To determine the level of visibility of a developed latent fingerprint when applied to ceramic cups, glass, painted wood, and doorknobs, using sand as fingerprint powder
4. To determine the significant difference in the level of visibility of a developed latent fingerprint when applied to ceramic cup, glass, painted wood, and doorknobs using sand as fingerprint powder.

2. Literature Review

The simplest and most commonly used procedure for latent fingerprint development is powder dusting. Powder dusting is a "physical" method of enhancement that relies on the mechanical adherence of fingerprint powder particles to the moisture and oily components of skin ridge deposits. Application of powder to latent prints by brushing is a simple technique and yields instantly apparent prints, but it also has disadvantages. Contact of the brush with the fingerprint ridges has an inevitably destructive effect (Krumar, et. Al., 2017). Yamashita's Fingerprint dusting theory (2011) added that dusting fingerprints is relatively simple and relies on the adherence of powder to the latent print residue to provide good visibility and definition of fingerprint detail. Fingerprint powder has an affinity for moisture and preferentially clings to the residue deposited by friction ridge skin. It is well accepted that the mechanical attraction between

these particles and the moisture and oily components in a print causes adhesion, with absorption being a factor.

According to ANG XIN YI (2018), Conventional carbon black powder is a fingerprint powder that comprised of resinous polymers and colorant. With the help of resinous polymer, adhesion happened between the powder particles and the oily and moisture on the fingerprint residues. With the help of colorant, it provides contrast with the background and shows out the clear ridges pattern. On untreated plywood porous surface and glossy paper, both of the surfaces only developed the outline of the fingerprint impression. Forensic tool (2021) added that there are several factors influencing the effectiveness of fingerprint powders such as Fineness, Adhesion, Sensitivity, Color, and Flow. Fineness, the powder must be fine enough to show the detail of the fingerprint. Finer powders would be theoretically capable of displaying greater detail than coarser powders. Adhesion, the powder must display the right level of adhesion, so that it will adhere to the residue of the fingerprint (often oils) and not adhere to the rest of the surface where it would obscure the view of the print. When a powder coats a surface, this is known as 'painting'. Sensitivity, s related to adhesion, and is how well the powder adheres to a surface. For example, aluminum flake is more sensitive than aluminum powder, but greater sensitivity is not always desirable. Color, the fingerprint powder must be a suitable color for the surface in question. Flow, to a lesser extent, it is important that the powder can flow, and does not 'cake' into a solid block, which would render it useless.

In the study of Camble and Bansod (2018), soil was used as a new powder method for development of latent fingerprint. The results of the study shown in a Photomicrograph reveals that soil powders gave a better result on contrast surfaces. The development of the latent fingerprint presents on surfaces such as plastic surface, aluminum surface, motor bike painted area, car bonnet, CPU, glass, table (sunmica-glossy), CD front and back and as well as transparency, could be successfully done and gives clear ridges. However, this technique is unable to develop a latent fingerprint on cotton and skin surfaces. In comparative evaluation of contrast surfaces, this method gives a good result. The reason for the adherence of soil powder to the invisible fingerprint can be assigned by the formation of non-covalent bonds between the soil powder and latent fingerprint residual components. These results advice that various soil powders can be successfully employed as a new powder method on the bulk surfaces except cotton and skin surfaces to development of latent fingerprints. This technique is cheap everyone can afford it and used it for the development of the latent fingerprint.

In the study of Garg, Kumari, & Kaur (2011), turmeric powder was used as a new technique for visualization of latent fingerprints on various surfaces. The comparative evaluation of different surfaces with this powder reveals that it gave a better result on contrast surfaces than the others examined. The development of latent fingerprint present on surfaces like, simple paper, bond paper, thermal paper, aluminum foil, transparency sheet, wood (sun mica-glossy), plastic sheet, painted steel, top and writing surface of the CD could be successfully done and gives clear ridges as is evident from the figures. The reason for the adherence of turmeric powder to the latent fingermarks can be assigned by the formation of hydrogen bonds between the fatty acids/glycerides of sebum and the carbonyl and hydroxyl group of the curcumin component of the turmeric powder. The latent prints can be developed with turmeric powder on the top as well as writing surface of compact disc and can be used for the personal identification in theft cases. It was further interesting to note that the latent prints after development with turmeric powder on writing surface of the compact disc did not destroy the data contained therein and can be further used. It is suggested that the turmeric power can be used to visualize the fingerprints particularly on the surfaces having contrast. However, prints present on skin could not be developed clearly in comparison to others may be due to lack of contrast. These results suggest that turmeric powder can be successfully employed as a powder on majority of the surfaces except skin.

