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Techniques for Latent Fingerprint Development Using Natural and Synthetic Powders: A Review

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Abstract

Background: Fingerprints are the most important for personal identity. Latent fingerprints are those which is invisible through our naked eyes due to which it gained all the researchers attention. Fingerprint remains same right from birth till death. It starts developing in the fourth month of gestation and can be recovered, after death from a dead body.

Main Body: In this topic we will explore invention and innovation in fingerprint development, being the most reliable for personal identification, helps in further forensic investigation. No two person has same fingerprint even identical twin sharing same DNA has different fingerprint. This area in forensic science is highly developed and many more such developments can be done. It is developed on various porous, non-porous surfaces through sebaceous secretion of skin, the oily matter gets deposit on the surface. Through the past research and review paper, it can be said that this topic is one of the most explored during forensic science, opened the doors for new researchers to works on it. Latent fingerprint development though powders is one of the physical method and powders used are expensive. These naturally occurring powder like sugar molasses, sugar, salt, turmeric, chilli, onion, etc powders to develop, this is easy and cost- effective way.

Conclusion: The basic method through horse or squirrel brush was used in every method to spread powder evenly on the print without disturbing the print. Many works have been done on fingerprint development powders, but we can do an innovation on the brush, instead of horse or squirrel brush we can use some other animal brush like camel or some other material like fibre.

Keywords: Latent Fingerprint; Powder Dusting Method; Sebaceous Prints; Natural and Synthetic Powders; Visualisation; Forensic Significance

Abbreviation

SPR: Small Particle Reagent

Introduction

Fingerprints are the permanent, individual, identifying friction ridge skin impression, created by skin's epidermal layeron any superficial part through the contact of friction ridge skin. It can be created by transferring prints from fingers to the surface through any transferable material like sweat, blood, cosmetic products, dust, soil, etc. Fingerprints are the most reliable evidence in forensic science. Justice may sometime rely on the prints, and one can easily navigate to the criminal through the prints. There are mainly three types of prints, get printed at the crime scene i.e.latent, patent and

plastic. Patent are prints which are easily visible through our naked eyes. No development is required. Plastic prints are 3D prints having proper dimensions like length breadth and width, created by cement, mud. POP, Dental stone is required to collect and preserve. Latent prints are invisible prints which is not seen through our naked eyes, alternative light source is used to view the prints. To develop different colour adhesive powers are used which adhere to the fingerprint component and fingerprint develops. Instead of traditional method of development, many synthetic and non- synthetic products are used. Cosmetic products like face pack, face powders, eye shadows and bleach activator were tested. These powders consist mainly talc, mica, titanium oxide and zinc oxide which provides good adhesion to the surface. Cosmetics are readily available, cost- effective, generally non- toxic and can be developed on both porous as well as on non- porous surface. Aluminium foil was found out to be the best substrate for fingerprint development through cosmetic reagents. Among all the cosmetics, bleach activator and face pack were the most effective in visualizing latent prints. This method of development is non- hazardous and simple in use [1].

Use of many natural powders like turmeric, coal, pepper, and chilli are used in this, for developing the print on glass surface. These powders are used due to its low cost, efficiency, no toxic and readily available. For glass as a surface, petri dishes or conical flasks are used. Coal powders produced the best and clear patterns, due to which made it more reliable. Turmeric, chilli powder, and pepper too produced the patterns but are less clear and visible as compared it to coal [2-4]. All four powders were functional, but coal is proven to be the best of rest three [2-4]. In this, only turmeric powder as an eco- friendly are specifically used. A comparative study has been done between the small particle reagent (SPR) techniquesspraying ninhydrin and sprinkling turmeric powder. Ninhydrin produced strong Ruhemanns purple, while turmeric produced yellow colour. Fingerprints were developed using there two techniques for comparison, turmeric powder made the pattern visible, proper ridge counting was done, whereas ninhydrin solution was sprayed on A4 white paper to visualize the print in purple colour.

Observation Table

Pattern	Fingerprint distribution (%)
Radial loop	16.60%
Ulnar loop	63.30%
Tented arch	1.60%
Twinned loop	1.60%
Plain whorl	16.60%

Table 1: Percentage Distribution of Observed Fingerprint Patterns [3].