Sand is a loose granular material blanketing the beaches, riverbeds and deserts of the world. Composed of different materials that vary depending on location, sand comes in an array of colors including white, black, green and even pink. The most common component of sand is silicon dioxide in the form of quartz. The Earth's landmasses are made up of rocks and minerals, including quartz, feldspar and mica. Weathering

processes such as wind, rain and freezing/thawing cycles break down these rocks and minerals into smaller grains. Unlike some other minerals, quartz is hard, insoluble in water and doesn't decompose easily from the weathering processes. Streams, rivers and wind transport quartz particles to the seashore, where the quartz accumulates as light-colored beach sand (Castro, 2013).

3. Research Method

Study1.

A descriptive research design utilizing a survey method was employed to determine the acceptability of sand as fingerprint powder in terms of fineness, adhesion, color, flow, and sensitivity. The respondents of the study were the 20 faculty members from various universities and colleges in Region 6, as well as 5 fingerprint experts from the PNP Crime Laboratory. They were selected as experts to evaluate the acceptability of sand according to the established criteria using purposive sampling.

To determine the acceptability of sand as fingerprint powder in terms of fineness, adhesion, color, flow, and sensitivity, the researcher utilized a rubric and 4-point Likert scale that underwent face and content validity. The study is divided into two part. Part one, is the preparation of needed materials and the collection of sand. Part two, is the process of making of sand as fingerprint powder and the evaluation of the experts as respondents. To make sand as fingerprint powder, the researcher personally process the said sand using the following materials and procedure.

Materials:

1. River Sand,
2. Medium size magnet,
3. mortar and pestle,
4. filter screen (sieve 125), and
5. plastic container.

Procedure:

The following are the steps in making sand as fingerprint powder:

a. Using a magnet, collect a sufficient amount of river sand;
b. Place the collected sand in the mortar and pulverize it with a pestle until the sand is finer; and
c. Place the sand powder in a sieve no. 125 ***μm*** to separate a very fine powder from coarser one.

To analyse the chemical components of sand, SEM-EDS mapping analysis was conducted. The descriptive statistics use to interpret the level of acceptability were mean and standard deviation.

4.Results and Discussion

Descriptive Data Analysis

Energy Dispersive Spectroscopy- Scanning Electron Microscopy analysis

SEM-EDS Mapping results of sand revealed a composition of sand comprises of Selenium (0.84%), Carbon (13.01 %), Calcium (36.85), Oxygen (49.78 %), Aluminum (0.95 %), Magnesium (0.56%), Silicon (3.63 %), and Sodium (0.13%).

Level of Acceptability of Sand as Fingerprint Powder

Table 2 revealed the level of acceptability of sand as fingerprint powder. Generally, the results were very acceptable in terms of fineness (M = 3.72, SD = 0.46), adhesion (M = 3.88, SD = 0.33), color (M = 3.96, SD = 0.20), and flow (M = 4.00, SD = 0.00), except for sensitivity which was acceptable (M=3.40, SD=0.57).

In terms of fineness, the results suggest that the sand powder is extremely fine, with all particles passing through a No. 125 sieve, making it theoretically capable of revealing greater detail in the friction ridges.

In terms of adhesion, the results indicate that sand powder exhibits strong adhesion to the residue left on the surface. This means it adheres mechanically to the oil and moisture components of the latent print when brushed onto the surface.

In terms of color, sand powder has a high contrast and stands out clearly on the surface it is applied to. Its lighter color makes it particularly effective for use on dark surfaces.

Sand powder has excellent flow properties and does not cake into a solid block. This suggests that the well-defined ridges of a developed latent print would make it easier to identify its individual characteristics.

Finally, sand powder is sensitive and can absorb moisture on non-porous surfaces left by fingers.

Table 2. Level of Acceptability of Sand as Finger Print Powder

Category	Mean	Description	Standard Deviation
Fineness	3.72	Very Acceptable	0.46
Adhesion	3.88	Very Acceptable	0.33
Color	3.96	Very Acceptable	0.20
Flow	4.00	Very Acceptable	0.00
Sensitivity	3.40	Very Acceptable	0.76

Note: To determine the level of acceptability of sand as finger print power, the researcher used this scale and its description: 3.25-4.00 - Very High; 2.50-3.24 - High; 1.75-2.49 - Low; 1.00-1.74 - Very Low.

Study 2.

An experimental research design utilizing the Randomized Complete Block Design (RCBD) method was applied in this study. The respondent of the study were 20 faculty members from the College of Criminal Justice Education teaching Personal Identification in various universities and colleges in Region 6, and 5 fingerprint experts from the PNP Crime Laboratory. They were chosen to comprise as expert evaluator using purposive sampling.