Being eco- friendly, brush may crush the ridges, yellow contrast disrupts the pattern sometimes and are less sharp in normal light, flash is required to view properly. As compared to ninhydrin, ninhydrin was proved to be more efficient. Both turmeric and ninhydrin has their own benefits and can be used according to the preference and requirements [3,4]. Onion powder contains quercetin and sulphur compound, known for their antioxidants and adhesive properties. Therefore, in this paper onion powders are used to develop the latent prints on surface. Onion powders were obtained through drying the onion completely and then crushing in, using mortar and pestle. These powders are then spread over the print using ostrich brush. Material used over which prints were made are iron, aluminium foil,glass, ceramic tile, rubber, black paper,steel, leather, plastic and cardboard. Onion powder visualised the print and made the friction ridge appear clear. Both sebaceous and eccrine prints were developed efficiently through this method. Further research is required to test contrast levels under different lighting conditions and to compare ridge clarity against standard forensic powders [5]. Ashwagandha also known as Indian Ginsberg, is an eco-friendly powder which may be used instead of traditional powders. Use of ashwagandha reduces health risks. Readily available, cost- effective. It is found abundantly in powdered form in India. The adoption of ashwagandha powder in fingerprint visualisation represents a significant step towards herbal forensics. It produced primary test, for ridge counting and tracing [6]. Food dyes are easily available, toxin- free, environment friendly. Conventional method often used metallic powders like titanium oxide which is hazard for regular use. Therefore, this all method came into picture. As dyes used in food products are usually edible causing no side- effects. It will not react with the prints form rather will enhance the print through colour. Different colours likeorange, blue, turquoise, red, and pink were applied. All dyes produced well defined prints. Red and black dyes produced most consistent and clear impressions across all substrates. Turquoise shoed good impression on glass [7]. Salt and sugar are readily available, safe to use, affordable, household material, and available in different colours. Powdered salt and sugar can also be used in replacement of conventional powders. It showed result on diverse substrate. It is non- destructive to fingerprint pattern. Both sugar and salt adhere excellently to the surfaces like glass, plywood, CPU, painted surfaces, flooring material [8-11].

Various more powders like arrow root powders- a white coloured powder, raspberry powders- a food product specially for flavouring agent and titanium oxide powder. Variousabsorption or resistancesubstrates were used to develop prints [12-15]. Titanium oxide, Maranta arundinacea, Rubus idaeus showed better result visualised the print in better way. Advantages of these powders are that they were stable and remained intact even after removing

the excess amount [16-20].

Body

Sample collection: In all the methods, the initial step is to collect samples from different sources for variety. Hands were cleaned using sanitizer or washed many a times using a soap causing no disturbance during fingerprint impressions. This helped the researcher to get clear and well- defined prints. Around 30-40 individuals' samples were taken to get the appropriate sample. The prints must be sebaceous or eccrine.

Requirements

Various natural and synthetic powders- which will help visualise the latent prints, Brush- through which powders will be spread over the print evenly, various porous and non-porous surfaces- on which sample will be examined, mortar and pestle- to cush into a fine powder (if necessary).

Procedure

- Firstly, the fingerprints were collected on various surfaces.
- A small number of powders were used directly; if the state of it is in powder, but if it is in solid it should be crushed into its powdered form.
- After this, the powder is sprinkled over the print, using the brush it is spread over the print evenly.
- Brush is moved over the print in a circular motion quickly, as the brush moves around the print, the enhancement is seen gradually.
- As a result, proper fingerprint patterns were visualised, even ridge counting and tracing can be done in few cases.

Methods and Methodology

The powder dusting method, a physical technique to generate latent fingerprints, was used in this study. This suggests that the chemicals or powders used don't interact with the underlying surface or fingerprint residue. It just sticks to the surface, creating better prints. The technique depends on an adhesion mechanism, whereby physical or electrostatic forces such as Van der Waals forces cause fine particles to attach to the print's fat, moisture, and oily residues. Materials like glass, metal, plastic, and cardboard that are smooth and non-porous enhance adhesion as well as render ridges simpler to perceive. The powder produces a noticeable distinction between the powder and the surface. Contrasting powder must be used to observe the prints under normal lighting conditions. Following development, it is essential to either fix or elevate the print to ensure its preservation. Consequently, the tape lifting method is applied by cutting a small piece of cello tape and adhering it to the improved print without any air bubbles, followed by gently lifting the tape. The print and the powder adhere to the adhesive side of the tape, which is then preserved by attaching the lifted print to another piece of paper with a contrasting colour for later reference [21-30].