To determine the level of visibility, the developed latent fingerprint using commercial black powder and sand powder were subjected to sensory evaluation by 25 different fingerprint experts coming from PNP crime Laboratory and the Academe. Every powder was tested into five different surfaces

In the experimental setup, five non-porous surfaces—glass, ceramic, painted wood, door knob, and plastic bottle—were treated with two types of fingerprint powder: black powder and sand powder. Each surface underwent three replications (R1, R2, R3) for each powder type to ensure reliability. The visibility of developed latent prints was assessed using a scoring scale ranging from 1 to 4: 4 (Very visible), 3 (Visible), 2 (Slightly visible), and 1 (Not visible). This scoring system was adapted from the study of Sobriaga (2020).

The steps for developing latent fingerprints on non-porous surfaces are as follows:

1. Collect a latent fingerprint specimen from a single donor using their thumb;
2. Have the donor imprint their thumb on the non-porous surface in three replications, with a 2 minutes interval between each;
3. Develop the latent fingerprints on the non-porous surfaces using black powder and chameleon powder, following standard powdering techniques; and
4. Allow experts to rate the visibility of the results according to the scoring system adapted from Sobriaga's study.

To determine the level of visibility of developed latent fingerprint using commercial Black powder and chameleon powder when used to developed latent fingerprint on non-porous surfaces, the mean and standard deviation were used.

The data was process using Statistical Package for Social Sciences (SPSS) software.

The results of developed latent fingerprint were evaluated using 4-point scoring system which are as follows;

Scale	Description	Interpretation
3.50-4.00	Very Visible	The fingerprint has clearly defined friction ridges across its entire print
2.50-3.49	Visible	The fingerprint has clearly defined friction ridges across its majority print
1.50-2.49	Lightly Visible	Majority of friction ridges of the fingerprint are not clearly defined. Print is almost completely smudged.
1.0-1.49	Blur/No Print	No ridge details were observed.

The scaling is based on Nearest- Integer Response from Normally-distributed Opinion Model for Likert Scale by Pornel, J., Balinas, V. and Saldaña, G. published by the Philippine Statistician, Volume 60, 2011. To determine whether or not a significant difference existed between black powder and chameleon powder when used to develop latent fingerprint in non-porous surfaces, Mann Whitney U test was used. Level of significant was set at .05 alpha.

Descriptive Data Analysis

Level of Visibility of Commercial Grey Powder When Developed into Porous Surfaces.

Table 3 revealed the level of visibility of commercial grey powder when developed into non-porous surfaces. When a commercial grey powder was used to develop latent fingerprints in glass (M=3.91, SD=0.23), plastic bottle (M=3.92, SD=0.24), ceramics (M=3.97, SD=0.40), plastic wood (M=3.76, SD=0.47), and door knob (M=3.72, SD=0.41), the results were generally very visible. This implies that the developed latent fingerprint had clearly defined friction ridges across its entire print.

Table 3 Level of Visibility of Commercial Finger Print Powder When Developed into Porous Surface

Category	Mean	Description	Standard Deviation
Glass	3.91	Very High	0.23
Plastic Bottle	3.92	Very High	0.24
Ceramic	3.79	Very High	0.40
Painted Wood	3.76	Very High	0.47
Door Knob	3.72	Very High	0.41

Note: *To determine the level of visibility of commercial finger print power, the researcher used this scale and its description: 3.25-4.00 - Very High; 2.50-3.24 - High; 1.75-2.49 - Low; 1.00-1.74 - Very Low.*

Level of Visibility of Sand as Fingerprint Powder when Developed into Non-Porous Surfaces. When a commercial grey powder was used to develop latent fingerprints into glass (M=3.88, SD=0.25), plastic bottle (M=3.85, SD=0.31), ceramics (M=3.77, SD=0.37), plastic wood (M=3.84, SD=0.31) and door knob (M=3.84, SD=0.31), the results were very visible. This implies that the developed latent fingerprint had clearly defines the friction ridges across the entire print.

Table 4. Level of Visibility of Sand as Fingerprint Powder When Developed into Non-Porous Surfaces

Category	Mean	Description	Standard Deviation
Glass	3.88	Very High	0.25
Plastic Bottle	3.85	Very High	0.31
Ceramic	3.77	Very High	0.37
Painted Wood	3.84	Very High	0.31

Door Knob	3.87	Very High	0.27

Note: *To determine the level of visibility of commercial finger print power, the researcher used this scale and its description: 3.25-4.00 - Very High; 2.50-3.24 - High; 1.75-2.49 -Low; 1.00-1.74 - Very Low.*

Inferential Data Analysis

This study probed whether or not significant difference existed in the level of visibility of developed latent fingerprint when applied to glass, plastic bottle, ceramic, painted wood, and doorknobs using Mann-Whitney H with level of significance set at 0.05 alpha. Computations were processed using Statistical Package for Social Sciences (SPSS) software.

Differences in the Level of Visibility of Developed Latent Fingerprint When Applied to Glass, Plastic Bottle, Ceramic, Painted Wood, and Doorknobs. The result revealed that no significant difference existed in the level of visibility of developed latent fingerprint when applied to glass, plastic bottle, ceramic, painted wood, and doorknobs with a p-value of 0.88, 0.43, 0.69, 0.78 and 0.23 respectively which was greater than the set 0.05 alpha level of significance.

Differences in the Level of Visibility of Developed Latent Fingerprint When Applied to Glass, Plastic Bottle, Ceramic, Painted Wood, and Doorknobs

Category	Mean Rank	Mann-Whitney U	p-Value	Statistical Decision
Glass				
Grey	25.72			
		307.00	0.88	Not Significant
Sand	25.28			
Plastic Bottle				
Grey	26.54			
		286.50	0.43	Not Significant
Sand	24.46			
Ceramic				
Grey	26.14			
		296.50	0.69	Not Significant
Sand	24.86			
Painted wood				
Grey	25.06			
		301.50	0.78	Not Significant
Sand	25.94			
Door Knob				
Grey	23.50			
		262.50	0.23	Not Significant
Sand	27.50			

5. Conclusion and Implications

1. The sand powder sample is predominantly comprised of calcium and oxygen, with least components of sodium. The dominant composition of oxygen would theoretically influence the adhesiveness of sand from oil and moisture left by fingers on various substrates. The SEM-EDS mapping results provides insights that could led into certain implications. The high calcium and oxygen content suggests the material is rich in calcium oxide or carbonate, which makes the sand potentially effective in developing latent fingerprint. The silicate components, such as silicon and aluminum, are also found in some

commercial fingerprint powders used today. Further, the relatively high carbon content may also influence the effectiveness of sand in developing latent fingerprint or enhancing its visibility when applied to various surfaces.

2. The results indicate that sand powder possess a very acceptable characteristics in terms of fineness, adhesiveness, color contrast, flow properties, and sensitivity. This suggest that sand could be a viable alternative to traditional commercial fingerprint powders.

   The very acceptable characteristics sand as fingerprint powder such as fineness, adhesiveness, color contrast, flow properties, and sensitivity suggests several potential implications. First, sand could be used in the field of forensic science as a cost-effective and readily available alternative to traditional commercial fingerprint powders. This is especially important in regions with limited access to expensive forensic materials, as sand can provide a locally sourced option without compromising on performance.
3. The study's findings demonstrate that the visibility of latent fingerprints developed on non-porous surfaces using both commercial grey powder and sand was equally high. This indicates that sand, as a fingerprint powder, can achieve the same quality of latent fingerprint development as traditional commercial powders. Therefore, sand powder can be considered an effective and viable alternative for development on non-porous surfaces, providing similar performance in terms of clarity and detail.This inference carries significant implications in the field of forensic science. This suggest that sand can be a novel innovation, a cost-effective and viable alternative to some traditional fingerprint powders, particularly in dark surfaces. This could be contributory to law enforcement agency and academic institution by reducing reliance on imported or expensive materials.

References

Camble, D. B. and Bansod, N. (2018). A new powder method for development of latent fingerprint**"**. Retrieved: May 16, 2021. From: https: https://www.researchgate.net/publication/327281078

Castro, J. (2013). Livescience. https://www.livescience.com/34748-what-is-sand-beach-sand.html

Forensic Toots (2020). The fingerprint Powder. https://www.forensictools.co.za/fingerprint-powders

Garg, R. K., Kumari, H., & Kaur (2011). A new technique for visualization of latent fingerprints on various surfaces using powder from turmeric: A rhizomatous herbaceous plant (*Curcuma longa*). Retrieved: May 16, 2021. From: https: https://www.sciencedirect.com/science/article/pii/S2090536X11000141.

Grant, T. (2019). Randomized Complete Block Design. https://plant-breeding-genomics.extension.org/randomized-complete-block-design/

Kumar, P., Tyagi, S. and Nisha, K. S. (2017). Recent Advancement in Development of Latent Fingerprints by Various Physical Methods: A Review. International Journal for Research in Applied Science & Engineering Technology (IJRASET).

MetalPowder (2012). Fundamental of paint adhesion. Retrieved: May 16, 2021. From: materialstoday.com/metal-finishing/features/fundamentals-of-paint-adhesion/

Miller, A.T. (2019). Dusting for prints: A guide to fingerprint powder. Retrieved from: https://www.safariland.com/fingerprint-powder-guide.html.

Writer, S. (2020). Why does sand absorb water? https://www.reference.com/science/sand-absorb-water-55d557baaa269e29

Scientific American. (2002). How does fingerprint powder work? Retrieved September 30, 2024, from https://www.scientificamerican.com/article/how-does-fingerprint-powd/.