Elements Influencing the Process

- Surface type: performs optimally on smooth, non-porous surfaces.
- Powder characteristics: fine, dry, and colour-differentiated powders produce improved outcomes.
- Composition of residue: fresh prints with elevated moisture and oil levels are prone to developing quickly.
- Environmental factors: humidity and temperature influence the adhesion of the powder.
- Powder adhesion mechanism: The powder particles stick to the oily or adhesive fingerprint residue through physical lodging.

An important factor is the form and dimensions of the particles; smoother and smaller particles adhere more effectively.

Powder easily adheres to adhesive areas on glass or plastic surfaces.

Attraction through Electrostatic Force

- The opposite electrical charges of the powder particles and fingerprint residue pull each other in.
- This is especially important when dealing with powders that have magnetic or metallic characteristics.
- A powder particle or brush that has a slight charge adheres to the ionic or moist components of the print.
- The influence of van der Waals.
- Dispersion forces, also known as weak intermolecular forces, aid in the adhesion of the powder to the remaining residues.
- These forces are minimal yet essential, especially for small particles on smooth surfaces.
- Interactions between Water-repelling and Fat-loving:
- Ingredients that are hydrophobic (repel water) and lipophilic (attract fats) are commonly present in powders.
- These improve bond strength by interacting with the fatty or oily remnants of the fingerprint.
- Oily impressions are firmly attached by talc used in cosmetics or powdered black carbon.

Binding agents might be included in magnetic or fluorescent powders to enhance selectivity.

Elements Affecting Adhesion

Surface Category: rough (like paper, wood) or smooth (such as metal, glass)
Print Age: As prints age, they become less adhesive due to moisture loss.
Environmental Factors: Temperature and moisture influence residue state.
Properties of Powder: Dimensions, composition, and electrical charge of particles
Application Technique: Brush speed and pressure.

Factors	Natural powders (turmeric, chilli powder, sugar, salts)	Synthetic Powders (titatium oxide, nanocarbon black, metallic)
Visualisation	Variable effective on both surfaces [21]; porous and non- porous.	Generally optimised for performance [27] often uniform particles.
Toxicity	Generally considered non-toxic and eco-friendly [21].	Many synthetic powders may contain toxic metals [27] like lead which may be carcinogenic and harmful for humans
Ridge clarity	Ridges can be seen [21], may require experimentation for optimal results.	Ridges can be seen clearly [27].
Cost-effectiveness	Highly cost-effective [21].	Commercial powders can be more expensive [27], compared to natural powders
Adherence	More experimentation is required for adherence [21]. Adheres to the prints slightly.	Adhesive for superior adherence [27].
Availability	Easily available and are found in abundant [21].	Complex ingredients may be difficult to obtain in some region [27].
Environmental impact	Highly sustainable [21], less waste materials and are biodegradable.	Can damage environment due to presence of some chemical components [27].

Table 2: Comparative Overview of Natural and Synthetic Fingerprint Development Powders Across Various Forensic and Environmental Factors.

Conclusions

The purpose of this review study was to get enough knowledge about different powders used or can be use in place of the conventional one which has found to be toxic.

This helps get through various topics and research papers, their innovative and new point of view. Extracted enough information gathered it at a place and used it in this review study. This helps give overview of all the previous studies in the field of forensic fingerprint especially fingerprint development. Many natural powders like neem powder, turmeric, coal, sugar, salt, chilli powder, pepper, were used and synthetic powders like food dye, make up products like eye shadow, blushes, face powder, face cream, bleach, etc. We can limelight the brushes used, can use different types of brushes so that less animals are harmed. Instead of squirrels and horse's hairbrush one can use fibre, cotton or carbon fibres to make brush or regular brooms brush to develop the brush to get the same efficiency. Many paths are still to explore.

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